The Digital Road to Recovery: A Stimulus Plan to Create Jobs, Boost Productivity and Revitalize America

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Spurring investments in IT infrastructure not only can provide an important short-term boost to the U.S. economy; it also can lay the groundwork for long-term economic growth, international competitiveness, and significant improvement in Americans' quality of life.

Spurring investment in our nation's infrastructure is an effective strategy for getting Americans back to work during an economic downturn, particularly one that is expected to be longer than normal in duration. Although projects to improve the country's traditional physical infrastructure (e.g., roads, bridges, sewer systems) are necessary and important, investments in certain parts of our national information technology (IT) infrastructure—America's digital infrastructure—will have a greater positive impact on jobs, productivity, and innovation. And economic stimulus measures that go to consumption, as opposed to investment, will have a less beneficial impact on productivity and innovation than infrastructure investments.

In this report, the Information Technology and Innovation Foundation (ITIF) identifies and analyzes the employment impact of investments in three IT infrastructure projects that (1) contribute to significant immediate direct and indirect job growth in our economy; (2) create a "network effect" throughout the economy that, in some cases, doubles the number of directly created jobs; and (3) provide a foundation for longer term benefits, including government cost savings, economy-wide productivity, and improved quality of life for Americans. The three IT infrastructure projects are broadband networks, health IT, and the smart power grid.

ITIF's major findings are as follows:

1. Investments in America's digital infrastructure will spur significant job creation in the short run.

ITIF estimates that spurring an additional investment of $30 billion in America's IT network infrastructure in 2009 will create approximately 949,000 U.S. jobs (see Table 1).[1] We also estimate that approximately 525,000 of these jobs will be in small businesses (defined as firms having fewer than 500 employees).

- **Broadband networks:** A stimulus package that spurs or supports $10 billion of investment in 1 year in broadband networks will support an estimated 498,000 new or retained U.S. jobs for a year.

- **Health IT:** An additional $10 billion investment in health IT in 1 year would create as many as 212,000 new or retained U.S. jobs for a year.
- **Smart power grid:** A $50 billion additional investment in the smart grid over 5 years (e.g., $10 billion per year) would create approximately 239,000 new or retained U.S. jobs for each of the 5 years on average.

TABLE 1: ESTIMATES OF U.S. JOBS CREATED OR RETAINED BY INVESTMENTS IN NETWORK INFRASTRUCTURES

	Investment	Total Jobs	Jobs in Small Businesses
Broadband	$10 billion	498,000	262,050
Health IT	$10 billion	212,000	121,675
Smart Grid	$10 billion	239,000	140,500
Total	**$30 billion**	**949,000**	**524,225**

Investments in IT infrastructure should not be minimized out of concern that the projects will take too long to begin to have an immediate impact on the U.S. economy. If the stimulus measures are designed properly, they can quickly spur a large number of investments—from deploying more and faster broadband networks to switching to electronic health records (EHRs) to rolling out advanced energy metering technologies (smart meters)—that are "shovel ready."

2. Investments in America's digital infrastructure that create a network effect (or network externality) will offer superior job creation benefits because of the "network multiplier."

Infrastructure investments—of both the digital and physical variety—will create direct jobs, indirect jobs, and induced jobs. Consider an investment in broadband networks or highway infrastructure. Direct jobs are those created specifically by new spending (e.g., the technicians or road workers hired to lay broadband "pipes" or asphalt). Indirect jobs are those created to supply the materials and other inputs to production (e.g., circuit boards that go into routers). Induced jobs are those created by newly employed (or retained) workers spending their paychecks, thus creating jobs in establishments such as restaurants and retail stores.

In economics, a multiplier is a number that expresses the extent to which a change in a given economic activity generates additional effects through interdependencies associated with some linkage system. Thus, when calculating employment growth generated by a given level of investment, employment multipliers are used to estimate the number of direct, indirect, and induced jobs created.

Investing in IT infrastructure offers superior job creation benefits because it creates what economists call a "network effect."[2] This network effect leads to an additional employment growth multiplier, herein referred to as the "network multiplier," which arises from the new consumer and business behaviors, functionalities, and downstream industries enabled by the IT infrastructure. The network effect employment multiplier refers to the new jobs that will be created through the new applications and services—many manifested in entirely new industries and/or firms—that digital infrastructure makes possible. This possibility arises because digital infrastructure acts as a platform that serves as the foundation for a multitude of innovative products and services.[3]

Investments in networks that are at an early stage of development—including broadband, health IT, and the smart grid—will create even more jobs as a result of the network effect. Building out an IT-based network like broadband, health IT, or the smart power grid leads to new jobs generated by upstream investment in industries that create new and innovative applications and services to take advantage of the more robust IT network. For example, building something like the smart power grid will spur a host of innovative new products and services from hybrid plug-in electric vehicles to smart appliances to more investment in renewable energy. Public expenditures (either through grants or tax incentives) to support building out a network that already exists and is using relatively mature technology, on the other hand, will not yield comparable network effects. Building or improving highways—while certainly a necessary investment to maintain and improve the nation's physical infrastructure—will not likely spur innovations in the auto industry or purchases of better tires for cars, for example. Thus these investments are less likely to create additional jobs through network effects.[4]

No widely applied econometric technique is currently used to capture the effects of IT infrastructure investments in broadband networks, health IT, and the smart grid. This situation may put these IT infrastructure projects at a disadvantage in comparison with more traditional infrastructure projects that economists and policymakers are more familiar with. For that reason, as described below, ITIF has developed estimates of the network effects of IT-based infrastructure investments.

In fact, the future growth of the U.S. economy depends on having a robust IT infrastructure.

3. Investments in America's digital infrastructure will lead to higher productivity, increased competitiveness, and improved quality of life in the moderate to long term.

IT-based infrastructure projects, in addition to providing an opportunity for creating jobs today, have the potential to spur long-term economic growth.[5] As ITIF has shown in previous reports, IT is central to economic growth. Between 1995 and 2002, for example, IT was responsible for two-thirds of total factor growth in productivity and virtually all of the growth in labor productivity in the United States.[6] During the period 2000 to 2005, IT continued to perform, contributing over 1 percentage point to growth in labor productivity.[7] And not only do IT infrastructure projects create more jobs than traditional infrastructure investments, in part because of the network multiplier, they also create more high-skilled, high-paying jobs. In fact, IT jobs on average pay 84 percent more than average jobs.[8]

Spurring investments in digital infrastructures will also create a market for the components and technical services of domestic firms. Investing in these infrastructures now will help ensure that domestic firms have the knowledge, skills, and abilities needed to become chief exporters of this technology (e.g., health IT services and devices, telecommunications equipment, and smart grid components and services) as other countries expand their own digital infrastructure initiatives. Thus an investment in digital infrastructures not only will spur short-term job growth but will enhance America's long-term competitiveness and lead to the expansion of higher value-added U.S. jobs.

Finally, the network effect of these IT infrastructure projects, beyond leading to additional job creation throughout the economy, is also indicative of the positive personal and societal benefits generated by such investments. Spurring the investment of $10 billion in health IT, for example, not only will create 212,000 new U.S. jobs but will also lead to better quality care and fewer medical errors for patients and lower costs for health care payers (including the federal government). And the network effects will go even further as advances in health IT enable new technologies, like rapid-learning health networks, that will enable researchers to spot dangerous side-effects from drugs or other treatments, as well as to identify effective treatments more rapidly.[9] Likewise, scholarly evidence has shown that increased broadband infrastructure will spur improvements in educational outcomes, reduce the relative growth of vehicles miles traveled, and have a wide range of other societal benefits.[10] And investments in the smart power grid will produce significant energy savings and lead to a less carbon-intensive economy.

