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Capturing the Promise of Broadband for North Carolina and America

June 2008

e-NC

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Preface & Acknowledgements

Since 2001, the e-NC Authority (originally known as the Rural Internet Access Authority) has been at the forefront of state initiatives to stimulate both broadband availability and adoption in rural and distressed urban areas. Among the many e-NC innovations are its programs to map broadband availability, aggregate demand, educate the public about the benefits of broadband, foster local "e-champions;" provide hands-on training and low-cost access to hardware, software, and technical advice; and develop many creative forms of public-private partnerships. The e-NC Authority has also used targeted subsidies effectively to achieve the goals of these programs.

Now, as several other states are just beginning to catch up to where e-NC was five years ago, e-NC is preparing to forge ahead again. Concerned that the United States and North Carolina are not keeping up with the leading Asian and European nations in developing world-class broadband networks, the e-NC Authority has commissioned the Baller Herbst Law Group to gather and analyze the pertinent facts, discuss the potential consequences for the United States and North Carolina, and offer suggestions to assist e-NC and the State in developing timely and effective responses.

We are grateful to Jane Smith Patterson and her colleagues at the e-NC Authority – especially Angie Bailey, Charlie Pittman, and Joanna Wright – for giving us this opportunity and for working closely with us throughout the project. We had thought highly of e-NC when we began, and our respect has only deepened as the project has proceeded.

We give special thanks to Catharine Rice for her work on the North Carolina issues covered in this paper, to Geoff Daily for his insights into ways to stimulate demand for high-capacity broadband networks, and to both Catharine and Geoff for their tireless assistance in drafting and editing the paper.

We also received invaluable assistance from many others, particularly Andrew Afflerbach and Joanne Hovis of Columbia Telecommunications, Thomas Bleha, Gary Bolles of XiGi Solutions, Scott Bowles of Spectrum Engineering, Dave Burstein of DSL Prime, Allison Cerra of Frontier Corporation, Michael Curri of Strategic Networks Group, Doug Dawson of CCG Consulting, Ken DePietro of NextGen Communications, David Isenberg, Mike Jude of Nemertes Research Group, Darlene Meskell of the U.S. Government Services Administration, Greg Richardson, Jason Shannon, and Bailey White of Civitium, Derek Turner and Adam Lynn of Free Press, and Dirk van der Woude of the City of Amsterdam, NL.

We take sole responsibility for the conclusions we have drawn and for any errors that we may have made.

Jim Baller and Casey Lide

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EXECUTIVE SUMMARY

Over the past few years, technologists, economists, consumer advocates, business leaders, service providers, government officials, and many others around the world have recognized that broadband services and capabilities are becoming as essential as water, roads, and electricity and are changing forever the way people live, work, and interact with each other. As *The Economist* recently noted:

> In eras past, economic success depended on creating networks that could shift people, merchandise and electric power as efficiently and as widely as possible. Today's equivalent is broadband: the high-speed internet service that has become as vital a tool for producers and distributors of goods as it is for people plugging into all the social and cultural opportunities offered by the web. Easy access to cheap, fast internet services has become a facilitator of economic growth and a measure of economic performance.[1]

Broadband is not simply a consumer service or good, like cable television or an XBox. Rather, it is also a distribution system, a personal tool for interacting with the world, and a catalyst and enabler of an endless array of other products, processes, and services. Broadband will increasingly become integrated into virtually everything that we do at work, at home, and at play. From economic development to entertainment, from education to health care, from environmental sustainability to public safety and homeland security, from our smallest hamlets to our largest cities, from our young people to our senior citizens, almost everything and everyone will come to depend directly or indirectly on affordable and ubiquitous access to broadband.

Furthermore, broadband does not merely benefit buyers and sellers of broadband connectivity. It also benefits designers and builders of broadband networks; manufacturers of broadband-enabled equipment and devices; developers of software and other applications; creators of content of all kinds; and countless others who have a huge stake in America's rapid transition to an online digital society. That is why the American Association of Retired Persons, Alcatel-Lucent, EDUCAUSE, the Fiber to the Home Council, Hitachi, Intel, Google, the Telecommunications Industry Association, Tropos, and so many other organizations and individuals opposed the bill introduced in the North Carolina legislature in 2007 that would have impaired municipal broadband initiatives.[2]

In short, "broadband is unique in that the social returns of broadband investment exceed the private returns to companies and consumers."[3] Because broadband "facilitates enormous economic opportunities that rise with the number of users," increasing the number of users is an important public objective.[4] As a result, "the normal rule that 'the development of a technology should be left solely to the marketplace' does not apply in the case of broadband, which promises an array of social and economic benefits, ranging from distance learning to telemedicine to public safety to democracy."[5]

In many respects, the potential of broadband is similar to that of electricity at the turn of the 20th Century:

> When electric power first emerged from the back rooms of inventors such as Charles Brush and Thomas Edison, it hit nineteenth century America with a dazzling impact. What fire had been for early man was a rough draft for the force electricity took on in lighting cities, running hundreds of thousands of industrial motors, engendering extensive networks of trolley car lines, and sparking the birth of mass communications.[6]

Yet, despite the vast benefits that electricity promised, it took more than 50 years for electrification to reach many parts of the United States. It would have taken even longer if thousands of municipalities and cooperatives had not stepped forward to establish their own electric utilities, believing that their economic survival and quality of life were at stake.[7]

Now, the history of electrification is repeating itself in the broadband area.[8] Like the power companies of a century ago, the major communications providers are focusing first on their most lucrative markets and are leaving less profitable communities behind. In the areas that are least attractive to these companies – rural and low-income urban areas – they are either not providing broadband at all or are limiting their offerings to low-capacity technologies such as Digital Subscriber Line (DSL) and Cable Modem Service (CMS).

Unlike a century ago, the United States does not have the luxury of time and isolation from the rest of the world to allow infrastructure of such strategic national significance to evolve at its own pace. The world is now a much more fiercely competitive and globally interconnected place than it used to be.

The United States is facing increasingly intensive competition from China, India, Brazil, Mexico, and other low-cost countries, whose workers are often as well-educated as Americans and are willing to accept much lower wages. As a result, economists uniformly predict that, sooner or later, the United States will lose virtually all of its traditional manufacturing *jobs*. This is not to say that the United States will lose all of its manufacturing *industries*, as some will remain competitive by occupying new technology-driven niches, automating, outsourcing jobs to other countries, or a combination of these measures.

This has already begun to occur in North Carolina, which has lost nearly 100,000 manufacturing jobs in the last few years. For example, in an extensive article on this, the *Washington Post* observed,

> Throughout the state, and indeed the nation, laid-off factory workers are typically able to find new jobs but mostly for lower pay. A June 2002 study published by the North Carolina Justice and Community Development Center found that workers who lost manufacturing jobs in 1999 and 2000 were earning 72 percent of their previous salaries six months later.
>
> Furniture-making is typical of the manufacturing sectors that are shrinking in the United States. For many, labor represents a relatively high proportion of total costs, making them vulnerable to foreign competition. If factories cannot automate, they die.
>
> The textile industry has been particularly aggressive in replacing people with machines. A half-century ago, a typical North Carolina textile worker operated five machines at once, each capable of running a thread through a loom at 100 times a minute. Now machines run six times as fast, and one worker oversees 100 of them.[9]

The *Washington Post* article also cites the example of a North Carolina textile company that has survived by "refocusing on specialty industrial fabrics for outdoor furniture, boats and awnings – expensive goods that require customization, high-end machinery and technical expertise." The company did so, however, by turning its factory floors into "lonely expanses" and sacrificing more than 30 percent of its workforce.[10]

Many of America's service industries are also at risk, particularly to countries with large English-speaking populations, such as India and the Philippines. These countries are already making significant inroads into accounting, customer service and support, computer-assisted design and graphics, legal research, and many other service industries. Many more inroads lie ahead.

As advanced communications networks have made the world smaller and "flatter," to borrow from Thomas Friedman's book, *The World is Flat*, American and foreign employers are increasingly breaking manufacturing and other processes into discrete tasks and assigning the tasks to the companies and workers anywhere in the world who can perform them most cost-effectively, using advanced communications networks to pull everything together in "real time."

If the United States wants to preserve its high standard of living and quality of life, it must rapidly prepare its workforce to move up the value chain to knowledge-based jobs that can command the high wages that Americans have come to expect. This will require improvements in many areas, especially to our educational system and our advanced communications infrastructure.

Once the undisputed world leader, the United States has not kept up with the leading Asian and European nations in developing advanced broadband networks. Too few Americans appreciate the significance of this or the scope or urgency of the challenges that it poses to our way of life. Unfortunately, the current Administration in Washington has simply refused to come to grips with the reality of America's descent into mediocrity on almost every internationally-recognized indicator of success in broadband deployment. As the Benton Foundation has observed, "[t]oday, our future is unfolding at a breathtaking rate. But what is different in this journey than at previous turns is that America is falling behind without a plan for harnessing broadband's extraordinary potential."[11]

We are confident that the United States can regain its position of global leadership in broadband deployment and realize all of the vast benefits that would flow from this. To do so, however, we must act quickly and boldly, before it is too late. This can only happen if our public and private sectors agree to share the considerable burdens involved and to work together in harmony, in a spirit of common purpose, mutual respect, and urgency.

In the remainder of this paper, we ask and answer the critical questions summarized below concerning broadband deployment, global competitiveness, and quality of life in the United States, the leading Asian and European nations, and North Carolina. We then make eight specific recommendations that we believe will boost availability and adoption of high-capacity broadband in North Carolina and the United States.

What is broadband? In Part I.A below, we begin with the basics, explaining what broadband is, defining important terms and concepts, and discussing the Federal Communications Commission (FCC)'s policies and practices. The key points in Part I.A are that "broadband" is a means of transmitting information at high speeds; that information-carrying capacity is typically referred to interchangeably as "data speed" or "bandwidth capacity" and is measured in "bits per second," with one kilobit per second (kbps) defined as 1,000 bits per second, one Megabit per second (Mbps) defined as one million bits per second, and one Gbps defined as one billion bits per second; that the FCC has until recently defined "broadband" as a very low 200 kbps in one direction and used data gathering and reporting techniques that grossly exaggerate broadband deployment in the United States; and that the FCC has pursued broadband policies over the last seven years that have contributed to the precipitous decline in America's international ranking in broadband deployment.

What are the benefits of broadband? In Part I.B, we review the rapidly growing benefits of broadband. We begin with the relationship between broadband and economic development, citing 10 studies, 10 case histories, and other information confirming that broadband, particularly at high data speeds, is a powerful driver of robust economic development. We then examine broadband's contributions to education, public safety, homeland security, health care, telework, environmental sustainability, urban revitalization, government service, and entertainment, including broadband video, social networking, and gaming. Next, we turn to the special needs of senior citizens, disabled individuals, and young people. Young people, of whom there are more than 100 million in the United States alone, are a particularly important group whose special interests, characteristics, and activities are pushing up the pace of broadband adoption and usage. We conclude this section by outlining some important new developments that will also drive up broadband demand in the years ahead, including the emergence of "Web 2.0" and the "Internet of Things" (bandwidth-hungry programs and devices that use broadband to perform a variety of functions, with or without the direct involvement of human beings).

How do the United States and the leading Asian and European nations compare in broadband deployment and adoption? In Part II.A, we review the current state of broadband deployment in the United States and in the leading Asian and European nations. During the last seven years, the United States has dropped steadily in nearly every measure of success in broadband deployment compared to other industrialized nations in the 30-member Organization for Economic Cooperation and Development (OECD). Currently, depending on which study one consults, the United States now ranks between 15th and 25th in broadband deployment (broadband lines divided by some measure of population), 14th in average advertised download speed; 9th in fiber connections as a percent of total subscribers; 22nd in average monthly price for broadband; 11th in price per unit of bandwidth (Megabits per second); 18th in price of the fastest available broadband services; and 17th in growth of broadband penetration. In the Information Technology and Innovation Foundation (ITIF)'s new composite global ranking, which takes into account penetration, speed, and price, the United States ranks 15th.

In short, according to FCC Commissioner Michael Copps,

> America's record in expanding broadband communication is so poor that it should be viewed as an outrage by every consumer and businessperson in the country. Too few of us have broadband connections, and those who do pay too much for service that is too slow. It's hurting our economy, and things are only going to get worse if we don't do something about it.[12]

America's dismal record in broadband deployment is particularly discouraging when compared to that of Japan. In 2001, when the United States ranked 4th in the world, Japan had only a small handful of broadband lines. Spurred by the "broadband miracle" under way in nearby South Korea, Japan's top government and private-sector leaders decided to make Japan the world's leading broadband nation. They then developed and executed an all-hands-on-deck action plan to achieve that goal, including aggressive federal subsidies, low-interest and no-interest loans, loan guarantees, tax breaks, grants-in-aid to municipalities, targeted government purchases of services, a concerted national public education campaign, and a wide range of private-sector initiatives driven by a sense of national purpose and long-term thinking.

Today, Japan has the fastest and cheapest broadband in the world. Consumers in Japan can get broadband that is 10 times faster than the speeds available to average Americans, for prices that are less than a quarter of the prices that Americans must pay. Broadband providers currently compete at 1 Gbps, and this is expected to increase to 10 Gbps by 2010. Broadband is now available almost ubiquitously throughout Japan, and the "almost" will be removed by 2010. Today, 85 percent of households have access to fiber connectivity, and more than 35 percent of households have adopted it. Availability of fiber connectivity will increase to 90 percent by 2010.

Impressive as these figures are, they do not tell the whole story. Even more impressive is Japan's attitude toward broadband, as reflected in its current "ubiquitous-Japan initiative." For the purposes of this initiative, the term "ubiquitous" has two meanings. One is that Japan seeks to make wireline and wireless broadband connectivity virtually seamless in most of Japan by 2010. The other is that Japan seeks to make broadband a critical component of its solutions to all of its major challenges, including accommodating the needs of an aging population, establishing energy sufficiency, ensuring environmental sustainability, etc.

The stakes for the United States could not be higher. As Thomas Bleha warned in 2005, focusing on the Asian countries:

> It is now clear that Japan and its neighbors will lead the charge in high-speed broadband over the next several years. South Korea already has the world's greatest percentage of broadband users, and last year the absolute number of broadband users in urban China surpassed that in the United States. These countries' progress will have serious economic implications. By dislodging the United States from the lead it commanded not so long ago, *Japan and its neighbors have positioned themselves to be the first states to reap the benefits of the broadband era: economic growth, increased productivity, technological innovation, and an improved quality of life.*[13]

The risks and potential lost opportunities are even greater for the United States today than they were then.

Where is broadband deployment heading in the foreseeable future in Asia, Europe and the United States? In Part II.B, we examine the future of broadband deployment in Asia, Europe, and the United States. As we show, the leading nations in Asia and Europe are rapidly moving toward ultra-fast broadband with bandwidth capacity of 100 Mbps or more. Some countries are already at or near the Gbps range. In discussing what these nations are doing and why, we do not mean to suggest that the United States should indiscriminately seek to emulate their strategies or actions. To the contrary, we believe that a national broadband strategy for the United States cannot succeed unless it accommodates our own unique history, geography, demographics, institutions, competitive environment, and values. Rather, we discuss these other nations primarily to put what the United States is doing – and not doing – into a wider global context.

As for the United States, we show that our major communications providers are pursuing strategies that will leave most Americans far behind their counterparts in the leading Asian and European counterparts for many years to come. Verizon's fiber-to-the-home (FTTH) service, known as "FiOS," may have ample bandwidth capacity, but, in the next few years, it will only be deployed in portions of 16 states, primarily in suburban communities surrounding selected major cities. To date, Verizon has announced a firm commitment to bring FiOS to only one major American city – New York City, by 2014. While Verizon has expressed interest in providing FiOS in other major cities, it has not yet indicated when or where it will do so. Also, the high price of FiOS at upper bandwidth tiers will deter widespread adoption.

AT&T, believing that consumers will not demand high bandwidth capacity any time soon, is deploying a form of advanced DSL technology known as "ADSL2+." Under ideal conditions, this technology has download capacity of about 20-24 Mbps and upload capacity of 1-3 Mbps. Like other DSL technologies, bandwidth diminishes with distance between the provider's central office or digital subscriber line access multiplexer (DSLAM) and the user's residence. Because AT&T must divide available capacity among all of its services, including standard and high-definition television, it is currently limiting broadband capacity to 6-10 Mbps. There is no telling whether, when, and where AT&T will change this.

Qwest is also deploying ADSL2+, but on a much smaller scale. To date, Qwest has publicly committed to installing this technology in only 23 of the thousands of communities in its huge marketing territory. Qwest is also limiting upload capacity to 768 kbps, which is far too low to support the many emerging interactive applications, particularly those necessary to support vigorous economic development.

The cable industry maintains that a technology known as "data over cable service interface specification" (DOCSIS) 3.0 will enable it to meet growing bandwidth requirements. DOCSIS 3.0 is said to have capacity of 160 Mbps downstream and 120 Mbps upstream, and Comcast has recently begun to offer DOCSIS 3.0-based service in Minneapolis/St. Paul with download speeds of 50 Mbps and upload speeds of 5 Mbps. Comcast is pricing this service at $149.50 and is also considering usage surcharges, both of which are likely to discourage uptake. Comcast has also announced that it will deploy DOCSIS 3.0 in "up to" 20 percent of its markets by sometime in 2008 or 2009 and in the rest of its markets by sometime in 2010.

DOCSIS 3.0 has a number of technical and other shortcomings that may prevent it from living up to its hype. For one thing, as with other cable technologies, all active users on a neighborhood node must share available bandwidth. Since a node in the United States typically serves 250-2,000 homes, in many of which multiple users may be online at the same time, the amount of bandwidth actually available to subscribers is likely to be much lower than advertised maximum levels. That is particularly true during peak usage times.

Moreover, cable companies other than Comcast, including Time-Warner, are in no hurry to roll out DOCSIS 3.0. As a result, as the *Wall Street Journal* recently reported, "for consumers not served by Comcast or Verizon, speeds [of 50 Mbps or more] may be a long time off." Why? North Carolina provides a good example. AT&T and Time-Warner are the major telephone and cable companies in many North Carolina communities. In most of these communities, AT&T is either providing DSL or is not offering broadband at all. When AT&T eventually introduces ADSL2+ – probably focusing on the state's most lucrative markets – its download speeds will be limited to 6-10 Mbps. As a result, Time-Warner will be under little competitive pressure to invest in upgrading its systems to higher-bandwidth DOCSIS 3.0.

Furthermore, a large part of the business of cable operators is to sell television programming to its customers, either by subscription or on demand. With television programs and other forms of content becoming increasingly available directly to broadband users over the Internet, cable operators are concerned that providing ultra-fast broadband connections will result in cannibalization of their sales of television programming and other content.

Another disincentive to rollouts of DOCSIS 3.0 is that cable operators typically charge broadband subscribers a monthly fee that gives them the right to use their connections for any lawful purpose "up to" specified data speeds, subject only to vaguely-worded limitations on "bandwidth hogging." As a result, cable operators derive no direct benefit from a subscriber's use of his or her broadband connection for economic, educational, medical, or other socially beneficial purposes. In fact, given the shared nature of cable systems, cable operators benefit most if subscribers *under-utilize* their broadband connections.

For all of these reasons, cable operators may well refrain from making high-capacity broadband available any time soon in markets in which they are not being pushed by Verizon or other FTTH providers. Rather, we may see the emergence of what has been called a "double or nothing digital divide," whereby communities that have *both* an FTTH provider and a cable operator that has deployed DOCSIS 3.0 will get significantly higher levels of bandwidth than other communities.

Aside from the major communications providers, about 400 independents and cooperatives, and about 44 municipal and other public entities are deploying world-class FTTH systems. The communities being served by these systems will be able to compete successfully in the emerging knowledge-based global economy, but, unfortunately, there are not enough of them to affect America's overall competitiveness. Wireless, satellite, broadband-over-power lines, and other technological options, while useful in appropriate circumstances, cannot fill this bandwidth gap.

In the meanwhile, several states are embarking on initiatives to stimulate broadband availability and adoption. These initiatives cover a wide range of approaches. While some states, like California and Minnesota, have recognized the need for high-capacity broadband networks, most states are focusing on ways to provide low-bandwidth technologies, such as DSL and CMS, to rural and distressed urban areas. Even if these initiatives succeed, they will do nothing to narrow the growing disparity between the United States and the leading Asian and European nations in affordable access to high-capacity networks. Nor will these initiatives provide rural and distressed urban areas access to sufficient bandwidth to compete successfully in the emerging global economy.

Where does North Carolina stand in broadband deployment and global competitiveness? In Part III, we turn to North Carolina. We begin by analyzing broadband statistics from a variety of sources – including the FCC, the e-NC Authority, and the Communications Workers of America. Each database has its own strengths, weaknesses, and gaps. The e-NC Authority's data are the most detailed, but e-NC lacks statutory authority to compel disclosure by communications providers, so the data that providers give it voluntarily may be incomplete or even inaccurate. Furthermore, none of the databases includes detailed information on adoption, data speeds, price, or reliability.

At the state level, North Carolina ranks 11th in the number of "high-speed" speed lines, approximately 26th to 28th in household penetration, and about 15th in the number of fiber lines. As of June 30, 2007, there were only 5,683 fiber lines in all of North Carolina, down nearly 35 percent from the 8,656 fiber lines a year before. The 5,683 fiber lines represented less than 0.2 percent of the "high speed" lines in North Carolina.

At the county level, the e-NC Authority's data, supplemented by the observations of e-NC's staff in the field, indicate that, as of the end of 2006,

- 16 percent of North Carolina's households had no "high-speed Internet access" (using the FCC's definition of 200 kbps in one direction);
- there were significant disparities among North Carolina's urban and rural areas;
- 21 rural counties had less than 70 percent access to "high-speed" Internet connectivity, of which four had less than 50 percent access;
- in-state independent and cooperative providers are extending DSL to nearly their entire marketing areas;
- the large communications providers with headquarters outside the State appear to be curtailing their deployments when they reach about 80 percent of the households in their territories;
- at least two cooperatives are deploying FTTH with speeds of 80 Mbps in some portions of their territories; and
- two municipalities, Wilson and Salisbury, are developing city-wide FTTH systems.

These data are consistent with North Carolina's surprisingly low ranking in ITIF's 2007 State New Economy Index. The ITIF index compares the states on how well they foster success in the "New Economy," which the Foundation defines as "a global, entrepreneurial and knowledge-based economy in which the keys to success lie in the extent to which knowledge, technology, and innovation are imbedded in products and services." The index rates states on 26 indicators, which are divided into five categories "that best capture what is new about the New Economy." North Carolina's rankings in these 5 categories and overall for 2007 were as follows:

Knowledge Jobs – 31st

Innovation Capacity – 21st

Globalization –17th

Overall rank – 26th

Economic Dynamism – 27th

Transition to a Digital Economy – 36th

Why did North Carolina rank so low? The authors of the index took a hard look at this, as well as similar results for New Mexico, and concluded:

> Given some states' reputations as technology-based New Economy states, their scores seem surprising at first. For example, North Carolina and New Mexico rank 26th and 33rd, respectively, in spite of the fact that the region around Research Triangle Park boasts top universities, a highly educated workforce, cutting-edge technology companies, and global connections, while Albuquerque is home to leading national laboratories and an appealing quality of life. In both cases, however, many parts of the state outside these metropolitan regions are more rooted in the old economy – with more jobs in traditional manufacturing, agriculture, and lower-skilled services; a less educated workforce; and a less-developed innovation infrastructure. As these examples reveal, most state economies are in fact a composite of many regional economies that differ in the degree to which they are structured in accordance to New Economy factors.

In short, the unavailability or under-availability of broadband in many of North Carolina's rural areas does not just render these areas unattractive to "New Economy" employers, but it also drags down the state's overall New Economy ranking. Furthermore, with the leading Asian and European nations moving rapidly toward high-capacity networks, the paucity of fiber lines in North Carolina poses a significant threat to the future competitiveness of even its high-technology areas.

How much bandwidth capacity do we really need? In Part IV, we ask and answer the question "How much bandwidth capacity do we realistically need to enable our businesses, institutions, and residents to survive and thrive in the emerging global economy?" In addressing this question, we took into account (1) the vast array of benefits that high-capacity broadband networks can provide, (2) the potentially explosive growth in demand for broadband capacity between now and 2012, particularly as bandwidth-guzzling video applications gain popularity, (3) the unrelenting drive of the leading Asian and European nations to develop networks with bandwidth capacities of 100 Mbps to 1 Gbps or more; (4) the arguments of EDUCAUSE, the Fiber-to-the-Home Council, and other entities in the United States that have addressed this question; and (5) the many other factors discussed in Part IV.

Based on all these considerations, we believe that the United States should establish a national goal of making at least 100 Mbps of bandwidth capacity available to all Americans at affordable rates by 2012, and that this capacity should be expanded to at least 1 Gbps by 2015. The best way to reach these goals is through a non-partisan blue-ribbon commission, as we outlined in our paper entitled "Eight Bold Steps to a National Broadband Strategy" in January 2007.[14] *At the same time, North Carolina and other states should do everything within their power now to increase availability and adoption consistent with these goals.*

Some may argue that targeting particular levels of bandwidth capacity is artificial and short-sighted, and that we should focus instead on ways to use broadband to maximum advantage. We believe that this should not be an either/or proposition – both are necessary. The special value of including explicit capacity-based goals is that (1) they are relatively easy for the public, the media, politicians, and others to understand, (2) they are amenable to measurement and comparison; and (3) they lend themselves to the establishment of benchmarks, timetables, and lines of responsibility and accountability. In any event, bandwidth comparisons are widely used around the world, and we will be judged by them whether we like it or not.

Some may also argue that our proposed bandwidth levels are exaggerated, as most Americans will not need that much bandwidth capacity within the timeframes we suggest. For the reasons discussed throughout this paper, we disagree. If anything, we fear that our targets may be too modest. After all, at least at the user level, as distinguished from the Internet core, what if AT&T Vice President Jim Cicconi is even close to being correct in predicting that "[w]e are going to be butting up against the physical capacity of the Internet by 2010."[15]

Opponents may also argue that the United States cannot realistically meet the targets and timetables that we propose, especially in hard-to-reach rural areas. To be sure, our proposed goals are very aggressive and may not be fully achievable. But the United States is losing critical ground every day, and we cannot afford further delays or half measures. In our view, setting aggressive goals is the best way – indeed, the only way – to underscore the nature and urgency of the challenge that we face. While some adjustments may ultimately be necessary, it is too early for that. If we channel our minds, energies, and resources into achieving bold goals, we will undoubtedly achieve much more than naysayers may think possible. In contrast, setting goals that are too low to achieve satisfactory results is a sure path to failure.

Furthermore, in the communications field, feasibility is often measured by comparing costs and revenues from system user fees. We think that this is not the appropriate comparison for critical infrastructure of the kind at issue here. Rather, we submit that when *all* of the benefits of a world-class broadband infrastructure to the United States are considered, not just the revenues generated by user fees, the monetary value of these benefits in the aggregate will far, far outweigh the costs involved. Conversely, *failing* to build a world-class infrastructure will impose huge long-term costs on the United States that will dwarf the investments at issue.

In the end, we believe that great nations find the means to do what will make them and keep them great. The United States has done this time and again – building canals and railroads, developing electric, telephone and highway systems, conquering outer space. Now, the time has come to build a world-class communications network.

By establishing the ambitious national goals that we propose, and, even more important, backing them up with aggressive action plans that include timetables, benchmarks, and clear lines of accountability, the United States would serve notice to all concerned that the United States is serious about retaining its leadership in the emerging knowledge-based global economy. We strongly believe that doing so would be a critical first step to wresting the United States out of its economic doldrums, galvanizing the public's attention and support, and unleashing powerful new waves of positive energy and innovation in all walks of American life.

Our Recommendations

In Part V, we offer the e-NC Authority and the State of North Carolina eight specific recommendations, some of which have several parts. These recommendations supplement our call for a national broadband strategy, which may take some time to develop and implement on a national level. Our recommendations focus on steps that the e-NC Authority and the State can take themselves immediately to improve broadband availability and adoption in North Carolina.

Recommendation 1: Think Big, Adopt High Goals, and Act Boldly.

Time is short, and the stakes for the United States and North Carolina are huge. Only big ideas and bold actions will bring world-class broadband services and capabilities to all Americans, including North Carolinians, in the foreseeable future. As a result, we recommend that the e-NC Authority and the State of North Carolina establish their own ambitious, but realistic, goals to inspire and focus the development of aggressive action plans.

In particular, *we recommend that the e-NC Authority and the State declare that, by 2012, North Carolina will rank as one of the top five states in the United States in both household broadband adoption and average bandwidth used per household.* This would achieve both breadth and depth of rich broadband experience. We do not include obtaining the lowest possible prices as an explicit goal because achievement of the other two goals would imply that prices were affordable.

Recommendation 2: Participate actively in the development of a national broadband strategy.

The e-NC Authority and the State can do much to expand broadband availability and adoption in North Carolina, but these efforts would be all the more effective if backed by a strong national broadband strategy and the federal resources necessary to carry it out. In particular, the federal government can offer universal service, economic development, transportation, agriculture, and other grants, loans, and subsidies; provide federal tax credits, deductions, and accelerated depreciation; use federal purchasing power wisely; and provide a host of other federal measures to stimulate broadband deployment and adoption. Also, e-NC's experience and insights would be of great value in the debate on a national broadband strategy. We therefore recommend that the e-NC Authority and the State support and become actively involved in the development of a national broadband strategy.

Recommendation 3: Initiate a new round of inquiry to gather the best current information available and to develop new policies and recommendations for the General Assembly.

When the e-NC Authority (then known as the Rural Internet Access Authority) got started in 2001, it conducted extensive information-gathering and policy-development sessions around the state. We recommend that e-NC do this again during the next year.

While continuing to focus on digital inclusion initiatives, we suggest that e-NC broaden the inquiry and encourage participation by all stakeholders who would benefit from a world-class broadband network in North Carolina. This would include economic development specialists, high-technology companies, state and local governments, all levels of the educational community, health care providers and recipients, labor, utilities, equipment manufacturers, software and content developers, senior citizens, disabled persons, young people, etc. With job creation and retention in the era of globalization a major challenge for North Carolina, we also urge e-NC and the State to draw upon the knowledge and experience of its universities and other specialists in this area, particularly Duke University's Center on Globalization, Governance & Competitiveness.

Of particular importance is the inclusion of agencies and individuals with detailed knowledge of how North Carolina works – i.e., where grants, loans, and other resources may be found; how agencies can combine and coordinate their efforts; and how legal and other impediments, including restrictive private easements, can be removed.

While the information-gathering process should focus on North Carolina itself, we suggest inviting in experts from elsewhere in the United States and abroad to share their experiences, best practices, and ideas.

We also recommend that e-NC and the State treat the inquiry as an opportunity to build energy, enthusiasm, and buy-in among the participants. That is essentially what the e-NC's innovative programs have been doing for the last few years, albeit in the service of a more modest vision of what broadband is and what it can do. It is now time to up the ante.

The inquiry should be scheduled to give the e-NC Authority time to develop a report and proposals for the General Assembly for its legislative session of 2009. This would require aggressive planning and execution, but time is of the essence.

Recommendation 4: Continue existing connectivity programs for the next year, but with a few changes.

DSL and CMS are past their prime and should now be viewed only as transitional technologies. We would like to suggest that the e-NC stop supporting them right away, but that would be unrealistic and premature. Instead, we recommend that e-NC continue its existing programs, including connectivity grants to support DSL or CMS where no better options exist, until e-NC is ready to recommend a comprehensive new strategy to replace them. In the meanwhile, we recommend the following additions, adjustments, or shifts in emphasis in e-NC's existing programs:

- Launch a new Request for Information process to learn about emerging technologies and providers and to develop a list of qualified vendors of all kinds, including major incumbents, independents, cooperatives, and public providers.
- Determine whether problems exist concerning affordable access to "middle-mile" connectivity – that is, "backhaul" between Internet service providers and the Internet core – and, if so, develop any necessary remedies.
- Use Connectivity Grants, public education, and other incentives the e-NC Authority can provide to encourage high-capacity broadband deployments to the maximum extent possible.
- Conduct two or three showcases for qualified vendors around the state during the next year. The vendors should be willing to cover the costs of such events.
- Add to e-NC's funding criteria a sizable value weight for options that will enhance competition. Such options might include wireless technologies, particularly technologies that offer higher bandwidths or lower costs than DSL or cable modems. They might also include alternative providers, such as independents, cooperatives, or public entities that have proven records of success in similar projects elsewhere.
- Encourage collaboration among communities. For example, approximately 25 communities in central Vermont have recently voted by wide margins to band together to develop a common fiber system, if feasible. Similarly, a large cooperative in northern Michigan is exploring ways to obtain the best possible broadband for the communities involved.
- Continue to seek informed local input on e-NC funding decisions.

Recommendation 5: Obtain legislative authority to require telecommunications, cable, and other broadband service providers to file with the e-NC Authority the data that it needs to fulfill its responsibilities.

Good data are crucial to the development and execution of good policies. We therefore recommend that the e-NC Authority seek legislation to empower it to compel disclosure of the information it needs and to ensure that it can protect legitimate business secrets from public disclosure.

Recommendation 6: Encourage collaborative, yet proactive policies to promote build-out by communications service providers.

Since the 1980s, North Carolina has had a positive and collaborative relationship with communications service providers in developing competitive technology infrastructure. For example, in the 1980s the State made the development of a statewide digital network possible by serving as the anchor tenant on the network. In the 1990s, the State and communications companies worked together again to upgrade the statewide network to an ATM SONET network, known as the North Carolina Information Highway (NCIH). This project, the largest deployment of ATM technology in the world at the time, was controversial at first, but its rapid deployment ultimately benefited all concerned – private companies benefited from access to the upgraded network, and the state government, schools, community colleges and universities, and other public entities obtained access to a state-of-the-art network to meet their needs. One thing that the NCIH did not do, however, was to provide last-mile access to citizens' households. This lack of last-mile access later became the rallying cry for the creation of e-NC.

Given the communications industry's long history of working cooperatively with the State and the substantial benefits that the industry has derived from doing so, we believe that the industry should now assume its share of responsibility for ensuring that broadband is promptly made available to all citizens in the state at affordable rates. As e-NC's data show, independent and cooperative telephone companies have stepped up to this responsibility, but the major communications providers have focused on serving only the most lucrative portions of their marketing areas. We therefore recommend that the e-NC Authority work with the N.C. General Assembly to find ways to encourage the major communications providers to complete their build-outs. Such ways should include, as a last resort, withdrawing or withholding state contracts or other benefits.

Recommendation 7: Encourage broadband initiatives by local governments.

If the United States is to remain competitive in the emerging knowledge-based global economy, our public and private sectors must meet this challenge together, in a spirit of mutual respect, shared purpose, urgency, and candor. As Senator John McCain noted on the Senate floor in the course of introducing federal legislation to encourage community broadband initiatives,

> Many of the countries outpacing the United States in the deployment of high-speed Internet services, including Canada, Japan, and South Korea, have successfully combined municipal systems with privately deployed networks to wire their countries. As a country, we cannot afford to cut off any successful strategy if we want to remain internationally competitive.

On this issue, Senator Barack Obama is in full accord with Senator McCain – as with Senator Hillary Clinton. We agree, and we recommend that the e-NC Authority encourage localities to consider public broadband initiatives as an option, along with other options. If any community in North Carolina is ready, willing, and able to do this, we suggest that the e-NC Authority treat it as favorably as it would treat any private provider.

Recommendation 8: Develop a wiki from our paper and post it on e-NC's website.

This paper contains an enormous amount of pertinent information, but it is not all-inclusive, and new information is emerging every day. A good and inexpensive way for the e-NC to keep current in all the areas covered by this paper would be to establish a "wiki" on its website, using the information in this paper as a starting point. (A wiki is a web-based program, such as the online encyclopedia, "Wikipedia," that allows individuals around the world to contribute to and edit a document collaboratively.) Having a living, up-to-date compendium of knowledge about broadband would make the e-NC website a unique and especially valuable tool, not only for e-NC, the State, and the organizations and individuals that they serve, but also for other organizations and individuals around the United States and the world who share e-NC's interests.

I. THE BROADBAND REVOLUTION

In this section, we begin by addressing the question "What is Broadband?" We then provide numerous examples of the vast contributions that broadband is making, and can make, to economic development, education, public safety, homeland security, health care, telework, environmental sustainability, urban revitalization, government services, senior citizens, disabled individuals, young people, and entertainment and cultural enrichment, including broadband video, social networking, and gaming.

Notably, most of the studies and case histories that we cite involved limited-capacity first-generation DSL and CMS systems.[16] As a result, most of these studies and case histories do not reflect the much greater benefits that high-bandwidth-capacity networks can make possible. We describe these additional benefits as well, citing information emerging from the leading Asian and European nations, where high-capacity networks are becoming increasingly common, and from pioneering communities in the United States that have developed such networks.

