Next Generation Connectivity:

A review of broadband Internet transitions and policy from around the world

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DRAFT

at Harvard University

Contributors

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1 Executive Summary and Introduction

1.1 A globally shared goal: Ubiquitous, seamless, high-capacity connectivity in the next generation

Fostering the development of a ubiquitously networked society, connected over high-capacity networks, is a widely shared goal among both developed and developing countries. High capacity networks are seen as strategic infrastructure, intended to contribute to high and sustainable economic growth and to core aspects of human development. In the pursuit of this goal, various countries have, over the past decade and a half, deployed different strategies, and enjoyed different results. At the Commission's request, this study reviews the current plans and practices pursued by other countries in the transition to the next generation of connectivity, as well as their past experience. By observing the experiences of a range of market-oriented democracies that pursued a similar goal over a similar time period, we hope to learn from the successes and failures of others about what practices and policies best promote that goal. By reviewing current plans or policy efforts, we hope to learn what others see as challenges in the next generation transition, and to learn about the range of possible solutions to these challenges.

Among the countries we surveyed, two broad definitions of "broadband" have emerged for the purpose of planning the transition to next-generation networks. The first emphasizes the deployment of substantially higher capacity networks. This sometimes translates into a strong emphasis on bringing fiber networks ever closer to the home. High capacity is mostly defined in terms of download speeds, although some approaches also try to identify a basket of applications whose supportability defines the quality of the desired next generation infrastructure. The second emphasis is on ubiquitous, seamless connectivity. Exemplified most clearly by the planning documents of Japan, which has widely deployed fixed and mobile networks half a generation ahead of networks in the United States and Europe, this approach emphasizes user experience, rather than pure capacity measures. Just as the first generation transition from dial-up to broadband included both the experience of much higher speeds, and the experience of "always on," so too next generation connectivity will be typified not only by very high speeds, but also by the experience that connectivity is "just there": connecting anyone, anywhere, with everyone and everything, without having to think about it.

All countries we surveyed include in their approaches, strategies, or plans, a distinct target of reaching their entire population. Many of the countries we observed explicitly embrace a dual-track approach in the near future: achieving access for the entire population to first-generation broadband levels of service, and achieving access to next generation capabilities for large portions of their population, but not necessarily everyone, in the near to medium term.

1.2 A multidimensional approach to benchmarking helps us separate whose experience is exemplary, and whose is cautionary, along several dimensions of broadband availability and quality

Our first task is to understand how to distinguish countries whose broadband outcomes are more successful from those whose outcomes are less desirable, so that we can tell which countries' experiences are exemplary, and which provide more of a cautionary tale. We reviewed a range of current efforts at benchmarking the broadband performance of different countries, and conducted our own independent studies and evaluations to complement and calibrate existing efforts. As a result of this process we have been able to produce a set of benchmarks on the three attributes of particular interest–penetration, capacity, and price–that we believe offers more fine-grained insights, and with greater

confidence, than do the benchmarks that have commonly been used in American public debates over broadband performance. These benchmarks attempt to answer the questions: (a) how many people have fixed, mobile, and nomadic broadband, (b) what is it that they "have" technically, and (c) at what prices.

1.2.1 The United States is a middle-of-the-pack performer on most first generation broadband measures

Our findings confirm the widespread perception that the United States is a middle-of-the-pack performer. On fixed broadband penetration the U.S. is in the third quintile in the OECD; on mobile broadband penetration, in the fourth quintile. In capacity the U.S. does better, mostly occupying the second quintile by measures of both advertised and actual speeds. In price, the U.S. does very well for the lowest prices available for the slowest speeds, but is otherwise a third quintile performer in average prices at medium, high, and very high speeds. On those few measures where we have reasonably relevant historical data, it appears that the United States opened the first decade of the 21st centuries in the top quintile in penetration and prices, and has been surpassed by other countries over the course of the decade.

Table 1.1. United States rank among OECD countries, data from OECD and Berkman studies, on dimensions of penetration, speed (advertised and actual), and price (by tier of service defined by speed).

Penetration metrics	Rank	Speed metrics	Rank	Price metrics	Rank
Penetration per 100, OECD	15	Max adv. speed, OECD	9	Price for low speed, OECD	12
Household penetration, OECD	14	Avg. adv. speed, OECD	19	Price for low speed, OECD+GC	5
3G penetration, GC	19	Median download, speedtest.net	11	Price mid speed, OECD	17
Wi-Fi hotspots per 100,000, Jwire	9	Median upload, speedtest.net	5	Price mid speed, OECD+ GC	18
		Median latency, speedtest.net	17	Price high speed, OECD	19
		90% download, speedtest.net	11	Price high speed, OECD+GC	14
		90% upload, speedtest.net	7	Price very high speed, OECD	11
				Price very high speed, OECD+GC	13

1st quintile
2nd quintile
3rd quintile
4th quintile
5th quintile

Note: Details in Part 3
Source: OECD, GlobalComms, Jwire, Speedtest.net, Berkman Center analysis

1.2.2 More important than identifying the U.S. position, our approach allows us to separate the experiences of other countries into positive and negative along various dimensions of interest

Quite apart from judging the relative performance of the United States, our benchmarking exercise allows us to diagnose which countries are potential sources of positive lessons, and which countries are potential sources of negative lessons. Here, our multidimensional benchmarking approach offers substantial new insights. Canada, for example, is often thought of as a very high performer, based on the most commonly used benchmark of penetration per 100 inhabitants. Because our analysis includes important measures on which Canada has had weaker outcomes—prices, speeds, and 3G mobile

broadband penetration—in our analysis it shows up as quite a weak performer, overall. Most other countries do not move quite as much from what that most common benchmarking measure describes, but countries like Switzerland and Norway nonetheless are not as strong performers as they are usually perceived to be, while France exhibits much better performance than usually thought because of its high speeds and low prices. The Netherlands has had good experiences with fixed broadband, but not with mobile, while Italy had exactly the inverse experience. The changes in our interpretation of the experience of other countries are particularly important when our goal is to learn from that experience what practices and polices may be helpful, and what practices may be less helpful, for which outcomes.

1.3 Policies and practices

1.3.1 Transposing the experience of open access regulation from the first broadband transition to next generation connectivity occupies a central role in other nations' plans

Our most surprising and significant finding is that "open access" policies—unbundling, bitstream access, collocation requirements, wholesaling, and/or functional separation—are almost universally understood as having played a core role in the first generation transition to broadband in most of the high performing countries; that they now play a core role in planning for the next generation transition; and that the positive impact of such policies is strongly supported by the evidence of the first generation broadband transition.

The importance of these policies in other countries is particularly surprising in the context of U.S. policy debates throughout most of this decade. While Congress adopted various open access provisions in the almost unanimously-approved Telecommunications Act of 1996, the FCC decided to abandon this mode of regulation for broadband in a series of decisions in 2001 and 2002. Open access has been largely treated as a closed issue in U.S. policy debates ever since.

Yet the evidence suggests that transposing the experience of open access policy from the first generation transition to the next generation is playing a central role in current planning exercises throughout the highest performing countries. In Japan and South Korea, the two countries that are half a generation ahead of the next best performers, this has taken the form of opening up not only the fiber infrastructure (Japan) but also requiring mobile broadband access providers to open up their networks to competitors. In leading countries like Sweden and the Netherlands, following the earlier example of the United Kingdom, regulators are addressing the complexities of applying open access policy to next-generation infrastructure by pushing their telecommunications incumbents to restructure their operations and functionally separate their units that sell access to network infrastructure from their units that sell connectivity directly to consumers. Moreover, countries that long resisted the implementation of open access policies, Switzerland and New Zealand, changed course and shifted to open access policies in 2006.

1.3.2 Open access policies in other countries have sought to increase levels of competition by lowering entry barriers; they aim to use regulation of telecommunications inputs to improve the efficiency of competition in the consumer market in broadband

Open access policies seek to make it easier for new competitors to enter and compete in broadband markets by requiring existing carriers to lease access to their networks to their competitors, mostly at regulated rates. The idea is that the cost of replicating the underlying physical plant: digging trenches, laying ducts, pulling copper/cable/fiber to each and every home is enormous; it therefore deters competitors from entering the market in broadband services. By requiring that capacity to be shared,

through leasing, with competitors, open access rules are intended to encourage entry by those competitors, who can then focus their own investments and innovation on electronics and services that use that basic infrastructure. The theory underlying open access is that the more competitive consumer broadband markets that emerge from this more competitive environment will deliver higher capacity, at lower prices, to more of the population. The competing theory, that underlies the FCC's decision early in this decade not to impose open access for broadband infrastructure, is that forcing incumbents to lease their network to competitors will undermine that industry's incentives to invest in higher capacity networks to begin with, and without that investment, the desired outcomes will not materialize.

