2 What is "broadband"?

When the term "broadband" was initially introduced, it was by differentiation from dial-up service, and was typified by two distinct characteristics: speed and "always on." The former was a coarse measure of capacity. The latter was a definition of fundamentally different user experience: the experience of relatively seamless integration into one's life—at least one's life at the desk—relative to the prevailing experience that preceded it. Today's planning documents for the next generation transition continue to reflect, in different measures, these two distinct attributes of future networks. A review of broadband planning efforts suggests that there is a broadly shared set of definitions and targets of policy, but some diversity of emphasis. The primary distinction in emphasis is between a focus on high capacity and a focus on user experience, in particular on ubiquitous, seamless connectivity. We also observe a secondary division, within the focus on high capacity, between a focus on numeric measures of capacity, most prominently download speeds, and a focus on applications supported.

There is substantial overlap in practical policy terms between the two goal definitions. Both would seek the highest capacity feasible within a time period. There might, however, be subtle differences. For example, both would emphasize fiber to the home infrastructure; but a high capacity focus might emphasize the theoretically unlimited capacity of fiber, while a focus on user-centric experience might focus on the relative symmetry of data carriage capacity, assuming that end-users have as much to give as to receive.

The primary difference between the two definitions of broadband would likely be the emphasis of ubiquitous seamless connectivity on mobile and nomadic connectivity, and on fixed-mobile convergence. As we will see in Part 4 however, countries that emphasize high capacity networks (such as France) have also seen entrants in fixed broadband develop vertically integrated services that combine mobile and fixed. This came both from fixed-broadband innovator Iliad/Free expanding its Wi-Fi reach to a system-wide nomadic network, and in the opposite direction, with the purchase of fixed broadband entrant Neuf Cegetel by mobile provider SFR. Similarly, in South Korea, both fixed-broadband incumbent KT merged with second-largest mobile provider KFT, while the largest mobile provider, SKT, purchased the second-largest fixed broadband provider. Japan, the primary proponent of the emphasis on ubiquity, can in some senses "afford" to emphasize ubiquity, rather than capacity, because it already has in place the high capacity fixed network that most other countries are still aspiring to achieve. The two approaches might therefore be better thought of as stages, rather than distinct pathways, with high-capacity, ubiquitous, seamless connectivity the broad long-term overlapping goal of all.

2.1 High speed networks

2.1.1 Goals set in speed measures

The most commonly used term to describe future planning for the next transition in networked connectivity is simply "next generation," used in reference to networks or access. Most of the definitions and considerations focus on measurable capacity, and largely continue to use speed as its measure. The Ofcom document in the United Kingdom, "Delivering Super-Fast Broadband in the UK"[2] is a well-thought-out document that offers a crisp example of this approach. The goal, while occasionally described in that document by the generic term "next generation access," is usually referred

2 Ofcom, 3 March 2009.

to as the title indicates: "super-fast broadband." The goal is defined in terms of download and upload speeds. The speeds set out as future goals in the UK document as "very fast" are what would be considered as second-tier speeds by the standards of what is available today in the best performing countries: 40 to 50 Mbps download, and 20 Mbps upload. Complementing this target, the government document "Digital Britain" emphasizes a commitment to universal availability of 2Mbps downstream service by 2012. This too is a modest goal by the standards of the highest performing countries, but is broadly consistent with the near-term goals of other European countries' universal access plans.

