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THE BENEFITS OF ROBUST WIRED AND WIRELESS NETWORKS

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Executive Summary

The proposed AT&T/T-Mobile merger has sparked renewed discussion on the rollout of high-speed wired and wireless networks across the United States.

Widespread broadband deployment has the potential to yield benefits to tens of millions of Americans. However, the United States—which largely invented the technologies undergirding the Internet—has fallen behind many other nations in both access to and the speed of our broadband connections, and there is no clear path to bridging the current digital divide (the lack of access to information and communication technologies in socially disadvantaged and rural communities).

This report summarizes the benefits of robust wired and wireless networks and assesses some of the principal barriers to full deployment of those networks. Bringing high-speed broadband to nearly all communities in our country is important not just for those individuals who have no access to it but for the broader economy as well. Broadband deployment is a critical part of restoring our economy, improving educational opportunity, reducing health care costs, and saving energy, as well as reducing greenhouse gas emissions through implementation of smart grid technology.

Wireless carriers such as AT&T, Verizon, T-Mobile and Sprint increasingly are just parts of a much broader ecosystem of wireless and wired telecommunications delivering services to customers with mobile devices. Policymakers thus need a better understanding of an emerging spectrum crisis in which excessive congestion in use of wireless services effectively could deny all communities full ability to access the benefits of wireless technology. Partly to deal with this spectrum crisis, there is an emerging synergy between wireless and wired broadband deployment, largely due to the rise of smartphones and the "offloading" of data through Wi-Fi connections onto the wired network.

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Given the benefits of broadband deployment, there is a role for policymakers to help ensure that access is expanded. For example, specific measures could be put in place to ensure that carriers such as AT&T deliver on promises of deploying advanced broadband as a condition of merger approval. Such measures would help ensure the promised job creation and maintain a competitive ecosystem of wireless services.

This report outlines key findings on the digital divide, benefits of broadband, competition in wireless service provision, and the potential impact of the AT&T/T-Mobile merger:

The continuing digital divide

The United States—which largely invented the technologies undergirding the Internet—has fallen behind many other nations in both access to and the speed of our broadband connections, and there is no clear path to bridging the digital divide:

- The most recent report by the Federal Communications Commission finds that more than 26 million Americans do not have access to what the FCC defines as high-speed broadband.
- Low-income, lower-education, rural, and black and Hispanic households are far less likely to subscribe to broadband in their homes.
- The United States continues to lag behind many other industrialized nations in the percentage of the population with access to broadband, putting our nation and its citizens at an economic disadvantage.
- The current budget debate already is affecting spending on broadband access, making it unlikely that the public sector can close the digital divide; thus, it becomes all the more important to find ways to encourage private-sector broadband deployment.

The benefits of broadband

Not only would near-universal high-speed broadband improve economic opportunities for individuals, but it promises broad social benefits in areas ranging from education, telehealth, building a smart grid to save energy and reduce greenhouse gas emissions, and improving productivity and economic growth throughout the economy:

- The payoff from deploying advanced broadband would be worth hundreds of billions—even trillions—of dollars over time, but the first step is ensuring that everyone has access to it.
- Wireless broadband expands the existing benefits of wired broadband by allowing greater access to remote data when on the go, strengthening social networking, enhancing use of geolocation services, and better networking physical objects such as medical equipment or logistics tools into the Internet.
- Given the fact that communities of color have been far more likely to adopt broadband via wireless than through wired connections, expanding advanced wireless broadband is an important tool for closing the racial digital divide.

The increasingly competitive ecosystem of wireless services

Wireless carriers such as AT&T, Verizon, T-Mobile, and Sprint increasingly are just parts of a much broader ecosystem of wireless and wired telecommunications delivering services to customers with mobile devices:

- The exponential surge in data use on wireless phones is requiring carriers to offload more of their data onto wired networks in order to manage traffic. This highlights the dependence of wireless networks upon, and their increasing linkage to, wired networks.
- Given these increasing synergies between wired and wireless broadband, any competitive analysis of the telecommunications industry must take a broader view of the whole ecosystem of wireless services provided to mobile handset customers. The rise of smartphones, in particular, with their range of alternative "apps" and access to the wired Internet via Wi-Fi connections, is playing a sizable role in an explosion of new competitive wireless service options for customers.
- Wireless carriers now face competition in providing revenue-generating voice and wireless services, not just from other mobile operators but from applica-

What differentiates 'wired' from 'wireless' and the role of 'spectrum'

In this paper, "wired" broadband refers to cases when the local Internet connection for the user is over a wire or fiber optic cable to that location. As will be detailed, both computers and handheld devices may access that local wired connection through Wi-Fi or other untethered connections, but the local source of Internet access is still wired.

"Wireless" Internet, on the other hand, is available via a cell phone provider's service using longer-distance radio waves. Radio waves operate at multiple frequencies across what is referred to as a "spectrum" of frequencies. Signals sent across the same radio wave frequency potentially can interfere with one another, so each provider licenses a certain frequency of the radio wave spectrum in any geographic area. When the available frequencies for cell phone service by a provider are exhausted by the number of users transmitting signals, the spectrum is considered "congested."

tions on their own phones, whether Internet calling via Skype, texting options via Facebook's Beluga texting app, or video options from Netflix.

- The option to access Wi-Fi allows customers to bypass carrier data plans as well, meaning the major carriers face competitive pricing pressure and the potential loss of revenue for building out broadband capacity on every wireless service they sell to their customers.
- In their review of antitrust issues regarding broadband networks, policymakers should therefore consider that these new players are expanding competition through smartphone apps for wireless services in new ways.

Potential impact of the AT&T/T-Mobile merger on deployment

The proposed AT&T/T-Mobile merger—with the proper conditions imposed by the Federal Communications Commission—could increase investments in broadband:

- With the spectrum and other assets from T-Mobile, AT&T could provide long-term evolution (LTE) broadband—much faster high-speed Internet—to 55 million more people than under its current projections.
- Because AT&T and T-Mobile share the same underlying wireless technology, they could integrate their assets efficiently and make better use of spectrum, thereby mitigating the spectrum scarcity problem overwhelming the wireless telecom system.
- According to an Economic Policy Institute estimate, an $8 billion net increase in AT&T's investment would create 55,000 to 96,000 job-years of employment through both direct and indirect jobs created and induced jobs stemming from income injected into the economy by the spending of those newly hired workers.
- Those jobs likely would be high-quality, given the track record of AT&T as an employer respected by both major unions and civil rights organizations for its employment practices.
- If the merger is approved, the FCC should impose specific conditions to ensure that AT&T delivers on its promises of deploying advanced broadband, generating the associated jobs, and maintaining the competitive ecosystem of wireless services that this report has detailed.

The nation's failure to achieve universal access to broadband

Two decades ago, the nation enacted the High Performance Computing and Communication Act of 1991, with the promise to bring what was then called the "Information Superhighway" to communities across the nation. Unfortunately, that promise remains unfulfilled.

In its most recent May 2011 *Seventh Broadband Progress Report*, the Federal Communications Commission (FCC) found that 26.2 million Americans living in 9.2 million households are not served by broadband sufficient to access high-quality, graphic- and data-rich Internet sites. (Federal Communications Commission 2011c, 15)

The absence of fixed-line broadband providers offering high-speed Internet in these neighborhoods threatens to leave large swathes of our nation's population behind in the new information economy. There are thousands of unserved communities in almost every state as well as Puerto Rico and the Virgin Islands, hundreds of unserved areas in the other states, and unserved areas in the District of Columbia and American Samoa, as shown in **Table 1**.

TABLE 1

United States populations unserved by broadband, 2010

	Unserved census blocks	*Unserved population*	*Percent of state population unserved*	*Unserved households*
Alabama	18,817	638,771	14%	227,670
Alaska	3,518	155,309	22%	48,848
American Samoa	248	47,183	82%	20,958
Arizona	17,974	763,459	12%	257,878
Arkansas	16,357	414,584	15%	150,611
California	46,164	3,896,443	11%	1,251,093
Colorado	9,665	270,265	6%	95,920
Connecticut	641	26,063	1%	8,465
Delaware	474	12,487	1%	4,653
District of Columbia	6	445	0%	107
Florida	20,793	962,513	5%	375,139
Georgia	19,258	633,971	6%	217,732
Hawaii	749	32,402	3%	10,866
Idaho	9,335	231,722	15%	76,954
Illinois	26,650	388,563	3%	133,729
Indiana	56,102	1,814,495	28%	671,369
Iowa	26,205	341,836	11%	115,644
Kansas	16,653	230,869	8%	70,971
Kentucky	22,654	1,176,170	28%	435,564
Louisiana	10,897	352,915	8%	120,311
Maine	3,074	80,577	6%	30,397
Maryland	3,384	121,529	2%	44,385
Massachusetts	1,710	58,866	1%	19,850
Michigan	26,390	654,001	7%	236,559
Minnesota	23,031	398,080	8%	136,569
Mississippi	20,466	560,637	19%	193,932
Missouri	37,137	801,407	14%	288,751
Montana	12,082	276,417	29%	97,200
Nebraska	22,372	327,588	18%	108,705
Nevada	2,177	63,315	2%	21,140
New Hampshire	2,252	56,163	4%	20,826
New Jersey	1,074	37,915	0%	12,783
New Mexico	14,310	441,798	22%	146,568
New York	21,548	558,286	3%	190,598
North Carolina	13,715	435,307	5%	165,819
North Dakota	8,788	131,611	21%	40,950
Ohio	15,196	284,816	3%	100,734
Oklahoma	29,823	762,750	21%	265,115
Oregon	9,518	275,097	7%	103,586
Pennsylvania	15,184	378,115	3%	141,269
Puerto Rico	11,511	2,123,848	54%	802,134
Rhode Island	201	4,385	0%	1,857
South Carolina	13,068	576,384	13%	205,048
South Dakota	12,325	214,183	27%	66,976
Tennessee	14,837	489,103	8%	175,798
Texas	42,858	1,214,025	5%	415,202
Utah	4,685	141,914	5%	44,229
Vermont	2,076	42,796	7%	15,785
Virgin Islands	2,701	108,599	100%	40,593
Virginia	14,567	516,407	7%	187,429
Washington	7,517	229,796	4%	77,421
West Virginia	16,739	496,538	28%	192,412
Wisconsin	25,338	664,603	12%	238,430
Wyoming	7,453	243,017	47%	86,912

SOURCE: Adapted from Federal Communications Commission, *Connecting America: The National Broadband Plan*, Appendix B, p. 42-44

A note on defining 'broadband' speeds

For years, the FCC continued to define broadband based on a 1999-defined speed of 200 kilobits per second (Kbps) for download and upload speeds. This definition was roundly criticized in recent years as barely faster than fast dial-up service and insufficient for accessing the graphic-rich features of the modern Internet.

Finally, in the 2010 *Sixth Broadband Progress Report,* the FCC redefined sufficient broadband as "one that enable**s** consumers to download content at actual speeds of at least 4 Mbps and to upload content at speeds of at least 1 Mbps across the broadband provider's network" (FCC 2010c). According to the FCC, this is the minimum speed that delivers enough capacity for video-rich broadband applications and services, while retaining sufficient capacity for basic web browsing and email.

While the FCC in the 2010 and 2011 progress reports uses this more realistic definition, some other FCC reports and many other reports use the older definition, so reported broadband access levels can vary. This report will seek to use the current FCC standard where possible and will note when other cited surveys use a different definition.

Of course, not everyone with service available has broadband in their home. Given the additional educational and economic barriers to access, only 33 percent of American households have a broadband connection that the FCC considers adequate to qualify as full broadband. (*See "A note on defining 'broadband' speeds"*)

Even using older, slow definitions of broadband—defined only as speeds of more than 200 kilobits per second—only 64 percent of American households have subscribed to any kind of broadband connection in their homes (FCC 2011c, 30–31).

Notably, the FCC highlights that 80 percent of schools and libraries funded under the national E-rate program say their broadband connections do not fully meet their needs as well (FCC 2011c, 3).

Low-income, lower-education, and black and Hispanic households are far less likely to subscribe to broadband in their homes. Households in rural areas, with less access to broadband networks and with lower incomes in general, have even lower broadband subscription rates (FCC 2011c, 30–31).

Essentially, our nation is divided into three types of broadband households: One-third subscribe to broadband of sufficient speed to access two-way video and other data-rich applications effectively, slightly less than one-third have slow and inadequate access, and more than one-third (36 percent) do not subscribe to broadband at home, as shown in **Figure A**.

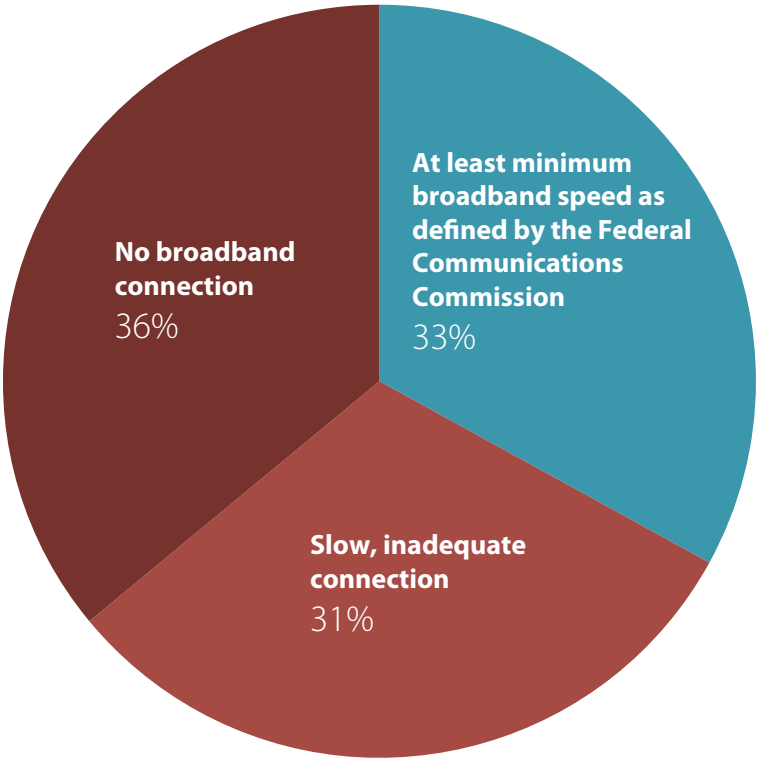
While current wireless deployment fills in some of these gaps, the FCC has noted that wireless deployment has not up until now been able to deliver an adequate, sustained speed alternative to local wired broadband. (FCC 2011c, 17) The current deployment of next-generation broadband wireless—so-called 4G LTE technologies—finally should be able to deliver speeds that match wired broadband, although, as detailed below, the spectrum crunch means that advanced wireless deployment can play a major factor in addressing the digital divide but cannot be a substitute for full wired broadband deployment.

As a result, the United States has fallen behind many other nations in both access to and the speed of our broadband connections. According to the Organization for Economic Cooperation and Development, among developed nations, the United States ranks 15th out of 34 countries in the number of broadband subscriptions per capita. As shown in **Figure B**, the United States does slightly better on measurements of mobile broadband but still only ranks ninth out of 34 countries in per capita subscriptions (OECD 2011, Table 1d[1])

Further, top broadband download speeds in many competing European and Asian cities are substantially higher than in comparably sized U.S. cities. For example, access speeds are 24.8 megabits per second (Mbps) in Paris and 35.8 Mbps in Seoul, Korea versus 6.9 Mbps in San Francisco, 9.4 Mbps in Chicago, and 9.9 Mbps in Phoenix (FCC 2011b, paragraph 15).