A. What is Broadband?

The term "broadband" has many technical, legal, political, and commercial meanings. Each is the subject of heated controversy in the United States and abroad.

The term "broadband" is generally understood to mean a service or facility that allows a human user or device to send or receive "digital" data over "the Internet" at "high speed." The Internet is a global "network of networks" that includes millions of interconnected public, private, commercial, and institutional networks that can communicate with each other because they all follow a set of standardized rules called "Internet Protocol." The common language of these networks is called "digital" because it reduces information of all kinds, including numbers, mathematical formulas, spreadsheets, text, voice conversations, music, videos (including television and movies), photographs, X-Rays and Magnetic Resolution Images, and virtually all other kinds of information, to computer-readable sequences of the digits "1" and "0." Each "1" and "0" is known as a "binary digit," shortened to a "bit," which is the basic unit of digital language. A "byte," in turn, consists of a sequence of bits (typically eight) in various combinations. Bytes can be combined in infinite ways and lengths, as the letters of an alphabet can be combined to form words, sentences, paragraphs, etc.

Once information is reduced to digital form, it can be carried by many different kinds of media. For example, telephone companies can provide it over their twisted-pair copper wires using a technology known as "digital subscriber line" or "DSL;" cable companies can provide it over their steel coaxial cables using a technology known as "cable modem service" or "CMS;" and power companies can provide it over their electric wires using a technology known as "broadband over power lines" or "BPL."

There are also a variety of wireless technologies that can carry digital information, of which the best known terrestrial technologies are WiFi and WiMax. WiFi stands for "wireless fidelity" and WiMax stands for "Worldwide Interoperability of Microwave Access." Satellite companies can also provide wireless service, but the great distance that signals must travel causes problematic delays (called latency or jitter).

Of all current technologies, the most robust is fiber optics. Hair-thin glass fiber optic cables can carry virtually infinite amounts of digital information encoded on light beams traveling at nearly the speed of light between lasers at the ends of the cables. Capacity is limited only by the capacity and quality of the lasers, which are constantly improving. Once fiber cables are deployed, which is the most costly part of building a fiber system, the system can readily be upgraded simply by swapping out the lasers.

As a rule of thumb, the closer a provider brings fiber to end users, the greater its network's capacity will be – and the higher its construction costs will be. Thus, there is a critical trade-off between capacity and cost. For example, Verizon's FiOS system extends fiber all the way to subscribers' homes (FTTH), whereas AT&T's "U-verse" extends fiber only to neighborhoods (FTTN) and relies on AT&T's existing copper wires to complete the links between neighborhood "nodes" and subscriber homes. Verizon's network will have much more capacity than AT&T's, but it will also cost much more to deploy. In essence, Verizon is betting that consumer demand for high-capacity applications will grow quickly, and AT&T is betting that such demand will grow slowly.

The most common way that broadband services and facilities are rated and compared is by data speed. Data speeds are usually expressed as the number of bits that a service or facility can process in a second of time. A "kilobit" is 1,000 bits; a "Megabit" is 1,000 kilobits or one million bits; and a "Gigabit" is 1,000 Megabits or one billion bits. Thus, a good dial-up connection operating at about 50 kilobits per second (kbps) can carry about 1/100 of the data that a good cable modem operating at five Megabits per second (Mbps) can carry and about 1/20,000 of the data that a fiber-to-the-home connection operating at one Gigabit per second (Gbps) can carry.

Another common term used to describe the information-carrying capacity of broadband is "bandwidth." According to the Federal Communications Commission (FCC), "bandwidth" is "the capacity of a telecom line to carry signals. The necessary bandwidth is the amount of spectrum required to transmit the signal without distortion or loss of information."[17] Another useful definition is "the width of the frequency band used to transmit data. The broader the bandwidth, the faster the connection."[18] Some sources define "bandwidth" in a way that is virtually indistinguishable from data speed: "Bandwidth refers to how fast data flows through the path that it travels to your computer; it's usually measured in kilobits, Megabits or Gigabits per second."[19] We have no strong preference as between "data speeds" and "bandwidth" and use both terms in this paper, depending on the context.

To compare bandwidths, practitioners sometimes refer to "pipes," with data-carrying capacity growing with the "fatness" of the pipe. For example, a dial-up "pipe" is often compared to a drinking straw; a DSL, CMS or wireless "pipe" to a garden hose; and a fiber-optic "pipe" to a fire hose.

Until recently, the (FCC) used the terms "broadband" and "high-speed Internet access" interchangeably to describe services or facilities that have the capacity to carry data at more than 200 kilobits per second (kbps) in one direction – that is, either to receive it (download) or to send it (upload). The FCC used the term "advanced telecommunication capability" to describe services or facilities with the capacity to carry information at more than 200 kbps in both directions. For many years, the FCC received intensive and widespread criticism for these definitions, including from two of the five FCC commissioners. The critics maintained that using such puny data speeds was out of step with current realities and gave the false impression that the United States was more successful in deploying "broadband" and "advanced telecommunications capabilities" than it really has been.

Recognizing that these criticisms were valid, the FCC recently issued an order that raised the minimum data speed necessary to qualify as "broadband" to 768 kbps.[20] The FCC also adopted a new seven-tier classification scheme, as summarized in the following table:[21]

Table 1

FCC's New Speed Tiers	
1st Generation Data	200 kbps to 768 kbps
Basic Broadband Tier 1	768 kbps to 1.5 Mbps
Broadband Tier 2	1.5 Mbps to 3 Mbps
Broadband Tier 3	3 Mbps to 6 Mbps
Broadband Tier 4	6 Mbps to 10 Mbps
Broadband Tier 5	10 Mbps to 25 Mbps
Broadband Tier 6	25 Mbps to 100 Mbps
Broadband Tier 7	Greater than 100 Mbps

Source: FCC Wireless Competition Bureau

In considering broadband data speeds, it is important to bear two significant limitations in mind. First, broadband providers often advertise far greater data speeds than they actually deliver. This is an especially significant issue for cable systems. Cable systems generally connect their central operations centers (called headends) by fiber-optic lines to several neighborhood "nodes" and then connect the nodes by coaxial cables to hundreds of homes. Cable systems are designed so that all homes connected to a node must share the total broadband capacity available to that node.[22] As a result, at times of high usage, such as early evenings when subscribers come home from work, data speeds will be much slower than at off-peak times. In fact, cable data speeds rarely approach advertised maximum speeds, even at low-usage times. Furthermore, if even a relatively small number of subscribers use BitTorrent or other lawful bandwidth-rich applications, or download videos through YouTube, Hulu, Joost, Stream, or similar services, data speeds for other subscribers can fall below dial-up levels.

For example, AT&T recently conducted field trials to test the veracity of certain cable industry claims that download speeds would be "up to" 6-8 Mbps. According to AT&T, actual speeds fell far short of these promises:

> The result was quite different from what the cable company advertised. While AT&T saw peak speeds in the 3-4 Mbps range, average throughput was closer to 400 kbps. "Peak might be something that occurs at 3 am, when the network is lightly loaded," said [AT&T Telecom Operations Group president John] Stankey. "Even at peak, the performance on these types of transactions was well below the 6 or 8 Mbps access speeds."[23]

This problem is going to become increasingly acute as the number of broadband users grows and as applications consume ever-increasing amounts of capacity.

Second, broadband providers typically emphasize download speeds in their advertising and downplay upload speeds – if they even mention upload speeds at all. This disguises the fact that, in the United States, most broadband connections today are asymmetric – i.e., they have substantially less capacity for uploads than they do for downloads. That is so because most DSL and CMS networks have limited capacity, and network operators have dealt with this by allocating most of their available capacity to downloads. As discussed more fully below, such restrictions on upstream capacity can severely limit economic development and user creativity.

Furthermore, Internet users, particularly young people, are increasingly becoming producers of content and need more upstream capacity to send it to the Internet. This trend is likely to gain compelling force as the Internet evolves to its so-called "Web 2.0" stage, during which users will typically become "prosumers" – i.e., both producers and consumers of information. We will discuss these developments in Section B.13, below.

B. The Many Benefits of Broadband

1. Economic Development

Among the most important attributes of broadband is its ability to serve as an engine of economic development, enabling communities, regions, nations, and even whole continents to develop, attract, retain, and expand job-creating businesses and institutions. Broadband also improves the productivity and profitability of businesses and institutions of all kinds in an endless variety of ways. This is not only true of large enterprises, but also of the small and medium businesses (SMBs) that "comprise more than 98 percent of U.S. firms and roughly half of all U.S. workers. SMBs spend in the range of $70 billion to $80 billion annually on voice and data services, or between $600 and $800 monthly per firm, on average."[24]

There was a time when the major telecommunications and cable companies, seeking to persuade state legislatures to ban or restrict municipal broadband initiatives, insisted that there was no relationship between broadband and economic development. To back up their claims, they relied upon reports by "experts" who attacked the early studies showing that such a relationship existed.[25] Now, the evidence overwhelmingly proves that broadband and economic development go hand-in-hand, even at the paltry data speeds that the FCC used to treat as "broadband." A growing body of evidence also indicates that high-capacity next-generation broadband networks will have a much more pronounced effect on economic development.

In this section, we first summarize ten studies connecting broadband and economic development. We then review ten representative case histories confirming that this is so. Because municipalities around the world, including the United States, have led the way to deploying high-capacity next-generation networks, most of these examples involve municipal fiber projects. Next, we pull back from our narrow focus on the United States and examine developments around the world that are leading to the emergence of a vast knowledge-based global economy. Finally, we discuss the Information Technology and Innovation Foundation's 2007 State New Economy Index, a highly useful tool to compare and contrast how well the various states are doing in establishing competitive economies. In Part III, we apply the Index to North Carolina.

a. Studies

In July 2001, Criterion Economics released a Verizon-sponsored study finding that "[b]roadband access to the Internet in all its forms – ADSL, cable modems, and various wireless services – will bring enormous benefits to our economy."[26] The authors calculated that widespread adoption of broadband by 2013 would result in a net present value of more than $500 billion.

In February 2002, TeleNomic Research published a study concluding that a national broadband network would result in the addition of 1.2 million permanent jobs, broken down as follows:

- 166,000 jobs would be created directly in the telecommunications sector
- 72,000 manufacturing jobs would be generated by the direct purchase of network plant and equipment and customer premise equipment, and
- 974,000 indirect jobs would be created if a high-capacity network were built[27]

In September 2002, the U.S. Department of Commerce (DOC) issued a seminal report on broadband demand in the United States.[28] The DOC reviewed the Criterion Economics and TeleNomic studies cited above as well as numerous other then-existing studies and concluded that widespread broadband deployment and adoption was critical to "promoting jobs, productivity, and sustained growth," to "enabling anywhere, anytime, student-appropriate learning," to "transforming health care," to upgrading the military to cope with "the global war on terror," to "securing the home front" by enhancing homeland security, and to "bringing new possibilities and hope" to disabled persons and senior citizens. The DOC then set forth numerous actions that all levels of government, business leaders, and innovators and entrepreneurs could take to stimulate broadband demand.

Notably, after reviewing what it called the "U.S. Supply of Current Generation Broadband (Cable & DSL)," the DOC cautioned:

> It is important to note here that the current generation of broadband technologies *(cable and DSL)* may prove *woefully insufficient* to carry many of the advanced applications driving future demand. *Today's broadband will be tomorrow's traffic jam*, and the need for speed will persist as new applications and services gobble up existing bandwidth.[29]

In 2003, Criterion Economics refined its research and found that, over the next 19 years, ubiquitous adoption of current-generation DSL and CMS would result in a cumulative increase in gross domestic product (GDP) of $179.7 billion and in 61,000 new jobs a year. Criterion also found that introducing next-generation fiber-to-the-home (FTTH) technology at a reasonable pace would increase cumulative GDP to $440 billion and new jobs to 140,000 a year.[30]

In April 2005, Applied Economic Studies published a study focusing on a municipal broadband deployment in Lake County, Fla. The study concluded that "Lake County has experienced approximately 100% greater growth in economic activity-a doubling-relative to comparable Florida counties since making its municipal broadband network generally available to businesses and municipal institutions in the county."[31]

In February 2006, Massachusetts Institute of Technology and Carnegie Mellon University published the results of a study that they had performed for the U.S. Department of Commerce, to measure the impact of broadband on economic growth.[32] The MIT/CMU team found that "between 1998 and 2002, communities in which mass-market broadband was available by December 1999 experienced more rapid growth in employment, the number of businesses overall, and businesses in IT [Information Technology]-intensive sectors, relative to comparable communities without broadband at that time." They also found that broadband's impact on the number of jobs and business establishments "was particularly large relative to our expectations."

In June 2007, a study sponsored by the Brookings Institution found that, for every one percentage point increase in broadband penetration in a state, employment increases by 0.2-0.3 percent per year. For the entire U.S. private non-farm economy, the study projected an increase of about 300,000 jobs a year, assuming that the economy was not already at full employment.[33]

In November 2007, a study commissioned by AT&T found that increased use of DSL and CMS would directly result in 14,853 new jobs in the Solano County area of California in the next 10 years. The study also showed that, with a nearly 4 percent annual percentage point increase in adults using broadband, the state could see a net cumulative gain of 1.8 million jobs and $132 billion in payroll over the next decade.[34]

In February 2008, Connected Nation issued a report estimating that if broadband adoption were to increase an additional 7 percent in every state, the United States would experience aggregate economic benefits of approximately $134 billion a year. This would include $92 billion from 2.4 million jobs produced or saved; $662 million in reduced health-care costs; $6.4 billion in savings from reduced driving; $18.2 million in carbon credits associated with 3.2 billion fewer pounds of carbon dioxide emissions; and $35.2 billion in the value of saving 3.8 billion hours by accessing broadband from home.[35]

Most recently, Strategic Network Group concluded, based on a study of the effects of fiber deployments on a total of 223 businesses in three communities, that

> The real benefits of FTTP (fiber to the premises) are more than about doing the same things faster. The most significant gains from FTTP occur after 2 years of use once organizations have adopted new business models to realize new revenue streams and to transform their business operations for cost avoidance. *While the greatest gains are*

realized when moving from dial-up to FTTP, there continue to be significant gains for businesses that move from other forms of broadband access.

In addition to these direct benefits, there are economic multiplier effects (increases in GDP, jobs, tax revenues) that can be calculated. In SNG's research since 2003, we have found significant increases in local economic activity attributable to broadband. *In fact, the increase in local GDP is more than ten-fold the value of the investments in broadband infrastructure.*[36]

The difference between the 5-10 Mbps and the 100 Mbps is not simply one of moving data faster. It is, rather, an economically crucial difference that causes a profound shift in how the medium is used. For example, a study in Japan of the effects of widespread, near-symmetric 100 Mbps (as opposed to the asymmetric download-priority model that dominates in the U.S. and elsewhere), found a dramatic increase in the use of peer-to-peer applications of various types, as well as in the creation of a whole new class of creative "heavy hitter" users who take advantage of such applications.[37] In other words, affordable access to high-bandwidth capacity results in a surge of applications and of both content users and content creators that does not – and cannot – exist in an asymmetric, low-capacity environment.

There are two important lessons to be gleaned from the experience in Japan. The first is the crucial importance of robust upstream connections, enabling users to produce and distribute their own content and applications. The second is that "big" broadband, as opposed to puny broadband at DSL and CMS speeds, makes not only a quantitative difference, but also a crucial and economically significant qualitative difference.

b. Case Histories

The results of the studies cited above are borne out by the experience of numerous communities around the United States. Some representative examples follow. These examples predominantly involve municipal systems because, as in other countries around the world, municipalities were the pioneers of high-capacity networks, and "[o]ne important early result of municipal FTTH systems was to help prove and incubate the technology of direct fiber optic access."[38]

- ***Lafayette, La.:*** "When Nucomm International needed to locate a new call center – one that would add 1,000 jobs ... to the local economy – it chose Lafayette, Louisiana, because the city is building a massive fiber network to connect everyone."[39]
- ***Fort Wayne, Ind.:*** Between 2000-2004, industrial employment in Fort Wayne fell 21 percent (compared to 15 percent statewide). In response, then-mayor Graham Richard launched a vigorous and ultimately successful effort to attract a Verizon "FiOS" fiber-to-the-home network to the City. The City then established several innovation teams (ITeams) to develop ways to take maximum advantage of the high-bandwidth capacity that would now be available to the City and its businesses, institutions, and residents. ITeams have focused on government services, health-care information systems, transportation, public safety, online learning, library services, advanced manufacturing, and various other areas, and their efforts have resulted in numerous innovative programs. Examples include enhancing net literacy of senior citizens, handicapped individuals, and others through public computer labs and training programs; putting special cameras in clinics to enable real-time remote health diagnoses and treatment; establishing an "e-Mentoring" program that enables college students to support under-served urban students; and an initiative to support new business development and job creation. The latter program has, among other things, prompted Raytheon to expand its facilities in the City to take advantage of the new bandwidth. Now, Fort Wayne has a 4 percent annual growth rate, which is tops in the state.[40]
- ***Cedar Falls, Iowa:*** "In the 1990s, Cedar Falls Utilities built a citywide municipal hybrid fiber/coaxial network and provided specialized broadband telecommunications services including fiber connections to commercial and industrial customers in both the city and the industrial park. In contrast, the neighboring town of Waterloo, served by incumbent cable and telecommunications operators, generally did not have any fiber connectivity. Cedar Falls projected that, by the end of 2003, it would have companies employing over 5,000 people and occupying 4,000,000 square feet of building space. In contrast, Waterloo had a total of 10 businesses in its three industrial parks and has witnessed companies relocating from Waterloo to Cedar Falls, in part because of their need for bigger bandwidth."[41] As Doris Kelly showed in an analysis comparing Cedar Falls and Waterloo on a broad range of criteria, the only significant difference between them was Cedar Falls' broadband utility.[42]

  In Cedar Falls's most recent coup, Peregrine Financial Group decided to relocate 70 high-paying jobs, with an annual $10 million payroll, to the Cedar Falls area.[43]
- ***Bristol, Va.:*** As the 21st Century began, Bristol, Virginia, a town of 18,000 on the border of Virginia and Tennessee in southwest Virginia, was facing the simultaneous decline of its bedrock industries – tobacco, textiles, coal mining, and agriculture. Many of its stores and businesses were boarded up, and the future looked grim for Bristol and the entire region. The City leaders, with the encouragement and assistance of U.S. Rep.

Rick Boucher, decided to take matters into their own hands and rebuild the local economy through advanced telecommunications infrastructure and services. In 2001, Bristol won a crucial challenge to Virginia's then-existing barrier to public entry, and it began to build a state-of-the-art FTTH system. Three years of industry-backed legislative challenges and litigation disrupted Bristol's progress and substantially added to its burdens and costs, but Bristol stayed the course. Now, the City system serves more than 65 percent of Bristol's residents and businesses, and it has begun to attract hundreds of high-paying jobs to the town and region. For example, a recent article notes that two new employers alone will bring up to 1,500 high-paying jobs to Bristol.[44]

- ***Tacoma, Wash.:*** Tacoma Click! Network has just passed its 10th anniversary. It played a significant role in revitalizing Tacoma and has attracted more than 100 high-tech businesses to the community. Business leaders readily acknowledge that it is the municipal communications utility's ability to serve their needs that made them comfortable with moving to Tacoma rather than to Seattle or other large cities.[45]

- ***Powell, Wyo.:*** In anticipation of the construction of a fiber-to-the-home system in rural Powell, Wyo., this summer, a South Korean venture capital firm has agreed to pay up to $5.5 million to engage 150 certified teachers in rural Wyo. to teach English to students in South Korea using high speed video teleconferencing. The Powell fiber system will enable the teachers to work from home. The company that developed this project is now planning similar projects for China, Japan, and Taiwan.[46]

- ***Scottsburg, Ind.:*** In Scottsburg, Verizon refused to wire the 6,000 person town because the company believed there was not enough interest or a large enough population to make its efforts profitable. In response, the Town created a wireless municipal broadband network that utilized the local power company's fiber for backhaul. The network, which cost $385,000 to create, was directly responsible for saving 60+ jobs at a local Chrysler repair shop that Chrysler corporate headquarters had planned to close due to the lack of high-speed access. In addition to the benefits of retaining these jobs, the network saves the community $6,000 per month in telecommunications costs.[47]

- ***Auburn, Ind.:*** Auburn's story is similar to Scottsburg's, except that Auburn used fiber rather than wireless to achieve its economic development goals. Cooper-Standard Automotive was going to move 75 high-tech jobs out of this small Indiana town because no private company was willing to provide broadband in the town. The mayor and municipal electric utility offered to furnish Cooper "industrial strength connectivity" through fiber optics. Cooper accepted and stayed.[48]

- ***The Dalles, Ore., vs. Danville, Va.:*** The Dalles, Ore., a city of 11,873 in the picturesque Columbia River Gorge, operates a 17-mile municipal fiber optic network. As a direct result of The Dalles' municipal networking capabilities, Google in 2005 decided to purchase an industrial site there for $1.87 million, to house high-tech equipment that would be connected to the rest of the company's network. The project will create "between 50 and 100 jobs over a matter of time, earning an estimated average of $60,000 annually in wages and benefits."[49] In contrast, Danville, Va., did not have a fiber network when AOL came looking for a site. As a result, AOL struck Danville off its list of potential sites for a new data center and located the center in Prince William County, Va.[50]

- ***Jackson, Tenn.:*** "For a small city, Jackson, Tenn., boasts a high concentration of firms that provide off-site computing resources for other businesses. The reason: its state-of-the-art fiber network."[51]

The examples above – particularly the contrast between The Dalles' and Danville's experience – confirm that advanced telecommunications networks are essential to attract or retain "New Economy" businesses and institutions. As business site selection experts now frequently say, "[t]o be a real competitor in the new global economy, an area must provide an advanced telecommunications infrastructure – the basic building blocks of the IT [information technology] sector."[52] In other words, having an advanced telecommunications network will not guarantee that a business will move to or stay in a community, but not having such a system will for many communities guarantee failure.

c. Competitiveness in the Emerging Global Economy

The potential of broadband to spur economic development has become particularly important for the United States in view of the sharp increase in competition from low-cost nations in the last few years. As the blue-ribbon New Commission on the Skills of the American Workforce noted in its recent report entitled "Tough Choices or Tough Times," American workers are increasingly competing with workers in China, India, and other countries who are not only better educated but are also willing to work for far lower wages than Americans are used to earning.[53] To maintain its high standard of living, the United States must therefore prepare its workforce for highly-skilled, knowledge-based work that can command the wages American workers want and need from American and foreign employers. Success in achieving this will, in turn, depend on the availability of advanced communications networks:

> Every day, more and more of the work that people do ends up in a digitized form. From X-rays used for medical diagnostic purposes, to songs, movies, architectural drawings, technical papers, and novels, that work is saved on a hard disk and transmitted instantly over the Internet to someone near or far who makes use of it in an endless variety of ways. Because this is so, employers everywhere have access to a worldwide workforce composed of people who do not have to move to participate in work teams that are truly global. Because this is so, a swiftly rising number of American workers at every skill level are in direct competition with workers in every corner of the globe. So it matters very much that, increasingly, it is easier and easier for employers everywhere to get workers who are better skilled at lower cost than American workers.[54]

Similarly, in his best-selling book *The World is Flat*, Thomas Friedman focused on the trend of companies worldwide to break manufacturing, production, service, and other processes into discrete tasks, to "source" the tasks to the workers anywhere in the world who can perform them most cost-effectively, and to use advanced communications technology to make everything work successfully:

> The dynamic force in [the current stage of globalization]-the thing that gives it its unique character-is the newfound power for individuals to collaborate and compete globally. And the lever that is enabling individuals and groups to go global so easily and so seamlessly is not horsepower, and not hardware, but software-and all sorts of new applications-in conjunction with the creation of a global fiber optic network that has made us all next-door neighbors. Individuals must, and can now ask, "Where do I fit into the global competition and opportunities of the day, and how can I, on my own, collaborate with others globally."
>
> ....
>
> [W]e are entering into a phase where we are going to see the digitization, virtualization, and automation of almost everything. The gains in productivity will be staggering for those countries, companies, and individuals who can absorb the new technological tools. And we are entering a phase where more people than ever before in the history of the world are going to have access to these tools-as innovators, as collaborators, and, alas, even as terrorists. You say you want a revolution? Well, the real information revolution is about to begin. ...[55]

China's surging economy is particularly threatening to America's standard of living. In his book *China, Inc.*, Ted Fishman observed that China expects some three hundred million people to move from the countryside to major cities over the next 15 years. To accommodate this massive population shift, China will have to build the equivalent of Houston, Texas, *every month*, and will have to expand and accelerate its aggressive twenty-year-old program of encouraging importation of as many businesses and jobs from around the world as possible. The following passage from *China, Inc.* captures well the high stakes involved for the United States and the rest of the world:

> The most daunting thing about China is not that it is doing so well at the low-end manufacturing industries. Americans will be okay losing the furniture business to China. In the grand scheme of things, tables and chairs are small potatoes in the U.S. economy. The Japanese, for their part, have lost the television business. The Italians are losing the fine-silk business. Germans cannot compete in Christmas ornaments. Everyone but the Chinese will lose their textile and clothing factories. More worrisome for America and other countries is the contour of the future, where manufacturing shifts overwhelmingly to China from all directions, including the United States. Consumer goods trade on the surface of the world's economy and their movement is easy for consumers to see. The far bigger shift, just now picking up steam, is occurring among the products that manufacturers and marketers trade with each other: the infinite number and variety of components that make up everything else that is made, whether it is the hundreds of parts in a washing machine or computer or the hundreds of thousands of parts in an airplane. And then there are the big products themselves: cars, trucks, planes, ships, switching networks for national phone systems, factories, submarines, satellites, and rockets. China is taking on *those* industries too.[56]

To remain competitive in the face of challenges, the United States must ensure that its businesses, institutions, and residents have affordable access to world-class communications infrastructure that is capable of supporting the most advanced broadband technologies and applications.

d. The 2007 State New Economy Index

The Information Technology and Innovation Foundation (ITIF) has developed an invaluable index for measuring and comparing the degree to which state economies are knowledge-based, globalized, entrepreneurial, Information Technology (IT)-driven, and innovation-based.[57] We introduce the index and the concepts underlying it here, and we return to it later in Section III.B, in our discussion of North Carolina.

ITIF posits that the United States has evolved through several kinds of economies during the last century – the "factory economy" that emerged in the 1890s, the "mass-production, corporate economy" that emerged in the 1940s and 1950s, and the "New Economy" that has begun to emerge in recent years. ITIF defines the "New Economy" as "a global, entrepreneurial and knowledge-based economy in which the keys to success lie in the extent to which knowledge, technology, and innovation are imbedded in products and services."[58] ITIF compares the major features of the "New Economy" to those of the "Old Economy" in the following chart:

Table 2

The Old and New Economies

ISSUE	OLD	NEW
Markets	Stable	Dynamic
Scope of Competition	National	Global
Organizational Form	Heirarchical	Networked
Production System	Mass Production	Flexible Production
Key Factor of Production	Capital/Labor Intensive	Ideas
Key Technology Driver	Mechanization	Digitization
Competitive Advantage	Economies of Scale	Innovation/quality
Relations Between Forms	Go it alone	Collaborative
Skills	Job-specific	Broad and changing
Workforce	Organization Man	"Intrapreneur"
Nature of Employment	Secure	Risky

Source: ITIF

The ITIF index consists of 26 indicators, which are divided into five categories "that best capture what is new about the New Economy" – Knowledge Jobs, Globalization, Economic Dynamism, Transformation to a Digital Economy, and Technological Innovation Capacity.[59] While all of these categories are important, we will focus here on two of them – Knowledge Jobs and Transformation to a Digital Economy.

According to ITIF, knowledge jobs are important for the following reasons:

> Workers who were skilled with their hands and could reliably work in repetitive and sometimes physically demanding jobs were the engine of the old economy. In today's New Economy, knowledge-based jobs are driving prosperity. These jobs tend to be managerial, professional, and technical positions held by individuals with at least two years of college. Such skilled and educated workers are the backbone of the states' most important industries, from high value-added manufacturing to high-wage traded services.

Of the transformation to a digital economy, ITIF says,

> As the use of IT has transformed virtually all sectors of the economy, the result has been a significant boost in productivity. For example, the $500 billion trucking industry has saved $16 billion annually through the use of on-board computers that allow companies to track and dispatch trucks more efficiently. Farmers use the Internet to buy seed and fertilizer, track market prices, and sell crops. Governments issue E-Z Passes to automate toll collection. Whether it is to pay bills or locate a package, consumers increasingly forgo a phone call to corporate customer service centers in favor of more efficient self-service over the Internet. All of this translates into productivity gains and increased standards of living. In this way, digital technology is doing as much to foster state economic growth in the early 21st century as mechanical and electrical technologies did in the early and mid-20th century.[60]

Of particular relevance here is ITIF's discussion of broadband deployment, one of the key indicators included within the transformation-to-a-digital-economy category:

> **Why Is This Important?** Over computer networks, bandwidth measures the "size of the pipes" between the sender and receiver of data. Greater bandwidth allows faster transmission of larger amounts of data, which is critical for the increasing number of businesses that use the Internet to communicate with customers, suppliers, and other parts of the company. Broadband access for households is also important, not only allowing a state's residents to more robustly engage in ecommerce, but also enabling telecommuting, distance education, telemedicine, and a host of other applications that can boost productivity and quality of life.[61]

As we will discuss at greater length in Section III.B, below, North Carolina ranks a surprisingly low 26th among the states in the New Economy Index for 2007. According to ITIF, the primary reason for this is the sharp disparity between the North Carolina's urban and rural areas on what it takes to foster a "New Economy."

2. Education

Another important benefit of broadband is its ability to enhance lifetime education. "In the City of the future, education will be open to all. Learning will no longer be confined to particular times in a citizen's life or to particular places. It will be a lifelong process, easy to engage in and accessible anytime, anywhere."[62]

As the California Broadband Task Force has recently observed,

> Broadband networks ... have enhanced education by providing students and teachers with access to a vast array of resources. Text-based materials, photos and images, videos, animations, interactive lessons, data-manipulation tools, oral history collections, music, and educational gaming programs are just a few of the valuable benefits. Interactive 3-D experiences and visual-simulation software allow critical-care nurses, for example, to effectively train from their homes and gain simulated "hands-on" experience comparable to those in a hospital setting. And the future holds even more opportunity. The National Science Foundation (NSF) report "Cyberinfrastructure Vision for 21st Century Discovery," predicts that the "future will see increasingly open access to online educational resources including courseware, knowledge repositories, laboratories, and collaboration tools." To effectively realize this future, access to a robust broadband infrastructure is imperative.[63]

For insights about the higher education community's need for high-capacity next-generation networks with speeds of at least 100 Mbps, we turn to EDUCAUSE, the association representing America's 2,500 colleges and universities. EDUCAUSE's mission is to advance higher education by promoting the intelligent use of information technology. In a recent white paper, EDUCAUSE briefly summarized these needs as follows:

> Distance learning is perhaps the most obvious, but not the only, educational use of bigger bandwidth. Because the majority of today's students live off campus today, the need for big broadband is important to ensure that they receive the same quality of education as on-campus students. Furthermore, many state colleges, especially those in rural states, have extensive distance learning programs to serve students all across the state. Many community colleges need big broadband to provide their students with the same quality of instruction as larger institutions. There are not enough teachers in enough places to meet the need; while it is not physically possible to provide a teacher of advanced calculus to every community, a high-speed network can extend the boundaries of the classroom anywhere.
> ...
>
> [H]igh-quality video can provide meaningful two-way, interactive, real-time educational experiences: a student at home can continue to participate in regular classes; parents can confer with a teacher using a videoconference; study groups can form, with members working on projects together, remotely consulting databases, video libraries, computer simulations, and each other. Virtual field trips can take students and teachers sitting in their classrooms to faraway places, such as touring the Smithsonian National Air and Space Museum, experiencing a tribal dance in Africa, or scouring the depths of the Pacific Ocean in a submarine. Music students can receive lessons from a master instructor hundreds of miles away, who will be able to hear, see, and interact with the student. Homework can be researched using digital archives at the Library of Congress, where 3D objects can be examined from all angles.[64]

Before leaving education, we pause to pose a few important questions: How can children in rural and disadvantaged urban areas that do not have access to bandwidth-rich broadband connections, particularly at home, keep up with students in areas that do? How can children in states that do not have enough certified teachers for higher mathematics and science excel without increased access to certified teachers via distance learning? In a world that is constantly changing at a breathtaking pace, requiring ongoing learning and relearning, how can Americans of all ages compete effectively with their counterparts in the leading nations around the world if they do not have access to comparable 21st Century broadband-based tools of education? The short answer to these questions is that they simply can not.

3. Public Safety and Homeland Security

Public safety and homeland security are of crucial importance in this age. Providing for the safety of the public and assuring rapid, effective responses in case of disasters (manmade or natural) are among the most fundamental obligations of government. Broadband, particularly wireless broadband, is becoming indispensable to police, fire, health, and other government entities that seek to protect the public with increasing skill and efficiency, in both day-to-day and crisis situations.

For example, with a municipal broadband system, fire departments can receive building blueprints wirelessly, directly to fire trucks. One report estimates that they can leave the station 90 seconds faster as a result.[65] To the extent various city departments make data available in a usable format, firefighters can access and transmit other relevant data on the fly, including information from other jurisdictions and departments such as traffic control, transit authorities, county inspectors, the FBI and Homeland Security.

In a study conducted in 2004, Carnegie Mellon University found that putting wireless-enabled laptop computers in police cars gave police officers the ability to file reports from their cars, ultimately allowing them "to spend two extra hours per week on the street, where they can deter and react to crime."[66] A municipal wireless video surveillance system in Rockford, Ill., operational since 2005, has reportedly improved security force productivity by four to six hours per week.[67]

The collapse of the Interstate 35 bridge in Minneapolis on Aug. 1, 2007, offers a prime example of how "the potential for muni networks in disaster response is tremendous."[68] At the time, the City's municipal wireless network was only one-quarter complete, but the completed area happened to include the area surrounding the bridge collapse. When the bridge fell, U.S. Internet, the contractor for the citywide Wi-Fi network, attempted to call the City to offer assistance but could not get through because the cellular phone network was jammed. U.S. Internet immediately opened the network to the general public. Soon, wireless cameras were installed around the collapse site which, working with GIS data, sent to City crews via the network, proved invaluable in assisting the response.

The Department of Homeland Security has also written a paper containing a long list of potential uses for broadband to enhance national security. Its paper describes in detail how broadband can be used successfully in numerous medical, fire, traffic, and other scenarios.[69]

For public safety and homeland security agencies, redundancy is a particularly important issue. Our economy has come to rely on broadband so much that an outage of a few hours – or even minutes – is far more than a mere inconvenience. The recent spate of undersea cable cuts in the Middle East demonstrated that communications networks may be subject to a single point of failure.[70] Despite the Internet's tendency to "route around" such blockages, users who rely on a single node for access may find themselves inconvenienced, or worse, as a result of a system failure of some kind. As a result, redundancy is crucial:

> [T]he construction of one or even two robust communications pipelines into police stations or military posts would still leave the United States vulnerable. The sole reliance on only one or two sources of communications creates an inviting target and, at the very least, creates the potential for deadly communications bottlenecks. Telecommunications businesses won't help us solve this problem. At their best, they work to create greater efficiency by eliminating redundancy. At their worst, they work to eliminate any and all competition so that even efficiency doesn't matter.
>
> When reliability is essential, redundancy is highly valued. When lives are at stake, establishing alternative systems that can do as good a job as any designated primary system is routine. And while our policymakers speak of competition-sometimes even embracing competitive communications infrastructures that might lead to alternative "consumer" choice-policymakers rarely seem to understand that alternatives are essential to national defense and emergency preparedness.
>
> In fact, redundancy is so essential to public safety and national security that where private industry refuses to create these alternatives government must do so.[71]

4. Health Care

Broadband offers great promise in the medical area, particularly given the relentlessly climbing cost of modern health care, the growing expense of complex, high-technology diagnostic equipment, the distance between rural areas and specialized medical hospitals, and the aging of the population in the United States.