2.1.2 Dual targets

Many of the European plans adopt a dual-track approach. They seek truly universal access to first generation broadband technologies, and independently also seek to catalyze high levels of availability and adoption of next generation capacities. The Finnish Government's National Plan of Action for improving the infrastructure of the information society sets a goal that by 2010 every permanent residence, permanent business, and government body will have access to a network with an average download rate of 1Mbps.[3] The Finnish plan has a more ambitious medium-term goal, calling for a fiber-optic or cable network permitting a 100Mbps connection to be available for access within 2 kilometers of 99% of permanent residences, businesses, and public administration bodies by 2015. The "bite" of this plan is that it authorizes regional governing bodies that conclude that market demand will not meet that target to design public plans that will. The German Federal Government's Broadband Strategy[4] adopts a similar two-step strategic goal, with universal availability of at least 1Mbps throughout Germany targeted by the end of 2010, and a less ambitious availability of 50Mbps to 75% of households by 2014. The October 2008 French plan, Digital France 2012, originally included universal service with a capacity of over 512 kbps as its core emphasis and first target.[5] That target is out of step with offerings already available in the highly competitive French market, but is intended to represent a commitment to truly universal access to what would count as prior-generation broadband. Since that time, a new minister has been appointed and the targets are reorienting towards a fiber and applications-based definition of targets, as well as to supporting fixed-mobile convergence.[6] Recognizing this dual-target approach of universal access to first generation broadband and high degrees of penetration for next-generation connectivity, the European Commission's recent guidelines on state aid specifically separate out first generation broadband networks and next generation networks for separate analysis. They make it easier for states to invest even where there already are two providers offering speeds on the order of 20Mbps or so, as long as there are no current genuine plans, by at least two providers, to get higher, next-generation speeds in place in the geographic market within three years.[7]

2.1.3 A focus on fiber

Another way of defining "next generation" in terms of high and potentially growing capacity is to focus on the trajectory of deployment of fiber-to-the-home (FTTH) in particular. The recent European Regulator's Group report entitled "Report on Next Generation Access: Economic Analysis and Regulatory Principles" captures the degree to which this focus on "next generation" heavily emphasizes

3 Government Resolution: National Plan of Action for improving the infrastructure of the information society. Government of Finland, 4 December 2008.

4 Federal Ministry of Economics and Technology, February 2009.

5 Eric Besson, *Digital France 2012*. October 2008.

6 http://www.arcep.fr/fileadmin/reprise/communiques/communiques/2009/comnq-nkm-fibre-100709.pdf.

7 17.9.2009 Community Guidelines for the application of State aid rules in relation to rapid deployment of broadband networks, available http://ec.europa.eu/competition/state_aid/legislation/guidelines_broadband_en.pdf.

fiber as a widely shared goal in Europe.[8] This approach is at odds with the equally widely-stated commitment to technological neutrality in government planning. The ERG report attempts to reconcile this tension by emphasizing that cable broadband also largely depends on fiber backhaul; that current investments in higher-speed cable infrastructure include pulling fiber deeper into the neighborhood; and that a core goal of all current models is therefore to bring cable as close to the home as possible. The idea expressed is that fiber capacity is more "future proof," and will likely scale over longer periods to accommodate the increasing capacities and growth rate of communications needs, capacities, and innovations. Hybrid fiber coaxial, as well as fiber-to-the-cabinet or fiber-to-the-curb (FTTC)[9] deployments (that is, pulling fiber deeper into neighborhoods and distributing from there over ever-shorter copper loops), are thought to be way stations on the way to a fully fiber optic infrastructure. This belief is supported by a recent UK report by the Broadband Stakeholders Group, influential in both UK and European debates, that FTTC deployment costs roughly one-fifth of the cost of fiber-to-the-home (FTTH). The recent increasing concerns with middle mile—as opposed to last mile—issues is certainly consistent with a near term focus of providers on rolling higher capacity facilities to the neighborhood before linking the very last mile and last 100-meter drop.