1.3.3 The emphasis other countries place on open access policies appears to be warranted by the evidence

Because the near-universal adoption of open access is such a surprising result, because this kind of regulation goes to the very structure of the market in broadband, and because the policies adopted by other countries are so at odds with American policies during this decade, we dedicate the bulk of our discussion of policies in other countries to assessing the international experience on open access regulation. Our approach is both qualitative and quantitative. We first undertake detailed country-by-country and company-level analyses of the effects of open access and the political economy of regulation on broadband performance. We find that in countries where an engaged regulator enforced open access obligations, competitors that entered using these open access facilities provided an important catalyst for the development of robust competition which, in most cases, contributed to strong broadband performance across a range of metrics. Today these competitors continue to play, directly or through successor companies, a central role in the competitiveness of the markets they inhabit. Incumbents almost always resist this regulation, and the degree to which a regulator is professional, engaged, and effective appears to play a role in the extent to which open access is successfully implemented with positive effects. In some places where incumbent recalcitrance has prevented effective implementation of open access, regulators have implemented functional separation to eliminate the incentives of the incumbent to discriminate among consumer broadband market providers in access to basic infrastructure. We supplement these case studies with two quantitative analyses. First, we conducted a study of pricing at the company level of 59 companies that offer high speed access. Our pricing study (Figure 4.2) shows that prices and speeds at the highest tiers of service follow a clear pattern. The highest prices for the lowest speeds are overwhelmingly offered by firms in the United States and Canada, all of which inhabit markets structured around “inter-modal” competition—that is, competition between one incumbent owning a telephone system, and one incumbent owning a cable system. The lowest prices and highest speeds are almost all offered by firms in markets where, in addition to an incumbent telephone company and a cable company, there are also competitors who entered the market, and built their presence, through use of open access facilities. Companies that occupy the mid-range along these two dimensions mostly operate either in countries with middling levels of enforcement of open access policies, or in countries that only effectively implemented open access more recently. Second, we re-analyzed two of the most recent econometric studies of the effect of one form of open access–unbundling–on broadband penetration. Our econometric analysis confirms the positive contribution of unbundling to penetration per 100 inhabitants. We also perform several transformations of the analysis that suggest that the effect is larger and the result more significant and more robust than prior studies based on the same data found.

1.3.4 Wireless policies

The next generation broadband user experience is built upon not only the deployment of high capacity networks, but also the creation of ubiquitous seamless connectivity. A central part of this new user

experience involves the integration of fixed, mobile, and nomadic access. (By mobile, we mean networks evolved from cellular telephones to offer mobile broadband, primarily 3G networks; by nomadic, we refer to versions and extensions of Wi-Fi hotspots.) Approaching that goal has in most countries been associated with embracing fixed-mobile convergence. In many countries this has entailed accepting vertical integration of fixed with mobile network operators. Importantly, those countries that permit, or even encourage such vertical integration, couple it with open access policies that seek to preserve competition in, and in Japan's case with net neutrality or non-discrimination rules for, these integrated networks. The countries we reviewed are actively identifying or allocating more spectrum for 4G, or very high speed mobile services, and many are struggling with how to transition existing uses—both earlier generation cellular, and television spectrum—to these future uses.

We review the wireless experience of several countries, both high performers and low, both those that do well in fixed and mobile, and those that do poorly in one but well in the other. We find that the effects of basic policy choices in wireless are difficult to tease apart. We find good performers and poor who have used auctions and beauty contests (that is, the awarding of licenses through a regulatory selection process); we find good performers and poor that started out early with four or five identical 3G licenses, and good performers who started out with what should have led to a weaker market, with only two or three licenses. We find high performers who imposed strict buildout requirements, and others who did not. Nomadic access has developed with little support from policy: it is increasingly integrated into innovative service models. It is offered by fixed broadband providers who seek to make their networks more flexible, by mobile broadband providers who seek to increase the utility of their networks to their subscribers or reduce load on their 3G infrastructure by handing some traffic over to their nomadic access networks, or through public efforts to create connected public spaces. A major consideration in future planning will be identifying regulatory policies and practices that allow these kinds of integrations that promote seamless, ubiquitous access, without undermining competition.

1.4 Investments in infrastructure and demand side programs

1.4.1 Stimulus and recovery funds are spent in many countries

Like the United States, several countries plan to use stimulus and recovery funds to support rollout of high capacity networks, either to upgrade to fiber for everyone, or to bring underserved areas up to speed. Here we survey the investments of other countries both in response to the economic crisis and in response to the perceived challenges and opportunities of the next generation transition. We found that the current U.S. investment of $7.2 billion appropriated in the American Recovery and Reinvestment Act, adjusted per capita, is commensurate with, and mostly higher than, investment made in other countries. The exception to this statement is the announced, but not yet fully-funded, very high levels of planned government investments in Australia and New Zealand.

1.4.2 Large, long term investments have played a role in some of the highest performing countries

Several countries have invested over the long term as a strategic choice rather than as a stimulus measure. Sweden's investments are the most transparent in this vein. While the relative share of direct government investment is harder to gauge outside of Sweden, it does appear that the leaders in fiber deployment—South Korea, Japan, and Sweden—are also the leading examples of large, long term capital investments through expenditures, tax breaks, and low cost loans that helped deployment in those countries. These countries have spent substantially more, in public spending on a per capita basis, than the U.S. has appropriated for stimulus funding. On the other hand, there are models of high performing

countries, like France, that invested almost nothing directly, and instead relied almost exclusively on fostering a competitive environment.

1.4.3 In Europe, substantial effort has been devoted to delimiting when government investment, both national and municipal, is justified and will not risk crowding out private investment

Because public investment risks crowding out market investment, we review current decisions by the European Union on the proper guidelines for when and how public investment is appropriate. In the context of considering municipal investments, like Amsterdam's CityNet, and country-level investments, the European Commission has studied both specific cases and the general policy question under an explicit mandate to limit state interventions that could undermine the development of a common market in goods and services. Here we review that experience, and the new European guidelines, issued September 17th, 2009. These guidelines are a formal decision of the European Commission on two kinds of state and municipal investments. The first is aimed to achieve universal access to first generation broadband technologies. This decision refers to similar problems, and takes a broadly similar approach to, funding for access to unserved and underserved areas as taken under the stimulus funding in the U.S. The second is intended to speed deployment of next generation broadband technologies, so as to harvest the anticipated social and economic benefits of the next generation transition. On this subject, the European ruling holds that government funding can be appropriate even where there are two present facilities-based incumbents, offering triple-play services, including 24Mbps broadband service, as long as there are no discrete plans for deployment of next generation connectivity, with truly high capacity, within three years, by both incumbents. Moreover, building on the experience of Amsterdam's CityNet, the European guidelines permit government investment where it is shown to be on terms equivalent to what a market investor could have undertaken. Public investments in next generation networks, permissible under these conditions, should be oriented towards providing "passive, neutral, and open access infrastructure."

1.4.4 Several countries engaged in a range of investments to support broadband demand, including extensive skills training, both in schools and for adults

Several countries we observed invested on the demand side of broadband, not only in supply side policies. Here we survey the experience of these countries, and identify specifically the prevalence of national and local skills training programs. We see adult training, workplace training, and a heavy emphasis in schools, including both teacher training and curriculum development programs. We also see on occasion major programs to subsidize both computers and connections for low income users.

1.5 Overview of this document

The remainder of this document is organized as follows:

- Part 2 outlines current thoughts on "what is broadband?"—that is, how the target of the policy should be defined, and how the definition may reflect on policy emphases. It briefly notes current reasons given in other countries for emphasizing next generation connectivity as a policy goal.

- Part 3 describes our independent assessment of current benchmarking and measurement sources, and describes the results of our independent analysis and testing of benchmarks.

- Part 4 describes our findings on competition and open access policy.
- Part 5 offers an overview of practices and policies concerned with mobile and nomadic access.
- Part 6 discusses government investment practices, on both the supply and demand sides of broadband and next generation deployment.

This document is accompanied by a series of select country overviews, in which we offer country-specific overviews of performance and policies.

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 and 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" 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"[1] 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 to as the title indicates: "super-fast

1 Ofcom, 3 March 2009.

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.[2] 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[3] 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.[4] 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.[5] 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.[6]

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

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

3 Federal Ministry of Economics and Technology, February 2009.

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

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

6 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.[7] 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)[8] 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

7 ERG(09)17, June 2009.

8 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.[9] 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). (While geography plays some role, urban density does not appear to be an adequate explanation in Japan's case, see Section 3.3.2 and Figure 3.7; competition, however, seems to play an important role, see Sections 4.9 and 4.10.) 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.[10]

9 See Japan case study, Appendix, for list of references.
10 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 3.5.3. 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%.[11] 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%.[12] 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."[13]

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11 *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.

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

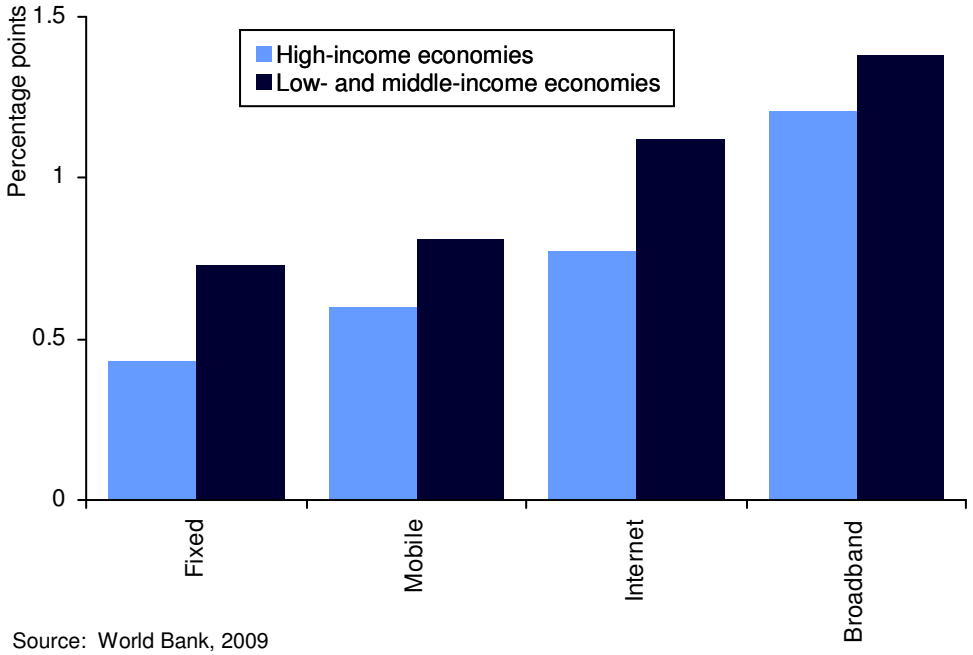
13 The Federal Government's Broadband Strategy, p. 6.