The Case for a Strong Federal Role in Spurring IT Infrastructure Investments

Some people may question why spurring IT infrastructure investments should be a significant part of the U.S. national economic stimulus package, particularly given that such investments have never been considered in previous stimulus proposals. The reason is this: in 1993, when incoming President Bill Clinton proposed a stimulus package, the United States did not yet have a digital economy. Now we do, and the expansion of the digital economy is central to societal progress going forward. In fact, the future growth of the U.S. economy depends on having a robust IT infrastructure. Addressing many social challenges—from creating more high-paying jobs to controlling the rising cost of health care to achieving energy independence, requires a strong IT infrastructure—such as a national health information network or a smart power grid.

Some individuals may oppose the idea of spurring investment in IT network infrastructure out of a desire to save U.S. taxpayers' money. If a multibillion dollar stimulus program is necessary to give a boost to the U.S. economy, though, the question is not "Should money be spent?" but rather "Where should the money be spent?" Ignoring IT infrastructure investments will do nothing to save U.S. taxpayers' money; instead, it will simply shift the proportion of the economic stimulus money that goes to other areas, some of which, including personal consumption, do not offer many added benefits such as longer-term economic growth or innovation.

An immediate short-term stimulus can drive networks for broadband, health IT, and the smart grid to the tipping point, after which investment can be almost exclusively provided by the private sector.

Others may ask, "Why not let the states or the private sector be solely responsible for IT infrastructure investments?" Building the U.S. interstate highway system required the federal government's involvement, and the IT infrastructure projects discussed here—broadband networks, health IT, and the smart power grid—are national networks that states cannot support on their own without federal support. Indeed, we have already seen the failure of states to effectively spur national networks in health care: the Bush-era proposal of using a bottom-up strategy to interlink regional health information organizations (RHIOs) has failed to produce sustainable progress towards a national health information network. Likewise, while state efforts to promote broadband have helped, states lack the resources in the form of grants and tax incentives to get the job done on the scale required.

The federal government cannot rely on the private sector acting alone to develop broadband networks, health IT, and the smart power grid without incentives for these IT infrastructure investments. The private sector will tend to underinvest in these networks because it is unable to capture all of the benefits (externalities) of its investments and because of other well-documented market failures. In the case of health IT, for example, doctors and hospitals incur much of the cost, but patients and insurers get much of the benefit.[11] In broadband, significant network externalities exist that consumers of broadband by definition do not receive.[12] Moreover, building out some parts of the broadband network, particularly to high-cost areas, is not economical absent some incentives. And the same is true with the smart grid, where savings from energy efficiency and reduced pollution benefit everyone, not just certain customers. The United States should take a page from other nations like Japan, South Korea, and Sweden, which have successfully used incentives, including tax incentives, to spur the private sector to invest more in digital infrastructures.

Only the federal government is in a position to achieve the scale of investment needed for these projects to be a true economic multiplier for the United States. This is not to say that federal investment is needed on a continuous basis. Far from it. Nevertheless, we believe that an immediate short-term stimulus can drive networks for broadband, health IT, and the smart grid to the tipping point, after which investment can be almost exclusively provided by the private sector without strong incentives.

Method of the Study

To measure the impact of additional investment in the areas of broadband networks, health IT, and the smart power grid on direct jobs, indirect jobs, and induced jobs, ITIF used standard economics methodology. We determined the specific impact of such investments on direct, indirect, and induced employment by measuring the total increase in direct spending within various industries created by a stimulus proposal. We determined the number of direct jobs created in each industry using industry-specific data on employee compensation provided by the Bureau of Labor Statistics in the U.S. Department of Labor. We then calculated the number of indirect and induced jobs created using industry-level employment multipliers from the Bureau of Economic Analysis in the U.S. Department of Commerce. Finally, we applied a network effect multiplier to estimate additional job growth based on the expected immediate network effect.[13]

In addition, ITIF estimated the number of jobs that will be created in small businesses (defined here as firms with fewer than 500 employees) by these IT-based infrastructure investments. For direct jobs, we based our

TABLE 2: BROADBAND NETWORKS: U.S. JOBS CREATED OR RETAINED FOR 1 YEAR BY A $10 BILLION BROADBAND STIMULUS PACKAGE

Job Type	Total Jobs	Small Business Jobs
Direct Telecommunications Jobs	49,820	24,910
Direct Capital Equipment Jobs	13,840	7,280
Indirect and Induced Jobs	165,815	93,200
Network Effect	268,480	136,660
Total Jobs	**497,955**	**262,050**

estimates on the industry ratio of industry workforce in small businesses to total industry workforce.[14] To calculate the share of indirect jobs attributable to small businesses, we analyzed the largest intermediate input industries to the industries in question and assessed the percentage of the workforce in those industries found in small businesses. Finally, we estimated the number of induced jobs and jobs created from the network effect to be in proportion to the overall share of small business jobs in the economy—50.9 percent.[15]

BROADBAND NETWORK STIMULUS PACKAGE

We estimate that a broadband network stimulus package that spurs or supports $10 billion of investment in 1 year in broadband networks will support approximately 498,000 new or retained U.S. jobs for a year (see Table 2).

High-speed broadband Internet access is increasingly viewed as essential infrastructure for our global information economy.[16] Indeed, IT, of which broadband Internet is a central component, added a full 1.18 percent to gross domestic product (GDP) growth and accounted for two-thirds of the growth in total factor productivity during the second half of the 1990s—at a time when IT assets accounted for less than 5 percent of the nation's capital stock.[17] Going forward, broadband-enabled Internet business solutions are expected to add a total of 0.43 percentage points to U.S. productivity growth through 2011.[18] Broadband is therefore an essential contributor to long-term economic, productivity, and wage growth in the United States.

Broadband access is also critical to economic and employment growth in communities and regions throughout the country.[19] One study found, for example, that over a 4-year period from 1998 to 2002, employment in communities with broadband grew 1 percentage point more than in communities without it.[20] This means that a community with 50,000 jobs with broadband would have added 500 more jobs over 4 years than a similar community without broadband. Broadband is also an excellent source of high-skilled, high-paying jobs; in fact, jobs involved in the building and expansion of broadband networks pay well above—42 percent higher, in fact—than the average for manufacturing jobs.[21]

Despite the importance of broadband, other developed countries have outpaced the United States, the Internet's birthplace, in broadband penetration. At the end of 2007, the United States fell to 12th on a per-household basis in Organization for Economic Co-operation and Development (OECD) rankings of nations in terms of broadband penetration,[22] with a U.S. broadband penetration rate of about 56 percent.[23] The United States also ranked just 15th among OECD nations in terms of average broadband speed.[24]

The United States similarly appears to rank relatively low among OECD countries in terms of broadband coverage, although data are less available. Some observers will point to our more rural geography as the cause. Although our geography does play some role, other nations with relatively large rural populations have made dramatic progress in achieving universal broadband coverage. One example is Sweden, where just 1.6 percent of people in 2007 lived in homes without access to wired broadband—a percentage that is probably four to five times lower than the percentage of people without access to wired broadband in the United States. The central reason for Sweden's superior performance in broadband coverage is that the Swedish government has allocated $820 million to stimulate the broadband infrastructure rollout, including $250 million in grants to communities to build local broadband networks, both in the towns and in the surrounding countryside, and another $250 million in tax incentives, amount-ing to 50 percent of the cost to build the network. For the United States to match that on a per-GDP basis, it would have to allocate more than $30 billion in grants and/or tax incentives.