FIGURE A

Broadband connection type by household in the United States, 2010



Source: Author's analysis of data from the Federal Communications Commission (2011c)

The rankings shown in Figure B are based on the older, slow FCC definition of broadband access, so lower speeds in the United States mean the actual rankings for full broadband access likely are worse.

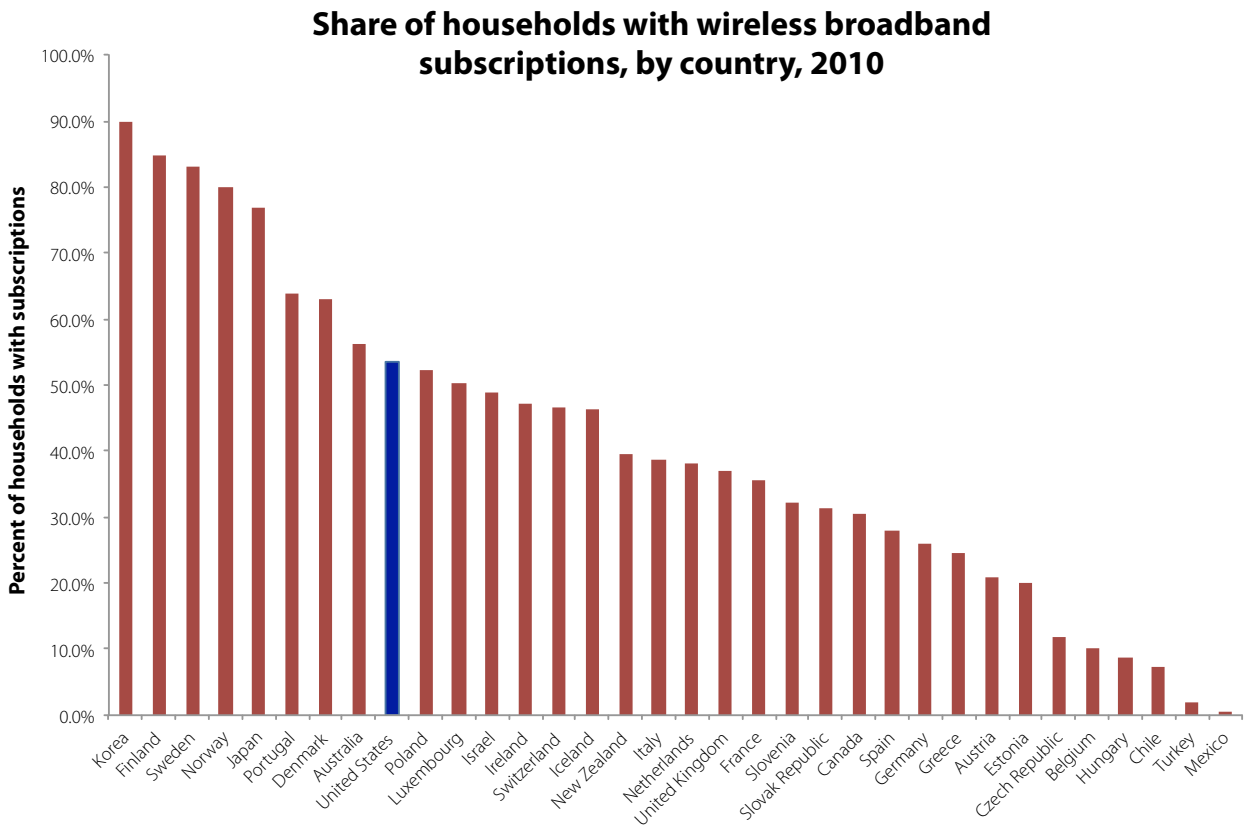
This is not just a measure of slow progress for U.S. residents in gaining broadband access but a signal to companies operating internationally that significant areas of the country are not ready to compete economically in the global information economy.

No current path to universal broadband deployment

The problem, according to the FCC's 2010 and 2011 broadband progress reports, is that "broadband was not being deployed to all Americans in a reasonable and timely fashion." Worse, under current conditions of competition, there is no clear path to delivering that access. As the FCC details:

> *The private sector will not bring broadband to Americans living in areas where there is no business case for operating a broadband network. In areas with low population density, for example, deployment is often uneconomical, as the costs to build a network exceed potential revenues … cell towers capable of supporting mobile broadband service are often not built or are significantly delayed because of permitting obstacles and other issues. The limited supply of wireless spectrum is another factor that could limit the growth of wireless broadband in the United States. (FCC 2011c, 33–34)*

FIGURE B



Note: Subscriptions are a total of dedicated mobile data subscriptions, standard mobile broadband subscriptions, satellite subscriptions, and terrestrial fixed wireless subscriptions.
Source: Adapted from OECD Broadband Portal , "Fixed and wireless broadband subscriptions per 100 inhabitants by technology, December 2010," 2011

Counting on public funds to make up for the private sector gap looks ever less likely. President Obama in his 2011 State of the Union address announced the goal of extending 4G wireless broadband to 98 percent of the nation's population (White House, 2011), but few public dollars are likely to be available in the current shortsighted frenzy to cut public investments.

One major component, a commitment to fund the Department of Agriculture's Broadband Loan Program for building out rural broadband, was axed as part of the continuing resolution agreement to keep the government from shutting down. While there are negotiations to restore part of the funding, the unmistakable message is that federal funds are unlikely in the near term to close the gap in broadband access for unserved communities (*Stimulating Broadband* 2011a, 2011b).

As well, while the FCC is seeking to revamp the Universal Service Fund to provide up to $4.5 billion to encourage telecom companies to provide broadband for unserved areas, the amounts discussed are clearly insufficient to address the current gaps in broadband access (Hatch 2011).

There is some hope that current private sector carrier efforts to introduce advanced 4G technology to replace their current broadband systems—so-called 3G technology, which, however, does not generally deliver download speeds the FCC considers to be broadband—can help ease some of the digital divide facing many communities. That promise will be met only if the deployment reaches most communities.

Another way to expand deployment is to place conditions on industry mergers. For example, as described below

in more detail, if AT&T is allowed to absorb T-Mobile, the FCC should include conditions that would require AT&T to make good on its promises to deploy next-generation high-speed wireless to areas currently lacking fixed-line high-speed broadband. While wireless broadband is not a substitute for deploying wired broadband to all homes, it is a good first step, and guaranteeing next-generation high-speed wireless Internet is an important complement to that service and critical for achieving many of the overall benefits of deploying broadband in our nation.

The benefits of broadband: Why high-speed Internet matters to our economy and our nation

High-speed broadband access is not merely a convenience for consumers but is critical for making Americans competitive in a 21st-century global economy. Jobs will grow, health will improve, energy will be saved, and our democracy will be strengthened based on how successful we are as a nation in extending broadband access to every American.

Many of the benefits of broadband go directly to the immediate user of the broadband service, but because broadband strengthens networks of communities and commerce, there are additional gains from its spread for others sharing that network. Therefore a virtuous cycle starts up, with greater broadband use by others increasing the benefits of the network for those who already have access.

Jobs and broadband

Part of the network effects from broadband show up directly in the economy as additional jobs. Some of these jobs are created as a result of the investments in the information infrastructure, while other labor market benefits are a result of being better connected to the Internet.

Broadband and the Internet allow small and medium-size businesses, in particular, to reach new markets and access support services not available to them locally. This lowers startup costs and puts them in the position to compete for contracts that might have been out of reach in the past. Broadband jobs and the associated infrastructure also encourage a range of additional support jobs in IT applications and services for businesses taking advantage of these new opportunities, including communications, entertainment, professional skill development, and other tools to reach customers and improve internal productivity. For individuals seeking improved work opportunities, broadband is a critical pathway to gain the required skills and access the networks to find those jobs.

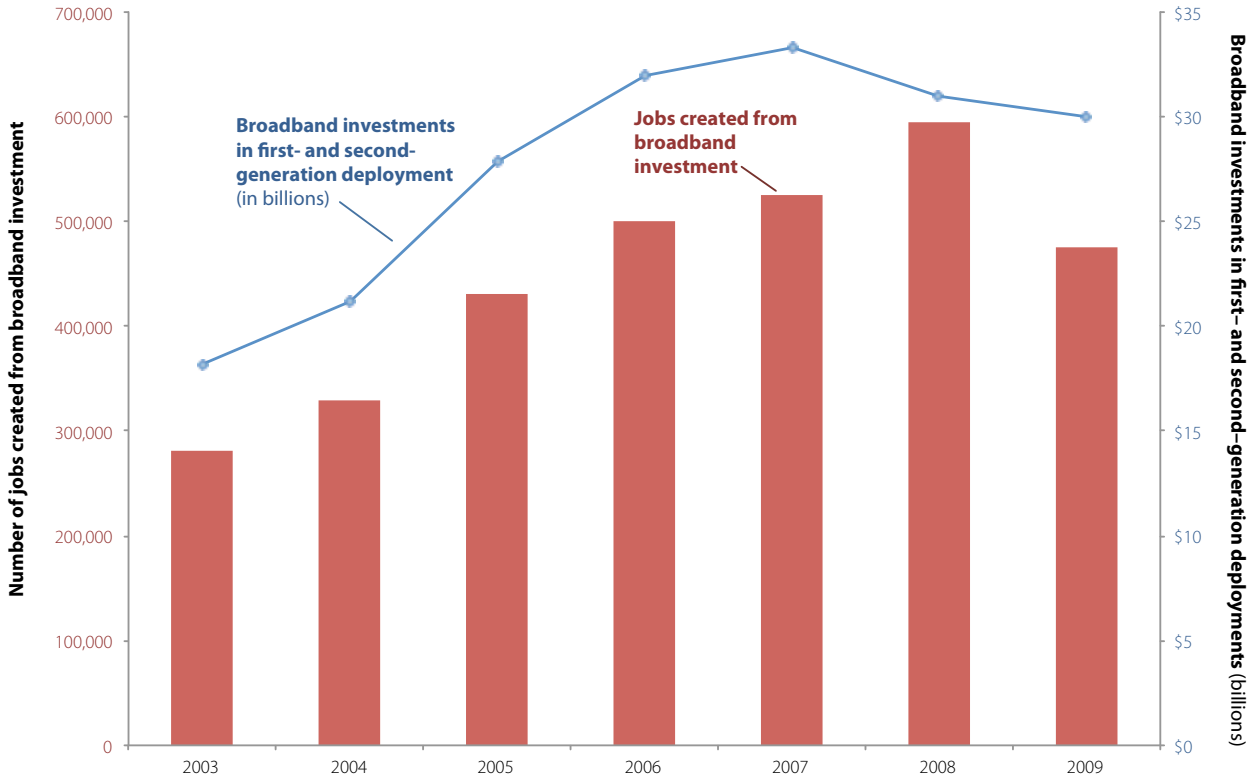
A wide range of research details how broadband greatly increases job growth and economic productivity. For more than a decade, investments in information-related technology have been disproportionate drivers of job growth, and for both individuals and businesses, access to broadband is critical for taking advantage of those investments.

Between 1998 and 2008, the number of domestic information technology jobs grew 26 percent, which was four times faster than employment in the nation as a whole (NTIA 2011, 2) In fact, the Information Technology and Innovation Foundation estimates that between 1995 and 2002, information technology was responsible for two-thirds of all productivity growth and essentially all labor productivity growth in the United States. This trend continued between 2002 and 2005, with IT contributing more than one percentage point to labor productivity growth (Atkinson, Castro, and Ezell 2009, 3). The Bureau of Labor Statistics continues to project that such information-based jobs will continue to grow by 25 percent in the period 2008–15, 2.5 times the average across other occupations and industries (FCC 2010a, 265).

Broadband deployment has been critical for communities and individuals to take advantage of those IT investments. One early study found that, over a four-year period, from 1998 to 2002, communities in which broadband had been deployed grew by one percentage point more than communities without it. That translates into an additional 500 jobs across four years for a community with 50,000 working people (Lehr, Osorio, Gillett, and Sirbu 2005; see also Gillett et al., 2006). Research by the Brookings Institution found more broadly that for every one percentage-point increase in broadband deployment, employment rose between 0.2 and 0.3 percent—or about 300,000 jobs nationally for each percentage-point increase in deployment. As the authors wrote, "The effect of broadband is most significant in explaining employment growth in education, health care, and financial services" (Crandall, Litan, and Lehr, 2007, 2).

FIGURE C

Broadband investments and job creation in the United States, 2003–09



Source: Adapted from Crandall, Robert W. and Hal J. Singer, *The economic impact of broadband investment* (Washington, D.C.: Broadband for America, 2010), Table 2

In a recent paper by Broadband for America, authors Crandall and Singer (2010, 12) estimate that nearly $190 billion was invested in broadband deployment between 2003 and 2009, with an average of 434,000 jobs supported each year during the period (**Figure C**).

Different economists calculate slightly varying estimates of this multiplier effect, but all agree it is substantial. The estimate for a multiplier by Broadband for America is relatively conservative, figuring that roughly $30 billion of broadband investments in 2008 yielded a little more than 600,000 jobs, while the Information Technology and Innovation Foundation calculated in 2009 that a broad-based public investment in broadband and related technologies of $30 billion could yield almost 950,000 jobs (Atkinson, Castro, and Ezell 2009, 1). Lawrence Summers, then head of the president's National Economic Council, argued in 2010 that, "Each dollar invested in wireless deployment is estimated to result in as much as $7 to $10 higher GDP" (Summers 2010).

The Economic Policy Institute has estimated that for every $1 billion invested in wireless broadband deployment per year, the result will be approximately 12,000 job years of employment, as shown in **Table 2** (Pollack 2011).

One of the advantages of investments in broadband is that, because of the way ancillary support jobs form through new industries created to service businesses and customers using broadband, a dollar of direct investment in broadband leads to multiple dollars in overall economic activity and jobs created.

Investments by the wireless industry delivered $240 billion in industrywide infrastructure investments between 1998 and 2009 to create a platform for the rapid growth in online industries that continues even in the midst of the recent great recession (FCC 2010b, 119)

Unlike most industries, telecom leaders are actually spending more on capital investments today than before the recession. The Progressive Policy Institute estimates that telecom and broadcasting companies have stepped up their investment in new equipment and software by 45 percent since 2005, after adjusting for inflation, compared with only a 6 percent overall increase in private real spending on nonresidential equipment and software in the rest of the economy. Leading the nation in the most recent fiscal year in capital spending was AT&T, which invested $19.5 billion, followed closely by Verizon, which invested $16.5 billion (Mandel 2011). In the wireless sector alone, Verizon slightly led AT&T, with both carriers investing in excess of $30 billion in capital expenditures from 2006 to 2010. (See **Figure D**).