	Implications					
Definition	**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

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.

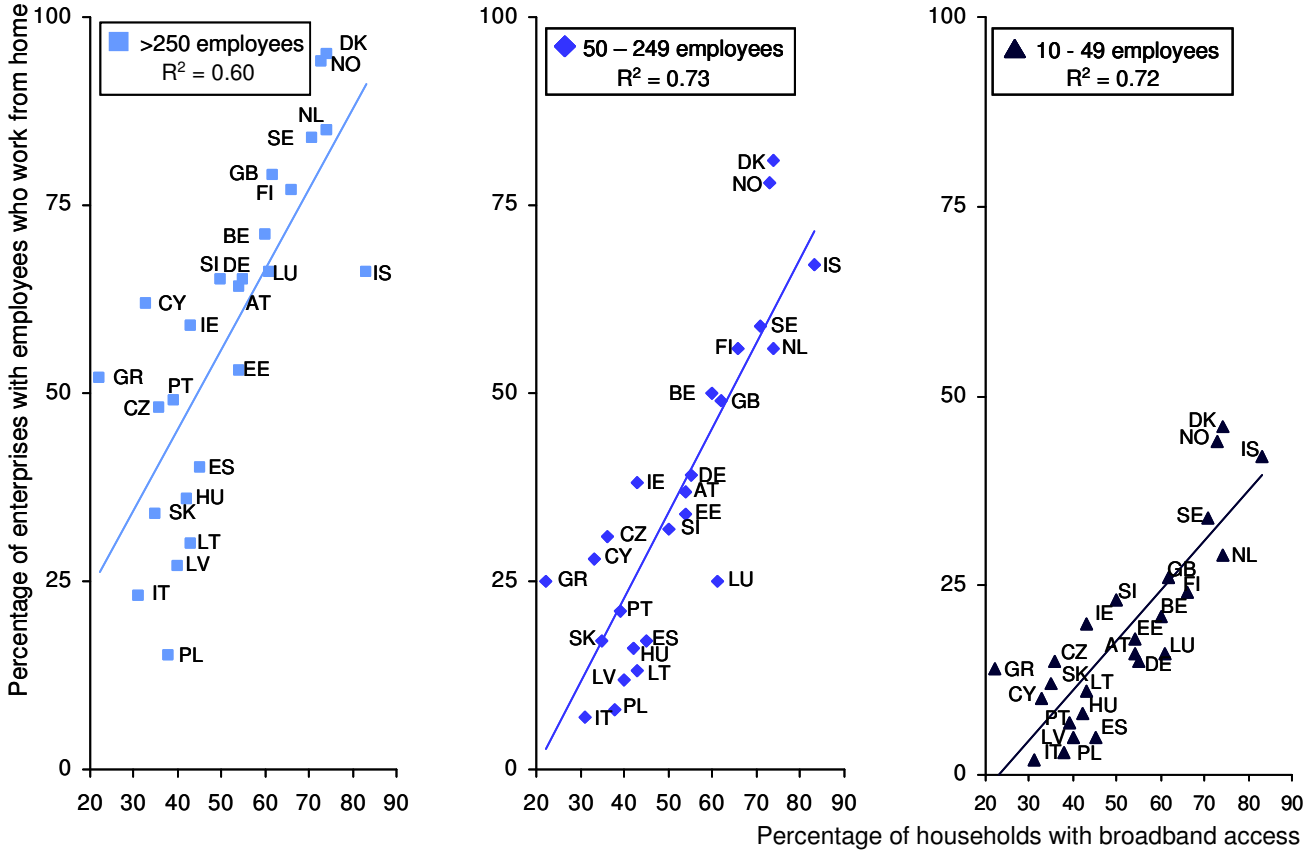
Figure 2.1. Growth effects of ICT



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

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

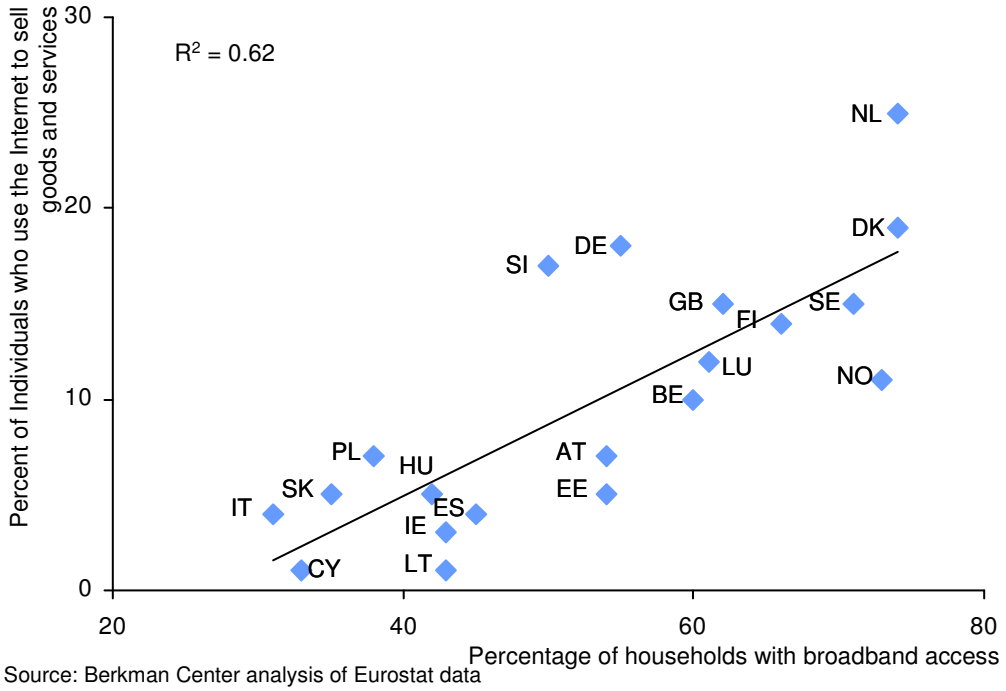


Source: Berkman Center analysis of Eurostat data

Beyond telecommuting for other businesses, European data also suggests that household broadband penetration is correlated with individuals 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.

3 International comparisons: Identifying benchmarks and practice models

3.1 Why use international comparisons?

International comparisons, in particular broadband penetration rates as reported by the Organization for Economic Cooperation and Development (OECD) and International Telecommunications Union (ITU), have been a political hot button in the past few years. Because the United States began the first decade of this century with the fourth highest levels of broadband penetration among OECD nations, and is closing the decade in 15th place in these same rankings, and because, according to ITU measures the United States slipped from 11th to 17th between 2002 and 2007, many have used these data to argue that the United States, on its present policy trajectory, is in decline. Others have responded by criticizing the quality of the data in various ways, asserting that the United States broadband market is performing well and there is no concern to be addressed. The debate occasionally resembles that of a horse race; indeed, a horse race in which those who have already placed their bets are arguing about how to decide which horse has won.

There are two primary problems with the horse race approach to international rankings as it has been used in public debate in the United States. First, there has been too much emphasis on one particular measure—penetration per 100 inhabitants, which is only one way of measuring one facet of what one might plausibly seek to learn from a benchmarking exercise. Second, there has been too much emphasis on precisely where the United States ranks, as opposed to on defining a range of metrics that would allow us to identify countries that are appropriate targets of observation, so that we can learn from their successes and failures. The point of benchmarking along multiple dimensions is to provide us with an ability to identify countries that have had positive or negative outcomes along given dimensions of interest. Where a country measures well on a given desired outcome—for example, high levels of mobile broadband penetration, or low prices for very-high-speed offerings—it is worthwhile to look at the environmental conditions and policy actions that contributed to this outcome, and to consider whether these could be transplanted successfully to the U.S. If a country or cluster of countries performs well on several different measures, one can begin to look more holistically at that country or cluster, and consider whether there are characteristics that are susceptible to transposition into the American context. The basic premise is that, in broadly similar democratic, market societies, intelligent, well-intentioned people face similar problems and have different approaches to addressing those problems. Through real world experimentation, by a process of trial and error, different approaches are tried in different places. Looking to the experience of places that implemented a policy and thereafter began to perform better (or worse) than other places that did not implement that policy at the same time, on measures we consider pertinent, allows us to separate when there is a lesson to be learned at all, and whether the lesson is that a given practice may make sense to adopt or should be avoided (or at least treated with suspicion). Because countries differ along many dimensions, the lesson is practically never available as a determinate command: this or that policy is clearly justified for a given country, without room for judgment. This is why the rankings and quantitative analyses can point in the right direction, but must be supplemented with a qualitative understanding of the detailed conditions and practices as market, social, geographic, and regulatory-political determinants.

While there can and should be plausible critiques of any sources of data and analysis, along with adjustments to data collection over time, and appropriate caution in its interpretation, it would be a grave mistake on the part of the United States simply to ignore and fail to use such data sets as exist in its planning and longer-term monitoring of our own performance and the consequences of policies we

adopt. To support the integration of evidence into American policymaking, here we endeavor to do two things. First, we present a wider range of measures than are commonly used to get at the core questions: how many people have broadband; what, technically, do they "have" when they have broadband; and at what price. That is, we look at measures of penetration, capacity, and price. Second, we provide independent data that we gathered or analyzed, aimed to fill in gaps, and independently test existing measurements. We use market analysis data for penetration and price, and actual measurements of speed and latency, in the case of capacity. We describe these data alongside other sources of data, most extensively OECD data, and correlate the data from different sources. The combination of independent measurement or analysis with reanalysis of OECD data gives us a degree of confidence in our results here. While we do not claim that our measurements are necessarily better than those made by others, we do gain confidence where the results of our observations, using independent techniques and/or sources of evidence, are well correlated with other sources of measurement. Before turning to reporting the measurements, the analysis of critiques, and the results of our independent tests, we explain in Section 3.2. the relative emphasis of different existing measurement exercises, and which of these exercises is most useful to provide evidence for which kind of policy focus.