In 2009, without the additional investment in broadband infrastructure that can be spurred through fiscal stimulus (whether in the form of tax incentives, grants, or other means), private-sector broadband infrastructure investment in the United States is likely to fall from 2008 levels. As UBS Warburg notes, capital expenditures by telecom and cable firms in the United States are expected to decline by 10 percent, if not more, in 2009 (in the absence of a federally driven effort to stimulate broadband investment).[25]

For these reasons, ITIF proposes a three-tiered set of investments focused on addressing the three primary broadband policy goals: (1) getting broadband to unserved areas; (2) expanding network speeds in areas currently served by first-generation broadband (3 Mbps or less); and (3) spurring increased adoption of broadband by households.

Broadband access is critical to economic and employment growth in communities and regions throughout the country.

Policies that could be used to spur the deployment of broadband to unserved areas that currently do not have access to wired or terrestrial wireless broadband include extending tax credits of between 30 to 60 percent, depending on the population density of the area for investments in broadband faster than 3Mbps. Of the estimated 10 million dwelling units and businesses without broadband access in the United States, we estimate that 90 percent could be served at an overall cost of about $8.2 billion if tax incentives of $3.6 billion were extended to telecom and cable companies. In addition, up to $5 billion in grants should be provided for areas with even higher costs to serve, as well as to support federal funding to map broadband speeds throughout the country.

To spur higher speeds on the existing network, ITIF proposes incremental tax credits of 20 percent for investments in networks supporting speeds of at least 20 Mbps and 40 percent for investments supporting speeds of at least 50 Mbps. In order to ensure that these incentives actually spur additional investment, the credits should apply only to capital expenditures that exceed 85 percent of 2008 capital expenditures for companies. These would be supplemented by strategic grants to upgrade networks for schools, libraries, hospitals, and government buildings.

Finally, to help spur increased adoption of broadband in U.S. households, ITIF proposes allowing expenses related to computer purchases and monthly broadband service to qualify for Lifeline and Linkup programs.[26]

Broadband Stimulus: Impact on Employment

To assess the employment impacts of the incentives just described, ITIF estimates the number of jobs created by a broadband stimulus package that spurs $10 billion in investment. Obviously, any package that spurred more investment would result in the creation of additional jobs.

ITIF estimates that a stimulus package that spurs $10 billion worth of investment in broadband network infrastructure will lead to the creation or retention of almost 500,000 jobs. The additional $10 billion broadband investment would represent about one-third of the estimated $30 billion spent specifically on broadband by private operators in 2008.[27] This investment would create about 64,000 direct jobs in the telecommunications and related computer and electronic equipment industries, and an additional 166,000 indirect and induced jobs—many in the year the investment occurs. Broadband's network multiplier effect slightly more than doubles the number of 229,500 direct, indirect, and induced jobs created, generating an additional 268,500 jobs in upstream industries throughout the economy.

Direct jobs are created in the telecommunications industry as additional frontline technicians are hired to install broadband networks and a host of employees are hired or retained to fill back-office functions, from managers to customer service representatives. Approximately 50 percent of the cost of deploying fiber optic broadband is in the labor component.[28] The labor cost to deploy digital subscriber line (DSL) or cable modem broadband service tends to be less than deploying fiber to the home (FTTH) because DSL and cable modem entails more retrofitting of existing lines with capital equipment. Stephen Pociask, president of TeleNomic Research, has estimated, for example, that "telephone plant requirements [for broadband installation] consist of 28 percent capitalized labor."[29] Assuming 75 percent of broadband investment goes to fiber and 25 percent goes to phone-based DSL service or cable-based broadband, then a $10 billion investment in broadband would create about 50,000 direct jobs in the telecommunications and cable industries.[30]

With roughly 45 percent of the cost of broadband deployment in labor (given the mix of cable-, fiber optic-, and phone-based broadband deployment presented here), the balance of the cost—55 percent—is in capital equipment: that is, the actual fiber optic cable, routers, servers, switches, and related computer equipment. Jobs are created in the industries that manufacture these products as demand increases for the telecommunications, electronic, and computer equipment ("capital equipment") needed to deploy broadband. In the computer electronics industry, 34 percent of the cost to the industry is in workforce compensation.

Thus, a $10 billion investment in broadband would create 20,650 direct jobs in the computer and electronics industries supporting the telecommunications industry. Because about one-third of manufacturing jobs created through the increased demand for telecommunications and computer equipment would leak out of the U.S. economy because of imports of computer products, we decrease that figure by 33.3 percent to arrive at about 13,850 manufacturing jobs created in the United States.

The 64,000 direct jobs created by the additional $10 billion broadband investment support additional jobs throughout the U.S. economy in the form of indirect effects (also called supplier effects) and induced effects. In his 2003 paper "Updated Employment Multipliers for the U.S. Economy," Josh Bivens finds that jobs in the communications sector have an employment multiplier of 2.52.[31] This means that the 50,000 service jobs created by a $10 billion broadband stimulus package create an additional 125,500 jobs. Manufacturing jobs have a slightly higher multiplier, 2.91. Therefore, the 13,800 communications/computer equipment manufacturing jobs created support an additional 40,000 indirect and induced jobs. Together, the 64,000 direct jobs support 166,000 more jobs throughout the U.S. economy.

Over half of the jobs generated from a $10 billion broadband investment will be created within small firms with less than 500 employees. We expect that 262,000 of the 498,000, or 52.6 percent, of jobs stemming from a $10 billion investment in broadband will be created by small to medium-sized businesses. These jobs will be created through all channels of employment growth, with roughly 32,000 direct jobs created, 58,000 indirect jobs created from the initial investment, 35,000 induced jobs created through respending effects, and 136,600 small business jobs created through the network effect.

According to the U.S. Census Bureau, 67.5 percent of jobs in the telecommunications industry are in firms with fewer than 500 employees.[32] Because much of the investment to deploy faster broadband networks or bring service to unserved areas will be made by large cable and telecom firms like Verizon, Comcast, AT&T, and Qwest, however, we conservatively estimate that only half of the direct telecommunications jobs created will go to small firms. These can be small incumbent telecom or cable providers or third-party outside plant subcontractors that telecom and cable firms commonly subcontract to for the physical installation of broadband. Many third-party outside plant subcontractors are small to medium-sized enterprises that specialize in installing physical infrastructure, such as the road and curbside work needed to install fiber conduits and cables.

Broadband Stimulus: Network Effect

The increased deployment of broadband infrastructure creates a network effect multiplier. The reason is that broadband itself increases business productivity, spurs upstream investment (e.g., of higher speed computer equipment), and contributes to the creation of new industries. We expect a network effect multiplier of 1.17 to more than double the number of direct and indirect jobs created, adding over a slightly longer term 268,500 more jobs.

Broadband encourages upstream investment in industries creating new and innovative applications and services such as telemedicine, Internet search, e-commerce, online education (distance learning), and social networking. In fact, high-speed broadband Internet, a network still far from maturity and adopted by less than 60 percent of America's households,[33] spurs new consumer behaviors and creates new functionalities and business opportunities. As an example, broadband has been found to spur the adoption of new and more powerful computers: there is a moderately strong correlation between computer speeds and broadband penetration rates (0.41), indicating that as states increase access to high-speed internet connections consumers are more inclined to upgrade their personal computers and other internet-based devices.[34] Broadband also spurs consumer purchases of additional peripheral computer equipment—from web cameras to gaming consoles to computer speakers.