2.1.4 Capacity to support future applications

A variant of the effort to define high capacity as the measure of the next generation transition uses anticipated applications, rather than speed measures, or as a complement to speed measures, to define the goal. This variant is most explicitly represented in South Korea's IT839 program. South Korea uses the term "ubiquity" to describe its goals, but defines it very differently than that term is used in Japan, as we will see. South Korea's plan calls for a network aimed to support a list of eight services, three infrastructures, and nine growth engines, hence 839. Ubiquity gets translated most directly into WiBro service—wireless broadband, anytime, anywhere, on the move; digital multimedia broadcasting, in vehicle infotainment, RFID etc. The three infrastructures are called Broadband Convergence Network, aiming to provide services of 50-100Mbps to 20 million people, Ubiquitous Sense Network, to manage information through RFID so that things can be connected to people, and provision of Ipv6-based services. The growth engines are various technologies thought to provide a technological growth path, from high-speed packet mobile transmission and digital TV to Intelligent Service Robot. While the particulars of the plan are representative of the explicitly industrial policy frame of mind that has typified South Korean Internet development since the 1990s, the basic idea is for the plan to identify currently attainable as well as futuristic technologies, and plot a path toward their implementation. Along some dimensions—such as delivering high adoption of fixed networks with speeds of 50-100Mbs, or achieving a stepping stone towards WiBro (South Korea is the only country in which 100% of mobile phones subscriptions are 3G)—the policy has already achieved success. Other dimensions, such as attaining an intelligent service robot, appear distant. Certainly South Korean past successes at least recommend consideration of aspects of this approach, such as identifying a basket of currently-imagined high-capacity, high-sensitivity applications, and targeting a network whose capacity is more than sufficient to support at least those applications.

Other countries have also referred to a suite of applications as targets or measures. No other country, however, has relied so heavily on such a suite to define its national plan targets. Digital Britain focuses on near-future applications like transportation control, energy/smart-grids, home-based telehealth, and

8 ERG(09)17, June 2009.

9 In Europe the term more often used is fiber-to-the-cabinet; in the US, fiber-to-the-curb. On occasion, fiber-to-the-neighborhood is used. Functionally, these are various ways of describing the intermediate solution between fiber-to-the-home, on the one hand, and fiber to a main switch serving many neighborhoods, whose capacity is distributed over copper plant.

education, as well as smoother high capacity to download music, video, and texts. The French ARCEP Annual Report notes similar target applications, adding the possibility that the relevant applications could be video-calls integrated into social networking or location-specific access to cultural content (such as in a museum). A current communiqué about intended stimulus investments also identifies as targets the development of Web 2.0 applications and "serious games": or video-game-like experience software environments applied to more functional applications like health or language instruction.

2.2 Ubiquitous seamless connectivity

The main alternative definition of next generation connectivity emphasizes user experience: ubiquity and seamless connectivity. Just as "always on" fundamentally changed what it meant to be connected in the first broadband transition, so too ubiquity is intended to identify a fundamentally different user experience: seamless connection that supports creation and innovation from anyone, anywhere, communicating to and with anyone and any thing, anywhere and anytime, connecting devices, applications, people, and objects, with room to innovate. The prime examples of this definition are Japan's major policy documents.[10] The first generation e-Japan policy, governed the massive growth in high-speed Internet access in Japan, and involved regulatory reforms and market developments in 2000-2001. The transition to a next-generation emphasis on ubiquitous, seamless connectivity was marked by the introduction in 2005 of the u-Japan policy. While it is culturally normal for Americans to be skeptical about grand names and plans from government agencies, we should at least acknowledge that the first generation policy was accompanied by results that continue to leave other countries far behind by several relevant measures. Japan has not only the highest percent of fiber penetration, but providers in Japan have also invested in squeezing out the highest possible speeds over DSL and cable (160 Mbps from J:COM, as compared to 50Mbps offered using the same DOCSIS 3.0 technology in the United States, and J:COM's offering is available for about half the price). In service of ubiquity, Japan has the second highest percentage of 3G deployment, second only to South Korea.

As in the speed-based definition, network capacity measured in speed does play some role in the next generation access definition. An important example, following the dual-target European model, is the 2006 commitment to achieving ultra-high speeds in 90% of Japan by 2010, alongside eliminating all zero-broadband areas. But the core of what is distinct about Japan's definition of the goals is its focus on user experience. This includes not only ultra-high speeds, but also seamless connectivity between all devices, people, and networked objects; support for distributed creativity from anyone, anywhere; and a well-skilled population that has access to applications and devices designed for a wide range of needs. While ubiquity and its anyone-anywhere-anytime concept may be easier to intuit, seamlessness appears to focus on an experience that connectivity is "just there," without the user needing to think about connecting. As a target, this definition is more ambitious. Its ambition should be understood on the background of the fact that it sets out the future plans of country with the most advanced network currently deployed, whose network already matches or exceeds the "next generation" targets of some of the European plans. This suggests that it may be a better predictor of future-proof policy than a definition focused more specifically on speeds currently within plausible reach, or on currently well-understood applications. In current French planning, ubiquity shows up, alongside continuous connectivity, primarily in the context of spectrum policy.[11]