As a Joint Advisory Committee on Communications Capabilities of Emergency Medical and Public Health Care Facilities recently reported to Congress:

> Telemedicine and telehealth can:
>
> - Extend the continuum of patient care beyond the "walls" of a hospital
> - Make possible remote access to clinical services for patients
> - Enable distance education, disease management, consumer outreach
> - Provide significantly improved, cost-effective access to quality health care
>
> Broadband also enables a host of remote patient monitoring technologies. Whether patient procrastination, age, isolation, or distance, sometimes patients do not stay in regular medical contact and do not seek appropriate medical care until there is a medical emergency. Innovative home health-care monitoring devices and systems now allow doctors to remotely monitor high-risk patients and their blood-pressure, pulse, and other measures over broadband. Progress can be monitored and intervention made before a medical crisis occurs. These technologies can avoid expensive house calls, provide real-time feedback, and allow resources to be focused on the most urgent cases. Some are even using video over broadband for regular video consults.
>
> Telemedicine is not just about connecting health care to people at home. Every hospital, clinic, doctor's office, and medical facility should have also affordable access to broadband. Broadband access can help level the playing field between urban and rural medical capabilities. With broadband, training becomes more accessible; second opinions don't require long car trips for patients; and live-saving technologies can often be extended to wherever the patient may be located.[72]

The magnitude of the benefits that broadband can provide is highly dependent on connection speed. The transmission of huge, detailed medical imagery and diagnostic files, the use of two-way video communications to facilitate patient monitoring as a substitute for travel between homes and medical facilities, and particularly such bandwidth-rich applications as telesurgery, all require massively more bandwidth than is available to most Americans today. As the examples in this section demonstrate, high-capacity broadband can not only reduce the costs of modern health care, but it can also improve the quality of care and quality of life of those not located near urban facilities.

In a study published in 2005, Robert Litan estimated that using broadband more extensively in caring for senior citizens and persons with disabilities could result in cost savings and productivity gains of at least $927 billion through 2030.[73] Litan noted that such benefits would occur in three main ways: by directly lowering health care costs, by postponing or eliminating the need for institutionalized care, and by enabling increased workforce participation. According to Litan, certain policies that Litan recommends could increase the payoff by another $530 to $850 billion.

Numerous other studies have also found that broadband can dramatically cut health care costs. For example, a paper prepared for the Internet Innovation Alliance reviews many of these studies, including two that were particularly impressive.[74] One found that diabetic patients using a telehealth system average hospitalization costs of $87,000, versus $232,000 for members of a control group who received only traditional in-person nurse visits. The other study found that remote monitoring of health conditions could reduce the number of emergency room visits by 40 percent, cut hospital admissions by 63 percent, and reduce the number of days in the hospital by 60 percent. Similarly, a paper by Alliance for Public Technology cites two other impressive studies, one involving a telehealth program in Alaska that cut Medicaid-reimbursed travel costs by 82 percent, and the other involving a rural telehealth program in Arkansas that saved millions in Medicaid costs and decreased infant mortality.[75]

The California Broadband Task Force notes some additional benefits of broadband on health care that are often overlooked:

> What may be less obvious are the benefits beyond those to the patient. For example, 83 percent of parents of children with special health care needs report driving more than an hour to see a specialist. For many of these families, this driving time results in lost work and missing wages. By allowing families the opportunity to be served

> at local clinics through telemedicine applications that enable remote screening, diagnosis, treatment, and monitoring, families can receive quality care in the communities in which they work and live. Though e-health applications have different bandwidth requirements, applications such as video conferencing, digital x-ray transmission, and remote monitoring require fast broadband connections.[76]

The tremendous promise of broadband-enabled health care would be severely hamstrung if it had to rely solely on a few Megabits of capacity. A crucial part of effective telehealth services is the transmission of high-definition medical images. Under the FCC's former definition of "broadband" (200 kbps), it would take nearly a full day to download a 10 minute diagnostic video clip. At current DSL speeds, it would take almost three hours. Moreover, because DSL and CMS are typically asymmetric – i.e., upload speeds are much slower than download speeds – it would take much longer than three hours for the patient or his local doctor or health care facility with only DSL or CMS to upload the images to forward them to the reviewing health care facility. With a symmetric 100 Mbps broadband connection, it would only take three minutes to transmit the video clip.

In Japan, NTT has a system that helps small-town doctors by relaying images of cell slides, X-rays and other medical data to pathologists in well-staffed city hospitals. Hitachi has developed a rubber mat that can monitor and transmit a person's pulse, blood pressure and other data. Both of these applications rely on fast, dependable broadband connections.

Mark Lloyd recounts the example of a cardiac patient in a small hospital in Guam:

> [The patient] was able to undergo a life-saving heart operation supervised by an expert doctor located 3,500 miles away at Tripler Army Medical Center in Honolulu. The surgery was relatively routine for Dr. Benjamin Berg, who was able to dictate the procedure to a less experienced colleague, monitoring every move and heartbeat with a high-resolution video camera and instant sensor gathering data from the catheter as it was slid carefully into the right chamber of the patient's heart.[77]

In Fort Wayne, Ind., the extensive fiber optic network deployed by Verizon enabled the City to set up a system in which retired nurses help provide health evaluations for low income residents without health insurance over two-way broadband video.[78]

5. Telework

High-capacity broadband networks can enable people to work productively from anywhere. As jobs continue to shift away from manufacturing and toward knowledge-based services, workers, managers, and society at large, are all increasingly realizing the benefits of telework. This works in two distinct ways.

First, knowledge workers can more readily live and work in locations of their choosing, without having to be within commuting distance of a corporate center or other base location. For example, a worker with access to a high-capacity broadband network could live and raise his family in the farmland or mountain regions of North Carolina, or anywhere else in the world, without sacrificing his or her professional interests. Similarly, advanced broadband networks would enable skilled senior citizens from colder climates to move to North Carolina without losing their ability to earn income and stay productive.

Second, studies show that commuters drive 53 to 77 percent less on days that they "telecommute" – i.e., work from home using broadband capabilities – than on days when they drive into their offices.[79] One study estimated that a three-day-a-week telecommuter could save an average of $5,878 a year in commuting costs and would avoid putting 9,060 pounds of pollutants into the environment.[80] Another study estimated that full use of telecommuting opportunities would annually save $3.9 billion in fuel costs and the equivalent of 470,000 in jobs.[81]

These studies, done before the recent run-up in petroleum prices, undoubtedly understate fuel cost savings by a large extent. With crude oil prices having passed $126 a barrel for the first time on May 9, 2008, and estimates of oil prices now as high as $200 a barrel within the next 6-24 months, the savings will surely be much greater.[82] This, in turn, will undoubtedly accelerate the emergence of "virtual workplaces," as Mike Rhodin of IBM has predicted:

> The Virtual Workplace will become the rule. No need to leave the office. Just bring it along. Desk phones and desktop computers will gradually disappear, replaced by mobile devices, including laptops, that take on traditional office capabilities. Social networking tools and virtual world meeting experiences will simulate the feeling of being there in-person. Work models will be changed by expanded globalization and green business initiatives that reduce travel and encourage work at home.[83]

Credit: CNET Networks

But such savings may only be part of the picture. Recent studies suggest that, for a variety of reasons, teleworkers are also more productive and happy. One such study finds:

> [T]o the extent that telecommuting boosts worker productivity, society benefits as the increases in productivity are translated into lower prices (as opposed to higher wages). To date, much of the telecommuting productivity evidence is anecdotal or from self-reported data, but there are good reasons to believe that telecommuting does allow employees in many fields to work more productively. For instance, many workers report that they can accomplish more with fewer interruptions at home. Further, telecommuting also allows employees to work when personal or family needs might otherwise force them to be absent from the office. Finally, telecommuting frees employees from, on average, almost one hour of commuting each day. If any of this time is dedicated to working, it translates into greater output.
>
> For example, by relying on technologies such as broadband, mobile e-mail, and voice, retailer Best Buy was able to give most of its corporate headquarters employees the option of more flexible working hours, including working at home. As a result, productivity increased by thirty-five percent in departments that implemented the program. More and more Best Buy employees are working outside the office, with forty percent of all employees working remotely on any given day. Similarly, airline JetBlue's entire workforce of reservation agents works from home, using a personal computer and a broadband connection. Taken together, these factors make it reasonable to expect that telecommuting can make some workers more productive, yielding benefits for society.[84]

Not only does telecommuting raise worker productivity, but it also enables more people to join or remain in the workforce. Parents staying home to raise children, for example, can work flexible hours from home rather than sacrifice the income altogether. Elderly people can avoid the physical stresses of commuting, and remain productive and engaged.

As broadband applications become increasingly bandwidth-rich, telework will achieve its full potential only if broadband networks have sufficient capacity to handle these applications with ease.

> Home-based businesses can achieve much greater efficiencies from big broadband capabilities. Video editing, game development and serving, engineering/drafting, scientific sample analysis, software development, and other types of independent content creation can be done remotely with a big broadband network, but not with small broadband. According to one source, the availability of fiber networks has quadrupled the amount of time employees spend working from home.[85]

6. Environmental Sustainability

Discussion of the environmental benefits of broadband typically begins with the impact of telework on oil consumption and pollution. As discussed in the prior section, this is certainly a real and important factor. But the environmental implications of broadband go far beyond this.

For one thing, broadband enables buildings to communicate with utilities, utilities to communicate with each other, and the energy market to provide real-time information to both buildings and utilities. "Smart buildings" and "smart grids" hold great promise for dramatic reductions and greater efficiencies in energy consumption.

> One of the ways wiring our homes and offices promises large economic payoffs, along with immense environmental benefits, is by allowing interactive monitoring of and more efficient energy use. By creating "smart buildings" tied to the local power grid, as a 2002 Department of Energy report highlighted, utility companies won't have to keep as much wasted reserve power on hand, leading to "lower prices and less price volatility" which will "create a more resilient electric grid that is more robust and secure against brownouts, blackouts, and hostile attacks"—the latter especially attractive in the wake of the 2003 blackout of much of the Northeast and Canada.[86]

The State of California, for example, is funding an ambitious program targeting energy use by commercial buildings. One third of all electricity consumed in the state is by commercial buildings – about $10 billion per year. The goal of the High-Performance Commercial Buildings Project (HPCBS), launched in 2000, is to cut energy use by 70 percent in new buildings and save 50 percent in retrofits of older buildings using broadband connections combined with other technologies.[87]

Another way that broadband enhances environmental sustainability is by enabling a wide range of programs that can collectively contribute to overcoming global problems that experts believe would otherwise be insurmountable. For example, the cities of Amsterdam, Netherlands; San Francisco,

Ca.; and Seoul, Korea, with support from Cisco, have launched a pilot program to use fiber optic technology to reduce traffic congestion and carbon dioxide emissions.[88]

Similarly, visionaries in the utility industry are exploring ways to use fiber technologies to manage electricity usage in ways that will significantly reduce the need for expensive new power plants. Billy Ray of Glasgow, Ky., has estimated that the cost of providing FTTH connectivity to the nine million homes in the Tennessee Valley Administration (TVA)'s service area would cost no more – and probably far less – than the $18 billion that the TVA proposes to spend on expanding its nuclear facilities over the next 10 years, would result in reduced energy usage equivalent to double or triple the electricity that TVA's investment in new facilities would produce, and would give the residents of the TVA region all of the other benefits that flow from FTTH.[89] World-renown fiber expert, Bill St. Arnaud, has similarly proposed creative means of deploying FTTH through utilities to marry critical energy savings with expanding availability of cheap, ubiquitous FTTH.[90]

Perhaps most important of all, broadband also contributes in countless other ways to environmental protection and sustainability, by making production, distribution, and service processes more efficient. The following excerpts from "Digital Prosperity," ITIF's trenchant analysis of the economic benefits of the information technology revolution, illustrate this:

> Today [information technology] enables just-in-time (JIT) production in which businesses gather better information from suppliers in order to track moment-by-moment changes in the supply chain. The ability to track shipments online allows firms to time production and anticipate bottlenecks in supplies, while up-to-the-minute information about inventories tells suppliers when fresh deliveries are needed. An example of an integrated and informed supply chain is Cisco Systems. Using remote monitoring of production lines, Cisco can detect a problem and adjust production at an assembly line or distribution center immediately in factories across the globe, often not even owned by Cisco, all from its headquarters in San Jose, California.
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> ...
>
> Because of difficulty in predicting demand, transportation equipment is often underutilized. For example, trucks might be fully loaded for delivery, but might make the return trip partially or completely empty. Indeed, about one-fifth of trucks at any one time are "transporting air." With global positioning systems (GPS), cell phones, and wirelessly connected computers, truck drivers and dispatchers can now more easily find loads to pick up for return deliveries. ... The Web enables this kind of demand aggregation. Sites like Getloaded.com act as a matching service, preventing excess capacity from going to waste by connecting trailers that would otherwise be traveling empty with loads that need to go to the same destination. One study found on-board computers that allow managers to better coordinate trucks and loads boosted capacity utilization 3.3 percent and saved $16 billion annually in the $500 billion trucking industry.
>
> ...
>
> New advanced teleconferencing technologies that enable "telepresence" (enabling eye contact between participants, life size images, and no jerky video images) will likely spur even more substitution of travel. ... Compared to reading a newspaper, receiving the news on a PDA wirelessly results in the release of 32 to 140 times less CO2, and several orders of magnitude less NOx and SOx. The energy involved in selling $100 of books for a traditional superstore vs. an online bookseller is 14 times more. Romm documents how a 20 mile round trip to the mall to purchase two 5 pound products consumes about 1 gallon of gasoline. Shipping the packages 1000 miles by truck consumes 0.1 gallon of gasoline.[91]

Not everyone agrees that broadband will reduce travel and the resulting burdens on the environment. For example, Professor Andrew Odlyzco argues,

> The reasons for the simultaneous growth of supposed substitutes are manifold. There is a direct stimulation effect (higher capacity on fiber cables enables off-shoring jobs to India, but the workers there have to be trained, supervised, and coordinated, which means a jump in air travel to and from India). There are also improvements from one technology that are absorbed into another (computer and communications improvements led to better and much less expensive printers, which satisfied the latent demand for printing on the desktop, and have thus far made a mockery of the "paperless office" concept). And there is the old Jevons Paradox, which says that greater efficiency often increases usage ... All these combine to yield a simple observation, with overwhelming evidence going back centuries, that as society develops economically, both communication and transportation boom. They are both services whose consumption grows with technological and economic advances. Thus simply deploying the Internet more widely and

> with increased capacity is likely, in the absence of other developments, to stimulate travel and energy usage. This would be true even without counting the energy usage of the Internet and the computers connected to it.[92]

As Professor Odlyzco recognizes, however, history may not turn out to be instructive here, as diminishing petroleum supplies and skyrocketing energy prices may reinforce broadband-enabled reductions in travel.[93] In any event, even if broadband does not completely displace travel, it can substantially reduce it and its adverse effects.

7. Urban Revitalization

Broadband can play a key role in urban revitalization. Not only do the broadband-based benefits discussed elsewhere in this section apply as well to blighted urban areas (economic development and job creation, public safety and effective law enforcement, telework, a clean environment), but the introduction of broadband can itself serve as a rallying-point that can directly contribute to the resurgence of previously blighted neighborhoods.

An example of a successful project of this kind can be found in Edgewood Terrace, a complex of 792 residences located in northeast Washington, D.C. Through a non-profit community development corporation, a strategy was devised to turn the neighborhood around, including broadband connectivity for each residence through a community network known as "EdgeNet." Fully wired community centers in the neighborhood offer classes in career and skill enhancement. Residential broadband enables seniors to have regular checkups via video and to connect to health care providers.

As the Alliance for Public Technology reports:

> Edgewood Terrace has seen significant benefits from CPDC's efforts. Graduates of the IT skills program dramatically increase their incomes, on average jumping from $9,800 to $28,000. School attendance has improved as children take advantage of after school programs and online resources to improve their academic performance. Residents use broadband tools to work together for common goals, creating a safer, more involved community that has seen a decrease in criminal activity and is once again an attractive place to live.[94]

To be sure, broadband is not a panacea for such a complex and difficult problem as urban revitalization. But it is safe to say that urban areas without robust and affordable broadband will probably not be revitalized as quickly, and marginal neighborhoods may not be saved from blight as successfully.

8. Government Services

In its roadmap to the future for local officials, Cisco includes the following "Broadband Vision for a More Efficient, Citizen-centric City:"

> In the City of the Future, public sector organizations will share tasks and processes with each other in order to capture economies of scale and organization. Their employees will have access to electronic productivity tools, such as online purchasing applications and electronic performance management systems, which will virtually eliminate low value-added administrative tasks. They will be able to communicate better within and across departments and will be freed to focus on providing better service to citizens. Services will be integrated and more easily accessible, and citizens will have more opportunities to shape the services they receive and to participate in public decision-making.[95]

Across the United States today, government agencies at all levels are improving quality, lowering the cost, and increasing the transparency of government service by making it increasingly easy for citizens to interact with them online and by using information technology to improve internal government operations in a variety of ways. Broadband is playing a significant role in this, and it holds the key to how much and how fast further progress will occur in the future.

Given the many ways that e-government can be defined and implemented, it is difficult to make accurate estimates of its financial benefits.[96] It is clear, however, that such benefits are enormous. For example, the federal Office of Management and Budget reported to Congress that certain federal e-government initiatives resulted in benefits totaling $508 million in Fiscal Year 2008.[97] The United Nations has estimated that e-government initiatives can result in cost savings of 10-50 percent, and the U.S. Department of Commerce, focusing just on savings in procurements, has estimated annual savings of $49 *billion* by the federal government and $58 *billion* by state and local governments.[98]

Examining the benefits of e-government services from the standpoint of citizens, the Pew Foundation recently examined how citizens go about solving a variety of problems, such as dealing with serious illnesses or health concerns; making important decisions about schools, upgrading work

skills, starting businesses; dealing with Medicare, Medicaid, Food Stamp, military and other benefits; addressing voter registration and government policies; becoming involved in legal matters, etc. Pew found that 58 percent of the adults who had recently experienced one of those problems said they used the Internet (at home, work, a public library or some other place) to get help; that of those who used the Internet, 63 percent believed that they had been very successful; and that those who used broadband were substantially more likely to report success (63 percent) than those who did not use the Internet or did so through dial-up connections (collectively 54 percent).[99]

The Pew study did not break down the data further, so one cannot precisely determine why 37 percent of Internet users did not believe they were successful. Some of them might have faced problems for which there simply were no good solutions. Some might have had inadequate search skills. Some might have given up after visiting some government websites that did not provide useful information or were difficult to use. Whatever the reasons, the study suggests that there are two avenues for improvement – making government websites even more useful to citizens and increasing the percentage of citizens who use broadband for their searches.

Access to high-capacity broadband could improve matters even further. For one thing, it would enable citizens to perform their searches more quickly, resulting in increased success rates. It would also pave the way for bandwidth-rich video and other applications that could enhance citizens' online experiences.

In the last few years, government agencies have used broadband to improve their internal operations in many ways. We have already discussed some of these improvements in the preceding parts of this section. Others include developing and using GIS and GPS data in increasingly sophisticated ways, enhancing mobility and cost-effectiveness of inspectors and enforcement personnel, using broadband to make meter-reading, parking, and traffic control easier, cheaper, and more accurate; and a virtually endless list of other examples. Opportunities for improvement also abound, particularly through the introduction of high-capacity broadband.

9. Senior Citizens

The Census Bureau predicts that, by 2030, the number of Americans over 65 will have increased by 104 percent compared to 2000 and will make up nearly 20 percent of the overall population.[100] Also, a substantial percentage of elderly citizens reside in rural areas, making physical isolation a potentially significant problem.

Access to affordable, world-class broadband can provide dramatic benefits for this growing segment of the population. Broadband-enabled technology can enable home-based rehabilitation and monitoring services, allowing seniors to "age in place," receiving services in their homes rather than in institutional settings. It can enable seniors to live anywhere they choose and still stay connected with their families and friends. Many seniors will not want to retire completely – or will not be able to afford to do so. Some will want to start new careers or projects. Some will want to serve as volunteers or mentors. High-capacity broadband connectivity will make all of these options available to them.

Affording senior citizens the means to stay productive will not just benefit them; public and private entities across the nation have a huge stake in being able to tap into the experience and expertise of these individuals.

> The coming surge in the retirement of workers born into the Baby Boomer generation represents a significant risk to private-sector and public-sector organizations that cannot be ignored. The problem affects many occupations, but it varies widely by geography, occupation, and gender. CIOs should ensure that their peers on the executive management team take action to mitigate the threat and retain the intellectual property stored in the heads of all staff, before it retires along with its owners.[101]

Recognizing the need to "improve the daily lives and social participation of older people and create new opportunities for Europe's industry," the European Commission launched an action plan in June 2007 entitled "Ageing Well in the Information Society."[102] The Plan aims at:

- overcoming technical and regulatory barriers to market development, through market assessments and by facilitating the exchange of best practices between Member States;
- raising awareness, and building consensus via stakeholder cooperation in 2007 and the establishment of a best practice internet portal;
- accelerating take-up through, for example, a set of pilot projects and a European award scheme for smart homes and independent living applications; and

- boosting research and innovation by immediately supporting a joint public-private research programme dedicated to "ambient assisted living". It aims to foster the emergence of innovative, [Information and Communications Technology]-based products, services and systems for Europe's ageing population.

10. Disabled Persons

Disabled individuals suffer from many of the same disadvantages as senior citizens, but they also have their own special needs. As with senior citizens, broadband offers disabled people the ability to remove the "remoteness" in their lives and live more satisfying and productive lives.

Many of the benefits that broadband offers are of special value to handicapped individuals. For example, speech and hearing impaired individuals may find email, instant messages and other written means of communication to be of particular value.

In addition, in the last few years, several specialized broadband-based applications have begun to address the special needs of disabled individuals. For example, there are now several websites that provide language, pictures, news, chat rooms, and other features that focus on individuals with particular handicaps.[103] Deaf and hearing impaired individuals can now communicate with each other through sign language with a technique known as "two way video," which involves using webcams at each end over broadband connections. Similarly, blind and visually impaired people can use "screen reader" programs that audibly describe website material to users, and special software programs now exist to interpret screen content into Braille.[104] Various other "assistive technologies" are also emerging.[105]

Despite these improvements, disabled individuals are about half as likely to use the Internet as the general public, especially in rural areas.[106] While organizations such as the Blandin Foundation have stepped forward with small grants to support development of additional broadband applications,[107] much more needs to be done.

11. Young People

Dr. Jonas Salk, inventor of the polio vaccine, once said that "Our greatest responsibility is to be good ancestors." In the same vein, when supporters of local broadband initiatives explain their reasons for doing so, they almost invariably include at or near the top of their lists "Giving our young people a reason to stay in the community." If we do not promptly provide our young people affordable access to world-class broadband networks, we will do them and our nation a grave disservice.

In *Wikinomics*, Don Tapscott and Anthony Williams maintain that young people born between the 1977 and 1996, known as the "Net Generation" (a/k/a "Millennials" or "Digital Natives"), are worth special investigation because they "represent the new breed of workers, learners, consumers, and citizens" and "are bringing a new ethic of openness, participation, and interactivity to workplaces, communities, and markets."[108]

> [I]nternationally the Net Generation is huge, numbering over two billion people. This is the first generation to grow up in the digital age, and that makes them a force for collaboration. They are growing up bathed in bits. ... Unlike their parents in the United States, who watched twenty-four hours of television per week, these youngsters are growing up interacting.
>
> Rather than being passive recipients of mass consumer culture, the Net Gen spend time searching, reading, scrutinizing, authenticating, collaborating, and organizing (everything from their MP3 files to protest demonstrations). The Internet makes life an ongoing, massive collaboration, and this generation loves it. They typically can't imagine a life where citizens didn't have the tools to constantly think critically, exchange views, challenge, authenticate, verify, or debunk. While their parents were passive consumers of media, youth today are active creators of media content and hungry for interaction.
>
> ...
>
> N-Geners...increasingly satisfy their desire for choice, convenience, customization, and control by designing, producing, and distributing products themselves. Indeed, N-Geners are not only creating new art forms, they're helping to engender a new creative and philosophical openness.
>
> ...
>
> Past generations have each brought unique characteristics to the workplace, but the high-technology adoption, creativity, social connectivity, and diversity embodied in the N-Gen genuinely differentiates it from others. As workers, this

> generation will transform the workplace and the way business is conducted to an extent not witnessed since the "organization man" of the 1950s.[109]

According to the Pew Foundation, members of the Net Generation have the following characteristics:

- 97% own a computer
- 94% own a cell phone
- 56% own an MP3 player
- 76% use instant messages
- 76% are online an average of 35 hours a week
- 75% do schoolwork while instant messaging
- 24% own a blog
- 44% read blogs
- 34% get their news primarily from Web sites
- 69% have a Facebook account or something like it[110]

In other studies, the Pew Foundation has found that 63 percent of young people (18-29 years old) surveyed use broadband, the highest population demographic to do so.[111] More than 55 percent use it to participate in "social networks"[112] – which we discuss at greater length in the next section. Young people also use broadband more than any other group to obtain news. According to researcher John Horrigan of the Pew Foundation, "For many of these young broadband users, the Internet is their main course for news, and they don't always eat their vegetables or order dessert in the form of using other media."[113] This has become particularly true of news about the presidential campaign:

> [T]he Internet has now become a leading source of campaign news for young people and the role of social networking sites such as MySpace and Facebook is a notable part of the story. Fully 42% of those ages 18 to 29 say they regularly learn about the campaign from the internet, the highest percentage for any news source. In January 2004, just 20% of young people said they routinely got campaign news from the internet.[114]

Young people are also using broadband to make a variety of valuable contributions to the well-being of the world. In *Wikinomics*, Tapscott and Williams give the following example:

> TakingITGlobal is one of the world's best examples of how N-Geners are using digital technologies to transform the world around them. With 110,000 registered members in nearly two hundred countries, a Web site in seven languages, and five million unique visitors, one could mistake TakingITGlobal for the United Nations. In a sense, you wouldn't be wrong. After all, its members rub shoulders with business and government leaders at the World Economic Forum in Davos and the World Summit on Sustainable Development. Plus the site lists over two thousand youth-initiated-and-managed community action projects that tackle tough issues ranging from closing the digital divide in rural India to preventing HIV in Uganda. This United Nations is run not by senior diplomats, but entirely by young people aged thirteen to twenty-four year olds.
>
> Like MySpace and Facebook, TakingITGlobal harnesses all of the latest tools, such as blogging, instant messaging, and media sharing. But it promotes a decidedly different kind of social networking. Rather than list their favorite movie stars and music tracks, members list information about the languages they speak, the countries they have visited, and the issues they're most concerned about. Members link to other members' profiles when they share similar interests, and those links create social connections that lead to new friendships and projects. Cofounder Jennifer Corriero calls TakingITGlobal "a platform to support collaboration among young people in developing projects, in understanding and grappling issues, and influencing the decision-making processes, especially around those issues that are directly affecting young people."[115]

As increasingly bandwidth-rich applications emerge, young people will insist on affordable access to high-capacity broadband networks that can handle them, or will relocate to get such access. As discussed in the next section, this trend has already begun for broadband video, which young people have embraced much more rapidly than any other age group.[116] The Nemertes Research Group recently made much the same point in explaining why the growth of Internet traffic is accelerating rapidly:

> It's true that there's often a significant time lag between the point in time when an innovation is introduced and when it reaches widescale deployment. But as has been discussed copiously elsewhere, the millennial generation (18 and under) that is coming of age is comprised of people with demonstrated capacity to adopt networked applications in widespread fashion in record time – 12-18 months or less. (Examples include YouTube, Facebook, etc.) Based on the best available data, including that from the Center for Digital Life, Internet users today, and younger users in particular, are:
>
> - Multitasking (two-thirds say they run more than one application at one time)
> - Running multiple IP-enabled devices at once (in other words, it's not either/or it's both/and)
> - Switching preferentially from non-IP applications to IP-based versions of the same applications (for example, listening to radio streams on the 'Net rather than via satellite or radio, and watching television shows on the 'Net instead of on TV).[117]

Furthermore, as Richard Florida wrote in *The Flight of the Creative Class: The New Global Competition*, the United States is becoming less and less attractive to the world's creative class, while the reverse is becoming increasingly true of many other countries.[118] Loss of young people has long been a major problem for rural communities, and now it is becoming a growing issue for major cities as well. To turn this around, the United States must do much more than it is currently doing.

In its thoughtful paper on the need for universal broadband now, the Center for Creative Voices in Media (CCVM) quotes an incisive passage from an essay in *The Economist*:

> ...people no longer passively 'consume' media (and thus advertising, its main revenue source) but actively participate in them, which usually means creating content, in whatever form and on whatever scale... What is new is that young people today, and most people in the future, will be happy to decide for themselves what is credible or worthwhile and what is not. They will have plenty of help. Sometimes they will rely on human editors of their choosing; at other times they will rely on collective intelligence in the form of new filtering and collaboration technologies that are now being developed. "The old media model was: there is one source of truth. The new media model is: there are multiple sources of truth, and we will sort it out," says Joe Kraus, the founder of JotSpot, which makes software for wikis.[119]

CCVM then concludes that "the crucial prerequisite for widespread citizen participation in this oncoming media revolution is universal, high speed, always-on access to the Internet. Without that access, America's Digital Divide will also be America's "News, Information, Culture, and Entertainment Divide." We agree.

12. Entertainment

Last, we come to entertainment. While some may view entertainment as a luxury that is unworthy of serious government attention, it is undeniably a critical part of the broadband picture. In fact, entertainment is probably the leading driver of broadband deployment today.

In this section, we emphasize the entertainment-related benefits of broadband, focusing on three key applications: broadband video, social networking, and gaming. Before doing so, however, we wish to make clear that entertainment is not the only use for these applications. To the contrary, they are also widely used for business, social, and other purposes, including several of the purposes discussed in the previous sections.

a. Broadband Video

According to Bret Swanson and George Gilder, video is the key driver of broadband supply and demand:

> New technologies are driving a deep transformation of the Internet's capabilities and uses. We are entering a new phase. The first phase of the Internet, starting with Arpanet in 1969, was a small research project that linked together

> a few, and then a few thousand, scientists. They exchanged rudimentary messages and data. In the mid-1990s the second broad phase delivered the Internet to the masses with e-mail, graphical browsers, and the World Wide Web.
>
> Today, the third phase is underway. Video over the Net portends innumerable consumer and commercial possibilities. This new medium will change every realm of communication and content. The broadcast petabyte flows of radio and television will branch out into narrowcast, multicast, mobilecast, and everycast streams. With real-time transactions and collaborations, rich images, video, and interactive virtual worlds, the Net's current content of static text and pictures will swell to form exabyte rivers. We call this third phase of rich broadband content the Exaflood.[120]

To the major communications companies, particularly telephone companies, the dominant driver of broadband deployment is television, particularly high-definition television:

> Video is by far the largest driver. ... Starting with sub-100-Mbit/sec services in 2010, [operators] expect a tenfold increase in demand per decade, reaching as much as 10 Gbits/sec per home by 2030.
>
> ...
>
> ...Consumer demand for more high-definition channels, added video streams, and time-shifted television has network operators scrambling to stay ahead of their subscribers' bandwidth appetite. Today's access networks, even PONs [Passive Optical Networks], will not support tomorrow's needs.
>
> ...Bandwidth needed per home is more than quadrupling from today's requirements. In the not-so-distant future, demand per home will increase from about 30 Mbits/sec per subscriber to more than 125 Mbits/sec. Today's GEPON and GPON technologies that deliver 1 Gbit/sec and 2.5 Gbits/sec, respectively, with a 32-split topology are adequate for today. But as more HDTV channels and video services are added to the service lineup, today's PONs [Passive Optical Networks] will fall short. With 64 splits, next-generation PON systems will need to supply 8.1-Gbit/sec payloads to meet the demand. Even if the next-generation topology only matches today's 32 splits per PON, more than 4 Gbits/sec will be required for residential deployments, which is well beyond today's PON capabilities.[121]

While traditional television programming (whether or not in high definition) is likely to be for some time the dominant driver for broadband deployment, it is not the only kind of broadband video that is making headway in the market. One other kind is video-to-computer service, such as YouTube clips and on-demand streamed movies from NetFlix and television shows from Hulu. Another kind is video conference calls – called "telepresence" when rendered in extremely high quality. Both of these other kinds of video service are growing rapidly and will consume ever-increasing quantities of bandwidth.

In a recent article in *USA TODAY*, Leslie Cauley, quoting Phillipe Morin, a division manager at Nortel, described in especially memorable language the coming explosion of bandwidth-gobbling video-to-computer service:

> Video is the biggest driver of bandwidth consumption, by far. Online video-viewing soared 66% in the USA in February from a year earlier, according to market tracker ComScore.
>
> Video site YouTube reflects the trend. It fields 100 million video downloads and 65 million video uploads daily. And a high-definition video-streaming option is on the way. Once that happens, high-definition video will go mainstream, Morin predicts.
>
> The problem: High-definition video is the Humvee of broadband, guzzling five times as much capacity as regular video. Once high-definition video takes off, bandwidth consumption, now at a record high, could blow into the stratosphere, Morin says.[122]

In particular, video-to-computer services are growing at explosive rates among young people – whose unique characteristics and needs we discussed in the previous section. According to a recent study by the Leichtman Research Group, young people between the ages of 18 and 34, especially males, have begun a "macro trend" that is likely to spread quickly to the rest of the population.[123]

> This is a macro trend that all programmers need to be in synch with. Previous technology adoption patterns show that what starts with young, and often male, early adopters, eventually spreads out to other groups as well. There's

> no putting the broadband video genie back in the bottle. Three-to-five years from now, virtually all Internet users will view video as just another routine application, alongside email, search, commerce, etc. Today's video providers need to position themselves properly.[124]

The Leichtman study indicates that 80 percent of males aged 18-34 watch video online at least once a month, 64% do so at least once a week, and 22 percent do so at least once a day. The comparable figures for females in the same age group are 54, 35, and 12 percents.[125]

b. Social Networking

According to a new study by Datamonitor, "social networks" have grown "explosively" over the last few years, reaching some 230 million members by the end of 2007 and generating an estimated $965 million in revenues from social-networking services in 2007. Revenues are expected to grow to $2.4 billion by 2012.[126] The following is a succinct description of social networks and Web 2.0:

> Social media is one of the defining characteristics of Web 2.0, a term used to describe the set of technologies, applications, and other elements defining the current stage of evolution of the Internet. The term encompasses the change from a "flat" web model to a highly dynamic mix of rich applications. These latest technologies enable a much higher participatory role for users in the generation of information content and a new level of interactivity of users with information and among themselves, among other features. Social media involves a wide range of technologies and services, including blogs (Blogger, Blogflux, etc.); wikis (Wikipedia, Wikia, Wetpaint, etc); social networking sites (MySpace, facebook.com, gather.com, etc.); video and picture sharing sites (YouTube, Flickr, Google Video, etc.); social bookmarking sites (del.icio.us, Digg, reddit, etc.); chat services (Yahoo!Chat, Skype, Windows Live Messenger, Gmail chat, etc.); virtual worlds (Second Life, Active Worlds, There, etc.); as well as podcasts, forums, and others.[127]

Another noteworthy phenomenon is the emergence of "virtual worlds." According to Susan Tenby and Beth Kanter, "[b]logs, wikis, and podcasts are just a few of the burgeoning tools nonprofits use to connect, engage constituents, and collaborate. All have revolutionized the way people interact online, but a new 3-D, virtual world called Second Life is taking things one step further."[128]

> Linden Lab's Second Life is an immersive online world where nearly 850,000 (and growing) residents – also called "avatars" – can purchase their own property on land allotments, interact with other avatars, build anything imaginable, and buy and sell products and services. But unlike reality, Second Life avatars can also fly, make copies of certain products (say, a t-shirt) without any new materials, or take on [a] completely different form – a fox, a space alien, or a hybrid of the two. The options are limited only by your imagination.[129]

Victor Cid and Laura Bartlett provide additional details about Second Life:

> Participation is free, but a paid subscription is required for a few advanced features. The highly graphical and interactive medium allows for an elaborate level of social interaction and can potentially enable new ways to present, access, and interact with information. Mechanisms embedded in the virtual world allow its residents to create applications that communicate with the web, allowing both virtual environments to converge. Although [Second Life] is a very popular virtual world today, it is not the only such virtual environment on the Internet. Other prominent ones include Active Worlds, There, and Entropia Universe. Second Life and other virtual worlds have their own virtual economy that is connected to the real economy.[130]

While some people may consider the virtual world "a quirky hub for bizarre subcultures and utopian dreamers" or something frivolous or even dangerous,[131] it has become a $1 billion business, attracting a flood of venture capital.[132] Moreover, the virtual world has become important enough for a number of government agencies and hundreds of private companies and universities to participate in them.