TABLE 2

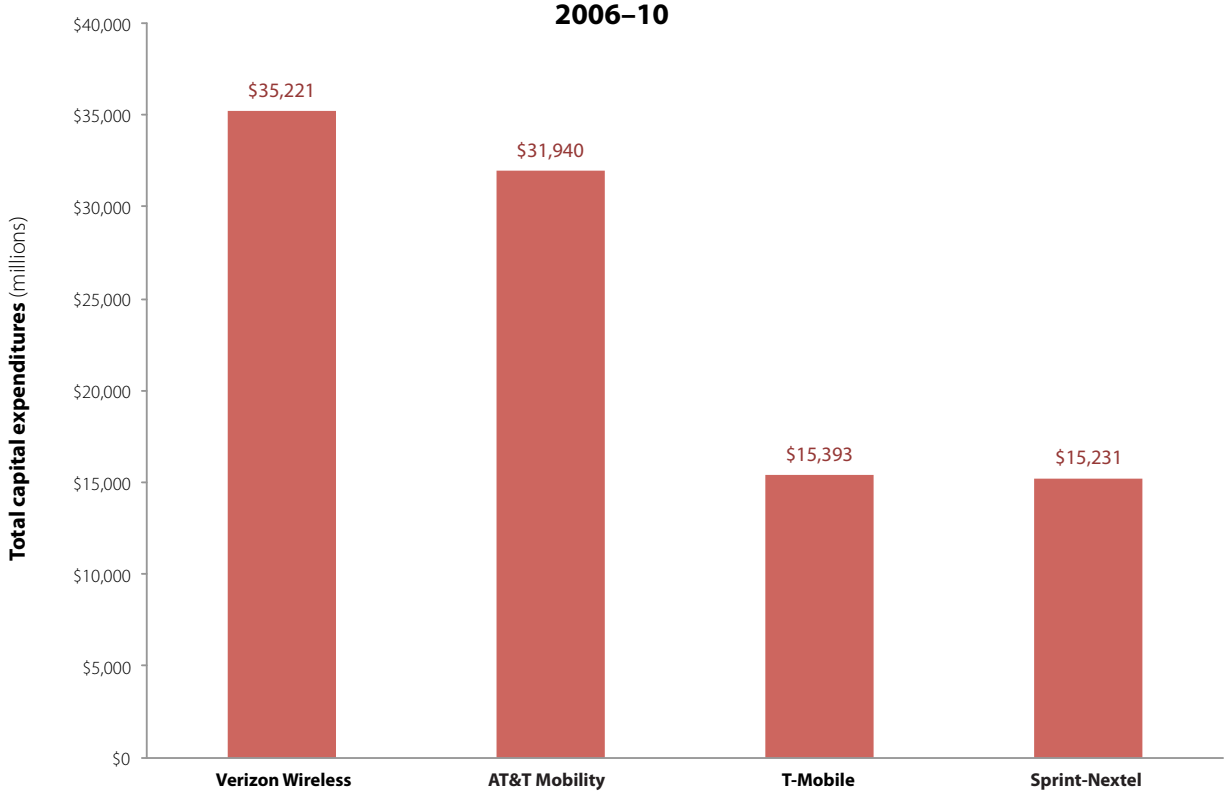
Jobs impact of $8 billion investment in wireless network infrastructure over seven years

	Direct jobs	*Supplier jobs*	*Induced Jobs*	*Total jobs impact*
High-end estimate	27,297	36,676	31,986	95,959
Low-end estimate	15,598	20,958	18,278	54,834

NOTE: Jobs denoted in job years
SOURCE: Adapted from Ethan Pollack, The Jobs Impact of Telecom Investment (Washington, D.C.: Economic Policy Institute, 2011)

FIGURE D

Total capital expenditures by telecom and broadcasting companies, 2006–10



Source: Adapted from George Kohl and Debbie Goldman, "Reply Comments of Communications Workers of America," (Washington, D.C.: Communications Workers of America, 2011); based on data in Goldman Sachs,"Wireless Industry Model," June 7, 2011

Distance education

The most obvious place broadband can bolster both the economy and individual opportunity is through better use in the educational system. For advanced students in rural areas without an Advanced Placement course in calculus, for example, online education can bring not only video lectures but interactive classrooms, instant messaging, and other communication tools to connect students and teachers at a distance.

For students at the other end of the educational spectrum, school districts have found that online programs are a way to reclaim dropouts and at-risk students. Oregon's Salem-Keizer school district has re-enrolled more than 50 percent of its dropouts and at-risk students through its online Bridge Program, while Florida's Virtual School (FLVS) has 20 percent of the program's students enrolled for remedial credit. Such systems also can better accommodate students who cannot be in school for reasons of health, child care, work, or other issues. (Watson and Gemin 2008, 8–9)

However, such programs require robust broadband in both homes and schools, and while Internet access is nearly universal in the nation's schools and libraries, 50 percent of teachers surveyed say that slow or unreliable broadband access presents obstacles to effective use of technology in their classrooms (U.S. Department of Education 2009 12). Community colleges, meantime, which have surging enrollments for both remedial education and job retraining, lack anything like the high-speed broadband connections available to those attending research universities or four-year colleges (Arroway et al. 2010, 51).

Expanding access and improving broadband speeds for online educational programs help provide the opportunity for everyone to gain the skills needed in a rapidly shifting global economy.

Health care and broadband

One key arena in which broadband can cut costs and save lives is health care. In nearly every measure of use of health information technology (HIT), the United States lags other developed nations, so the opportunity for explosive economic and health gains from faster broadband deployment and associated health information technologies is tremendous.

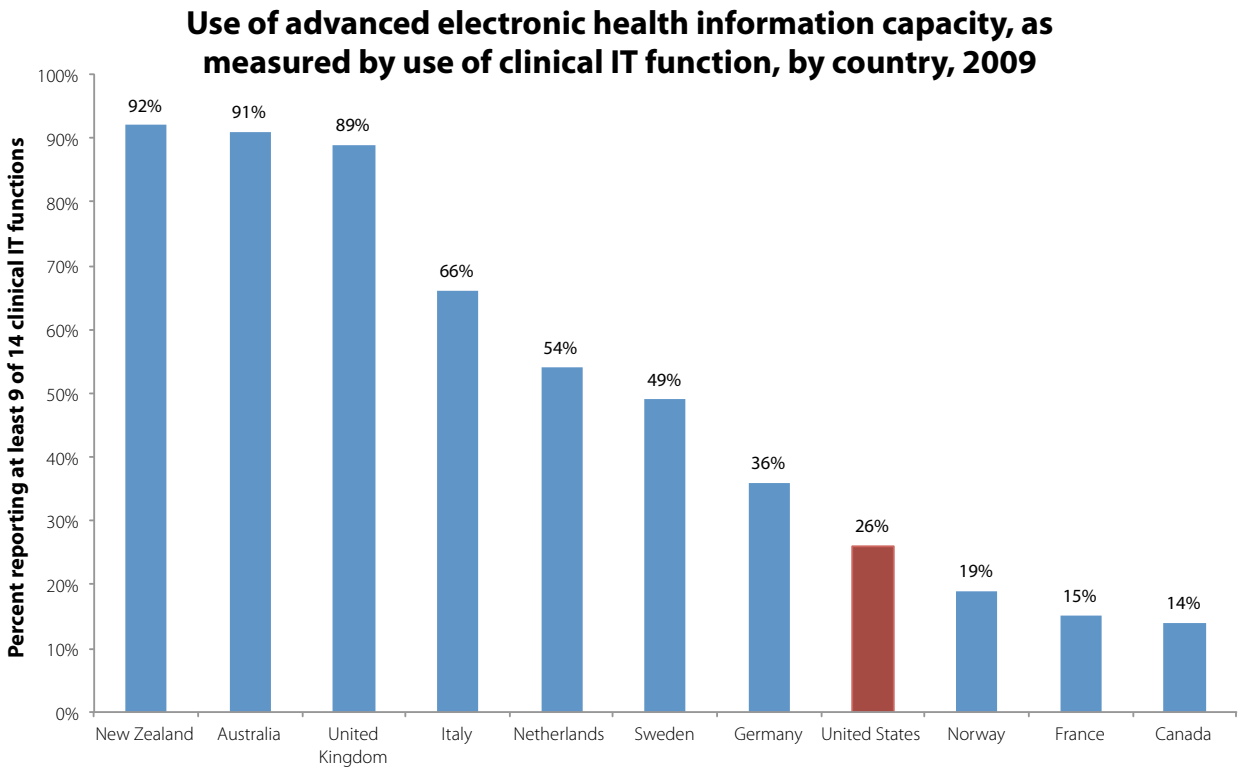
The economic and social gains from broadband and information technology deployment in the health field come from a number of areas:

- ***Electronic health records.*** One oft-cited study argues that the adoption of electronic health records alone could save our medical system $500 billion over 15 years, while others estimate the amount could be doubled if HIT is used to lower the costs of chronic conditions (Hillestad et al. 2005; FCC 2010a, 201). Beyond cost savings, use of information technology can improve patient care in myriad ways. For example, RAND estimates that just reminding physicians of the need for influenza and pneumonia vaccinations during patient visits could help save up to 39,000 lives each year (Bigelow et al. 2005, xxiv).
- ***Remote monitoring.*** Similarly, remote monitoring of patients in their homes can allow early detection of health problems, often before noticeable symptoms and before they explode into expensive medical crises. Remote monitoring of just four chronic conditions could generate savings of $197 billion over 25 years and significantly reduce permanent patient disabilities, according to one study (Litan 2008, 2).
- ***Video consultations.*** Video consultations are a cutting-edge tool for extending the reach of specialists to patients far from major hospitals. They can reduce the costs of transporting patients, which could generate cost savings in the billions of dollars by avoiding the need to move prisoners from correctional facilities or residents from nursing homes to hospitals or physician offices (Cusack et al. 2007, 2–3).

A model program showing the benefits of telehealth is the Veterans Health Administration (VHA), which coordinates care for 32,000 veterans through a Care Coordination/Home Telehealth (CCHT) initiative focusing on the treatment of chronic conditions.

Using videophones, digital cameras, and remote monitoring, CCHT has reduced the number of bed days of care by 25 percent and has lowered hospital admissions by 19 percent. The program costs $1600 per patient per

FIGURE E



Note: Fourteen functions include: electronic medical records, electronic prescribing, electronic ordering of tests, electronic access of test results, electronic access of Rx alerts, electronic access of clinical notes, computerized system for tracking lab tests, computerized system for tracking guidelines, computerized system for tracking alerts to provide patients with test results, computerized system for tracking preventive/follow-up care reminds, computerized list of patients by diagnosis, computerized list of patients by medications, computerized list of patients by when they are due for tests, and computerized list of patients by preventive care.
Source: Adapted from Schoen et al.., "2009 International Health Policy Survey of Primary Care Physicians in Eleven Countries," Powerpoint presentation (Washington, D.C.: Commonwealth Fund), and author's analysis

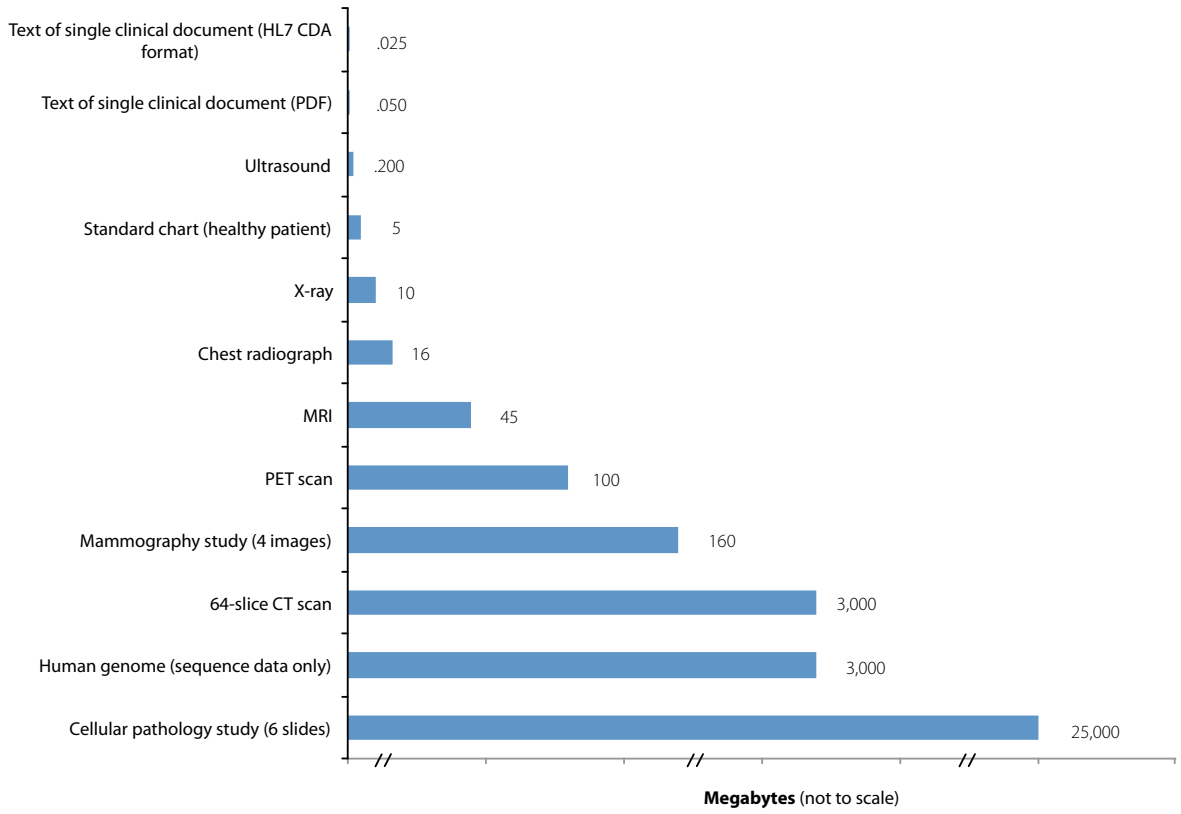
year—a dramatic savings from the VHA's home-based primary care services ($13,121 per year) and from nursing home care ($77,745 per year). Beyond cost savings, it has helped veterans live independently at home. (Darkins et al. 2008)

Unfortunately, the VHA's telehealth program is anything but typical, with most U.S. medical facilities far behind those in most other developed nations in use of information technology to reduce costs and improve health care results. In a survey of 11 countries' use of information technology based on 14 functions, the Commonwealth Fund (Schoen et al. 2009, 9) found the United States seriously lagging, as shown in **Figure E**.

A similar study by the Information Technology and Innovation Foundation confirmed that the "United States was far behind the global leaders," with only 28 percent of primary care doctors in the United States reported as using an electronic health record system (Castro 2009, 10).

Rising bandwidth needs in telemedicine will likely exacerbate the lack of capacity in U.S. telehealth. A single video consultation session can require a 2 Mbps connection both ways with good quality service, while new technologies using 3D imaging will require increasingly large file transfers for effective monitoring. As one example, six slides from a cellular pathology study require more than 2,000 times the bandwidth of transmitting a simple X-ray (see **Figure F**), highlighting the need for rolling out robust next-generation broadband to reap the full benefits of telehealth. (FCC 2010a, 210) With escalating data needs in modern medicine, the inadequacy of current U.S. telehealth deployment is only likely to grow if action is not taken.