3.2 Measures focused on users/consumers vs. measures focused on business

There are two clusters of rankings: those that tend to locate the U.S. in the mid-teens of the rankings, and those that locate the U.S. at the very top of the rankings. The most important of the former are the OECD (U.S. ranked 15th) and ITU (17th) rankings.[14] The second cluster includes, most prominently, the Connectivity Scorecard (U.S ranks 1st) created by Leonard Waverman of the University of Calgary in collaboration with the consulting firm LECG and funded by Nokia Siemens Networks, and the World Economic Forum Network Readiness Index (3rd), produced in collaboration with the Insead Business School in France.

The difference between these two clusters of indices or rankings is not their methodological quality but their focus. The purpose of one's inquiry determines which cluster is more relevant. The OECD and ITU measures are directly focused on Internet, broadband, and telecommunications-specific measures of performance. The OECD in particular covers and reports extensively on broadband-related data: such as number of subscribers and their percentage in the population or among households, price ranges, speeds of access, etc. The ITU itself also collects and reports actual statistics on telecommunications, but covers many more countries. It therefore includes many comparators that are sufficiently different in wealth and technological state as to be noisier targets of observation, and it reports information that is not quite as rich on this much larger set of countries. Its index or ranking, the ICT Development Index (ITU-IDI), largely reflects communications and computer data, but also includes a component reflecting literacy, as well as secondary and tertiary educational enrollment rates. In this regard, both the OECD broadband measures and the ITU-IDI, particularly its sub-indices that exclude the educational attainment, are focused on specific measurable outcomes in terms of population-wide broadband availability, use, capacity, and price.

14 In this cluster there is also an additional sensible adaptation of the OECD data, produced by Robert Atkinson of the D.C.-based Information Technology and Innovation Foundation (ITIF) (15th), which creates a ranking based on a composite of penetration per households rather than per-inhabitant, speed, and price (while it does not change the position of the U.S., which is the concern of those looking at the horse races, it does change the position of several other countries, emphasizing in particular the successes of South Korea and Japan).

By contrast, the WEF/INSEAD Network Readiness Index and the Waverman Connectivity Scorecard emphasize business use and availability. The WEF/INSEAD index captures a wide set of indicators, addressing a much broader range of policy concerns, not only in science and technology, but also in business environment more generally. Factors that the report accompanying the Index explicitly cites as burdens on the U.S. ranking (3rd overall) are its relatively high burden of regulation and tax, the inefficacy of American law making, the inefficiency of American dispute resolution and its low level of judicial independence (the U.S. ranks in the 20s on efficacy of law making and on judicial independence in this index). Factors tending to support the relatively high ultimate standing of the U.S. on this index are the efficiency of its markets and venture capital activity, its well developed R&D clusters, like Silicon Valley or the Research Triangle, its large pool of scientists and engineers, and the high quality of its universities.[15] The breadth of parameters, both positive and negative, should provide sufficient flavor to understand that this Index is useful in considering broad science and technology policy questions. If one is interested more specifically in broadband policy—understood as policy aimed at supporting ubiquitous high capacity access to all Americans at affordable rates—the measures that influence standing in this index sweep too broadly to provide meaningful guidance. It would be odd to include in a National Broadband Plan an effort to improve the efficacy of American law making or the independence of its judiciary. Moreover, in the more relevant sub-index of the WEF/Insead index (the sub-index that focuses on individual network readiness) the U.S. ranks 14th, very similar to its ranking in the OECD and ITU rankings, and in the individual usage sub-index the U.S. ranks 10th. In the sub-index describing business readiness the U.S. ranks 3rd, and in business usage we rank 5th.

Consistent with the findings of the WEF/INSEAD Readiness Index, the Waverman Connectivity Scorecard also focuses on business use of information and communications technology. And, like the Network Readiness Index, the Waverman Scorecard finds that businesses in the United States are well connected and networked, and relatively well-positioned to take advantage of that connectivity. As the 2009 edition states, "the Scorecard is relatively heavily weighted towards the business sector. As a result, countries that perhaps have superior fiber residential broadband networks, or perhaps high mobile subscriber rates, will find themselves weighed down if there has not been a corresponding investment in business infrastructure and the necessary capital and skills to turn infrastructure into productivity enhancing vehicles."[16] Beyond the general focus on the business sector, the Waverman Scorecard, because of its focus on economic growth and its determinants, measures not only connectivity, but factors that would complement network connectivity to make for growth. The U.S. occupies a middle-tier position based on the measures that are shared with the other indices. As Waverman and his collaborators put it: "When one considers consumer infrastructure measures – as is typical of most indices – the U.S. performance is mediocre on some metrics. However, our results are actually consistent with much published research showing that the U.S. economy has benefited more strongly from ICT than most others, with the primary difference lying in more intensive ICT use by business." To the extent one is concerned with business use of information technology, these two indices suggest that the United States is in a reasonably good condition. To the extent that one is concerned with wide dispersion of broadband to consumers, in both served and underserved areas, and with developing ubiquitous access for the American population, both the Connectivity Scorecard and the WEF/INSEAD Network Readiness Index provide less insight and, where they cover similar ground, do not appear to contradict the OECD and ITU data.

15 WEF/INSEAD 2009 report, Chapter 1.1, page 14.
16 Waverman 2009, at 3.

3.3 Penetration: Fixed

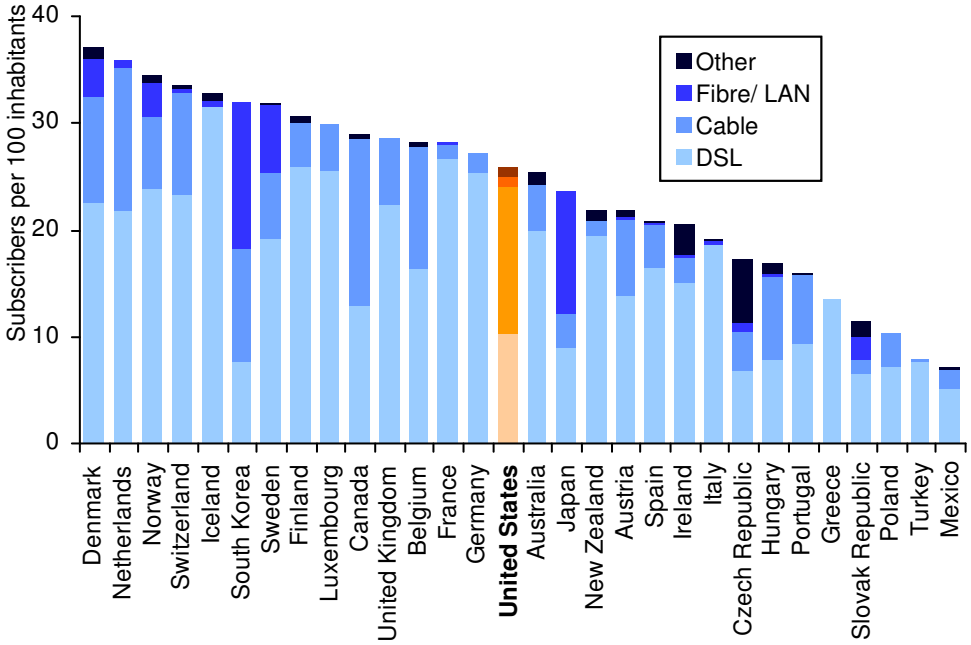
3.3.1 Penetration per 100 inhabitants measure

The best known benchmark of international performance on broadband has been the OECD's annual release of rankings of its 30 members, based on penetration of fixed broadband per 100 inhabitants. In these rankings the United States was 15th in the most recent report in 2009. These rankings have been the most salient, and have received the most extensive critique.

Figure 3.1 represents the number of subscribers per 100 inhabitants in a country. We emphasize several aspects of this ranking. First, the Nordic countries are uniformly high performers by this measure, occupying five of the top eight slots. The top six, or top quintile, includes Denmark, Norway, and Iceland, as well as the Netherlands, Switzerland, and South Korea. The second quintile includes, in addition to Sweden and Finland: Canada, the United Kingdom, Belgium, and Luxembourg. In our analysis throughout much of this report we largely exclude close analysis of the very small countries like Iceland and Luxembourg, because their experience is too different to provide useful insight. The third quintile is made up of France, Germany, the United States, Australia, Japan, and New Zealand. Spain, Ireland and Italy only make the fourth quintile. As we continue to go through the various metrics, one of the things we will be looking for are particularly high performers, and another will be performers with particular anomalous rankings ratios between different measures. For example, Italy is only 22nd out of 30 in fixed broadband penetration per 100 but, as we shall see, is fifth in mobile broadband penetration. Canada is a second quintile performer in penetration (down from having penetration levels second only to South Korea's in 2003), but only a fourth quintile performer on speeds and prices. Keeping an eye out for these kinds of discrepancies allows us to identify false "successes" and false "failures," or be more precise about what aspects of a country's performance are worth learning for adoption, and which are worth learning for avoidance.

The ITU reports the same measure of fixed broadband subscribers per 100 inhabitants as part of its ICT Development Index.[17] If we look only at OECD countries as reported in the ITU index for 2007, the United States switches places with Germany, edging ahead to 14th place.