> For example, the National Oceanic and Atmospheric Administration is displaying 3-D simulations of hurricanes, tsunamis, and other environmental events; the Centers for Disease Control and Prevention is providing access to health information; and the National Aeronautics and Space Administration is showcasing 3-D models of its spacecraft. Many organizations and other groups conduct meetings and other regular activities in this environment. Political candidates and activists have held virtual political rallies, and a number of government officials have made live presentations to the (virtual) public participating in this medium.[133]

Mary Beth Henry, deputy director of the City of Portland's cable commission, has documented several other examples of recent nonprofit and educational events in, or inspired by, Second Life:

- The American Cancer Society raised more than $40,000 through its Second Life Relay for Life event.[134]
- The San Jose Technology Museum, in collaboration with Linden Lab, built a scaled-down version of Second Life as a way to help children explore virtual worlds and expand their creativity in new ways.[135]
- A variety of nonprofits are using Second Life to promote their causes and enhance their operations.[136]
- The George Eastman House, said to be the world's oldest photography museum, has set up in Second Life an exhibit, "Seeing Ourselves: American Face," that emulates a real-world tour of the photographs.[137]
- Educators are using Second Life to present seminars, stage performances, and storytelling sessions designed to help youth learn about other cultures.[138]
- People with disabilities are using Second Life to explore environments in which physical constraints are minimized and they have almost absolute control over their avatars' features and actions.[139]

Quite clearly, the virtual world is more than just a place to escape real-world reality but can also be a useful vehicle for achieving important societal goals.

c. Online Gaming

Online gaming is a major driver of demand for bandwidth. "Online gaming needs no venue except the seat of a PC or a TV. And, it is going to eat up a great deal of bandwidth and needs to compete with IPTV and VoIP as another bandwidth-hungry application clogging the Internet."[140]

Gamers want the fastest pipes around so they won't lag behind their competitors in "massively multiplayer online games" which involve "hundreds or thousands of players online simultaneously," who "cooperate and compete with each other on a grand scale."[141] And through broadband new capabilities are made possible, like live voice communications between players.

According to a recent report, online gaming is a substantial global business now and will quadruple by 2011, driven in part by the increasing availability of broadband:

> Online gaming is big, and with the spike in broadband Internet subscribers and all three next-generation systems making it a major part of their strategy, it only looks to be getting bigger. But how much bigger?
>
> About four times bigger than it is today, according to industry-research firm DFC Intelligence. In its latest report, the firm has pegged the worldwide online market to effectively quadruple in the next five years, going from $3.4 billion last year to more than $13 billion in 2011.[142]

Who are these players? In the United States, according to NPD Group, about 42 percent of the population played online video games in 2007. About 40 percent of these online gamers were between two and 17 years old (children aged six through twelve drove this category), while children between the ages of two through twelve accounted for over 25 percent of online gaming, and 18-24 year-olds were responsible for 10 percent.[143]

As to adults, Parks Associates reports that 34 percent of adult Internet users in the United States played online games on a weekly basis, compared with 29 percent who watched short online videos and 19% who visited social networking sites with the same frequency.[144] The Electronic Software Association adds that 67 percent of gamers were heads of households and averaged 33 years of age.[145]

13. Other Emerging Broadband Drivers

a. The "Internet of Things"

The combination of ubiquitous broadband, embedded wireless sensor technology, and automation presents a striking picture of a broadband infrastructure's long-term possibilities, particularly as costs decrease and capabilities increase. As UCLA's Center for Embedded Network Sensing explains, such a network involves "robust distributed systems of thousands of physically-embedded, unattended and often untethered devices."[146] The concept mirrors a vision described over a decade ago by the late Mark Weiser, referred to as "the Internet of Things," in which tiny, inexpensive radio transceivers would be installed in various everyday items, "enabling new forms of communication between people and things, and between things themselves."[147]

The presence of various types of radiofrequency identification devices (RFID) in items as diverse as inventory pallets,[148] automobiles,[149] passports, pets,[150] and even humans[151] presages a future in which the presence of embedded wireless devices becomes far more widespread. Many current examples of RFID tag usage do not rely upon a broadband connection, requiring the close proximity of specialized sensor devices. The sensor devices themselves, though, may well be increasingly Internet-connected, and there is no shortage of innovative ideas for the future of this field.

There are several notable examples of innovative applications already in use that pair embedded wireless sensors and broadband connectivity. One such application is Automated Meter Reading (AMR), a technology now employed by numerous municipal electric utilities across the country.[152] With AMR technology, cities have the ability to check meters (typically those measuring electricity, but also sometimes applied to those measuring natural gas and water) as often as necessary and can match usage with price fluctuations. The U.S. Energy Policy Act of 2005 recommends that utility regulators support a "time-based rate schedule [to] enable the electric consumer to manage energy use and cost through advanced metering and communications technology."[153] Utility companies in the U.S. and elsewhere are exploring various approaches for doing so, virtually all of which rely on some sort of wireless sensor technology.

One of the first municipalities to use a municipal Wi-Fi network for AMR was Corpus Christi, Texas. In 2002, Corpus Christi decided to automate meter reading for municipal gas and water services supplying a 147-square-mile area.[154] Human meter readers were running into several difficulties caused by fences and dogs, among other complications, and the City was receiving several complaints daily from customers who believed their reading was incorrect.[155] This municipal Wi-Fi application eliminates these problems. Overall, the City spent around $20 million for their AMR and Wi-Fi network, which reportedly will provide a $30 million savings over the estimated $50 million that they would have spent over the next twenty years without an AMR system.[156] A similar AMR system in Anderson, Ind., is expected to save the city $18 million over 15 years.[157] Likewise, in Northern California, nine million customers of Pacific Gas & Electric are being retrofitted with smart meters, which will report electricity consumption in their homes on an hourly basis.[158] PG&E can alter pricing by season and time of day, and provide discounted rates to customers who shift energy usage to off-peak periods.[159] Similarly, the Los Angeles Department of Water and Power, the nation's largest municipal utility, has expanded its AMR system.[160]

Wireless sensor technology has many potential uses beyond AMR. A pilot project in Cambridge, Mass. involves the mounting of over 100 Wi-Fi-enabled sensors on streetlamps, from which they will also draw power. These sensors will allow researchers to track pollution and weather and experiment with models for the distribution of biological agents.[161]

Wireless sensors could also be used to notify a municipal employee when it is necessary to visit a particular facility or device, with the labor time saved in eliminating needless trips rapidly paying for the cost of the technology. A Wi-Fi enabled parking meter could send a signal to a local enforcement officer when the meter has expired. A trip to the meter even could be eliminated entirely if the sensor was rigged to take a picture of the offending vehicle's license plate.[162] A municipal trash receptacle in a remote public park might send a message to the sanitation department when it is ready to be emptied, eliminating wasteful trips.

These sorts of sensor-based applications are not entirely new. For years, industrial processes and critical facilities have used large-scale measurement and control systems known as SCADA (Supervisory Control and Data Acquisition).[163] Used extensively to protect and monitor critical facilities such as power plants, SCADA refers to the ability of sensor-equipped buildings, facilities or other devices to automatically communicate with a designated person or process upon a particular event. For example, if a fire alarm is triggered in a room in a plant, or if a video camera notices motion where there should be none, software can instantly notify a particular chain of command or public safety response. As SCADA-like concepts and technology are scaled more broadly to the municipal level – with the possibility of sensor-equipped manhole covers, hydrants, traffic lights, switches, trash cans, vehicles, etc. – imaginative applications with potentially dramatic benefits to governments and citizens will emerge.

In summary, as the "Internet of Things" becomes increasingly pervasive in our lives, it will increasingly add to Internet traffic and demands on broadband networks. This is particularly true of video-based applications.

b. Web 2.0

The term "Web 2.0" was officially coined in 2004 by Dale Dougherty, a vice-president of O'Reilly Media. It is sometimes described as a trend in the *use* of World Wide Web technology and design to enhance creativity, information sharing, and, most notably, collaboration among users.[164] It has also come to mean a second generation of technology and design of the Web. Tim O'Reilly has himself defined "Web 2.0" as "a set of economic, social, and technology trends that collectively form the basis for the next generation of the Internet – a more distinctive medium characterized by user participation, openness, and network effects."[165]

Below are some examples of Web 2.0 services/applications:

- "Blogs" (short for Web logs) are Web pages consisting of regular entries of commentary, descriptions of events, or other material, such as graphics or video, that typically focus on particular topics. Entries are commonly displayed in reverse chronological order.[166]
- "Multimedia Sharing" is the storage and sharing of multimedia content. An example is YouTube, a video sharing website to which users can upload, view and share video clips.[167]
- "Podcasts" (audio blogs) are "audio recordings, usually in MP3 format, of talks, interviews and lectures, which can be played either on a desktop computer or on a wide range of handheld MP3 devices [such as iPODs]."[168] Podcasts can now also include video (called "vidcasts" or "vodcasts").[169]
- "Wikis" are collections of webpages designed to enable anyone who accesses them to contribute or modify content, using a simplified markup language. Wikis are often used to create collaborative websites and to power community websites.[170]
- "Social Bookmarking" is a method for Internet users to store, organize, search, and manage bookmarks of webpages on the Internet with the help of metadata.[171] Examples are digg.com and del.icio.us.
- "Mashups" are applications "that combine data from two or more sources to create something more valuable than the sum of their parts."[172] An example would be a service that combines Google maps with real estate listings.
- "Really Simple Syndication" or "Rich Site Summary" (both "RSS") is "a family of formats which allow users to find out about updates to the content of RSS-enabled websites, blogs or podcasts without actually having to go and visit the site. Instead, information from the website (typically, a news story's title and synopsis, along with the originating website's name) is collected within a feed (which uses the RSS format) and 'piped' to the user in a process known as syndication. In order to be able to use a feed a prospective user must install a software tool known as an *aggregator* or *feed reader*, onto their computer desktop. Once this has been done, the user must decide which RSS feeds they want to receive and then *subscribe* to them. The client software will then periodically check for updates to the RSS feed and keep the user informed of any changes."[173]

In his seminal article, "What is Web 2.0: Design Patterns and Models for the Next Generation of Software," Tim O'Reilly sought to clarify what Web 2.0 meant, focusing on seven fundamental principles: The Web as platform, Harnessing collective intelligence, Data is the next 'Intel inside,' End of the software release cycle, Lightweight programming models, Software above the level of single device, and Rich user experiences.[174] In his brilliant paper, "What is Web 2.0? Ideas, technologies and implications for education," Paul Anderson boils these principles down to six less technical issues and provides the following insights about them.[175]

(1) Individual production and user-generated content

In the first stage of the Web, websites were generally one-dimensional and one-directional – i.e., site owners, usually large companies, posted information and users browsed through it. User interaction was largely limited to placing orders and filling in forms. Today, millions of users upload pictures or videos from digital cameras, tag and share information with friends, write blogs, create podcasts, work on wikis, etc.

(2) Harnessing the power of the crowd

This principle is based on the James Surowiecki's book, "Wisdom of Crowds." In the book, Surowiecki, a columnist for the *New Yorker*, demonstrates how groups operating according to specific conditions can solve problems more effectively than even the most intelligent individual member of the group.

(3) Data on an epic scale

In the Information Age, vast amounts of information are being generated and used at all times. A great deal of data is gathered, aggregated, and used by companies such as Google, eBay, Amazon, and others, as a byproduct of our ordinary uses of the Internet. For example, Amazon records our book buying choices, combines them with other information about us and others like us, recommends other books that we may enjoy, and markets the information to other vendors. Rhapsody and iTunes do the same with our music preferences. Such practices may be beneficial on some levels, but they can also create privacy issues.

(4) Architecture of participation

Architecture of participation basically means that the way a service is actually designed can improve and facilitate mass user participation. At a more sophisticated level, the architecture of participation occurs when, through normal use of an application or service, the service itself gets better. To the user, this appears to be a side effect of using the service, but in fact, the system has been designed to take user interactions and utilize them to improve itself (e.g. Google search).

(5) The Network Effect

The "Network Effect" is the economic and social principle that, the more users there are of a network service, the more valuable the service will be for everyone. Once the Network Effect begins to build and people become aware of the increase in a service's popularity, the service often takes off very rapidly in a marketplace.

(6) Openness

The Web has a long history and strong tradition of openness. While many of the major network owners and content creators are seeking to control network access and rights to digital content, Web 2.0 remains committed to openness. It does so through open standards, open-source software (such as Linux), free data, and collaborative innovation.

✦✦✦

As time goes on, the global information workforce will increasingly use Web 2.0 processes. That is particularly true of "hyperconnected" individuals – those who "have fully embraced the brave new world, with more devices per capita than the other clusters and more intense use of new communications applications. They liberally use technology devices and applications for both personal and business use."[176] According to Nortel and IDC, these individuals currently account for 16 percent of the global information workforce, and another 36 percent is about to join them. They are "the first dwellers in the Web 2.0 society, but they won't be the last. Whether they are creating this Web 2.0 society or the Web 2.0 society is creating them, it is almost certain they, together with those who follow them, will dramatically change the enterprise work environment, perhaps beyond recognition."[177]

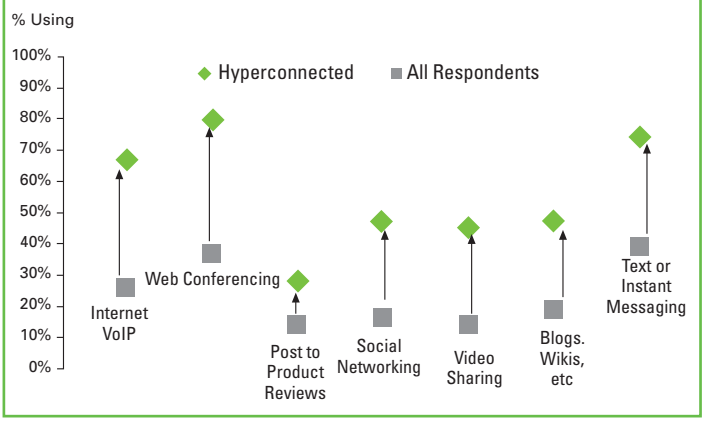
Hyperconnected individuals have the following characteristics:

- They are found in all countries, although higher than average in the U.S. and China
- They are found in all industries, but are above the average in banking and high tech industries
- They come from all job functions and occupations, but are above the average in IT and research and development functions, [and] lower than average in sales
- They come from all levels of the corporate ladder, but are above average in management positions
- They can be any age, although 60% are under 35, only 7% over 55
- They can be either male or female, but 60% are male
- They have wired homes – 63% have home Wi-Fi versus the average of 40%
- They tend to live in urban areas more than the other clusters
- They listen to more MP3s and play more networked games than the other clusters
- They push the envelope – leading the clusters in adoption of the Amazon Kindle, Apple iPhone, and Slingbox video transmitter
- They'd take their laptop out before their wallet or even mobile phone if they had to leave their house for 24 hours
- They see Hyperconnectivity as normal with less than a third thinking of themselves as early adopters of technology
- They tend to work for companies that are also early adopters and enable their employees to use advanced tools and solutions[178]

The Web 2.0 processes that such individuals use for business are as follows:[179]

Figure 1

Applications Used by Respondents for Business



Source: IDC

Looking ahead, it is not clear what shape Web 2.0 will take from a technological standpoint. Will "cloud computing" (running personal and business applications and data off central computers) be the "the story of our lifetime," with eventually everything being done over the Net, as Google's CEO Eric Schmidt maintains?[180] Or will it "just be a passing vapor,"[181] as Intel believes? What other technological options are there? There is little consensus on such issues. From a user standpoint, however, there is little doubt that the main principles underlying Web 2.0, as outlined above, are here to stay and will only grow more important as time goes on.

14. Putting It All Together

Perhaps most important of all is that bandwidth requirements are cumulative. While system designers typically employ complex "contention ratios" (also known as "oversubscription" formulas) to account for potential sharing of bandwidth at various times and places,[182] networks can succeed only if they have enough bandwidth to meet all current and future bandwidth needs, both predictable and unpredictable. If there is one thing that the discussion above should make clear, it is that the United States and North Carolina have not even begun to take advantage of all the benefits that broadband can provide.

II. BROADBAND DEPLOYMENT TODAY AND TOMORROW

In his thoughtful new book, *Innovation Nation: How America is Losing Its Innovation Edge, Why It Matters, and What We Can Do to Get It Back*, John Kao observes,

> The eighth-century Scottish writer Alexander Tytler is said to have argued that all great nations reenact an inevitable cycle that takes them from bondage through liberty to abundance, and then from complacency through dependence back to bondage. If the United States is to be an exception to that theory, we must start by confronting the dismal facts of our situation. We have done it before.

In this section, we begin by examining the current state of broadband deployment in the leading nations of the world and in the United States. Unfortunately, the United States ranks low on most of the key indicators of success in broadband deployment. We then turn to the future and show that the United States is not likely to meet growing bandwidth needs unless it significantly changes its present course.

A. The Current State of Broadband Deployment

The United States gave birth to the Internet, and for most of the 1990s, was the indisputable world leader in broadband deployment. By 2001, the United States had fallen to 4th place among the 30 developed nations that participate in the Organization for Economic Co-operation and Development (OECD).[183] By 2004, the United States had sunk to 10th place, prompting President Bush to say,

> That's not good enough. We don't like to be ranked 10th in anything. The goal is to be ranked 1st when it comes to per capita use of broadband technology. It's in our nation's interest. It's good for our economy.[184]

In March 2004, President Bush announced his administration's "national goal" for broadband deployment:

> This country needs a national goal for ... the spread of broadband technology. We ought to have ... universal, affordable access for broadband technology by the year 2007, and then we ought to make sure as soon as possible thereafter, consumers have got plenty of choices when it comes to [their] broadband carrier.[185]

In its recent report entitled "Networked Nation," the National Telecommunications & Information Administration (NTIA) claimed that the Bush Administration met this goal by "execut[ing] a combination of initiatives to develop and rapidly deploy new technologies, eliminate regulatory underbrush, and remove economic disincentives for investment in this critical area."[186] According to the NTIA, broadband is now "available in 99 percent of the nation's zip codes, encompassing 99 percent of the nation's population."[187] While literally true, this claim is misleading, as it implies that broadband is available to *everyone* in these zip codes.

In fact, the FCC has long been criticized for pretending that if even a single residential or commercial broadband line is present anywhere in the zip code, then all businesses and residents in that zip code have access to broadband. That is demonstrably untrue, as confirmed by the e-NC Authority's data, discussed in Part III below, as well as similar mapping data that several other states have developed.[188] Furthermore, NTIA's claim of success was also based on the FCC's now-discarded definition of "broadband" as the capacity to transmit information at a speed of 200 kbps or more in one direction.

To be sure, the United States has experienced a significant increase in the number of "broadband" lines during the last few years – applying the FCC's old definition of that term. According to the FCC's latest data, the United States had 100.9 million "broadband" lines as of June 30, 2007, more than a 10-fold increase from the 9.2 million lines it had on Dec. 31, 2001.[189] Of these, 50.6 percent were CMS, 37.5 percent were ADSL, 0.2 percent was SDSL or traditional wireline connections, 1.7 percent were fiber to the end user premises, and a whopping 35 percent – 35,305,323 lines – were "mobile wireless."[190]

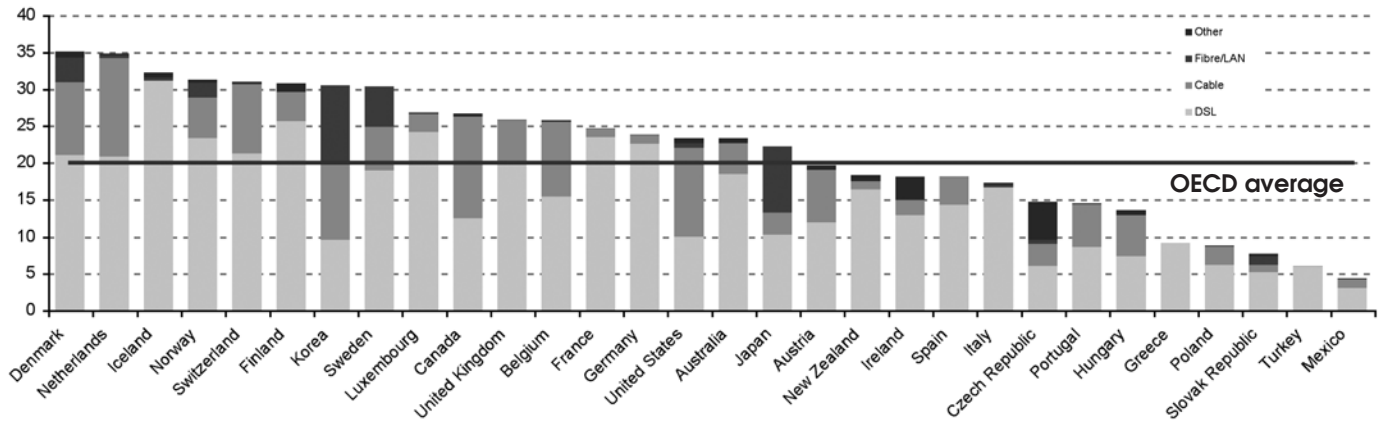
When put into context, however, these figures are considerably less impressive. In fact, the number of broadband lines has grown significantly *everywhere*, and in many cases, at a much faster rate than in the United States. For example, China has gone from a negligible number of broadband lines to first place in the world with more than 163 million broadband lines today, and it plans to extend broadband to 95 percent of its villages in 2008.[191] Likewise, on the same day that the FCC published its latest data, the European Commission published its own data indicating that the European Union now has more than 99 million broadband lines.[192] Unlike the FCC, the European Commission did not include "mobile wireless" – handheld devices with minimal broadband capacity, especially in the upstream direction, which would not qualify as "broadband" under the FCC's new definitions. *Ironically, since such devices are much more popular in Europe and Asia than they are in the United States, the United States would rank far lower than it already does if other countries counted them as well.*

In the next few pages, we compare the United States with other nations using recent rankings from a variety of sources. *While these rankings do not reflect the latest data that the FCC and the European Commission released on March 19, 2008, the rankings shown below are not likely to change much, if at all, when the surveys in question are updated.*[193]

First, in broadband penetration scaled by population, the United States now ranks 15th (OECD), 18th (International Telecommunications Union), or 25th (Point Topic) depending on the number of countries included in the survey.[194] The following chart shows where the United States stood as compared to the other OECD countries in December 2007:[195]

Figure 2

OECD Broadband Subscribers Per 100 Inhabitants, by Technology, December 2007

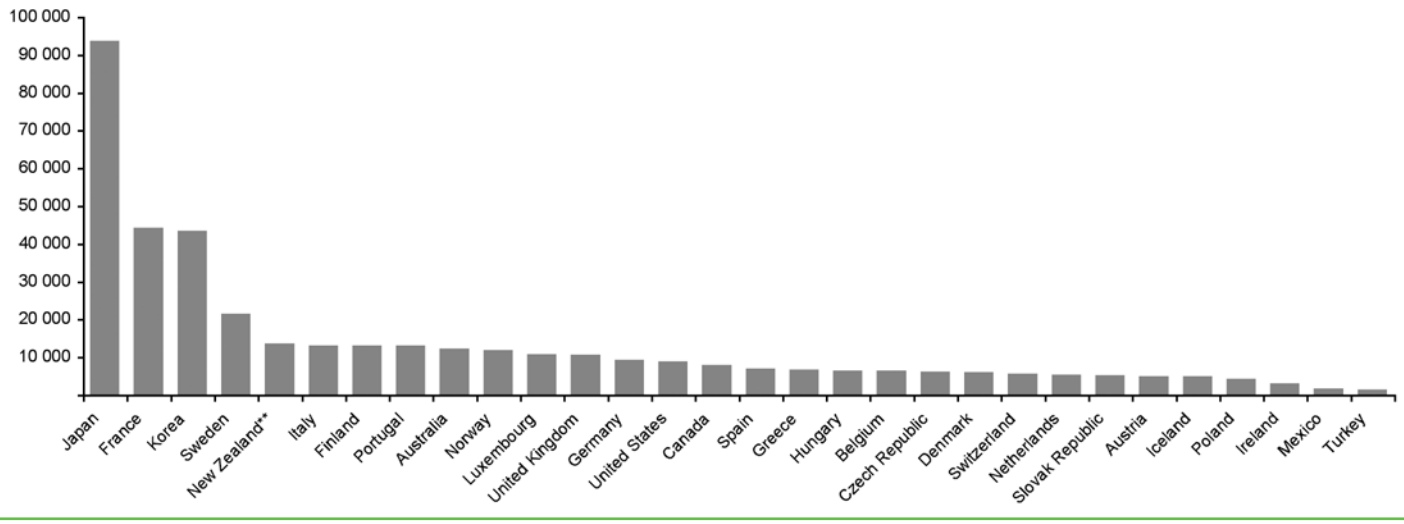


Source: OECD

In average advertised download data speed, the United States ranked 14th among OECD nations as of October 2007:[196]

Figure 3

Average Advertised Broadband Download Speed, by Country. Mbit/s. October 2007

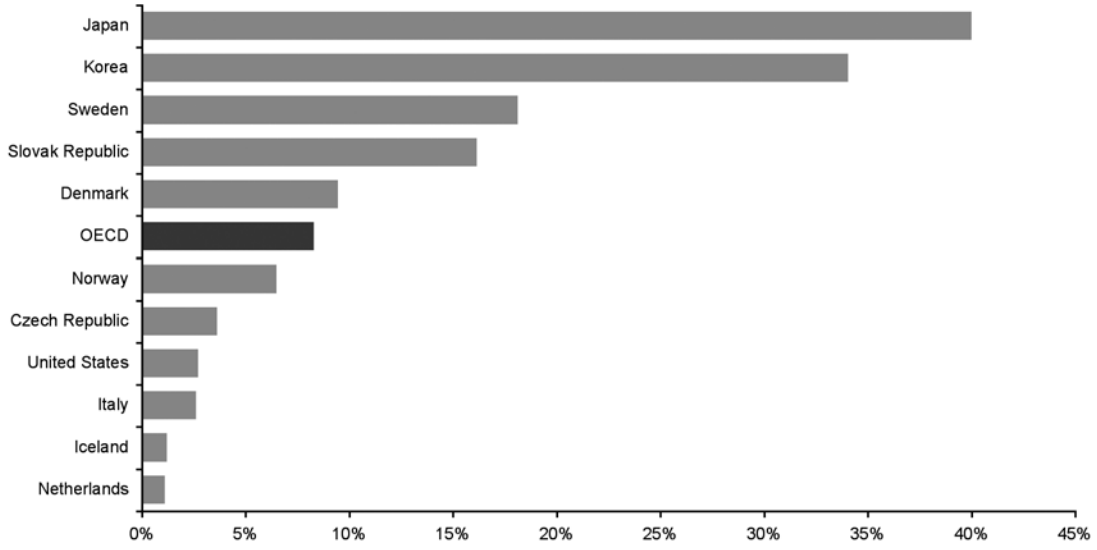


Source: OECD

In fiber connections as a percent of total subscribers, the US ranked 9th among the OECD nations as of December 2007:[197]

Figure 4

Percentage of Fibre Connections in Total Broadband Subscribers, December 2007

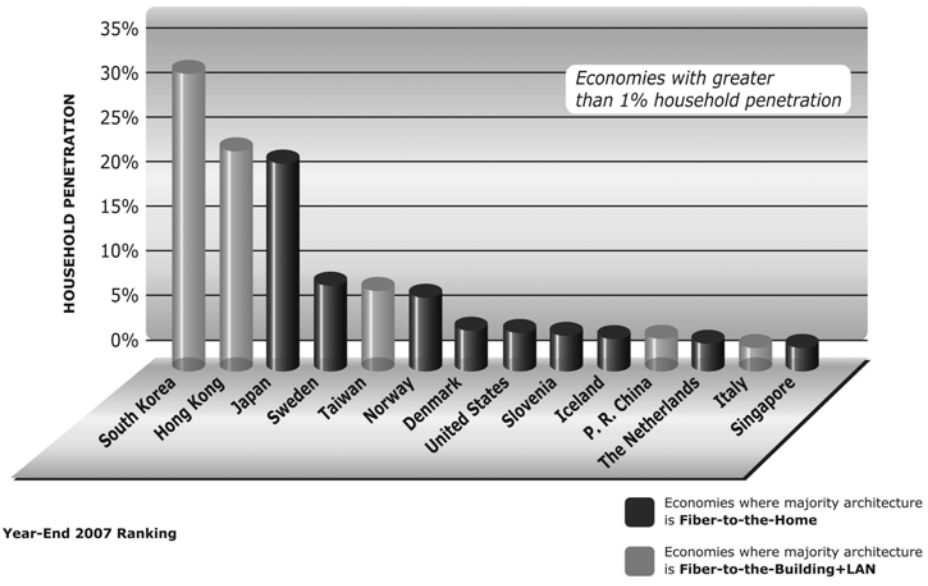


Source: OECD

These data are generally consistent with the FTTH Council's data for household penetration of FTTH, on which the United States ranked 8th in FTTH subscribers as of the end of 2007:

Figure 5

Economies with the Highest Penetration of Fiber-to-the-Home / Building+LAN

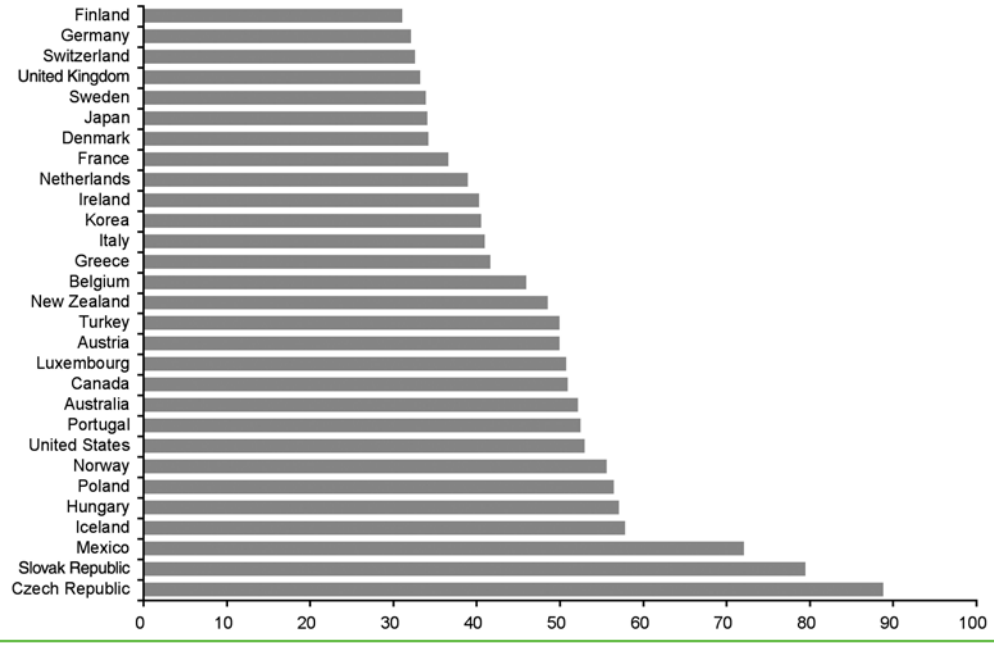


Source: Fiber-to-the-Home Council

In average monthly price for broadband, the US ranked 22nd among the OECD nations as of October 2007:[198]

Figure 6

Broadband Average Monthly Subscription Price, October 2007, USD PPP

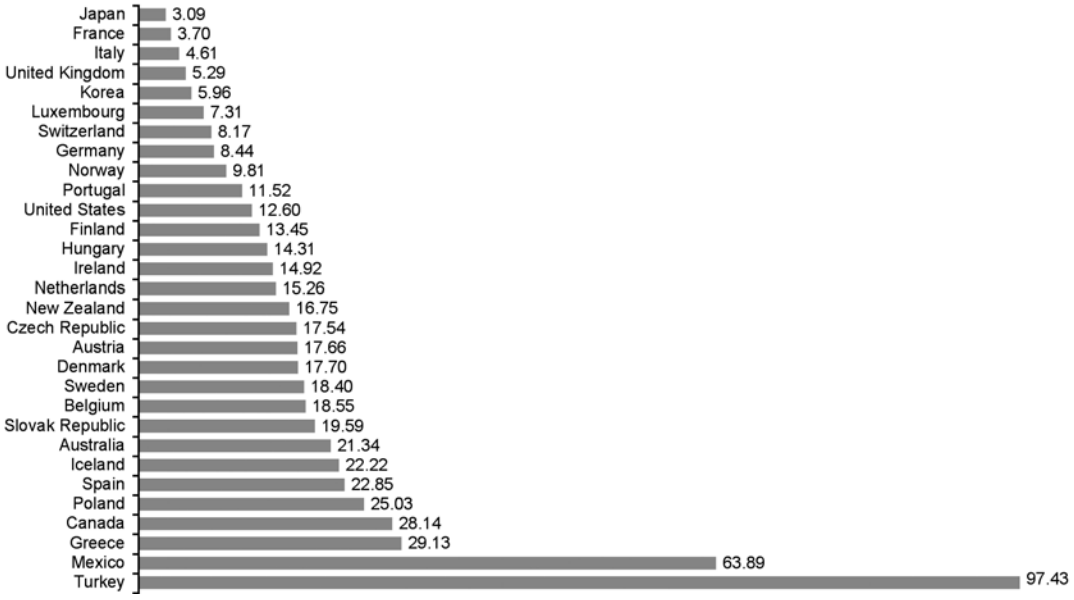


Source: OECD

In average monthly price per unit of bandwidth (Megabits per second), the United States ranked 11th among the OECD nations as of October 2007:[199]

Figure 7

Average Broadband Monthly Price Per Advertised Mbit/s, October 2007, USD PPP

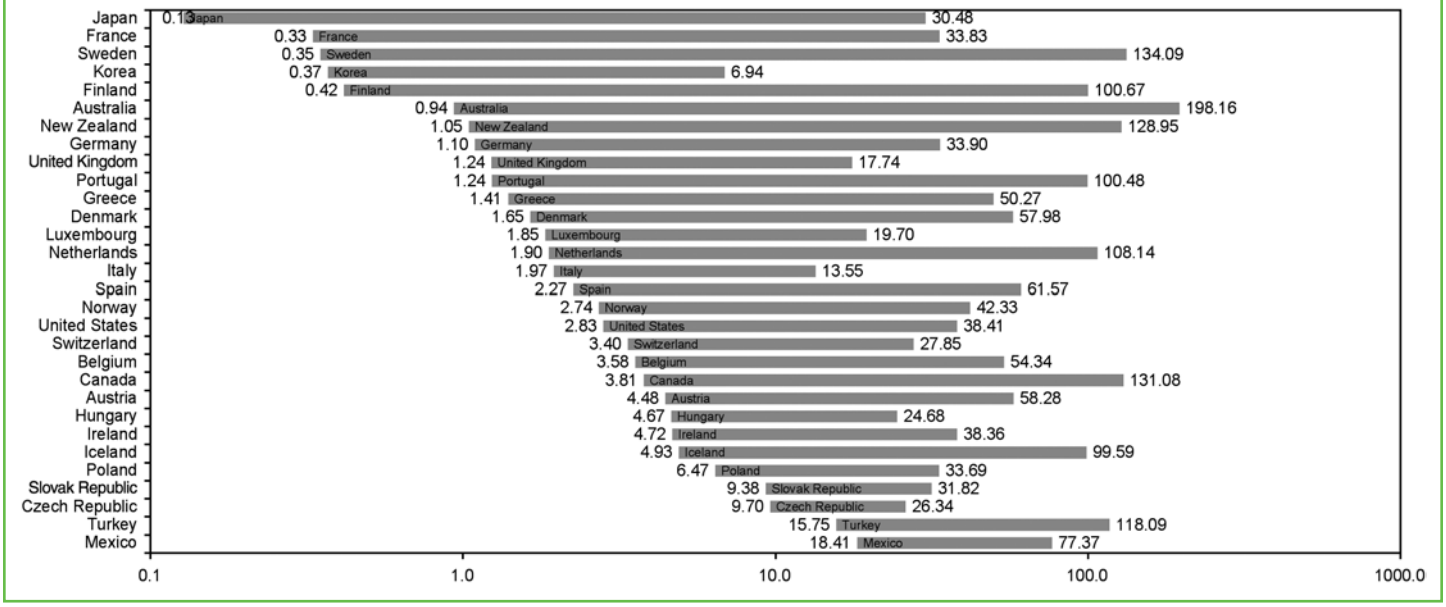


Source: OECD

In average monthly price per unit of bandwidth (Megabits per second) for the fastest tier of service, the United States ranked 18th as of October 2007:[200]

Figure 8

Range of Broadband Prices Per Mbit/s, October 2007, All Platforms, Logarithmic Scale, USD PPP