More importantly, broadband creates jobs by enabling the emergence of new businesses or other organizations developing a wealth of innovative new services, including electronic commerce, telemedicine, VoIP (Voice over Internet Protocol), video on demand, smart homes, telework, and access to electronic government. The network effect as it pertains to broadband is not simply about the value of the network increasing as more people join the network; it is also that by providing an architecture for the seamless and instantaneous creation, distribution, and consumption of information, it enables forms of commerce on a national and global scale previously impossible, transforming whole industries from retailing, to financial services, to manufacturing.

Broadband makes possible new business models that leverage the aggregation of both supply and demand, with the ensuing scale driving prices down and expanding consumer choice. Thus, for example, eBay aggregates both supply and demand to create an electronic auction marketplace for consumer goods, creating "prosumers" by turning consumers into producers. Similarly, Zipcar makes fractional ownership possible by aggregating demand for short-term rental of vehicles in one venue, providing a viable alternative to and decreasing the need for auto ownership in congested cities. Other business models exemplifying the network effect and made possible by high-speed broadband connections include the mass customization of products through the Internet, such as Dell's build-to-order PCs or personalized Mini Coopers, and the marketing of excess capacity through Priceline.com or Hotels.com. In fact, the latter are variants of Web-enabled just-in-time manufacturing practices that have revolutionized global supply chains in industries from aircraft and automobile manufacturing, to wholesale and retail trade, to logistics.

It is this ability of high-speed broadband to create the conditions, the fertile soil, that generates entirely new upstream industries that is perhaps the most important component of the network effect. The resulting deployment of innovative services, applications, and content enhances communications, entertainment, health care, education, job search, and professional skills development, delivering substantial consumer benefits, increasing business productivity, and spurring economic growth.[35] And, as we discuss below, a number of studies have found significant employment gains from broadband investments. In fact, the number of jobs created by the upstream network effect can be as great or even greater than the number of direct and indirect jobs created from the initial investment.

The ability of high-speed broadband to create the conditions, the fertile soil, that generates entirely new upstream industries is the most important component of the network effect.

Research from both the Brookings Institution and Criterion Economics confirms the presence of the network effect multiplier for broadband. Brookings found that for every 1 percentage point increase achieved in broadband penetration, employment rises from 0.2 to 0.3 percent, or about 293,000 jobs nationally for an economy at less than full employment.[36] As the authors write, "The effect of broadband is most significant in explaining employment growth in education, health care, and financial services."[37]

Robert Crandall, Charles Jackson, and Hal Singer, in a study by Criterion Economics, affirmed the same effect, writing: "The increased capital spending in upstream industries [spurred as broadband subscriptions grow] could result in an increase of up to 665,000 jobs. When added to the 546,000 jobs created by capital spending by broadband providers, more than 1.2 million jobs may be created."[38] Their research showed that the increased capital spending empowered by broadband in industries ranging from education services to health services, to tourism, entertainment, and manufacturing industries could generate 1.17 jobs for every single direct job created by capital spending by broadband service providers.[39]

And although network effects do decline with the buildout of networks and maturing technology over time, there is still considerable opportunity for network effects stemming from broadband investments because more than 40 percent of Americans still do not have broadband Internet, and even a great number of Americans who do access the Internet via broadband do so at much slower network speeds that citizens in nations such as Japan, South Korea, and Sweden.

The impact on economic and employment growth from broadband is real and substantial. Communities and citizens that lack high-speed broadband Internet access are at a deficit in comparison to their peers; likewise, the lagging rate of national broadband penetration in the United States places us at a deficit in comparison to peer countries. The federal government is justified in supporting efforts to build up America's digital infrastructure, much as it did in past centuries with rail, highway, and telephone infrastructure. Supporting efforts to build up America's digital infrastructure will deliver considerable employment gains through some 230,000 jobs created in the short-term, more than double that, 268,000 over a slightly longer term, and at least 498,000 jobs overall. It will also deliver lasting improvements to business productivity and enduring consumer benefits that raise the quality of life by enabling telecommuting, telemedicine, entertainment, access to e-government, and a wealth of other online services.

HEALTH IT STIMULUS PACKAGE

Investment in health IT, particularly in interoperable electronic health records (EHRs), in the United States is necessary to improve quality of care and help stem the rising cost of health care. We estimate that an additional $10 billion investment in health IT for 1 year would create as many as 212,000 new U.S. jobs for a year (see Table 3).

IT promises to be a major part of our nation's health care system, with technologies such as e-prescribing and computer order entry improving patient safety and saving thousands of lives every year. Modernizing our health care system also depends on harnessing the vast quantities of data locked up in paper medical records. Tools such as rapid-learning networks will enable researchers to spot dangerous side-effects from drugs or other treatments, as well as to identify effective treatments more rapidly.

Unfortunately, progress in the effort to spur the deployment and use of health IT in the United States to date has been slow. In 2004, President Bush called for the rapid deployment of a nationwide interoperable health information technology network, including EHRs for all Americans, within 10 years. The U.S. Department of Health and Human Services was tasked with leading the effort and has supported a strategy of building the national health information network from the bottom-up through regional health information organizations (RHIOs). Although more than 100 RHIOs have been established across the country, most are financially unsustainable. Moreover, the RHIO strategy has not led to a nationwide interoperable system, and this bottom-up strategy does not appear to be succeeding.

The U.S. failure in health IT to date is not one of technology or a lack of technical maturity. Other countries

TABLE 3: HEALTH IT: U.S. JOBS CREATED OR RETAINED FOR 1 YEAR BY A $10 BILLION HEALTH IT STIMULUS PACKAGE

	Total Jobs	Small Business Jobs
Direct Jobs	43,410	31,790
Indirect and Induced Jobs	115,670	62,895
Network Effect	53,025	26,990
Total Jobs	**212,105**	**121,675**

have pursued health IT strategies with much higher levels of success. While the United States continues to show EHR adoption levels among primary providers of only 10-30 percent (depending on how an EHR is defined), more than 75 percent of primary care doctors use EHRs in countries such as the Netherlands, New Zealand, the United Kingdom, and Australia.[40]

The United States continues to lag in health IT for at least two reasons. First, governments in the United States have not committed the same level of resources to health IT as governments of other nations have. Although various U.S. government programs have sponsored health IT initiatives, none have approached the level of spending as the United Kingdom's £12.4 billion Connecting for Health program.

Investment in health IT, particularly in interoperable electronic health records (EHRs), in the United States is necessary to improve quality of care and help stem the rising cost of health care.

Second, the costs and benefits of investing in health IT are less closely aligned in the United States than they are in nations with single-payer health care systems. In the United States, medical providers often must pay for most of the costs of deploying EHRs, but patients and insurers receive most of the benefits. Thus, for most health care providers, cost continues to be a limiting factor to adopt EHRs, and without a convincing value proposition or government mandate, many medical providers will continue to delay investments in health IT. As a result, the United States will not transition quickly to EHRs without government encouragement.

The complete transition to EHRs for all inpatient and ambulatory care providers is estimated to cost, on average, $7.6 billion annually over 15 years.[41] Current spending on IT (not exclusively on EHRs) by health care providers and payers is expected to exceed $30 billion in 2008. Spending in this area is projected to grow at approximately 4.5 percent annually over the next 5 years. Tightening credit markets and the downturn in the U.S. economy means that these projections are likely to be lower than expected, and capital expenditures on health IT could even decline in 2009, absent government support through a stimulus measure.[42]

A substantial investment in health IT in the United States, in addition to spurring more rapid deployment of EHRs, would create new high-tech jobs. The structure of the proposed investment in health IT could take various forms including entitlement spending (e.g., Medicare and Medicaid reimbursement rates), tax credits, loans, grants, and direct spending. ITIF has proposed a tax credit of 40 percent of the costs of investments made by doctors in "fully functional" EHR systems.[43] In addition, we have proposed a tax credit of 25 percent of the costs of other qualified health IT investments, including e-prescribing systems, telemedicine equipment, and other basic EHR systems. Also, a program of entitlement spending, direct grants, and low-interest loans to nonprofit hospitals, community health centers, rural health clinics, and other public health facilities can similarly help spur health IT adoption in 2009. All of these investments are important building blocks for constructing a robust national health information network.

