



The Whole Picture: Where America's Broadband Networks Really Stand

BY RICHARD BENNETT, LUKE A. STEWART, AND ROBERT D. ATKINSON

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EXECUTIVE SUMMARY

Taking the whole picture into account, this report finds that the United States has made rapid progress in broadband deployment, performance, and price, as well as adoption when measured as computer-owning households that subscribe to broadband. Considering the high cost of operating and upgrading broadband networks in a largely suburban nation, the prices Americans pay for broadband services are reasonable and the performance of our networks is better than in all but a handful of nations with densely populated urban areas. Such nations have employed large government subsidies to leap-frog several generations of technology ahead of where the market would go on its own in response to changing consumer demands.

All in all, the state of American broadband is good and getting better, but there is still room for improvement in selected areas.

The status of broadband networking in the United States versus other countries has been a hotly debated topic. Broadband has significant effects on economic growth, education, and quality of life, and is therefore a matter of immediate as well as long-term concern. ITIF has reported previously on America's broadband policy.¹ Other think tanks and advocacy groups such as the New America Foundation, Technology Policy Institute, Free Press, and the Berkman Center have commented on this issue, and a number of popular books have dealt with the subject, two of them in the past few months.²

Studies claiming the United States lags in international broadband standing tend to be out-of-date, poorly-focused, and/or analytically deficient. Many international broadband reports cherry-pick the wealth of data on the subject in order to reach a foreordained conclusion. Many ignore the higher costs of building broadband networks in low-population-density nations such as the United States. Many conflate advertised and actual speeds, globally ranking the speeds that Internet service providers claim to offer though little accurate data exist outside the U.S. confirming whether customers receive these speeds in most nations. Many ignore differences between nations in computer ownership rates, neglecting the fact that people will not subscribe to broadband, no matter how cheap and good it is, unless they own a computer. Finally, while most studies take snapshots of the dimensions their authors deem relevant, a more comprehensive approach would treat each as a trend line over time. This is important because at any given time, the cost and performance of any broadband network is in part a function of the generation of technology that was current when the network was last upgraded. So there's no inherent reason to suppose that any nation has a permanent position at the top or the bottom of the broadband technology curve.

Finally, much international broadband analysis is focused on the elusive number one position, and many countries can claim that position in one or more metrics in any given year. All such rankings should be viewed with caution, in part because of the way they selectively omit data. One measurement will focus on subscriptions, another on speeds, yet another on prices of bundles of broadband and broadband-enabled services, and still

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another on wireless services. Moreover, rankings are not always apples-to-apples comparisons. Any valid comparison of the United States to other nations must include a wide array of variables and reflect the demographic, geographic and policy context of the each nation.

This report seeks to present a comprehensive picture of the health of wired and wireless broadband networks along four dimensions based on reliable and verifiable criteria:

1. Deployment (the geographic reach of broadband networks)
2. Adoption (the number of users who subscribe)
3. Performance (speed, latency, and reliability)
4. Price (per unit of usage and speed tier)

Moreover, it attempts to account for exogenous factors (e.g., differences in population density in urban areas, loop lengths, computer ownership, and public subsidies (through tax breaks and direct subsidies) that have major influences on deployment, adoption, performance and/or price. In addition, it measures adoption not only on a per-capita basis, as the OECD does, but also on a per-household basis, since households are the principal subscribers to residential broadband. Finally, it focuses on national systems of broadband, rather than selectively picking high-performing, low-cost networks exclusively serving dense populations in metropolitan areas.

In addition, by examining the trajectory of broadband progress, we assess where the United States is heading relative to other nations to highlight both the advantages and the disadvantages of the road we've taken. This holistic view will enable policymakers to better interpret all too common claims about America's relative underperformance. It will also help them to understand the role that broadband policy plays in a field where success comes from steady focus on making the kinds of improvements and investments that the economy actually demands, when they're actually needed, and not from forcing the construction of infrastructure to serve particular visions of the future that may never come to pass.

Our chief findings are:

1. America enjoys robust intermodal competition between cable and DSL fiber-based facilities, with the third-highest rate of wired intermodal competition in the OECD (behind Belgium and the Netherlands).
2. America leads the world in the adoption of 4G/LTE mobile broadband, a technology that's a credible competitor at the lower end of the broadband speed spectrum and a gateway technology for bringing broadband non-adopters online.
3. Entry-level pricing for American broadband is the second lowest in the OECD, behind Israel.
4. The average network capacity of all broadband connections in the United States was 29.6 Mbps in the third quarter of 2012; in the same period, we ranked seventh in the world and sixth in the OECD in the percentage of users with performance faster than 10 Mbps.
5. Of the nations that lead the United States in any of the four key metrics (deployment, adoption, speed and price), no nation leads in more than two.

6. In the last few years American firms bought more fiber optic cable than all of Europe combined. 2011 was the first year in which America's fiber purchases exceeded those of 2000, and 2012 orders have remained strong.
7. 82 percent of American homes are passed by a cable technology capable of supporting broadband speeds of 100 Mbps or higher and a new technology known as Vectored DSL may soon bring a second 100 Mbps service into the market.
8. Broadband adoption in the United States is not as high as some leading nations, but our 68.2 percent adoption rate for all households exceeds the EU-15's 66.9 percent. When looking at adoption rate for households with computers, the U.S. rate is close to the top 4 percentage points from the leader) and three percentage points above the EU-15's 85.9 percent for this population.
9. American broadband service providers are no more profitable than those in the rest of the world.
10. American broadband prices are progressive: American users of low-speed, entry-level broadband services pay less than their peers in other countries, but those who use the fastest services pay more.

While some critics selectively point to some very limited high-performance broadband offerings in a few scattered foreign cities in an effort to prove that the United States trails Europe in broadband, the facts strongly suggest otherwise. The United States outpaces EU-15 nations as a whole on deployment, adoption and speed. This is why European Commission Vice President Neelie Kroes has called for new European policies modeled on ours to catch up with the United States, where: "high speed networks now pass more than 80 percent of homes; a figure that quadrupled in three years."³ In Kroes's view, private investment is the primary driver of broadband progress: "Though the public sector can help, the real heavy lifting must be done by private investment."⁴ To facilitate private investment, Vice President Kroes is developing a "Ten Step Plan" for a single, cross-border European market for broadband that mimics our interstate facilities-based broadband market.⁵

Likewise, some critics point to gigabit rollouts in some cities and nations (e.g., Korea) as evidence of U.S. broadband failure. But this critique misses two key factors. First, virtually all of these projects involve public subsidies or are private test bed facilities, not wide-scale deployments. Second, while gigabit test bed projects (like America's Gig.U⁶) are important, the idea that most U.S. broadband users currently need networks this fast is simply wrong. Virtually all existing broadband applications run quite well on the average broadband network in most U.S. cities. This does not mean that higher speeds may not or will not be needed as new applications emerge, but the notion that nations should massively overbuild most of their networks far ahead of real consumer demand is not wise economics nor sound broadband policy.

For our own part, the United States needs to invest significantly more in policies and programs that encourage more of our residents to come online and reap the benefits of the broadband Internet. Pay television (by cable and satellite) is more widely used in the U.S. than broadband, despite the fact that the prices of pay TV services and TV sets are higher than those of broadband and computers—suggesting that many households could afford computers and broadband if they truly valued it. Moreover, bringing more people online

spreads the costs of network operation and investment while increasing the social benefits of broadband.

We should also continue our policy of relying on intermodal competition in areas where population density will support it, as it continues to provide considerable benefits in terms of investment and service improvement. However, we must also recognize that broadband service in many less-densely populated rural areas is not yet capable of sustaining itself without carefully applied and targeted government subsidies. Finally we cannot rest on our laurels with respect to spectrum allocation: more needs to be done, especially in transferring underutilized spectrum from the public sector to wireless broadband.

All in all, the state of American broadband is good and getting better, but there is still room for improvement in selected areas.

OVERVIEW

Policy discourse on broadband networks generally focuses on broadband networks as enablers of innovation, and on the beneficial role such innovation plays in enhancing quality of life and stimulating economic growth. Networks aren't directly beneficial in their own right except insofar as they serve as a key component of the full Internet "ecosystem," as applications, systems, and processes would not be possible without them. ITIF analyzes these indirect benefits in its reports on network enabled e-commerce, the smart grid, smart transportation systems, education, and dozens of other areas.⁷ Broadband networks are products of innovation that become important by enabling further innovation in applications.

The OECD rankings are a very useful effort, given the available data and the difficulties in obtaining apples-to-apples data between nations, but they suffer from serious limitations and the misuse of the data creates more confusion than clarity.

However, there is an increasingly vocal strain of policy discourse that treats networks as an end product, chiefly important as vehicles for bragging rights in an international competition. Many of these advocates rely on Organization for Economic Cooperation and Development (OECD) reports that rank the broadband networks of member nations on various scales that attempt to measure network deployment, adoption, performance, and price. The OECD rankings are a very useful effort given the available data and the difficulties in obtaining apples-to-apples data between nations, but they suffer from serious limitations and the misuse of the data creates more confusion than clarity.

The major shortcoming of the OECD reports is the expedient of ranking. No matter how good the networks of OECD members are—and at this point they are all extremely good except in Mexico, Greece, and Israel—there is only one “Number 1” position in any ranking. This method creates the appearance of scarcity where it doesn’t exist in any meaningful sense. The determinants of network performance are technologies, and the nations with the best current technologies are often late entrants, lacking the “innovation ecosystem” to take advantage of current speeds. A high-speed network without innovative applications is an empty promise, but the two in tandem are enormously beneficial.

OECD data also rely more on surveys than on direct measurement. The OECD collects its information from governments that may or may not take the obligation of reporting to the OECD seriously. Passing data from government analysts to the OECD for further analysis slows down its dissemination, rendering much of the data stale before it becomes available. Some of the OECD’s most current data dates to 2008 or even earlier—at least a generation ago in terms of technology and deployment. But there is no comparable dataset that draws so many data points from so many nations, so the OECD’s efforts are valuable despite their limited accuracy.

OECD data, and selected studies by such firms as Pando Networks (that inaccurately deflate network performance by claiming that measurements of the speed of a particular application are actual network performance measurements), are grist for a mill of policy criticism aimed at asserting U.S. broadband policy failure.⁸ This tendency to overdramatize broadband data is epitomized by recent books by David Cay Johnston and Susan Crawford.⁹ Self-appointed watchdogs who paper America’s broadband industry with indiscriminate criticism tend to obscure real shortcomings where they do exist, ignore successes that should be followed, and encourage policy practitioners and lawmakers to

support policies that are at best unnecessary and at worst destructive to the long-term dynamics of innovation.

The goal of broadband network policy should be to ensure that conditions exist that will promote continual improvement in the deployment, adoption, performance, and price of broadband networks; not to achieve bragging rights in networking, but to ensure that all citizens enjoy the positive influence of innovation on their lives and on the economy. As long as we have networks of sufficient quality that we can be sure innovation doesn't suffer and the national purse isn't strained, we should be satisfied—regardless of which nation is atop any particular ranking in any given year.

Similarly, the fact that America leads the world in the adoption of leading edge 4G/LTE mobile broadband networks—arguably the most significant technical advance in mobile since the smartphone, because they're designed around Internet Protocol (IP)—should not make us complacent about the looming spectrum crisis that threatens our leadership on this technology. And, the fact that the United States leads most of the world in making 100 Mbps broadband connections available to the home means very little as long as most Americans choose not to subscribe to this service tier.

We have a long way to go before every American household has a connected computer, much less one connected to a broadband network. Until both LTE and 100 Mbps adoption become universal, we don't want to be derailed from achieving these goals. Otherwise, important policy factors that are very much under Washington's control garner insufficient attention, which is instead diverted to a raucous debate over fringe issues based on faulty international assessments.

Starting Points

The Internet was commercialized in the mid-1990s, and the broadband era began shortly thereafter. The United States had an early advantage with broadband because we invented the Internet and sat close to its major switching centers, and because we had the makings of a competitive broadband market in which providers had the ability to compete on the basis of network performance and a corresponding incentive to invest directly in network performance. Broadband needs suitable wiring and sophisticated electronics to meet the needs of users, but most of the world's communication networks had neither in the 1990s. The intermodal competition model the United States adopted for broadband made it possible for ISPs to compete with each other on the basis of speed as well as on price, unlike the dial-up ISPs that struggled to differentiate themselves from each other when speed was out of their control.

The wiring for early broadband was a mix of the telephone network's twisted copper pairs and cable TV's coaxial copper cables. In 1999, cable TV was a relatively rare global phenomenon. For OECD countries as a whole, only 55.7 percent of homes were passed by cable, but 94 percent of American homes could subscribe to cable if they chose.¹⁰ (See Table 1)

	Nation	Percentage of homes passed by cable TV, 1999
1	Belgium	96
2	United States	94
3	Netherlands	90
4	Canada	73
5	Luxembourg	73
6	Switzerland	70
7	Denmark	66
8	Hungary	65
9	Sweden	63
10	Finland	60
11	Czech Republic	56
	OECD	53
12	Austria	51
13	United Kingdom	50
14	Ireland	48
15	Korea	47
16	Norway	47
17	Portugal	37
18	Slovakia	32
19	Mexico	20
20	Japan	8
21	Spain	7
22	New Zealand	5
23	Italy	5
24	Australia	0
25	Chile	0
26	Estonia	0
27	France	0
28	Germany	0
29	Greece	0
30	Iceland	0
31	Israel	0
32	Poland	0
33	Slovenia	0
34	Turkey	0

Table 1: Cable TV Deployment in 1999 in OECD Nations¹¹

Despite common claims, the cable TV wiring system is not uniformly or even inherently superior to that of the telephone system.¹² While coaxial cable has superior noise immunity to twisted pair, the topology of cable is optimized for delivering TV's broadcast programming. The telephone network, on the other hand, is designed for private, person-to-person communication. One system provides high bandwidth over shared wires, and the other provides narrow bandwidth over dedicated wires. The Internet works best with high

bandwidth and a minimum of sharing, so each of the two wiring plants possesses both advantages and disadvantages as an Internet medium.

The fascination with fiber optic cable to the home as a means of Internet use stems from its ultimate superiority over copper wire of any kind in both dimensions. Fiber most commonly works in conjunction with copper as a medium for backhaul, aggregating and connecting neighborhoods to far-away switching centers at high speed. Hence, there's not really a dichotomy between fiber and copper in real-world systems; the technical name of the cable modem network is "Hybrid Fiber-Coaxial" (HFC), for example. Similarly, high-speed DSL and wireless networks rely on fiber backhaul. However, networks in some parts of the United States, such as areas served by Verizon and parts of certain other cities (Chattanooga, Kansas City, and Lafayette, Louisiana, for example) extend fiber all the way to the home.

While the United States possessed a "cable advantage" over the rest of the world (except for Belgium) at the turn of the century, we were at a disadvantage in terms of our telephone network. With the requirement that they cover large suburban and rural areas at the same price as urban customers, our telephone companies had opted for a wiring plan that minimized the number of switching centers (known as "central offices" or COs) by deploying longer wires (also known as "copper loops") carefully tuned for telephony. In fact, the United States appears to have had the longest average telephone loop length of any OECD nation. (Figure 1)

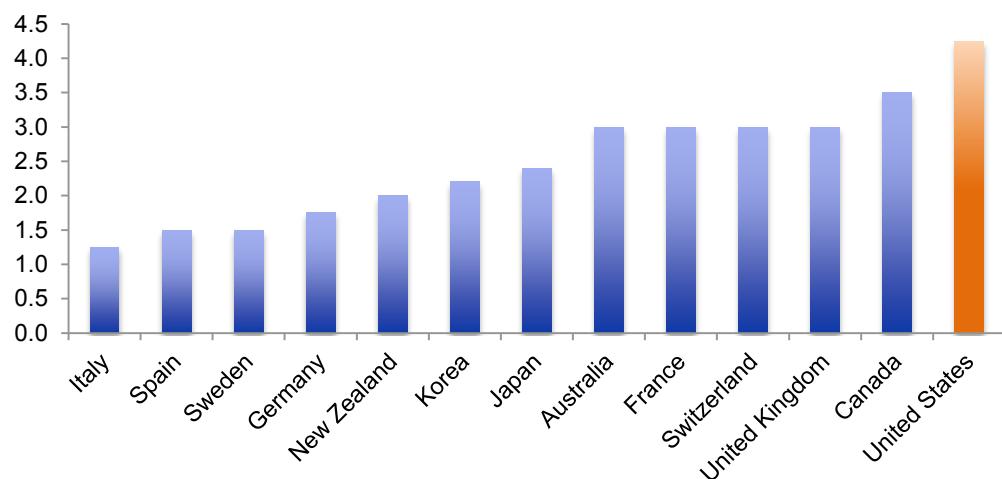


Figure 1: Average Wired Telephone Network Loop Lengths in Selected OECD Countries (km)¹³

Unfortunately, longer loops mean lower speeds for Digital Subscriber Line (DSL), the technology that provides broadband over telephone wires. Just as high population density means lower effective speed for cable because of increased sharing, DSL performance is directly related to wire lengths. The long loop (telephone line) lengths in the United States meant lower speeds than other nations with shorter loops. But both DSL and cable were capable of delivering speeds 25-50 times faster than dial-up at the turn of the century, well in excess of consumer demand.

The presence of two systems of wiring enabled the United States to develop intermodal, facilities-based competition that in turn enabled the ultimate deployment of additional facilities—such as full fiber networks and high-capacity wireless—when and where they were required. Both cable and telephone required significant and ongoing investment to reach their current performance: cable had to connect to the Internet, reduce its degree of sharing, and become bi-directional; telephone had to reduce the length of its loops (by installing fiber deeper into the neighborhood), develop sophisticated electronics to permit high bandwidth operation, and make its own Internet connections. With tens of millions of potential broadband subscribers to compete for, both had incentives to invest. The competition largely played out in the electronics that enable the wires to transmit and receive bits, but also in improving the condition of the wires themselves and in stringing new optical cable where needed.

Other nations were less ready for broadband, especially those that lacked a cable alternative. Some of the nations with limited cable deployment (such as Germany) adopted flawed regulatory frameworks that allowed incumbent telcos to own cable companies, which in turn led to limited cable modem deployment. In such nations, the absence of competition at the level of infrastructure led to an early emphasis on deploying DSL over their shorter copper loops, and on simulating competition between Internet Service Providers (ISPs) using the incumbent provider's telephone wire. This scenario simply mimicked the thin competition on price rather than speed that characterized Internet service in the dial-up days. The extension of this inter-modal vision of competition also betrayed a lack of imagination on the part of some regulators.

Because telephone networks provide unique wires from the phone company CO all the way to the home or office, it was relatively straightforward to allow the connection of an arbitrary number of ISPs in each CO, through devices known as Digital Subscriber Line Access Multiplexers (DSLAMs). If a customer changed ISPs, the phone company would simply move the user's wires from one DSLAM to another. This level of competition is not possible on the cable television system, as most of cable's wires are shared. Hence, the United States initially applied entirely different policy models to DSL and cable, and yet another policy model to wireless. We were driven to the intermodal model in part by the accident of history that gave us such different facilities at our broadband starting point.

There is another aspect of broadband evolution and relative ranking that is important to understand. Broadband deployment began with the addition of specialized electronics to existing telephone and cable networks. The nations that were quick to deploy were those with relatively large populations of computer-savvy users who were already using dial-up modems to access bulletin board systems, information services such as CompuServe, and the Internet. In these nations, adoption followed fairly soon after deployment for those already accustomed to the Internet. The United States was an early leader in broadband deployment and adoption for three reasons: we created the Internet; we were the early leader in personal computers, information services, cable television, and broadband technology development; and we were beneficiaries of a telephone services market in which unlimited, flat-rate pricing was the norm when the rest of the world had to pay a per-

minute charge to be online. But broadband development has advanced several stages past the starting point.

At any given time, the cost and performance of any broadband network is primarily a function of the generation of technology that was current when the network was last upgraded, and the distance the cable/wire plant has to cover. If we compare DSL networks in Nation A and Nation B, the one that was last upgraded will generally run faster, assuming average loop (wire) length is equal. If we compare two nations using the same generation of technology, the one with the shorter average loop length will generally clock in with higher speeds because signals degrade with distance.

The broadband technology portfolio (DSL, cable modem, fiber and wireless) is the same throughout the world, and copper loop lengths can be shortened (albeit at considerable cost) by deploying fiber deeper into the network. Hence, there's no inherent reason to suppose that any nation has a permanent position at the top or the bottom of the broadband technology curve.

Network service providers often sit out generations of technology that are small upgrades to the current standard, but such firms are typically quick to jump into the following generation. Comcast, for example, did not replace its DOCSIS 1.1 cable modem technology with DOCSIS 2, but it was the first to deploy DOCSIS 3. In this case, generation 2 offered a 10 percent improvement over generation 1, but generation 3 was a 400 percent improvement. While DOCSIS 2 networks were marginally faster than DOCSIS 1.1 networks, the difference was not substantial enough to represent a meaningful difference in utility, innovation, or productivity.

Similar logic stimulated the operators of CDMA wireless networks to be among the first to deploy LTE and gain a 1,000 percent improvement over 2G data rates. Consequently, it can be misleading to place much stock in instantaneous measurements of current conditions when upgrades are constantly underway and major ones may be just around the corner.

To understand the differences in international broadband performance, therefore, it is not enough to look at only one number at one point in time. Rather, multiple factors determine national broadband performance. The most important metrics are:

1. Deployment: How far does the physical network actually reach? This is best measured according to the postal addresses in a region. Full broadband deployment would mean that it's possible for a user to obtain broadband service from at least one service provider at each dwelling and workplace with a postal address in the nation. Secondary characteristics concern the generation of technology and the cable/wire miles involved.
2. Adoption: How widespread is broadband utilization? This is best measured by the share of offices and households with at least one broadband subscription, correcting for those that aren't able to use broadband because they don't own a computer and presumably have no interest in going online.

3. Performance: This is measured by the bits per second capacity of each grade of network service, and refined by secondary characteristics such as latency and packet loss when possible. In most cases, the only available data represent capacity (e.g., speed), and latency is estimated by assuming that terrestrial technologies such as copper wire and cellular radio have no latency while satellite technologies have high latency.
4. Price: This is measured by examining the monthly charge for the service adjusted for quality. In the United States, this figure has tended to be a flat rate dependent on speed but independent of the amount of usage for wired connections, and a variable rate dependent on volume for wireless ones. In many parts of the world, all rates have historically been volume-dependent. Some studies instead focus on price per-megabit/speed. But this is a misleading measure of performance because cost does not scale arithmetically to speed (e.g., a 100 Mbps network does not cost twice as much to build or operate as a 50 Mbps network), and therefore nations with faster speeds will appear to have significantly better prices per bit—even if their overall prices are higher than those in nations with lower speeds, and even if users not able to utilize the capacity they purchase.