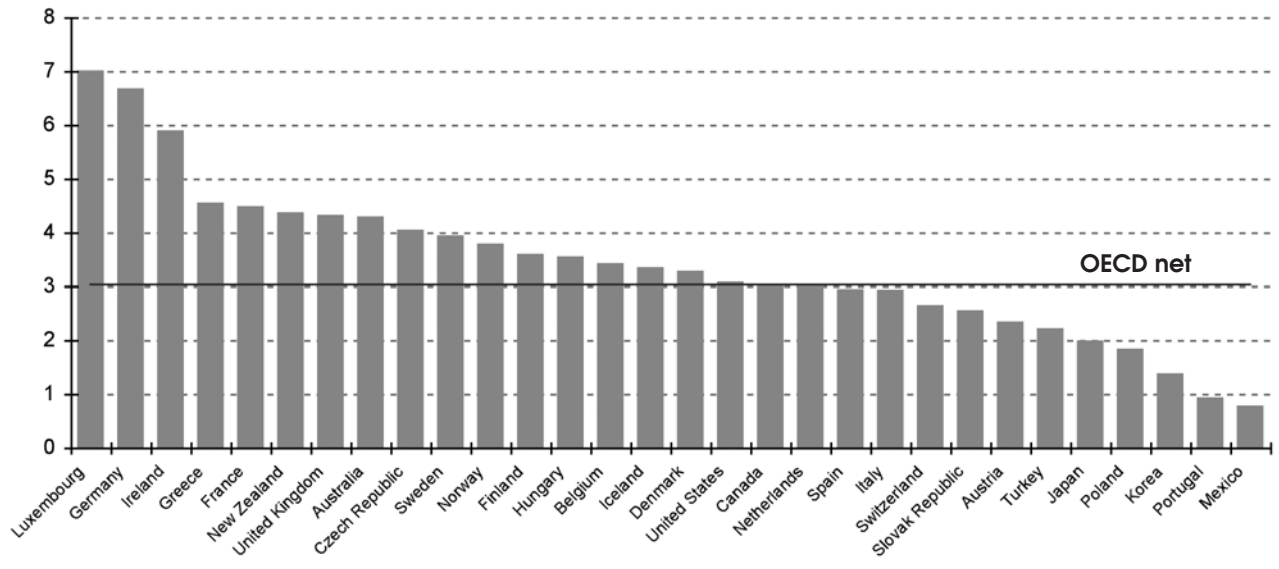


Source: OECD

In growth of broadband penetration, the United States ranked 17th among the OECD nations as of December 2007:[201]

Figure 9

OECD Broadband Penetration (Per 100 Inhabitants) Net Increase 2006-2007, by Country



Source: OECD

The Information Technology and Innovation Foundation has developed a new composite standard that combines household penetration (subscribers per household), speed (average download speed in Mbps), and price (lowest monthly price per Mbps). The United States ranks 15th on this standard:[202]

Table 3

Ranking	Nation	Score on Specific Broadband Measures			Composite Score
		Household penetration (Subscribers per household)	**Speed** (Average download speed in Mbps)	**Price** (Lowest monthly price per Mbps) (US $ purchasing power parity)	
1	South Korea	0.93	49.5	0.37	15.92
2	Japan	0.55	63.6	0.13	15.05
3	Finland	0.61	21.7	0.42	12.20
4	Netherlands	0.77	8.8	1.90	11.77
5	France	0.54	17.6	0.33	11.59
6	Sweden	0.54	16.8	0.35	11.53
7	Denmark	0.76	4.6	1.65	11.44
8	Iceland	0.83	6.1	4.93	11.20
9	Norway	0.68	7.7	2.74	11.05
10	Switzerland	0.74	2.3	3.40	10.78
11	Canada	0.65	7.6	3.81	10.61
12	Australia	0.59	1.7	0.94	10.53
13	United Kingdom	0.55	2.6	1.24	10.30
14	Luxembourg	0.56	3.1	1.85	10.25
15	**United States**	**0.57**	**4.9**	**2.83**	**10.25**
16	Germany	0.47	6.0	1.10	10.17
17	Belgium	0.57	6.3	3.58	10.17
18	Portugal	0.44	8.1	1.24	10.15
19	New Zealand	0.42	2.5	1.05	9.68
20	Spain	0.49	1.2	2.27	9.68
21	Italy	0.41	4.2	1.97	9.54
22	Austria	0.45	7.2	4.48	9.37
23	Ireland	0.46	2.1	4.72	9.01
24	Greece	0.18	1.0	1.41	8.26
25	Hungary	0.29	3.3	4.67	8.22
26	Poland	0.23	7.9	6.47	7.83
27	Czech Republic	0.30	2.0	9.70	7.03
28	Slovak Republic	0.22	3.5	9.38	6.77
29	Turkey	0.23	2.0	15.75	5.25
30	Mexico	0.20	1.1	18.41	4.41
	Average	**0.51**	**9.2**	**3.77**	**10.00**

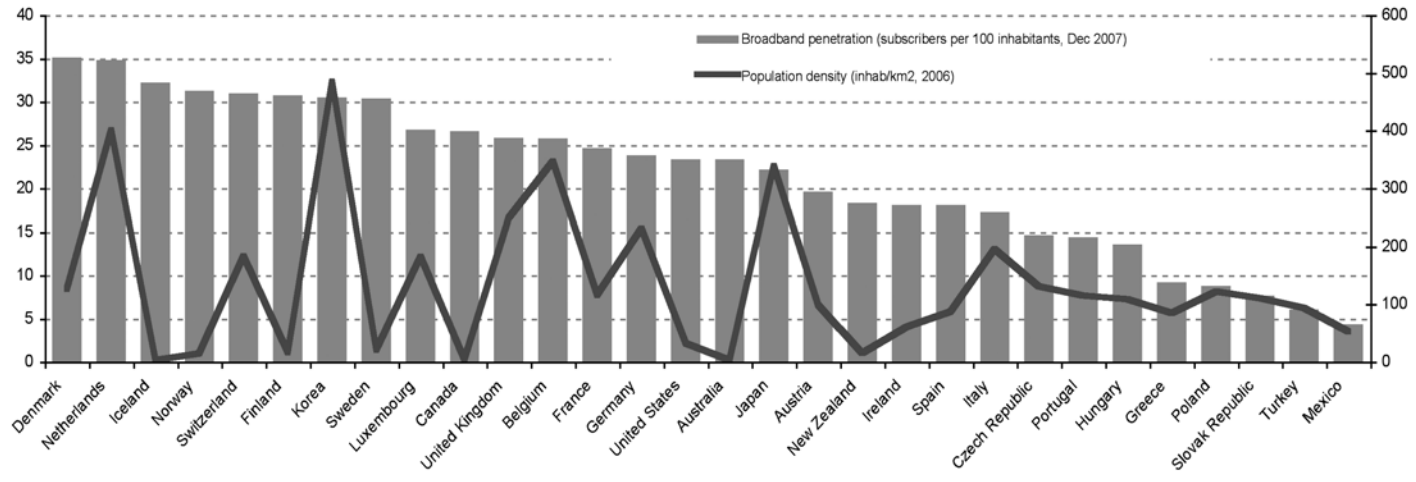
Source: ITIF (May 2008)

Over the years, supporters of the Bush Administration's broadband policies have made three main arguments in defense of them. First, they have asserted that comparisons of the kind discussed above are irrelevant, as the only comparison that really mattered was America's number one ranking in the raw number of broadband subscribers.[203] Now, China and the European Union have both forged ahead of the United States in raw subscriber counts, and their lead is likely to widen significantly in the years ahead.[204]

Second, supporters of the Administration's policies have maintained that international comparisons are deficient because they do not take into account the severe competitive disadvantage that the United States suffers because its population density is substantially lower than that of several of the leading Asian and European nations.[205] As the two charts below show, however, the population-density argument does not hold up.[206]

Figure 10

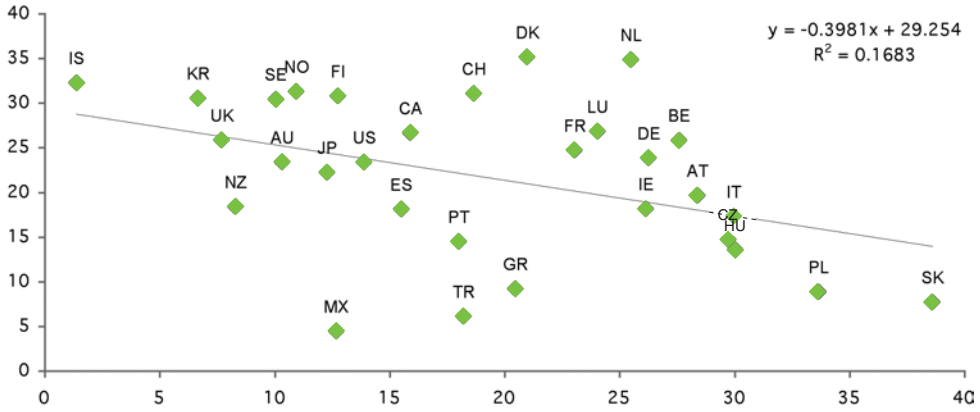
OECD Broadband Penetration and Population Densities



Source: OECD

Figure 11

Broadband Penetration Per 100 Inhabitants (June 2007) and Percentage of Total Landmass Used by 50% of the Population



Source: OECD

In any event, if the population-density argument had merit, one would have expected to see fiber-to-the-home widely deployed in New York, Chicago, Los Angeles, and many of the other major population centers in the United States. But unlike Amsterdam, Cologne, Hamburg, Hong Kong, Milan, Munich, Oslo, Paris, Rotterdam, Seoul, Singapore, Stockholm, Tokyo, Vienna, Zurich, and many, many other major cities in Asia and Europe,[207] not a single major American city – not one! – is likely to get fiber-to-the-home in the near future. The only one for which a FTTH build has even been announced is New York City, and Verizon does not expect to get that done until 2014.[208]

Third, supporters of the Administration's policies have quibbled for a variety of reasons with the data used for international comparisons.[209] But even if the data were adjusted to address these supposed deficiencies, America's rankings would not change significantly.[210]

Most recently, supporters of the Administration's policies have drawn comfort from a report by the World Economic Forum and Insead (a business school near Paris, France) suggesting that the United States ranked 4th in the world in 2007, up from 7th the year before, in overall broadband "readiness." *The New York Times* breathlessly – and incorrectly – reported that "[contrary to] earlier studies, conventional wisdom and politicians' rhetoric, European researchers say that the Internet infrastructure of the United States is one of the world's best and getting better. ... The Insead assessment offers a stark contrast to other appraisals based on single measures that have portrayed the United States, the nation that invented the global data network, as both lagging and declining in the broadband boom."[211]

In fact, the WEF/Insead report did nothing of the kind. For one thing, it evaluated a bewildering 126 criteria, most of which were only indirectly related to broadband infrastructure. For example, among the "strengths" that drove the high ranking of the United States were venture capital availability, utility patents, university-industry research collaboration, state of cluster development, quality of scientific research institutions, company spending on R&D, local availability of research and training services, and secure Internet servers.[212]

Furthermore, the interactive features of the WEF site enable one to drill into the details of the authors' rankings. Such an exercise reveals that many of the rankings were highly subjective. For example, the tool that allows a head-to-head comparison of Japan and the United States yields the following:[213]

Table 4

Variable	United States	Japan
Number of telephone lines*	57.15	43.02
Secure Internet servers*	869.00	332.00
Electricity production*	14124.16	8382.91
Availability of scientists and engineers	5.60	5.95
Quality of scientific research institutions	6.13	5.56
Tertiary enrollment*	82.72	55.31
Education expenditure*	4.79	3.12
Quality of math and science education	4.54	5.03
Quality of the educational system	5.09	4.69
Internet access in schools	**5.84**	**5.15**
Buyer sophistication	5.32	5.64
Residential telephone connection charge*	0.10	0.94
Residential monthly telephone subscription*	0.71	0.52
High-speed monthly broadband subscription*	0.55	1.04
Lowest cost of broadband*	**0.01**	**0.00**
Cost of mobile telephone call*	0.04	n/a
Extent of staff training	5.42	5.64
Local availability of research and training services	5.99	5.82
Quality of management schools	5.75	4.11
Company spending on R&D	5.81	5.79
University-industry research collaboration	5.64	4.88
Business telephone connection charge*	0.18	0.94
Business monthly telephone subscription*	1.26	0.80

Variable	United States	Japan
Local supplier quality	5.82	6.26
Local supplier quantity	5.73	6.28
Computer communications and other services imports*	30.00	37.80
Government prioritization of ICT	**5.42**	**5.47**
Gov't procurement of advanced tech products	4.94	4.49
Importance of ICT to government vision of the future	**4.64**	**4.68**
E-government readiness index*	0.86	0.77
Mobile telephone subscribers*	77.40	79.32
Personal computers*	76.22	67.45
Broadband Internet subscribers*	19.31	20.09
Internet users*	69.10	68.27
Internet bandwidth*	**33.06**	**10.35**
Prevalence of foreign technology licensing	5.46	5.59
Firm-level technology absorption	6.11	6.25
Capacity for innovation	5.44	5.85
Availability of new telephone lines	6.45	6.79
Extent of business Internet use	5.87	5.67
Government success in ICT promotion	**5.00**	**4.74**
Availability of government online services	5.69	4.08
ICT use and government efficiency	5.35	4.12
Presence of ICT in government offices	5.44	5.00
E-participation index*	1.00	0.61

Given the information provided elsewhere in this paper about Japan's broadband performance compared to that of the United States, some of WEF/Insead's rankings, particularly those highlighted in the chart above, border on the absurd. The fact is that American citizens pay more than 10 times the average monthly price that Japanese citizens do (US $12.60 versus Japan $3.09) and get less than a tenth of the average advertised download speed that the Japanese receive (U.S. 8.9 Mbps v. 93.7 Mbps). These are a matters of grave concern for America's global competitiveness that the other criteria examined cannot disguise.

Holding aside the apparent analytical or arithmetic errors in the WEF/Insead's analysis, the paper does suggest an important point: the United States is strong in many areas that would enable it to take better advantage of a world-class communications infrastructure than would be true of other countries that lack these advantages. As a result, if the United States aggressively improved its communications infrastructure, it might well be able to rise from fourth to first in future WEF/Insead rankings.

In summary, we believe that FCC Commissioner Michael Copps has aptly observed,

> America's record in expanding broadband communication is so poor that it should be viewed as an outrage by every consumer and businessperson in the country. Too few of us have broadband connections, and those who do pay too much for service that is too slow. It's hurting our economy, and things are only going to get worse if we don't do something about it.[214]

The data discussed above and elsewhere in this paper amply support Commissioner Copps's concerns.

B. Broadband Deployment in the Future

In this section, we compare the probable trajectory of broadband deployment in the leading Asian and European nations with that in the United States in the years ahead. We base our predictions on both past performance and the strategic actions of the governments and key stakeholders in these nations and in the United States. Some analysts believe that the United States has already lost the race and can never catch up.[215] Whether or not this is true, one thing is certain – the United States will forever relinquish any hope of regaining its world leadership in broadband deployment unless it acts immediately and decisively to turn things around.

1. The Leading Asian Nations

Each of the leading Asian countries has a remarkable story to tell. We can focus here only on some of the highlights of a handful of them.

a. Japan

Any discussion of the leading Asian nations must begin with Japan. In 2000, Japan's top government and business leaders got together and decided to become the world's leader in information and communications technology (ICT). By 2001, they had adopted a national plan called "e-Japan Strategy" to achieve that goal. At the time, Japan had only about 16,000 DSL subscribers, no fiber to the home, and few cable broadband lines. Almost immediately, however, Japan's drive to achieve global eminence gathered momentum:

> Japanese telecom authorities began pushing DSL in 1997, according to Adam Peake, a telecom strategist based in Japan. But, [Adam Peake of GLOCOM] says, NTT [Japan's national telephone company, Nippon Telephone & Telegraph] resisted until late 2000, when Japanese regulators rebuked NTT and mandated, "unbundling and co-location that required NTT to offer easy access to its premises and facilities at low rates and with short provisioning periods." NTT's local exchange companies expressed shame and obeyed, offering line sharing at mandated prices, about US $1.50 per month for unbundled copper loop and 3.5 US cents per meter per month for unbundled fiber. In part, this is culture; no U.S. ILEC would ever be this compliant. But in part it reflects NTT's effort to please its majority shareholder – the Japanese government.[216]

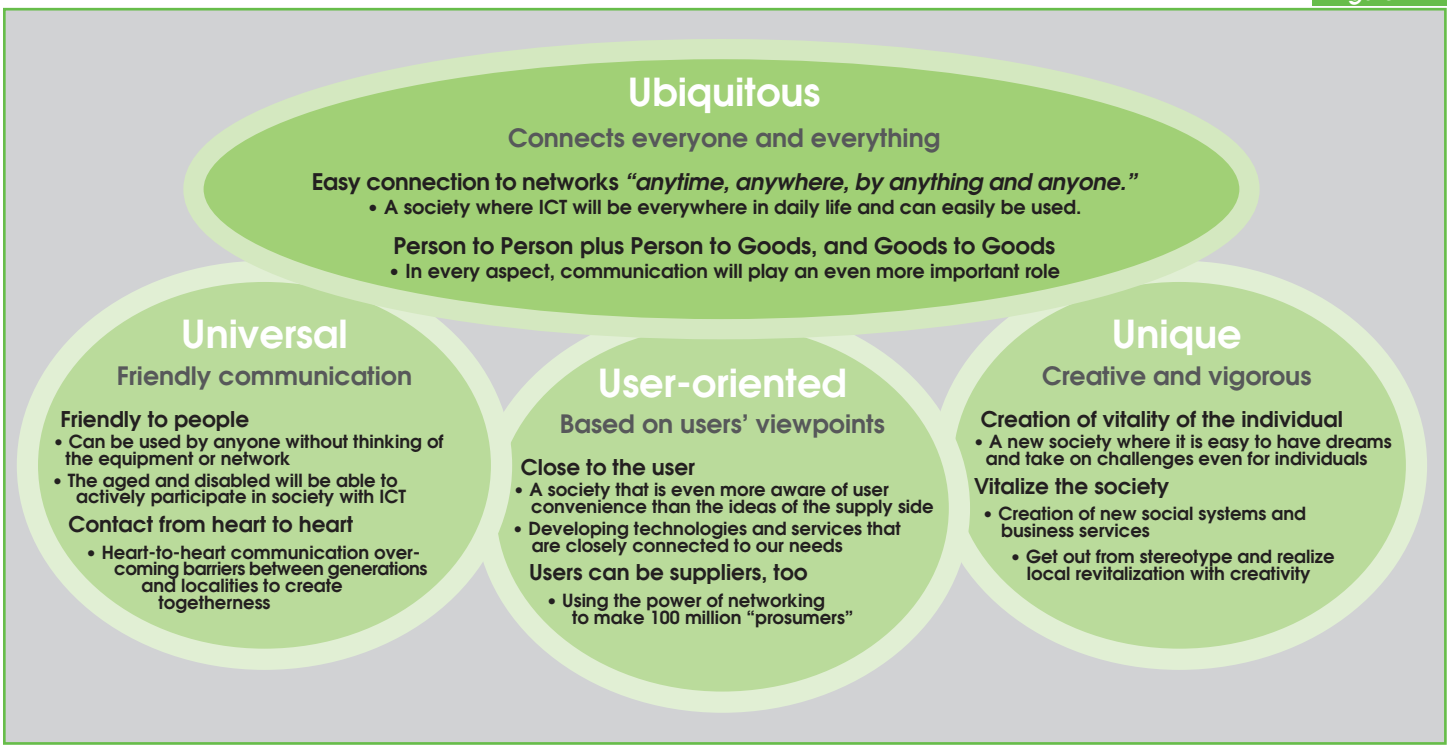
Numerous other factors also contributed to Japan's success. Among them were Japan's use of subsidies, low-interest and no-interest loans to both private entities and local governments, loan guarantees, tax breaks, targeted government purchases of services, grants-in-aid to local governments, and a concerted national public education campaign.[217] The private sector's sense of responsibility to contribute to the fulfillment of Japan's national goals and the financial sector's willingness to view investments from a long-term perspective also played prominent roles.[218]

When Japan reached the point at which achieving the goals of "e-Japan" was in sight, it embraced an even loftier vision. In December 2004, it adopted a new national plan called the "Ubiquitous-Japan" or "u-Japan" policy.[219] Japan's Ministry of Internal Affairs and Communications (MIC), described "u-Japan" as follows:

> The goal of broadband infrastructure improvement which is set in "e-Japan Strategy" has been achieved. The development of infrastructure in the past mainly centered on wired connections, ranging from narrowband to broadband such as DSL, cable networks, and fiber optics. However, under "the u-Japan policy," a seamless ubiquitous network environment will be created in which people can receive services without being conscious of the networks (wired or wireless). MIC aims to prepare the seamless access environment in every scene, by organic cooperation between fixed networks and wireless networks, and between terminals and networks, or between authentication, data exchange and networks. As a result, ICT environment that networks are integrated into all aspects of everyday life at the grassroots level is realized.[220]

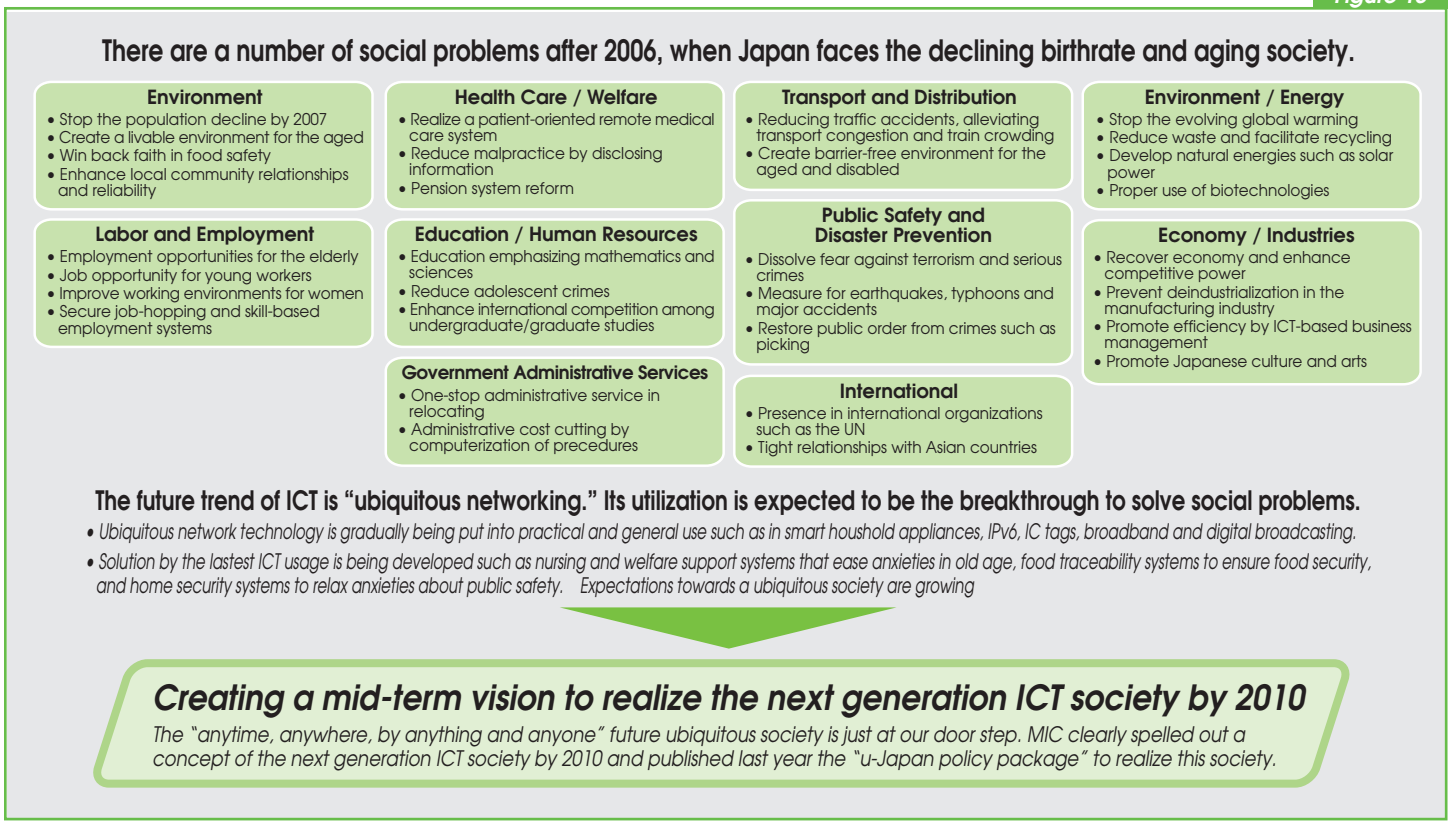
The basic concept underlying "u-Japan" is that broadband access should be pervasive, seamless, and easy for everyone: [221]

Figure 12



Japan does not view "u-Japan" as a stand-alone communications issue, as it did with "e-Japan." Rather, it views "u-Japan" holistically as an initiative to solve a broad range of social problems. Some of the ways that u-Japan would do so are summarized in the following MIC schematic:[222]

Figure 13



The "u-Japan" initiative reflects visionary thinking and national consensus and commitment that are far beyond anything imaginable in the United States today. Even more amazing is that Japan is well on its way to making major components of "u-Japan" a reality by its target date of 2010.[223]

Today, Japan has fulfilled its goal of being the top nation in the world in broadband infrastructure. It now has more than 11.3 million FTTH lines, by far the most in the world.[224] According to the OECD, Japan's price per Mbps for high-bandwidth broadband is lowest in the world, at $0.13 per Mbps (compared to $2.83 for the U.S.).[225] Japan boasts the highest average advertised download speed in the world, at 93 Mbps.[226] FTTH is available to approximately 85 percent of households in Japan,[227] and over 35 percent of broadband connections in Japan are now fiber-based (as compared to less than 3 percent in the United States).[228] By 2010, Japan expects FTTH to be available to 90 percent of households.[229] Furthermore, competitors in Japan now are competing at 1 Gbps, and Japan expects the leading edge of competition to be at 10 Gbps by 2010.[230]

In 2005, in an article in *Foreign Affaires* analyzing how Japan had picked up the "Internet leadership baton" that the United States had dropped, Thomas Bleha observed:

> It is now clear that Japan and its neighbors will lead the charge in high-speed broadband over the next several years. South Korea already has the world's greatest percentage of broadband users, and last year the absolute number of broadband users in urban China surpassed that in the United States. These countries' progress will have serious economic implications. By dislodging the United States from the lead it commanded not so long ago, *Japan and its neighbors have positioned themselves to be the first states to reap the benefits of the broadband era: economic growth, increased productivity, technological innovation, and an improved quality of life.*[231]

Unfortunately, these insights are even more pressing today than they were in 2005.

b. South Korea

South Korea's story is often called a "miracle." From less than one Internet user per 100 residents in 1995,[232] South Korea has surged to the top ranks in the world in broadband penetration, data speeds, and price. How has it done this?

For one thing, Korea's geography is conducive to broadband deployment – 80 percent of its population lives in urban areas, and apartments account for about half of its housing stock. The average distance of customers from the nearest telephone central office is 1.375 miles, and 95 percent of the population lives within 2.5 miles of a telephone central office, so ADSL was a viable option for the overwhelming majority of Korea's population.[233]

Other success factors include a highly literate and well-educated population; a widespread "Hurry, hurry" mentality among the Korean population; substantial government tax breaks and investments in infrastructure, first connecting government facilities, public research centers, major libraries, and schools, and later supporting development of a super-speed information network covering the whole country; relatively low and flat prices; and aggressive competition among the incumbent telephone company, Korea Telecom, Hanaro Telecom, Thrunet (until acquired by Hanaro), PowerComm, and various other providers, including cable operators.[234]

Now, like Japan, Korea has shifted its emphasis from ADSL to fiber as the communications medium of the future.[235] Korea has its own "u-Korea" program and is pursuing a massive broadband-integration effort known as the "Broadband Convergence Network" (BcN). Through the BcN, Korea seeks to provide bandwidth of 50-100 Mbps per end user to at least 20 million users by 2010. It also seeks to promote widespread availability of seamless multimedia services, including IP video and music, online entertainment, real-time health and welfare response, Voice over IP, and many more, regardless of device or location.[236]

c. China

China's broadband experience is particularly important because of its massive population and its aggressive national policies. Even accounting for China's opportunity to do a first-build and leap-frog older technologies, it deserves respect for seeing the shape of the future and pushing as fast as possible to deploy new technologies. While China's huge population constrains its world rankings on measures that divide broadband lines by some form of population-based denominator (e.g., 100 residents or households), China has now surged to first in the world with 163 million broadband users as of the end of December 2007.[237] This number should grow dramatically in 2008, as China has announced that it plans to extend broadband to 95 percent of its villages.[238] Furthermore, the number of FTTH connections in China should also grow rapidly, as China has recently announced its intent to stop ADSL builds in their tracks and switch to FTTH:

> A number of provinces, including Jiangsu, will stop constructing ADSL networks and adopt Fiber-to-the-home (FTTH) networks, reports Sina quoting Telecommunications equipment provider FiberHome Telecommunication Technologies (600498.SH) general engineer Mao Qian on March 13. Mao said that China Telecom (NYSE:CHA; 728.HK) subsidiary Jiangsu Telecom has begun bidding for its FTTH network already, and it plans to stop constructing ADSL network[s] before the end of June. China Netcom (NYSE:CN; 906.HK) has [been] testing its FTTH network in Beijing. Wuhan's municipal government announced its plan to acquire 100,000 FTTH network users in 2008 and 500,000 FTTH users by 2010, said Mao.[239]

d. Other Asian Nations

Other Asian nations have also achieved, or are rapidly moving toward, high-capacity broadband networks. Hong Kong already has Gigabit connectivity – which costs $215.40 (US). Singapore, building on its history of deployment of advanced telecommunications, is developing a national broadband network that will offer 100 Mbps to 1 Gbps connectivity to half the nation by 2012 and to the rest of the nation by 2015.[240] In the meanwhile, Taiwan's major telecommunications company, Chunghwa, has earmarked $60 billion to deploy fiber to the home and buildings over the next five years, bringing 100 Mbps connectivity to 25 percent of the country's 7.4 million residents.[241] Australia is also attempting to get on the fiber bandwagon:

> The Australian quest for FTTx stems from its Broadband Connect program for underserved and rural areas. The government initially gave $869 million to OPEL (a SingTel Optus/Elders JV) to build ADSL2+ and Wimax networks covering 889,322 underserved premises in rural and regional Australian at metro comparable prices. In April, however, Stephen Conroy – Australia's new minister for Broadband, Communications and the Digital Economy under PM Kevin Rudd – pulled funding for the whole project to clear the way for his plan to bring FTTx to 98% of Australian homes. A $4.3 [billion] tender process to build it is already underway.[242]

2. The Leading European Nations

a. The European Union

Before turning to individual European countries, it is important to recognize the significance of the European Union and, in particular, the role of the European Commission, in organizing and driving broadband development in Europe.

The European Union, with 25 member nations whose combined population exceeds 500 million, has established a common governing entity based in Brussels (the European Commission), a common currency (the Euro), and a common body of overarching laws that all member nations must follow. It has also removed internal trade barriers and adopted numerous other measures to foster convergence in financial, political, military, social, and other affairs. As a result, many experts contend that the European Union should be viewed as a single entity rather than as 25 separate nations, a superpower that will share leadership of the world in the 21st Century with the United States and China.[243] As one such expert recently observed,

> At best, America's unipolar moment lasted through the 1990s, but that was also a decade adrift. The post-cold-war "peace dividend" was never converted into a global liberal order under American leadership. So now, rather than bestriding the globe, we are competing – and losing – in a geopolitical marketplace alongside the world's other superpowers: the European Union and China. This is geopolitics in the 21st century: the new Big Three. Not Russia, an increasingly depopulated expanse run by Gazprom.gov; not an incoherent Islam embroiled in internal wars; and not India, lagging decades behind China in both development and strategic appetite. The Big Three make the rules – their own rules – without any one of them dominating. And the others are left to choose their suitors in this post-American world.[244]

In the communications area, the European Commission has the authority and responsibility to develop and enforce uniform approaches among member nations. The Commission has vigorously exercised these powers. For example, it rejected a challenge to Amsterdam's FTTH project by the major cable incumbent in the Netherlands,[245] fined Deutsche Telecom millions for acting in an anticompetitive manner,[246] and invalidated German legislation that would have protected Deutsche Telecom from opening its network to competitors.[247] Now, the European Commission is vigorously pushing its member nations to increase broadband penetration and drive up broadband speeds as rapidly as possible.[248]

b. Sweden

In 1999, Sweden became the first nation in the European Union to make broadband access for everyone a national priority. To implement this goal, the government spent a total of $820 million to subsidize infrastructure through a variety of programs, "including tax reductions for broadband access installations in high cost areas, funding to local authorities that established operator neutral networks in rural and remote areas, and requiring state-owned companies to build a high-speed backbone infrastructure for emergency services."[249]

To encourage broadband adoption, the Swedish government also created various programs to enhance digital literacy, provide access to personal computers, and increase the use of broadband in education.[250] Among the most important and successful of these programs was one that gave employers huge tax breaks to provide computers to their employees.[251]

As early as June 2004, Sweden's broadband infrastructure (mostly ADSL) had already reached some 85 percent of the population.[252] Now, nearly 100 percent of the population has access to broadband, but the Swedish government is concerned that data speeds are too low to meet future bandwidth requirements and that more safeguards are necessary to ensure a competitive environment. As a result, Sweden's counterpart to the FCC recently proposed another round of significant investments and other measures to extend broadband to the last remaining unserved areas, to increase data speeds, and to protect and preserve competition.[253]

Sweden has already made a good start on meeting these goals. Its 7.1 percent penetration leads Europe and ranks fourth in the world behind South Korea, Hong Kong, and Japan.[254] Moreover, deployment of FTTH in Sweden is about to skyrocket. Up to now, Sweden's major broadband provider, TeliaSonera, has been focusing on ADSL. As a result, more than 200 municipalities, electric utilities, and B2, a competitor of TeliaSonera, have stepped forward to deploy FTTH themselves. Now, TeliaSonera has finally taken "big broadband" seriously and announced a massive new FTTH buildout program of its own:

> TeliaSonera is ... planning to deploy a range of technologies to deliver broadband speeds of "up to 100 Mbit/second and higher... different technologies will be used to upgrade the network, depending on the geographic circumstances and the market's needs." Fiber access and VDSL2 technology is to be used, sometimes in collaboration with "external parties, such as municipalities, building owners and housing co-operatives."
>
> As part of the rollout, the operator has committed to taking its high-speed access services to "smaller towns and communities – and not just the major metropolitan centres."[255]

c. France

In 2000, the French government issued a five-year plan that depended heavily on the private sector to meet France's broadband requirements. By 2001, however, the government concluded that market forces alone would not drive broadband deployment and adoption quickly enough to meet its goals. As a result, the French government offered local governments grants-in-aid of up to 70 percent of the costs of constructing municipal broadband systems, and it authorized the Caisse des Dépôts et Consignations (a government-owned bank that handles most of France's pension funds) to make low-interest loans to municipalities to cover the remaining 30 percent of the costs.[256]

At first, France prohibited municipalities from providing communications services themselves over their municipal broadband infrastructure. In 2003, however, the French Parliament eliminated this prohibition where there was no other private-sector provider willing to use the municipal network to provide such services.

Over the last two years, France has become the most competitive environment in Europe for FTTH. Initially, as was the case throughout Europe, municipalities and utilities drove the market.[257] (Note: Municipalities and utilities have accounted for 61 percent of the European fiber deployments announced since mid-2005.[258]) Then Free Telecom, taking advantage of the considerable size that it had reached as a result of France's aggressive DSL unbundling requirements, launched a € 1 billion initiative to deploy FTTH in various cities around France. Free Telecom offered its customers the following bundle of services for € 29.99 per month:

- Internet access at a speed of 100 Mbp/s download, 50 Mbp/s upload;
- Free access to a landline;
- Unlimited calls to fixed lines in 49 destinations including mainland France, except special numbers;
- A range of audiovisual services including access to more than 100 channels and to High Definition (HD) channels on two televisions;
- Provision of two Freebox units for these TV services: High Definition compatible Optical Freebox including router and WiFi functions, with four Ethernet ports, and a High Definition compatible Freebox HD connected to the Optical Freebox via Ethernet or WiFi to provide access to the audiovisual services on a second television, including a digital video recorder.[259]

Free's initiative elicited strong responses from France Telecom and Neuf Cegetel. France Telecom countered by pricing its own 100 Mbps FTTH service, which was then available only in limited geographic areas, at € 44.90 per month. Neuf Cegetel responded with a "triple play" voice, video, and broadband service for € 29.90 per month, at a maximum speed of 50 Mbps in both downstream and upstream directions.[260] Now, France Telecom has raised the pot by announcing "plans to begin massive commercial FTTH roll-outs nationwide in 2009."[261]

The growth of FTTH in France should also benefit greatly from new regulations – to which France Telecom acceded – mandating that FTTH providers make their ducts, conduits, and other facilities available to competitors.[262]

d. Other European Nations

A "high level of optimism" about FTTH now exists in Europe.[263] Sweden, Norway, Denmark, Slovenia, Iceland, the Netherlands, and Italy are all among the top 14 nations in FTTH deployment.[264] The Netherlands is particularly active, with several major municipal FTTH projects under way.[265] "[I]n Norway the local utilities company has an ambitious FTTH project for more than two million households in the cards [and] Italy is planning a massive € 6.5 billion modernisation program that includes FTTB, with an ultimate goal to provide 65 percent of Italian households with broadband access of up to 100 Mbit/s by 2012."[266] Even in the UK, which is said to be "stuck in neutral," British Telecom's local access service provider, Openreach, has just completed its first 100 Mbps FTTH project.[267]

In short, as one analyst has observed, the last 12 months have seen "staggering changes in the outlook for FTTH in Europe and the rest of the world."[268] He summarized the changes in Europe as follows:

> France Telecom (as the incumbent in France and challenger elsewhere) was the first of Europe's giant telcos to invest, jumping in with both feet to plan a significant FTTH roll-out. Telefónica followed suit in the various countries where it is present. Other national operators have joined the fray: Neuf Cegetel in France, Telecom Italia, Iceland Telecom, and Telenor in Norway, for instance. And now, most nationwide operators have become noticeably more enthusiastic, studying and trialling their fibre-in-the-access strategy.