FIGURE F



Source: Adapted from the Federal Communications Commission, *Connecting America: The National Broadband Plan*, Exhibit 10-B, 2010

Using broadband to save energy and the environment

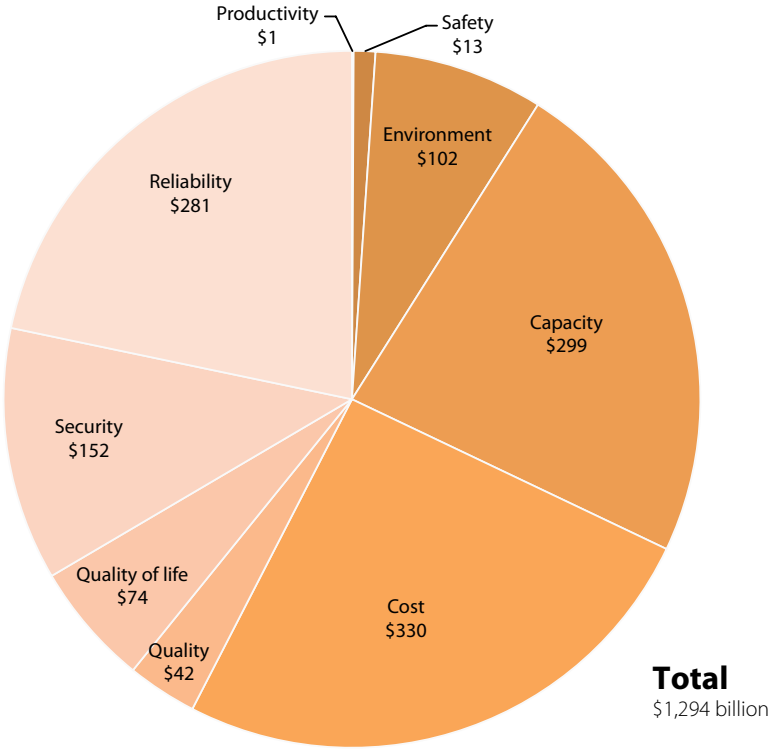
One of the largest payoffs from effective deployment of high-speed broadband will be a massive savings in energy—potentially a key to saving the planet from destruction owing to carbon emissions. As the National Broadband Plan released by the Federal Communications Commission in March 2010 argued, "Broadband can play a major role in the transition to a clean energy economy. America can use these innovations to reduce carbon pollution, improve our energy efficiency and lessen our dependence on foreign oil" (FCC 2010a, xiv).

Much of the wasted energy in our economy is attributable to poor communications infrastructure. By linking utilities, power systems, homes and offices more effectively, a robust "smart grid" would allow utilities to reduce losses of power during transmission, while consumers could reduce energy use in homes and offices. By reducing demand, utilities could take polluting plants offline during current peak hours of use. Enhanced communication can lessen the need for travel-induced energy use; notably, significant savings from telehealth are based on reduced energy use in the transport of patients.

Broadband and related smart grid technologies could reduce greenhouse gas emissions by as much as 20 percent by 2020, according to multiple analyses, including those by McKinsey & Company (Davito, Tai, and Uhlaner 2010; the Climate Group 2008, 6), an international organization of business and government members; and the Technological Leadership Institute (Chima 2011), which has pioneered research on the smart grid. In the next two

FIGURE G

Benefits of the smart grid over next 20 years in 2010 net present worth, low estimate (in $billions)



Source: Adapted from C. Gellings, *Estimating the Costs and Benefits of the Smart Grid: A preliminary estimate of the investment requirements and the resultant benefits of a fully functioning smart grid (Palo Alto, Calif.:* Electric Power Research Institute, 2011)

decades, with the proper technology investments, the United States could cut its electricity emissions by up to 58 percent, with an estimated savings of up to $2 trillion and the elimination of 53 quadrillion BTUs of energy use by 2030, according to the Electric Power Research Institute (2011, I-9). (See **Figures G** and **H** and **Table 3**). These savings come from a combination of greater energy reliability, direct energy cost savings, environmental gains, and higher-quality power delivery systems.

For consumers, one key to these savings is through the use of demand-side information management tools to help them better measure and manage energy usage, from reducing energy use during peak energy-use hours when costs are higher to integrating smart appliances into building facility communications systems to turn off appliances when unneeded. Simple behavioral changes in use of energy based on better information have been found to

TABLE 3

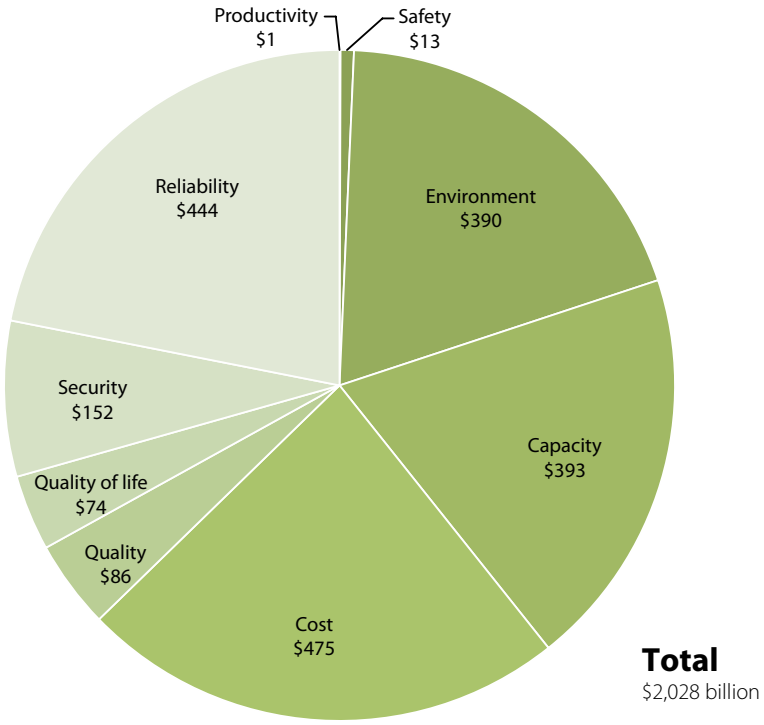
Estimated benefits of the smart grid over next 20 years

	Net present worth, high and low estimates, 2010 (in $ billions)	
	Low	***High***
Productivity	$1	$1
Safety	$13	$13
Environment	$102	$390
Capacity	$299	$393
Cost	$330	$475
Quality	$42	$86
Quality of life	$74	$74
Security	$152	$152
Reliability	$281	$444
Total	$1,294	$2,028

SOURCE: Adapted from C. Gellings, *Estimating the Costs and Benefits of the Smart Grid: A preliminary estimate of the investment requirements and the resultant benefits of a fully functioning smart grid* (Palo Alto, Calif.: Electric Power Research Institute, 2011)

FIGURE H

Benefits of the smart grid over next 20 years in 2010 net present worth, high estimate (in $billions)



Source: Adapted from C. Gellings, *Estimating the Costs and Benefits of the Smart Grid: A preliminary estimate of the investment requirements and the resultant benefits of a fully functioning smart grid (Palo Alto, Calif.:* Electric Power Research Institute, 2011)

cut electricity consumption by 5 to 15 percent—savings that would amount to $60 to $180 per year per customer (Pacific Northwest National Laboratory 2007; Lu 2009). Combined with broader energy conservation incentives, simple demand-management tools could save $59 billion between 2010 and 2019, according to a McKinsey study estimate (Davito, Tai, and Uhlaner 2010).

With buildings accounting for 72 percent of all electricity consumption and 28 percent of carbon dioxide emissions (U.S. Green Building Council 2010), long-term energy gains will come from integrating smart technology into new construction and the renovation of existing buildings, making it possible for digital systems to manage and reduce energy use across whole buildings or even regions. For example, Chicago's Building Owners and Managers Association is working to make 260 downtown office buildings "virtual generators" through better management of energy use with the goal of reducing energy costs annually by $82 million and carbon emissions by 300 million pounds—a 20 percent decrease for the buildings involved (Peeples 2010; Building Owners and Managers Association Chicago 2010).

Critical to the long-term success of the smart grid are upgrades in broadband deployment since, as has been true repeatedly, new systems deployed in the information economy rapidly overwhelm initial estimates of bandwidth needs. The National Broadband Plan has observed that "the lack of a mission-critical wide-area broadband network capable of meeting the requirements of the Smart Grid threatens to delay its implementation" (FCC 2010a, 251).

Keeping communities wired to our democracy

As traditional media, especially local media, face new challenges in the Internet era, more and more critical information for participating in our democracy is migrating to the Web. We have also experienced an avalanche of new, online political organizing, for example in the primary and general election campaigns of President Barack Obama.

In fact, out of the 36 percent of Americans involved in a civic or political group, more than half (56 percent) use digital tools to communicate with other group members (Smith et al. 2009). Internet access has been shown in studies to correlate with higher degrees of civic engagement across a variety of groups and organizations (Stern, Adams, and Boase 2008).

Whether in political campaigns, nonprofit activism, or the mobilization of whole communities, as we have seen in the recent Arab Spring, the Internet is increasingly an essential tool for fueling democratic debate and action in our communities. Ensuring that all Americans have the digital tools to participate in this new era of online organization and debate is critical for maintaining the health of our political system.

Rural communities would receive particular payoff from robust broadband

Often far from their markets and from many needed services—both personal and professional—rural communities stand to benefit disproportionately from robust broadband deployment. Unfortunately, those communities are the most likely to be unserved by adequate broadband. While rural people are as avid in their use of the Internet as urban dwellers, their access is too often still limited to dial-up connections.

The economic payoff of robust broadband for rural communities is clear. A recent study by the Department of Agriculture's Economic Research Service found that "total employment grew faster in counties that had greater broadband Internet access sooner than in similarly situated rural counties without broadband access. Wage and salary jobs, as well as number of proprietors, grew faster in counties with early broadband Internet access" (Stenberg et al. 2009, 21–22). Earnings of rural businesses outside of farming had greater growth corresponding to greater broadband Internet access. For farmers, many goods are increasingly sold directly to customers, so e-commerce allows them to increase income through direct marketing and building new markets online.

Distance education is a clear gain for rural areas without the density to maintain advanced placement classes or access to large research libraries. Also, reducing the need to travel when employing telehealth and other ways in which broadband can reduce the need for long-distance travel will disproportionately benefit low-density rural areas.

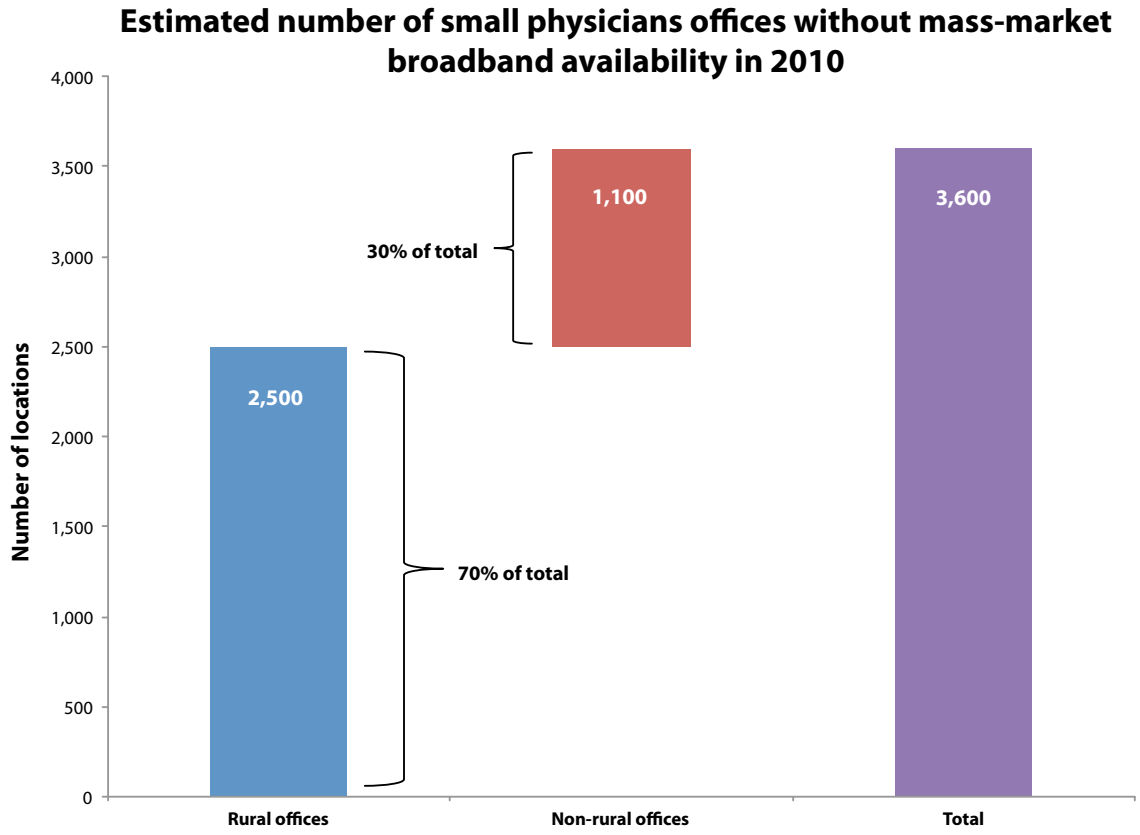
Far from many specialist hospitals, rural areas would be prime beneficiaries of telemedicine, yet 29 percent of rural health clinics lack broadband access. Of the 3,600 small physicians' offices without broadband access, 70 percent are in rural areas, as shown in **Figure I** (FCC 2010a, 211–13).

Thus, rural areas would see some of the greatest benefits from new broadband deployment, both because of the current lower levels of deployment and because of the distance-collapsing elements of broadband-based services such as telemedicine which disproportionately help rural areas.

How advanced wireless broadband enhances gains from wired broadband deployment

While many broadband benefits accompany wired infrastructure, many of those benefits will be significantly enhanced and others will depend completely on the spread of advanced wireless broadband across the nation. Being able to access data while on the move, engage in social networking, network physical devices through wireless connections, and use services that provide individuals' locations in real time (so-called "geolocation services") will all depend on a robust wireless deployment. Because African Americans and Hispanics have taken to wireless broadband in greater numbers, proportionately, than to wired subscriptions, the expansion of wireless services promises to help close the racial digital divide.

FIGURE I



Source: Adapted from the Federal Communications Commission, *Connecting America: The National Broadband Plan*, Exhibit 10-D, 2010

Replacing current 3G levels of broadband with advanced 4G LTE broadband will magnify these possibilities. First and foremost, 4G LTE delivers download speeds comparable to some fast fixed broadband, meaning wireless access will actually meet Federal Communications Commission standards for true broadband. It will also manage spectrum more efficiently, making it easier to accommodate the explosion of data use expected in coming years (to be discussed more in the section, "The Spectrum Crisis and the Emerging Synergy between Wireless and Wired Deployment").

Managing remote access to wired data on the go

Smartphones and other wireless tools tied to the mobile Web are natural avenues for managing communication to wired data centers while on the move. By allowing people in transit to access data on central servers, wireless broadband allows greater on-site provision of information-based services, gives people greater freedom to collaborate with others wherever they go, and creates new portable tools for professionals. In everyday life, people are increasingly able to check movie schedules, restaurant reviews, or a range of other information while on the move because of smartphones.

For medical professionals, wireless broadband allows physicians to download data from lab results, images, and drug information to smartphones. It lets emergency medical responders track patient information and records then send key information ahead to a hospital, and it helps patients share health data with their physicians. Patients can be reminded of appointments or other medically needed activities on their smartphone calendars. The

free Text4baby service, for example, is providing updates to expectant and new mothers, such as reminders for pre- and post-natal health checkups and other critical information (Text4Baby 2011).

New geolocation services—smartphone applications that track where you and your coworkers are at any moment—are beginning to transform the on-site service industry. Companies can now better assign field service technicians to jobs on the fly. By integrating such data with traffic updates, it further helps with planning and cutting delays. By knowing where coworkers are in the field, inventories can be synced: If a part carried by one technician is needed by another, they can connect on the road and increase the number of jobs completed (Yarnold 2011).

Accessing remote data on the go is also critical for a wide range of energy-saving strategies to reduce transit costs. In fact, experts cite access by customers to route-planning applications as increasing the use of public transportation.