The most important sources of data for these metrics are the following:

In the United States:

1. The National Broadband Map (NBM) created by the National Telecommunications and Information Administration (NTIA) with help from the FCC for deployment, adoption, and price.¹⁴
2. The FCC's "2012 Measuring Broadband America" report, produced in conjunction with SamKnows, for measurements of speed.¹⁵

Internationally:

1. The Organisation for Economic Co-operation and Development collects data on deployment, adoption, speed, and price from its 34 member nations.¹⁶ OECD data are widely used, but require a great deal of interpretation since their collection method (national self-reporting) and the way they analyze some of the data are questionable. OECD doesn't measure actual speeds, for example, and tries to simply infer it from rate plan advertised speeds.
2. Akamai's "State of the Internet Report" covers most of the United Nations' 193 member states as well as certain administrative regions that aren't actual nations, such as Hong Kong.¹⁷ These reports, primarily focused on the growth of the Internet, emphasize the number of connected devices, attacks, and typical speeds between Akamai servers and global users. With some interpretation they provide valuable insights regarding broadband performance.
3. "Net Index" by Ookla provides the results of self-initiated speed tests performed by users around the world using the test system that runs "speedtest.net."¹⁸ Ookla is much less precise than SamKnows because it can't distinguish machine speed from network speed and the sample is likely to be biased toward those

experiencing problems, but the system has the virtue of being open and international.

4. TeleGeography collects statistics on several aspects of broadband deployment and use.

BOX 1: BROADBAND DEFINITION AND MAJOR BROADBAND TECHNOLOGIES

Broadband is a term applied to transmission media with bandwidths that can carry multiple signals by dividing the total capacity of the medium into multiple, independent channels. The standard wireline broadband technologies in most areas are digital subscriber line (DSL) technologies and cable modems. Depending on the medium and the transmission method, bandwidth is measured in thousands of bits (kilobits) per second (Kbps); millions of bits or megabits per second (Mbps); or billions of bits (or gigabits) per second (Gbps). The OECD, which provides the most widely cited international rankings of broadband adoption, has defined broadband as a service that enables users to upload or download data or both at a speed of 256 Kbps—and this rate is the most common baseline that is marketed as “broadband” around the world. Until recently, the U.S. Federal Communications Commission (FCC) defined broadband as a service that enables users to upload or download data at speeds of 200 Kbps; it has recently upgraded its definition of broadband to 4 Mbps download speed or better.

DSL Technologies

DSL technologies transform telephone lines into high-speed digital lines by using the higher frequency range to deliver data while leaving the lower frequencies for analog voice. The term “xDSL” refers to all types of DSL technologies. The main categories of DSL for home subscribers are Asymmetric DSL (ADSL) and Very High Speed DSL (VDSL), and the next generation is Vectored DSL, supporting speeds up to 100 Mbps.

Cable Modems

Cable modems allow users to have a broadband connection that operates over cable TV lines. Cable Internet works by using reallocated TV channel space for data transmission, with certain channels used for downstream transmission, and other channels for upstream transmission. Because the coaxial used by cable TV provides much greater bandwidth than telephone lines, a cable modem can be used to achieve extremely fast access to the Internet. Cable modems support speeds up to 160 Mbps with DOCSIS 3.0, and even higher speeds with the new standard, DOCSIS 3.1 (320 Mbps and higher). The cable network as a whole has a capacity of approximately 4 Gbps, but most is dedicated to traditional TV today.

Wireless

Present day 4G/LTE networks support transmission speeds up to 40 Mbps over short distances, and 5 to 10 in more common circumstances. 3G cellular broadband runs at speeds comparable to entry-level DSL and cable modem broadband plans, ranging from 1 to 2.5 Mbps. Some ISPs, known as WISPs, provide Internet service over outdoor Wi-Fi, and satellite-based broadband services are available to practically all American homes—albeit at speeds and for prices that are not necessarily competitive with alternatives.

WHERE DOES U.S. BROADBAND ACTUALLY RANK INTERNATIONALLY?

Deployment

Perhaps the single most widely confused aspect of international broadband comparisons is between deployment and adoption. This is in part because of the proliferation of confusing terms. The OECD, for example, uses terms such as “penetration,” “subscription,” “access,” and “coverage” sometimes to mean “adoption” and sometimes to mean “deployment,” without actually using either of those latter terms. It is therefore not surprising that many assume “adoption” is the same as “deployment.” It is indeed common for press articles about U.S. broadband to criticize broadband deployment when in fact the data they utilize measures adoption.

We use “deployment” to measure the reach and extent of broadband networks; this concept is similar to “coverage” for cellular networks. We use “adoption” to measure the number of people who actually pay the money to subscribe to broadband services; this is similar to “subscriptions” for a newspaper.

The best study of broadband deployment in the United States is the National Broadband Map (NBM)¹⁹ created by NTIA with help from the FCC. The NBM was most recently updated in January, 2013.²⁰ The OECD reports deployment data, but they are less recent.

Homes passed

The NBM shows that more than 99.9 percent of Americans have access to some form of broadband with download speed in excess of 3 Mbps, either by satellite, terrestrial wireless, or wired technology. Of this number, 96.3 percent have access to some form of wired broadband, 84.3 percent have access to cable modem service, 82.2 percent have access to DSL (over telephone wires), and 17.8 percent have access to fiber. The NBM also shows that 82.3 percent have access to some form of wireless with an advertised speed of 3 Mbps or higher, including 34.1 percent with access to fixed terrestrial service (such as Clearwire,), 30.1 percent with access to unlicensed wireless service, and 76.1 percent with access to mobile broadband at the requisite speed.

The OECD’s U.S. data (which come from the FCC) are older, much less detailed, and more lenient with respect to the definition of “broadband,” accepting services with download speeds of 256 Kbps or above. As a result, the OECD reports that 96 percent of Americans have access to cable modem broadband service, 85 percent have access to DSL, and 92.3 percent have access to 3G wireless. The OECD figures are sufficiently out-of-date that they under-count fiber, reporting that only 13 percent have access to an all-fiber service (the latest actual number is 17.8 percent).²¹ OECD does not distinguish available technologies or speeds beyond basic distinctions between cable, DSL, and mobile; it has no figures on DOCSIS 2 versus DOCSIS 3 or for LTE, for example.

The collection of statistics on deployment is a new wrinkle for OECD, which uses the term “coverage” rather than “deployment” to describe them. These new coverage data allow us to see the picture of how widely deployed broadband networks are, as well as the state of intermodal competition internationally. While the United States ranked 31st in terms of

United States is third in the OECD with concurrent facilities reaching 85 percent of the population; only the Netherlands and Belgium are ahead, at 92 and 88 percent respectively. This is not an inconsiderable achievement given that the United States has the second-least densely populated urban area of any OECD nation.

the extent of DSL deployment in 2008, it ranked first in terms of cable modem deployment (in 2009), with 96 percent coverage. (Figure 2)

With regard to other nations, the United States is among the leaders in intermodal competition. The clearest way to see this is to compare the concurrent deployment of cable and DSL in OECD nations. Doing this shows that the United States is third in the OECD with concurrent facilities reaching 85 percent of the population; only the Netherlands and Belgium are ahead, at 92 and 88 percent respectively. This is not an inconsiderable achievement given that the United States has the second-least densely populated urban area of any OECD nation (See price section below). The high level of coverage by both DSL and cable allows the United States to benefit from an intermodal competition policy, an option that is not available to most nations because they lack significant cable modem coverage.

In fact, only nine OECD member nations score higher than a combined 60 percent on cable/DSL coverage. One reason for this is that telecommunications incumbents in many European nations were allowed to own cable networks. They had little motivation to roll out cable modem services that would compete with their own broadband offerings over DSL.²² For example, France Télécom dominated the French cable market via its cable subsidiary France Télécom Cable until it divested in 2005, and held additional investments in other large cable companies, such as a 28 percent share of Noos until a 2004 divestiture. Similarly, in Sweden, TeliaSonera controlled cable networks through its Com Hem subsidiary, which it only divested in 2003. In Germany, Deutsche Telekom owned the cable network until 2000. Moreover, regulation meant that local delivery of cable services, provided through third parties, was fragmented. So even though more than 70 percent of German households have access to the cable TV network, fragmentation in the cable market limited early uptake of cable broadband services.²³

Many nations—usually those with little intermodal competition between telecommunications providers offering broadband via DSL and cable providers offering broadband services via cable—focused on promoting “intramodal” broadband competition, often via local loop “unbundling.” This is a regulatory requirement that incumbent telecommunications operators that own the local loops (the physical wire connection between the customer and company) had to give their competitors access to the loops at prices set by the regulator. Compared to the expense of installing multiple wiring systems afresh, unbundling was seen as a shortcut to competition.

The United States jumped from twelfth place to seventh in the relative number of high-speed broadband connections between the third quarters of 2009 and 2012.

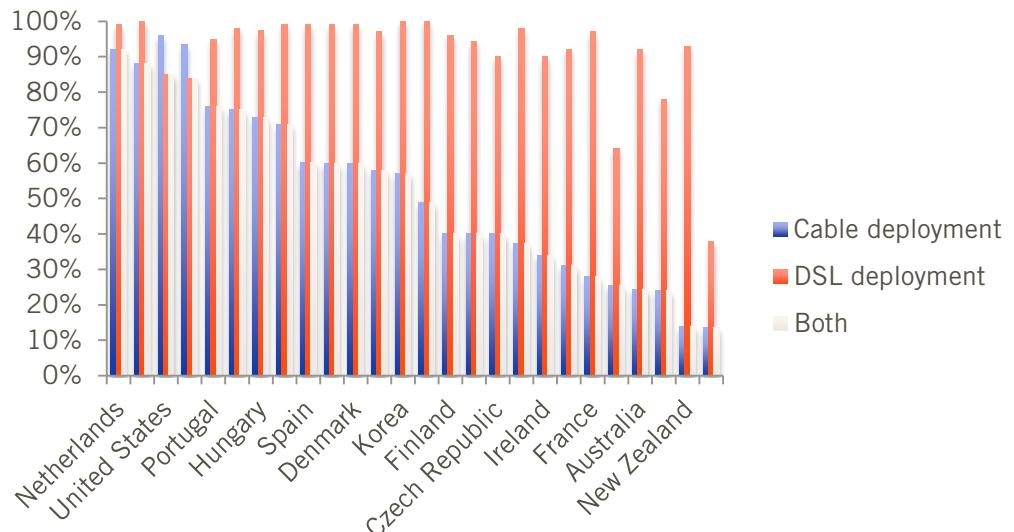


Figure 2: Intermodal Broadband Deployment by Nation²⁴

Deployment Trends

One useful way to judge the success and failure of national policies in deployment terms would be to examine the trend lines that follow after the various international starting points—but these data have not been collected, let alone analyzed.²⁵ What we have instead is anecdotal information about the technologies that were installed in various nations at different times, and some information about major upgrades.

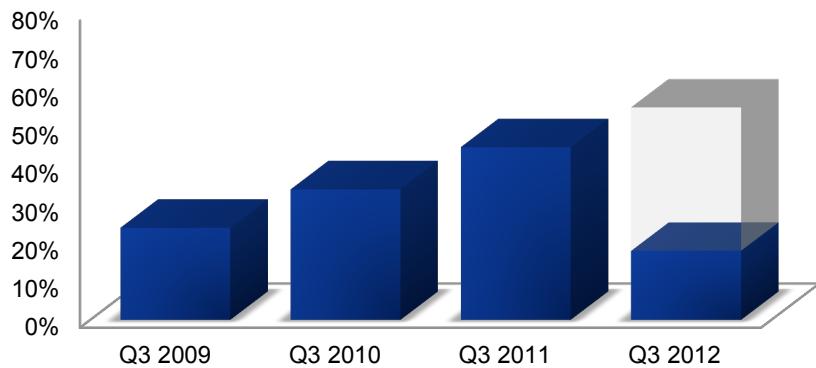


Figure 3: United States “High Broadband” as Percentage of all Broadband (shadow corrects for adjustment of baseline from 5 Mbps to 10 Mbps in 2012)²⁶

In addition, Akamai has collected data from 180 nations and regions since 2008 on average connection speeds, as well as on “High Broadband Adoption,” showing the portion of connections to Akamai at speeds above 10 Mbps. This metric can be considered a proxy for the portion of the total broadband user population that subscribe to high-speed services as opposed to average speed services.²⁷ “High Broadband Adoption” rankings serve as a very rough proxy for the pace of upgrades to national broadband networks.

The United States jumped from twelfth place to seventh in the relative number of high-speed broadband connections between the third quarters of 2009 and 2012 respectively, and sixth among OECD members. During this time, the percentage of connections in the high speed category doubled from 24 percent in 2009 to 48 percent in 2011. (Figure 3) Akamai raised the baseline for high-speed connections in 2012, which accounts for an apparent reduction to 18 percent from the previous year.

Seventh place isn't first place, but the deployment and use of high-speed broadband connections in the United States is clearly improving. This data on the relative number of users with high-speed connections contradicts claims made by critic David Cay Johnston, who titled the broadband chapter in his book "In Twenty-Ninth Place and Fading Fast,"²⁸ and by Susan Crawford, who insists that "America has slipped over the past decade to 22nd place" in download speed.²⁹ Crawford also insists that other nations have moved far ahead of the United States in the deployment of radically more advanced broadband networks:

Meanwhile, the service that all Americans would need within five years (truly high-speed Internet access ranging from 100 Mbps, or megabits per second, to gigabit speeds over fiber-optic lines), the service that would allow symmetrical (same-speed) uploads and downloads and extensive use of online streaming video for a host of educational, medical, and economic purposes, was routinely available in other countries but could not be purchased at all in most parts of the United States.³⁰

First, there is absolutely no evidence to support the claim that 100 Mbps symmetrical service is "routinely available" in *any* part of the world, except as a commercial grade service (as it is in the United States as well). The source that Crawford cites in support of this claim, the "Next Generation Connectivity" report by the Berkman Center, failed to identify a single offering with upload speeds in excess of 20 Mbps; in fact the report actually ranks the United States fifth in median upload speed.³¹ Moreover, virtually all current applications perform well on average speed networks and certainly don't require or perform better on gigabit networks.

Other metrics on broadband speed will be discussed in the section on performance following.

Number of Providers

Some critics of American broadband policy charge that consumers are in the grip of a dangerous duopoly, or even worse, an abusive monopoly. Susan Crawford says, for example, that wireless and wired broadband networks in all of their forms are "monopolies" (an inherent contradiction, since "monopoly" means control of a market by a single provider).

These days what basic transmission service is facilitating is high-speed access to the Internet. In that market, there are two enormous monopoly submarkets—one for wireless and one for wired transmission. Both are dominated by two or three large companies.³²

David Cay Johnston insists that telephone service is a national duopoly:

Through one technology or another, the AT&T–Verizon duopoly controls more than 60 percent of the telephone business in America.³³

And the New America Foundation echoes Crawford's "looming cable monopoly" claim:

In the future, consumers wishing to subscribe to higher speed Internet services will likely face a near-monopoly from cable providers, as telephone providers have halted wide scale upgrades of their networks.³⁴

In the face of these assertions, the National Broadband Map paints a very different and factual picture regarding consumer choice. The NBM says:

- 89 percent Americans have a choice of five or more broadband providers, including wireless and satellite. (Figure 4)
- 85 percent of Americans have a choice of two or more wireline broadband providers. Nearly half of Americans, 43.6 percent, have access to three or more wireline providers.
- 86.7 percent of Americans have a choice of four or more wireless broadband providers.
- More than half of Americans, 57.9 percent, have access to five or more wireless broadband providers.³⁵

Critics may argue that DSL is a poor substitute for cable and that wireless is no substitute at all; arguments of this sort are necessary if one wishes to make the case for regulating broadband as if it were a monopoly. But such arguments are blind to the nature of technological progress, as we discuss later; consumers experience speeds and prices directly, but not technologies (at least for non-nomadic uses).

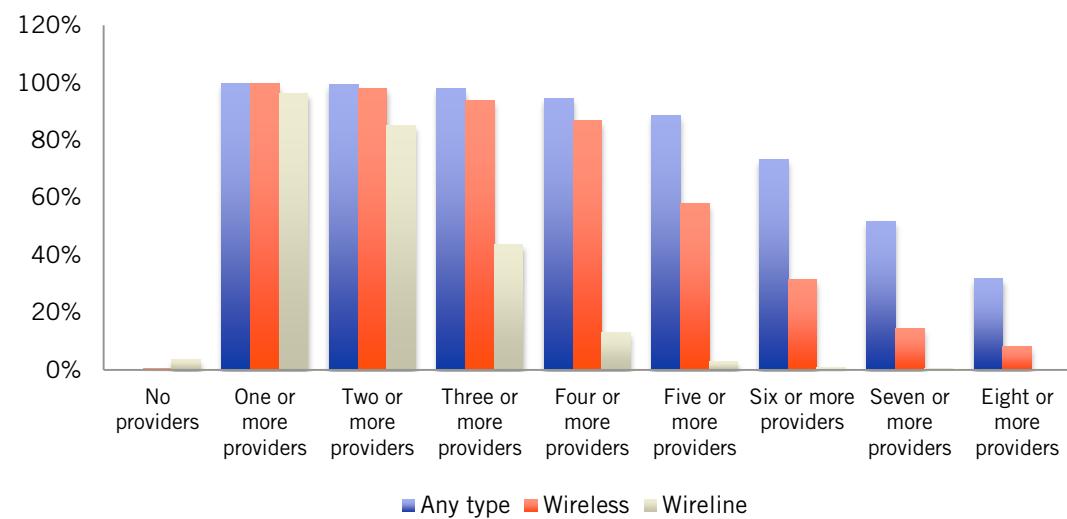


Figure 4: United States Broadband Provider Choice³⁶

Extremely High Speed Providers

Contemporary technology options generally provide a level of performance that's at least adequate for most contemporary applications. According to NCTA, more than 82 percent of America's cable homes have access to DOCSIS 3, a technology that runs at a native speed (e.g., the speed at which the network operates internally) of 160 Mbps, and can provide 100 Mbps service where the distribution network is adequate to bear the load.

Some 136 providers make 100 Mbps service available in America today, and 322 providers offer services at 25 Mbps or more.³⁷ To put these speeds into context, it may be useful to bear in mind that the average rate of Netflix video streaming over Google's gigabit Kansas City network is 2.55 Mbps, because of slower speeds in other parts of the Internet.³⁸

The throughput that Netflix achieves over the Google network is within the range of the connections currently employed by more than 80 million of America's 206 million total broadband connections—those who connect at 3 Mbps or faster. More demanding applications may appear as faster connections become more common, but they aren't here yet, either in the U.S. or anywhere else.

The most common extremely high speed broadband services at the time of the NBM's latest data collection were fiber to the home and DOCSIS 3. NBM reports that 39.4 percent of households had access to DOCSIS 3 at speeds of 100 Mbps or more, and 5.4 percent had a fiber option faster than 100 Mbps (some DOCSIS 3 services are capped at 50 Mbps because of backhaul limitations). These figures most likely understate the availability of extremely high speed service, as both Verizon FiOS and DOCSIS 3 operate at native speeds in excess of 150 Mbps. The internal speed is not always offered to the public, however, as networks need reserve capacity to account for sharing.

Judging by native speeds, the 82 percent of homes with access to DOCSIS 3 and the 17.8 percent with access to an all-fiber option are potentially capable of enjoying access to a service with download speeds in excess of 100 Mbps now or in the near future. The broad deployment of such high-speed networks in the United States is the source of great concern for Europe, where the European Commission is developing a "Ten-Step Plan" for cross-border, intermodal competition in order to catch up with the United States and the East Asian nations and escape from their DSL cul-de-sac.³⁹

The United States has a large number of very high speed and extremely high speed broadband providers: 235 offer services at 50 Mbps or more, 136 offer 100 Mbps or more, and 64 offer gigabit speeds. (Figure 5) Most of the 100 Mbps and gigabit providers focus on the business market, of course.

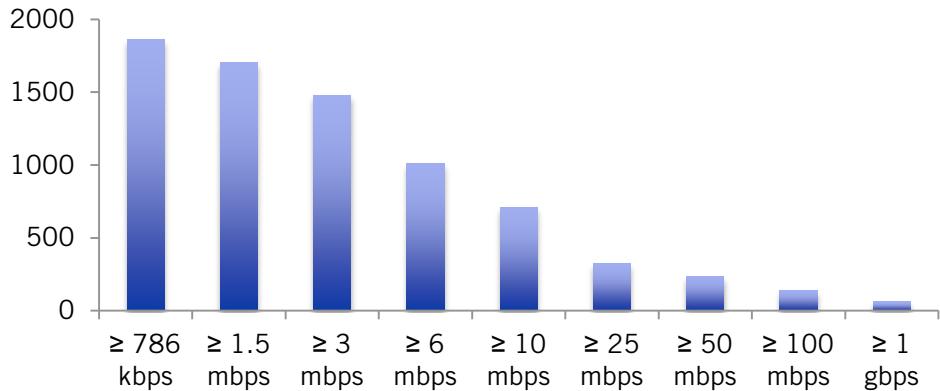


Figure 5: U.S. Broadband Providers by Speed⁴⁰

Some 19 million miles of fiber were installed in the United States in 2011, more than in the entirety of Europe.

Fiber Deployment

Some critics of U.S. broadband performance argue that the only “true” broadband is fiber to the home. They minimize the role played by fiber optics as the backhaul and aggregation component of residential, commercial, and wireless networks. These critics bemoan a supposed lack of fiber in the United States, when in fact there are more actual route miles of fiber in the United States than in all of Europe combined. We’re still adding fiber at a faster rate than Europe, as we explain later.⁴¹ The construction of full fiber networks is probably inevitable in the long run because fiber is more robust and sustainable than copper, independent of the higher bandwidth it offers. But it’s also labor intensive to install fiber, so the general path to the ultimate replacement of the copper infrastructure we inherited from the telephone and cable TV networks at the dawn of the broadband era is to grow the fiber infrastructure from the inner portions of the broadband network, the so-called “core,” to the outer portion, known as the “edge.” The backbones that comprise the Internet core and the middle, distribution portions of the broadband networks that serve users (between the core and the edge) are already comprised of fiber; broadband networks are hybrids of fiber, twisted pair copper, coaxial copper, and wireless. In fact there are more actual route miles of fiber in place in this country than there are in any other country in the world, in part because the United States is so large but also because we’ve invested more heavily in fiber than comparable regions such as the European Union have.⁴²

One important way to judge the progress of the fiber build is to measure the installation rate of fiber throughout the entire network infrastructure. Carriers in the United States over-installed fiber during the Internet bubble of the late 1990s. Until 2011, the greatest annual build of American fiber had occurred in 2000.⁴³ The over-supply of fiber left over from the collapse of the Internet bubble meant that there was very little reason to install additional fiber for core and middle networks until the inventory was exhausted. This occurred by 2010, and by 2011 large-scale fiber installation began again. According to the CRU Group, 19 million miles of fiber were installed in the United States in 2011, more than in the entirety of Europe.⁴⁴ Leading manufacturers of optical fiber have placed customers on allocation:

Some 19 million miles of optical fiber were installed in the U.S. last year, the most since the boom year of 2000, research firm CRU Group says. Corning Inc., a leading maker of fiber, sold record volumes last year.⁴⁵

The fiber build followed the same pattern in 2012, with the United States again ahead of Europe by 15 percent.⁴⁶

The deployment picture for broadband in most of the world is now heavily colored by the strategic replacement of legacy copper with fiber, an activity that must proceed from the core through the middle before it makes any sense at the edge. Fiber is still most valuable as backhaul, where its high bandwidth is vital for the combination of data streams generated by or for groups of individual users. With LTE capable of supporting streams of 20 Mbps and higher for each user, LTE Advanced and Vectored DSL (over copper telephone lines) capable of 100 Mbps, and DOCSIS 3.1 capable of handling 320 Mbps (and more, with additional channel bonding), the fiber edge (all the way to the home) will not be a critical need for many years to come.