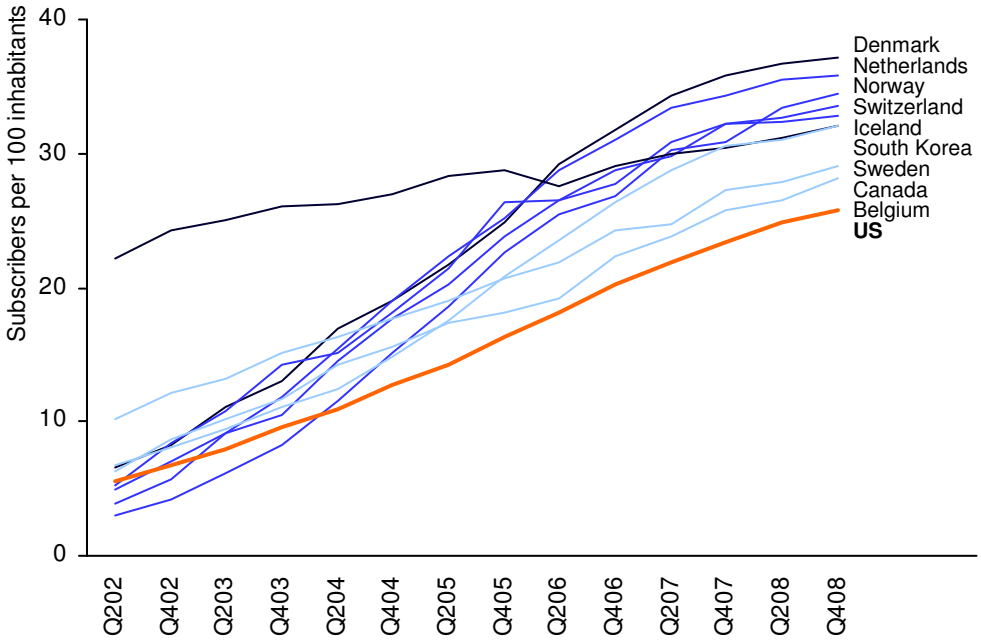
Figure 3.1. Broadband penetration



Source: OECD 2008

17 ITU, ICT-IDI, 2009, Indicator 7. Reported under Use Indicators, pp. 93-94.

Figure 3.2 Top quintile penetration rates over the last 6 years.

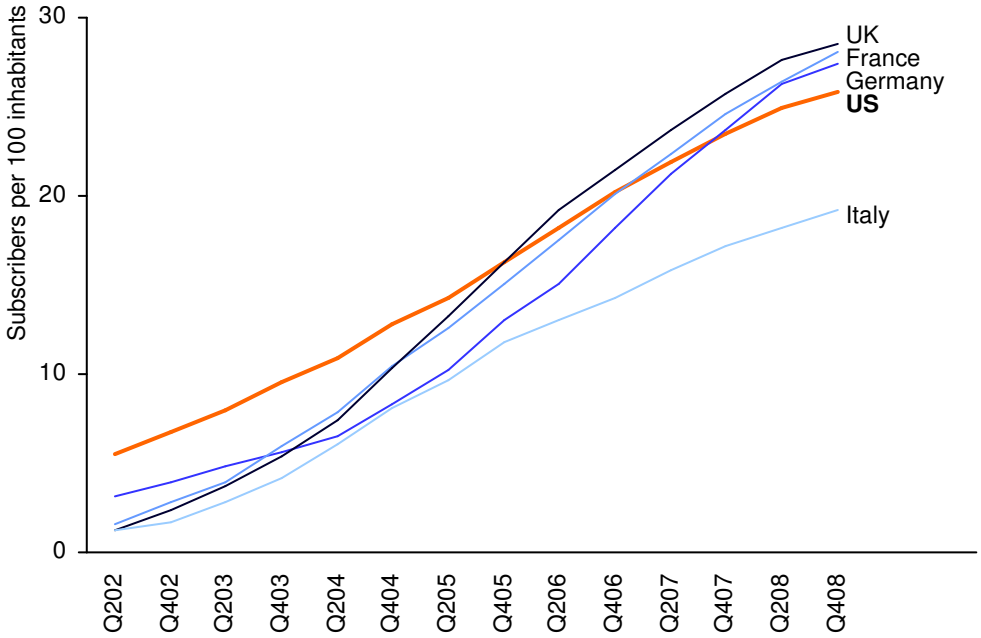


Source: OECD 2008
Note: US, Belgium, Canada, Sweden were top quintile in 2002, but are no longer in 2008

The only substantial change is that Sweden moves from 7th to 1st place, nudging Denmark and the Netherlands from first and second to second and third places, and Finland and South Korea switch places from the bottom of the first to the top of the second quintile and vice versa. The ITU data shows Hong Kong as the only non-OECD member with higher fixed broadband penetration than the U.S.

The penetration rates per 100 have been the most salient politically because they are collected and published regularly, and so have provided the starkest image of what has been described by some as American relative decline in the pace and level of uptake of the first broadband transition. Figure 3.2 presents historical penetration rates from the second quarter of 2002 until the fourth quarter of 2008 for the top quintile performers in 2002, and the top quintile performers in 2008. Figure 3.3 presents a similar longer term comparison of the United States and the four largest European economies.

Figure 3.3. Large European economies penetration rates over the last 6 years.



Source: OECD 2008

There can be little argument that, to the extent that the OECD reports of penetration per 100 inhabitants are a pertinent measure of broadband uptake, they provide a long term view of the performance of the American broadband market relative to the performance of other markets. The numbers suggest that many of these other countries started with lower levels of penetration,

and, with the exception of Italy, at some point between 2002 and 2005, accelerated and overtook the U.S. broadband market. Trying to identify what made these countries accelerate as they did, which countries accelerated more, and why, could offer some insight into the potential contribution of policy to broadband penetration.

3.3.2 Critiques of OECD penetration per 100 inhabitants measure

Because of their salience, the OECD penetration per 100 rankings have been the subject of extensive criticism. The most plausible arguments against their usefulness or competence as a benchmark have been: (1) Measuring penetration per 100 inhabitants "penalizes" countries with bigger households, like the U.S.; (2) The OECD data represent what companies tell their regulators, and what these regulators in turn tell the OECD; the concern is that companies sometimes misreport to their governments, and governments misreport to multilateral organizations, in each case to make themselves look good; (3) High speed facilities are harder to deploy in sparsely populated countries, and the U.S. is less densely populated than are the countries ahead of it in the rankings (note that, unlike the other critiques, this is not a claimed refutation of the findings, but a reason to explain the findings on grounds other than policy divergence); (4) Americans access broadband at work and in their educational institutions, and these are under-counted by the rankings; and (5) the OECD rankings do not cover wireless connections, in particular 3G and publicly-available Wi-Fi connections.

Because this measure has been the longest standing available metric, it is of particular importance as an element of benchmarking over time, and a means of learning about broadband policy. We therefore dedicate some space here to evaluate these critiques. We find that none undermines the competence or validity of the OECD numbers, though we agree that an exclusive focus on penetration per 100 as a measure is too narrow a focus. We take up the last critique, about mobile broadband penetration, in the context of the next part: mobile penetration, which we treat here as sufficiently important to be reported as an independent metric.

Counting penetration per 100 inhabitants rather than per household

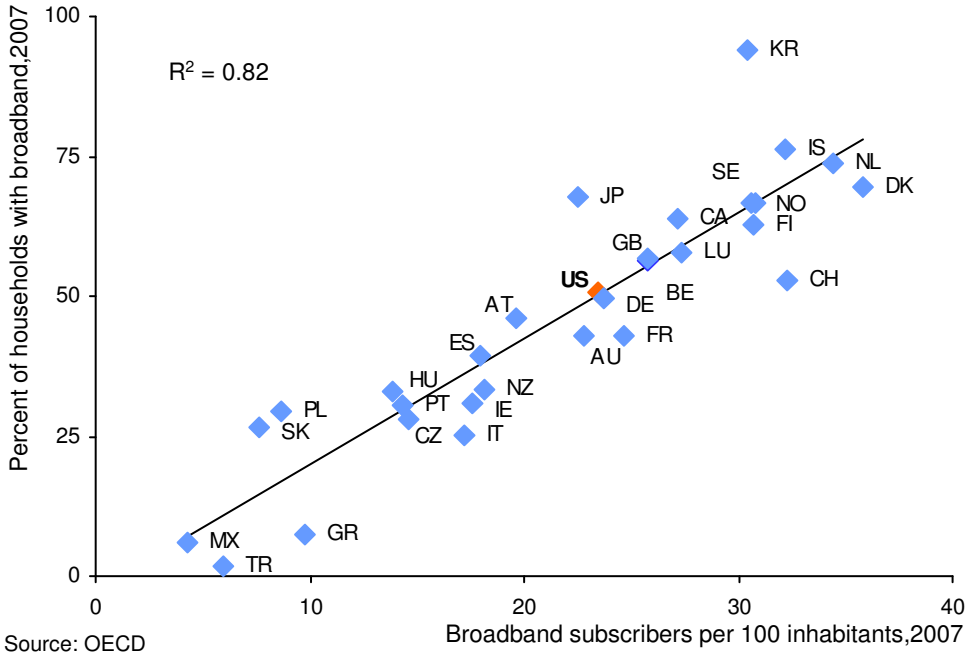
The first, most important, and widely accepted critique of the OECD per 100 rankings is that they penalize the United States, which has larger households than other countries. The argument is that fixed-line broadband is subscribed to by households, not by individuals, and so percentage penetration of households is the appropriate measure. While we agree that observing household penetration is distinctly important, indeed, likely more important than penetration per 100, two reasons make this critique unpersuasive in context. First, each measure has slightly different advantages, and using both is better than using one. Second, the measures are highly correlated, so shifting to look at household penetration does not in fact result in a significant change in U.S. performance.