> In hindsight, the promise was laid before us 12 months ago for all to see. The municipal and regional governments were forging new kinds of legal and business relationships with private money to create the underpinnings for competitive FTTH services-opening sewers, building passive infrastructure, and championing the cause of Europe's disadvantaged digital citizens in particular. Alternative nationwide operators were starting to look at fibre in the access as the dominant next step of their growth. Several regulators increasingly shifted their focus from access network replication to investigation of the underlying infrastructure needed to resolve the horizontal (ducts) and vertical (indoor cabling) barriers to mass fibre deployment.[269]

3. The United States

In the next few years, if current trends in the United States continue, many Americans will have access to more broadband capacity than they have today, and some will benefit from a degree of competition between communications providers. Nevertheless, the United States is likely to fall farther and farther behind the leading Asian and European countries on most key measures of success in broadband deployment. Even worse, Americans in many rural and distressed urban areas will have access to, at most, DSL and CMS, which is rapidly becoming obsolete.

a. The major communications providers

Of the three major telecommunications companies, only Verizon has embarked on an aggressive strategy to deploy fiber all the way to the home, through a system that it calls "FiOS." The communities in which Verizon is deploying FiOS may have access to sufficient capacity to meet current and foreseeable bandwidth needs (assuming that Verizon makes any needed upgrades). But Verizon is constructing FiOS in only parts of 16 states, and it is planning to pass only 18 million homes by 2010.[270] When the system is fully deployed, it will cover only 15 percent of the nation.[271] Also, as deployment maps and Verizon's own announcements indicate, it is initially deploying FiOS in suburbs surrounding selected major cities and not in the inner cities or the communities outside the suburban rings.[272] Verizon has recently announced that it will build out New York City by mid-2014,[273] and it has expressed interest in other major cities, but it has not indicated when it will seek to introduce FiOS in other major or non-suburban cities.[274]

In addition, Verizon's prices for premium broadband services are very high, especially compared to prices in the leading nations. To illustrate this, we set Verizon's published rates[275] side by side with those of Hong Kong Broadband Network (HKBN).[276] Note particularly the difference between what $50 will buy from Verizon and HKBN:

Table 5

Speed (Mbps)	Verizon	HKBN
5 down / 2 up	?	Not available
15 down / 2 up	?	Not available
15 symmetrical	?	Not available
20 symmetrical	$64.99	Not available
30 down / 15 up	$89.95	Not available
50 down / 20 up	$139.95	Not available
100 symmetrical	Not available	$48.50
200 symmetrical	Not available	$88.20
1000 symmetrical	Not available	$215.40

Deployment maps indicate that AT&T is currently marketing U-verse in only a limited number of areas,[277] but AT&T claims that it will pass about 30 million homes in its 22-state marketing area by 2010.[278] AT&T is using a form of DSL technology – known as "ADSL2+" – that does not run fiber all the way to the home but only to neighborhood "nodes." Between the nodes and homes, AT&T uses its existing copper wires, which significantly limits AT&T's bandwidth capacity. Under ideal conditions, which are rarely achieved, AT&T will have maximum bandwidth capacity of approximately 20-24 Mbps downstream and 1-3 Mbps upstream.[279] AT&T must then divide this bandwidth among all of its services, including standard and high definition television, voice, and Internet access. Currently, AT&T allocates a maximum of 6-10 Mbps to broadband, and there is no telling whether or when AT&T will be able to increase this capacity.[280]

Qwest, with limited resources, has embarked on a much more modest deployment strategy, which also relies on ADSL2+ technology.[281] Qwest has a large, aging network, and unlike Verizon and AT&T, it does not have a nationwide wireless service that enables it to cross-subsidize its investments in its wireline network. Qwest has recently announced that it will spend $300 million on an upgrade that will enable it to provide 12 or 20 Mbps downstream and a paltry 768 kbps upstream in 23 cities in 10 states.[282] This will leave the vast majority of the communities in Qwest's huge territory with no better than DSL speeds – if they can even get that.

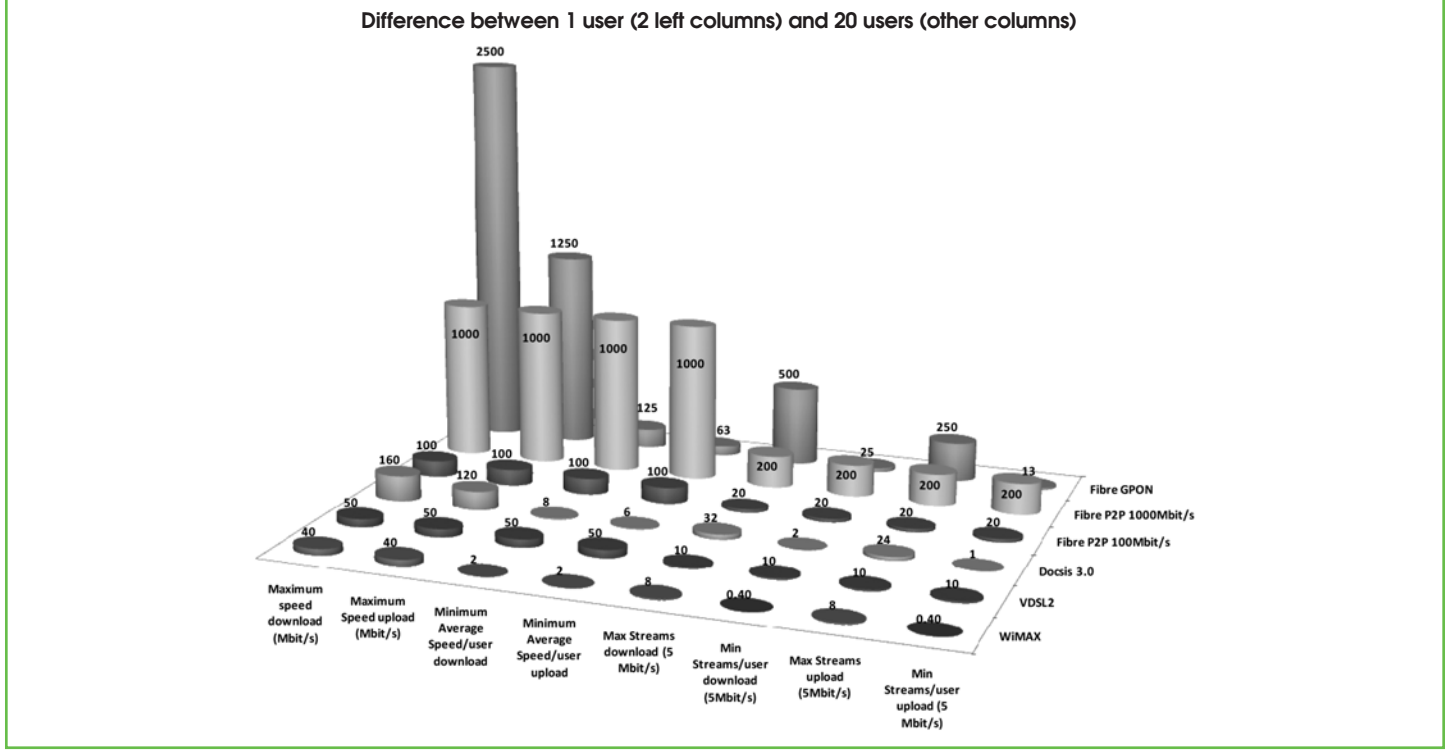
The cable industry maintains that a technology known as "data over cable system integration specification" (DOCSIS), version 3.0, will provide sufficient capacity to meet their current and future bandwidth needs. Comcast has just introduced DOCSIS 3.0 in Minneapolis/St. Paul, where it will provide a maximum of 50 Mbps downstream and a maximum 5 Mbps upstream for $149.50 a month. This high price is likely to discourage demand,[283] and Comcast is now exploring usage surcharges that would enable it to "rein in" the "power users" who are most likely to take advantage of DOCSIS 3.0.[284] Comcast claims that it will provide similar service to "up to" 20 percent of its customers in 2008 or 2009 and to the rest by sometime in 2010.[285]

Like any other broadband service offered over a cable system, however, available bandwidth must be shared among all homes on a node. As a result, the effective bandwidth that each home gets will be lower than the reported maximum bandwidth capacity. How much lower will depend on a variety of factors that are currently uncertain or untested under actual market conditions. A critical issue is the number of active users per node and the extent to which users will increasingly demand high-bandwidth services, including high definition television on several sets per home at the same time.

The effect of sharing bandwidth available to a node is illustrated in the graphic below, in which OECD compared the performance of various technologies serving a single user and serving 20 users.[286] Given that cable nodes in the United States typically serve 250-2,000 homes,[287] many of which may have multiple users sharing a connection at the same time, the possibility that at least 20 active users of bandwidth-rich applications will be online simultaneously, particularly at peak times, seems very reasonable.

Figure 14

Comparison of networking technologies



Some experts suggest that a further problem that cable operators will have with even DOCSIS 3.0 is that video on demand, particularly in high definition, cannot be broadcast but must be dedicated to individual subscribers, which effectively makes that bandwidth unavailable for sharing with other subscribers. Other experts suggest that buffering can mitigate this concern.

The primary options that cable operators have to get bandwidth up to high levels for individual homes is (1) divide nodes into smaller ones, which can be expensive and disruptive, and (2) pairing cables, which is as yet unproven. As a result, even the cable operators that are pursuing DOCSIS 3.0 may not be able to deliver high bandwidths to users any time soon.

Furthermore, some cable operators, including Time Warner, appear to be in no hurry to adopt DOCSIS 3.0 where they do not face competition from Verizon or another FTTH provider.[288] The worst case for consumers may well be the substantial number of markets in which AT&T and Time Warner face each other, including many communities in North Carolina. As the *Wall Street Journal* recently reported,

> For consumers not served by Comcast or Verizon, speeds [of 50 Mbps or more] may be a long time off. Time Warner Cable and AT&T offer top speeds of 20 megabits and 10 megabits a second, respectively. These services typically cost from $50 to $60 a month. Both companies question whether consumers need higher speeds right now. ... Time Warner Cable and AT&T argue that the money needed to upgrade their networks for higher speeds can be better utilized on other projects.
> ...
> The philosophical divide will have big consequences for the camp that gets it wrong. If customers end up flocking to the superfast connections, Time Warner Cable and AT&T will be caught flat-footed without a high-end offering.[289]

If the cable industry can truly upgrade to DOCSIS 3.0 for "a couple billion dollars ... the kind of money we can find in Bill Gates' sofa cushions,"[290] why wouldn't cable operators jump at the opportunity to do so? One reason is that they have a conflict of interest – with more and more video programming becoming available to consumers directly over their broadband connections, including television programs, cable operators would inevitably cannibalize some of their subscription and on-demand content business by giving subscribers high-bandwidth connectivity.[291]

Furthermore, once they have sold a subscriber a high-capacity broadband connection, cable operators derive no benefit from the economic, educational, and other socially valuable uses to which the subscriber may put that connection. To the contrary, given the shared nature of cable systems, the more a subscriber uses his or her connection, the more the subscriber burdens the network and potentially slows it down for all other users.

Cable operators also benefit from the media's ignorance about how limited their services really are. Here is a recent example from *The Pilot* in Southern Pines, N.C:

> Time Warner Cable will dramatically increase the speeds of its award-winning high-speed Internet service, Road Runner.
>
> Road Runner Standard will see a 40 percent speed boost from 5 mega bits per second (Mbps) to *a blazing 7 Mbps*. Road Runner Turbo will jump from 8 Mbps to 10 Mbps.
> ...
> "With faster speeds for even quicker file sharing, Web surfing and gaming, Time Warner Cable continues to add value to our simple, reliable, always-on Road Runner High Speed Online service," states Time Warner Cable's regional vice president. "With this boost in speed at no additional cost, *we continue to take advantage of our advanced fiber network* to offer our customers best in class service in high-speed Internet, digital cable and digital phone."[292]

As long as the media and consumers in some areas do not understand that 7 Mbps is not "blazing speed" and that an ordinary cable system is not an "advanced fiber network," cable operators will have little incentive to upgrade to DOCSIS 3.0 in those areas.

b. Independents, cooperatives, and public broadband providers are deploying high-capacity next-generation networks, but there are not enough of them to have a major impact on the United States as a whole

Across the United States, small independent, cooperative, and public broadband providers are stepping forward to develop high-capacity, next-generation networks – as their predecessors did a century ago in accelerating the pace of deployment of telephone service and electricity. According to Michael Render, the leading authority on the number and characteristics of fiber projects around the world, there are now approximately 400 independent or cooperative fiber projects and 44 public FTTH projects in the United States today.[293] Two rural telephone cooperatives (Atlantic TMC and Yadkin Valley TMC) and one independent (Windstream) are also deploying fiber to the home in rural North Carolina communities. Wilson, N.C., is an example of a municipal FTTH project, and in March 2008, Salisbury, N.C. voted to deploy a $30 million FTTH project.[294] As the following chart indicates, communities that have FTTH networks are likely to attract high-technology businesses and compete successfully in the emerging knowledge-based global economy.[295] But 440 FTTH networks are too few to have a major impact on the global competitiveness of the United States as a whole.

Table 6

Public Entities Reporting Plants Locating In Part Because of FTTH	
Public Entity	**Plant(s)**
Bristol, Tenn.	Media General
Bristol, Va.	Northrup Grumman, CGI
Chelan County, Wash.	Yahoo
Douglas County, Wash.	Sabey Corporation
Grant County, Wash.	Microsoft, Ask Jeeves, Intuit
Independence, Ore.	Various metal fabrication companies
Kutztown, Pa.	Various film production companies
Lafayette, La.	Nucomm International
Mason County, Wash.	Louisville Slugger, Sims, various high technology and online engineering firms
Morristown, Tenn.	Colgate Palmolive
Windom, Minn.	Various trucking companies

Source: FTTH Council

c. Wireless cannot provide as much bandwidth capacity as fiber but, in some cases, may be a better choice than DSL or CMS

Fiber and wireless are complementary technologies.[296] There is no technology more potent than fiber for carrying the high-bandwidth applications that will increasingly drive demand in the years ahead. Wireless technologies will undoubtedly improve, but the laws of physics and lack of available spectrum due to current regulatory constraints prevent wireless technologies from carrying such high-bandwidth applications over long distances. At the same time, wireless allows for mobility that is essential for some applications (e.g., police vehicles) and desirable for others.

As a result, wireless and fiber systems will increasingly be used in combination, with wireless extending the reach of fiber systems and fiber systems providing the infrastructure that supports the new wireless applications. In some cases, however, wireless may be the only unsubsidized option to provide broadband in difficult-to-reach areas.

While wireless technologies cannot deliver as much bandwidth to end-users as fiber does, some wireless technologies in use today can offer substantially more bandwidth to end users than DSL or CMS. For example, Google's WiFi project in Mountain View, Ca., is using a high-capacity wireless technology known as GigaBeam *WiFiber* as a carrier-grade substitute for fiber backhaul.[297] It offers up to a Gigabit of capacity for wireless networks that require bandwidth intensive applications for a very large number of subscribers on a metro scale. Unlike fiber, *WiFiber* can be installed very quickly and inexpensively, in as little as a day. The data speed ultimately available to each user will depend on the network designers' choices concerning the number of access points and number of users that each access point will support.

Other wireless technologies also offer potentially attractive alternatives to DSL and CMS. One such technology is WiFi (which stands for "wireless fidelity"), which employs "mesh network technology" to blanket a community with modest connectivity (about 1-3 Mbps) at relatively low cost. WiFi operates on an unlicensed basis and can be deployed relatively quickly almost anywhere. WiFi networks are working well in several communities outside major population centers.

Another promising wireless technology is WiMax (which stands for "Worldwide Interoperability for Microwave Access"). WiMax generally operates in the 2.5 and 3.5 GHz bands, which require licenses from the FCC. There is also a limited amount of unlicensed spectrum available for WiMax, the 5.8 GHz band. In many areas of the country, Sprint and ClearWire hold the licenses for the most suitable spectrum for WiMax, and they are getting ready to hold a private auction of some of this spectrum. WiMax can serve either as a means of connecting WiFi access points or as a stand-alone wireless network that can serve as an alternative to DSL or CMS. It has longer range than WiFi, can penetrate more deeply into interior spaces, and does not require line-of-site visibility.[298]

A third wireless technology uses spectrum in the 3650 MHz band. According to the FCC, this wireless band is "well suited to high-power broadband operations," particularly in "smaller markets and less densely populated areas."[299] As a result, the FCC has adopted special rules to provide wireless Internet service providers "an economical means of quickly initiating broadband services, particularly in under-served and rural areas."[300]

Furthermore, a number of companies are introducing very low-cost wireless networks. For example, Meraki uses a form of mesh network that takes advantage of user-volunteered bandwidth purchased from DSL or CMS providers at commercial rates.[301] The non-profit Mountain Area Information Network has deployed Meraki equipment in the North Carolina mountains.

Whether fiber, wireless, DSL, CMS, or some other technology offers the best option in a particular situation will depend on numerous factors, including topography, vegetation, condition of the existing wires, distance from central or remote offices, availability of pole attachments, etc. These factors must be evaluated on a case-specific basis. One certainly cannot categorically state that DSL or CMS is the most cost-effective technology for rural areas or distressed urban areas.

d. Broadband over powerlines will not offer high-capacity broadband in the foreseeable future

Broadband over powerlines (BPL) has been "just over the horizon" for some time now. Despite the relatively modest bandwidths demonstrated in BPL trials, the FCC remains optimistic about the future of BPL as a "third pipe." According to the NTIA, there are currently about 35 BPL deployments in the United States,[302] but nothing approaching 100 Mbps world-class broadband has been proven in the U.S. Even at its best, however, BPL is not capable of supporting high bandwidth requirements.

e. The satellite broadband available in the United States is not a solution

Internet access by satellite cannot fairly be called "broadband," at least not in the world-class sense. Typical satellite "broadband" offerings of relevance to rural residential and business users involve the one-way downstream transmission of Internet content through the satellite, with the upstream capacity, such as it is, being transmitted via dial-up. Two-way satellite systems are available, but the equipment is extraordinarily expensive, and bandwidth is so scarce in such systems that users typically are strictly limited in terms of capacity used per month. Furthermore, the transmission delays endemic to satellite broadband – called "latency" – make it unsuitable for applications such as Voice over Internet Protocol that requires instantaneous communication. As a result, the U.S. Government Accountability Office concluded,

> Satellite technology can provide a high-speed Internet service throughout most of the United States. However, the most economical package of satellite broadband service generally offers, at this time, upstream speeds of less than 200 kilobits per second, and therefore this service does not necessarily meet FCC's definition of *advanced telecommunications services*, while it does meet FCC's definition of high-speed service. Despite the near universal coverage of satellite service, consumers need a clear view of the southern sky to be able to receive transmissions from the satellites. Additionally, transmission via satellite introduces a slight delay, which causes certain applications, such as VoIP (i.e., telephone service over the Internet), and certain computer gaming to be ill-suited for use over satellite broadband.[303]

f. Various State initiatives are likely to increase broadband deployment and adoption, but most of these initiatives are focusing on low-capacity broadband that will not meet America's needs in the years ahead

The e-NC Authority has shown that state initiatives can increase both demand and supply of broadband – up to a point, as discussed in Section III. Recently, a number of other states have launched initiatives to increase broadband deployment and adoption.

Several state initiatives are focusing on low-capacity broadband, not the high-bandwidth technologies that America's rural and distressed urban communities will need for sustainable economic development. For example, in Kentucky, a project known as ConnectKentucky borrowed some of e-NC's broadband mapping and demand-aggregation techniques and is now seeking to take the "ConnectKentucky model" nationwide, through an entity called Connected Nation. Some of ConnectKentucky's claims of success have recently been called into question, and whether or not these claims have merit, the ConnectKentucky/Connected Nation program has several shortcomings, including (1) its failure to encourage communities to aspire to more than low-capacity DSL or CMS; (2) its very close – some say inappropriate – relationship with incumbent communications providers, and (3) its bias against public broadband initiatives, even those that might provide substantially greater benefits to the communities involved than the private-sector projects that ConnectKentucky/Connected Nation favor.[304] Several other states have adopted or are considering the "ConnectKentucky Model," including Alabama, Ohio, South Carolina, Tennessee, and West Virginia.[305]

Other state initiatives take a wide range of approaches. For example, California's task force report is discussed elsewhere in this paper. California has also established the California Emerging Technology Fund, financed with $60 million that the California Public Utility Commission (CPUC) obtained from SBC/AT&T ($45 million) and Verizon/MCI ($15 million) as a condition of approving their mergers. Pursuant to rules established by the CPUC, the Fund targets rural and remote areas; urban disadvantaged neighborhoods; and disabled populations.[306]

Vermont has developed a program intended to make "adequate fixed broadband" available in 100 percent of the state by 2010. The initial definition of adequate fixed broadband is 3 Mbps service in at least one direction, and that may ratchet up to an estimated 20 Mbps in both directions by 2013. The key features of the Vermont initiative are a program to issue state revenue bonds to finance infrastructures such as radio towers and middle-mile fiber, and the creation of a State authority to manage the program. The initiative encourages both private and public providers of all kinds to provide retail services.[307]

New York has established the New York State Council for Universal Broadband.[308] Among many other things, the Council is mapping broadband, studying innovative programs to increase the level of digital literacy in underserved urban and rural areas, and issuing grants to provide seed money for research, design and implementation of affordable broadband networks for underserved urban and rural communities.[309]

Georgia has established the OneGeorgia Authority to invest one-third of up to $1.6 billion in tobacco settlement funds over the next 25 years to assist the state's most economically challenged rural areas.[310] One of the Authority's initiatives is the Wireless Communities of Georgia program, which is providing 50 percent matching funds for wireless projects that meet its criteria in numerous counties in the State.[311]

Maine created the ConnectME Authority (unrelated to Connected Nation) in 2006. The Authority's mission is to expand broadband access "in the most rural, un-served areas of the state that have little prospect of service from a traditional provider. The Authority is to identify un-served areas of the State; develop proposals for broadband expansion projects, demonstration projects and other initiatives; and administer the process for selecting specific broadband projects and providing funding, resources, and incentives." The Authority will be funded with a 0.25 percent surcharge on in-state retail communications services. The Authority will fund proposals through grants, direct investments, or loans made on behalf of, in partnership with, or in support of, one or more communications service providers.[312]

Massachusetts has established a $25 million fund to support broadband deployment in the rural western part of the state, [313] and Maryland is investing funds in supporting fiber deployment in the nine counties on the Eastern Shore and three counties in Southern Maryland.[314]

Several other states have launched task forces, commissions, or similar efforts to explore the options available to them and to recommend action plans. These include Hawaii, Illinois, Oregon, Minnesota, Missouri, Washington, and various other states. A partial list of state broadband initiatives is available from the National Government Association Center for Best Practices.[315]

4. Conclusion

The leading Asian and European nations are moving rapidly to fiber technologies that will offer broadband connectivity of at least 100 Mbps, and several have already made, or have plans for, deployments in the Gigabit range. In contrast, in the United States, the major communications providers are not pursuing strategies that will make comparable bandwidths available to most Americans any time in the foreseeable future, and there are too few alternative providers or viable alternative technologies likely to fill the gap.

In the meanwhile, a number of states are studying ways to stimulate broadband availability and adoption. Most of these states are emphasizing the needs of unserved or underserved rural and urban areas, but they are only focusing on low-speed technologies. Even if these states are successful in achieving their limited goals, they will not narrow the digital divide between the United States and the leading nations in affordable access to high-capacity networks, nor will they enable America's rural and urban areas to compete successfully with their counterparts abroad.

III. BROADBAND DEPLOYMENT AND ECONOMIC DEVELOPMENT IN NORTH CAROLINA

In this section, we turn to broadband deployment in North Carolina. First, we summarize the available data on broadband access, adoption, and speed in North Carolina. We then discuss North Carolina's performance on the key indicators in the Information Technology and Innovation Foundation's 2007 State New Economy Index. Next, we review the work that Duke University's Center on Globalization, Governance & Competitiveness is doing to evaluate the international competitiveness of businesses in North Carolina. We conclude with a review of the steps that the e-NC Authority has taken to improve availability and adoption of broadband in North Carolina.

A. The Relevant Data

Data on broadband deployment in North Carolina and related matters are available from several sources, discussed below. No individual data base provides a complete picture, and even collectively, they leave many important gaps.

1. The FCC's Statistics

As FCC Commissioner Michael Copps noted in his statement accompanying the FCC's recent decision to upgrade its data collection and reporting practices,

> Our prolonged failure to create high quality broadband data is emphatically not just an academic concern. It has real-world, dollars-and-cents consequences. When companies and investors put money into e-commerce, Internet video, VoIP and other technologies that ride on consumer broadband connections, they need to know what kinds of broadband infrastructure America actually has. They need to know how many Americans have a broadband connection, where those consumers are located, how fast their connections actually are, and-importantly-how much they cost. The broadband data that we release every six months-and that, coincidentally, I understand we will be releasing this very day under separate cover-doesn't answer these questions in any meaningful way. I wonder how much investment our failure to develop high-quality broadband statistics has prevented. We will never know.[316]

The FCC's latest available high-speed Internet access data reflect the shortcomings to which Commissioner Copps referred, and more useful data will not be available for at least a year, when the FCC's improvements to its data collection practices begin to bear fruit. In the meanwhile, we will do the best we can with the data we have.

The FCC's two most recent reports on deployment of "high speed" lines in North Carolina were published on Oct. 31, 2007, for the period ending Dec. 31, 2006, and on March 19, 2008, for the period ending July 30, 2007.[317] We cite both of these reports, not merely the latter, because they contain significant unexplained discrepancies, and we cannot determine which report, if either one, is correct.

Tables 9-12 of the FCC's report of Oct. 31, 2007, contain the following information about the "high speed" lines (defined as "over 200 kbps in at least one direction") in North Carolina as of that December 2006:[318]

Table 7

North Carolina "High Speed" Lines		
Type	**June 30, 2006**	**Dec. 31, 2006**
ADSL	561,102	648,001
SDSL	-	23,883
Traditional	-	17,903
Cable Modem	650,757	1,040,513
Fiber	-	8,656
Satellite		
Fixed Wireless	-	18,506
Mobile Wireless	*	*
BPL	0	0
Total	**1,601,938**	**2,366,079**

* Data withheld to maintain firm confidentiality

The data summarized in Table 7 are surely incorrect, and significantly so. According to these data, the number of ADSL lines increased from 561,102 to 648,001 between June 30 and Dec. 31, 2006, while the number of cable modem lines grew from 650,767 to 1,040,513. While the increase in the number of ADSL lines is plausible, the 60 percent increase in the number of cable modem lines is not, as it vastly exceeds the percentage increase in cable modem lines anywhere else in the United States during that period and is not offset by decreases in the number of ADSL lines. Furthermore, had such a whopping increase in fact occurred, the e-NC Authority would surely have known about it – and perhaps even have taken some credit for it – but the e-NC Authority's own data for the same period, which are more granular than the FCC's, show no such increase.

In addition, there are 608,617 unaccounted lines in the FCC's data, which represents the difference between 2,366,079, the total number of lines, and 1,757,462, the number of lines by technology for which the FCC provides data.

In any event, with 2,366,079 "high speed" lines as of Dec. 31, 2006, North Carolina ranked 11th among the states, behind California, Texas, New York, New Jersey, Pennsylvania, Illinois, Ohio, Florida, Georgia, and Michigan.

Tables 9-12 of the FCC's report of March 19, 2008, contain the following data about "high speed" lines in North Carolina:

Table 8

North Carolina "High Speed" Lines			
Type	**June 30, 2006**	**Dec. 31, 2006**	**June 30, 2007**
ADSL	561,102	648,001	725,396
SDSL	-	23,883	24,100
Traditional	-	17,903	21,531
Cable Modem	963,651	1,040,513	1,134,075
Satellite		*	*
Fiber	-	8,656	5,683
Fixed Wireless	-	18,506	*
Mobile Wireless	-	*	*
BPL	-	0	0
Total	**1,601,938**	**2,366,079**	**2,894,042**

* Data withheld to maintain firm confidentiality

Notably, this time the FCC, without explanation, retroactively increased by 312,384 the number of cable modem lines in North Carolina as of June 30, 2006, while leaving all other data about cable modem service going back to 2001 without change. The FCC also decreased the number of fiber lines by nearly 35 percent, from 8,656 to 5,683. The 5,683 fiber lines represented less than 0.2 percent of the "high speed" lines in North Carolina. The FCC also increased the number of unaccounted lines to 983,287.

North Carolina's 2,894,042 "high speed" lines as of June 30, 2007, again ranked it 11th among the states, behind the same states as before. In fiber lines, it slipped from 14th to 15th.

Also of interest are the data on household penetration in the National Telecommunications and Information Administration (NTIA)'s report, "Networked Nation: Broadband in America 2007." In Table B-3, NTIA ranks North Carolina 33rd among the states in "Percent of Households with Broadband Access, 2007," with 47.1%.[319] NTIA's figures are puzzling, as NTIA does not provide the sources of its data, and we have been unable to replicate NTIA's figures.

Like NTIA, we used the FCC's data for the period ending Dec. 31, 2006, as set forth in its report of October 2007.[320] In particular, we used the number of residential lines set forth in Table 13 of that report. For the corresponding number of households, we used the data on occupied households compiled by the United States Census Bureau for 2006.[321] As reflected in the table below, our results differ markedly from NTIA's in some respects:

Table 9

FCC and US Census Data as of December 31, 2006							
State	Total Lines	FCC Rank	Resid Lines	FCC Rank	NTIA Rank	2006 Households	Res. Lines/ Households
Penn.	3,374,313	6	2,279,971	6	31	4,845,603	47.05%
Ohio	3,186,537	7	2,141,752	7	28	4,499,506	47.60%
N.C.	2,366,079	11	1,659,657	11	34	3,454,068	48.05%
Va.	2,183,019	13	1,451,016	10	17	2,905,071	49.95%
Utah	638,318	33	393,388	33	5	814,028	48.33%

As the table shows, North Carolina had a substantially higher percentage of household penetration than Ohio in 2006, yet NTIA ranked Ohio 28th and North Carolina 34th out of 51 states (including the District of Columbia). At the same time, Utah had only a slightly higher percentage of household penetration than North Carolina in 2006, yet NTIA ranked Utah 29 places higher than North Carolina, at 5th. Indeed, NTIA ranked Utah 12 places higher than Virginia, whose household penetration significantly exceeded Utah's in 2006.

In short, NTIA's data, like the FCC's, are less than reliable. Based on our own calculations, which are unfortunately dependent on the FCC's, we estimate that North Carolina's rank in household penetration in 2006 was somewhere between 26th and 28th.

2. The e-NC Authority's Data

As a result of the e-NC Authority's mapping activities, data are available on the percentage of households that have access to "high-speed Internet" in each of North Carolina's 100 counties.[322] Service providers are not required by law to provide such data, however, so the data may not be fully accurate or complete. Furthermore, the data do not reflect price, speed, actual subscription rates, business or residential use, or additional useful information.