A much more compelling case can be made for fiber to the campus, the office complex, and to the neighborhood for performance reasons, unless the mix of applications running inside homes changes radically. Even the most full-throated advocates of full fiber networks grudgingly admit that the need for full fiber Internet connections depends on the emergence of new applications, which they always whimsically judge to be “five years away.”⁴⁷

The current business case for more immediate deployment of fiber to the home can only be made for full service providers such as Verizon who use it to provide triple and quad-play packages that combine TV, high resolution video calling services, and other “managed services” with simple Internet access.

Currently, 17.8 percent of American homes are reached by full-fiber networks, primarily in areas served by Verizon. Fiber is also available in select United States cities such as Chattanooga, Kansas City, and Lafayette, Louisiana, and in select apartment blocks in larger cities such as San Francisco and New York.

In 2010, the United States ranked sixth in the OECD in fiber to the home deployment, at 13.1 percent.⁴⁸ The current figure is 17.8 percent, as noted, which would put us above the OECD average and even farther ahead of the OECD median of 9 percent. (However, this median only includes countries that report fiber coverage data; assuming that the non-reporters generally have low to none fiber coverage, the actual OECD median is likely much lower). (Figure 6)

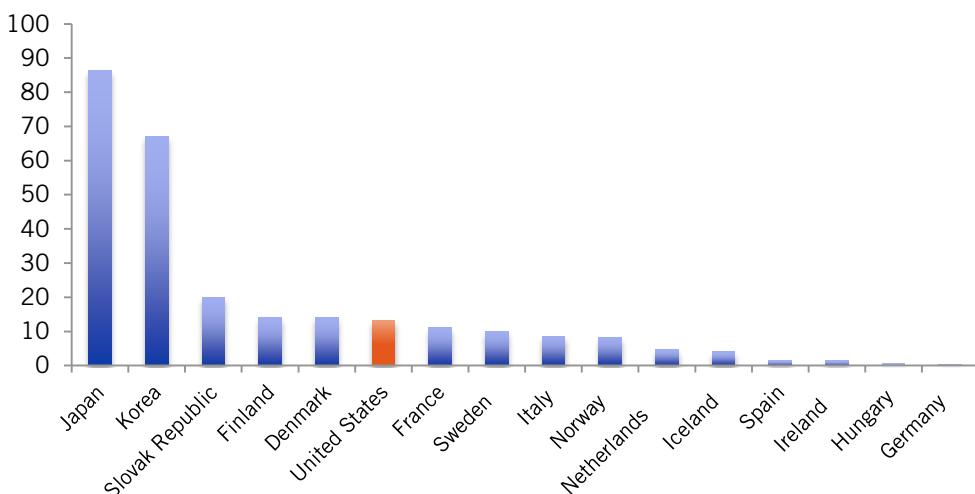


Figure 6: Percentage of OECD Fiber to the Home/Building Household Availability in 2010⁴⁹

Korea, Japan, Hong Kong, and Singapore are high fiber countries, thanks in large part to government subsidies and incentives for fiber to home that are quite large in relation to GDP. The details of many of these initiatives are found in our 2008 report, *Explaining International Broadband Leadership*.⁵⁰ For example, the Japanese government allowed providers to depreciate during the first year about one-third of the cost of the broadband capital investments, as opposed to the usual depreciation schedule of up to 22 years for telecommunications equipment. And, as part of their own “stimulus package,” the Japanese government provided funds to help the incumbent providers NTT East and West deploy more fiber.

In Korea, the government established the Korean Information Infrastructure initiative (KII) in 1994 to construct a nationwide optical fiber network. The government followed KII with a string of 5-year programs that combined government funding with private sector contributions—including Cyber Korea 21 in 1999, e-Korea Vision 2006 in 2002, IT Korea Vision 2007 in 2003, and finally the Broadband Convergence Network (BcN) and IT 839 initiatives in 2004.⁵¹ Through these programs, Korea invested a substantial amount of money and provided incentives to private companies to build fiber networks. Moreover, the governments in both Korea and Japan either own or recently owned significant shares of the incumbent telecommunications companies. Consequently, these governments have been able to pressure the incumbent telecommunications companies to roll out broadband, particularly high-speed broadband, faster than would otherwise be the case.

These programs, even though large, are much less costly than similar programs would be in the United States because of the urban concentrations of these nations’ populations. To measure the relative expense of laying cable, ITIF has developed an “urbanicity” index that measures the share of a nation’s population living in urban areas and the population density of these urban areas. Korea, for example, has a level of urbanicity that is nearly 13 times higher than the United States, and Japan has an urbanicity score that is nearly five

times higher than that of the United States. Serving regions with lower urbanicity scores would mean installing more cables—an expensive, labor-intensive process.

LTE Wireless Deployment

The advent of LTE and LTE Advanced wireless broadband have the potential to drive more sustained competition for broadband services. LTE can deliver as much as 20 Mbps in low-density scenarios—an adequate rate for all contemporary applications and more—and the 100 Mbps that LTE Advanced promises is a legitimate challenge to DOCSIS 3.

The build-out of LTE is especially significant because it's ongoing. MetroPCS was the first United States carrier to offer LTE, and Verizon followed close behind with a much more robust and extensive offering. (Figure 7) AT&T was the next LTE mover, followed by Sprint. T-Mobile has announced plans for its LTE rollout as well, so the United States will soon have four nationwide LTE options, each offering speeds that exceed the FCC's 4 Mbps threshold for broadband.

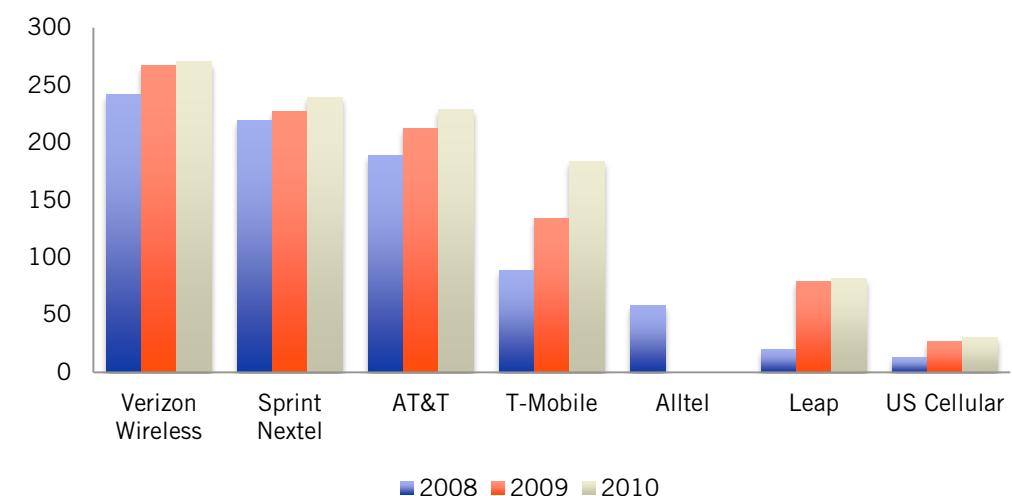


Figure 7: Population Served by Major Mobile Broadband Networks (millions)⁵²

Internationally, LTE deployment is moving much more slowly. The European Union has been hampered by regulatory mandates that specified the technologies that carriers could use in the spectrum allocated to them, and LTE was not initially allowed by these mandates; a similar problem occurred with the European 3G rollout. Moreover, the United States was the first nation to take advantage of the “digital dividend” from the digital TV transition. In contrast, the process of allocating new spectrum for LTE and modifying regulations to permit LTE use on previous allocations is still underway in Europe.

Adoption

There is perhaps no more widely cited statistic to support the claim that the U.S. broadband system lags behind other nations than broadband adoption. As noted above, some analysts, advocates and journalists mistakenly portray adoption to be the same thing as deployment, but, in fact, adoption is simply the number of people or households that decide to purchase broadband service. Adoption is not a measure of broadband coverage or of broadband quality; it's simply a count of the percentage of homes and businesses that

When computer ownership is taken into account, the broadband adoption rate in the United States is in fact nearly on par with that of leading nations.

choose to subscribe to available broadband service. When critics charge that the United States ranks behind other nations in broadband without qualification, the ranking generally relates to adoption rather than deployment, speed, or price.

On both the share of Americans subscribing to broadband and the rate of growth of this share, the United States does not rank high, placing just 15th and 16th, respectively, among OECD countries. However, as we note below, people do not subscribe to non-mobile broadband unless they own a computer, just as people would not subscribe to electric power service unless they owned an electric appliance or had electric lights. When computer ownership is taken into account, the broadband adoption rate in the United States is in fact nearly on par with that of leading nations. Furthermore, Americans who can afford a computer will generally refrain from purchasing them unless they believe the Internet is worthwhile; the largest share of non-adopting households fall into this “relevance” category.

Adoption in the United States

In 2010, the FCC reported that approximately 65 percent of Americans subscribed to broadband of any speed, and the OECD reported that 68 percent of American households (see Table 2) subscribed to broadband of any speed.⁵³ As Figure 8 shows, Americans with less than a high school diploma are far less likely to have a broadband Internet connection than other Americans, with only 24 percent of this group having broadband. Perhaps unsurprisingly, age is also an important factor, with only 35 percent of Americans aged 65 years or older having a broadband connection. People with low incomes and people with disabilities also lag behind the national average in broadband adoption. Hispanics have a broadband adoption rate that is 16 percentage points lower than the national average. African Americans are closer to the national average, although they are still 6 points behind the average.⁵⁴ According to the FCC, in 2011, over 66 million American households and 14 million American businesses had Internet connections with speeds greater than 3 Mbps. This translates to approximately 56 percent of households and 49 percent of business establishments with connections faster than 3 Mbps.⁵⁵

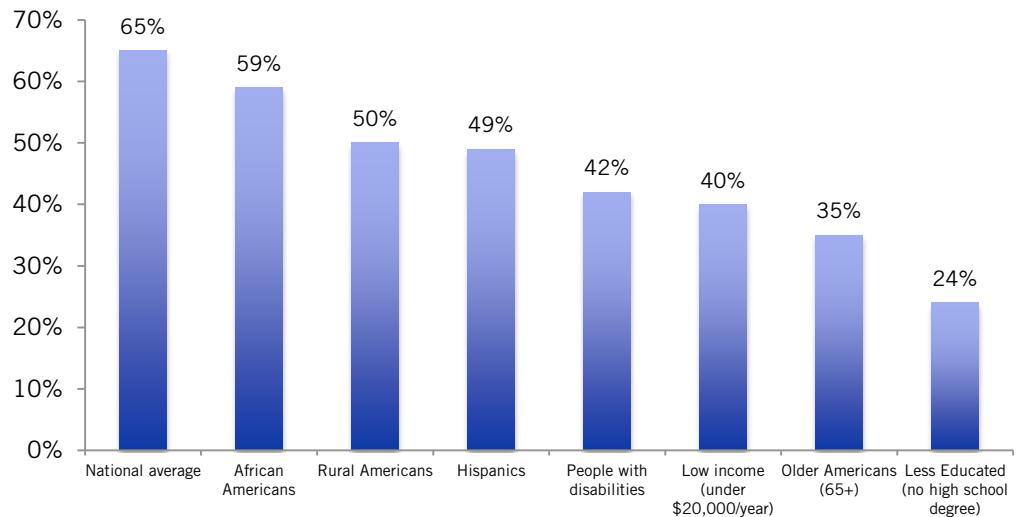


Figure 8: Broadband adoption rates in the United States, 2010⁵⁶

Looking at the states, broadband adoption and speeds tend to be highest in high-tech, high-income states that have a well-educated population. Indeed, there is a strong correlation (0.73) between state broadband adoption rates and the years of schooling obtained by the workforce.⁵⁷

Rank	State	Share of Households with Broadband Internet
1	Utah	79.7%
2	New Hampshire	77.8%
3	Washington	76.7%
4	Massachusetts	75.9%
5	Connecticut	74.8%
6	Oregon	74.7%
7	Kansas	74.6%
8	Nevada	74.2%
9	Arizona	74.2%
10	Maryland	74.1%
11	Alaska	73.4%
12	New Jersey	73.3%
13	California	73.1%
14	Wyoming	72.9%
15	Idaho	72.0%

Table 2: Top 15 States by Share of Households with Broadband Internet⁵⁸

Trends in U.S. Adoption

The share of Americans with broadband access has increased dramatically since 2000 when just 3 percent of Americans accessed the Internet through a broadband connection. (Figure 9) By 2010, that had increased to 65 percent. Meanwhile, dial-up connections peaked in 2001, with 41 percent of Americans accessing the Internet this way. Dial-up connections have since plummeted to just 5 percent in 2010, and are almost certainly significantly lower in 2013.

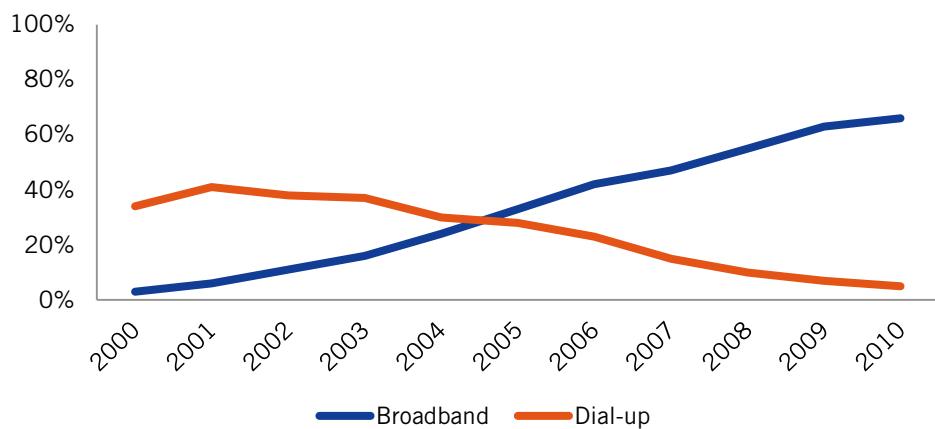


Figure 9: Percentage of Americans with Broadband vs. Dial-up, 2000-2010⁵⁹

Despite an ever-increasing level of broadband adoption, the rate of broadband adoption has slowed since 2006. (Figure 10) Between 2005 and 2006, broadband adoption in the United States increased by 28 percent. However, between 2006 and 2007 this rate fell to just 12 percent. Although the rate picked up again between 2007 and 2009, the period between 2009 and 2010 showed an even slower increase of just 5 percent. This is in part the familiar “S-curve” phenomenon whereby most households owning a computer have now subscribed to broadband—although part of it may be the effects of the Great Recession on incomes and purchasing habits of American households.

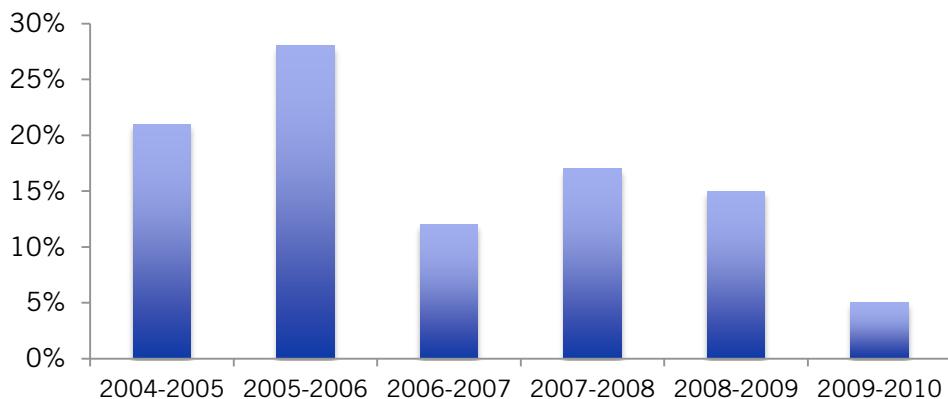


Figure 10: Percentage change in home broadband adoption, 2005-2010⁶⁰

Looking at the absolute change in these connections by speed tier, between 2009 and 2011, the highest growth for households was in the 10-25 mbps tier, with over 15 million consumers joining this tier.⁶¹ This was followed by the 25-100 mbps tier, which gained over two million households. This is a reflection of the fact that while virtually all potential adopters (households owning a computer) have already subscribed to broadband, many households are choosing to subscribe to faster speeds as networks grow faster and as households grow more sophisticated and demanding in their Internet usage. On the business side, the highest growth tier was the 6-10 Mbps tier, which gained over six million businesses over the period, followed by the 3-6 Mbps tier, which had nearly four million new business connections.⁶²

How U.S. Broadband Adoption Stacks Up Internationally

The OECD uses two methods to measure broadband adoption rates across countries: subscriptions per capita and the share of households with broadband access. ITIF finds the OECD’s household share measure more accurate, because average household sizes vary across countries, and thus the per capita measure is biased against countries that have larger than average household size. After all, a household with four members does not have four wired broadband connections. Looking at the share of households with access to wired broadband, the United States ranks 15th out of 34 OECD countries. (Table 3) Korea leads, in part because its data are skewed by the inclusion of mobile subscriptions (others are not), but also because the Korean government has established sophisticated and well-funded broadband adoption programs. Interestingly, Japan—seen by many as a model of broadband deployment—lags behind the United States in both measures of adoption, despite the fact that close to 90 percent of Japanese households have access to reasonably priced fiber optic broadband service. This suggests that price and speed are not the only

There is no correlation between adoption and peak and average speed (0.03 and 0.00, respectively), nor between adoption and prices for connections under 20 mbps (0.04).

factors—or even the dominant factors—driving adoption. Indeed, among the OECD countries that have complete data, there is no correlation between adoption and peak and average speed (0.03 and 0.00, respectively), nor between adoption and prices for connections under 20 mbps (0.04).

Rank	Country	Share of Households Subscribing to Wired Broadband
1	Korea*	97.5%
2	Iceland	87.0%
3	Norway	82.6%
4	Sweden	82.6%
5	Denmark	80.1%
6	Netherlands	79.5%
7	Switzerland**	77.8%
8	Finland	75.8%
9	Germany	75.2%
10	Australia**	73.8%
11	Canada**	73.6%
12	United Kingdom**	73.5%
13	Luxembourg	70.3%
14	Belgium	70.0%
15	United States	68.2%
16	France	66.8%
17	New Zealand**	66.0%
18	Estonia	64.5%
19	Austria	63.7%
20	Japan	63.4%
21	Slovenia	62.0%
22	Ireland	57.5%
23	Spain	57.4%
24	Poland	56.8%
25	Czech Republic	53.6%
26	Hungary	52.2%
27	Portugal	50.3%
28	Slovakia	49.4%
29	Italy	48.9%
30	Greece	41.2%
31	Chile**	35.0%
32	Turkey	33.7%
33	Mexico	21.1%
34	Israel	-
	EU-15	66.6%

*Includes mobile subscriptions **ITIF estimate

Table 3: Share of Households Subscribing to Wired Broadband, 2010⁶³

Comparing the United States to the richer nations of Europe, the United States is ahead in broadband adoption, clocking in at 68.2 percent compared to the EU-15's 66.9 percent.

Some critics of U.S. broadband policy point to European countries like the Netherlands, Denmark, and the United Kingdom as models for broadband policy—particularly their network unbundling regimes aimed at promoting intramodal competition.⁶⁴ However, while it is true that these nations lead the United States in broadband adoption, many other European nations with similar unbundling policies lag behind, including France and Austria. In fact, comparing the United States to the richer nations of Europe, the United States is ahead in broadband adoption, clocking in at 68.2 percent compared to the EU-15's 66.6 percent. (Figure 11)

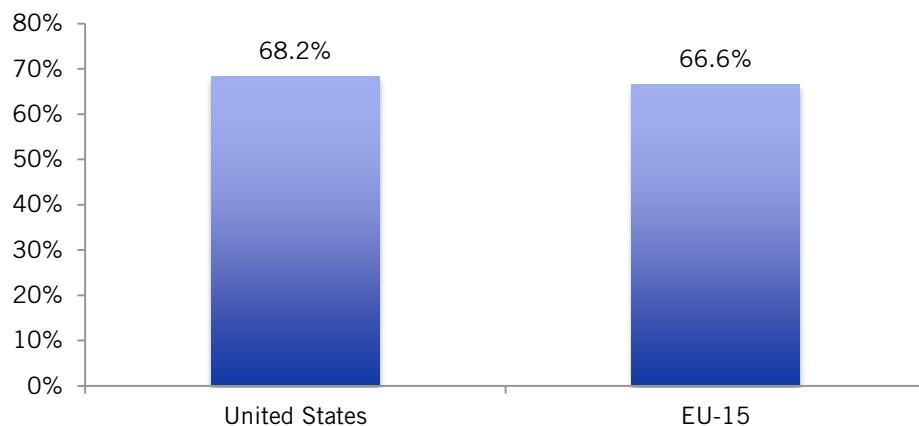


Figure 11: Share of Households Subscribing to Wired Broadband, United States and EU-15, 2010⁶⁵

International Adoption Trends

In terms of recent growth in the share of households with broadband access, the United States ranks 16th, growing its share by 17.4 percentage points between 2007 and 2010. (Table 4) This is lower than the growth rate in the EU-15, which grew its share by nearly 20.8 percentage points over the period.⁶⁶ One reason for this is that the United States had a head start in broadband adoption, and thus neared its saturation point faster than most other countries, naturally reducing its broadband adoption growth rate. For example, many countries with fast rates of growth (such as Greece, Poland, Ireland, Germany and France) had lower rates of adoption to begin with, whereas nations with high rates of adoption (such as Korea and Iceland) rank much lower in the growth of adoption. This is why the negative correlation between the rate of adoption in 2007 and the percentage point change to 2010 is very strong (-0.72).