Any additional government stimulus would come on top of the current projected investment of over $30 billion on health IT in 2009. However, the previously estimated levels of investment are likely to be less than projected in the face of the current U.S. economic downturn. For the employment projections described in this report, there is no additional increase in jobs in subsequent years if the additional investment remains constant.[44]

Health IT Stimulus: Impact on Employment

A $10 billion per year investment in health IT would generate approximately 212,000 new or retained jobs for 1 year. Of these 212,000 new jobs, approximately 121,700, or 57.4 percent, will likely be in small businesses. Approximately 43,400 of these jobs would come from direct spending by hospitals and health care providers on health IT systems. These jobs will come in high-paying industries such as computer hardware manufacturing (5,800), software (10,600), and IT services (27,000).

Another 36,000 indirect jobs would be created from spending on intermediate inputs involved in producing hardware, software and IT services. Respending by the additional workers employed by these direct and indirect jobs would create another 79,000 jobs. We derived the employment multiplier used in our calculations based on the proportion of job growth from health IT expenditures that is allocated to different industries.[45] The direct employment projection includes a leakage factor of 33.3 percent to account for any spending on imports of manufactured goods.[46]

Health IT Stimulus: Network Effect

Any investment in health IT in the United States will likely spur additional job growth in related industries (i.e., the network effect) because health IT will spur the development of new products and services. The net impact of these network effects cannot be precisely quantified; however, a conservative estimate would be to expect at least an additional 33 percent employment gain, or approximately 53,000 jobs.

Indeed, the potential network effect of health IT comes from the almost limitless possibilities of using digital health information to advance medical research, drug discovery and evaluation, and even personal health. Thus, for example, advancements in health IT will likely serve as a catalyst for the use of Web 2.0 technologies for health care including health information portals, personal health records, and health-related social networking. Websites such as WebMD and Revolution Health may develop new services for consumers that provide personalized medical information based on a patient's health data.

Further investment in health IT may also be expected to spur telehealth applications that will increase the demand for home medical devices, broadband, and related services. Thus, for example, more consumers may purchase Web cameras to have Internet-based video consultations with their health care providers. In addition, the expansion of health IT systems in hospitals, outpatient settings and pharmacies will likely lead to further innovation and use of radio-frequency identification (RFID), smart cards and sensors in the health care environment, as well as higher productivity and lower costs for health care payers (including the federal government).

Clearly, a major investment in health IT in the United States will generate both sizeable employment gains and advances in health IT adoption and the related benefits.

SMART GRID STIMULUS PACKAGE

Although today's power grid has greatly expanded from its origins in Edison's New Jersey lab in the late 19th century, many of its components would be familiar to the Wizard of Menlo Park were he alive today. Although electrical power has been harnessed for uses inconceivable a century ago, and the United States consumes over 4 billion megawatt-hours (MWh) of electricity annually, the networks that distribute this power have not kept pace.[47] Indeed, although the power grid is the cornerstone of modern life, from industrial manufacturing to the IT revolution to everyday conveniences, relatively few upgrades have occurred in our transmission and distribution infrastructure.

With growing concern about energy efficiency, carbon emissions, and energy independence, modernizing our national power grid infrastructure represents an important investment opportunity for our nation's future. We project that a $50 billion additional investment in the smart grid over 5 years (e.g., $10 billion per year) would create approximately 239,000 new U.S. jobs for each of the 5 years on average (see Table 4). We project that if this investment were doubled to $100 billion over 5 years, 477,000 U.S. jobs would be created or retained for each of the 5 years on average.

TABLE 4: SMART POWER GRID: U.S. JOBS CREATED OR RETAINED UNDER VARIOUS OPTIONS

Job Type	$50B over 5 years	$100B over 5 years	Federal Mandate
Direct and Indirect Jobs	58,645	117,290	22,725
Induced Jobs	120,415	240,830	45,630
Network Effect	59,685	119,370	22,785
Small Business Jobs	*140,475*	*280,950*	*23,385*
Total Jobs Over 5 Years	**238,745**	**477,490**	**91,140**

We also evaluate a third option, a federal mandate to states to order utilities to implement smart metering and construct a smart grid, and to direct state regulators to allow utilities to receive cost recovery for their investment. This option would create approximately 91,000 new jobs (see Table 4). A federal mandate would require passing new legislation and would take some time to implement. Given the need for immediate action to stimulate the economy, ITIF does not recommend this third option as part of any economic stimulus package. Instead, ITIF recommends that the option of a federal mandate be evaluated later as the Obama administration considers additional legislation for energy independence and the green economy.

The central idea behind modernizing the power grid's infrastructure is to use two-way communication, sensors, and advanced IT to create an intelligent and connected power grid—that is, the "smart grid." The smart grid is intended to be a revolutionary network, much like the Internet, that will deliver power more efficiently and more reliably than our existing grid. With the smart grid, utilities can utilize real-time data from sensors and advanced meters throughout the power grid to better understand specific supply and demand requirements, spot failed or failing equipment, and better manage their resources. The smart grid will enable a host of societal benefits including lowering peak demand and the associated costs, enabling the greater use of clean energy, and providing electricity more reliably. Moreover, the smart grid will enable the use of new technologies including plug-in hybrid electric vehicles, distributed generation, and energy storage solutions.

Historically, peak demand for power in the United States has grown faster than overall demand—a challenge for electric utilities. To satisfy peak demand, utilities must bring online additional generators, or peaker power plants, which are generally more expensive to operate and produce more pollution. Reducing peak demand can generate substantial savings: for example, reducing peak demand by 5 percent would save $31 billion over 20 years.[48] The smart grid enables a variety of demand response options for consumers targeted specifically at this problem.

In the short term, one step the United States could take to develop the smart grid would be to deploy an advanced energy-metering infrastructure—i.e., "smart meters"—to U.S. residences and businesses. Smart meters encourage energy efficiency by allowing consumers to determine their energy usage based on dynamic price signals that fluctuate throughout the day in response to energy supply conditions or at certain times of critical peak demand. At a basic level, smart meters can simply cycle off a major appliance, such as an air conditioner, for a short interval at peak periods of the day. On a more advanced level, smart meters can interface with smart appliances, so that, for example, a refrigerator will wait until the evening to run its defrost cycle or a clothes dryer will turn off its heating element when drying clothes on a hot afternoon. By responding to price signals, consumers can help reduce peak demand and their own energy costs. In one pilot program, for example, participants using smart meters saved on average 10 percent on their utility bills.[49] Utilities also save money from smart meters by automating functions such as meter reading and connecting and disconnecting service.

The smart grid will also lead to a number of additional cost savings by making electricity transmission and distribution in the United States more reliable and efficient. In many parts of the country, for example, a utility will not know that a customer has lost power unless the customer reports the outage. The costs of these outages are substantial: the RAND Corporation and the Electric Power Research Institute have estimated that outages cost businesses as much as $100 billion per year.[50] Better sensors throughout the grid will give utilities more situational awareness and allow grid operators to repair damage more efficiently and anticipate potential problems earlier.

It should also be noted that additional investment in the smart grid is in line with national objectives to better protect and defend against cyber attacks, particularly those targeted at critical infrastructure such as the power grid. Modernizing our power grid will not only create a more robust and resilient grid, it will also allow utilities to improve the security of their Supervisory Control and Data Acquisition (SCADA) systems, or grid control systems, and reduce their vulnerability to cyber threats.