10 See Japan case study, Appendix, for list of references.
11 ARCEP Annual Report 2008 (June, 2009).

2.3 Next generation connectivity: Recap

The targets of current plans for the future infrastructure of the digitally networked environment suggest two broad types. The first focuses on high capacity networks. Its most common variant focuses on objective measures of network performance, most often download speeds. In other variants it focuses on fiber deployment as a temporary proxy and a long-term primary pathway, and on the capacity to support a basket of capacity-hungry applications whose performance is seen as desirable and not yet supported by first generation broadband networks. The second type of definition focuses on user experience of seamless, ubiquitous access to a fully distributed network. Table 2.1 summarizes the implications of adopting one or another of these two main emphases.

The primary differences between the two definitions include:

- Data collection, benchmarking and future monitoring: an emphasis on high capacity treats all pathways—3G, WiMax, Wi-Fi, fiber—as substitutes for each other on the dimension of interest. They are all potential means of achieving penetration to high capacity connectivity. The emphasis on ubiquity needs to measure penetration, speed, and price independently for connectivity that is untethered, be it mobile (evolved from cellular networks) or nomadic (evolved from Wi-Fi campus access and hotspots).

- Deployment: high-speed broadband definitions focus on residential households—universality can be satisfied by access for households. It can focus on fiber deployment as its core form. Ubiquitous connectivity requires equal attention to individual connectivity, not only households and businesses, and requires a dual focus: on high-speed fixed and high-speed mobile as distinct targets for deployment as an integral part of broadband policy.

- Competition and Access: A focus on high-speed networks emphasizes the role of wireless access as an alternative pathway of providing competitive pressure on prices, penetration, and innovation in technologies to offer high-speed capacity to households. The most important implication of this would be a wariness of permitting integration between wireless providers and fixed-broadband providers, because it would tend to limit competition on the dimension of interest: high-speed capacity to the home. Access regulation, if any, is focused on fixed infrastructure: the last mile and the last fiber drop in the building. A focus on ubiquity and seamless connectivity would be more amenable to vertical integration between fixed and mobile, seeing them as complements in a single service: ubiquitous access. To the extent that it perceived access regulation as important to a competitive market where entry barriers are high, however, it would tend to extend open access obligations to the cellular, as well as fixed, infrastructure of the combined entities, and to assure a competitive environment for services that ride on both.

- Fiber: on fiber deployment the primary difference is between a carrier-centric view of how to deliver high-capacity as soon as possible, and a user-centric view of how to achieve the most end-user controllable architecture. The high capacity definition emphasizes the maximum total capacity of fiber, and may thus be willing to accept topologies that lower the costs for carriers, at the cost of accepting more single-firm controlled topologies, like PON. The user-centric view would tend to emphasize the long term benefit of giving users as much symmetric upload capacity at the edges as there is download, and a point-to-point fiber topology that enables more cost-effective upgrading and innovation on a per-user basis. The difference between the two on how to deploy fiber, as opposed to whether to focus primarily on fiber as opposed to mobile,

should not be overstated: we discuss the implications of fiber network topology on competition and innovation in Section 4.11.3 below.

- Subsidies: A high capacity focus would tend to emphasize subsidies to network rollout to high cost or poor areas. Subsidies might focus on equipment, like computers. A user-centric focus would tend to emphasize user skills and training programs. Furthermore, where ubiquitous connectivity is the goal, equipment subsidies could focus on mobile or nomadic access as well as computers and fixed broadband connections, although we have not seen this in practice.