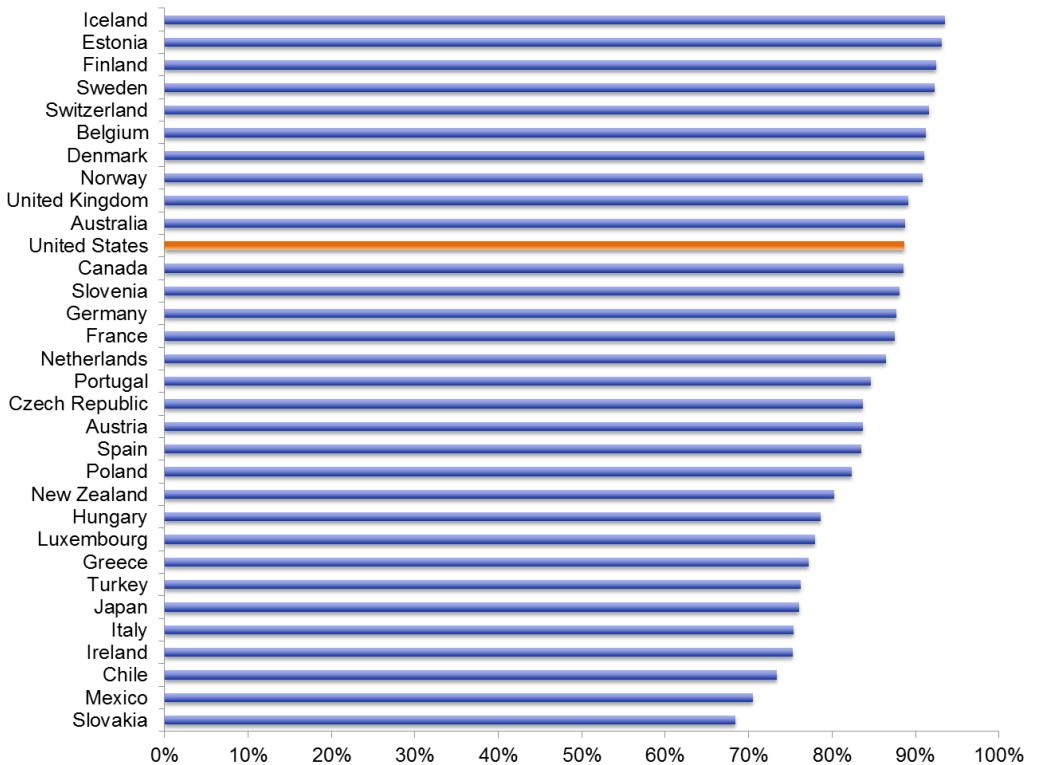
Rank	Country	Percentage Point Change
1	Greece	33.7%
2	Poland	27.2%
3	Ireland	26.3%
4	Germany	25.6%
5	Czech Republic	25.5%
6	France	23.9%
7	Italy	23.6%

8	New Zealand**	23.0%
9	Slovakia	22.8%
10	Australia**	21.8%
11	Portugal	19.9%
12	Hungary	19.3%
13	Slovenia	18.4%
14	Spain	18.1%
15	Austria	17.6%
16	United States	17.4%
17	Chile**	17.2%
18	Turkey	17.1%
19	Estonia	16.9%
20	United Kingdom**	16.8%
21	Sweden	15.9%
22	Norway	15.9%
23	Mexico	15.0%
24	Switzerland**	14.8%
25	Belgium	13.6%
26	Finland	12.9%
27	Luxembourg	12.6%
28	Japan	11.7%
29	Iceland	10.9%
30	Denmark	10.6%
31	Canada**	9.4%
32	Netherlands	5.7%
33	Korea*	3.3%
34	Israel	-
	EU-15	20.8%

*Includes mobile subscriptions **ITIF estimate

Table 4: Percentage Point Change in Share of Households Subscribing to Fixed Broadband, 2007-2010⁶⁷

However, as noted above, one fundamental limitation of these measures is that they conflate broadband adoption with computer ownership. Consumers will not subscribe to fixed, non-mobile broadband if they do not have, or know how to use, a computer at home. The more accurate way to assess broadband adoption is to measure adoption among those households actually owning a computer. While the United States ranks only slightly above the median in the original household share measure of broadband adoption, its standing improves on this measure, ranking 11th out of 34 OECD countries. (Figure 12 and Table 5) Even if we assume that Korea, for which we lack appropriate data, out-ranks the United States (which is far from certain since only 81.8 percent of Korean households have computers), the United States would still rank 12th. The United States outperforms the EU-15 (Figure 13) on this measure by nearly 3 percentage points, despite the fact their computer adoption rates are within half a percentage point of each other.



Thus the United States is very close to having the same rate of broadband adoption by computer-owning households as Iceland, the leader.

Figure 12: Share of Households with Access to a Computer that also Subscribe to Wired Broadband, 2010⁶⁸

Moreover, the ordinal rank on this measure is somewhat misleading, because these scores are clustered much more closely together, and thus the United States is very close to having the same rate of broadband adoption by computer-owning households as Iceland, the leader. While in Table 2, the original ranking, 19 percentage points separate the leader, Iceland (excluding Korea because it includes mobile subscriptions), from the United States, less than 5 percentage points separate the leader (Iceland again) from the United States when we control for computer adoption in Table 5. Again, it is notable that adoption in the United States is ahead of many nations that some advocates point to as models of broadband policy, including France, the Netherlands, and Japan. In fact, the United States is among the world leaders when it comes to deploying broadband—a large share of households have access to broadband—and its prices for introductory, lower speed services are among the lowest in the world (see price section below). This suggests that one of the most important steps policymakers could take to boost U.S. rankings on broadband adoption per household would be to spur computer ownership, Internet awareness, and digital literacy.

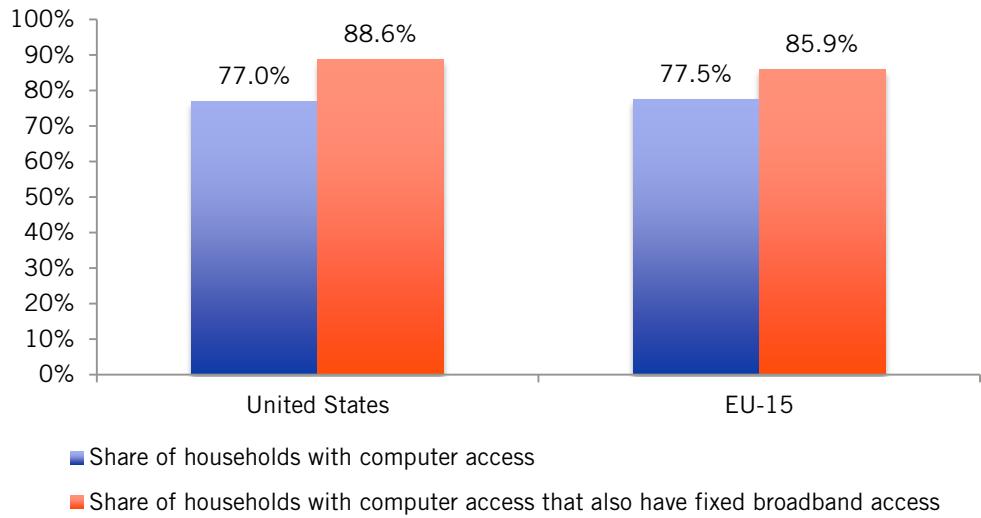


Figure 13: Share of Households with access to a computer that also Subscribe to Fixed Broadband, United States and EU-15, 2010⁶⁹

Rank	Country	Share of Households with Computer Access that Also Have Fixed Broadband Access	Share of Households with Computer Access
1	Iceland	93.5%	93.1%
2	Estonia	93.1%	69.2%
3	Finland	92.5%	82.0%
4	Sweden	92.2%	89.5%
5	Switzerland*	91.6%	84.9%
6	Belgium	91.2%	76.7%
7	Denmark	91.0%	88.0%
8	Norway	90.8%	90.9%
9	United Kingdom*	89.1%	82.6%
10	Australia*	88.7%	83.2%
11	United States	88.6%	77.0%
12	Canada*	88.5%	83.2%
13	Slovenia	88.0%	70.5%
14	Germany	87.7%	85.7%
15	France	87.5%	76.4%
16	Netherlands	86.5%	92.0%
17	Portugal	84.6%	59.5%
18	Czech Republic	83.7%	64.1%
19	Austria	83.6%	76.2%
20	Spain	83.5%	68.7%
21	Poland	82.3%	69.0%
22	New Zealand*	80.2%	82.3%
23	Hungary	78.6%	66.4%

24	Luxembourg	78.0%	90.2%
25	Greece	77.1%	53.4%
26	Turkey	76.2%	44.2%
27	Japan	76.0%	83.4%
28	Italy	75.4%	64.8%
29	Ireland	75.2%	76.5%
30	Chile*	73.3%	47.8%
31	Mexico	70.5%	29.9%
32	Slovakia	68.4%	72.2%
	Israel*	N/A	77.0%
	Korea	N/A	81.8%
	EU-15	85.9%	77.5%

*ITIF estimate

Table 5: Share of households with access to a computer that also subscribe to fixed broadband, 2010⁷⁰

Reasons for Non-adoption

When we examine why Americans fail to subscribe to broadband, one largely irrelevant factor is its availability. In a survey undertaken by the Pew Research Center (Figure 14), just 6 percent of Americans report availability as their primary barrier to Internet adoption. (That said, virtually all of this group could access broadband over satellite). Additionally, just 10 percent report price as their primary barrier to Internet adoption. In fact, the two most common reasons reported for Internet non-adoption relate to relevance (respondents simply are not interested in, or are too busy for, the Internet) and usability (the Internet is too difficult to use or dangerous). The third most common reason was the lack of computer access. However, given that one can purchase an Internet accessible netbook for less than \$250, around the price of a low-end television, this reason is likely a sub-factor of usability and relevance.⁷¹ These three factors were the main reasons for non-adoption for 78 percent of non-adopters. Including uncategorized responses, this figure rises to 84 percent.

The FCC's Lifeline and Link Up programs, which subsidize standard telephone connections, should be extended to broadband connections in some form.

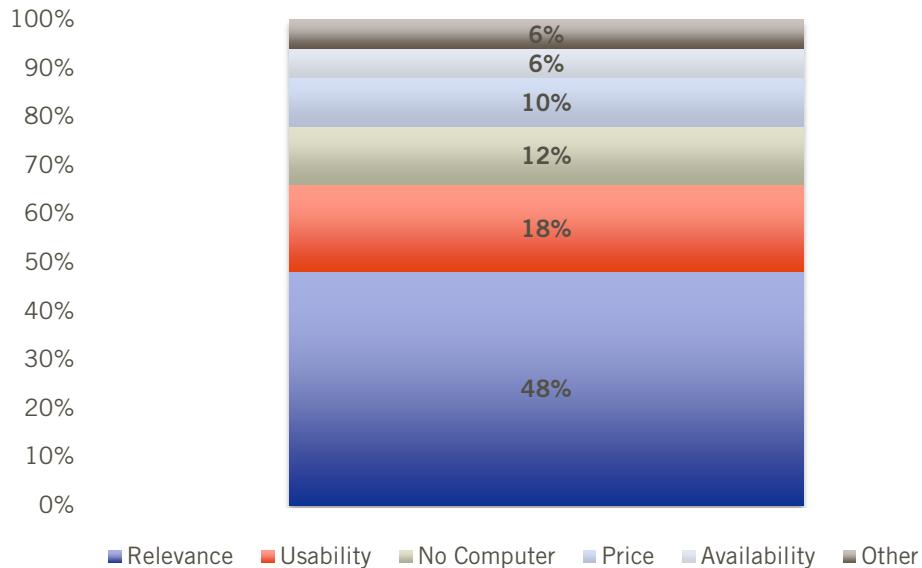


Figure 14: Pew survey: Americans' main reasons for not using the Internet, 2010⁷²

A second survey from the NTIA shows similar results. (Figure 15) In this sample, 47 percent of respondents stated that they were not interested or did not need Internet access. A further 15 percent stated that lack of a computer was their primary reason for non-adoption. (The NTIA did not report usability responses in its survey results.) Along with uncategorized responses, these factors accounted for 74 percent of survey responses. Although the price factor for non-adoption comprises a higher share of responses than in the Pew survey, price and availability combined still only accounted for a quarter of all survey responses.

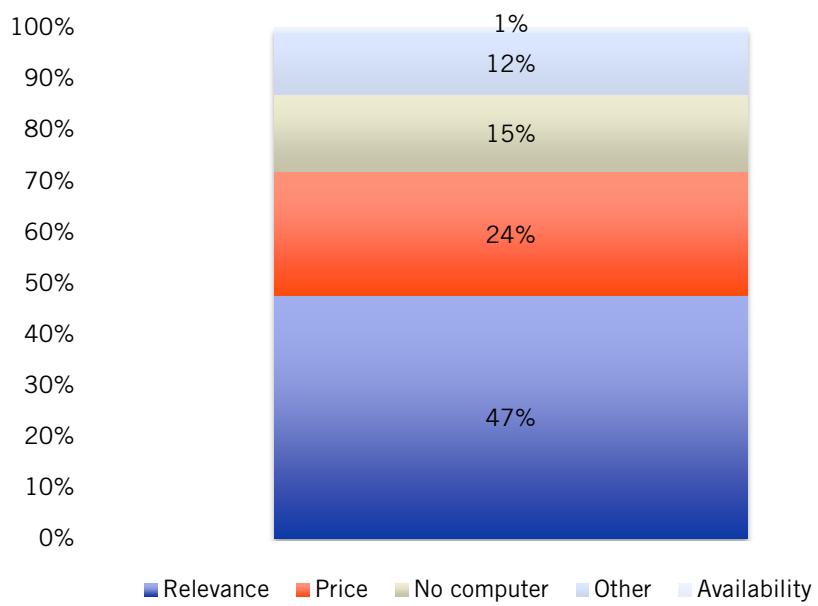


Figure 15: NTIA survey: Americans' main reasons for not using the Internet, 2010⁷³

While the previous section showed that policies that increase computer adoption are vital for increasing broadband adoption, this section shows that perhaps the most important policies are those that improve digital literacy. Without digital literacy—which includes an understanding of the importance of Internet use—households are unlikely to purchase a computer. Nonetheless, given that between 10 and 25 percent of respondents reported that price was their primary barrier to adoption, this is indeed a facet of the non-adoption problem that policymakers should address. However, it is important to note that, as shown before, the price of entry-level broadband subscriptions in the United States is below average. What this signifies, instead, is that some Americans believe they simply cannot afford even reasonably priced broadband. In fact, out of the 34 OECD countries, the United States has the fourth-highest share of persons living below 50 percent of the median equivalized income, with rates that are dramatically higher than France, Germany, the Netherlands and the United Kingdom.⁷⁴ (Figure 16) Hence, while price may indeed be a barrier to broadband adoption, it is not necessarily indicative of high broadband costs, and certainly not an indication of higher U.S. prices. Rather, it is more likely a reflection of the high degree of poverty in America. Along with other goods and services, many Americans simply lack the income to afford even broadband that is cheap relative to other countries' prices. This is one important reason why the FCC's Lifeline and Link Up programs, which subsidize standard telephone connections, should be extended to broadband connections in some form.

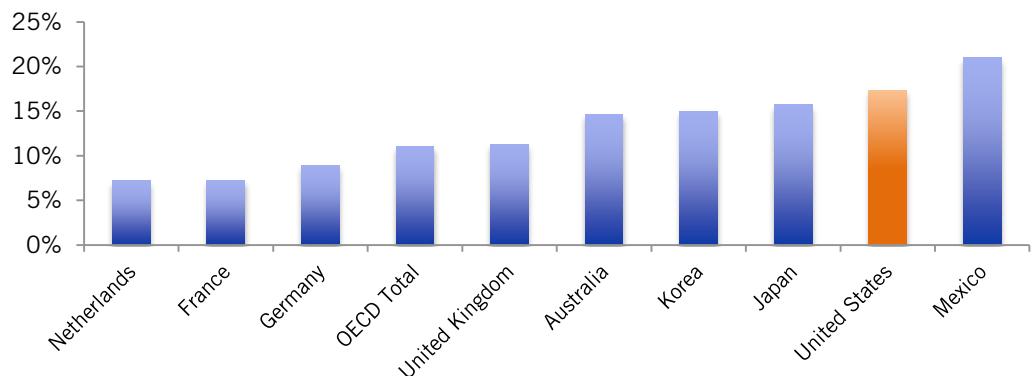


Figure 16: Percentage of persons in selected OECD nations living with less than 50% of median equivalized household income, late-2000s⁷⁵

Subscriber Growth and Churn

Broadband subscriber growth has slowed somewhat in the United States now that most households with computers and broadband interest have subscribed. Leichtman Research finds that net new subscriptions increased by 579,521 in the third quarter of 2012, a slightly lower rate of increase than the historical trend. For the year, the rate of increase was somewhat modest:

While top cable and telephone companies now account for over 80 million broadband subscribers, the industry continues to grow at a modest pace,” said Bruce Leichtman, president and principal analyst for Leichtman Research Group, Inc. “Over the first three quarters of 2012, the top broadband providers added over 2.1 million

subscribers, compared to nearly 2.3 million subscribers added in the first three quarters of 2011.⁷⁶

Subscriber churn typically draws a great deal of attention from observers keen to emphasize the possible dominance of the broadband market by particular players. Indeed, recent trends have been used to make the argument that a significant migration of DSL customers to cable is taking place. The third quarter results show that cable is not growing at the expense of DSL as much as adding customers who previously were non-adopters. Cable added about 575,000 subscribers in the quarter, but telephone companies added a modest 5,000 new customers as well.

More interesting than the overall growth rates of cable and telephone-based broadband is the nature of the technologies that telephone-based broadband subscribers are choosing: AT&T and Verizon added 749,000 fiber-intensive subscribers (for U-verse and FiOS) in the quarter, while losing 799,000 DSL subscribers. Many of CenturyLink's 44,000 new subscribers use a service similar to U-verse, although the data aren't detailed enough to show the precise number.⁷⁷

Claims to the effect that the United States is falling behind the rest of the world in broadband performance are common, even though the data clearly contradict them.

The trend exhibited in the most recent quarter shows increases in the adoption of high-speed broadband services in both the cable and telephone sectors, with more overall use of fiber in extant broadband services to achieve higher speeds. The traditional market share split between cable and telephone companies, 55 to 45 percent, respectively, has shifted slightly to 57 to 43 percent. This 4 percent shift is noteworthy, but not dramatic. It is counterbalanced by the 30 percent stronger growth rate for fiber-based broadband services offered by telephone companies than for cable-based broadband overall.⁷⁸

Performance

Performance analysis tells us where American broadband networks are relative to the rest of the world in factors such as speed and latency, and whether they are moving ahead or falling behind—an important part of the overall broadband policy story. Performance is more difficult to evaluate than deployment, adoption, and price, and the data are not as extensive as we'd like. Much of the data that purports to measure performance is deeply flawed. Consequently, false claims to the effect that the United States is falling behind the rest of the world in broadband performance are common, even though the data drawn from observation clearly contradict them. False performance claims may be deliberate attempts to make U.S. performance look worse than it actually is, but they can also come from a genuine lack of understanding of a complex subject.

The OECD attempts to estimate performance by averaging the advertised speeds of broadband offers in member nations and then allocating population among these plans according to infrequent surveys. By its own admission, the OECD fundamentally does not know how many users are subscribed to which offers, let alone how fast the offered services actually run:

Broadband subscriber and user data are much the same. Operators know how many "subscriber lines" they have in their network. The OECD collects and publishes this data from telecommunication regulators twice a year. The data give a very good

measure of the physical lines in a country. The subscriber data does not however, provide any information on how the lines are used.⁷⁹

The FCC tries to correct the OECD speeds and services estimates by adjusting advertised rates by Ookla's estimates of the deviation of actual speeds from advertised ones, but Ookla doesn't know which service tiers are used by which users either, and the Ookla system has its own problems with accurate measurement.⁸⁰ So correcting the OECD estimates with Ookla's estimates simply compounds the error. The only way to determine the actual speeds of all broadband plans in use in any nation is to observe all lines in action, and Akamai is one company that does that.

Overall broadband performance is a function of speed (also known as "bandwidth" or "capacity"), latency, and packet loss. Of these variables, speed is the most commonly measured, the easiest to measure, and the most important. The other two variables are complex results of many factors; latency is influenced by the distance bits travel from origin to destination, and packet loss can be the result of physical interference, network congestion, or low computer speed. Consequently, we use "speed" as a proxy for overall network performance except as noted.

Broadband networks consist of three basic elements: a high capacity backbone or core that connects Internet Exchange points (IX) to each other; an edge network that connects directly to subscribers in the home or office; and a distribution network that connects the edge to the core. Performance is limited by bottlenecks anywhere in the path between origin and destination, typically between clients in the home or office and servers connected directly to the core (the Netflix/YouTube scenario), or between peers in the home or office and corresponding peers in other homes or offices (the Skype/BitTorrent scenario).

The operation of computers and applications contribute to perceived speed; a high-performance desktop computer using the latest zippy quad-core processor and a solid-state disk can transfer files faster than a smartphone or laptop, for example, as we all notice when we get a fast new computer.

The goal of broadband network performance analysis, however, is to isolate the contributions made by such non-network factors in order to make meaningful comparisons between networks. The SamKnows broadband measurement system does just this: it measures speed from the initial entry point of broadband service to the home or office, not from an arbitrary point within an application running on a consumer's computer that may have its own shortcomings. While we have a good set of SamKnows data for the United States, very little SamKnows data are available for the rest of the world.⁸¹ Consequently, we are currently limited to comparing the United States to other countries according to data collected by Akamai and Ookla, systems that combine computer, server, and application performance with network speed. Of these sources, Akamai is the only one that preserves the historical data necessary to the construction of trend lines.

It's particularly important to track how the United States is trending relative to other nations. Whether a nation is rising or falling relative to the norm is an important indicator

of the rationality of its broadband policies with respect to speed. While speed is not the sole determinant of a nation’s “IT innovation readiness,” it’s certainly a very important part of the picture. If we lack networks of sufficient speed, we lack the ability to use any applications that depend on higher speed. It’s possible to under-power a network and thereby limit its usefulness, but it’s also possible to over-power one by racking up high costs for excess capacity that can’t be used, at least in the near- to medium-term. Of these two errors, the under-powered network is the more detrimental to innovation than the over-powered one, because there’s always a chance that high capacity will be useful in the future; no one builds applications that require significantly greater speed than commonly-deployed networks have to offer, after all.

The United States has been in the Top 10 for broadband speed in three of the five years, most recently in 2012, with a seventh place standing.

We’re also interested in knowing whether the claims that broadband providers make about the speeds of the services they offer are true. The dataset collected by the FCC using the SamKnows system answers this question, at least for the United States and the UK.⁸²

Most analysis of broadband speeds focuses on wired connections to the home, but the connections to offices and campus are also important and arguably of greater relevance to innovation, particularly in the business-to-business sector. The speed of mobile wireless networks is also very important as smartphone ownership becomes more widespread and the “apps economy” for smartphones becomes more important. Unfortunately, the data for commercial and mobile services are less well developed than they are for wired, residential connections.

High Broadband Speeds and Adoption

The best indication of the diffusion of high-speed networks at affordable prices is provided by Akamai’s “High [Speed] Broadband Adoption” figure we used in the deployment section.⁸³ This indicator provides some insight into the percentage of subscribers using network services at the top performance tier. It covers the Top 10 nations each year out of a total of 180 nations it reviews. Hence, it provides insight into three factors at once: 1) How widely deployed are high-speed network services; 2) How competitively are high-speed network services priced; and 3) How favorably do consumers view the utility of high-speed network services.

Akamai has collected data on high-speed broadband adoption since 2008, and has chosen to set the bar for “high speed” at 5 Mbps from 2008–2011 and raising it to 10 Mbps in 2012. Only five nations have made Akamai’s Top 10 list all five years: Korea, Japan, Hong Kong, the Netherlands, and Denmark. The United States has been in the Top 10 for high broadband adoption in three of the five years, most recently in 2012, with a seventh place standing. The seventh place ranking for the United States in 2012 is our highest ranking ever.

While Akamai provides a global average for each quarter, it does not provide information on nations that finish below the Top 10 except for the United States, which ranked 12th in 2009 and 13th in 2011. (Figure 17) Several nations have made the Top 10 once or twice, such as Canada, the Czech Republic, Finland, Ireland, and Singapore. In addition to the five nations that consistently rank in the Top 10, only Romania has made the Top 10 list more frequently than the United States; Romania appeared every year until 2012.