Following is a chart setting forth the percentage of households with access to high-speed Internet, by county, as of the end of 2006:

Table 10

North Carolina Households with Access to High-Speed Internet					
County	Composite: % of Households w/CMS or DSL service available	% of Households with CMS available to them	% of Households with DSL service available to them	2005 Pop.	2005 Households
				8,683,242	3,378,623
Total Rural Households	**1,351,273**	**1,127,080**	**1,233,893**		
Total Urban Households	**1,471,136**	**1,384,357**	**1,364,870**		
Jones	45.07%	36.09%	40.05%	10,311	4,034
Warren	46.89%	34.91%	46.89%	19,729	7,614
Gates	47.96%	0.00%	47.96%	11,224	4,164
Greene	49.10%	0.00%	49.10%	20,026	7,067
Pamlico	51.43%	0.00%	51.43%	12,735	5,098
Tyrrell	53.25%	37.14%	53.21%	4,157	1,540

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Table 10 (continued)

North Carolina Households with Access to High-Speed Internet					
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				8,683,242	3,378,623
Total Rural Households	**1,351,273**	**1,127,080**	**1,233,893**		
Total Urban Households	**1,471,136**	**1,384,357**	**1,364,870**		
Duplin	53.35%	41.37%	52.48%	51,985	19,355
Person	53.95%	37.38%	53.95%	37,217	14,715
Graham	56.00%	0.00%	56.00%	8,085	3,393
Mitchell	58.25%	45.10%	58.25%	15,784	6,592
Cherokee	59.04%	42.83%	52.72%	25,796	10,973
Caswell	60.23%	36.01%	51.97%	23,608	8,709
Columbus	61.46%	19.12%	61.46%	54,746	21,307
Alexander	62.39%	49.15%	62.39%	35,492	13,875
Madison	65.32%	36.28%	50.73%	20,256	8,253
Chatham	66.82%	50.82%	66.82%	58,002	23,212
Franklin	66.96%	27.01%	57.38%	54,429	20,550
Stokes	68.07%	58.04%	68.07%	45,858	18,030
Montgomery	69.87%	11.43%	69.87%	27,322	10,032
Caldwell	69.88%	69.88%	67.25%	79,122	31,446
Macon	69.91%	62.17%	69.91%	32,148	13,834
Clay	70.00%	0.00%	70.00%	9,765	4,281
McDowell	71.45%	69.86%	50.85%	43,201	17,018
Martin	72.60%	48.32%	65.72%	24,643	9,648
Alamance	**72.61%**	**72.61%**	**67.86%**	**140,533**	**55,422**
Burke	73.86%	56.54%	63.34%	89,399	34,625
Rutherford	73.89%	73.89%	67.39%	63,771	25,540
Pender	73.91%	69.82%	63.50%	46,429	18,143
Henderson	74.16%	73.43%	60.83%	97,217	40,789
Camden	74.62%	74.62%	61.74%	8,967	3,467
Johnston	74.70%	71.77%	73.30%	146,437	55,944
Avery	75.07%	59.27%	75.07%	17,641	6,712
Swain	75.82%	57.02%	58.29%	13,167	5,216
Nash	76.32%	62.09%	76.32%	91,378	35,167

Bolded counties = urban counties

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Table 10 (continued)

North Carolina Households with Access to High-Speed Internet					
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Total Rural Households	**1,351,273**	**1,127,080**	**1,233,893**		
Total Urban Households	**1,471,136**	**1,384,357**	**1,364,870**		
Vance	76.68%	60.55%	76.68%	43,771	16,507
Washington	76.79%	73.32%	72.87%	13,282	5,195
Onslow	77.00%	67.47%	77.00%	152,440	48,789
Buncombe	**77.37%**	**68.94%**	**73.12%**	**218,876**	**90,992**
Edgecombe	77.40%	58.08%	77.40%	54,129	19,850
Jackson	77.40%	59.15%	61.66%	35,368	14,086
Granville	77.62%	68.61%	59.02%	53,674	18,431
Northampton	78.35%	72.14%	39.24%	21,483	8,454
Pasquotank	78.53%	78.53%	76.07%	38,270	14,155
Perquimans	78.81%	66.84%	64.64%	12,080	4,936
Bertie	79.86%	67.16%	55.96%	19,480	7,628
Rowan	**80.48%**	**74.71%**	**74.05%**	**135,099**	**51,763**
Halifax	80.64%	71.74%	80.64%	56,023	21,603
Sampson	81.00%	45.46%	79.93%	63,063	23,347
Wilkes	81.02%	60.81%	81.02%	67,390	27,364
Hertford	81.05%	80.92%	72.22%	23,574	9,338
Lincoln	81.70%	65.02%	64.77%	69,851	26,329
Rockingham	81.86%	81.86%	62.90%	92,614	37,265
Scotland	82.03%	81.46%	63.42%	37,180	13,839
Iredell	82.31%	82.31%	81.32%	140,924	54,412
Mecklenburg	**82.39%**	**78.26%**	**80.45%**	**796,372**	**313,092**
Wayne	82.86%	77.50%	70.34%	114,448	43,033
Moore	82.90%	79.22%	81.54%	81,685	33,554
Lenoir	83.05%	58.25%	83.05%	57,961	23,187
Robeson	83.31%	80.79%	55.03%	127,586	45,181
Gaston	**83.40%**	**83.40%**	**69.57%**	**196,137**	**76,178**
Beaufort	83.72%	54.83%	83.72%	46,018	18,751
Currituck	83.96%	83.96%	57.02%	23,112	8,770

Bolded counties = urban counties

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Table 10 (continued)

North Carolina Households with Access to High-Speed Internet					
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				8,683,242	3,378,623
Total Rural Households	**1,351,273**	**1,127,080**	**1,233,893**		
Total Urban Households	**1,471,136**	**1,384,357**	**1,364,870**		
Guilford	**84.17%**	**78.86%**	**74.80%**	**443,519**	**177,669**
Harnett	84.94%	59.15%	84.94%	103,692	38,504
New Hanover	**84.98%**	**83.13%**	**84.64%**	**179,553**	**76,369**
Union	84.98%	83.49%	58.96%	162,929	57,161
Haywood	85.04%	81.33%	73.90%	56,482	24,147
Carteret	85.14%	81.92%	85.14%	62,525	26,538
Catawba	**85.15%**	**64.28%**	**79.19%**	**151,641**	**59,435**
Watauga	85.37%	71.41%	85.37%	42,472	16,454
Richmond	85.70%	85.70%	58.61%	46,781	17,956
Bladen	86.25%	59.52%	81.04%	32,938	13,161
Polk	86.30%	39.66%	86.30%	19,134	8,258
Craven	87.05%	82.87%	81.20%	90,795	34,340
Cleveland	87.28%	68.49%	62.83%	98,288	37,816
Davie	87.80%	86.05%	87.80%	39,136	15,448
Randolph	88.55%	72.05%	88.54%	138,367	53,732
Davidson	**88.72%**	**73.22%**	**88.72%**	**154,623**	**61,070**
Ashe	88.77%	0.00%	88.77%	25,347	10,822
Yancey	89.15%	61.55%	52.24%	18,201	7,652
Pitt	89.64%	77.14%	89.41%	142,570	55,984
Surry	89.68%	84.00%	89.68%	72,601	28,959
Forsyth	**90.13%**	**84.63%**	**85.83%**	**325,967**	**131,904**
Hoke	90.15%	84.99%	86.70%	41,016	13,864
Orange	**90.27%**	**74.19%**	**78.20%**	**118,386**	**45,925**
Wilson	90.80%	81.20%	76.77%	76,281	29,569
Anson	91.33%	48.46%	91.33%	25,499	9,286
Brunswick	91.69%	83.60%	91.69%	89,162	37,104
Durham	**91.82%**	**91.59%**	**86.53%**	**242,582**	**96,695**
Alleghany	92.00%	23.59%	92.00%	10,900	4,689

Bolded counties = urban counties

continued next page

Table 10 (continued)

North Carolina Households with Access to High-Speed Internet					
County	Composite: % of Households w/CMS or DSL service available	% of Households with CMS available to them	% of Households with DSL service available to them	2005 Pop.	2005 Households
				8,683,242	3,378,623
Total Rural Households	**1,351,273**	**1,127,080**	**1,233,893**		
Total Urban Households	**1,471,136**	**1,384,357**	**1,364,870**		
Lee	92.27%	69.26%	92.27%	55,704	20,975
Hyde	92.71%	86.31%	65.88%	5,413	2,030
Cumberland	**93.86%**	**89.31%**	**88.06%**	**304,520**	**107,910**
Chowan	93.98%	83.25%	58.26%	14,528	5,581
Wake	**94.57%**	**91.48%**	**81.83%**	**748,815**	**288,675**
Dare	95.94%	90.07%	95.94%	33,903	14,357
Cabarrus	**96.36%**	**93.19%**	**96.36%**	**150,244**	**56,766**
Transylvania	96.42%	0.00%	96.42%	29,626	12,443
Yadkin	96.70%	87.37%	96.70%	37,668	15,032
Stanly	98.34%	92.97%	98.34%	58,964	22,553

Source: The e-NC Authority, data supplied by service providers

Bolded counties = urban counties

As reflected in the e-NC Authority's *100 County Report*, as of the end of December 2006,

- Overall, access to high-speed Internet services in North Carolina has stalled since 2004. More specifically, households in North Carolina with high-speed Internet access reached 82.33% in 2004, declined to 82.01% in 2005, and rose to only 83.54% in 2006. (High-Speed is defined as a minimum of 200 Kbps in one-direction);
- 16.46% of North Carolina's households still had no access to even the minimum speed of 200 kbps Internet service;[323]
- As of the end of 2006, 21 counties had less than 70% access to 200 kbps of Internet service, and four of these counties had less than 50% access. (The lowest four counties were a focus of e-NC's 2007 incentive funds. These counties are being upgraded, with all four counties to have over 70% access, and Warren County to have 86% access by fall 2008. Once completed, 17 counties will still have less than 70% of their households able to access "high-speed" Internet.);
- Of all rural counties, Stanly County had the highest level of access, with 98.34% of households having access to a high-speed Internet connection, while Jones County had the lowest level, with 45.07% of households having access to a high-speed Internet connection;
- Of all urban counties, Cabarrus County had the highest level of access, with 96.36% of households having access to a high-speed Internet connection, while Alamance County had the lowest level of access, with 72.61% of households having access to a high-speed Internet connection; and
- 67% of North Carolina's rural households have access to cable modem service versus 82% of North Carolina's urban households.

Because the e-NC Authority has not been able to obtain subscription data from the providers, it has been limited to making broad estimates through a series of Citizens Surveys conducted by East Carolina University. In May 2005, the e-NC Authority released the latest findings from these surveys, which showed that, in early 2004, 59 percent of all North Carolina adults reported using the Internet from home (either dial-up or broadband), and that 40 percent of North Carolina home Internet users reported using a broadband connection.[324]

3. Communications Workers of America's Data

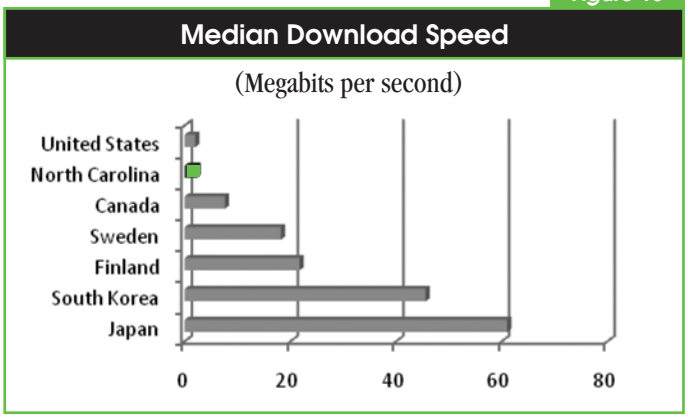
Combining the results of more than 80,000 speed tests performed around the United States in 2006 and ITIF data for Internet speeds in other countries, the Communications Workers of America (CWA) compared the Internet speeds available in all 50 states with those in Japan, South Korea, Finland, Sweden and Canada.[325] The CWA's data for North Carolina are reflected in the following charts:

Table 11

North Carolina Internet Speed test	
Location	**Median Download Speed (Megabits per second)**
Japan	61.00
Sooth Korea	45.60
Finland	21.70
Sweden	18.20
Canada	7.60
North Carolina	**2.23**
United States	**1.97**

International data from the Information Technology and Innovation Foundation. U.S. data from speedmatters.org test results. Most test participants had DSL or cable modem connections.

Figure 15



As CWA's data show, the median download speed in North Carolina – 2.23 Mbps – was slightly higher than the national average for the United States – 1.97 Mbps – but was far less than that of the other countries, particularly Japan.[326]

B. North Carolina's Rankings on the 2007 State New Economy Index

In Section I.B, as part of our discussion of the relationship between broadband and economic development, we introduced the Information Technology and Innovation Foundation's 2007 New Economy Index. As noted above, the New Economy Index ranks states according to their performance on 26 indicators, which are divided into five broad categories: Knowledge Jobs, Globalization, Economic Dynamism, Transformation to a Digital Economy, and Technological Innovation Capacity. We now apply that index to North Carolina. Table 12 below summarizes North Carolina's ranking on these indicators compared to other states.

In view of North Carolina's reputation for technological leadership and progressiveness, its overall ranking of 26th on the New Economy Index is startlingly low. The authors of the New Economy Index puzzled over this, and after studying the data carefully, they arrived at the following conclusion:

> Given some states' reputations as technology-based New Economy states, their scores seem surprising at first. For example, North Carolina and New Mexico rank 26th and 33rd, respectively, in spite of the fact that the region around Research Triangle Park boasts top universities, a highly educated workforce, cutting-edge technology companies, and global connections, while Albuquerque is home to leading national laboratories and an appealing quality of life. In both cases, however, many parts of the state outside these metropolitan regions are more rooted in the old economy – with more jobs in traditional manufacturing, agriculture, and lower-skilled services; a less educated workforce; and a less-developed innovation infrastructure. As these examples reveal, most state economies are in fact a composite of many regional economies that differ in the degree to which they are structured in accordance to New Economy factors.[327]

These observations are consistent with both the data cited in the previous section and with the work that Duke University is doing on North Carolina's global competitiveness, to which we now turn.

Table 12

NC's Rankings on the 2007 State New Economy Index		
Category	**Indicator**	**NC's Rank**
Knowledge Jobs	Information Technology Jobs	15
NC's Rank = 31st	Managerial, Professional, and Tech Jobs	32
	Workforce Education	33
	Immigration of Knowledge Workers	36
	Manufacture Value-Added	36
	High-Wage Traded Services	28
Globalization	Export Focus of Manufacturing and Services	34
NC's Rank = 17th	Foreign Direct Investment	8
	Package Exports	26
Economic Dynamism	"Gazelle" Jobs	16
NC's Rank = 27th	Job Churning	23
	Fastest Growing Firms	24
	Initial Public Offerings	25
	Entrepreneurial Activity	36
	Inventor Patents	36
Transition to the Digital Economy	Online Population	42
NC's Rank = 36th	Internet Domain Names	25
	Technology in Schools	34
	E-Government	26
	Online Agriculture	28
	Broadband Telecommunications	18
Innovation Capacity	High-Tech Jobs	25
NC's Rank = 21st	Scientists and Engineers	17
	Patents	27
	Industry Investment in R&D	17
	Venture Capital	9
North Carolina		
Overall Rank = 26		

C. Duke University's Work on North Carolina's Global Competitiveness

Competition from, and cooperation with, China are of particular interest to North Carolina. In fact, Duke University's Center on Globalization, Governance & Competitiveness has established a program that focuses on this issue.

In recent testimony on China's impact on the economy of North Carolina, the director of the Center, Professor Gary Gereffi, characterized the relationship between China and North Carolina as follows:

> The relationship between the United States and China has become vital to both sides in recent years, given China's rapid ascent as a global economic powerhouse as well as its growing geopolitical prominence within Asia. North Carolina's

> most salient issues in its relationship with China overlap with broader U.S.-China relations. Concern in the highest U.S. political circles has focused on the mushrooming trade deficit with China, the undervalued Chinese currency, the need for more stringent protection of intellectual property rights in China, and most recently, a series of quality complaints about Chinese imports ranging from lead paint in children's toys to tainted food products.
>
> Within North Carolina, the precipitous decline of jobs in traditional manufacturing industries like textiles, apparel, and furniture has had the greatest economic impact in recent years, and much of this job loss can be attributed to intense international competition from low-cost offshore production in countries like China and Mexico. However, North Carolina has engaged China on a number of other levels associated with the state's shift toward high-technology and knowledge-oriented industries, based on two-way foreign direct investment, collaboration in research and development (R&D), the upgrading of infrastructure to facilitate trade and investment, and new educational programs to upgrade skill sets in North Carolina.[328]

Professor Gereffi draws an important distinction – like the United States as a whole, North Carolina is generally doing well from the standpoint of manufacturing *output*, but also like the United States as a whole, North Carolina is losing *jobs* in large numbers in traditional manufacturing industries.

> The problem is not that American manufacturing output is declining, but that American manufacturing employment has been shrinking from its peak of 19 million workers in 1979 to just 14 million today, the lowest level since 1950 (Goodman, 2007).
>
> North Carolina mirrors this trend. Between 2001 and 2006, employment in North Carolina's two top manufacturing sectors, textiles and furniture-making, fell by 90,000 jobs. Textile employment in North Carolina fell from 110,000 to 60,000, apparel from 40,000 to 21,000, and furniture from 72,000 to 52,000. However, the state has also shown significant job growth in a number of lucrative high-technology sectors, such as biotechnology, pharmaceuticals, banking and finance, software and computer system design, and data processing. In biosciences, for example, the number of firms established in the state has risen from 131 to 386, and the number of workers has grown from 20,000 to 47,000.[329]

Professor Gereffi goes on to describe several "successful cases of innovation and adaptation in North Carolina." What is most striking about these examples is that all but one – Google's new facility in Lenoir – are located in urban areas, and most are in Research Triangle Park:

Examples of Shifts to High Technology and Knowledge-Oriented Industries

- Conversion from traditional cotton manufacturing to high-tech textile manufacturing as one of the state's growing export markets to China – Glen Raven Custom Fabrics in Alamance County (urban); VF Corporation in Greensboro, Guilford County (urban)
- GE producing engines to power Chinese aircraft in Durham, Durham County (urban)
- GE Nuclear Energy in Wilmington, New Hanover County (urban)
- GE Smiths Aerospace plant in Asheville, Buncombe County (urban)
- Cree tripling its manufacturing capacity in China but headquarters remain in Durham, Durham County (urban)
- Dell establishing manufacturing plant in Winston-Salem, Forsyth County (urban)
- IBM locating R&D and manufacturing facility in Research Triangle Park in Durham County (urban)
- RedHat software developer headquartered in Research Triangle Park, Durham County (urban)
- Duke University focus on nanotechnology and the Emerging Global Knowledge Economy, Durham, Durham County (urban)
- Emergent Games licensing gaming technology to China's largest publisher of interactive games, located in Chapel Hill, Orange County (urban)
- Google locates server facility in Lenoir, Caldwell County (rural)

Examples of Increased Chinese investment in North Carolina technologies and education

- Lenovo locating Fulfillment Center in Guilford County (urban)
- China's Suzhou Industrial park opening American headquarters in Raleigh, Wake County (urban)
- China's Lenovo buying IBM computer business located in Morrisville, Wake County (urban)
- China Everbright International in partnership with NC China Center established an environmental science and technology center in Raleigh, Wake County (urban)

Examples of Adoption of Global Educational Curriculum

- Glenwood Elementary offering "dual immersion" program using Chinese and English in classes – Chapel Hill, Orange County (urban)
- N.C. State University planning student exchange program with three major Chinese universities – Raleigh, Wake County (urban)
- Lenoir Early College Program for high school students in partnership with Caldwell Community College and Technical Institute, Lenoir, Caldwell County (rural)

In his testimony, Professor Gereffi described the Google project as follows:

> Although relatively small, Lenoir, NC is the site of a $600 million investment by Internet giant, Google. The arrival of the high tech company is a relief to the town which has been hit hard with traditional manufacturing moving to China. Just in the past three years, seven furniture factories in town have closed, resulting in the loss of more than 2,100 jobs. When tentatively approached by Google, the government reacted by pulling together a package of state and local tax incentives and infrastructure valued at $212 million over 30 years (Gray, 2007). Government actions reflect the realization that the future is not in manufacturing, but in technology. Google's server farm "put [Lenoir] on the map" and will bring much needed jobs to the town (*Business Week*, 2007). More than that, it is raising people's morale and giving "people a reason to stay, build a prosperous life and make a contribution" (Hicks, 2007).

Conspicuously absent from this discussion is any mention of the fact that Google also obtained access to fiber optic connectivity that enabled it to connect the Lenoir facility to Google's worldwide network. That this was a critical factor in Google's decision is confirmed by press reports about Google's acquisition of a virtually identical facility in Berkeley County, S.C., at around the same time.[330]

> The size and type of the operation that Google [was planning] in Berkeley County [was] similar to what the company [had] described for Lenoir, about 70 miles north of Charlotte, in Caldwell County. According to Rhett Weiss, Google's senior team leader for global infrastructure, the company chose the South Carolina site in part because it had ample fiber optic cable connections. "The fiber optic connection is sort of the modern version of what Charleston traditionally was as port city," Weiss said. "The fiber optic network is sort of the import-export aspect of the project. That's how the information is coming in and out."

Google's facility-siting decisions are good examples of the points we made in our discussion of the relationship between broadband and economic development in Section I.B.1. above – i.e., that New Economy companies will locate facilities only in areas that have ready access to advanced telecommunications capabilities. This is not merely true of fiber connections to the facilities themselves. Companies are also looking for locations that are attractive to employees, and the availability of affordable high-capacity networks is a major contributor to quality of life. The absence of high capacity broadband infrastructure in North Carolina's rural areas poses a clear handicap for these areas in attracting knowledge-based companies that represent the new knowledge-based global market.

D. The e-NC Authority

The State of North Carolina has long recognized that, "[a]ffordable, high-speed Internet access is a key competitive factor for economic development and quality of life in the New Economy of the global marketplace ... [and that in] the digital age, universal connectivity at affordable prices is a necessity for business transactions, education and training, health care, government services, and the democratic process."[331] In 2000, facing an exodus of jobs from North Carolina's core textile, apparel, furniture, and manufacturing sectors, particularly in rural areas, the North Carolina General Assembly established

the Rural Internet Access Authority (RIAA) to expand the deployment and adoption of high-speed Internet access in the State's rural areas. At the time, the General Assembly defined high-speed Internet access as at least 128 kbps for residential customers and at least 256 kbps for businesses.[332]

The RIAA promptly launched an aggressive initiative to gather the facts and develop policies, programs, and recommendations to the Governor, the General Assembly, and other thought leaders in North Carolina. Among other things, the RIAA formed several advisory committees (Technical, Applications, Telecenter, Outreach, Communications, and Legal, Legislative & Regulatory), and it reached out to a wide range of interested parties and the public to participate in them (subject to strict ethics requirements to guard against conflicts of interest). It also held numerous hearings around the state. All these activities contributed to the many innovative programs and projects discussed below.

In 2003, the General Assembly found that the RIAA had "in large measure, successfully accomplished the goals set forth for the RIAA and then dissolved as required by law."[333] The legislature also recognized, however, that "[a]n organized effort must continue to ensure that the citizens of North Carolina keep pace with the ever faster technological changes in telecommunications and information networks in order to assure the economic competitiveness of North Carolina with special focus on rural and urban distressed areas."[334]

The General Assembly responded to this challenge by passing a new law that established "the e-NC Authority" (e-NC) as successor to the RIAA, added distressed urban areas to e-NC's primary jurisdiction, and expanded the scope of the e-NC Authority's responsibilities to include communicating and coordinating with State, regional, and local agencies and private entities "to continue the development and facilitation of a coordinated Internet access policy for the citizens of North Carolina."[335] The new law also redefined high-speed Internet access, tying it to the FCC's definition of that term.[336]

The e-NC Authority's mission was – and continues to be – to ensure that residents and businesses in North Carolina, particularly in rural and distressed urban areas, are aware of high-speed Internet services and capabilities, have affordable access to them, and know how to use them. From early on, the RIAA and the e-NC Authority recognized that facilitating affordable access to high-speed Internet access was essential but would not be successful unless potential users were willing and able to take advantage of it. As a result, e-NC established and funded a broad range of programs addressing both the demand and supply sides of the broadband equation.

In the remainder of this section, we provide an overview of e-NC's demand-building and supply-building programs. These programs are described in greater detail, with many examples provided, at e-NC's website (www.e-nc.org) and in the publications available there. We then review the lessons that e-NC has learned from these and other efforts during the last seven years.

1. Building Demand

Between 2001 and 2007, e-NC invested more than $11 million in "demand building" programs. These programs included "e-Communities" projects; Public Internet Access Sites, Digital Literacy Training grants, e-NC Business and Technology Telecenters, and e-government training and other educational efforts.

a. e-Communities, Public Internet Access Sites, and Digital Literacy Training

In 2001, e-NC began to provide leadership, coordination, and training of "e-Champions" for North Carolina's 85 rural counties and for the Eastern Band of the Cherokee Indians.[337] The e-Champions, designated locally, created local steering committees that, in turn, were responsible for marshalling community support.

The e-NC Authority also offered grants to encourage counties and the Eastern Band to use Internet technology to enhance local businesses, health care systems, and government and educational institutions. The grants targeted connectivity, public Internet access, digital literacy, and Web applications.

Between 2001-2006, e-NC issued more than $2.7 million in grants related to building e-communities. Thirty-two of the state's most economically distressed counties received public engagement grants (up to $5,000 each) for the coordination of community meetings to discuss local needs and the way technology could be used to meet those needs. All 85 rural counties, plus the Eastern Band of the Cherokee Indians received planning grants (of approximately $10,000/each), and all 86 of these entities received recognition as "e-Communities" at the end of the process. Between 2002-2004, e-NC awarded 14 of these "e-Communities" implementation grants (ranging from $15,000 – $375,000) to act on their strategic plans, and it later awarded support grants of approximately $3,000 each to another 56 to continue their programs. Between 2005-2006, e-NC made another five action grants ($4,000-$5,000 each) to continue their implementation efforts.[338]

Between 2002 and 2004, e-NC also awarded more than $1.7 million in digital literacy training and in establishing over 135 public Internet access sites in 64 of the rural counties that had completed their e-Communities planning processes. The public access sites served to provide residents in rural

areas access to the Internet at little or no cost, to gain familiarity with the technology and to improve their employment and educational opportunities. The e-NC provided digital literacy training grants of $20,000-$40,000 each to 28 communities across the state to develop or sustain free or low-cost computer and Internet training. These programs focused on building technology skills among the unemployed, disabled, elderly, and non-English speaking residents, with training ranging from basic computer skills to the operation of advanced computer software applications.

In January 2004, the e-NC Authority also began to fulfill its new responsibilities in distressed urban areas. First, the e-NC launched a study, completed in early 2005, to understand the unique issues surrounding availability and adoption of high-speed Internet connectivity in these areas.[339] It then designed and initiated two pilot projects to stimulate communities in urban areas to plan their own technology-driven economic futures. The two pilot cities, Charlotte and Wilmington, ultimately became the first two "urban e-Communities" in North Carolina.

Although e-NC's official "e-Communities" activities ended in 2006, and training of e-Champions tapered off with the reduction in grants and associated e-NC training staff, e-NC still encourages communities needing local technology planning efforts to utilize its e-Communities Tool Kit, outlining the model for this program. e-NC also believes that the e-Communities program played a valuable role in galvanizing a local awareness of, and training in, computers and in the Internet's influential role in local economic development.

b. e-NC Business and Technology Telecenters and "Technopreneurs"

Believing that technology must be combined with activities that build and enhance the capabilities of local firms, attract experienced entrepreneurs, and provide training and technical assistance to both residents and businesses, the e-NC Authority invested almost $6 million (from 2001-2006) in establishing Business & Technology Telecenters (BTTs) in several of the most economically distressed areas in the state. These BTTs serve as "technology hubs," offering a combination of business-oriented services, including Internet access and training in computer and Internet use. They also provide business incubation resources, such as business assistance, office and meeting space, equipment, etc. Seven of the original nine centers remain active today and are working to become self-sustaining.

Between 2005 and 2007, four of the Telecenters received additional grants from e-NC, Golden LEAF and the W.K. Kellogg Foundation, as part of an initiative called the "Technopreneur Program."[340] This program provided one staff person to foster local-level entrepreneur development, by going into the communities and providing one-on-one training and counseling for individuals interested in starting or growing technology-oriented small businesses.[341]

Although results varied by site, e-NC found the Telecenter program to be an overall success. Established in communities that were experiencing drastic manufacturing and textile layoffs and closings, the Telecenters helped thousands of individuals and businesses gain access to the Internet as well as improve computer literacy and skills. These individuals acquired new or better jobs and incomes. Companies learned how to use the Internet to work efficiently with their suppliers, to develop new products and services, to find new markets, and to compete more effectively. Students gained access to courses from outside the region and broadened their world views. Municipal and county governments improved the availability and quality of their services. Everyone gained new optimism about their future. More specifically, between 2001-2006, the Telecenters contributed to the creation of 1,190 jobs, served 20,533 small businesses and entrepreneurial clients, and leveraged an additional $9,966,760 in funding from the initial e-NC grants.[342]

c. Local e-Government Utilization Program (LEG-UP)

A central "demand-building" effort by e-NC was the Local e-Government Utilization Program (LEG-UP) launched in late 2002 through a $700,000 grant from the U.S. Department of Commerce Technology Opportunity Program ("TOP"), in partnership with the Rural Internet Access Authority and the University of North Carolina at Chapel Hill's Center for Public Technology. The funds were matched by an additional $605,000 from the Rural Internet Access Authority, plus $204,000 in in-kind support. The effort was designed to improve the delivery of public services and to connect rural citizens to local government using the Internet.

Fifty-six LEG-UP counties and municipalities received training, equipment, and funds to help them bring transactional, e-government services to local citizens and businesses. This included Web-sites, utility billing and customer-payment mechanisms, and means for public access to title and deed records. One customized service enabled citizens to see pictures of animals up for adoption and to track newly rescued animals. A Geographic Information System [GIS]-based application assisted the Federal Emergency Management Administration and county officials in the recovery effort following Hurricane Ivan. Other programs included an online tax system that enables the public to pay tax bills online; a system that allows realtors to view tax bills for a listed property; and a system that integrates real estate and tax data with a county's GIS. All these projects resulted in a significant reduction of county staff time spent researching and delivering data to its residents, while increasing timeliness, accuracy, and awareness of government services.[343]

2. Building Supply

The e-NC Authority's supply-building initiatives have focused on bringing affordable high-speed Internet access to unserved and underserved areas in two primary ways: by documenting the availability of broadband infrastructure and services and by providing grants to stimulate deployment of broadband infrastructure.

a. Mapping availability of broadband services

The e-NC Authority was the first state organization in the United States to map broadband availability, recognizing that doing so was an important first step in establishing priorities and advocating for expansion of broadband services.[344] The e-NC Authority has also developed sophisticated GIS mapping capabilities that enable e-NC to specify and print out various kinds of maps. Unfortunately, the data that e-NC has obtained from broadband providers is not entirely reliable, as broadband providers are under no statutory duty to provide e-NC complete, accurate, and verifiable information.

In 2001, e-NC commissioned a large consulting firm to develop an initial inventory of telecommunications infrastructure in the state. The consulting firm did so based on data from FCC reports and other sources and on limited interviews of some of North Carolina's broadband providers. The e-NC Authority did not find this approach satisfactory. Instead, since 2002, e-NC has mapped access to broadband services in two ways: (1) communicating directly with broadband providers and (2) conducting independent staff research.

Each year, e-NC releases a report entitled *High Speed Internet Access in North Carolina: a 100 County Report*, which ranks counties by the percentage of households with access to DSL and cable modem service. The e-NC Authority does not include broadband provided through wireless or satellite technologies. For its 2004-2006 reports, e-NC determined household access to "high-speed Internet access" in accordance with the FCC's definition of that term – a minimum of 200 kbps in one direction.

In performing its demand and supply stimulation activities, e-NC would find it very useful to have complete and accurate data on adoption of broadband services, broadband speeds, and broadband prices. Currently, e-NC has only sporadic and incomplete access to such information, because many broadband providers, citing confidentiality, will generally not provide all the necessary data to e-NC.[345]

b. Connectivity Incentive Grants

Between 2002 and 2006, guided by the information that it had gathered in developing its *100 County Reports*, the e-NC Authority invested almost $9.5 million in Connectivity and Infrastructure grants to non-profits and companies serving the least-wired rural counties in the state.[346] These projects included sending buses equipped with computers and Internet satellite equipment to remote communities in nine counties; connecting schools, government agencies, businesses, and residents in various counties; financing the upgrade of a small cable company serving low-income communities; subsidizing expansions of DSL equipment and services; and funding deployment of a fiber ring through five mountainous counties in the northwest. The Eastern North Carolina Broadband Initiative, launched in 2002, is another "supply-side" program. This project, including a $2.925 million investment from e-NC, was a $14 million public-private initiative to install a fiber ring in northeastern North Carolina and to bring broadband access to more than 30,000 residents who did not have DSL capability.

c. Eastern North Carolina e-Learning Grants

The Eastern North Carolina Broadband Initiative also included an e-learning component. The e-NC Authority, through funding from Golden LEAF , provided $2 million to fund connectivity costs at local school systems in northeastern NC.[347] Fifteen county school systems (including 121 schools) have now been awarded grants to improve their broadband infrastructure networks. This e-learning program ends in 2011, but the e-NC Authority is continuing to work with the BETA initiative in North Carolina (chaired by Lt. Governor Beverly Purdue). The BETA initiative, which has gained the support of the legislature, seeks to provide all schools in North Carolina connectivity at speeds of at least 1 Gbps (through the Local Education Agency in a region) and at least 100 Mbps to each school.

d. Other e-NC initiatives

The e-NC Authority has also been involved in a variety of other initiatives. These include several additional educational and health care programs. The e-NC Authority has sponsored numerous conferences on using information technology to spur economic development, including its annual Southeast Information and Communications Technology Symposium.[348] It has also developed numerous expert publications on the adoption of information technology for rural economic development.[349]

3. e-NC's Observations and Lessons Learned

Over the last seven years, the e-NC Authority has had extensive experience with a broad range of initiatives to increase broadband deployment and adoption in North Carolina's rural and distressed urban areas. As a result, e-NC's staff has observed and learned a great deal, including the following:

a. Rural broadband availability has leveled off

In its *100 County Report*, e-NC documented that access to high-speed Internet services in North Carolina has stalled at about 83 percent of households. Specifically, households in North Carolina with high-speed Internet access reached 82.33 percent in 2004, declined to 82.01 percent in 2005, and rose to only 83.54 percent in 2006. These figures are consistent with e-NC's first-hand observations, and they undermine the FCC's data, which suggest that high-speed Internet access grew rapidly during this period.[350]

b. A persistent disparity exists between rural and urban areas

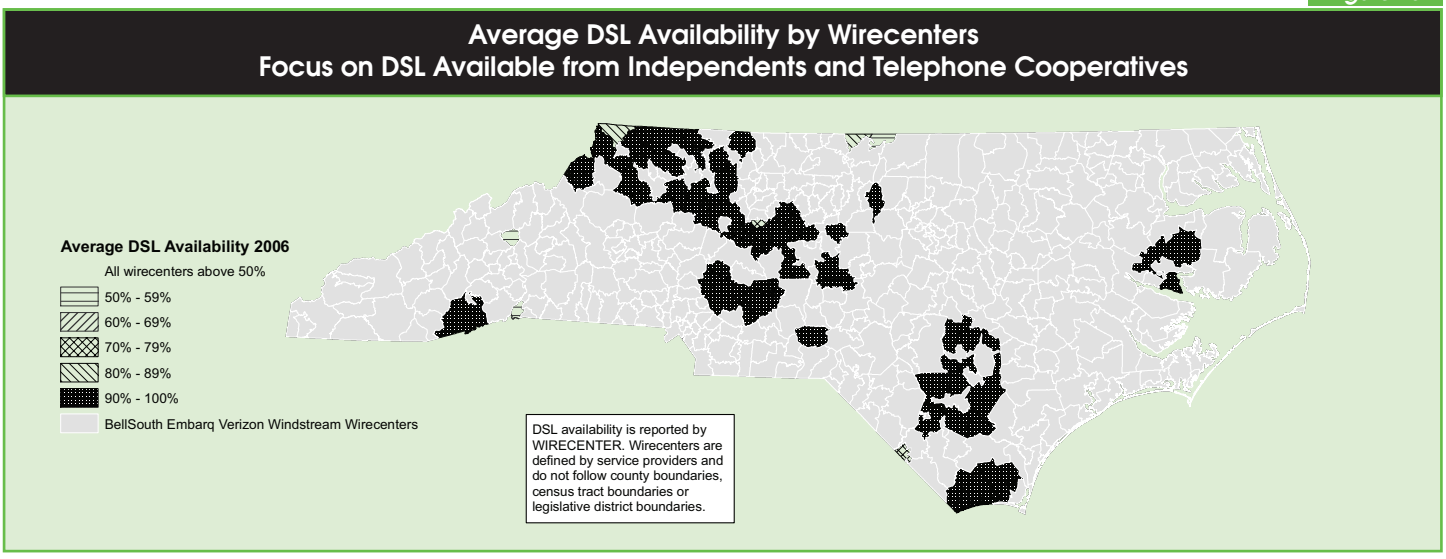
The e-NC Authority's data also show that disparities between North Carolina's rural and urban counties have persisted. While the percentage of households in rural counties that have DSL increased from 44 percent in 2002 to 73 percent in 2006, the unfortunate corollary is that 27 percent of rural households were still completely without access to DSL.[351] The same pattern holds for CMS, at an even more distressing level – while 82 percent of North Carolina's urban households have access to CMS, only 67 percent of its rural households have similar cable modem access (as of December 2006). The rural households without access to DSL or CMS will find it increasingly difficult to function in even a rudimentary way in the knowledge-based global economy.

c. Small providers headquartered in-state are more likely than large providers, headquartered out of state to offer broadband throughout their entire service areas

As reflected in broadband availability map below, small North Carolina-based independent and cooperative service providers typically offer DSL to 98- 100 percent of the households in the rural counties they serve.[352]

Furthermore, two cooperatives are building out FTTH at 80 Mbps in portions of their territories. In contrast, the larger telephone companies, which are headquartered out of state, typically extend DSL only to about 80 percent of the households in the rural areas they serve. The e-NC Authority does not have as much detailed information for cable companies, but its observations in the field suggest that a similar pattern exists as between small and large providers of CMS.

Figure 16



Source: The e-NC Authority, data supplied by service providers

According to the e-NC Authority's staff, the reason for the disparity is that the small North Carolina-based providers say they live and work in their communities and feel a sense of responsibility to their neighbors to build out their entire service areas, whereas the larger companies appear to be shifting capital dollars to larger markets, where they face more competition for voice, video and data services. The major telephone companies are also investing heavily in expanding their cell phone service offerings, which further reduces capital available for upgrades in rural areas.

d. Provider stability is important

The e-NC Authority has learned many lessons from its Connectivity Incentive grants. Most of the projects provided infrastructure and equipment that is still being used today. However, some of the small wireless companies and one satellite company found that they were unable to maintain the service envisioned. In addition, some projects, such as the two mobile Internet access buses, provided key access for a time, but are no longer active.

As a result of the earlier incentives grants, and the lessons learned, e-NC changed the application criteria with the 2007 incentives program. Originally, any provider willing to bring high-speed Internet service to any of North Carolina's 85 rural counties could apply. In the 2007 funding round, applicants had to provide last-mile service to currently un-served areas in targeted counties. Applicants were required to show five years of experience in providing high-speed Internet service, have positive cash flow, and be able to match the grants dollar for dollar. While this probably biases the awards toward more experienced firms, e-NC has learned that provisioning high-speed Internet access service in sparsely-populated, low-income communities, has proven difficult for start-ups. Small-business entrepreneurs who attempted to grow these businesses seemed to lack the management, financial or technology expertise to run the projects as self-sustaining enterprises, as well as lacking the underlying capital and financial assets often required. A number of the non-profits seemed to be in a constant struggle to cover operational expenses, and were unable to make necessary upgrades to the equipment due to a lack of revenue generated by the need to price services within the incomes of less wealthy residents. Other barriers included finding access to affordable back-haul fiber networks. Overall, the business case was, so often, simply not there.

This is not to say that only large, well-established companies should be able to receive support, particularly when they are only providing low-capacity DSL or CMS. The small independent and cooperative communications providers certainly have the necessary managerial, financial, and technical competence, and even some less-experienced companies may qualify for support, particularly if they are willing to provide more robust broadband than larger companies. Furthermore, numerous public entities across the United States, particularly those that operate their own electric utilities, have shown that they either have, or can obtain, the resources and expertise they need to meet their communities' communications needs.

In the end, e-NC believes that a balance must be struck between supporting large communications providers, which can deploy low-capacity DSL and CMS relatively quickly, and supporting smaller providers that offer to introduce new services or technologies that can provide (1) alternatives to DSL and CMS, or (2) higher-capacity, fiber-based, broadband services and capabilities of the kind that communities will need to be competitive in the years ahead. The e-NC Authority further believes that such determinations should be made on a case-by-case basis. At a minimum, where the form of support is subsidies to large communications providers to provide "last mile" DSL or CMS, such support should be conditioned on commitments to install fiber rich "middle-mile" facilities that can readily support upgrades when communities can afford them.

IV. HOW MUCH BANDWIDTH CAPACITY IS ENOUGH?

We now come to the critical question, "How much bandwidth capacity is enough?" To date, the FCC has addressed this question only in the context of defining the minimum levels of bandwidth capacity that can be said to qualify as "broadband." Similarly, North Carolina has addressed the question only in the course of establishing goals for the minimum levels of bandwidth capacity to which all North Carolinians should have affordable access. The FCC's minimalist approach has coincided with – and undoubtedly contributed to – America's dismal ranking in broadband deployment compared to other nations.