Achieving this vision of an intelligent grid necessitates strong federal leadership, both as a champion and advocate, as well as an investor. Estimates vary as to the total cost to build the smart grid. For example, former Vice President Al Gore estimated the cost at $400 billion over 10 years. Another estimate pegs the cost at $60-$100 billion over 10 years.[51] And President-elect Obama has announced plans to invest at least $150 billion over 10 years in energy efficient technology, including building a smart grid. Most of these estimates include only spending on smart grid technology and do not account for additional needed investment in power grid infrastructure and capacity.

More general estimates that include new generation capacity have found that "by 2030, the electric utility industry will need to make a total infrastructure investment of $1.5 trillion to $2.0 trillion."[52] Of this total, approximately $880 billion will be needed to invest in transmission and distribution capabilities.[53] But much of this investment would be needed regardless of whether the power grid was smarter or not—and in fact, moving to a smart grid could help reduce the magnitude of the needed investment in new capacity.

The smart grid is intended to be a revolutionary network, much like the Internet, that will deliver power more efficiently and more reliably than our existing grid.

Residential smart meters alone will cost $150-$250 per connected unit,[54] and with over 110 million occupied housing units in the United States, universal adoption of such meters will take some time.[55] But the unit cost of smart meters should drop with economies of scale and as the technology becomes more mature. In addition, there is a wide spectrum of options for smart meters, each with varying costs and benefits. For example, some utilities may invest in low-end smart meters with limited functionality, such as having a remote connect/disconnect function or providing automated meter reading, while on the other end of the spectrum a more advanced smart meter could integrate with a home network, "talk" with household appliances and provide other consumer and societal benefits.[56] One estimate by the Brattle Group is that under an optimistic deployment schedule, absent federal incentives such as the ones proposed here, 30 percent of residential customers and 50 percent of commercial and industrial customers in the United States could be using smart meters by 2020. Achieving this level of adoption would require $27 billion in capital costs.[57]

Utilities have begun testing smart meter programs in earnest, but adoption of smart meters has not yet become widespread. One survey of advanced metering infrastructure (AMI) programs found that the average cost of a smart meter project was $775 million. On average, projects lasted slightly more than 5 ½ years with the actual pilot testing occurring for 9 months and including approximately 2.2 million meters.[58] But more large-scale deployments are on the horizon. In California, for example, the California Public Utilities Commission recently approved Southern California Edison's $1.3 billion program to install 5 million smart meters between 2009 and 2012.[59] In Houston, Texas CenterPoint Energy has proposed a $400 million advanced metering system to provide smart meters to 250,000 customers. Rollout will be gradual, at a maximum of 9,200 meter per month, depending on demand.[60]

It is important to recognize that building the smart grid will require much more than just investment in smart meters. Utilities must implement IT throughout their entire operation, from advanced back office servers to automating substations to integrating renewable energy sources into the existing grid.[61] Communication networks must be integrated with the system, such as through wired broadband, including over power lines, cellular networks, or WiFi. At the end-points, consumers must implement tools, such as smart thermostats, smart appliances, and other energy management tools.

Utilities in the United States will continue to invest in IT; however, they will invest at lower levels then previously projected given the country's current economic downturn. According to a recent estimate by Energy Insights, an IDC company, given current economic conditions, utilities will likely invest $19.5 billion in 2009 on hardware, software, and IT related services, a drop of approximately $500 million from previous estimates.[62] Such estimates represent total investments in IT by utilities, though, and are not limited to investments in smart grid technology. Since 2000, utilities have invested over $50 billion in transmission. In the near to mid-term, investments in the smart grid will be for advanced metering at large commercial and industrial facilities, smart metering for residences and small businesses, and better grid network intelligence, including broadband over power lines, intelligent electronic devices, and advanced distribution protection and restoration devices.[63]

Given the difficult economic conditions in the United States today, in the short term, it is likely that many utilities will avoid investing in IT projects as a result of the tight credit market and reduced economic activity. Without access to sufficient credit, some smart grid projects will likely be scaled back, postponed, or eliminated. One important contribution of including a smart grid investment in an economic stimulus package is to ensure that work on existing and proposed smart grid projects continue. Such a program would not be without precedent: In 1935, as poor economic conditions and tight credit markets threatened the expansion of electric utilities, President Franklin D. Roosevelt signed into law the Rural Electrification Administration to provide low-interest loans to allow electricity cooperatives to bring electricity to American farms.[64]

Federal efforts to spur investment in the smart grid could come from a variety of programs including public investments on transmission lines, grant programs and tax incentives. The Energy Independence and Security Act of 2007 (EISA) outlines a number of steps to promote the smart grid that need to have funding appropriated. One important step, for example, could be to fully fund the $100 million smart grid regional demonstration projects authorized by EISA.[65] Funding for smart grid pilot projects will help ensure continued progress of existing projects and encourage other utilities to move forward with new smart grid proposals. In addition, EISA outlines a program for the U.S. Department of Energy to reimburse utilities for up to 20 percent of qualified smart grid investments. Funds appropriated to the Department of Energy grant program could spur additional investment in the smart grid by utilities. Finally, accelerated depreciation or tax credits for certain smart grid infrastructure equipment and smart meters could spur utilities to invest in new infrastructure projects during a recession.

As others have noted, building the smart grid requires a diverse workforce from the meter and power line installers to build the network to software engineers and administrators to run the network. In addition, manufacturers must produce the computer systems, networking devices, sensors, and meter hardware used to run the smart grid by employing machinists, team assemblers, and technicians.[66]

Smart Grid Stimulus: Impact on Employment

As noted earlier and shown in Table 4 above, ITIF projects that a $50 billion additional investment in the smart grid over 5 years (e.g., $10 billion per year) would create approximately 239,000 new U.S. jobs for each of the 5 years on average. We project that if this investment were doubled to $100 billion over 5 years, an additional 477,000 new U.S. jobs would be created for each of the 5 years on average. Finally, we project that a federal mandate to states to order utilities to implement smart metering and construct a smart grid, and to direct state regulators to allow utilities to receive cost recovery for their investment would create approximately 91,000 new jobs. The manner in which we developed these estimates is discussed further below.

Scenario 1: A $50 billion direct investment in the smart grid over 5 years would create, on average, approximately 239,000 new jobs. (Note: Job creation is not cumulative, but rather the average number of additional jobs over 5 years as a result of this investment).

We calculate this projection using a final-demand multiplier for estimated spending increases in grid construction, hardware, software, and IT services.[67] These estimates are based on a 5-year projection of baseline and subsidy level spending on domestic goods and services by utilities provided by Energy Insights, an IDC company specializing in market-based research in the energy sector.[68] Investment on grid construction involves adding new pipes and wires, and includes design, construction, equipment, and labor. This spending also includes upgrades to the transmission and distribution lines and repairs due to aging and weather. Hardware expenditures include smart meters, substation automation equipment, networking equipment and servers. Software spending includes items such as meter system interfaces, network automation and control, analytics, and Web-enabled consumer applications. Expenditures on IT services consist of spending on systems integrating, customer equipment installation and other IT services.

We estimate that a $50 billion direct investment over 5 years would generate on average 179,000 jobs annually in direct, indirect, and induced employment. These estimates are based on a 5-year projection of baseline and subsidy level spending on domestic goods and services by utilities provided by Energy Insights, an IDC company. In addition, we estimate that an additional 60,000 jobs would be created through network effects (see below for a discussion of the network effects). Of these new jobs, approximately 140,500 or 58.8 percent will likely be created in small businesses.[69] Given that smart grid technology is relatively nascent, all of the gains in employment should not be expected immediately, but should scale up rapidly once funding is made available.