The primary disadvantage of using penetration per household rankings, rather than rankings per 100 inhabitants, is that by seeking to correct for household size such a ranking will miss—and therefore understate—business use. Most pertinently, this approach will result in ignoring use by small and medium size businesses that may use consumer-type offerings. Moreover, household penetration, properly done, is based on household surveys, not carrier-level subscription data reporting, because not all subscriptions reported by carriers are for households. One occasionally sees efforts to state household penetration numbers based on taking all subscriptions and dividing them by number of households, instead of by number of inhabitants. This includes businesses in the numerator, but divides by households, which overstates household penetration in countries with relatively high business use (a larger numerator) and large households (a smaller denominator). This makes data collection for

household penetration more expensive and time consuming. Well constructed household level data is therefore updated less frequently, and offers more coarse-grained observation over time. The reason to use both metrics is that, while we care about small business use as a measure of broadband policy, is it clearly correct that, for purposes of identifying countries that have been more or less successful in connecting citizens in their homes, a household measure is indeed analytically better.

Using household subscription levels provides useful nuance, but does not fundamentally change the picture. As Figure 3.4 shows, the two measures are highly correlated. The U.S. rank is entirely unaffected by counting penetration per household, as opposed to penetration per 100 inhabitants. The only two countries that appear to be "penalized" by the use of a "per inhabitants" rather than "per households" measure are South Korea and Japan. Table 3.1 shows that the primary effects of looking at household penetration are to move South Korea back to the top of the list, to move Japan, which has widely been understood to lead the way on speed and price-per-speed measures, into the top quintile for penetration as well, to move Switzerland from the first to the third quintile on penetration, and France from the top of the third to the top of the fourth quintile. The Japanese numbers are potentially polluted by the fact that they include 3G subscriptions, which are particularly high in Japan, and therefore make it potentially inappropriate to interpret the Japanese household penetration numbers as in fact comparable to those of other countries. It is the case, however, that 3G services include, for example, NTT DoCoMo's "U Home" service, which offers 54Mbps service in the home. This home-specific 3G service is, in other words, faster than the fixed service available in all but a handful of countries. Given this fact, we report the Japanese household numbers with the remainder of the household penetration numbers, though with the noted caution.

Figure 3.4. Broadband penetration per 100 inhabitants and by households.



Source: OECD
Note: Data for Belgium and New Zealand reflects 2006; data for Turkey reflects 2005

Because we have a longer period of consistent measurement by the OECD for penetration per 100 inhabitants, because that measure is so highly correlated with the real target of interest for much policy—household penetration, and because it is more current, we will often use penetration per 100 inhabitants where doing so will allow us to make claims about periods that precede good comparable data on household penetration, or periods that are more recent than available household-level data. While we do so, however, we must remember that per inhabitant penetration has little effect on the standing of all countries, except that it substantially understates penetration in South Korea, slightly

overstates penetration in France and Denmark, and substantially overstates penetration in Switzerland. It has no effect on U.S. standing.

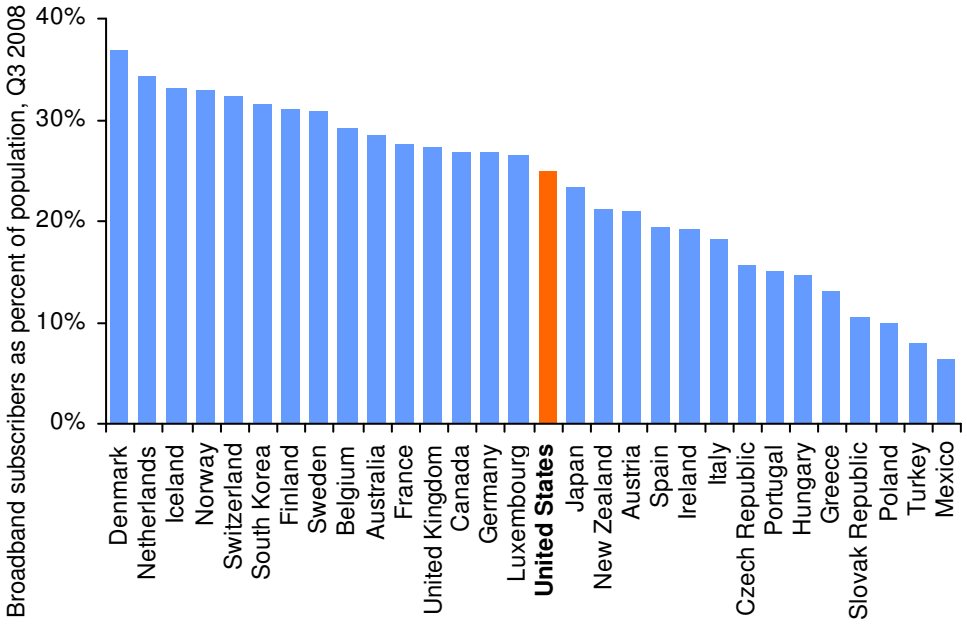
Doubly distorted self-reporting.

Another critique of the penetration data is that it comes through doubly distorting self-reporting. First, companies report to their national regulators, then national regulators report to the OECD. The concern raised is that these numbers therefore cannot be taken seriously, in part because some countries are less reliable in their data collection than others, and may try to "look good" in the international rankings, and in part because companies may misreport to their regulators. The correlation with household data is one signal that this critique is unlikely correct, because household penetration is generally based on household survey data, not on company reporting. Its high correlation with a measure of penetration that does depend on company reporting increases our confidence in the quality of the first prong of the double distortion: the company data as reported by the countries to the OECD. Second, we attempted to assess the rankings by correlating them to estimations of penetration levels in an independent market analysis database, as applied to OECD countries. The market analysis data is based largely on reports by the companies directly to Telegeography, the firm collecting the data, and so moderates concerns over the imperfections inherent in communications between a company and its regulator, on the one hand, and a country and the multilateral organization of which it is a member, on the other. In our dataset, the United States comes out 16th, instead of 15th, (Figure 3.5) but the basic finding is that penetration rankings based on independent market data and penetration rankings of the OECD are almost perfectly correlated, with an R^2 of 0.98 (Figure 3.6).

Table 3.1. Impact on country rank

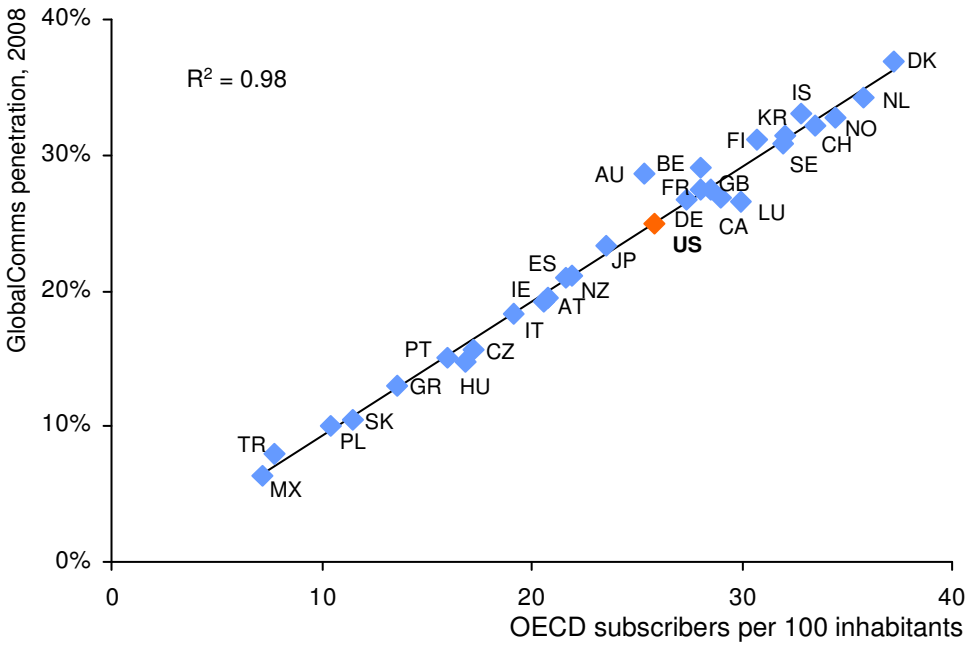
Country	Per household rank	Per inhabitant rank	Change in rank
South Korea	1	8	↓↓↓↓↓↓↓
Iceland	2	4	↓↓
Netherlands	3	2	↑
Denmark	4	1	↑↑↑
Japan	5	17	↓↓↓↓↓↓↓↓↓↓↓↓
Norway	6	5	↑
Sweden	7	7	
Canada	8	10	↓↓
Finland	9	6	↑↑↑
Luxembourg	10	9	↑
United Kingdom	11	11	
Belgium	12	12	
Switzerland	13	3	↑↑↑↑↑↑↑↑↑↑
United States	14	15	↓
Germany	15	14	↑
Austria	16	18	↓↓
Australia	17	16	↑
France	18	13	↑↑↑↑↑
Spain	19	20	↓
New Zealand	20	19	↑
Hungary	21	25	↓↓↓↓
Ireland	22	21	↑
Portugal	23	24	↓
Poland	24	27	↓↓↓
Czech Republic	25	23	↑↑
Slovak Republic	26	28	↓↓
Italy	27	22	↑↑↑↑↑
Greece	28	26	↑↑
Mexico	29	30	↓
Turkey	30	29	↑

Figure 3.5. Broadband penetration as reported in GlobalComms 3.0.



Source: GlobalComms 3.0

Figure 3.6. Comparison of OECD and GlobalComms data.