2.4 Universal access and next generation plans

Practically all countries we observed set achieving universal access to "broadband" (by their own definitions) as a goal of their current plans. That ambition is distinct from the ambition to achieve widespread, even if not universal, access to the highest capacity networks technically achievable. For example, Japan seeks to completely eliminate all zero-broadband areas, but also seeks to have ultra-high speeds in 90% to of its population. Germany seeks to reach its entire territory with 1 Mbps service, but states an independent ambition to reach 75% coverage at 50Mbps. The United Kingdom has a similar bivalent target—2Mbps throughout the country; 40-50Mbps as a broad goal for widespread deployment. The basic lesson from these kinds of targets is that the equity or universality concern is distinct from, and cumulative to, the cutting-edge technology concern. Countries seem to be concerned both with assuring that substantial portions of their economy and society enjoys what is, by international standards, high capacity connectivity, and with assuring the availability of substantial capacity, by historical standards, to their entire population.

2.5 Why do we want next generation connectivity?

Efforts to foster a ubiquitously networked society connected over high-capacity networks share the belief that moving to the next generation of networked communication will provide social, political, economic, and cultural benefits. As Figure 2.1 shows, a July, 2009 report from the World Bank on information and communications technologies calculates that every 10 additional broadband subscribers out of every 100 inhabitants are correlated in high income countries with GDP growth increases of 1.21%, while the correlation was even more pronounced for low- and middle-income countries, at 1.38%.[12] To understand the magnitude of the effect, it is important to realize that the average growth rate of a developed economy over the period of the study—from 1980 to 2006—was 2.1%. U.S. growth in the shorter period of 1997-2008 was 2.8%.[13] Confidence that this statistic describes causality would support substantial focus on assuring future networked capacity at the highest levels. Several countries specifically think of next generation access as tied to their competitiveness in a global information economy. South Korea's IT839 certainly emphasizes growth paths that support its export-oriented industries that depend on, and support, information infrastructure, devices, and services. Digital Britain, the core vision document published by the British government in June, 2009, defined as its core ambition: "To secure the UK's position as one of the world's leading digital knowledge economies." The German strategic plan simply opens with the sentence: "High-speed broadband networks that enable the rapid exchange of information and knowledge are crucial for economic growth."[14]

12 *Christing Zhen-Wei Qiang and Carlo Rossotto, with Kaoru Kimura,* Economic Impacts of Broadband*, in Information and Communications for Development 2009: Extending Reach and Increasing Impact*, World Bank, July 2009.

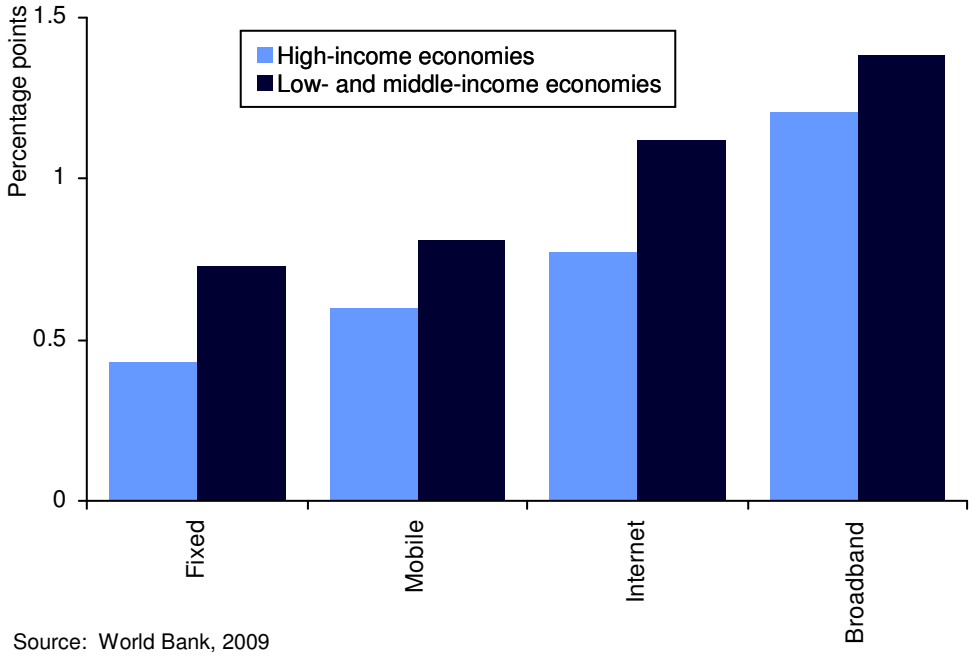
13 Bureau of Economic Analysis, July 31, 2009. http://www.bea.gov/newsreleases/national/gdp/gdpnewsrelease.htm