A study of transit users in Boston and San Francisco, two cities that have made data on their systems widely available online, "found people are more willing to ride the bus or train when they have tools to manage their commutes effectively." Such wireless data allow people to find local transit stops easily and decrease wait times, thereby making transit alternatives to local car use attractive (Barry 2011).

The availability of wireless on new intercity bus routes is one of the main reasons given for the upsurge in recent years in the use of intercity bus travel, which has been the fastest-growing mode of transportation for three years running. DePaul University's Chaddick Institute argues that "the growing prevalence of portable electronic technology among intercity travelers is giving intercity bus travelers a new competitive advantage." An institute study found that 40 percent of travelers on new Wi-Fi-equipped buses were using portable devices, a far higher percentage than on Amtrak and an option not available to people driving cars—highlighting how the availability of mobile broadband is driving more energy-efficient travel options (Schwieterman and Fischer 2010, 9).

Wireless social networking is key to broadband benefits

Without question, mobile phones are a driving force in the exponential growth of social networking, and, in turn, "one of the major applications driving mobile data usage is social networking," according to analysis by the Federal Communications Commission. Facebook, for example, is popular on the wired Internet—being the No. 4 domain accessed—but it is the No. 2 Web domain accessed by mobile devices (FCC 2010b, 175) (see **Figure J**). Highlighting the demand for online social networking, when Google launched its Google Plus social networking service, its iPhone app quickly jumped to being the most downloaded free app, with 20 million people signing onto the service within the first three weeks (Yin 2011).

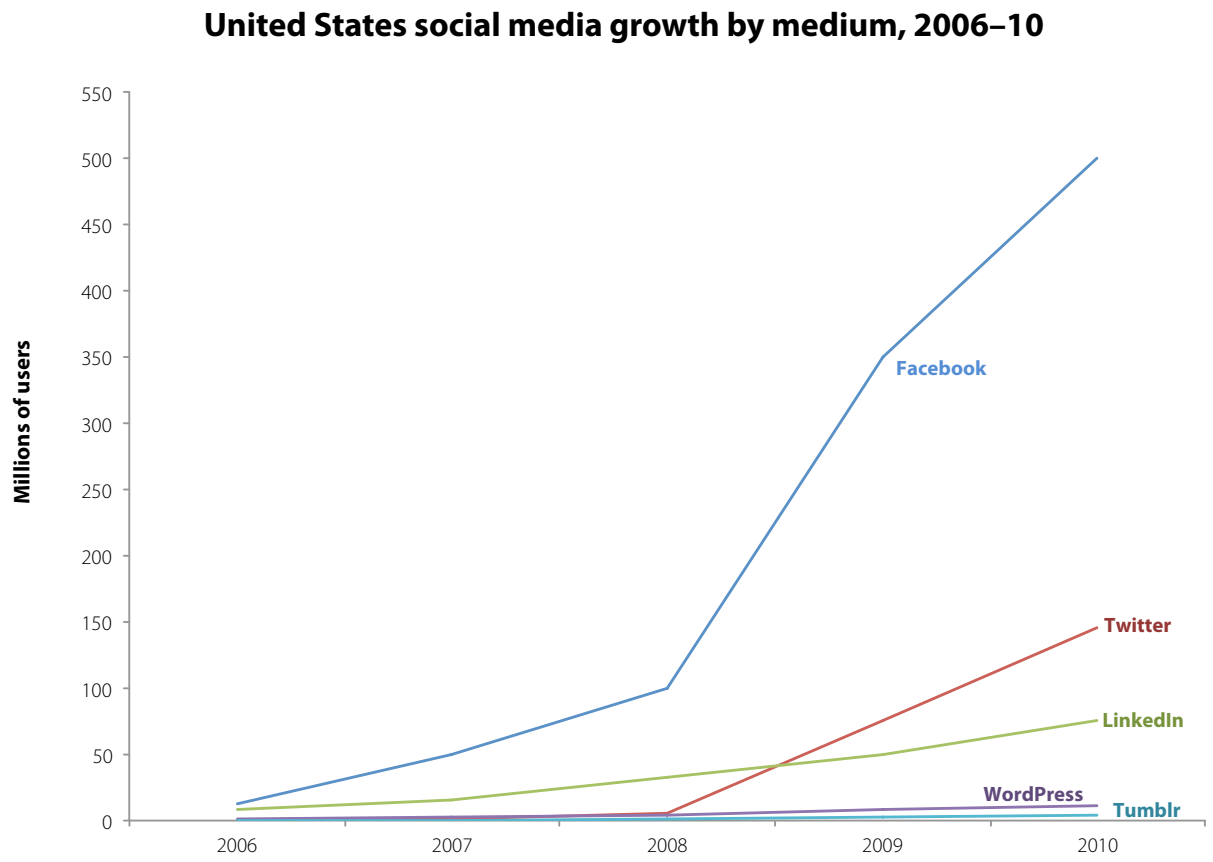
More than entertainment. Social networking gets talked about more in terms of celebrity tweets and entertainment, but it is an increasingly critical tool in making information-based economic strategies effective. As one commentator recently argued, "…focusing on the social and entertainment industry in this context [social networking] is akin to focusing on vacation travel as the chief economic benefit enabled by the 1950s construction of interstate highways" (Mills 2011).

Marshaling the expertise of disparate individuals through social networking into new forms of collaboration is reshaping multiple industries. Companies are increasingly monitoring social media to gauge the effectiveness of advertising strategies, and social media is giving clues to tracking other critical economic and social processes. As well, social networking is making civic engagement more robust and strengthening our democracy.

Networking health care. A number of services are working with social media users to track illnesses within communities and even groups of friends, the better to forecast outbreaks among users' own circles. Other sites help patients share information and experiences with their particular disease or condition (Naone 2011). Medical professionals increasingly see social networking as critical to enlisting the patient as part of the health care team (Justice 2011).

Medical professionals are also using social networking to collaborate more effectively on treatment of patients,

FIGURE J



Source: Adapted from Steven D. White, "Social Media Growth from 2006–2010," *All Things Marketing* blog, Aug. 8, 2010

especially when this is combined with telemedicine. One stroke surgeon has described the decreased emergency travel to hospitals by doctors and enhanced patient treatment from enabling doctors to oversee hospital operations from remote locations. Beyond direct patient interaction, the new system has improved data collection and enhanced training among colleagues working more closely together across multiple hospitals (O'Neill 2010).

Motivating adoption of smart grid strategies. Similarly, leaders in the smart grid industry are harnessing social networking to accelerate adoption of energy-reduction strategies. Not only are smartphones a natural interface for controlling smart appliances and energy management in the home, especially from remote locations, but they allow consumers to compare energy reduction strategies with neighbors and friends through social networking. One leading smart grid firm, OPower, has devised multiple strategies for using social media to motivate its two million customers nationwide to monitor their consumption data more closely and share best practices with other customers. By creating user demographic profiles, they can connect customers with those with similar energy-use patterns and even encourage head-to-head competitions in reducing energy consumption among friends and acquaintances.

Hearing about energy reduction strategies from friends and peers is the most effective way to speed adoption, OPower cofounder and CEO Dan Yates maintains:

> *All you need are a few enthusiasts to create momentum—we've never seen consumers drive action like they have using social media.… Online communi-*

ties are a very valuable way to share this information.… It allows us to use the information generated by the 5% of very engaged and enthusiastic customers, and share it to benefit the other 95%. (Chima 2011)

Other companies are adopting similar customizable online interfaces for customers to connect with their energy suppliers and with other customers. Enlisting customers to propagate best practices is seen as the key to achieving the most aggressive energy savings. Of course, many in the population will be left out of this outreach if they are not online, highlighting the need for expanding broadband's reach and adoption to realize in full the social gains from the smart grid.

Building the 'network of things'

Beyond connecting people, the fastest-growing aspect of the wireless Web is connecting objects to the Internet, sometimes to provide data directly to individuals but often to connect them with other networked devices in a so-called "Internet of Things."

The promise of this Internet of Things is of smart homes communicating seamlessly with utilities, healthcare products monitoring patients and automatically updating hospitals about problems, farmland monitors alerting supply houses of the need to send additional fertilizer, and cars alerting other cars to imminent crashes. The simplest example is the E-ZPass, which instructs tollbooths to charge user accounts, but with a robust wireless connection, the opportunities become nearly infinite as potentially millions, even billions, of objects in our environment communicate with each other (Mills 2011).

Sometime in the middle of 2010 marked a watershed date when more Internet wireless subscriptions by nonhuman objects—computers, printers, picture frames, GPS devices, televisions, etc.—were registered with Verizon and AT&T than from individual phone connections (Kirkpatrick 2010). While many of these Internet-enabled objects are computers and related consumer tools, a growing number of those subscriptions are for machine-to-machine (M2M) connections. A whole range of business-based app companies, with names such as Aveda, SensorLogic, and ILS Technology, are emerging to service these Web-connected business devices (Kirkpatrick 2011). These include businesses networking products in transit to central databases to better manage inventory, automatically monitoring livestock, and even monitoring roads and other infrastructure for repair needs.

Moving beyond medical monitoring in the home, new wireless-connected medical devices promise even more cost-cutting and life-saving solutions. Mobile sensors in disposable bandages and in pills can relay real-time health data—vital signs, glucose levels, etc.—and help reduce infection risks while increasing patient mobility. Heart rhythms can be monitored constantly regardless of a patient's travel, and diabetics can receive steady insulin delivery through real-time glucose monitoring sensors that transmit data to insulin pumps (FCC 2010a, 202). These kinds of tools are not just more efficient but represent what could be a fundamental shift to preventive care for those with chronic conditions, replacing the current model of expensive, reactive care after each crisis. Such wireless remote monitoring should reduce the need for hospital admissions and make a significant impact on public health care costs (Jones 2010).

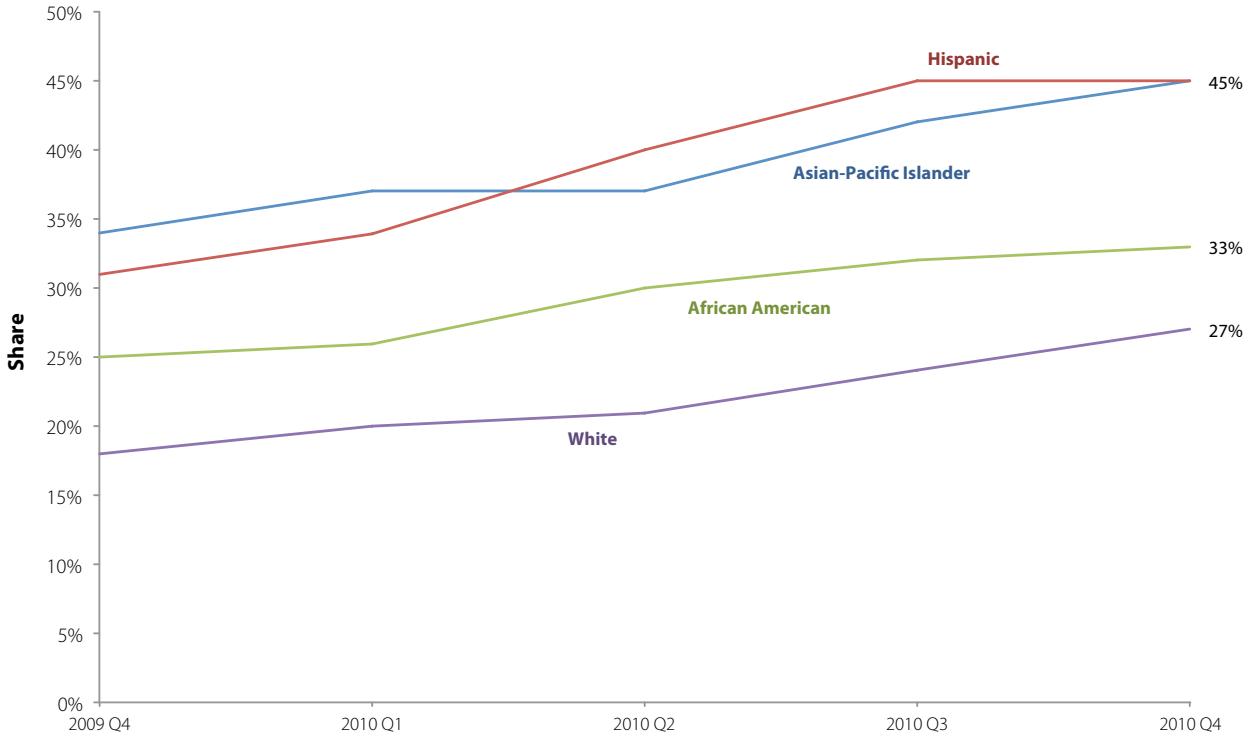
As customers begin to buy smart appliances to reduce energy use in the home, Google has launched its Android@Home initiative to work with smart appliance and lighting makers to create a seamless integration of those systems into home network controls by phone handsets. Many analysts also expect Microsoft's new Kinect sensor system, which allows users to control electronic devices with just a physical gesture—pioneered on its Xbox gaming device—to become another potential control hub for home-based "networks of things" (MacManus 2011). Smart grid companies are already developing multiple apps for the iPhone, Android, and other wireless platforms.

Wireless as a pathway to closing the racial digital divide

One reason the deployment of advanced broadband is so critical is that wireless broadband use is beginning to offset the racial digital divide that has characterized wired broadband. While lagging white households in adoption of home broadband, both blacks and English-speaking Latinos are more likely to own a mobile phone than whites.

FIGURE K

Share of U.S. cellphone owners with smartphones by race/ethnicity, 2009Q1–2010Q4



Source: Adapted from Don Kellogg, "Among mobile users, Hispanics, Asians are most-likely smartphone owners in the U.S." *Nielsenwire* blog, February 1, 2011

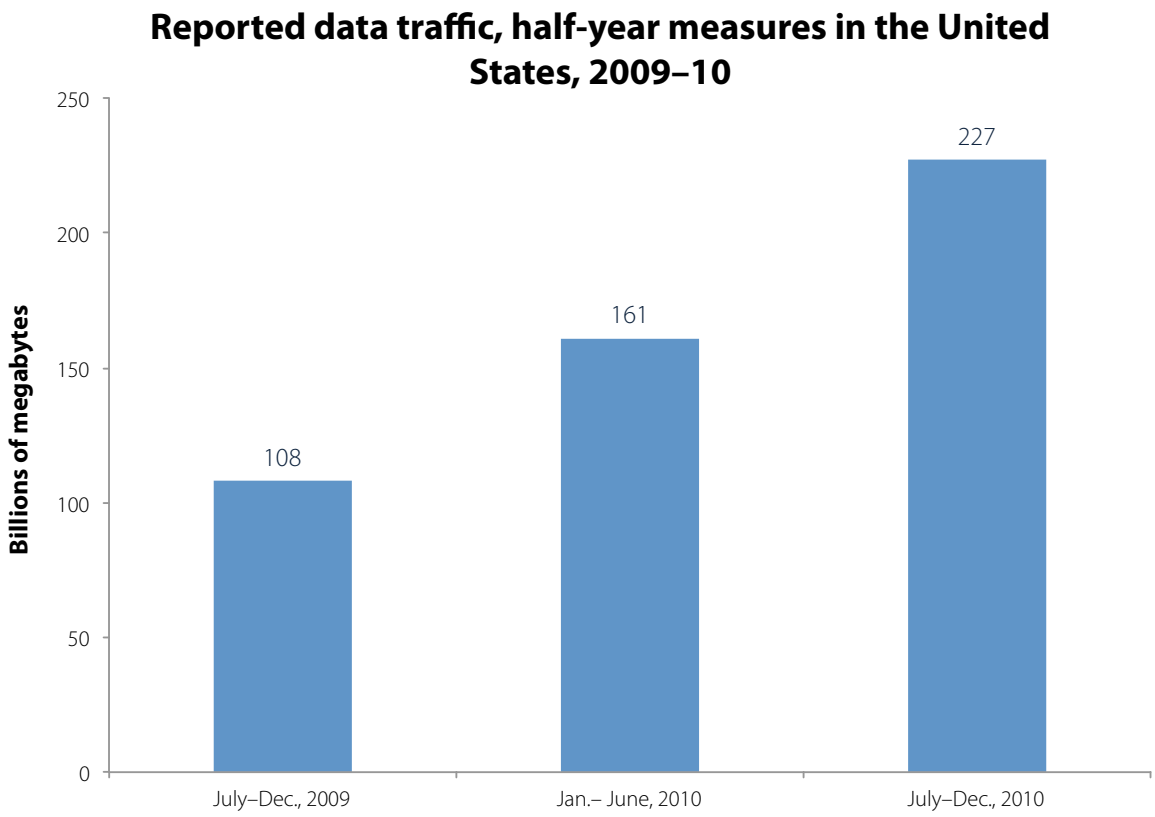
And nonwhites with mobile phones have been more likely to be smartphone users, with 45 percent of both Asians/Pacific Islanders and Hispanics and 33 percent of African Americans choosing smartphones compared with just 27 percent of white cellphone users, as shown in **Figure K** (Smith 2010; Kellogg 2011).