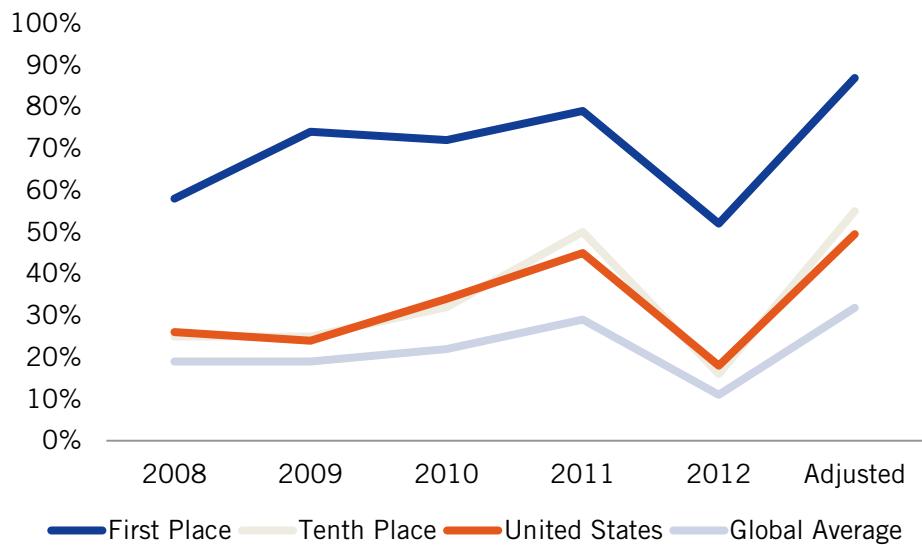


Figure 17: Percentage High Speed Broadband Adoption Ranking in Q3 of Each Year⁸⁴

The significance of this chart may be hard to discern since the slope of the line is downward for all nations in 2012 because Akamai increased its threshold for “high-speed broadband” to 10 Mbps; to correct for the perception of decline in Q3 2012, we add an adjustment. The item of most significance for network policy is the fact that the United States improved its standing from 13th in 2011 to 7th in 2012. (Figure 18)

While some critics of American broadband policy claim we’re falling behind the rest of the industrialized world in broadband performance and affordability, the Akamai data shows we’re not.

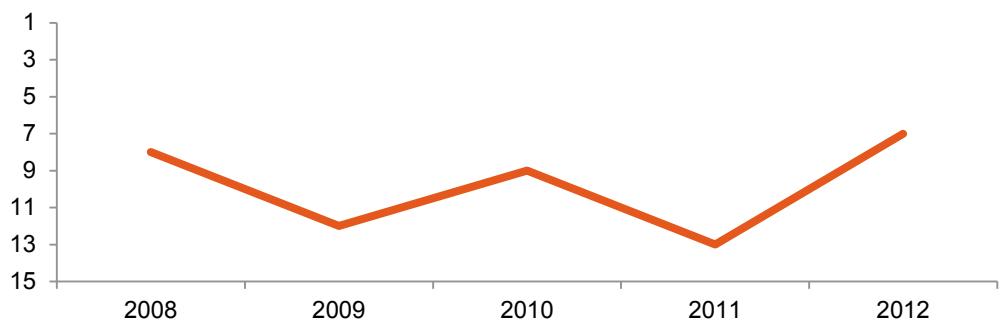


Figure 18: America's International Ranking in High Broadband Adoption⁸⁵

Average Peak Connection Speeds

High broadband adoption is a good measure of the diffusion of high-speed broadband all the way to the subscriber, but it doesn’t tell us the actual speeds of *all* broadband services in use. To grasp the performance of all network service packages actually in use, we turn to another metric from Akamai, “Average Peak Connection Speed.”⁸⁶

American broadband networks are improving in speed faster than those of the 10 fastest nations, so we're closing the gap; Americans enjoy an average peak broadband connection speed of 29.6 Mbps.

Average peak connection speed is the average top speed of each individual connection rather than the speeds of the fastest connections. The limitation of the average peak metric is that it fails to show us the range of speeds that are available for purchase, so it is partially an indication of perceived value. In other words, if many consumers in a nation are choosing to purchase less expensive lower speed tiers, the nation's speeds on this metric would be lower than otherwise. Similarly, if a relatively small number of users have extremely high speed plans—as they do in Korea—but most users have DSL, the nation's score in average peak speed will be artificially high.

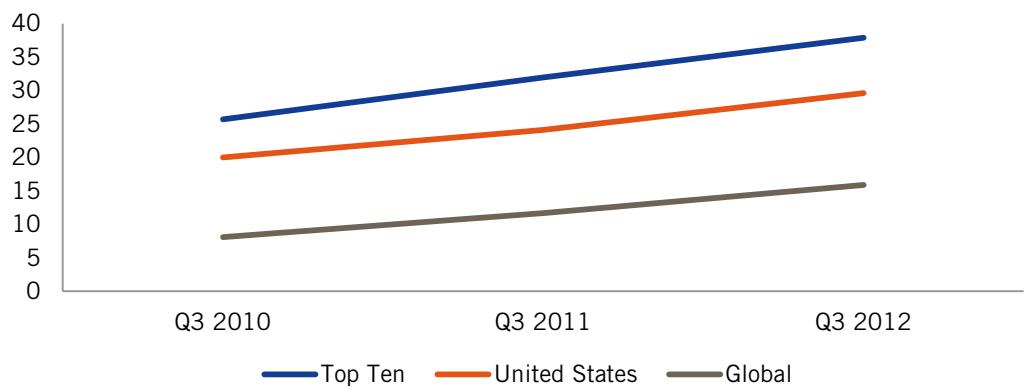


Figure 19: Average Peak Connection Speeds over Time (Mbps)⁸⁷

The data show that the average peak speed of all broadband connections in use in the United States was 29.6 Mbps in the third quarter of 2012, compared to the Top 10 average peak of 37.9 Mbps and the global average peak of 15.9 Mbps in the same period. (Figure 19) It's the most up-to-date indication of overall average broadband speed (or "Internet connection capacity" in Akamai's terms).

America's average peak speed increased 9.3 percent between 2Q 2012 and 3Q 2012, a period in which the global average declined by 1.4 percent; our quarterly improvement exceeded that of all other nations except Hong Kong. Our average speed increased 25 percent for the year, 11 points below the global average but one point ahead of the rate of increase among the Top 10.

In other words, the average capacity of America's broadband connections is improving faster than the 10 fastest nations (in part because they have already achieved faster speeds), and Americans are either choosing higher speed service offerings or benefitting from no-cost upgrades on the part of their providers. In international terms, the five U.S. states with the highest average peak speeds are faster than all but five foreign nations.⁸⁸

The data show that the claim that America is falling behind the rest of the world in terms of broadband speeds is simply false. American broadband networks are improving in speed faster than those of the 10 fastest nations, so we're closing the gap; Americans enjoy an average peak broadband connection speed of 29.6 Mbps.⁸⁹

Advertised Speed and Actual Speed

SamKnows measures the speeds of American broadband services for the FCC and compares them to advertised speeds. There is unfortunately no international data set that provides comparable information across the globe, despite the fact that SamKnows contracts with dozens of nations to perform similar tests in other countries. The tests SamKnows conducts are proprietary, and other nations have chosen not to make their results public in most cases; the one exception is a study SamKnows did for Ofcom, the UK's version of the FCC. According to the FCC, this study showed a significant discrepancy between advertised speeds and actual ones, with actual speeds being more than 50 percent lower:

...a November 2011 U.K. broadband study (conducted by the U.K. regulator Ofcom with the assistance of SamKnows) revealed an average advertised speed of 16.3 Mbps, with a corresponding average actual speed of 7.6 Mbps—a significant gap between the advertised and actual speed that U.K. consumers experience. By contrast, the most recent U.S. data on actual speed shows that American ISPs deliver on average 96% of advertised speeds during peak intervals, with five ISPs routinely meeting or exceeding advertised rates. In an attempt to address the gap that exists between advertised and actual speeds in the U.K., the Advertising Standards Authority (ASA) and Committee of Advertising Practice (CAP) issued guidance (effective April 2012) providing that ISPs may advertise a given broadband speed only if at least 10% of the customer base can achieve it.⁹⁰

In contrast, the FCC found that U.S. advertised speeds correlate closely regardless of technology, while actual upload speeds generally exceed advertised ones for uploads on all technologies. (Figure 20)

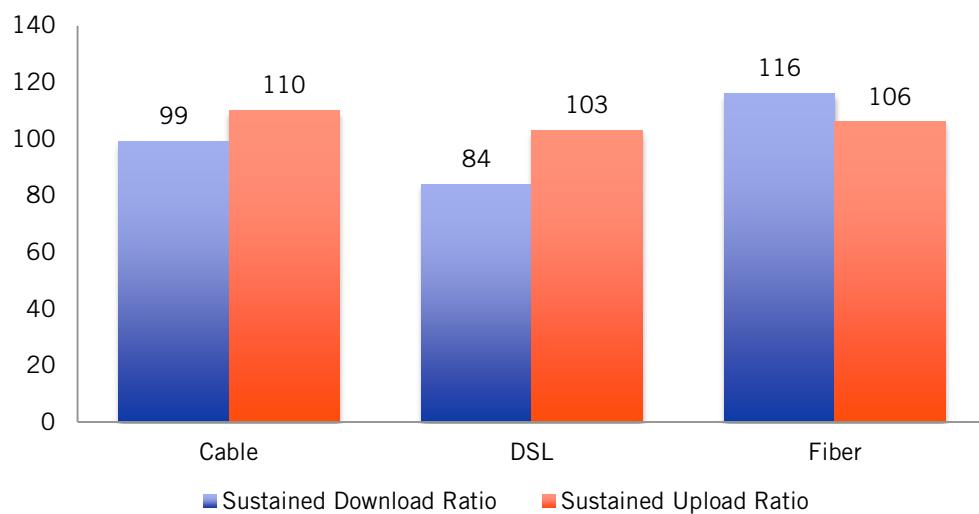


Figure 20: Average Peak Period Sustained Download and Upload Speeds as a Percentage of Advertised, by Technology—April 2012 Test Data⁹¹

The finding that American upload speeds exceed advertised rates is especially significant given the emphasis that critics such as Crawford place on “symmetrical” broadband. The

If consumers were clamoring for more relative upload capacity, we would expect to see a shortfall between advertised and actual rather than an abundance.

typical connection offers greater speed in the download direction than in the upload direction because such an allocation fits consumers' actual pattern of usage and allows consumers to pay less than for more expensive symmetrical service. Actual upload speeds are faster than advertised ones because the upload path is more lightly used than the download path. If consumers were clamoring for more relative upload capacity, we would expect to see a shortfall between advertised and actual rather than an abundance. It's well and good to insist that upload capacity should equal download capacity according to some vague pseudo-philosophical principle of network architecture, but when the facts speak as loudly as they do in this matter, it's wise for policy analysts to listen to the voice of the users. Moreover, very few applications require symmetrical upload speeds. Most of what consumers do on the upload is not affected significantly by slightly slower upload times.

Our survey of international speeds and services would not be complete without the data published on the Net Index by Ookla website. These data show a very different picture than the one we see in the Akamai data. Net Index ranks the United States in 34th place in average download speed, behind 20 nations that trailed the United States in the Akamai peak connection speed study.

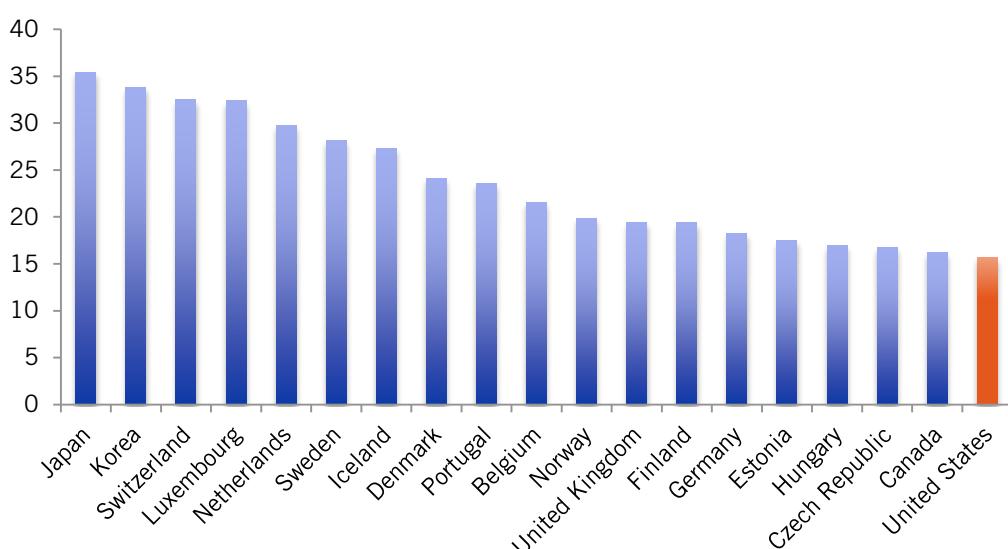


Figure 21: Net Index by Ookla Speed Rankings, February 2013 (Mbps)⁹²

The Ookla system ranks the United States between Canada and France, two nations that don't appear in the main Akamai ranking because their speeds are too slow (although they're listed in the Appendix.) The discrepancy is puzzling. One explanation might be that the Ookla data are more recent, as they represent a rolling average of the last 30 days, in this case running from January 6 to February 4, 2013. (Figure 21) But the Akamai data were taken from the third quarter of 2012—not far back enough to account for such a dramatic drop (from 29.6 Mbps to 15.71 Mbps). It's highly unlikely that the average connection speed in the United States would have dropped over this period, as there is no historical period where it has.

Two causes are most plausible: the nature of Ookla's sample and the location of their test servers. Akamai measures speeds registered by the full range of users whose data are measured as they access ordinary Internet services hosted by Akamai servers. As the Internet's largest Content Delivery Network, it maintains a network of hundreds of thousands of servers around the world and sees more than half of the entire Internet.⁹³

In contrast, Ookla only sees the performance of the computers used by people who make the decision to test their connection speeds—a much smaller, self-selected sample. For the United States, Ookla measured 11.3 million IP addresses for this ranking. Since the United States is home to some 245 million Internet users (10 percent of the world's 2.4 billion total Internet users), this is a smaller sample that may be biased.⁹⁴ Many people go to speedtest.net (the source of Ookla data in the United States) when they feel that they are getting slow speeds. The slow speeds these users experience may be caused by computer hardware problems, viruses, or overloaded servers; but if the user can't tell, neither can Ookla. So the sample is intrinsically suspect and there's no reason to believe that the causes of these problems have uniform impact on speeds in every nation.

In addition, the Ookla method relies on a small number of test servers located in major cities—a few dozen of which are in the United States—and a test program running on the user's computer. While the Akamai system measures the performance of more than half of Internet users worldwide as they're using the Internet in the way they normally do, the Ookla system measures the performance of less than 5 percent of Internet users who have chosen to perform a test for troubleshooting reasons.

The small number of servers employed by Ookla, and their tendency to give exceptionally high rankings to very small countries and regions such as Andorra, Macau, Luxembourg, Iceland, and Liechtenstein, suggests that their methodology is biased against geographically large countries. We can see from experience that Ookla reports higher speeds from test servers close to the user than from servers farther away (as would be the case in a nation like Macau, for example); this pattern apparently repeats itself on a global scale. (The underlying cause for higher performance over shorter paths is a technical quirk in the TCP-IP protocol).

The discrepancy is nevertheless larger than we would expect and may suggest that some core networks are under-provisioned with respect to edge networks, perhaps at peak congestion periods. Akamai servers bypass the core and serve the user through the distribution network, so the siting of their servers means they can only measure two parts of the overall broadband ecosystem—the edge and distribution networks (the “last mile” and “middle mile.”) Increasing the speed of the edge and distribution networks will not alleviate this problem, if it exists at all; if anything, a faster edge would simply put more stress on the core and cause greater delay. In any case, this is an issue that warrants further study as congested core networks are known to be characteristic of Japan and Korea—nations with very fast edge networks and ample distribution networks.

Mobile Broadband

Conventional wisdom holds that mobile broadband speeds are so low compared to wired ones that they can't be considered a reasonable substitute for residential connections, but

the data tell a different story. In the latest Akamai report, a number of mobile networks show peak speeds that are actually much faster than comparable wired connections. The Top 10 mobile networks worldwide showed peak speeds between 19 Mbps and 39 Mbps. (Figure 22) The fastest American network had the 47th peak speed—9.8 Mbps—still fast enough to support a reasonable broadband connection in the home and faster than any of the entry-level broadband packages offered in the United States.

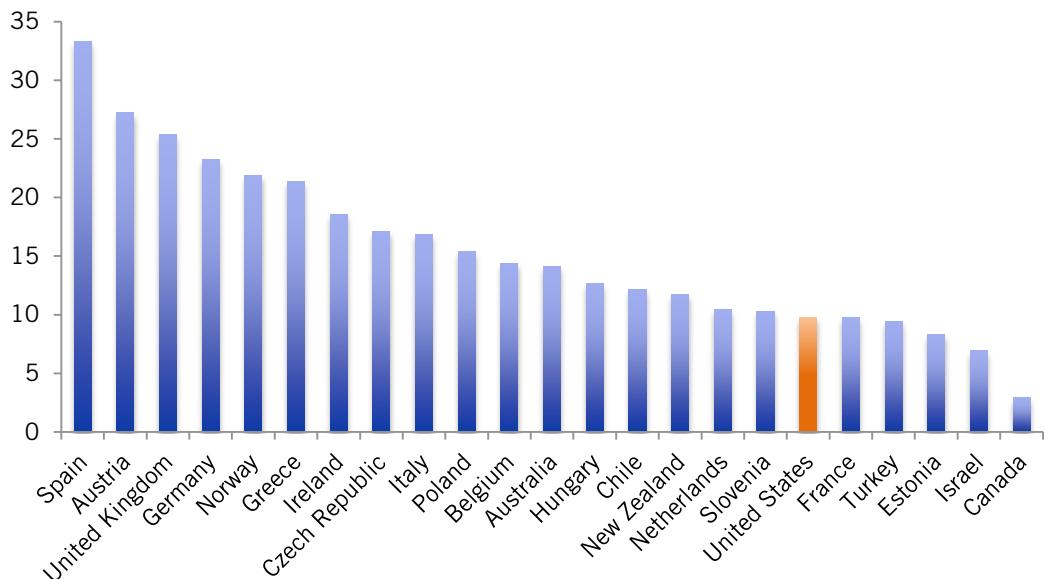


Figure 22: Peak Mobile Broadband Speeds, 3Q 2012 (Mbps)⁹⁵

By average speed, the Top 10 ranged from 7.8 to 3.7 Mbps, with the best network in the United States clocking in at 2.7 Mbps. These figures suggest that American mobile networks are less well provisioned with spectrum than those of our competitors, but that American mobile broadband is an acceptable entry-level broadband option, in terms of performance, if not by price and by usage limit.

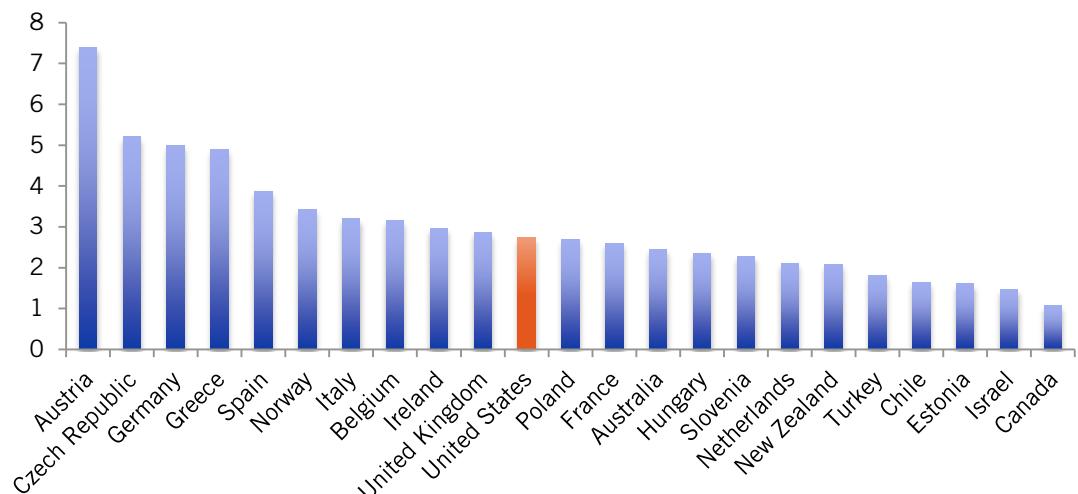


Figure 23: Average Mobile Broadband Speeds, 3Q 2012 (Mbps)⁹⁶

Performance Conclusions

Analysis of the data collected by Akamai and SamKnows suggests that American broadband speeds are higher than is generally thought, and are in many cases actually faster than advertised. The data also show that the performance of American broadband networks has steadily improved over the past five years—especially during the third quarter of 2012, when American average peak speed increased by 9.3 percent and the global average peak declined by 1.4 percent. According to Akamai, the United States is tied with Denmark as the eighth-fastest broadband network in the world in terms of the average speed of all connections, but a different testing methodology employed by Ookla suggests that we're only in 34th place. Ookla also says the American average speed is only half as fast as Akamai's average peak speed, but twice as fast as Akamai's average of all connections.

The larger sample employed by Akamai and the dearth of test servers in the Ookla system suggests that the Ookla system is biased toward small countries and by user self-selection, and the large variation between peak and average speeds in the Akamai system suggests that average speed is strongly affected by factors beyond the control of the broadband provider. Broadband speed declines under load, but the variation seen by the SamKnows system suggests that this degradation is on the order of 15 percent, but Akamai reports a 400 percent variation between peak and average speeds. In any event, Akamai declares that “average peak connection speed is more representative of Internet connection capacity” than is average connection speed, as previously noted.

Mobile broadband networks are extremely fast in some countries, with average peak connection speeds near 40 Mbps in some cases. Average speeds are much lower, but still fast enough to serve as an entry-level gateway to the broadband ecosystem. In order for mobile broadband to fully compete with wireline broadband, however, mobile service plans will need to be adjusted to provide more generous download quotas than they currently do. While this may not be feasible in densely-populated urban areas, it's practical in less-populated rural ones.

Price

International data on broadband pricing are even more problematic than similar data on deployment, adoption, and performance because there are so many variables involved with respect to tiers of service, special offers, regional variations, and public subsidies.

Broadband providers commonly bundle packages of Internet access, telephone service, and TV in ways that are hard to compare across borders, or even across regions in a nation as large as the United States. Some analysts and critics pay special attention to high-speed offerings, and some to low-speed offerings. The data on this subject are regularly revised, and should improve in the future; both the FCC and its British counterpart, Ofcom, have hosted workshops with the OECD in the interest of improving and standardizing international data collection.⁹⁷

In many cases, the cost of broadband service is not fully reflected in the monthly bill the subscriber pays, especially where broadband is heavily subsidized. With the exception of the United States, all nations with extremely high fiber deployment at the network edge have subsidized broadband. The ultimate cost of these subsidies to the taxpayer should be

The United States ranked first in low-cost broadband offerings in 2008 and second in 2010.

considered when calculating the actual price of the service. However, this element is routinely ignored by most analysts, in part because it is very difficult to obtain but also because excluding it helps advance the advocates' argument that American consumers pay too much for broadband.