14 The Federal Government's Broadband Strategy, p. 6.

Definition	Implications					
	Benchmarking	**Deployment**	**Competition and Access**	**Fiber**	**Subsidies**	**Net neutrality**
High capacity networks	Highest available speed, fixed line, fixed wireless, or mobile; Household and place-of-business penetration; Prices for same;	Residential; per household; in businesses; Communication pathways treated as a single pool of potentially substitutable connectivity;	Emphasis on access to fixed infrastructure competition; Passive and active components of fiber systems; emphasis on open access to in-building, last drop, last mile fibers; Mobile is seen primarily as a potential competitive driver to fixed deployment: may resist vertical fixed-mobile integration;	Emphasis on high capacity; long-term theoretical capacity; Less clear emphasis on bi-directionality and symmetry; Preference for point-to-point topology focused on competitive access to passive components; can trade off PON or VDSL topologies to achieve earlier deployment of very high speeds;	Network rollout to high cost or poor areas; Subsidies focused on equipment;	May be sufficiently implemented through competition; Requires justification outside the target of high capacity networks, whose focus is pre-cloud;
Ubiquitous connectivity	Discrete measuring of fixed, mobile, and nomadic penetration, capacity, and prices;	Per individual; emphasis on 3G; 4G nomadic access independently of fiber and other fixed, including fixed wireless;	Fixed, mobile, nomadic; Expands access regulation from fixed plant to mobile infrastructure like towers; More amenable to vertical integration between fixed and mobile to achieve seamless ubiquity;	High capacity important, but symmetry may be more important; Point-to-point topologies supported more for anywhere, anyone logic and innovation over time;	Emphasis on user skills; equipment (hypothetical, not yet in practice) may expand to mobile or nomadic aspects;	Integral to the policy; innovation and creativity from anywhere, user-centricity requires a relatively passive network that accommodates innovation from anywhere and anyone equally;

Table 2.1. Practice and policy emphases implied by high capacity networks and ubiquitous seamless connectivity