Moreover, African Americans and English-speaking Latinos use social networking sites and other aspects of the wireless Web at higher rates than whites. For example, nonwhite users are more than twice as likely to be active on Twitter as non-Hispanic whites. Twenty-five percent of black Web users and 19 percent of Hispanic users are on Twitter, as opposed to 9 percent of whites who use the Web (Smith 2011). As FCC Commissioner Mignon Clyburn recently highlighted, the African American and Hispanic communities have "excelled" in their adoption of mobile broadband services, and both groups "take advantage of a much wider array of their phones' data functions than their white counterparts" (Clyburn 2011).

The spectrum crisis and the emerging synergy between wireless and wired deployment

All of the potential benefits from broadband are emerging in a rapidly changing communications environment, where any vision of universal wireless broadband access is threatened by escalating data use crashing against the limits of spectrum capacity. Managing scarce spectrum will require the seamless integration of wired and wireless solutions, including shifting chunks of phone and data communication from wireless to wired backbones (networks) as needed.

FIGURE L



Note: Total data traffic grew more than110 percent year-over-year.
Source: Adapted from Robert Roche, "Wireless Data Traffic Grew 110% from 2009-2010," *CTIA Blog: The Wireless Association*, May 31, 2011

The coming data tsunami

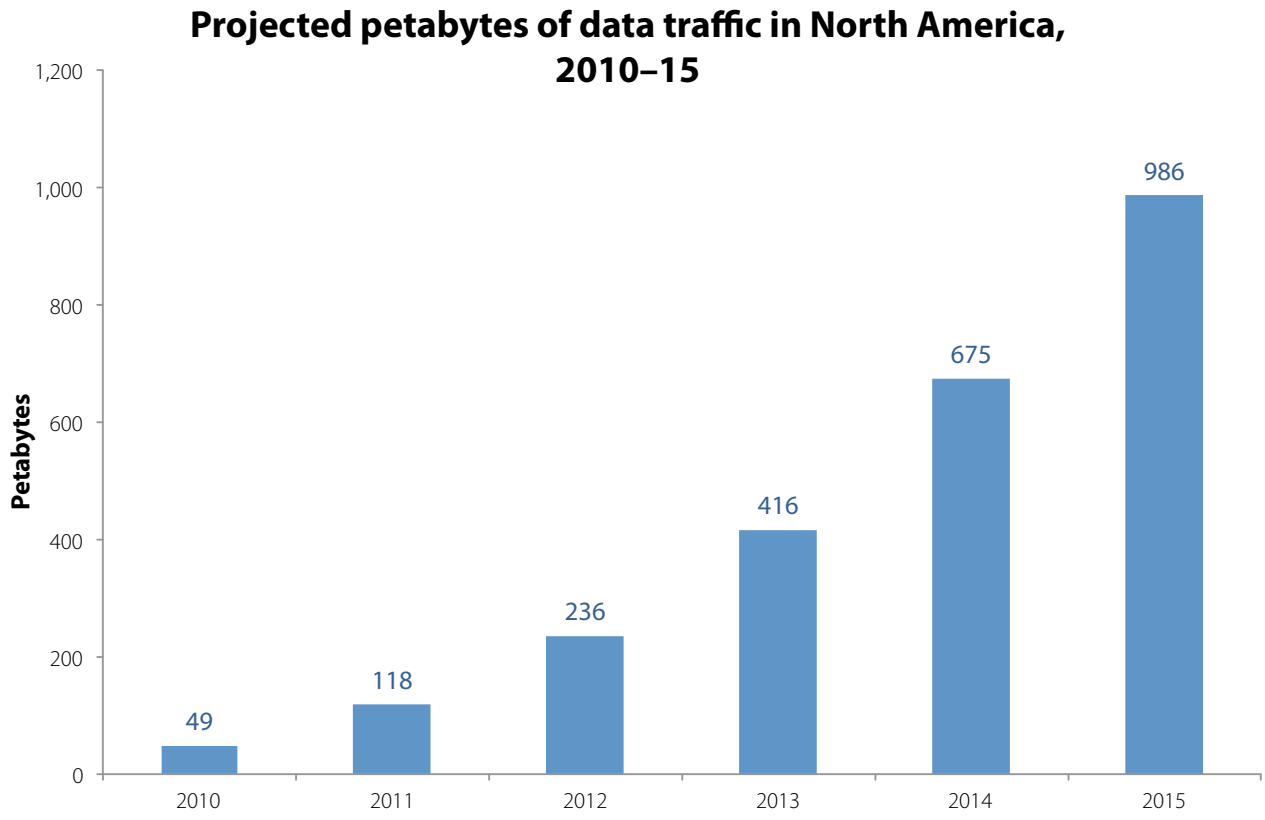
With the massive proliferation of new applications using the wireless Internet, data use is expanding exponentially. In just one year, wireless data traffic in the United States more than doubled, growing from 107.8 billion megabytes in the latter half of 2009 to more than 226.5 billion MB in the second half of 2010, as shown in **Figure L** (Roche 2011).

This growth is just the tip of the iceberg. Cisco Systems, working with research partners, has projected that wireless data traffic in North America will grow 20 times again from 2010 to 2015 (**Figure M**), which, along with estimated growth from the two preceding years, suggests that wireless data traffic by the middle of the decade will be 56 times what it was in 2009 (Cisco 2011, 16; Roche 2011).

Responding to this projection, FCC Chairman Julius Genachowski has detailed how the commission has tripled the amount of spectrum capacity in recent years, but that this pales in the face of the nearly 60-fold increase needed by 2015. There is a likelihood of higher prices if the spectrum shortage is not resolved, as Genachowski argued in the spring of 2011:

> *The coming spectrum crunch threatens American leadership in mobile and the benefits it can deliver to our country … [i]f we do nothing in the face of the looming spectrum crunch, many consumers will face higher prices—as the market is forced to respond to supply and demand—and frustrating service—connections that drop, apps that run unreliably or too slowly. The result will be downward pressure on consumer use of wireless service, and a*

FIGURE M



Note: One petabyte is one trillion kilobytes.
Source: Cisco Visual Networking Index: Forecast and Methodology, 2010–2015 , 2011, Table 18

slowing down of innovation and investment in the space. (Genachowski 2011, 6–9)

Spectrum auctions, better spectrum management, and integrating wireless into the wired grid are critical

To tackle this problem, the FCC is already proposing significant auctions of existing spectrum by current holders—who would receive some portion of the auction proceeds. If Congress enacted the proposal, that would double the amount of spectrum available for broadband, but it would take years to implement (Genachowski 2011, 8). Better management of existing spectrum held by wireless carriers would also free up capacity for wireless broadband needs.

Still, making somewhat more spectrum available and using it more efficiently is almost inevitably going to be outpaced by the explosive growth of spectrum use. This is one reason why the industry is increasingly focused on offloading existing wireless traffic onto the wired grid.

Such "backhaul" operations have always been part of managing mobile phone systems, but with the expanding data deluge, wireless carriers are looking to a range of options. Traditional backhaul has used local wire lines to transfer data from local base station cell sites to the carriers' core wireline network. This has also included microwave links for traditional voice traffic and has increasingly uses IP-based wired and wireless options that take the data from a base station to the point where it can connect with either the person being called or a data source. Wireless carriers use wired affiliates and even cable

companies for such wired backhaul services (Riddell and Thomson 2010).

Using Wi-Fi to offload traffic. Such options, however, do not solve congestion problems if the initial wireless data needs to be transferred to a base station using the cell operator's wireless spectrum, so carriers are increasingly looking to offload data onto the wired network without ever using their wireless spectrum at all, primarily by using Wi-Fi connections on smartphones to offload data onto wired networks at the point of use. Wi-fi wireless connections use a special unlicensed portion of the spectrum that has traditionally only operated for short distances and is used to link electronic devices to a local Internet source, usually one that uses wired connections. Using Wi-Fi connections, a cell phone user near a Wi-Fi "hotspot" can access the Internet without ever having to use a provider's own wireless spectrum.

Wireless carriers themselves are making use of Wi-Wi and other systems that are operated by a range of wired Internet providers to offload traffic to wired networks and thereby relieve their overused spectrum of congestion. For example, Verizon has invested in developing 5,824 Wi-Fi hot spots, while AT&T has 24,000 hot spots around the country, including at Starbucks and McDonalds (Gabriel 2011). According to one estimate, AT&T experienced 500 percent growth in hot spot usage from 2008 to 2009 (FCC 2010b, 182). Carriers are deploying areawide Wi-Fi "hot zones" to handle congestion in dense areas such as New York's Times Square (Bode 2011).

Carriers are also selling services that offload voice calls in the home, sometimes using an alternative to Wi-Fi called a femtocell—essentially a mini-cellular base station for the home or office. AT&T offers an unlimited monthly wireless phone plan for home use if customers offload calls onto their wired broadband, while T-Mobile has gone even further and introduced "Wi-Fi Calling" to send voice calls directly over any available Wi-Fi access point to the company's core network (Shaw 2011).

Wi-fi is handling an increasing percentage of data traffic. Offloading of data is playing an increasing role in the management of cell traffic. A Juniper Research report has projected that 63 percent of traffic originated by cell phone users will transfer onto the fixed-line network via Wi-Fi and femtocells by 2015 (Eddy 2011). A recent study by WeFi found that heavier monthly users of data are already offloading two-thirds or more of their data traffic onto Wi-Fi (WeFi 2011). This highlights the increasing dependence of wireless networks on the maintenance of a strong wired broadband sector as well.

In a keynote address at a spring 2011 technology conference, Tony Melone, Verizon's chief technology officer, stressed the importance of such data management and argued that the company now regards its wireline and wireless broadband systems as "all one network now" (Gabriel 2011). As a consequence, no market analysis of the wireless sector unto itself is complete without scrutinizing the broader ecosystem of wired networks as well.

Smartphones and the changing competitive ecosystem of wireless communications

The emergence of the smartphone lies at the heart of the changes driving the phenomenal expansion in data use through new applications, which in turn impels the use of Wi-Fi and other alternatives to move data onto wired broadband. Wi-fi has emerged as a "must have" feature on phones, and users have become savvy about accessing Wi-Fi on those phones, even as public locations now advertise Wi-Fi to entice consumers (Shaw 2011).

As dramatically, the range of applications on smartphones is fundamentally changing the nature of competition in the wireless industry. Instead of a handful of integrated services focused on voice calls sold by a few competing carriers in each local market, the wireless companies end up competing furiously for market share with smart apps on their own phones. This interaction between smartphone applications and carriers is transforming how policymakers need to think about networks and competition in the wireless telecommunications world.

As the 2010 FCC *Fourteenth Wireless Report* noted, the traditional mobile phone companies now provide just "one class of services that are part of the larger mobile wireless services industry" (FCC 2010b, 199). Voice, messaging, video, and broadband data plans all become individual services sold amid a broader competitive environment.

Buying a smartphone becomes the equivalent of buying a handheld computer with its own operating system that can access applications and services provided by a wide range of competing companies. From a policy perspective, "each of the interrelated segments of the mobile wireless ecosystem has the potential to affect competition" (FCC 2010b, 5).

As will be detailed below, the cost per unit of each of those services has been falling rapidly because of these new competitors. Even as average monthly wireless bills have remained relatively stable over the last decade, the quantity and diversity of services used by customers have expanded almost exponentially. This is the ultimate promise of advanced wireless broadband deployment across the nation: an explosion of competition and lower costs for communication services that no company seems able to control.

The triumph of the smartphone

In the initial quarter of 2011, for this first time ever, smartphones made up the majority (54 percent) of cell phone sales (Olivarez-Giles 2011). According to a survey by Arbitron and Edison Research, this development dovetailed with a doubling in overall smartphone ownership from 14 percent of the population in 2010 to 31 percent in 2011 (Arbitron 2011).

How much smartphones are driving the data tsunami is highlighted by an FCC estimate that a smartphone generates 24 times the mobile data traffic of a conventional wireless phone (FCC 2011d). After AT&T introduced the iPhone, its network experienced an 18-fold increase in data traffic during the following two and a half years, with an overall data traffic increase of 5,000 percent from mid-2006 to mid-2009 (FCC 2010b, 109).

What makes smartphones so radical is that the services at each individual consumer's disposal are no longer chosen by their wireless carrier but can include any of hundreds of thousands of apps available in the iPhone, Android, and other app stores. When AT&T in launching the iPhone agreed to cede to Apple so much control over what applications were available to customers, the company struck what one top industry executive in *BusinessWeek* called a "devil's bargain" (Burrows 2009). This ratcheted up pressure on other carriers to adopt operating systems like Android with similar app store variety. Now, with the availability of the iPhone on Verizon and likely through other carriers soon, the rivalry between wireless operating systems is often more salient to consumers than that between carriers. In fact, a Consumers Union report found that as many as 38 percent of consumers were switching providers to get the handset they wanted (FCC 2010b).