Entry-Level Pricing

Nonetheless, the oft-heard cry that American consumers pay the highest prices in the world for slow broadband service lacks an empirical foundation. According to the International Telecommunications Union (ITU), the United States is an international leader in entry-level broadband price competitiveness, with the fourth-lowest prices for basic broadband among the 165 countries and regions the ITU studied in 2010, and the second-lowest prices in 2008.⁹⁸ When non-OECD members are excluded, the United States ranked first in affordable, low-cost broadband offerings in 2008, and second in 2010.

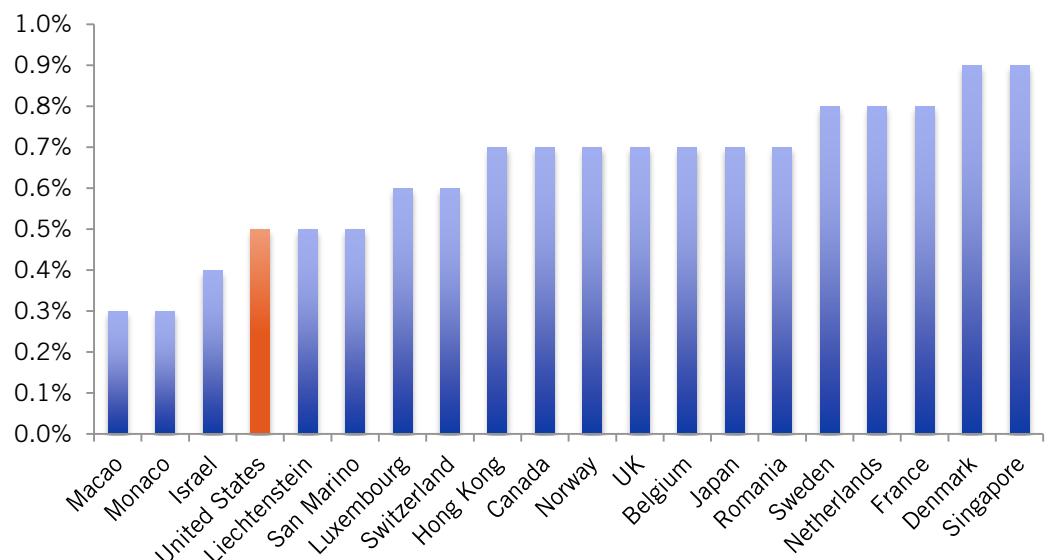


Figure 24: Entry-Level Broadband Price as Percent of Per Capita Income, 2010⁹⁹

ITU figures are calculated on the basis of the percentage of per capita Gross National Income required to pay for a very basic broadband plan, with at least one GB of monthly traffic allowed over a connection with an advertised speed of at least 256 Kbps. In many cases the plans are uncapped, and the entry level speeds in some countries are in the tens of megabits (30 Mbps for Monaco and 50 Mbps for Korea).¹⁰⁰ The United States' move from second in 2008 to fourth in 2010 came about as data were added for Monaco and Israel—countries for whom there were no data available in 2008. To put the ITU figures in the broadest possible context, we can contrast the 0.5 percent of per capita GNI paid by Americans for entry-level broadband with the rates paid in less developed countries (LDC), such as Malawi and Guinea, in excess of 2,400 percent.

More meaningful comparisons can be made by contrasting the \$20 per month for the United States with purchasing power parity (PPP) equivalents of \$17.60 for Japan, \$22.60 for Canada, and \$25.80 for the UK—all nations with rates of adoption similar to ours. Korea and Singapore are among the highest adoption nations, but their entry-level prices

(\$34.20 for Singapore and \$34.90 for Korea) are in fact 60 percent higher than ours. These findings suggest that the price of American broadband service is not, in fact, a barrier to adoption (as we explain in the section on adoption). Some argue that non-adopters would be more likely to become adopters if entry level packages were offered higher speeds, but no survey supports this claim; those who don't subscribe to broadband at all are not holding out for gigabit service—they're typically uninterested in what the Internet has to offer. If this were not the case, then Japan, with much higher speeds than the United States (thanks in part to government subsidies) would have higher rates of adoption than we do, which it doesn't.

In the United States, entry-level broadband services range in speed from 256Kbps in remote areas to 3 Mbps for DSL in more populated areas, and from 1.5 Mbps to 6 Mbps for cable. Any package with speeds of 1.5 Mbps or more can support a single video stream—such as Netflix standard definition—and any package with 3 Mbps or more can support streaming rates as high as Netflix achieves over Google's Kansas City network.

Higher Tier Pricing

The FCC analyzes OECD's price data by grouping plans into three categories: 1–5 Mbps, 5–15, and 15–25. It places the United States 15th of 25 in the low speed group, 21st of 31 in the middle group and 26th of 32 in the high speed group.¹⁰¹ The FCC data includes limited samples of higher speed plans as well, and we've extracted all the data and organized it by quintiles where dividing lines are drawn at 5, 20, 50, and 100 Mbps to better reflect technologies. After correcting speeds for the discrepancy between advertised and actual (following the FCC method that computes a very approximate "shortfall index" based on Ookla's loose international speed data), and resetting prices to PPP with the United States, we rank nations by average prices for all plans using the Wallsten net price formula used by the FCC.¹⁰²

Considering all plans and all fee elements (but not subsidies), our analysis ranks the United States 15th out of 25 nations in the 1–5 Mbps range, with an average price of \$33.73 per month. This figure is considerably higher than the ITU's reported \$20 per month for entry-level broadband because the FCC's data grouping combines the low-priced lower speed plans offered by America's DSL and cable providers with higher-priced 5 Mbps plans. The FCC's data in the low speed group includes upgrade plans as well as higher-priced entry-level plans; it also prices by PPP rather than per capita GNI.

The resulting ranking among countries that appear in both data sets is considerably different, and there is no data in this tier for high-adoption nations Korea and Singapore.

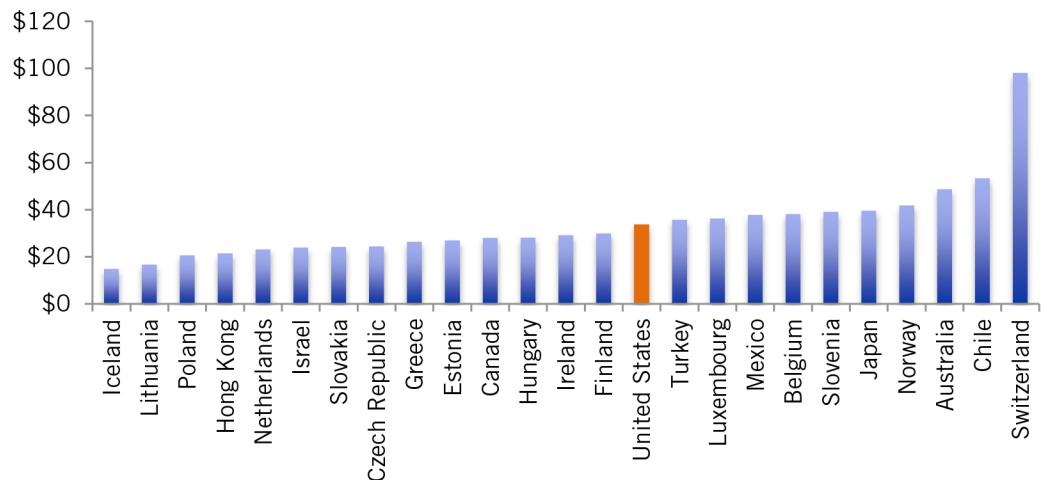


Figure 25: First Quintile Pricing, Less Than 5 Mbps (PPP dollars)¹⁰³

For today's applications, the 5 to 20 Mbps tier is the sweet spot where the lines cross between low price and high utility.

In the second quintile, from 5–20 Mbps, the United States ranks 15th out of 36 nations for which the FCC has data, at an average price of \$35.33 per month—only \$1.60 per month higher than the lowest speed quintile. (Figure 25) The nation with the highest price in this quintile is New Zealand, at \$243.29. High-adoption nations Korea and Singapore have prices considerably higher than the United States, at \$54.09 and \$95.59 respectively—so again the proposition that low prices lead to high adoption is not supported.

For today's applications, the 5 to 20 Mbps tier is the sweet spot where the lines cross between low price and high utility. Users with this service level can enjoy the highest resolution video streaming with simultaneous web surfing. At the higher end of the tier, multiple video streams can be combined with video calling, voice, and web surfing. In terms of general utility, this quintile is most important.

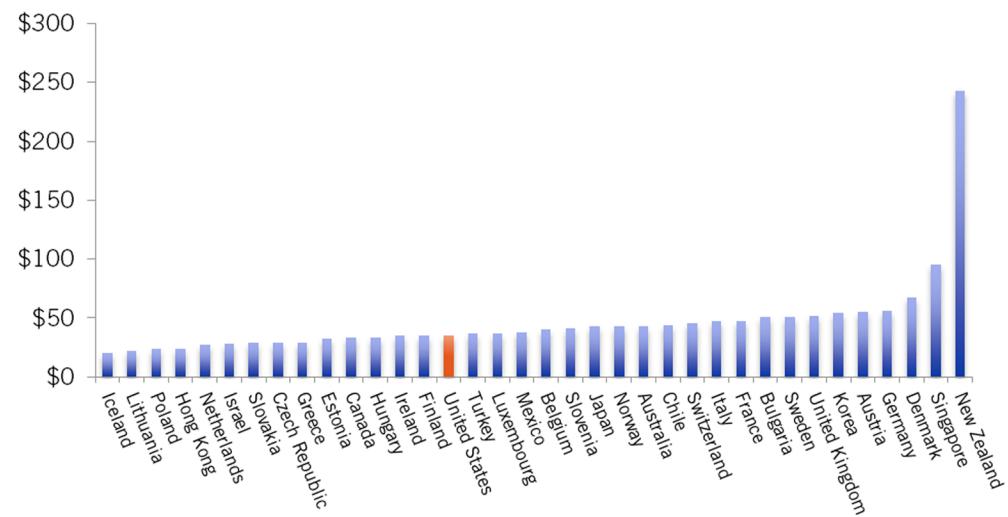


Figure 26: Second Quintile Pricing, 5–20 Mbps (PPP dollars)¹⁰⁴

Our third quintile covers speeds from 20–50 Mbps, in which the United States ranking is

near the bottom—25th out of 28, at an average price of \$76.84. (Figure 26) The price in this tier reflects the competitive scenario that prevails today between DSL, cable, and fiber, and the current state of technology. In countries with short copper loops, such as most of Europe, 20 Mbps and faster can be delivered over standard DSL (as well as over cable and fiber). (Figure 27) As a result, most European providers have been able to deliver these speeds with no upgrades to their cable/wire plants. In the United States however, speeds greater than 20 Mbps on telephone wires generally require VDSL2+, a technology that depends on fiber to the neighborhood and copper loops much shorter than our national average of 20,000 feet (3,000 feet would more typical for VDSL2+ in the United States). The service offering sold by AT&T as “U-verse” provides speeds in this range, at 20–25 Mbps, and CenturyLink employs copper pair bonding with VDSL2+ to reach 40 Mbps in selected areas.

Cable modems reach 20 Mbps easily with any version of DOCSIS from 1.1 to 3.0, and 20 Mbps is the first or second upgrade from entry-level broadband to fiber. In large parts of rural America, where cable and telephone services are provided by small carriers, prices are higher for reasons of coverage, density, and investment. Prices in this tier are likely to be affected quite dramatically by Vectored DSL and investment in upgrading DSL backhaul generally. Better rural DSL will put pressure on the smaller rural cable providers to upgrade their services; most of the 18 percent of American homes passed by cable to which DOCSIS 3 is not yet available are in rural areas.

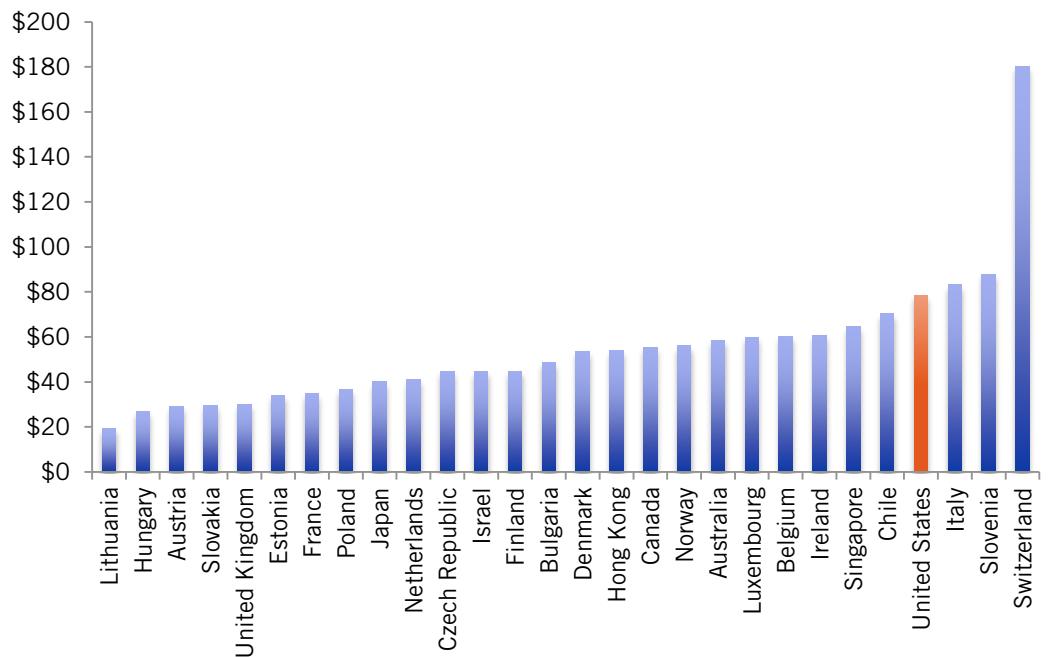


Figure 27: Third Quintile Pricing, 20-50 Mbps (PPP dollars)¹⁰⁵

Data are relatively sparse in the fourth quintile, which ranges from 50–100 Mbps; the FCC has no data for Iceland, Greece, Hungary, Turkey, Mexico, Chile, Germany, Portugal, Sweden, and Korea, despite the fact that this speed should be readily available in high-fiber nations such as Sweden and Korea. In the United States this speed tier is currently

In fact, there is no correlation between lower prices (plans in the first two speed tiers) and higher broadband adoption.

provided only by DOCSIS3 and fiber; it will remain outside the reach of DSL until high-speed Vectored DSL is installed, and will remain outside the reach of wireless until sufficient spectrum is allocated to make LTE Advanced a practical system.

Users in this range benefit from competition between cable and the DSL found in the third quintile in short loop nations and scenarios. In the U.K., for example, cable company Virgin Media offers both 60 Mbps and 100 Mbps packages, which it touts as faster than DSL. Virgin (covering just 60 percent of the UK) provides service mostly in lower cost, more densely populated urban areas. No United States broadband supplier offers a 60 Mbps package, so the head-to-head comparisons are not possible.

The relatively small price difference between the United States and Singapore—the high adoption nation served by both fiber and cable at these speeds—probably reflects the relatively new state of Singapore’s fiber network and the public subsidies for deployment. The United States price is \$106, which is somewhat above Singapore’s price of \$86.72, despite the fact that Singapore is a high-population-density city state where deployment of a high-speed network should be much cheaper. Once again, the evidence confirms that high adoption is not closely associated with low prices. In fact, there is no correlation between lower prices (plans in the first two speed tiers) and higher broadband adoption (0.04).

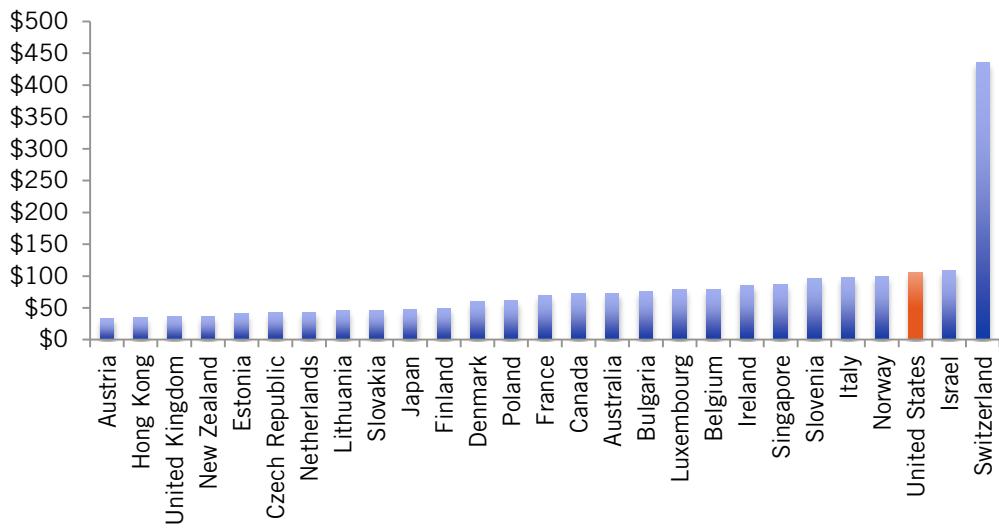


Figure 28: Fourth Quintile Pricing, 50-100 Mbps (PPP dollars)¹⁰⁶

The final quintile, greater than 100 Mbps, is poorly populated, with data from only 14 nations. (Figure 29) High adopters Korea and Singapore are absent, as are fiber-rich nations Japan and Sweden. The FCC has prices ranging from \$41.58 per month for Hungary to a staggering \$734.45 for Turkey, and the United States stands 12th out of 14 at \$199.99 per month. These prices reflect the fact that the service tier above 100 Mbps is more a curiosity than a meaningful service today.

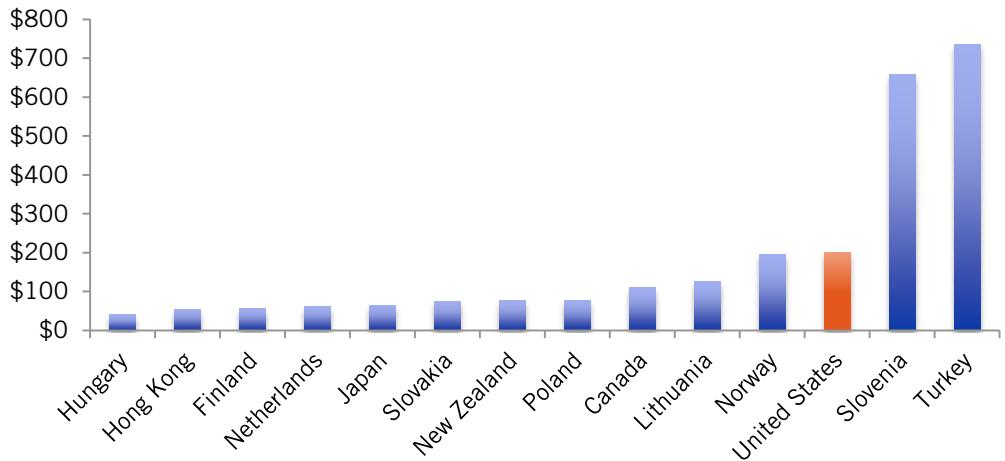


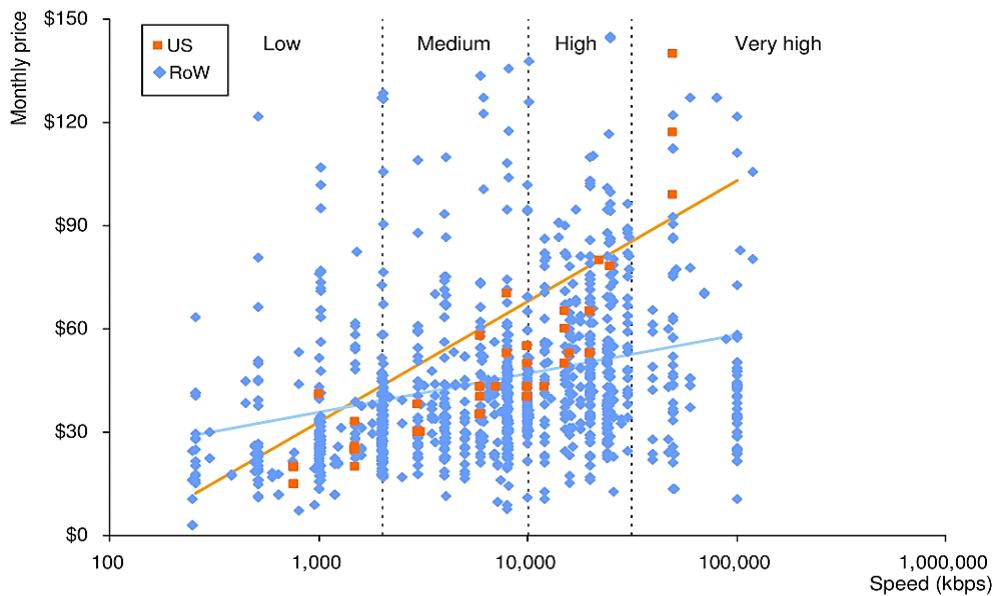
Figure 29: Fifth Quintile Pricing, More than 100 Mbps (PPP dollars)¹⁰⁷

The FCC's international pricing data suffers from a number of limitations. In the first place, it slices the data into tertiles where the divisions are arbitrary both in terms of technology and general utility. Excluding sub-megabit services from the entry tier means that the low-priced \$20 per month plans that the ITU discovered are drowned out by second and third upgrade steps. AT&T, for example, offers entry level DSL at 768 Kbps, with upgrades at 1.5 Mbps, 3 Mbps, and 6 Mbps, and Verizon offers plans at 500 Kbps, 1 Mbps and 3 Mbps for DSL. Cable offerings in this range are also quite varied: Time Warner Cable offers two service plans below 5 Mbps, while Comcast offers one. The fact that the prices for the first two quintiles we draw are so similar—they only differ by 4 percent—suggests that users perceive similar value across the two lower tiers, all the way from 1.5 Mbps to as high as 20 Mbps. Policy analysts may be surprised that consumers hold this view. The lack of data for the highest quintile is not surprising, however, as there are no new applications that require hundreds of megabits to operate. This tier is chiefly of interest to a very limited audience. For example, actual adoption of the gigabit broadband service provided by the municipal electric utility in Chattanooga, Tennessee (funded by federal stimulus dollars and priced at \$300 per month), was less than a dozen subscribers as of August, 2012.¹⁰⁸ (This is not to say that faster networks will not become more important as time goes on; for now, they are mostly of interest as test beds.)

The Progressive Pricing Strategy

Despite the shortcomings in the data for international comparisons, it's possible to draw some meaningful conclusions about the pricing policy it represents. Berkman Center law professor Yochai Benkler's study, *Next Generation Connectivity*, decodes the pricing strategy of American broadband suppliers quite succinctly in a chart that compares prices to service tiers based on massaged data from OECD, TeleGeography, and Point Topic.