In this section, we will take a different approach. Rather than focus on defining the bottom of the broadband barrel, we will recast the question as follows: "How much bandwidth capacity does the United States and North Carolina realistically need for its citizens, businesses, and institutions to survive and thrive in the emerging global economy?" That, we believe, is the critical question that the United States and North Carolina should be asking.

To answer this question, we will do four things. First, we will incorporate into our analysis the discussion of the contributions that high-capacity broadband networks can make in all areas of American life. All too often, those who claim that low levels of bandwidth capacity are sufficient focus only on a narrow list of user applications and overlook the vast array of other benefits that broadband can simultaneously bring to America.

Second, we will review the positions of the parties in the increasingly heated debate over whether Internet traffic is growing so fast that it will cause the Net to bog down or even crash between 2010 and 2015. For our purposes, we need not take sides on whether the proponents of doomsday scenarios are genuine or are merely seeking to justify buildout subsidies, usage-based rates, or a free hand in managing network traffic. Suffice it to say that none of the parties to the Internet traffic debate argues that DSL or CMS is sufficient to meet America's growing bandwidth needs.

Third, we will summarize developments in the leading Asian and European nations. Why are these nations moving rapidly to bandwidth capacity of 100 Mbps, a Gbps, or even more? What do the very bright people in these countries know that has escaped us in the United States? What will they be able to do that we in the United States will be unable to match? We will try to shed light on all of these questions.

Fourth, we will analyze the arguments that EDUCAUSE, the Fiber to the Home Council, state task forces and commissions, and others in the United States are making on how much broadband capacity the United States needs.

Finally, based on all this information we draw our own conclusions – that the United States should establish as national goals making available to all Americans, at affordable rates, bandwidth capacity of at least 100 Mbps by 2012 and at least 1 Gbps by 2015. The United States should also act quickly to establish a national broadband strategy and specific action plans to achieve these goals. The best way to do so, we believe, is through a non-partisan, blue-ribbon commission, as we recommended in our paper "Eight Bold Steps to a National Broadband Strategy" in January 2007.[353]

A. The Rapidly Growing Need for Bandwidth

As noted above, the U.S. Department of Commerce predicted in 2002 that DSL and CMS would soon be outstripped by growing broadband demand:

> It is important to note here that the current generation of broadband technologies (cable and DSL) may prove woefully insufficient to carry many of the advanced applications driving future demand. Today's broadband will be tomorrow's traffic jam, and the need for speed will persist as new applications and services gobble up existing bandwidth.[354]

Many experts believe that the traffic jam has already arrived or will soon do so. For example, Leslie Cauley, of *USA TODAY*, provides the following summary of an interview with Internet giant Vint Cerf, who helped design the technical protocols that led to the formation of the Internet:

> Vint Cerf, chief Internet evangelist for Google – that's his real title – says capacity constraints are just an excuse for carriers to squeeze customers.
>
> Cerf's solution: a cap on speed, not usage. He says it makes more sense for consumers to pay for a maximum rate of transmission. As for the peer-to-peer problem, Cerf doesn't disagree that it eats up a lot of broadband capacity – maybe too much.
>
> "It needs better engineering," says Cerf, one of the original architects of the technical protocols that led to the formation of the Internet. Cerf says the computing protocols that drive peer-to-peer services could easily be altered to make them more bandwidth-efficient.

> But network capacity is the real issue, he says. Cerf thinks a lot of carriers were simply caught off guard by the explosion in Web usage, which is why they're running so hard now to catch up.
>
> "Doubling (capacity) isn't enough," he says, not with bandwidth-sapping applications such as high-definition video headed their way. "These various attempts to constrain consumer demand ... are a reflection of limited capacity and oversubscription."[355]

Concerns such as these have been fueled by Comcast's grudging admission that it has been using traffic-shaping techniques to throttle its subscribers using BitTorrent to accelerate downloads.[356] In comments to the Federal Communications Commission explaining its practices, Comcast insisted that it has not yet run out of capacity, but it acknowledged that Internet traffic is growing faster than anyone had expected:

> Today's Internet is a copious buffet of multimedia content, applications and services – many of which consume vastly greater quantities of bandwidth than were needed just a year or two ago. Just as the availability of broadband Internet has spurred the development and growth of all manner of new Internet content, applications, and services, the growth of these items in turn helps drive the demand for broadband.[357]

Comcast relied, in part, on a study by Nemertes Research Group released in November 2007. Careful to distinguish capacity at the access level (the "last mile" between consumers and service providers) from capacity at the core of the Net, where it found that congestion was unlikely to occur, Nemertes predicted that the following would occur at the access level by 2011:

> Our model predicts that the far-and-away most likely scenario is that user demand will exceed access capacity (or effective access capacity, which we pegged at 30% utilization). In practice, this simply means that the access line begins to act like a local area network with too much contention – the rate of retransmission goes up, and net throughput goes down.
>
> At a practical level, the user experiences erratic performance: sometimes files will download quickly, and sometimes they'll drag on, seemingly forever. If large file transfers (such as peer-to-peer) are conflicting with latency-sensitive applications like voice, the voice quality may degrade, although it's worth noting that users can protect against this today by configuring quality-of-service capabilities on their local routers, which generally maintain overall service quality quite well even in congested links. This is not necessarily the case with interactive video, which consumes more bandwidth than voice – if the bandwidth isn't there to begin with, no amount of quality of service can help. But current access circuits can handle current video streams fairly well – the impact on video is likely to be what *won't* happen: no deployment of HD video, no telepresence applications.
>
> Overall, transmitting over a saturated broadband link will feel a lot like the bad old days of dial-up: Long pauses between request and response, with some applications just too painful to bother with.
>
> But the user experience is really just the tip of the iceberg. The real impact is the chilling effect that insufficient capacity exerts on companies that rely upon reliable Internet performance (YouTube, PhotoBucket, Amazon.com, etc.) [which] could be faced with a crisis if their customer base simply can't access their product in a tolerable manner. New companies that emerge – say to enable high-definition video downloads – may not survive. And finally [companies] that plan to rely upon the public Internet (via SSL and IP VPNs) as an increasing component of corporate connectivity may want to reconsider this strategy in light of the potential downstream performance impact.
>
> The Internet, therefore, does not really break in the sense that it will refuse to provide service. Performance degrades to a point at which users are unhappy (and find other things to do that don't involve using the network). Businesses that might generate value from the Internet infrastructure fail to launch, or thrive, and existing businesses that rely on Internet services suffer. In essence, it's as though the Internet protects itself from increasing demand.[358]

Similarly, in a speech in April 2008, AT&T vice president Jim Cicconi stated that "[t]he surge in online content is at the center of the most dramatic changes affecting the Internet today. In three years' time, 20 typical households will generate more traffic than the entire Internet today." He went on to say that at least $55 billion worth of investment was needed in new infrastructure in the next three years in the United States alone, with the figure rising to $130 billion to improve the network worldwide. "We are going to be butting up against the physical capacity of the Internet by 2010."[359]

Likewise, in a joint interview on May 1, 2008, the Chief Technology Officer of Charter Communications stated, "ISP traffic is increasing at more than 50 percent every year. So it is not so far-fetched to see 100 meg product becoming the norm in five or 10 years, and we expect our customers will find

exciting ways to use that capacity." To this the Chief Technology Officer of Comcast added, "For the short term, 100 Mbps is a marketing advantage – in the longer term, who knows? People didn't need 1 Mbps when we first started delivering it."[360]

In another recent study, IDC estimates that, by 2011, the digital universe will be 10 times what it was in 2006, with the fastest growing corners of the digital universe including digital TV, surveillance cameras, Internet access in emerging countries, sensor-based applications, datacenters supporting "cloud computing," and social networks:

> The diversity of the digital universe can be seen in the variability of file sizes, from 6 gigabyte movies on DVD to 128-bit signals from RFID tags. Because of the growth of VoIP, sensors, and RFID, the number of electronic information "containers" – files, images, packets, tag contents – is growing 50% faster than the number of gigabytes. The information created in 2011 will be contained in more than 20 quadrillion – 20 million billion – of such containers, a tremendous management challenge for both businesses and consumers.[361]

Bret Swanson and George Gilder take their own prediction out another four years, to 2015:

> From YouTube, IPTV, and high-definition images, to "cloud computing" and ubiquitous mobile cameras – to 3D games, virtual worlds, and photorealistic telepresence – the new wave is swelling into an *exaflood* of Internet and IP traffic. An exabyte is 10 to the 18th. We estimate that by 2015, U.S. IP traffic could reach an annual total of one zettabyte (10^{21} bytes), or one million million billion bytes.[362]

Elsewhere in their paper, Swanson and Gilder estimate that, by 2015:[363]

- movie downloads and P2P file sharing could be 100 exabytes
- video calling and virtual windows could generate 400 exabytes
- "cloud" computing and remote backup could total 50 exabytes
- Internet video, gaming, and virtual worlds could produce 200 exabytes
- non-Internet "IPTV" could reach 100 exabytes, and possibly much more
- business IP traffic will generate some 100 exabytes
- other applications (phone, Web, e-mail, photos, music) could be 50 exabytes

Thus, they conclude, "the U.S. Internet of 2015 will be at least 50 times larger than it was in 2006. Internet growth at these levels will require a dramatic expansion of bandwidth, storage, and traffic management capabilities in core, edge, metro, and access networks."[364]

To be sure, not everyone agrees that Internet traffic will grow as quickly as the sources cited above maintain. For example, Professor Andrew Odlyzco of the University of Minnesota suggests that Internet traffic growth has "decelerated" to 50-60 percent per year, making predictions of greater increases hazardous.[365] At 46 percent a year, Cisco's estimates are slightly lower:

> Driven by high-definition video and high-speed broadband penetration, consumer IP traffic will bolster the overall IP growth rate so that it sustains a fairly steady growth rate through 2011, growing at a compound annual growth rate (CAGR) of 46 percent and nearly quadrupling the monthly traffic run rate from 2007 to 2011.
>
> ...
>
> Internet video will account for 30 percent of all consumer Internet traffic in 2011. Internet video-to-PC will make up the majority of Internet video at 19 percent of the total Internet traffic, but Internet-video-to-TV will grow rapidly to 10 percent of the total by 2011.
>
> Internet video-to-TV will increase by more than a factor of 12 from 2007 to 2011. Internet video-to-PC will nearly quintuple over the same four-year period.
>
> ...
>
> The majority of today's consumer IP is Internet traffic, but consumer [Internet Protocol Television] and [Video on Demand] traffic will grow more rapidly at a [cumulative annual growth rate] of more than 80 percent.[366]

The highly-respected David Burstein of DSL Prime is even more conservative about the growth of Internet traffic, and he questions the motives of those who argue otherwise:

> I'm on a crusade to focus on evidenced-based policy. I'd be fascinated to see any hard data that the Internet is slowing down or having major capacity problems. I'd also welcome any careful estimates of traffic as well as the capacity to handle that traffic that suggest likely problems in any well maintained network.
>
> Net traffic per user, as documented by Odlyzko and Cisco, has been growing at about 35-40% the last five years, and that growth rate is flat and possibly down the last two years. The net has been able to handle the increase without price increases, much less overload, because the primary and rate limiting equipment (switches, routers, WDM, etc.) have simultaneously been going down at a similar 35-40%. Moore's Law is bringing costs down and capacity up at a remarkable rate.
>
> There are problems because people will want even higher speeds than current cable and DSL (Nemertes-read the study not the press release). There are also some limited problems in shared local upstream cable loops, most being easily remedied. (DOCSIS 3.0 is at least 4-20 times as fast. Comcast announced 20M homes servable in two years.)[367]

Notably, Burstein cites AT&T's Jim Cicconi as being among those "who have publicly and confidently said they can handle the load." Yet, one week later, Cicconi apparently had a change of heart, making the statement quoted above.

So, who is right? It is hard to tell. Indeed, the absence of solid traffic data and consensus among the experts on so important a matter itself is a strong reason for having a national broadband strategy. For our purposes, however, complete accuracy is not essential. Even under the most conservative assumptions, Internet traffic is expanding rapidly, and the levels of bandwidth generally available at the consumer level are likely to be unable to keep up with demand.

In particular, all parties to the debate appear to agree that the current generation of DSL and CMS do not have sufficient bandwidth capacity to handle the increasingly bandwidth-rich applications that are now emerging. Whether the more advanced technologies that Verizon, AT&T, the cable industry, and other entities are selectively deploying will be able to handle these applications effectively is a separate question, which we addressed in Part II.B. above.

Furthermore, great nations do not base decisions about much critical infrastructure they need on guesswork about how soon they will face congestion or even meltdown. Rather, great nations make decisions based on the need to accommodate both anticipated and unanticipated requirements for many years to come. That, we submit, is what the United States should now be doing.

B. Experience of the Leading Asian and European Nations

The leading nations in Asia and Europe have recognized for some time that high-capacity broadband networks will be critical to their success in the years ahead. As a result, these countries have decided to develop high-capacity networks as rapidly as possible.[368]

As discussed in Part II.B.1.a above, FTTH is already available to 80 percent of households in Japan today and is expected to be available to 90 percent by 2010. Furthermore, the leading edge of competition in Japan is at 1 Gbps and is expected to rise to 10 Gbps by 2010. Korea is right behind Japan in ubiquity and data speed. China has decided to switch its DSL projects to FTTH. Hong Kong has 1 Gbps connectivity today and Singapore will have it to half the country by 2012 and to the rest by 2015. Taiwan is pushing to 100 Mbps. Similarly, in Europe, Sweden, Norway, the Netherlands, France, Italy, Slovenia, and other countries are all driving rapidly towards of bandwidth capacities of at least 100 Mbps.

C. Positions of Various Interested Parties in the United States

Calls for high-capacity broadband networks have begun to proliferate in the United States. For example, the California Broadband Task Force (CBTF) recently stated that one of California's three key goals should be to construct broadband infrastructure that would position the State "as the global economic leader in a knowledge-based economy."[369] The CBTF developed the following list of applications that various levels of bandwidth can support:[370]

Table 13

Upstream and Downstream Speed Range	Applications	
500 kbps – 1 Mbps	Voice over IP SMS Basic Email	Web Browsing (simple sites) Streaming Music (caching) Low Quality Video (highly compressed)
1 Mbps – 5 Mbps	Web Browsing (complex sites) Email (larger size attachments) Remote Surveillance IPTV-SD (1-3 channels)	File Sharing (small/medium) Telecommuting (ordinary) Digital broadcast video (1 channel) Streaming Music
5 Mbps – 10 Mbps	Telecommuting (converged services) File Sharing (large) IPTV-SD multiple channels) Switched Digital Video Video on Demand SD Broadcast SD Video Video Streaming (2-3 channels)	HD Video Downloading Low Definition Telepresence Gaming Medical File Sharing (basic) Remote Diagnosis (basic) Remote Education Building Control & Management
10 Mbps – 100 Mbps	Telemedicine Educational Services Broadcast Video SD and some HD IPTV-HD Gaming (complex) Telecommuting (high quality video)	High Quality Telepresence HD Surveillance Smart/Intelligent Building Control
100 Mbps – 1 Gbps	HD Telemedicine Multiple Educational Services Broadcast Video full HD Full IPTV Channel Support	Video on Demand HD Gaming (immersion) Remote Server Services for Telecommuting
1 Gbps – 10 Gbps	Research Applications Telepresence using uncompressed high definition video streams Live event digital cinema streaming	Telemedicine remote control of scientific/ medical instruments Interactive remote visualization and virtual reality Movement of terabyte datasets Remote supercomputing

Notably, this chart lists numerous applications in the 10-100 Mbps range that many consumers want today or are likely to want in the years ahead. That is also true of some of the applications in the 100 Mbps – 1 Gbps range.

Elsewhere in its report, the CBTF recognized that the average reported download speed in Japan has already reached 95 Mbps and that

> [t]hese high speeds allow innovation to flourish. For example, Japan's telepathology system, which is expected to be used nationally by next spring, gives doctors the ability to diagnose cancer and other diseases remotely with just a microscope and a fiber optic line. Californians will lose significant economic and quality of life opportunities if leadership is not taken now to regain the state's world-class position in broadband.[371]

Nevertheless, the CBTF apparently concluded that catching up to Japan and obtaining such "significant economic and quality of life opportunities" were infeasible. Without explanation, the CBTF proposed that California define "next-generation infrastructure" as infrastructure capable of services with "total upload and download speeds of 50 Mbps or more" and that California establish goals of 75 percent availability and 50 percent adoption of such next-generation infrastructure by 2015.[372]

The Fiber to the Home Council has launched an initiative, entitled "A Hundred Megabit Nation by 2015," calling for Congress to establish this as the national goal and to establish a strategy to give it effect.[373] As a first step, Senator Jay Rockefeller (D-WV) introduced S. Res. 191 in support of the initiative, and Rep. Anna Eshoo (D-CA) circulated a "Dear Colleague" for the same purpose.

EDUCAUSE was more ambitious in its White Paper, calling for the United States to establish the goal of ubiquitous broadband with a minimum capacity of 100 Mbps by 2012, expandable to a Gbps. EDUCAUSE also furnished extensive analysis in support of this recommendation.

EDUCAUSE noted that consumer bandwidth usage has grown from 28 kilobits/second (kbps) in 1995 to about 3-10 Mbps today, which works out to doubling every 18 months. If that trend continues, Moore's Law suggests that demand will grow to 380+ Mbps within ten years, and to over a Gbps in 13 years.[374] EDUCAUSE cited several studies, including one by the Gartner Group finding that a goal of a Gbps is essential to support next-generation broadband applications.[375] EDUCAUSE also noted the critical consideration that consumers will use various increasingly bandwidth-rich applications simultaneously:

> Consider the following real-world scenario: A home in middle America may include dad watching a live HDTV football game; daughter using the computer to access streaming video of a college course lecture; son playing a real-time interactive game; mom engaged in a videoconference for her home-based business; grandma, visiting for the holidays, downloading an episode of *Masterpiece Theatre*; and grandpa hooked up to an uninterruptable medical video feed to a remote monitoring facility. While all these uses are taking place, the home appliances are being monitored and video home security devices are sending video feeds back to an emergency alarm center. Together, this single home could easily consume 150 megabits of bandwidth$_{22}$ with only the uses we can imagine today. Homes of the future will likely include even more imaginative products and services.[376]

In fact, "more imaginative products and services" are already under development. For example, Samsung is now developing next-generation high definition television powered by the Internet, which will have a large-screen display of 80 inches or more. It will have 4096 x 2160 resolution at a frame rate of at least 60 frames per seconds. Digital content with such a display at 24 frames a second will require around 300 Mb/s for transmission when compressed.[377] These and many other products that are now being designed for high-capacity networks may work well in Korea, Japan, Hong Kong, Singapore, and other countries that have them, but they will not work in most locations in the United States in the foreseeable future.

Some commenters insist that, if anything, EDUCAUSE has not gone far enough, that it would be folly to plan for only a 100 Mbps network today. For example, Jim Carlini asserts,

> If you have ever planned a large-scale network, you have to have a very high objective because going from planning to implementation takes a good several years. Ask the engineers at the phone companies. They do not plan for the next two to five years; they look at 20 to 30 years. At least they used to. Also, if you are trying to plan for the future, you cannot assume the network traffic that is here today.
>
> Adopting the recommendations in this EDUCAUSE white paper will still put the United States behind other countries. Some would still argue that 100Mbps is too much bandwidth for users. Those people do not have a clue as to new applications flooding the Internet including social networks as well as video-heavy applications like YouTube and its imitators. What is on the horizon?[378]

D. Our Conclusions

Quite obviously, many factors go into deciding what America's bandwidth goals should be, and reasonable minds can differ on whether we need at least 50 Mbps, 100 Mbps, or even more. That is one reason why the development of a national broadband strategy would be so useful.

In our view, however, the case for a national goal of 100 Mbps or more by 2012 and 1 Gbps by 2015 is compelling for several reasons. First, as we discussed in Section I.B, broadband is already making huge contributions in many areas of American life. These uses and benefits will continue to grow rapidly, particularly as higher-bandwidth networks are deployed. What's more, broadband applications are increasingly being used simultaneously and in tandem rather than sequentially, which multiplies bandwidth requirements.

Second, applications are becoming increasingly bandwidth-hungry as time goes on, and this can only continue. If anything, with broadband video only now beginning to take off, we may be at just the beginning of a vast run-up of bandwidth requirements. To be sure, those who predict a flood of Internet traffic that will bog the Internet down to a crawl may be wrong or premature. But what if Jim Cicconi of AT&T is only off by a few orders of magnitude or years in predicting that, within two years, 20 average families will produce as much traffic as the whole Internet today and that we are going to butt up against capacity limits by 2010? Surely a great nation cannot bet its future on the hope that such predictions will turn out to be wrong. Rather, great nations build superhighways and electric systems and other forms of critical infrastructure with plenty of excess capacity and assume that they will indeed be used for a wide range of socially beneficial purposes.

Third, the United States is inextricably intertwined with the rest of the world, and it cannot act in isolation. With the leading nations increasingly operating at speeds of 100 Mbps or more, cruelly, the United States cannot hope to remain competitive, let alone occupy a position of leadership, if it is operating at substantially slower speeds. As applications developers write programs that take advantage of these ultra-high speeds in the leading nations, the United States will increasingly find itself cut off from the means of global collaboration, innovation, opportunity, and profit.

Fourth, the arguments for lower bandwidth goals are unpersuasive. The only argument that rings true is that the cost of upgrading to world-class levels will be high. But the cost of failing to do so and falling farther and farther behind the leading nations across a wide range of activities would surely be far greater.

If nothing else, one thing is beyond doubting: DSL and CMS are past their prime. Urging Americans in rural and distressed urban areas to strive for nothing more than these technologies would be cruelly unfair to them and a disservice to America as a whole.

V. RECOMMENDATIONS

In this section, we present our recommendations to the e-NC Authority. Some of these recommendations apply to the Authority in its capacity as advisor to the General Assembly and two other state, local and private entities on broadband policy and legislation, particularly as it applies to rural and urban distressed areas. The other recommendations apply to the Authority primarily in its capacity as the administrator of programs to facilitate greater broadband supply and demand in rural and urban distressed areas.

Recommendation 1: Think Big, Adopt High Goals, and Act Boldly

The United States and North Carolina have fallen far behind the leading nations in broadband deployment, particularly in providing affordable access to high-bandwidth services and capabilities. This not only undermines our collective ability to remain competitive in the emerging knowledge-based global economy, but it also precludes us from taking advantage of the vast array of benefits that robust broadband offers. Time is short, and the stakes for the United States and North Carolina are huge. Unless we act boldly and quickly, our downward spiral will only get worse, becoming ever more difficult – if not impossible – to reverse.

As the legendary Chicago architect David Burnham said a century ago, "Make no small plans. They have no magic to stir the blood." We urge the e-NC Authority and the State of North Carolina to embrace this philosophy. Only big thoughts and bold actions will bring affordable high-capacity broadband services and capabilities to all of North Carolina and the United States.

Specifically, we recommend that the e-NC Authority and the State establish ambitious but realistic and measurable goals to inspire and focus the development of aggressive action plans. For example, we suggest that e-NC and the State establish the goal of ranking within the top five states in the United States by 2012 in both household broadband adoption and average bandwidth used per household. This would achieve both breadth and depth of rich broadband experience. We do not include obtaining the lowest possible prices as an explicit goal because achievement of the other goals would imply that prices were affordable.

Recommendation 2: Participate actively in the development of a national broadband strategy.

There is much that the e-NC Authority and the State can do now to expand broadband adoption and availability in North Carolina, but these efforts would be all the more effective if backed by a strong national broadband strategy. Furthermore, many tools are available at the federal level that no individual state can duplicate – e.g., federal universal service subsidies; economic development, transportation, agriculture, and other grants and loans; federal tax credits, deductions, and accelerated depreciation; use of federal purchasing power to support broadband deployment; and a host of other federal incentives.

We hope this paper has shown that the United States urgently needs a strong national broadband strategy. All of the other leading nations have them, recognizing that advanced communications networks are strategic assets that cannot be left to market forces alone. The United States must do so as well.

With both Senator Barack Obama and Senator John McCain supporting the development of a national broadband strategy, it appears likely that this will occur sometime in 2009, no matter which party wins the November elections.[379] With so much to gain from a national broadband strategy, and with so much knowledge and experience to contribute, the e-NC Authority and the State should become actively involved in this process as soon as possible.

Recommendation 3: Initiate a new round of inquiry to gather the best current information available and to develop new policies and recommendations for the General Assembly.

As the North Carolina General Assembly recognized in authorizing the e-NC Authority in 2003, "An organized effort must continue to ensure that the citizens of North Carolina keep pace with the ever faster technological changes in telecommunications and information networks in order to assure the economic competitiveness of North Carolina with special focus on rural and urban distressed areas."[380] The world has changed rapidly since 2003 and will continue to do so at an accelerating pace. As a result, we believe that the e-NC Authority, the General Assembly, and the other key stakeholders would benefit greatly from another round of information-gathering and policy-development of the kind that the RIAA and e-NC conducted early in the decade.

We understand that the e-NC Authority has begun to plan a series of one-day broadband summits around the state to obtain recommendations as to initiatives that will boost digital inclusion metrics relative to broadband deployment, digital literacy of citizens, digital up-take rates, and ways to provide the basics for subscription to broadband for economically challenged families. The goal of the summits is to develop a world-class, and inclusive,

broadband Internet plan ("local to global to local") for North Carolina in time for recommendations to the North Carolina General Assembly for the 2009-2011 session. This is a great idea, but we suggest that e-NC either expand the summits or hold additional hearings to ensure that they encompass North Carolina's broadband situation as a whole.

In particular, we believe that the e-NC Authority and the State should ask the following question: "What can and should North Carolina do to ensure that all North Carolinians, including those in the State's most challenged areas, have affordable access to high-capacity broadband networks as rapidly as possible?"

We recommend that the e-NC not only seek the views of communications providers, but also of all other major interest groups that would benefit from a world-class broadband network in North Carolina. This includes economic development professionals, high technology companies, state and local governments, educators, the health care community, labor, utilities, equipment manufacturers, software and content developers, senior citizens, disabled persons, young people, etc., all who have a vested interest in North Carolina making the transition from a traditional manufacturing to a knowledge-based economy. With job creation and retention in the era of globalization a major challenge for North Carolina, we urge e-NC and the State to draw upon the knowledge and experience of its leading colleges and universities, particularly the Duke University's Center on Globalization, Governance & Competitiveness.

Furthermore, we recommend including agencies and individuals with detailed knowledge of how North Carolina works – i.e., where grants, loans, and other resources may be found; how agencies can combine and coordinate their efforts; and what legal and other impediments may exist and how best to remove them. For example, we understand that private easements have impeded deployment of broadband in certain areas. This issue warrants careful study and prompt attention.

An inquiry of the kind that we recommend would provide a wealth of useful information about emerging technologies, business trends in the US, North Carolina, and other countries; best practices in other states and other nations; legal, financial, and other barriers; federal, state, and private grants, loans, and other resources; and a host of other pertinent and timely data. Furthermore, the interactions among the stakeholders could well be beneficial in their own right, as they would likely reveal many previously unrecognized areas of common interest and would unleash a host of innovative ideas.

The inquiry would also offers e-NC and the State an opportunity to build energy, enthusiasm, and buy-in among the participants. That is essentially what the e-NC's innovative programs have been doing for the last few years, albeit with a more modest vision of what broadband is and can do. It is now time to up the ante.

We strongly support e-NC's goal of completing the inquiry in time to develop legislative proposals to the General Assembly for its next legislative session. This will require aggressive planning and execution, but time is of the essence for both North Carolina and the United States.

Recommendation 4: Continue existing connectivity programs for the next year, but with a few changes.

We understand that the e-NC Authority is seeking limited funds to subsidize broadband deployment in North Carolina's neediest counties and that some of these funds may be available to providers of DSL, CMS or other low-bandwidth technologies. We would dearly love to suggest that the e-NC Authority do what China recently did – terminate support for low-bandwidth technologies and convert them to FTTH. But we cannot responsibly do so.

For one thing, FTTH would probably be infeasible in North Carolina's neediest counties, at least in the near term, particularly if most of the residents in these counties are not yet ready to take advantage of the benefits of high-capacity broadband. Furthermore, several of the studies cited above indicate that broadband contributes to economic development, even at the low bandwidth levels of DSL and CMS.

We therefore recommend that the e-NC Authority continue its connectivity incentives programs for at least another year, while it explores avenues for more promising long-term solutions. We suggest, however, that the Authority make the following adjustments to its current procedures.

- Depending on site-specific circumstances, DSL or CMS may or may not be the most cost-effective broadband solution for a particular community. In some cases, new wireless technologies can be installed more quickly than DSL or CMS and can achieve performance similar to that of DSL or CMS at lower cost. In other cases, wireless can achieve higher performance at a cost comparable to that of DSL or CMS. We suggest that, before issuing any additional subsidies for broadband deployment, the e-NC Authority issue a Request for Information, as it has done in the past, to elicit information from providers of these and other technologies that may work well in some communities in North Carolina. Although e-NC's current approach and its RFP process are technology-neutral, we recommend that e-NC be proactive in encouraging innovative proposals.

- The Request for Information process would also help the e-NC Authority to ensure that broadband providers have the technological, financial, and managerial experience to provide reliable service. Based on the information that it receives, the e-NC could create a list of qualified vendors of all kinds, including major incumbents, independents, cooperatives, and public providers. Such a list would be of great value to counties that lack expertise to evaluate vendors themselves.

- The e-NC Authority's latest round of Connectivity Grants focused only on "last-mile" solutions. While that may be the main challenge to broadband deployment in North Carolina, we have heard that problems with "middle mile" infrastructure may also exist in some areas. The term "middle mile" refers to facilities used for backhaul between the Internet service provider and the core of the Internet (sometimes referred to as "the Internet cloud").

  For example, a community might be ready and willing to deploy a robust fiber network, through the consolidated efforts of local businesses, but an inability to obtain affordable back-haul access to Internet Points of Presence could derail such a project. As part of its inquiry, e-NC should assess the availability and affordability of "middle mile" infrastructure in the State, and if it finds that problems exist in some areas, it should seek appropriate solutions. Such solutions might include grants or other incentives to encourage development of "middle-mile" networks. They might also include conditioning receipt of subsidies on cooperation in extending affordable "middle mile" infrastructure.

- Add to e-NC's funding criteria a sizable value weight for options that will enhance competition. Such options might include wireless options, particularly technologies that offer higher bandwidths or lower costs than DSL or cable modems. It might also include alternative providers, such as independents, cooperatives, or public entities that have proven records of success in similar projects elsewhere.

- Use Connectivity Grants to encourage companies to deploy fiber in North Carolina's rural and depressed urban areas. As the e-NC Authority has recognized, some in-state companies have begun to deploy fiber in North Carolina's rural communities. More would undoubtedly do so as well if grants were available to reduce their financial risks.

- Encourage collaboration among communities. For example, approximately 25 communities in central Vermont have recently voted by wide margins to band together to develop a common fiber system, if feasible. Similarly, a large cooperative in northern Michigan is exploring ways to obtain the best possible broadband for the communities involved.

- To ensure that local decisions on broadband options are as informed as possible, we suggest that the e-NC Authority conduct two or three vendor showcases around the state during the next year. The vendors are likely to be willing to cover the costs of such events.

- We understand that, due to accountability requirements for state funding, e-NC plans to release any connectivity grants directly to service providers. Despite this structure, we recommend that, to the maximum extent that North Carolina allows, e-NC continue to seek informed local input on its funding decisions, from the counties and municipalities in which the providers will serve.

Recommendation 5: Obtain legislative authority to require telecommunications, cable, and other broadband service providers to file with the e-NC Authority the data that it needs to fulfill its responsibilities.

The e-NC Authority's lack of statutory authority to require service providers to submit detailed data about the location, price, speed, type (business, institutional, or residential) and subscription levels to their various broadband services has impaired the Authority's ability to discharge its mapping and other responsibilities. In the absence of such statutory authority, e-NC must rely on the data that service providers submit voluntarily, which could well be incomplete or even inaccurate. When e-NC requests more complete and detailed data, the providers often respond that they are concerned that e-NC cannot protect the data from disclosure under North Carolina's public records laws.

To address both concerns, we recommend that the Authority seek legislation that (1) requires providers to submit such complete, accurate, and timely information as the e-NC Authority may request from time to time; and (2) exempts such information from open records and other public disclosure requirements, provided that a provider has properly designated the information as proprietary and confidential information, the disclosure of which would significantly harm the provider, and that such information is not available from other non-confidential sources (e.g., consumer surveys or consumer self-reporting services such as one operated by the e-Corridors project at Virginia Tech University).

Recommendation 6: Encourage collaborative, yet proactive policies to promote build-out by communications service providers.

Since the 1980s, North Carolina appears to have experienced positive and collaborative involvement with the communications service providers in helping the state remain competitive in technology infrastructure. For example, in the 1980s North Carolina initiated a digital statewide network with the State serving as an anchor tenant. In 1993, the State and communications companies committed to working together to upgrade the statewide network to an ATM SONET network, known as the North Carolina Information Highway (NCIH). This project, the largest deployment of ATM technology in the world at the time, was controversial at first, but it ultimately benefitted all concerned. For their part, the private companies benefited as well from access to the network. At the same time, the network provided capacity to state government, schools, community colleges and universities, among others. One thing that the NCIH did not do, however, was to provide last-mile access to citizens' households. This lack of last-mile access later became the rallying cry for creation of e-NC.

Given the communications industry's long history of working cooperatively with the State and the substantial benefits that the industry has derived from doing business in the State, we believe that the major communications providers should assume their share of responsibility for ensuring that broadband is promptly made available to all citizens in the state. Specifically, we believe that the major communications providers, like the independents and cooperatives, should assume responsibility for building out their entire service areas, not just the most lucrative pockets. We therefore recommend that the e-NC Authority work with the N.C. General Assembly to find ways to encourage such build-outs. This should include, as a last resort, withdrawing or withholding state contracts or other benefits.

Recommendation 7: Encourage broadband initiatives by local governments.

A century ago, private power utilities, lacking the resources to electrify all of America at the same time, focused first on their most lucrative markets and left much of America behind for later development. Today, the private sector lacks the resources to develop high-capacity next-generation networks everywhere in the United States at the same time. A century ago, thousands of communities stepped forward to develop their own electric utilities, believing that doing so was essential to their economic survival and quality of life. After doing so, about a third of these communities later sold their utilities to private companies, having achieved their goal of not being left behind in obtaining the benefits of the Age of Electricity. Today, for the very same reasons, many local governments are willing to play a similar role in the broadband area.

If the United States is to remain competitive in the emerging knowledge-based global economy, our public and private sectors must meet this challenge together, in a spirit of mutual respect, shared purpose, urgency, and candor. As Senator John McCain noted on the Senate floor in the course of introducing federal legislation to encourage community broadband initiatives,

> Many of the countries outpacing the United States in the deployment of high-speed Internet services, including Canada, Japan, and South Korea, have successfully combined municipal systems with privately deployed networks to wire their countries. As a country, we cannot afford to cut off any successful strategy if we want to remain internationally competitive.

On this issue, Senator Obama is in full accord with Senator McCain (as is Senator Hillary Clinton).[381] We agree. We therefore recommend that the e-NC Authority encourage localities to consider public-private partnerships and various other kinds of public broadband initiatives. If any community in North Carolina is ready, willing, and able to do this, we suggest that the e-NC Authority treat it as favorably as it would treat any private provider.

Recommendation 8: Develop a wiki from our paper and post it on e-NC's website.

This paper contains an enormous amount of pertinent information, but it is not all-inclusive, and new information is emerging every day. A good way for the e-NC to remain "current" would be to establish a "wiki" on its website, using the information in this paper as a starting point. A wiki is a program that would allow individuals around the world to edit the content of the document to contribute information that we did not and to add new information as it emerges. Having a living, up-to-date compendium of knowledge about broadband on the e-NC site would make the site a unique and an especially valuable tool for e-NC, the organizations and individuals that it serves, the State, and other states, organizations, and individuals around the United States and the world who share e-NC's interests.

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Notes

Devoted to connecting North Carolina communities, citizens and businesses with high-speed Internet and a more prosperous life, the e-NC Authority works in all 100 counties with a special focus on rural and distressed areas. The e-NC Authority was created by the N.C. General Assembly, and is dedicated to growing local-level wealth and educational opportunity through technology-based economic development. In this capacity, the e-NC Authority is also the primary Internet-planning body for the state of North Carolina. By legislative mandate in S.L. 2003-425, the e-NC Authority is a state authority housed and staffed by the N.C. Rural Economic Development Center in Raleigh, N.C. The e-NC Authority operates statewide and is supported through contributions from foundations, nonprofit organizations, and public and private entities.

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