Source: Berkman Center analysis of OECD Broadband Statistics and GlobalComms 3.0

Population urbanicity and density

A second common critique of the OECD penetration rankings is that population density affects the ranking. Note that this is not a critique of the competence of the penetration rankings, but of their pertinence to policy. In other words, if population density generally, or urban density in particular, overwhelm the effect of policy, then the penetration rankings are less relevant as a benchmark for policy makers, since they merely reflect geography, and not the comparative success of different broadband policies. If, on the other hand, density is irrelevant, or if it contributes only a part of the explanation of penetration, then the question remains how much of the residual effect is explained by policy. As long as penetration is not fully explained by non-policy considerations like density (or income or poverty, as we shall see), it remains a pertinent benchmark for policymakers to be able to identify which countries outperform their predicted levels of penetration, given known contributing causes. These then become a model of observation for positive policies, just as countries that substantially underperform their predicted levels of penetration given alternative causes become models of policies one might wish to avoid.

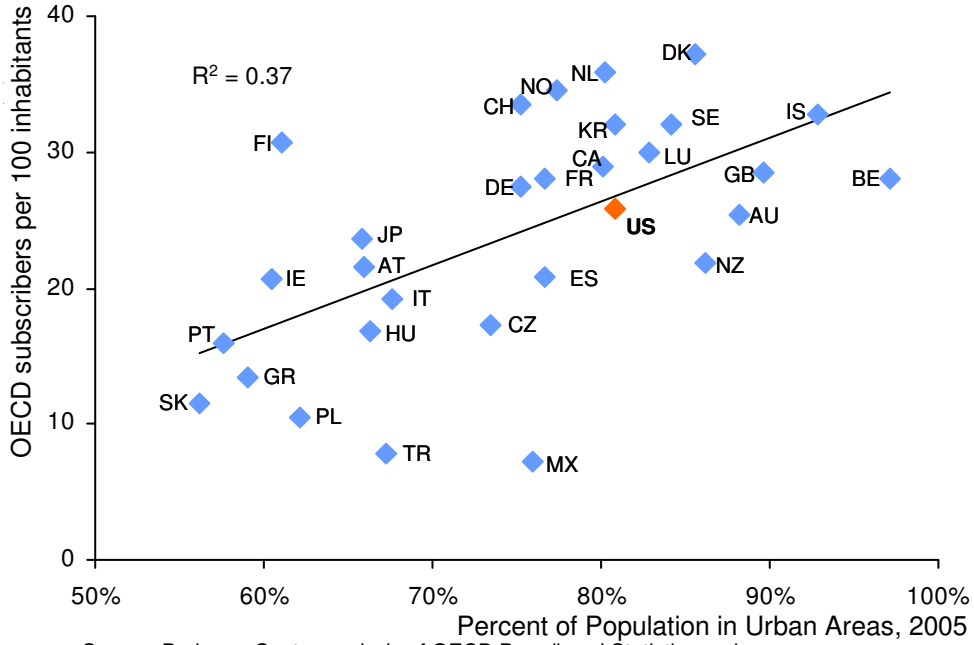
The basis of this argument against use of penetration data is that a widely dispersed population is more expensive to connect than a densely packed population. This argument has been particularly forceful, and probably correct, in explaining part of the early success of South Korea, and the emergence of some competitive fiber offerings in Japanese urban centers. This has led to efforts to correct for this mistake. One proposal is to introduce a measure of "urbanicity": how much of a country's population is located in dense urban areas, multiplied by the population density of those areas.[18] This measure, reasonably, assumes that the cost of reaching many customers is lower if they live in dense neighborhoods with high-rises. This suggests that one metric for country performance in the future may seek to compare penetration, speed, and price in similarly dense areas of different countries, as mandated by the Broadband Data Improvements Act.[19] As a very coarse initial pass at that approach we report speed test data from 55 cities throughout the OECD, in the section on speed below (Table 3.3.). That Busan and Seoul have the highest average download speeds in the OECD countries tends to support the urbanicity hypothesis. That New York City is not among the top twenty cities in average download speeds suggests that something else is at work as well. Given our focus on penetration in this section, however,

18 Atkinson ITIF rankings doc, in endnote 14 explained. Also cite the Correa paper that creates the methods.

19 Pub. Law 110-385, Section 103, requiring the FCC to include in its 706 reports measures of broadband capabilities (including speeds and prices) from at least 75 communities in 25 countries.

we report here a simple initial test of the urbanicity hypothesis, where we performed a simple bivariate correlation of OECD reported levels of penetration and urban concentration as reported by the UNDP (Figure 3.7).

Figure 3.7. Penetration and urban concentration.



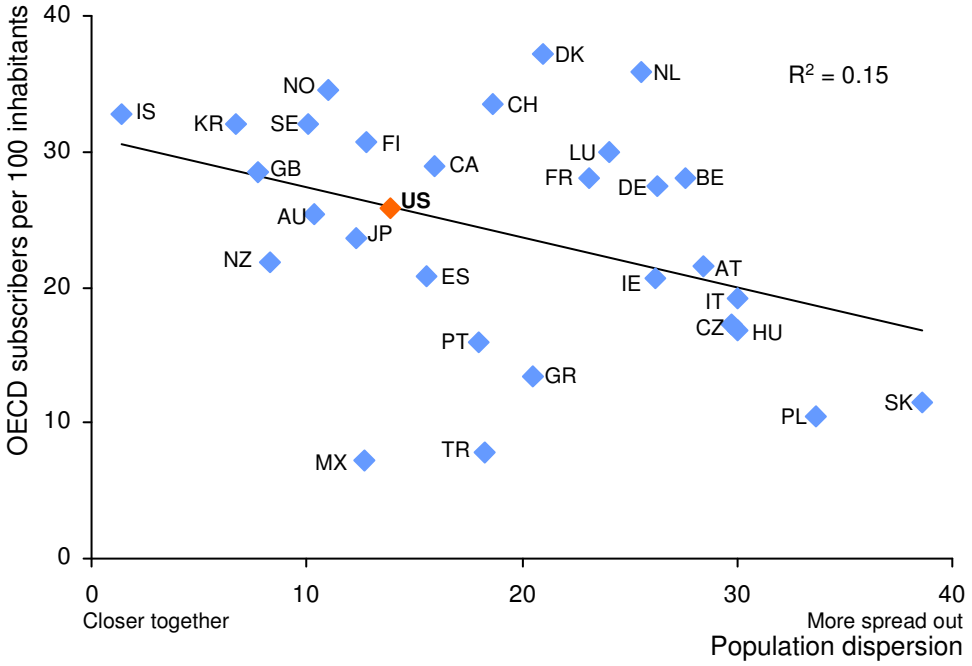
Source: Berkman Center analysis of OECD Broadband Statistics and UNDP Human Development Report Office

We find that the United States performs roughly consistently with the best fit line for the effect of urbanicity, and that urbanicity is positively correlated with penetration, though clearly is not a sole determinant. The surprise here is that despite its high density, South Korea actually outperforms even what its high urban density would predict, and that highly dense countries like the Netherlands and Denmark also outperform what their urban concentration would predict. In general, most of the countries that appear to be positive observation models, as identified by their levels of penetration, are above their predicted penetration levels given urban concentration, suggesting that their presence in the higher quintiles of penetration indeed marks them as potential models for policy observation, rather than simply as the beneficiaries of propitious geography.

The OECD itself has taken an alternative approach to correcting for rankings that reflect penetration in terms of population. Its analysis focuses on how densely packed half of a country's population is.[20] The intuition here is similar to the intuition around urbanicity, but focuses on relative proportion of a country's land mass necessary to reach half the population. This would be a particularly pertinent predictor for a country in which large portions of the population reside in suburbs, and is relatively densely populated, but still not urbanized. As Figure 3.8 shows, however, the correlation between density so measured and broadband penetration is not statistically significant. What this analysis does allow us to do, however, is again identify countries that outperform the (very limited) degree to which their 50% concentration measure predicts their penetration. As with urbanicity, the United States' ranking is largely unaffected, but the Netherlands, the Nordic countries, South Korea, and to a lesser extent France, outperform what their level of concentration, using this looser measure, would predict. For future benchmarking exercises, our measure of urban density appears to be more useful statistically than the measure of density by 50% concentration. This finding makes intuitive sense, given the relative benefits of rolling fixed lines to apartment buildings.

20 ITU IDI rankings.

Figure 3.8. Broadband penetration and population dispersion.



Source: OECD, 2008

Urban concentration versus poverty

The effect of the degree of urban concentration can be further confounded by cultural patterns of concentration or deconcentration of poverty.[21] This observation ties in to the more widely accepted observation that poverty and inequality explain a substantial portion of levels of broadband penetration.[22] While one would not put in a National Broadband Plan a target of reducing poverty and inequality in the United States generally, any more than one would include improving the efficiency of law making or judicial independence in response to the WEF Network Readiness Index, the observation does suggest the relative importance and potential high returns to policies focused on the poor as poor, whether urban or rural, rather than on the rural as rural, irrespective of poverty.

To test this hypothesis we used a 2008 dataset that enabled us to re-run the model proposed by Derek Turner (who first made this argument in context of broadband) on current data, and we obtained Turner's original data to evaluate whether we could replicate his findings. First, we were able to replicate Turner's findings with his data. Second, using our own updated data, we analyzed the effects of median income, urban concentration, and poverty (see Annex). We find that median income, urban concentration, and poverty all contribute to explaining levels of penetration. In all our models, median income explained more of the difference in penetration than urbanicity or poverty, but both urbanicity and poverty contribute to the explanation. When we tested whether the effect was primarily driven by any single country, we found that they were not. Our findings in this analysis suggest that interventions targeted at improving broadband penetration among poor people, urban or rural, may be warranted independently of interventions aimed at addressing rural access. Our data do not allow us to differentiate whether interventions focused on low-income users should be on measures such as public construction and management of facilities, or on Lifeline-like universal service subsidies. All these non-policy predictors of penetration, however, do not explain the entire difference between countries, leaving room for policy to have an effect at the margin.