Figure 3.28. Firm-level offerings in OECD, by price tiers; US offers in orange



Source: OECD, TeleGeography, Point Topic
Note: Top 4 providers only

Figure 30: Benkler's Price Analysis¹⁰⁹

America's broadband providers employ a progressive pricing policy in which users of the highest tiers of service effectively subsidize users of our lower speed services—the entry-level services that are among the cheapest in the world.

The Benkler analysis tells us several things. Like most analysts, Benkler finds that higher speed services are more costly than lower speed ones. Like the ITU, he finds that the United States has very low entry level prices, and he finds that we have very high prices for very high speed services. While he fails to notice the absence of meaningful price differences among service offerings ranging from 1 Mbps to 20 Mbps, he correctly discerns that the prices paid by Americans for broadband service are in fact more progressive than prices in the rest of the world. Benkler also fails to discern the low correlation between price and adoption.

It's evident that America's broadband providers employ a progressive pricing policy in which users of the highest tiers of service effectively subsidize users of our lower speed services—the entry-level services that are among the cheapest in the world.

While some seek to flatten America's broadband rates in order to get lower prices for higher speeds (which would mean, by definition, higher prices for lower speeds), there is a great deal of logic in the slope of the American trend line. It ensures that enticing prices are offered to our substantial non-adopter population, some of whom are price-sensitive. It also enables broadband providers to recoup investments on technology upgrades and rewiring projects by collecting higher fees from the users who benefit most immediately from these upgrades. When we examine prices over time, we see a steady decline in the costs per Mbps per network mile. The cable modem packages that sold for \$45 ten years ago offered 1 Mbps, but today's \$45 package offers 20 or 30 Mbps. It also suggests that the subsidies employed in nations with extremely high speed fiber edge networks serve more to reduce monthly fees paid by the highest intensity users than to reduce entry barriers to the poor and other non-subscribers.

The progressive pricing strategy seems to be working. Some argue that the strategy chosen by Korea, Japan, and Sweden in forcing the rapid build-out of heavily subsidized fiber networks has given them an innovation advantage, and to be sure, if taxpayer money were no object, extensive public support of private network improvement would lead to faster networks. But it can just as easily be argued that being too far ahead of the global norm for speed can represent a non-constructive misallocation of resources. In any case, the United States is neither too heavily invested in low-speed networks or in high-speed ones, and our consumers don't seem to discern much difference between the offerings in the most common service tiers from 1 to 20 Mbps. This is not to say that additional public support for network upgrades through more generous tax depreciation schedules, for example, would not be desirable.

Factors Determining Price

The question of why moderate- and high-speed service prices are as high as they are in the United States requires more detailed analysis. On a technical basis, network economics stem from the basic problem of moving bits over a distance. The more bits are moved, the higher the cost; and the more miles crossed, the higher the cost as well. Increasing the rate at which bits are moved involves, in practical terms, the purchase of new equipment capable of moving bits at the required rate over the required distance. Equipment is sold at various levels of performance. The price to the network operator only increases when the limits of a particular piece of equipment are exceeded, but when they do, the increase is a jump rather than a linear increase in cost.

By way of example, consider this situation: Most broadband users have a home gateway with a Wi-Fi antenna and some number of Ethernet ports running at 100 Mbps or 1 Gbps. If the 100 Mbps capacity of the Ethernet is exceeded, the user has to replace the gateway with a higher capacity model; typically this is a 100 Mbps to 1 Gbps upgrade. While the user may only have needed a 10 percent increase in capacity, the only way to obtain such a boost is to add 1,000 percent more capacity. Similarly, if a home user adds a room to the house, it will be necessary to add additional cables to reach it, and Ethernet cable is sold by the foot. Finally, a user who fills up all the available Ethernet ports on the home router will need to purchase an additional Ethernet switch with four or eight ports simply to obtain the one that is needed. Thus, the costs of network construction are "step functions" in which prices increase by periodic jumps rather than by smooth increments.

Networks are also a classic example of economies of scale. An eight port Ethernet switch does not cost twice as much as four port switch; the increment is closer to 50 percent. There are various correlations between cost and capacity, but none are liner. Hence, the practice of comparing prices on a dollars/bit per second basis, as some U.S. broadband critics do, is misleading.

Back to the question of the pricing of moderate and high speed services in the United States—there can only be four possible reasons for our relatively higher prices: 1) American service costs may be higher; 2) other nations' services are taxpayer-subsidized, so the bill doesn't reflect the full price paid by the consumer; 3) American service providers are

inefficient; or 4) American providers are overcharging and reaping excessive profits. Let us start with the two least likely answers.

It's common practice for America's broadband critics to argue that carriers use their supposed market power to charge unreasonably high prices simply to achieve supra-normal profits. This line of argument holds that structural separation or other kinds of forced unbundling of the local loop, increases competition and thereby drives prices down, in part by keeping profits low. For example, the Benkler Report asserts that unbundling in the Netherlands has "controlled profits for KPN (the incumbent telco) and encouraged opportunistic entry by alternatives."¹¹⁰ But in fact, KPN's net profit margin is 1.9 percentage points higher than comparable margins for American providers.¹¹¹

Rank	Country	Average net profit margin¹¹²
1	United Kingdom	21.1%
2	Turkey	19.9%
3	Sweden	13.6%
4	Australia	13.2%
5	Denmark	13.1%
6	Mexico	12.3%
7	Canada	12.2%
8	Belgium	11.2%
9	Greece	9.9%
10	Spain	9.7%
11	Poland	8.1%
12	France	6.9%
13	Japan	6.3%
14	Switzerland	5.1%
15	Netherlands	4.9%
16	Korea	4.4%
17	Norway	4.3%
18	Portugal	3.4%
19	United States	1.9%
20	Austria	-3.0%
21	Germany	-3.1%
22	Italy	-4.6%
	Average	7.4%
	EU-15	8.2%

Table 6: Average profit margin for publicly-traded telecommunications and cable broadband companies, October 2011–December 2012¹¹³

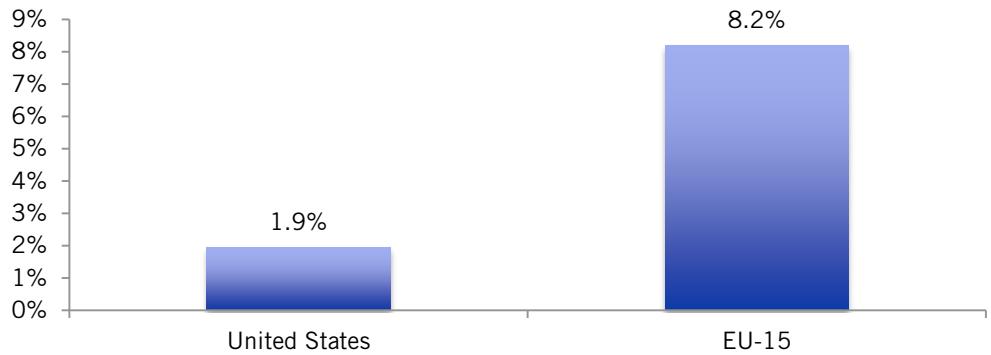


Figure 31: Average profit margin for publicly-traded telecommunications and cable broadband companies, United States and EU-15, October 2011–December 2012¹¹⁴

The last year's average net profit margins of U.S. broadband providers were 1.9 percent, compared to rates of above 10 percent for eight OECD nations.

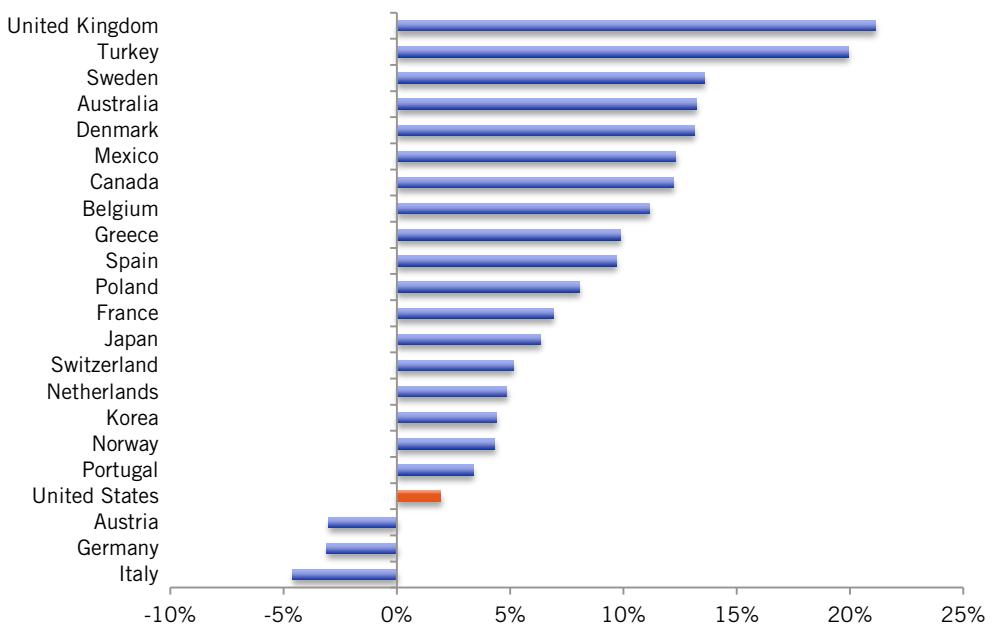


Figure 32: Average profit margin for publicly-traded telecommunications and cable broadband companies, October 2011 - December 2012¹¹⁵

In reality, the last year's average net profit margins of U.S. broadband providers were 1.9 percent, compared to rates of above 10 percent for eight OECD nations. (Table 6) Only three other nations had profit rates lower than the United States. The average margins for EU-15 providers were over four times higher than for U.S. providers. (Figures 31 and 32, and Table 6) Using a similar measure, return on equity (ROE), shows similar results. ROE is significantly lower for providers in the United States than it is for the average provider in the EU-15 and Korea and Japan. (Figures 33 and 34)

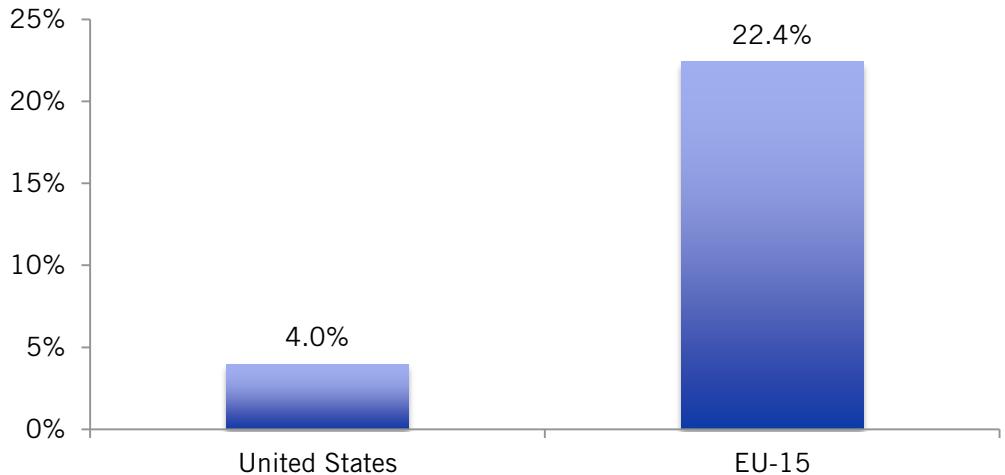


Figure 33: Average return on equity for publicly-traded telecommunications and cable broadband companies, United States and EU-15, most recent 12 months available¹¹⁶

The costs of network plant (for both cable and telephone companies) are especially high in the United States because such a small percentage of the U.S. population lives in high-rise urban apartment buildings.

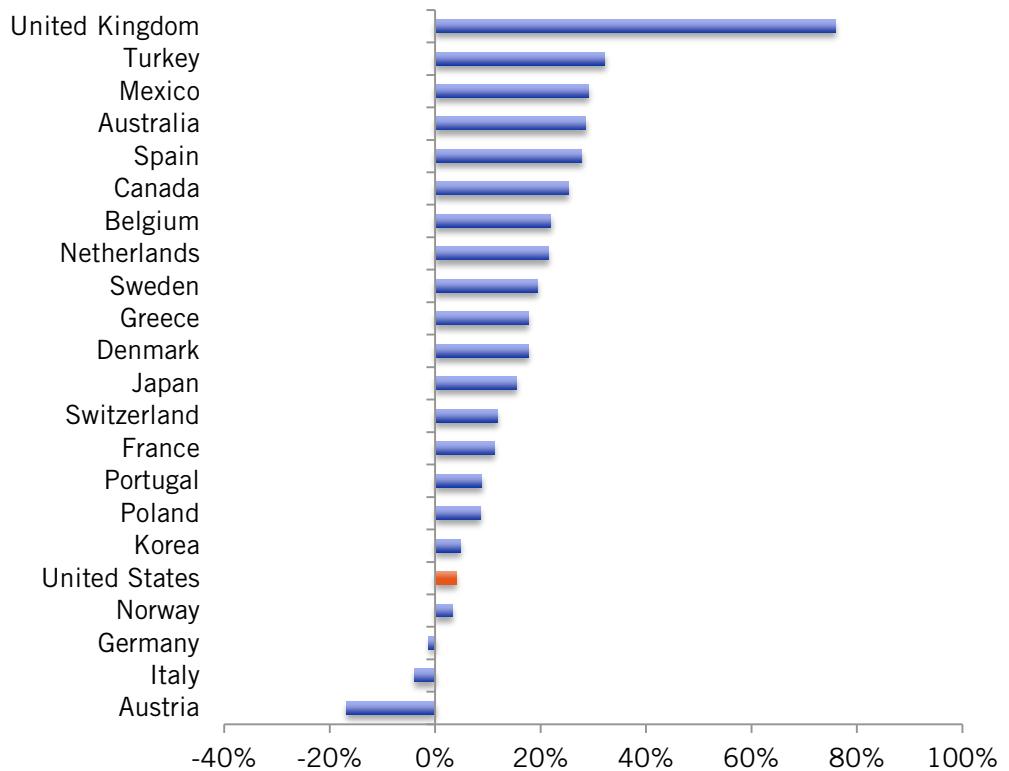


Figure 34: Average return on equity for publicly-traded telecommunications and cable broadband companies, most recent 12 months available¹¹⁷

Some may argue that these profitability rates are misleading because they reflect the performance of the entire company (including pay TV and phone services) and not just broadband operations, but it's unlikely that a deeper analysis with more precise data (that is not generally available) would tell a different story. Moreover, most European providers also provide telephone and pay TV service, so if they are losing money on broadband to

keep prices low, they must be earning excess profits on telephone and cable TV. In fact, there appears to be some evidence of this. The Benkler report reveals a little-known fact of the business model employed by the owner of Free.fr:

A significant portion of Iliad's profit is due to fixed-to-mobile calls, because of high interconnection rates. Iliad's business model could not be replicated in countries without such an interconnection regime.¹¹⁸

In other words, the European model for mobile compensation effectively subsidizes wired broadband, resulting in the high per-minute charges for cellular we see in Europe and Free.fr's low broadband prices. In the United States there is no evidence that traditional phone service or cable TV is a money-losing service propped up by high broadband prices or by telephone interconnection subsidies.

The European model for mobile compensation effectively subsidizes wired broadband.

The second possible explanation is that American broadband providers charge higher prices while earning generally lower profits than European providers, because they are inefficient. According to this theory, they simply waste money that if they were smarter could be used to increase profits and/or lower prices. For example, one blogger argues that Google can charge lower prices for broadband in Kansas City simply because they are more lean and efficient than the old guard (disregarding the fact that it's much too early to judge the Kansas City experiment a success).¹¹⁹ But U.S. broadband providers are for the most part publicly-traded companies that are quickly punished by the stock market for inefficient operation. They are also companies in which executive compensation is closely tied to share prices. If their sole motivation is to "put profits before people," it stands to reason they would function as efficiently as possible. So the greed hypothesis is inconsistent with the inefficiency conjecture; both cannot be right at the same time.

Moreover, if any broadband providers were to be unconcerned about being efficient and profitable, it's most likely that they would be state-owned enterprises or ones with a high proportion of state control. The European and Asian broadband providers were completely state owned until quite recently, and some are still partially state-owned; Japan's NTT and Belgium's Belgacom fit this description. State-owned enterprises have less incentive to cut costs and improve efficiency. They have greater sensitivity to policy objectives and political considerations, of course, and recently privatized firms operate under the threat of re-nationalization. The Australian government's National Broadband Network is an example of the re-nationalization of broadband infrastructure. Australia's NBN is seen by some as the Labour Party's reaction to the tendency of recently privatized operator, Telstra, to behave as a conventional business rather than as an instrument of government policy.

The third and most plausible explanation is that costs are simply higher in the United States. The costs of provisioning broadband include the network, equipment, services (such as backhaul and transit), labor, training, and advertising. Most of these cost elements are generally higher in the United States than in the nations that are most commonly touted as marvels of broadband achievement by America's critics. The costs of network plant (for both cable and telephone companies) are especially high in the United States because such a small percentage of the U.S. population lives in the high-rise urban apartment buildings that affect broadband costs so radically in places like Seoul, Tokyo, Singapore, and

Longer loop lengths and lower urban densities in America mean higher costs not only for deployment but for operations.

Stockholm. The task of extending broadband to a Seoul high-rise is extremely easy for KT, not only because so many households are so close together, but also because local regulations make the maintenance of vertical wiring the landlord's responsibility—which is therefore reflected in rent payments rather than broadband bills. In a scenario that's like unbundling in reverse, all that KT has to do is bring in a single optical cable and install one piece of equipment, leaving the landlord to deal with the maintenance of the indoor vertical wiring plant.

The American broadband provider, on the other hand, must maintain a massive network of outdoor wiring that's exposed to the weather and is millions of miles long; the Comcast network alone consists of 747,000 miles of cable, 147,000 of which is fiber.¹²⁰ This is one reason why American firms installed 19 million miles of fiber in 2011 alone.¹²¹ A compact network primarily deployed to service closets in high-rise buildings requires far less in the way of switches and repeaters to cover large numbers of users, and newer networks are less expensive to maintain than those built by the broadband pioneers.

Urbanicity: Density within Cities

Critics argue that the United States is urbanized to roughly the same extent as the high adoption nations (which is not true), but even this casual observation neglects the effects of our relatively low density *within* U.S. urban areas. Connecting people who live in detached single family homes within city limits is much more expensive to the carrier than connecting people who live in high-rise buildings.

Specialized carriers in the United States that exclusively serve high-rise dwellers offer lower prices for high speeds as well. These carriers are often cited as models of efficiency and used as evidence that U.S. incumbents are overcharging, but their market is much smaller relative to the overall population here than it is in Seoul. These specialized carriers are essentially “cherry picking” low-cost areas and excluding high-cost ones, a practice that incumbents are largely prohibited by law from doing. For example, Paxio.com offers one gigabit service to some San Francisco high-rises for \$138.50 per month—less than 100 Mbps cable service costs in many American suburbs—but offers no service at all outside its small urban core footprint.¹²² It only serves selected buildings where it has a deal with the landlord as well. Similarly, Sonic.net provides fiber service to a small part of affluent Bay Area suburb Sebastopol—a doughnut hole within larger territories served by Comcast and AT&T—but nowhere else. By serving only densely populated, higher income areas, these providers can get higher adoption and face lower costs, which allows them to charge less than an incumbent that must serve a much broader geographic and demographic area.

ITIF's 2008 broadband report covers the implications of urban density (“urbanicity”) quite extensively, and the facts haven't changed.¹²³ Urbanicity is the share of a country's population living in urban areas, multiplied by the average population density of those urban areas. Figure 34 shows the results for the OECD. The United States ranks 28th out of 34 OECD countries on urbanicity, with a score of 5.2. Contrast this with Korea, which has an urbanicity score of 67.1—nearly 13 times higher. Likewise, Japan has an urbanicity score (25.9) that is nearly five times higher than that of the United States. The same goes

for the EU-15 countries, which have an average urbanicity score of 8.9, which is 1.7 times that of the United States.

In fact, 27 of the 34 OECD nations have higher “urbanicity”. Only Australia, France, Slovenia, Hungary, Luxembourg and Slovakia have lower levels of urbanicity than the United States. And only Australia has less densely populated cities (although Australia has a higher share of their population living in these suburbanized cities), as both Australia and the United States are primarily suburban nations.

Governments can also adopt policies that leverage the effect of high urban density by adopting policies that make landlords shoulder some of the costs of broadband infrastructure in return for the ability to charge higher rents:

[Korea implemented a program] to expedite expansion of broadband Internet services. The government’s “Certification Program for Broadband Buildings” requires all newly constructed buildings in Korea to be designed to enable high-speed broadband connections, such as locating DSL access multiplexers (DSLAMs) or cable head-ends in apartment basements. The program also grades multiple unit buildings of 50 units or more based on the level of high-speed access they support, rating them as 1st, 2nd, or 3rd class depending on whether they provide access at speeds of 100 Mbps, 10-100 Mbps, or less than 10 Mbps, respectively. The government provides buildings and apartments that install a certain level of information and communications systems with a certificate and an emblem that the building owner can use to attract potential tenants. The government’s certification is a key standard and factor that lets prospective tenants or purchasers know what buildings and apartments in Korea have the best broadband connections.¹²⁴

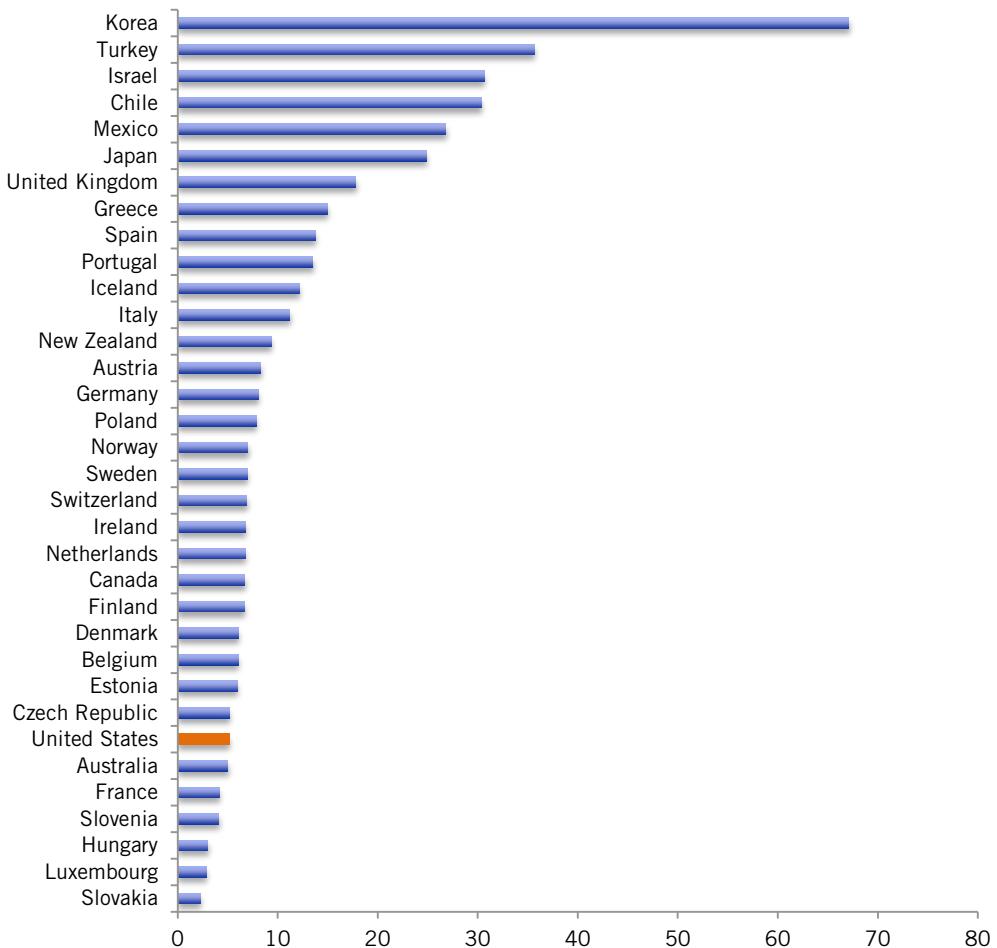


Figure 35: Urbanicity index for OECD countries¹²⁵

To ensure that US broadband speeds increase, U.S. broadband providers have to invest more in networks than do European and Asian providers.