Figure 2.1. Growth effects of ICT

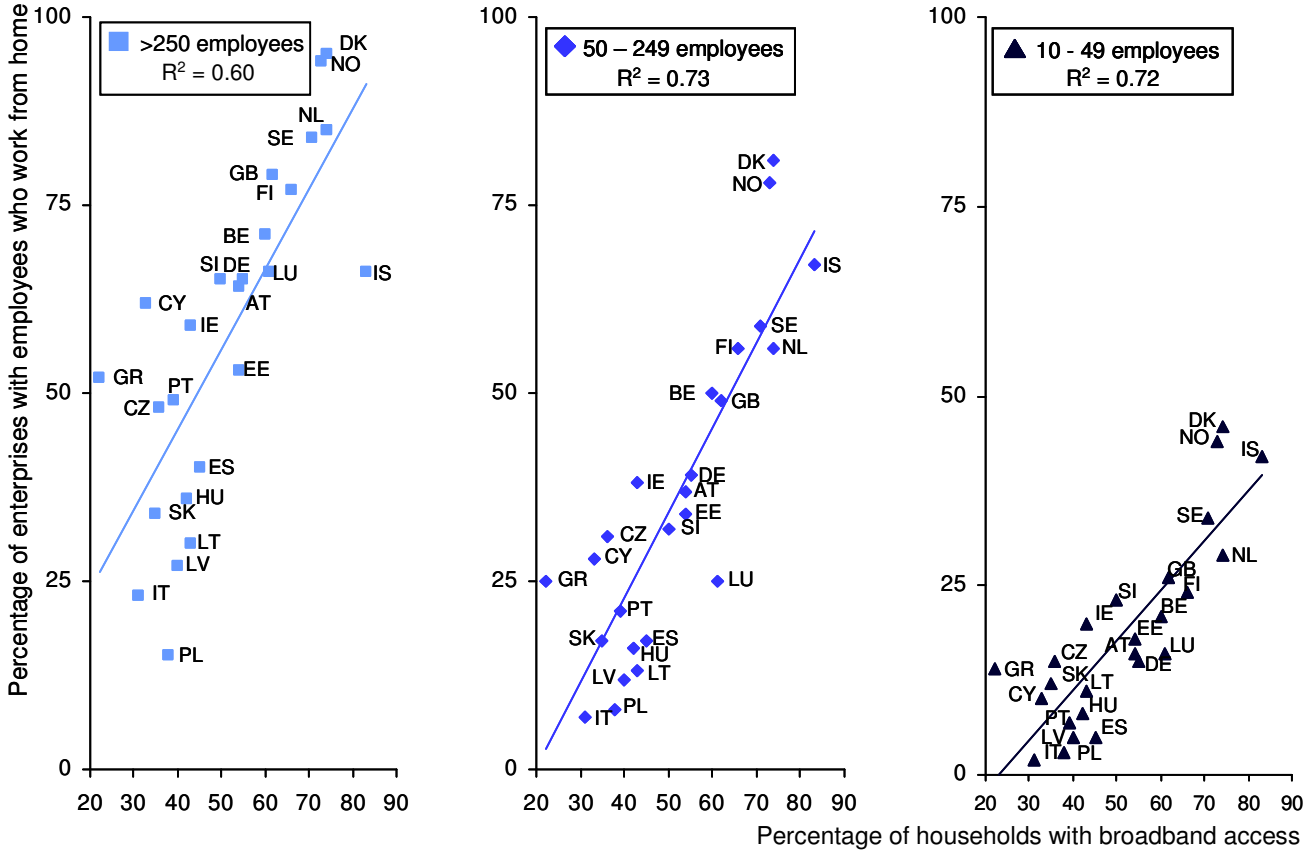


Source: World Bank, 2009
Note: The y-axis represents the percentage-point increase in economic growth per 10-percentage-point increase in telecommunications penetration. All results are statistically significant at the 1 percent level except for those for broadband in developing countries, which are significant at the 10 percent level

Various countries' plans and documents tend to converge on a number of avenues of benefit. These include telemedicine, particularly its extension to remote areas and the home for patient monitoring, smart grids and more efficient electricity use, better control of transportation systems, telecommuting, support for electronic commerce and payment systems and lower costs for businesses through infrastructure sharing on the cloud computing model, and better access to educational materials and experiences. They also emphasize supporting highly valued social and cultural practices, from social networking to, as Digital Britain put it, downloading the entire works of Charles Dickens in less than 10 minutes (alongside downloading Star Wars or mp3s). As the European Regulators Group noted, many of these concrete benefits are hard to measure and quantify. Nonetheless, the consensus of broadband planning efforts is that, even if we do not precisely know what the benefits might be, the likelihood that we will discover them is sufficiently high to justify the planning and investment. Furthermore, what little evidence there is does indeed suggest that the expected effects and correlations are indeed observable.

One major anticipated application often discussed is telecommuting. It is thought to offer cost-savings for businesses, permit workers to balance family and work, and contribute to reducing carbon emissions both from electricity use in offices and from commuting. Quantitative evidence, however, is sparse. Nonetheless, European survey data suggests that levels of household broadband penetration are correlated with businesses' and workers ability to telecommute, and that fit is slightly better for small and medium size businesses than for larger businesses, which seems plausible given that such businesses are more likely to depend on extant conditions in the population rather than on special programs they might initiate themselves (Figure 2.2).