Given the difficult economic conditions in the United States today, in the short term, it is likely that many utilities will avoid investing in IT projects as a result of the tight credit market and reduced economic activity.

Scenario 2: Doubling the additional investment in the smart grid to $100 billion over 5 years would, on average, create approximately twice that many jobs, or 477,000 new jobs. (Note: Job creation is not cumulative, but rather the average number of additional jobs over 5 years as a result of this investment).

Scenario 3: A federal mandate to states to order utilities to implement smart metering and construct a smart grid, and to direct state regulators to allow utilities to receive cost recovery for their investment, would create approximately 91,000 new jobs (Note: Job creation is not cumulative, but rather the average number of additional jobs over 5 years created in the economy as a result of this mandate).

A federal mandate to states to construct a smart grid would spur employment as utilities responded to the federal directive. Over a 5-year period, on average, approximately 68,000 jobs would be created from a mandate. These estimates are based on a 5-year projection of increased spending on domestic goods and services by utilities under a federal mandate provided by Energy Insights, an IDC Company.[70] These jobs would be split between direct employment by the utilities, indirect employment by the manufacturers and services providers, and induced employment from the downstream effects of respending by newly employed workers. In addition, we estimate approximately 23,000 jobs from the network effect of building the smart grid. Approximately 23,400 or 54.1 percent of these new jobs will likely be created in small businesses.

An important portion of this mandate would be to direct state regulators to approve cost recovery to pay for the upgrades to the power grid infrastructure. Rates could also be structured to reward energy efficiency, rather than overall energy production. Based on previous pilot projects, a typical surcharge for a residential customer would be approximately $2-3 per month. However, as noted earlier, many customers will see a drop in their peak energy usage and benefit from these savings. Moreover, in contrast to a program of grants and/or tax incentives, such a mandate program may not be the most effective stimulus measure because it would take more time to implement.

Smart Grid Stimulus: Network Effect

Building infrastructure like the smart grid will not only create direct employment from government investment, indirect employment from downstream inputs to the utility industry, and additional jobs from respending, but it will also create new jobs as related industries grow to take advantage of the new technology. These are the network effects that the smart grid enables. For example, the smart grid will encourage appliance manufacturers to produce new appliances that not only use energy efficiently, but also use it more intelligently. As a result, this may lead some consumers to upgrade old appliances more quickly, and other consumers may buy more smart refrigerators and fewer less expensive "dumb" refrigerators. But these advances also create an ecosystem of related products and services—for example, home networking kits to connect smart appliances to the Internet, software applications to interface with the appliances, and online services that take advantage of new digital information and wired appliances (e.g., tracking the expiration date on food).

And the smart grid will enable new products and services that cannot be deployed without this infrastructure. Many new technologies depend on the smart grid, from plug-in hybrid electric vehicles to energy storage solutions to home automation and commercial building intelligence. In addition, the smart grid will facilitate distributed generation and encourage the development of renewable energy sources, such as wind farms. Eventually, the smart grid will even create an energy marketplace where businesses and homeowners can sell energy back to the grid, enabling even more innovation. This will in turn spur consumer demand for products such as rooftop solar panels for their home. Indeed, the smart grid will likely serve as the foundation for the growth of many new industries much like broadband is creating new markets in e-commerce, telehealth, and online banking.

Findings from Other Studies of the Impact of Investing in the Smart Grid

Apart from ITIF, other researchers have examined the job impact of U.S. investment in the smart grid, although generally these estimates are in the context of a larger investment in energy efficient technology.

Pollin et al., for example, estimate that a $100 billion green recovery program over 2 years (an average of $50 billion per year, compared to the proposals above for $10 to $20 billion per year) could produce as many as 2 million jobs.[71] This estimate assumes a $10 billion investment in the smart grid, with the rest of the funds allocated to five other targeted areas including building retrofitting, mass transit and freight rail, wind power, solar power, and advanced biofuels. With an average investment in the smart grid of $5 billion per year for 2 years, Pollin et al. project such a stimulus would create approximately 65,500 jobs per year.[72] The Apollo Alliance, a clean energy advocacy coalition, estimates that a $500 billion investment in clean energy resources, including the smart grid, will generate 5 million "green-collar" jobs.[73] This estimate similarly does not break down job creation by investment.

More broadly, analysts have found that investments in energy efficiency spur employment. For example, Ehrhardt-Martinez and Laitner estimate that "in total, 1.63 million jobs are supported by efficiency-related investments."[74]

It is important to note that by spurring investment in the smart grid and its intermediate inputs, the United States not only will reap savings in energy efficiency and benefit from new innovations in green technology but will also create a market for these components and technical services to domestic firms. Investing in the smart grid now will help ensure domestic firms have the knowledge, skills, and abilities needed to become chief exporters of this technology as other countries expand their own smart grid initiatives. Thus, an investment in the smart grid, in addition to spurring short-term job growth in the United States, will enhance the country's long-term competitiveness and increase the number of higher value-added jobs.

CONCLUSION

With the U.S. economy now mired in a deep, and potentially prolonged, recession, increased investment is one of the best tools to stimulate aggregate demand and quickly get American workers back on payrolls. Spurring investments in IT infrastructure not only can provide an important short-term boost to the U.S. economy; it also can lay the groundwork for long-term economic growth, international competitiveness, and significant improvement in Americans' quality of life.[75]

ENDNOTES

1. We use the number of $30 billion as illustrative only. The actual amount of stimulus needed may be more or less than $30 billion.

2. A network effect is the effect that one user of a good or service has on the value of that product to other users. The value of the network increases logarithmically with each new user added to the network. The classic example is the telephone; the more people own telephones, the more valuable the telephone is to each owner.

3. John Windhausen Jr., "A Blueprint for Big Broadband," (Washington, D.C.: EDUCAUSE, January 2008), <net.educause.edu/ir/library/pdf/epo0801.pdf>.

4. Consider that the net social rate of return on highway capital was very high, about 35 percent, when the U.S. interstate highway system was first constructed in the 1950s and 1960s, but as the interstate highway network was built out, the rate of return from highway capital investments steadily declined until reaching about 10 percent in the 1980s. As the interstate highway network was first built out, it enabled innovations like guaranteed expedited shipping (e.g., United Parcel Service), consolidated freight shipping, dramatic expansion of the automobile industry, and the growth of new communities alongside interstate highways. Incremental investments in the U.S. highway infrastructure at its current level of maturity are unlikely to engender these network effects. Such investments will not, for example, spur individuals to go out and purchase a new set of tires or faster cars. Hence, investments in the highway or other physical infrastructure in the United States are capable of delivering only the traditional employment multiplier. For more discussion, see Theofanis P. Mamuneas and M. Ishaq Nadiri, "Highway Capital and Productivity Growth,"Appendix A, in Economic Returns from Transportation Investment (Lansdowne, Virginia: Eno Transportation Foundation, Inc., 1996): 56 <www.fhwa.dot.gov/policy/otps/060320a/060320a.pdf> (accessed January 1, 2009).

5. Stephen D. Oliner, Daniel E. Sichel, and Kevin J. Stiroh, "Explaining a Productive Decade," Finance and Economics Discussion Series Working Paper No. 2007-63, Federal Reserve Board, Washington, D.C., August 2007 <papers.ssrn.com/sol3/papers.cfm?abstract_id=1160248#> (accessed January 1, 2009).