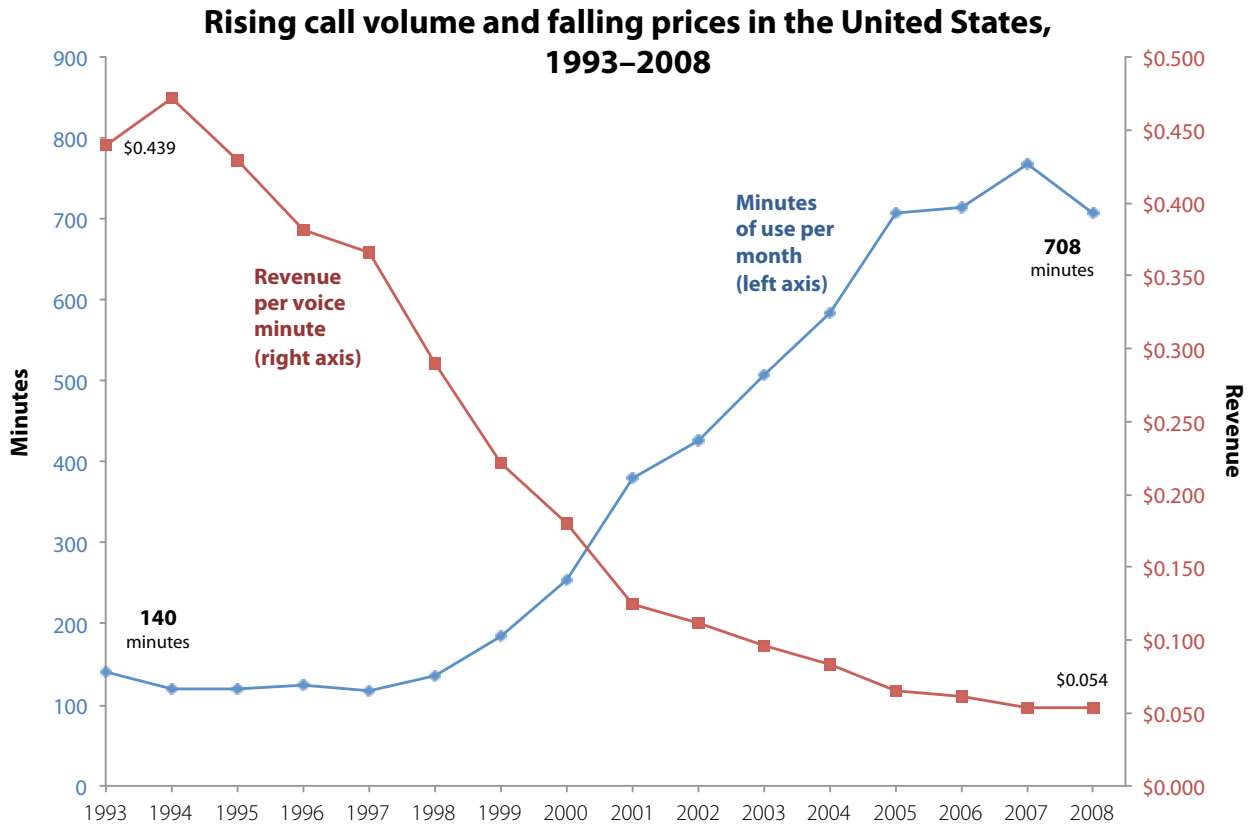
While the proliferation of new phone services has allowed carriers to remain profitable, a bevy of new competitors are now offering apps on the carriers' own phones and competing for market share on every service the wireless carriers sell, from voice calls to texting to video services to access to the Internet. So even as the total "units" sold of each product has increased—whether of minutes, texts, or gigabytes of data—the price per unit has been crashing in the face of newcomers that often charge nothing for their competing services.

Skype, Google Voice, and the rise of free phone calls

For two decades, the wireless carriers have been making less and less money on each minute of voice calling, but this was largely counterbalanced by escalating total minutes per month by each user. Even as the overall consumer price index increased by 34 percent from 1997 to 2008, the average revenue per minute for wireless voice calls declined from $0.37 to just $0.05, or less than one-seventh as much. While the rise in volume of calls just about offset this per minute revenue decrease (see **Figure N**) the number of voice minutes began leveling off in 2005 (FCC 2011a, 120).

The leveling off of voice minutes per customer no doubt has a number of causes, including increased texting and other changing social patterns, such as the proliferation of friends-and-family plans, but at least one contributor is the rise of Internet-based calls on smartphones using providers such as Skype and Google Voice. Such companies provide free phone calls over the Internet to other customers with the same software installed as well as relatively cheap connections to phones not connected directly to the Internet.

FIGURE N



Source: Adapted from the Federal Communications Commission, *Fifteenth Annual Mobile Wireless Competition Report*, 2011, Table 20

Given the high cost of international calls, such calls were the earliest heavy use of Skype; as early as 2008, Skype became the largest carrier of international phone traffic, carrying about 8 percent of the total. In 2010, analysts estimate, Skype's international traffic volume grew more than twice the volume increase achieved by all telephone companies in the world *combined* (Taylor 2011).

But the practice of making online calls is rapidly shifting to the domestic arena as well, especially with the spread of smartphone apps making it so simple for users to install—and as the network of users able to receive the free calls grows. A recent Pew study found that 24 percent of adult Internet users, both those with wired and wireless connections, have placed calls online and that on any given day 5 percent are making Internet phone calls. That is roughly triple the number who were doing either back in 2007. Pew attributes part of the increase to the enabling of Skype and other online calling options on smartphones; according to the survey, 7 percent of cellphone owners had participated in video calls or online chats with their handheld device (Rainie 2011).

As smartphone customers gain more access to apps that use Skype or similar services, this trend could threaten the voice-call revenue base of wireless carriers, putting sharp downward pressure on their pricing options for voice calls as they fear customer defection to free calling alternatives.

Carriers have been scrambling in different ways to respond to the challenge. Verizon cut a deal directly with Skype in early 2010 to place the service prominently on some phones but to run the calls over Verizon's infrastructure while sharing profits between the two companies

(Luna 2010). In March 2011, Sprint announced a parallel partnership with Google to make customers' Sprint numbers automatically Google Voice numbers as well, while offering low-priced international calling via Google Voice (Wortham 2011). Sprint announced it was hoping to market a "pure Google Experience" to sell its Android-based phones and, as part of the deal, will receive certain Android software upgrades and Google apps before other Android smartphones (Boulton 2011). While at first resisting Skype being allowed on the iPhone, AT&T reversed its position in late 2009 and allowed Skype apps on its network. By the following summer when Skype introduced version 2.0 of its app to take advantage of 3G data systems, 5 million Skype iPhone apps were downloaded in the first four days it was available. The FCC's open Internet rules now require mobile phone providers to allow voice apps that compete with the mobile phone carrier's own voice service.

Microsoft's announcement this past spring that it would pay $8.5 billion to acquire Skype just added to the sense that the era of wireless voice calls as a separate service category may be seeing its last days. The Microsoft-Skype alliance, coming from a major player developing its own wireless operating system and an expanding app store competing with Apple's, Google's and Research In Motion's, creates a massive new competitor that can drive down prices in the wireless voice field.

The subsequent announcement that Facebook would be integrating Skype into its service so that any Facebook friend can be called via Skype with a single click "will kill the phone network," in the words of *Information Week*'s Art Wittmann (2011). And Google' new "Hangout" service on its Google Plus social networking platform, which allows users to conduct ten-way video conference calls at the click of a button, will be a whole different kind of competition for the carriers since they do not even offer video conferencing on current voice plans (Lynley 2011).

Verizon executive Brian Higgins expressed a philosophical reaction to the rise of Skype and the like as competitors: "Eventually, everything migrates to a data channel." He went on to say that the company is concentrating on new services connected to the high-speed 4G data network.

The rise and fall of paid texting

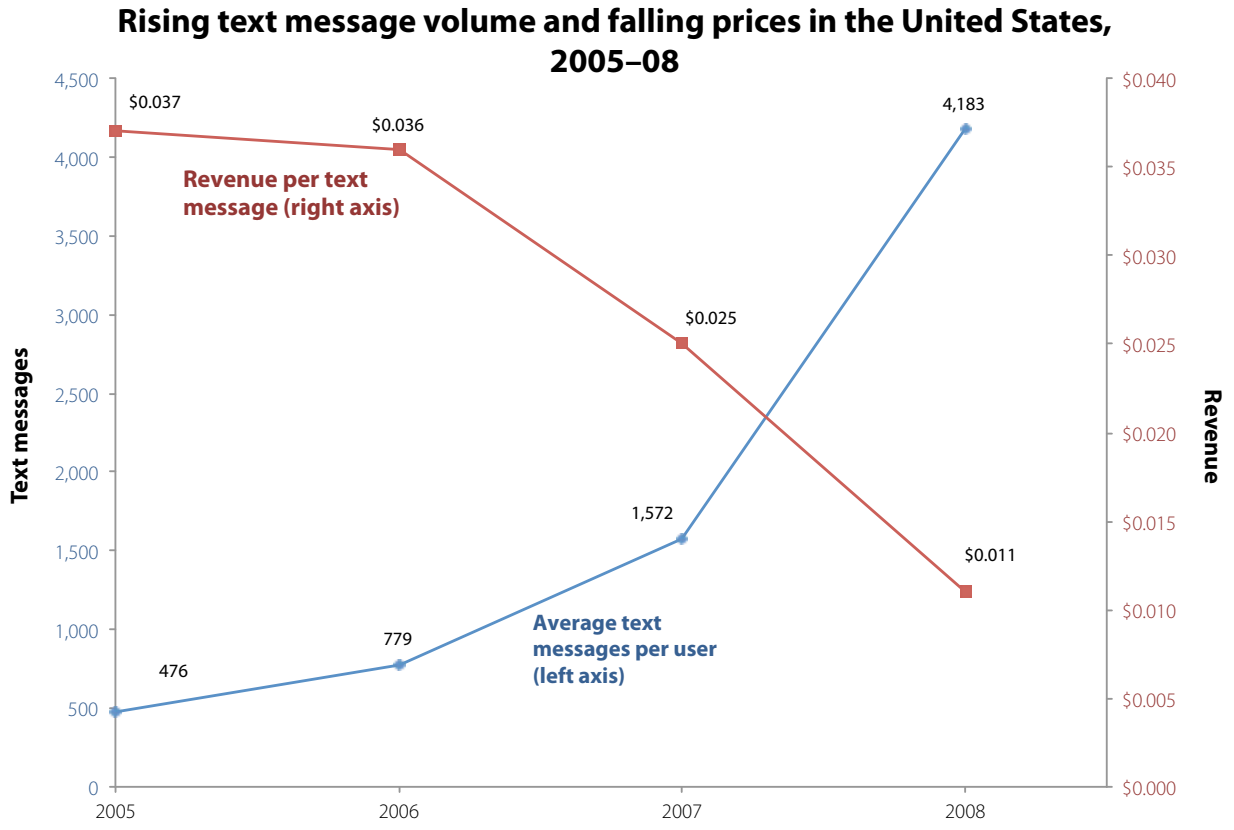
The story of cellphone texting seems to be following the trajectory of phone service, although with a much truncated timeline. Profits from text messaging exploded on carrier lines in the past half decade; between 2005 and 2008 alone, the average number of texts that users sent in a year grew from 476 to 4,183, a jump of nearly 10 times (see **Figure O**). The introduction of flat-rate texting plans both fed this boom and contributed to the plummeting of revenues per text message—from 3.7 cents down to slightly more than a penny per text by 2008—although the sheer volume of texts kept it a revenue growth area for carriers. Teens were a big part of this story, with one study showing them sending an average of 3,146 messages per month, which is the equivalent of more than 10 messages every hour that they were not sleeping or in school (FCC 2010b, 106).

While the growth in text volume continued into 2010, the rate of growth has slowed sharply in the past year, with just an 8.7 percent increase in the second half of 2010 from the prior six months (Troianovski 2011). Analysts are attributing the slowdown to the mushrooming of new free texting apps on smartphones, including WhatsApp, Kik, GroupMe, textPlus, and LiveProfile, the last of which amassed nearly 1 million users in just its first three months in 2011 (Wortham 2011; Kang 2011).

Adding to the sense that paid texting is increasingly giving way to alternative forms of electronic communication is the entry of heavyweight Facebook, which in March 2011 acquired Beluga, a year-old company that developed new ways to send texts to groups of people with one click as well as other tools not available with traditional texting software (Woolley 2011).

The announcement in June 2011, without prior consultation with the carriers, that Apple was introducing its own iMessage texting system in the next large update of its operating system has only added to the competitive pressure on the wireless companies. Google recently confirmed that it will be introducing a similar messaging application in its Android operating system, and its new Google Plus social networking system includes a group "huddle" texting service as well.

FIGURE O



Source: Adapted from Federal Communications Commission, *Fourteenth Wireless Report,* 2010, Table 20

The Netherlands may point the way to the future; there, adoption of the free WhatsApp messaging app went from zero in August 2010 to 85 percent of smartphone users in April 2011, accompanying an 8 percent decline in text messaging in the first three months of this year (Troianovski 2011).

While paid texting through carriers may still be required to reach people not sharing the same handset or using different texting software, it is clear that wireless carriers' texting services and their pricing power will be under pressure from these new competitors with free offerings. Making up the lost revenue from data plan use for use of the free texting apps is not possible since the revenue from a paid text currently yields somewhere on the order of 50,000 times the data costs alone (Woolley 2011).

Video and other services

Wireless carriers have been searching for new services, especially data-intensive ones, to expand their revenue sources, but they face competitors in almost every new venue.

Music and video have been a clear target for the carriers, but they have had little success launching their own apps to attract users. Adoption of Verizon's VCast music and video player is dwarfed by the success of Pandora, Hulu, YouTube, and especially Netflix, which is consistently ranked as one of the most popular apps on the iPhone and iPad. Cable companies and networks such as HBO are also providing their own apps.

For other services, Sprint and T-Mobile have both promoted global-positioning apps but struggle in competition with Google Maps (Kang 2011). In a bid for

yet another new revenue source, Verizon, AT&T, and T-Mobile attempted to team up on a project to create an alternative payment network using cell phones to edge out credit cards—permitting the carriers to collect a fee on each transaction. Finding going it alone impossible, the carriers in June 2011 announced they were looking to partner with Visa or MasterCard instead—only to confront the announcement that Google had beaten them to the punch with its own announced "Google Wallet," in partnership with Citi MasterCard, which will be incorporated into new Android phones and has already lined up merchants in multiple cities (Sterling 2011).

Wi-Fi providers' challenge to data plans

If "everything migrates to a data channel," as Verizon's Higgins projects, then revenue from data plans may end up being the wireless carriers' only dependable revenue source in coming years. Even as overall voice revenue declined in recent years, revenue from Internet data increased fivefold to $46.8 billion in the past five years, with data now making up 35 percent of the total revenue for the wireless industry (Kang 2011; Wortham 2011).

Given the growing data use by consumers, the wireless carriers will no doubt continue to see revenue growth from data plans in years to come, but they will also face fierce competition for those dollars, largely in the form of a proliferation of Wi-Fi options. As discussed earlier, the need to cope with the spectrum crisis has forced wireless carriers to encourage the development of alternative Wi-Fi options for consumers, but those options will also severely limit the carriers' pricing power over data plans.

The sturdiest competitor to carrier data plans will be Wi-Fi provided at homes and offices, whether by the wired broadband subsidiaries of the wireless companies themselves or by cable and other wired broadband competitors. Free Wi-Fi is also often available in coffee shops, restaurants, and hotel lobbies around the country and the world, with paid services like iPass, Boingo, and Trustive offering access to a network of Wi-Fi hot spots in airports, hotels, and other retail and business centers. A rapidly growing, innovative alternative is the Fon network, where individuals, by agreeing to buy a special router and share access to their own home or office Wi-Fi, can reach other Fon members' Wi-Fi around the world, with a global network of 4 million hot spots that grew by 30 percent just in the first five months of 2011 (Wireless Federation 2011).

Evidence seems to show that the heaviest users of smartphones, who might be subject to any increasing charges on data use, are increasingly offloading their data use onto Wi-Fi. As mentioned previously, a study by WeFi, which provides software for 6 million smartphone users to manage offloading data onto available Wi-Fi networks, found that the heaviest data users were also the ones disproportionately moving their data off the wireless networks and onto Wi-Fi alternatives. For even moderate users, more than two-thirds of their data was downloaded using Wi-Fi rather than over their wireless plans, while for the heaviest users—those downloading 2 gigabytes or more of data each month, more than 80 percent of their data was transmitted via Wi-Fi (WeFi 2011).