It's important to note that speeds in urban areas don't always live up to expectations, since many nations that have pursued fiber edge networks have neglected the quality of their distribution and core networks; backbones are consistently overloaded in Korea and Japan, as we discuss in the section on performance. Moreover, the longer loop lengths and lower urban densities in America mean higher costs not only for deployment but for operations as well. As noted above, many European broadband providers have been able to achieve higher speeds on legacy copper networks because their loop lengths are so much shorter than ours. They can get high speeds by switching out electronics in the central office without installing expensive new cabling. For example, DSL subscriptions still make up 95 percent of all broadband connections in France; this scenario is hardly "future-proof."¹²⁶

We see the effects of these policies reflected in the difference in capital expenditures by U.S. and European broadband providers. To ensure that US broadband speeds increase, U.S. broadband providers have to invest more in networks than do European and Asian providers. As a share of GDP, U.S. broadband providers invest somewhat more in capital equipment than European providers and their subsidizing governments do, reflecting the more urgent need to upgrade physical infrastructures in such a large, sprawling country as ours.¹²⁷ Significantly, European Commission Vice President Neelie Kroes enviously

observes that more than 80 percent of Americans now have access to 100 Mbps DOCSIS 3 networks. She seeks to promote greater capital spending in Europe to catch up, although this can only mean discarding (or severely restricting) Europe's unbundling policy which has to date relied on upgrading the electronics on either end of existing short copper telephone loops.¹²⁸ Higher capital investment, in the absence of subsidies, can only be recovered through higher subscription prices.

Some critics charge that lower density in America can't be an explanatory factor because while places like New York City are no less dense than many cities in Europe, national carriers still charge high prices. This ignores another critical fact, however. The prices we pay for broadband services in the United States reflect our historic commitment to uniform pricing of communications services across the nation despite the varying costs of providing service according to population density and distance. So even a cursory examination finds that most broadband services provided by cable companies or traditional phone companies are priced the same, both in hard-to-serve areas of low population density and in cheap-to-serve high-rise apartments in the big cities. Broadband service doesn't have to be priced this way, of course, but our carriers have always done it that way with very limited exceptions in markets where they're especially eager to attract new customers or to retain old ones. In essence, just as high-speed U.S. broadband customers effectively subsidize low-speed ones, customers located in densely populated urban areas effectively subsidize those in less densely populated communities.

In contrast, many of the low-priced foreign and domestic competitors that are featured in the OECD data serve almost exclusively high-density urban areas.

In contrast, many of the low-priced foreign and domestic competitors that are featured in the OECD data serve almost exclusively high-density urban areas. For example, Iliad—which sells its “Free.fr”-branded service in France and is often cited by U.S. critics as a model for American broadband—only offers fiber service in densely populated French cities. In most of France, Free.fr simply offers DSL over the incumbent’s loop. In Paris, Free is able to pull fiber through the famous Parisian sewer system for next to nothing. Likewise, a number of the ISPs earning good scores on prices in the OECD rankings are European municipal providers that have an even greater advantage than Iliad; they serve even more densely populated cities, and also benefit from explicit and implicit government subsidies.

It's much less expensive to serve urban customers, so firms that limit their offerings to the best parts of the urban market can naturally price their services lower than can large American ISPs that must serve urban, suburban and rural customers, as the example of Paxio.com shows. The United States could move up in price rankings if ISPs serving high-density, low-cost urban areas charged lower prices. But if they did, they would have to charge higher prices in poor urban areas with low subscribership and in low-density suburban and rural communities. If this happened, the broadband policy critics would complain bitterly about unfair discrimination against the urban and rural poor.

The last of the possible explanations for U.S. broadband prices is that service prices are distorted in other nations by subsidies. In other words, if the government covers some of the costs for broadband providers, they can in turn charge relatively lower prices on the monthly bill. If we add the taxes foreigners pay to cover subsidies to the charge on the

broadband bill, non-U.S. users are actually paying high prices in these scenarios, but the lack of price transparency makes it easy for critics of American policy to pretend otherwise.

Subsidies take many forms and are often quite substantial. In Japan, broadband providers benefit from an accelerated depreciation scheme consisting of “increased initial depreciation” and “accelerated depreciation.” In the UK, providers can depreciate network investments relatively quickly, at 20 percent per year. In the United States, telecom network equipment has to be depreciated over a much longer 15-year term, which is utterly unreasonable given that broadband equipment (other than cabling) has, at most, a useful life of five years.¹²⁹

Other nations have also provided direct grants and low interest loans for broadband. Japan offered a combination of subsidies, tax incentives, and low or zero-interest loans for broadband network deployment. For example, in 2004, the Japanese government extended subsidies to municipalities to provide broadband services in rural towns and villages covering about one-third of the cost of building a fiber broadband network. The Korean government provided over \$70 billion in low-cost loans to broadband providers to build high-speed networks.

U.S. critics point to the fact that the 2009 stimulus bill funded broadband to the tune of \$7.2 billion, a seemingly considerable sum. But little of this money went to the improvement of existing networks (in part because of onerous rules governing the use of the money), and a significant share went to over-builders installing additional networks where at least one already existed.¹³⁰ In other words, it did little to reduce the costs for most broadband providers, in contrast to other nations’ subsidies. Moreover, \$7.2 billion over three years is not much money at all in a nation that has already invested over a trillion dollars on broadband.

In fact, other nations have subsidized more than America has. The Swedish government invested the equivalent of \$35 billion on broadband (as a share of GDP), much of it going to the incumbent, TeliaSonera.¹³¹ During the last recession, Singapore, as part of its stimulus plan, invested the equivalent of \$40 billion in deploying a citywide fiber optic network.¹³² Remarkably, the Australian government is providing the equivalent of a \$107 billion investment to build a National Broadband Network that extends fiber to 92% of the population and requires the removal of cable modem networks scarcely a decade old in order to secure a broadband monopoly for the government.¹³³

While U.S. investment in network infrastructure comes almost exclusively from private sources, it nonetheless exceeds or meets the average of the rest of the OECD nations in terms of share of GDP. (Figure 36)

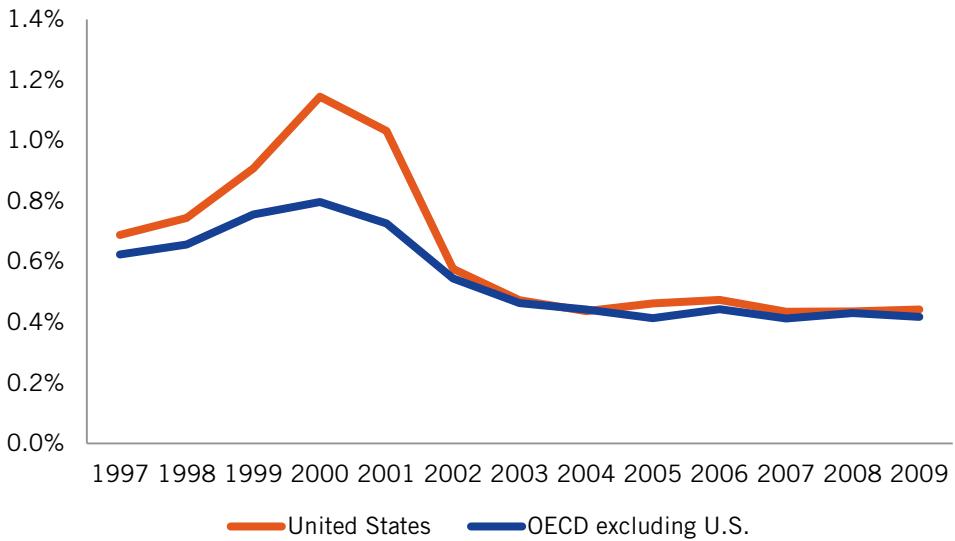


Figure 36: Network Investment over Time as Percentage of GDP¹³⁴

Given our population distribution and our lack of subsidies, it's unsurprising that some broadband users pay higher monthly bills for the level of service they consume than do residents of some other countries. It's actually quite remarkable that unsubsidized broadband service is as inexpensive and as good as it is in the United States, given the costs that our suburban lifestyles impose on broadband networks, our aversion to government subsidies to private firms, and the geographic uniformity of the prices we pay.

Our policy choices have not only made us the envy of European regulators, they've enabled us to deploy networks in a competitive scenario where adopting new generations of technology doesn't require the treasury to forego spending on other national priorities such as education, health care, firefighters, and freeways. This is no small achievement, even if it means we may have to permanently forego international bragging rights in every broadband ranking except "policy rationality."

CRITICISMS OF AMERICAN BROADBAND POLICY

As we've noted in the foregoing sections of the report, a small chorus of critics offers persistent and pointed criticism of America's broadband policy, the firms that provide broadband services, the agencies that regulate them, and the lawmakers who set United States policy. While the criticisms offered by authors such as Susan Crawford, David Cay Johnston, Nicholas Economides, and Tim Wu, and by think tanks and advocacy groups such as Free Press, the Open Technology Institute at New America Foundation, Harvard's Berkman Center, and Public Knowledge, all make similar claims about prices, speeds, deployment, and adoption, they all draw from a common pool of misleading and partial data.

Poorly-informed analysis (much of it deliberately biased) fuels a national push to discard policies that are plainly working in favor of those that have not worked at all well. Unproductive criticism forces policy-makers to neglect more pressing problems, such as lack of interest in broadband networking and use of the Internet among a sizable portion of

the American population. We are told that we must abandon *intermodal* competition policy in favor of the European *intramodal* policy at the very same time that Europe's leading policy thinkers and regulators advocate following the U. S. model to encourage investing in the future.

There is a huge disconnect produced by the false claims about the alleged "shoddy service and high prices of the [American] telecom and cable companies"¹³⁵ made by Free Press and echoed by Katrina vanden Heuvel in *The Washington Post* to the effect that "Fully one-third of Americans can't afford high-speed Internet. The rest are overpaying for substandard service in a so-called market that has been carved up by cable and telecom monopolists." The fact is that most of America's broadband non-users suffer more from lack of interest than an inability to pay the third-lowest entry-level broadband bill in the world.¹³⁶

Most policy critics of U.S. broadband are holders of a particular ideology or economic doctrine—Neo-Keynesian, populist economic thinking.

Vanden Heuvel wants the United States to take a radical new direction based on the European model, while European Commission Vice President Neelie Kroes envies the United States, where "high speed networks now pass more than 80 percent of homes; a figure that quadrupled in three years." Such services are barely available in Europe outside of a few large cities where public subsidies do the heavy lifting.¹³⁷

David Cay Johnston charges that the United States is "in 29th place and fading fast," and Susan Crawford alleges that "America has slipped over the past decade to 22nd place" in download speed, but the facts are fundamentally different: we're in the Top 10 and rising. Those in the press must check their facts and hold the people making these allegations accountable for their misrepresentations.¹³⁸ Making such overly dramatic charges can sell books, garner press attention, and build momentum for causes and career ambitions while policy truths are ignored; as Churchill famously said, "A lie gets halfway around the world before the truth has a chance to get its pants on."

Most policy critics of U.S. broadband are holders of a particular ideology or economic doctrine—Neo-Keynesian, populist economic thinking. Adherents of this doctrine are often trained in such disciplines as law and political science but not in economics. To the extent that they analyze the issue of broadband policy through an economic lens, they do so with a focus on distributional issues and a distrust of concentrated economic power.¹³⁹

For example, Crawford's economic doctrine is revealed by the subtitle of her book, *Captive Audience: The Telecom Industry and Monopoly Power in the New Gilded Age*.¹⁴⁰ She pays more attention to the situation she believes prevailed in the United States during the Gilded Age (between the end of Reconstruction in 1877 and the turn of the 20th century) than to the present. While the Gilded Age was a period of remarkable growth and opportunity in America that saw enormous waves of immigration from Europe and the growth of industrial manufacturing, it was also a time of great social ferment that gave rise to the labor and civil rights movements, Prohibition, and university education. The historical parallels between the Gilded Age and today are more pronounced in developing nations than in the United States.

Similarly, Tim Wu's criticism of American broadband, *The Master Switch: The Rise and Fall of Information Empires*, has more to offer in the way of history than in contemporary analysis, and its history is thinly sourced and weakly presented.¹⁴¹ For all their many talents, Crawford and Wu are law professors, not historians, economists, or technologists, after all.

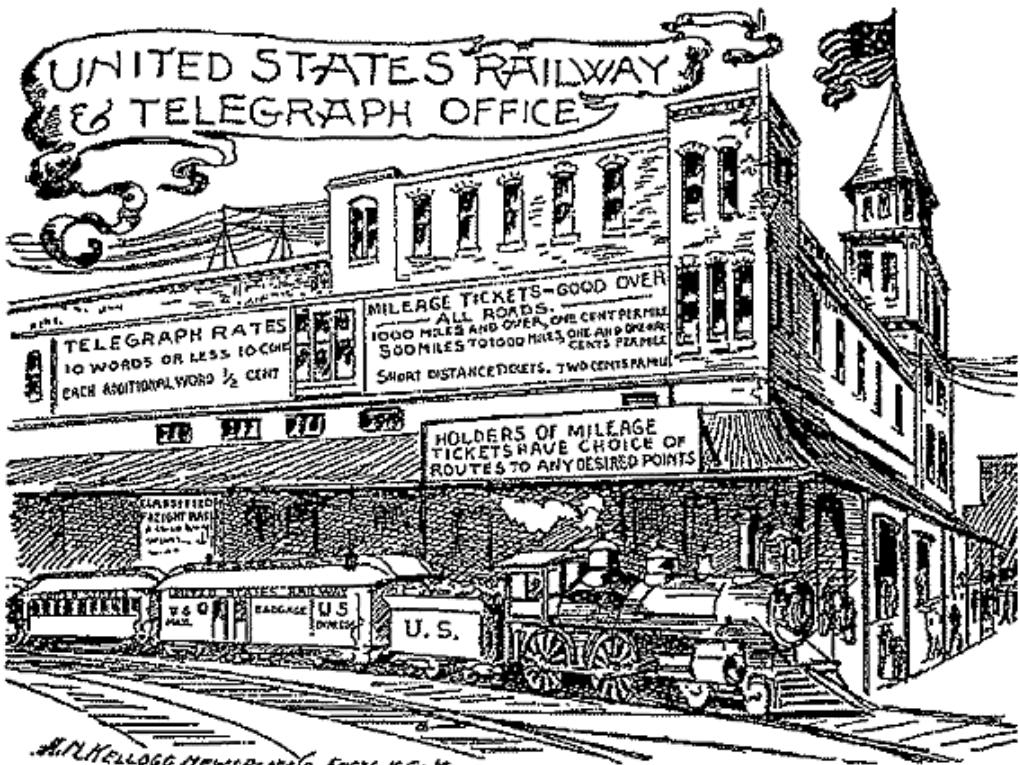
At the end of the day, the debate between supporters and critics of the general thrust of American broadband policy is less a battle of facts and figures than a question of fundamental public policy approaches underpinned by deeply conflicting economic doctrines. ITIF's Robert D. Atkinson described the actual debates of the Gilded Age as pitting opposed approaches to public governance:

The new public philosophy and governance that it supported did not come on the scene fully formed. At first, reformers resisted change and hoped to put in place piecemeal solutions to emergent problems, rather than attempt to come to grips with the need to fundamentally change the governing system. Such resistance to the new factory economy was epitomized by the Populist movement that sought a host of legislative 'fixes' to the problems, including the nationalization of railroads.¹⁴²

Like their anti-industrial precursors, the Luddites, Gilded Age reformers—the Populists—wanted to turn back the clock to the pre-industrial period when, they supposed, things were so much better (apart from such minor inconveniences as the Plague and the Spanish Inquisition, massive illiteracy, poverty, famine, pestilence, etc.). Modern-day broadband populists echo the program of an 1892 cartoon in the *Republic County Freeman* in support of public ownership of infrastructure known as the Omaha Platform.

The Omaha Platform called for government ownership of railroads, telephones, and telegraphs. The preamble to the platform said "the railroad corporations will either own the people or the people must own the railroads."¹⁴³ Populists believed that the power private monopolies conferred upon their owners constituted a threat to American liberties; similarly, modern broadband populists believe that *any* concentration of power in communications industries—even at 20 percent market share—is equally destructive, regardless of the facts demonstrating the relative success of the American broadband system.

The United States has re-established its mobile broadband leadership as the first serious adopter of LTE, and will soon begin the planning for an even better system, LTE Advanced.



ANOTHER FEATURE OF OUR PLATFORM.

Third—Transportation being a means of exchange and a public necessity, the government should own and operate the railroads in the interest of the people.
The telegraph and telephone, like the post office system, being a necessity for the transmission of news, should be owned and operated by the government in the interest of the people.

The debate will continue between those who support the vision of broadband as a privately-owned, privately-financed marketplace—powered by consumer demand, risk capital, and vested stakeholders, and regulated by elected officials and the expert agencies they oversee (such as the FCC and FTC)—and those who want a United States Broadband Office in control. At the end of the day, neither side will declare total victory or unconditional surrender. The purpose of this report is simply to ensure that there is less misinformation and more fact and accurate analysis in this debate.

CONCLUSION

American broadband is neither a wasteland nor a utopia. It's a complicated, capital-intensive marketplace fraught with risk where players enjoy periods of apparent success punctuated by moments of failure as they misallocate resources. Some of the failures are enduring, but the successes are generally temporary. The technology engine that drives this industry is relentless and consumers are fickle; they are just as likely to favor the latest new platform whether it's high bandwidth, like Netflix, easily accessible to the narrowband cell phone, like Twitter, server-oriented, like YouTube, or peer-to-peer, like Skype. The United States is in a commanding position in operating systems and platforms for smartphones, laptop computers, tablets, and traditional desktops, and it is a world leader in web services such as search, advertising, and social networking. The smartphone has given rise to a

A great deal of the criticism of American broadband providers is based on faulty information and is driven by antiquated social philosophies.

robust and growing apps industry; the old hands in media and publishing either adapt to the new reality with innovative revenue models and content that monetizes the web, or they fade away.

It's improbable that the industries that depend on reliable, high performance broadband network services at affordable prices could have developed in the United States if our broadband networks were anything but first-rate, and equally unlikely that America's broadband networks won't continue improving, thereby supporting their continued success.

Cable has rolled-out DOCSIS 3 to more than 80 percent of its installed base and now plans a next round of upgrades to DOCSIS 3.1. DSL providers have stepped up their investments in their fiber backhaul networks, as they begin the planning cycle for 100 Mbps Vectored DSL. Verizon and others have deployed fiber to nearly a fifth of American households. The United States has re-established its mobile broadband leadership as the first serious adopter of LTE, and will soon begin the planning for an even better system, LTE Advanced. Google's foray into network construction is proceeding well, and the company has said it plans to extend its high-powered, fiber networking footprint beyond Kansas City.

In November, AT&T announced a \$14 billion increase in infrastructure investment over three years, in addition to investments already planned, bringing annual investments to \$22 billion. Of the \$20.1 billion Softbank spends for control of Sprint, \$8 billion will be added to the balance sheet for infrastructure and other strategic investments. The German owners of T-Mobile have committed \$4 billion to upgrade their network, including deployment of LTE.¹⁴⁴ American firms bought more fiber optic cabling in 2011 than ever before and continued a high rate of acquisition into the first half of 2012.

Against this background, it's not surprising that the speeds of American broadband networks are increasing and have now broken into the Top 10 according to the highly reliable Akamai measurements. But it remains a matter of concern that so few Americans own computers because they have so little interest in joining the broadband revolution. Absent robust and creative public-private partnerships to address this challenge, incomplete adoption will remain the Achilles' heel of American broadband.

The reallocation of radio spectrum from non-broadband legacy users such as broadcast TV is well underway, and the reallocation from government hands to the civilian sector is starting to move, although nowhere near as rapidly as it needs to move. Initiatives such as Gig.U are improving broadband service to universities, while the Administration's U.S. Ignite program is working to promote high bandwidth applications.

Multiple initiatives are underway, using a range of technologies, funding models, and governance structures, and it's likely that some will succeed and others will fail. All roads lead to Rome, but there are many roads in many places carrying a wide range of cargo.

It's perfectly sensible and healthy to pay close attention to our broadband industries and to criticize them when they make missteps, fail to manage resources effectively, or lapse in

customer service and support, but the most effective criticisms are based on facts, reason, and evidence. As this report shows, a great deal of the criticism of American broadband providers is based on faulty information and is driven by antiquated social philosophies.

We need to pay particular attention to bringing more Americans online by increasing broadband readiness through training, outreach, and programs that reduce such barriers to entry as the lack of digital awareness and computer ownership. The smartphone revolution that's now sweeping the country and the world is a potential gateway to broadband adoption, not just through native smartphone apps, but by the opportunity it extends to tether laptops and tablets to the web.

The transition of the old universal service fund to the more up-to-date, broadband-centric Connect America fund will extend wired broadband farther into hard-to-serve rural and poor communities, and the replacement of the old telephone system by an all-IP broadband replacement is an opportunity to shift telephone network spending away from the antiquated legacy system toward its modern upgrade.

America will always be challenged in getting the latest broadband technologies everywhere for geographic and demographic reasons, but the vector of change leads, for the most part, in the right direction.

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ABOUT THE AUTHORS

Richard Bennett is a Senior Research Fellow at the Information Technology and Innovation Foundation. He has a 30 year background as a network inventor, system developer, entrepreneur, and standards engineer, chiefly in connection with Ethernet switching, the Internet, Wi-Fi™, and Ultra-Wideband. He joined ITIF three years ago to develop network policy.

Luke Stewart is an economic analyst at the Information Technology and Innovation Foundation. Prior to joining ITIF, he worked in business property appraisal, banking, and computer manufacturing. Luke earned a B.A. with highest honors in economics from the University of California, Berkeley, in 2009.

Dr. Robert Atkinson is the President of the Information Technology and Innovation Foundation. He is also the author of the books *Innovation Economics: The Race for Global Advantage* (Yale University Press, 2012) and *The Past and Future of America's Economy: Long Waves of Innovation that Power Cycles of Growth* (Edward Elgar, 2005). Dr. Atkinson received his Ph.D. in City and Regional Planning from the University of North Carolina at Chapel Hill in 1989.

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