6. Robert Atkinson and Andrew McKay, *Digital Prosperity: Understanding the Economic Benefits of the IT Revolution* (Washington, D.C.: Information Technology and Information Foundation, March 13, 2007) <www.itif.org/index.php?id=34> (accessed January 1, 2009).

7. Oliner, Sichel, and Stiroh, Explaining a Productive Decade," op. cit., August 2007; and Kevin Stiroh, "Information Technology and Productivity: Old Answers and New Questions," CESifo Economic Studies 54(3/2008):358–385 <cesifo.oxfordjournals.org/cgi/content/abstract/54/3/358> (accessed January 1, 2009).

8. Atkinson and McKay, op. cit.

9. Daniel Castro, "Improving Health Care: Why a Dose of IT May Be Just What the Doctor Ordered," (Washington, D.C., Information Technology and Information Foundation: October 25, 2007) <www.itif.org/index.php?id=88> (accessed January 1, 2009).

10. Robert D. Atkinson and Daniel Castro, *Digital Quality of Life: Understanding the Personal and Social Benefits of the Information Technology Revolution* (Washington, D.C.: Information Technology and Information Foundation, October 1, 2008) <www.itif.org/index.php?id=179> (accessed January 1, 2009).

11. Castro, "Improving Health Care," op. cit., October 25, 2007.

12. Robert D. Atkinson, "The Case for a National Broadband Policy," (Washington, D.C.: Information Technology and Innovation Foundation, June 2007): 5 <www.itif.org/files/CaseForNationalBroadbandPolicy.pdf> (accessed January 1, 2009).

13. Little empirical work has been performed to estimate the exact size of network multipliers in the technologies described in this report. For broadband networks, we estimated a network multiplier of 1.17 based on previous research by Robert Crandall, Charles Jackson, and Hal Singer for Criterion Economics. For health IT and the smart grid, we used a conservative estimate of 0.33 for the size of the multiplier since no prior data could be found.

14. Calculated from data found in U.S. Census Bureau, United States: County Business Patterns, 2004 (Washington, D.C.: 2006) <www.census.gov/prod/2006pubs/04cbp/cb0400a1us.pdf> (accessed January 1, 2009).

15. U.S. Small Business Administration, The Small Business Economy for Data Year 2006 (Washington, D.C.: U.S. Government Printing Office, December 2007): 9 <www.sba.gov/advo/research/ sb_econ2007.pdf> (accessed January 1, 2009).

16. Robert Crandall, William Lehr, and Robert Litan, "The Effects of Broadband Deployment on Output and Employment: A Cross-Sectional Analysis of U.S. Data," Issues in Economic Policy, No. 6, (Washington, D.C.: Brookings Institution, July 2007) :1 <www.brookings.edu/~/media/Files/rc/papers/2007/06labor_crandall/06labor_crandall.pdf>.

17. Dale Jorgenson, "Information Technology and the U.S. Economy," American Economic Review 91(1) (March 2001):1-33.

18. Crandall, Lehr, and Litan, "The Effects of Broadband Deployment," op. cit., July 2007:6.

19. Atkinson, "The Case for a National Broadband Policy," op. cit., June 2007.

20. William H. Lehr, Carlos A. Osorio, Sharon E. Gillett, et al., "Measuring Broadband'sEconomic Impact," presented at the 33rd Research Conference on Communication, Information, and Internet Policy (TPRC), September 23-25, 2005, Arlington, Virginia; revised as of January 17, 2006 <www.andrew.cmu.edu/user/sirbu/pubs/MeasuringBB_EconImpact.pdf> (accessed January 1, 2009).

21. Larry F. Darby, "Broadband Tax Relief Will Contribute Substantially to Efforts to Create Jobs," American Consumer Institute, Center for Citizen Research, Washington, D.C., posted November 25, 2008 <www.theamericanconsumer.org/2008/11/25/broadband-tax-relief-will-contribute-substantially-to-efforts-to-create-jobs/> (accessed January 1, 2009).

22. Robert D. Atkinson, Daniel K. Correa, and Julie A. Hedlund, *Explaining International Broadband Leadership* (Washington, D.C.: Information Technology and Innovation Foundation, May 2008) <www.itif.org/index.php?id=142> (accessed January 1, 2009).

23. Sally M. Cohen, "Broadband Growth Slows Further in the Tough Economic Climate," Cambridge, Massachusetts, Forrester Research, Inc., October 24, 2008: 2. <www.forrester.com/Research/Document/Excerpt/0,7211,47398,00.html>(accessed January 1, 2009).

24. Atkinson, Correa, and Hedlund, *Explaining International Broadband Leadership*, op. cit., May 2008.

25. Dan O'Shea, "UBS Predicts 10 Percent Carrier Capex Cutback," FierceTelecom, December 3, 2008 <www.fiercetelecom.com/story/ubs-predicts-10-percent-carrier-capex-cutback/2008-12-03> (accessed January 1, 2009).

26. Robert Atkinson, "Timely, Targeted, Temporary, and Transformative: Crafting an Innovation-Based Economics Stimulus Package," (Washington, D.C.: Information Technology and Information Foundation, October 2008) <www.itif.org/files/TimelyTargetedTemporaryTransformative.pdf> (accessed January 1, 2009).

27. National Telecommunications and Information Administration, Networked Nation: Broadband in America 2007 (Washington, D.C.: U.S. Department of Commerce, January 2008): Table 7 and Table 8, pages 32 and 33 <www.ntia.doc.gov/reports/2008/NetworkedNationBroadbandinAmerica2007.pdf> (accessed January 1, 2009).

28. For specific detail, see Claudio Mazzali, Robert Whitman, and Bernhard Deutsch, "Optimizationof FTTH Passive Optical Networks Continues,"LightWave, January 2005 <lw.pennnet.com/display_article/219598/13/ARTCL/none/none/1/Optimization-of-FTTH-passive-optical-networks-continues/> (accessed January 1, 2009).

29. Stephen B. Pociask, "Building a Nationwide Broadband Network: Speeding Job Growth," TeleNomic Research, LLC, Herndon, Virginia, February 25, 2002 <www.newmillenniumresearch.org/event-02-25-2002/jobspaper.pdf> (accessed January 1, 2009).

30. This blend of broadband investment is based on ITIF's estimates of needed investments to meet the dual policy goals of (1) bringing broadband service to at least 90 percent of unserved U.S. households and businesses, and (2) upgrading 50 million U.S. households currently served by first-generation broadband to faster speeds.

31. Josh Bivens, "Updated Employment Multipliers for the U.S. Economy," Working Paper No. 268, Economic Policy Institute, Washington, D.C., August 2003: 23 <www.epi.org/workingpapers/epi_wp_268.pdf> (accessed January 1, 2009).

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34. Broadband penetration data is taken from the Federal Communications Commission and is based on the percent of households that have a broadband connection. Personal computer speed data is from PC Pitstop's PC RAM diagnostic tests. Federal Communications Commission, "High-Speed Services for Internet Access: Status as of June 30th, 2008" (accessed December 16, 2008). PC Pitstop Research, "U.S. State Technology Metrics—Quartile Rankings," n.d. <www.pcpitstop.com/research/statetechrank.asp> (accessed December 16, 2008).

35. Pociask, "Building a Nationwide Broadband Network," op. cit., 2002:5.

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37. Ibid.:12.

38. Robert Crandall, Charles Jackson, and Hal Singer, "The Effects of Ubiquitous Broadband Adoption on Investment, Jobs, and the U.S. Economy," Criterion Economics, LLC, Washington, D.C., September 2003: 21-22. <www.newmillenniumresearch.org/archive/bbstudyreport_091703.pdf> (accessed January 1, 2009).

39. Ibid.

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