For users who want to drop their carriers' data plans altogether, they also have the option of mobile Wi-Fi routers that can accompany them anywhere, with service provided both by other wireless services and now by cable companies like Comcast, which in May 2011 announced it was offering a mobile hot spot with national service using bandwidth leased from Clearwire, which also markets spectrum to Sprint (Gorman 2011).

Already emerging are what might be called "area Wi-Fi" options, in which whole neighborhoods and even towns make Wi-Fi available. In September 2010, the FCC voted to free up specific spectrum for "unlicensed use," including what is often referred to as "super Wi-Fi," which can potentially connect computers and cell phones several miles away, even when they are behind brick walls (FCC 2010d).

Even before the new super Wi-Fi options are realized, a few communities have made Wi-Fi available in larger areas; a business improvement district covering a significant part of Brooklyn, where 100 digital and technology companies are located, made Wi-Fi accessible everywhere in that neighborhood in June 2010 to accommodate, in the words of one of its implementers, "a non-traditional workforce" and to allow "their work to literally spill out into the streets" (Reed 2011).

More ambitiously, a company called Towerstream is launching a system of 1,000 wireless routers to blanket

seven square miles of Manhattan with Wi-Fi access, then take a similar system to nine other cities, including San Francisco and Chicago. The initial free test of the system in Manhattan provided 250,000 wireless connections carrying more than a terabyte (1,000 gigabytes) of data daily, all without any publicity. The overall goal is to sell the capacity to wireless carriers to allow them to offload traffic seamlessly without customers even noticing, but Towerstream has already created a partnership with the global Wi-Fi hotspot company, Boingo, to provide direct Wi-Fi access to consumers throughout its Manhattan zones and other areas where it established area Wi-Fi service, supplying an alternative to carrier data plans for people living in those areas (Burrows 2011; G.F. 2011; Luna 2011).

Even if they do not serve as a complete replacement for carrier data plans, these multiple Wi-Fi alternatives likely will provide a strong downward pressure on the price that providers can charge customers for data access.

Smartphones have disaggregated wireless into multiple, competitive services segments

Wireless carriers now face competition from major corporate players in nearly every service they provide (See **Figure P**). By allowing users to access a wide range of apps and tap Wi-Fi sources to connect to the Internet to execute those apps, smartphones have essentially disaggregated wireless into separate services segments that users can access on a largely à la carte basis.

While the wireless carriers will no doubt retain a role in aggregating those services in a more convenient package for users, the new competitive reality means they will face price pressure not just from other wireless carriers but from all the other players providing those individual services.

In their review of the relevant antitrust issues, policymakers should consider that new players are expanding competition through smartphone apps. Conventional measures of competition such as traditional market concentration indexes do not capture the new competitive situation wireless carriers face in every segment of wireless services, from voice calls to texting to video services to data transmission itself as a result of the growing proliferation and use of smartphone apps as substitutes for wireless products.

Purchasers of smartphones can avoid paying for voice minutes by making phone calls using Microsoft's Skype app or Google's Voice app, can drop texting plans in favor of Facebook's Beluga texting app, and can bypass data plans by connecting through Wi-Fi at home using any wired carrier's broadband service, or through other Wi-Fi options away from home. These options have clearly increased competition in the wireless sector, and their rapid growth portends an intensification of that competition.

Potential impact of the AT&T/ T-Mobile merger and conditions that the FCC should impose

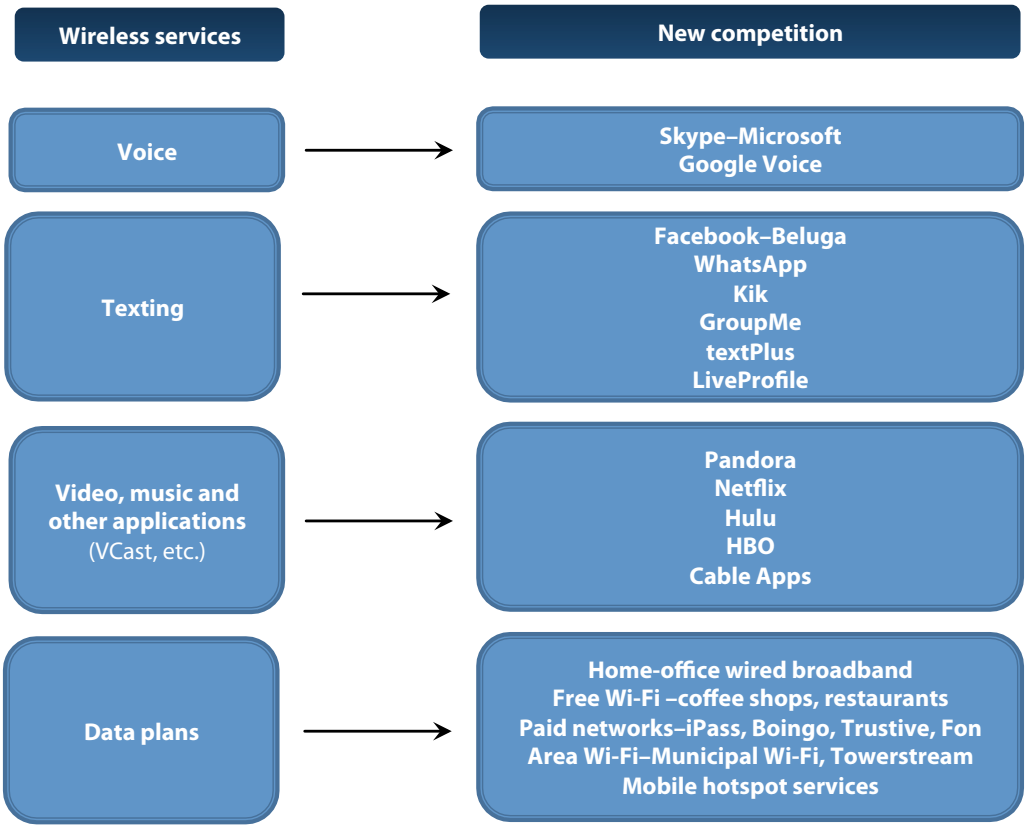
As noted at the beginning of this paper, AT&T has stated that the proposed merger with T-Mobile will bring advanced, next generation wireless broadband to 97 percent of the American populace.

According to the company, under the current market structure, AT&T would deploy its next-generation LTE broadband to just 80 percent of the population. The remaining 20 percent is largely the same population in rural and smaller communities that lacks wireless broadband and even wired broadband today. AT&T argues in its filing for the merger that it "simply lacks the spectrum necessary to deploy LTE" in those areas (AT&T 2011, 55). T-Mobile has stated that it has no plans to deploy full LTE advanced wireless anywhere in its coverage areas (Obermann 2011).

With the spectrum and other assets from T-Mobile, AT&T would be able to spread the costs of rural wireless infrastructure over a larger asset base and use the cost reductions from a more efficient use of spectrum to pay for the $3.9 billion needed to extend LTE to these largely rural counties. With the merger, the company says that it will provide LTE broadband to 55 million more people and offer 1 million more square miles of coverage than under its current projections. The company will in many cases be the only provider of next-generation broadband in the area; in other locales, AT&T's deployment will

FIGURE P

Wireless services versus the new competition



Source: Author's analysis

offer an additional advanced broadband option where consumer choices would otherwise be extremely limited.

If the investments are made, rural communities will benefit from access to telemedicine, distance learning, the energy saving options of smart grid technology, and the economic development possibilities that have flowed only to communities wired to compete in the global information economy. Those communities have waited decades for the elimination of the digital divide between communities in the United States.

According to an Economic Policy Institute estimate, an $8 billion net increase in AT&T's investment would create 55,000 to 96,000 job-years of employment through both direct and indirect jobs (e.g., immediate jobs in the telecom equipment field and indirect jobs in semiconductors) as well as induced jobs stemming from income injected into the economy by those newly hired workers, as shown previously in Table 2. (See Pollack 2011 for more in-depth analysis.) Of course, other aspects of the merger could lead to job impacts not measured here.

Significantly, the jobs created by investments in broadband deployment would likely be good-quality jobs with decent pay. A range of organizations, including labor unions, civil rights advocates, and other groups concerned about job quality have endorsed the merger precisely because AT&T has a track record of creating high-quality jobs.[1]

Whether the merger has a net positive impact depends on whether AT&T's stated plans actually come to fruition, as well as an assessment of what investment levels would be likely to occur without the merger. Given the

lack of plans by T-Mobile for deployment of advanced broadband and the constraints faced by AT&T, it looks likely that the combination would promote the extension of service provision. However, if the FCC opts to approve the merger, it should impose specific conditions to ensure that AT&T delivers on its promises to roll out advanced broadband on a widespread basis and to create the jobs associated with those investments.

In addition to any other conditions imposed to maintain competitiveness in local markets, the FCC should demand that AT&T meet the following stipulations:

Create specific timetables and minimum speeds for LTE broadband deployment with penalties for failure to meet those goals

The commission should require AT&T to convert its commitment of delivering advanced LTE wireless broadband to 97 percent of the population into a concrete set of timelines for deployment, with required benchmarks for moving toward that goal each year until completion. Failure to meet those benchmarks should include sanctions, from monetary fines up to required divestiture of acquired spectrum and other T-Mobile assets, the proceeds of which should be used by the FCC to encourage others to provide advanced broadband access in any areas where AT&T fails to meet its obligations.

There is good precedent for such timetables and deployment standards, including the recent approvals of the CenturyTel/Embarq and CenturyLink/Qwest mergers, as well as the earlier AT&T/BellSouth merger. Similarly, states have successfully required deployment by wired broadband companies seeking statewide franchise agreements in recent years. For example, in Maine, where FairPoint Communications' purchase of Verizon DSL assets was conditional on its extending broadband to 87 percent of its customers within five years, the company is on track to achieving these goals, with 83 percent of its Maine customers having access by the end of 2010, a steep increase from the 68.9 percent who had access in 2008 (Canfield 2011).

Part of the requirements should include minimum LTE speeds for both uploading and downloading data that will be delivered to customers. AT&T has demonstrated extremely fast LTE speeds (Higginbotham 2011), but the FCC should create clear guidelines for minimum speeds to be achieved as part of the required timelines for deployment.

Require better data reporting

To verify that AT&T is meeting its deployment promises and to monitor whether consumers are suffering any adverse price rises due to the merger, the FCC should require better reporting from the company about where it has deployed its LTE network, the actual speeds that customers experience, the prices charged for varying levels of access in each census block, and the revenues generated from customers for those services. In a 2010 report, the Government Accountability Office noted that the FCC does not collect enough data in specific markets on prices and access (U.S. GAO 2010). The National Broadband Plan also argued that the FCC should collect better data on "prices actually paid by subscribers" as well as better capturing "data on coverage, speeds and performance" in different areas (FCC 2010a, 47). Collecting this data to monitor the aftermath of the AT&T/T-Mobile merger would be especially critical.

Establish a time limit for any handset or feature exclusivity from third parties for AT&T phones

In the past, AT&T has used exclusive long-term deals with phone makers, such as the deal it initially had for the iPhone, to put competing carriers at a disadvantage. To avoid this in the future, a condition for the merger should be an agreement by AT&T not to insist that any handset manufacturer or other partner provide a particular operating system, or set of features not available to competitors, exclusively to AT&T for longer than some set time, say one year, which would give handset developers a useful but limited time period to develop an assured marketing channel for the innovation. As the FCC has argued, "studies show handsets playing an increasingly important role for consumers as a basis for choosing providers" (FCC 2010b, 161). Ensuring that consumers can

receive comparable features from different carriers will help maintain competition among carriers.

Require AT&T to keep smartphone apps competing with AT&T services

As this report has highlighted, there is increasingly vibrant competition available to consumers using smartphones to access a range of wireless services. The FCC should require that AT&T maintain that vibrancy and not block any apps that compete with its own products. Software partners like Apple or Google should be required to remove only those apps that might actively harm the functioning of the carrier's network.

Require a low-cost broadband option for low-income consumers

The FCC should compel AT&T to offer a low-cost broadband option for low-income consumers. Beyond physical access, cost remains one of the key barriers to universal adoption, with family income one of the primary variables determining whether people have broadband access (NTIA 2011, 5). The National Broadband Plan recommended that the FCC use access to some spectrum bands as "an inducement to provide a free (or very low-cost), advertising-supported service" (FCC 2010a, 173). The FCC should treat the T-Mobile spectrum that AT&T acquires as part of that vision.

There is already a precedent for this, whereby Comcast was required to provide a low-cost broadband plan as a condition of its merger with NBC. This led to the introduction of a $10 per month broadband plan and a discounted price for computers for any household making less than $20,000 a year. Requiring AT&T to provide some variation on this plan to its customers would guarantee not only physical access to advanced wireless broadband to Americans across the country but also an affordable option for all.

Conclusion

This paper shows the benefits of broadband deployment as well as some of the challenges in achieving near-universal access.

The economic crisis confronting our nation will only be overcome through investments in long-term, growth-generating infrastructure. As detailed in this report, broadband investments would yield direct short-term job gains that are significant, but much greater economic dividends would spring from the energy, health care, education, and business services sectors. By many estimates, the gains from full deployment of telehealth systems and smart grids alone would be measured in potentially multitrillion-dollar savings for the economy over the next two decades. Those savings would in turn free up resources for job creation and other investments desperately needed for our long-term economic health. The deployment of wireless broadband in particular would deliver specific benefits in diverse sectors ranging from enhanced social networking to freeing patients from hospital beds through remote health monitoring to improving business logistics.

Given the looming spectrum crisis, public policy also needs to promote more efficient management of spectrum in the wireless sector while continuing to invest in wired broadband networks that can support the offloading of data traffic to help ease congestion in the wireless broadband sector. We are seeing rapid change in the ecosystem of wireless services with both new challenges and new economic players that need to be addressed by federal regulators.

While the AT&T/T-Mobile merger raises antitrust issues that are beyond the scope of this report, it is important to note that if the FCC enforces a commitment to near universal broadband deployment by AT&T, the proposed merger could result in the first access to real broadband Internet for tens of millions of Americans. For the first time, our nation would have not just a hypothetical goal but an actual commitment and a mechanism to bring access to broadband speeds to nearly every American in our nation. By legally committing AT&T to its broadband deployment proposals, policymakers could both address the spectrum crisis and put AT&T's capital in service of the public good, moving us toward the goal of the universal broadband access.

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with writing numerous articles and reports on the economy, politics, and technology, his 2002 book on Internet public policy and its relationship to economic development, Net Loss: Internet Prophets, Private Profits and the Costs to Community*, was described by the* Harvard Business Review *as a "provocative case for business civic-mindedness" in the context of the information economy.*

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Endnotes

1. In recent U.S. Senate testimony, Communications Workers of America President Larry Cohen noted that AT&T is the only unionized wireless company and that the number of AT&T wireless workers represented by CWA has grown dramatically, from about 9,300 in 2001 to about 43,400 today (Cohen 2011). This praise for AT&T from the labor movement is long-standing; American Rights at Work in 2007 picked AT&T as a model employer in its "Partnerships that Work" list, citing that "AT&T and its unions serve as allies and business partners working to advance the success of the company" (American Rights at Work 2007).

   Similarly, the NAACP and a wide range of civil rights organizations have praised the commitment of AT&T to a diverse workforce and equal opportunity, along with supporting the goal of ending the digital divide in access to broadband. Again, this praise for AT&T as an employer is long-standing; the NAACP in 2008, in its annual corporate diversity report card, ranked AT&T as the top employer in the telecommunications industry and among the top ranks of all employers across the economy (NAACP 2008).

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