Figure 2.2. Household broadband penetration and telecommuting

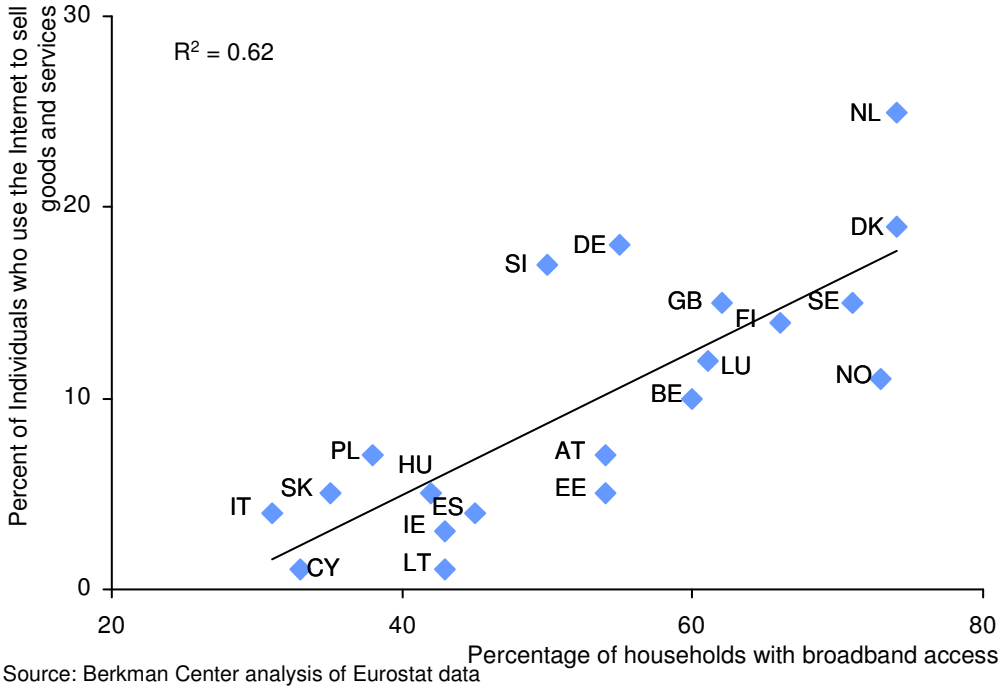


Source: Berkman Center analysis of Eurostat data

Beyond telecommuting for other businesses, European data also suggests that household broadband penetration is correlated with individual responses that they themselves sell goods and services on the Internet (Figure 2.3). Again, as with telecommuting, this is hardly a surprise. The story implied by this correlation is that higher levels of broadband penetration correlate with the ability of individuals to be entrepreneurial and run small businesses from their homes. This, in turn, would certainly support the Japanese focus on networks that are user-centric, as opposed to service-provider-centric. It seems entirely plausible that higher levels of adoption reduce the cost of home-based entrepreneurship, and therefore cause higher levels of reported instances of individual Internet-based small businesses (although it is not impossible that the causal effect is reversed: societies with more entrepreneurial individuals adopt new technology more rapidly). Again, however, these correlations are likely to hold for many online activities, and are merely suggestive of the more general-form predictions that animate next generation broadband planning.

Many of the benefits of a ubiquitously networked society are difficult to quantify or measure at all. How does one quantify the ability of grandparents and grandchildren to interact with each other through full video communications, keeping families together in an increasingly global economy with an increasingly mobile workforce? How would these improve when homes had built-in capacity for 3D real time video conferencing?

Figure 2.3. Household broadband penetration and individual entrepreneurship



Source: Berkman Center analysis of Eurostat data

The National Broadband Task Force has provided a broad review of the uses and benefits of broadband, from quantifiable measures of jobs created or health outcomes improvements from home monitoring, to necessarily less quantifiable entities, like civic engagement. The promise of both the quantifiable and the non-quantifiable benefits of networked connectivity seems to have been accepted more-or-less globally as sufficient justification to seek to promote the next generation of the Internet: be it defined in terms of high capacity infrastructure and supported applications, or in terms of a fundamental shift to a user-centric, ubiquitously networked society.