21 Derek Turner, Broadband Reality Check II 2006, Annex A.

22 This is a surprising point of congruence between the technically sophisticated advocates who have analyzed these questions from opposing policy perspectives. Compare Turner to Wallsten, Understanding Broadband (2008) pp 39-41.

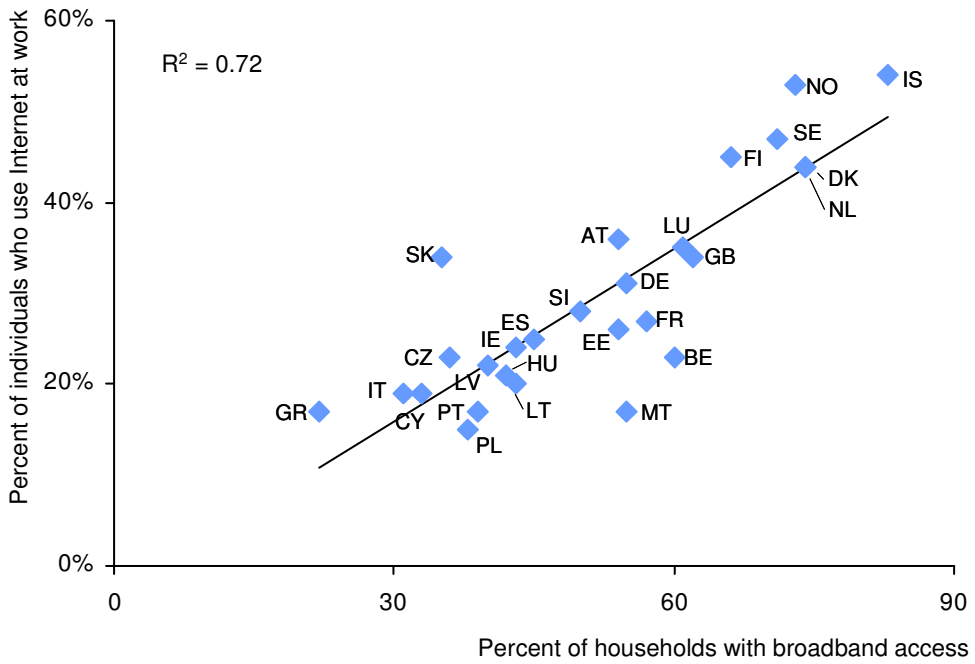
Workplace access

Another critique is that the OECD undercounts American broadband penetration because it does not count use at work in the numerator of the broadband per 100 metric. Given the relatively higher investment levels in information technology in the business sector in the United States, this is a plausible concern. First, however, it is important to remember that capturing a portion of business use is an advantage of the per 100 inhabitants measure over the per household measure, because only the former includes at least those businesses, particularly small and medium enterprises whose Internet access is likely counted in the carrier reports on broadband subscriptions. Second, much of the U.S. ICT investments are not in simple high speed Internet connectivity, but in business software and equipment. While data on U.S. business usage is weak, the OECD does collect and publish survey data from various national sources on broadband penetration among businesses.[23] Unsurprisingly in the global networked economy, 99% of businesses with over 250 employees in almost all OECD economies have broadband connections. This number drops off to about the 98% for mid-sized businesses, and only then, for businesses with between 10-49 employees, do some differences emerge. Among the higher performers in general broadband penetration, some indeed do have relatively low broadband penetration for small businesses: Canada (93.7%), the UK (92.1%), and Sweden (94.1%). The rest of the countries that have high penetration per 100 inhabitants also have penetration rates above 95% even in these smaller businesses. These are the only countries where it is possible that undercounting of business use would result in a substantial decline in their rankings relative to the US. Given the very high level of penetration in Sweden, if there is likely an effect on the meaning of penetration it is that Canada and UK may look slightly worse on penetration than by the standard measure.

Conceptually, however, it is not at all clear that use at work is a confounding factor. In order for use at work to be a critique of the U.S. position in the rankings, one would have to assume that broadband use at work is a substitute for home access, rather than a complement to it. That is, one would have to assume that people who access high speed Internet at home do so instead of getting broadband at home, rather than to assume that people who have high speed access to the Internet at work learn about what they can do when they are connected, and then subscribe at home, or simply live in a society where, increasingly, living without a connection is a burden. While we do not have data about the United States, European survey data suggests that within Europe at least, higher household broadband penetration is well correlated with higher individual use at work. See Figure 3.9. While this shows no causality, it is certainly consistent with the intuition that access at work would complement demand for access at home, rather than substitute for it.

23 http://www.oecd.org/dataoecd/20/62/39574066.xls.

Figure 3.9. Internet use at work and broadband penetration.



Source: Berkman Center analysis of Eurostat data

3.4 Penetration: mobile and nomadic broadband

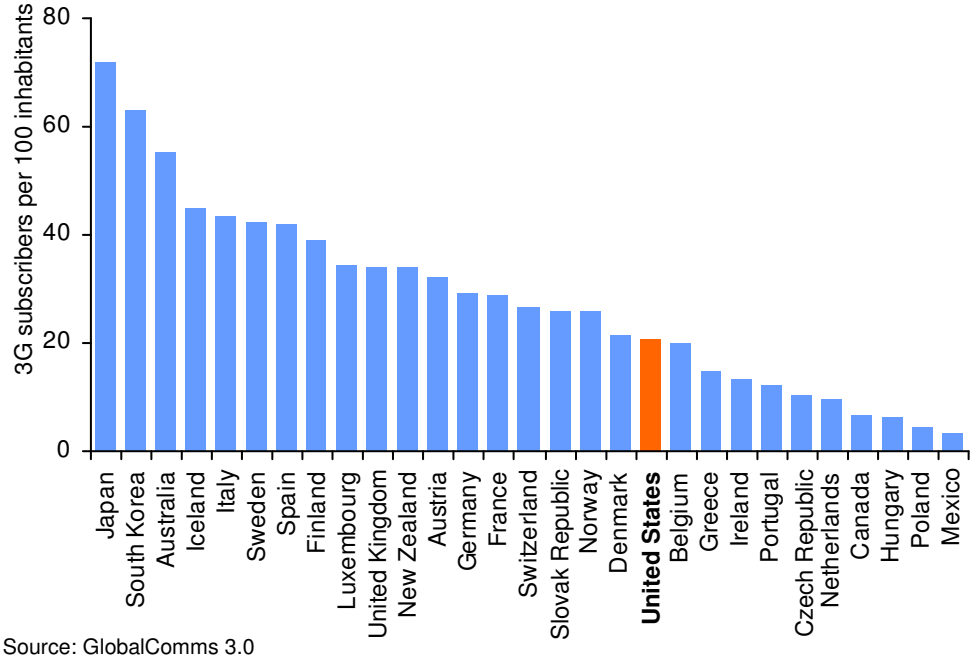
Understanding the future of the networked information environment as involving ubiquitous, seamless connectivity suggests that mobile and nomadic broadband are important independent measures of next generation transition performance. Even countries that follow capacity-oriented definitions treat mobile broadband, or ubiquitous connectivity, or Internet everywhere, as integral parts of their national plans. A critical component of ubiquity will be wireless access.

Wireless mobile connectivity for most people is experienced primarily and initially through devices that have evolved from what originally were mobile phones. However, providing a full picture of the next generation transition to ubiquity requires observations of both the trajectory from mobile telephony to mobile broadband, and the trajectory from local area network extension for laptops, to nomadic connectivity through whatever will develop from Wi-Fi hotspots. The need to consider mobile penetration was initially raised in the American context as a critique of the OECD penetration metrics. The argument was that the United States would rank higher if we accounted for wireless connectivity of both sorts instead of purely for fixed connection. Upon examination, that argument proves to be false. On mobile broadband the United States is a weak performer. On nomadic connectivity we do better, but are not a particularly high performer. Nonetheless, our purpose here is not to continue to test the competence and pertinence of measures of fixed broadband penetration, but to supplement that data with measures that would allow us to identify those countries that are particularly high performers in mobile and nomadic connectivity.

3.4.1 Mobile broadband: From phones to data

A commitment to understanding ubiquitous, seamless access as an integral part of next generation connectivity requires that we provide independent measures of mobile broadband penetration. In the longer term, it requires that we measure and monitor a set of metrics for mobile broadband similar to those we describe in the remainder of the chapter for broadband generally. Current OECD reporting on 3G subscriptions is wanting, as we explain below. We therefore report here on the results of our analysis of independent market data regarding 3G subscriptions.[24] We found that the United States ranks 19th among OECD members in 3G subscriptions per 100 inhabitants (Figure 3.10). Note that, given personal usage patterns, subscriptions measured as a proportion of population, rather than households, is the only appropriate measure for mobile communications penetration. The growth of 3G subscriptions in the United States was robust between the first quarter of 2008 and the first quarter of 2009, and indeed was the 10th highest in the OECD (Figure 3.11). The longer-term implications of this better performance in growth than in current penetration is moderated somewhat by the fact that several of the countries with higher growth rates, sometimes much higher growth rates, are those countries that currently have lower levels of 3G penetration than that of the United States. Canada, the Netherlands, Belgium, and the Czech Republic, have subscription growth rates that are two to three times larger than U.S. growth in 3G subscriptions, and Iceland, which a year ago had much lower levels of 3G subscriptions, has catapulted in one year into the top 5 countries. (Mexico has a much more pronounced late-mover high-growth rate.) Japan and South Korea are the highest performers, each with over 3 times as many 3G subscribers per 100 inhabitants as the United States. Three countries substantially outperform in 3G penetration their level of fixed penetration: Australia, Italy, and Spain; while the Netherlands, Denmark, Norway and Switzerland seem to underperform their high fixed broadband performance.

Figure 3.10. 3G penetration.

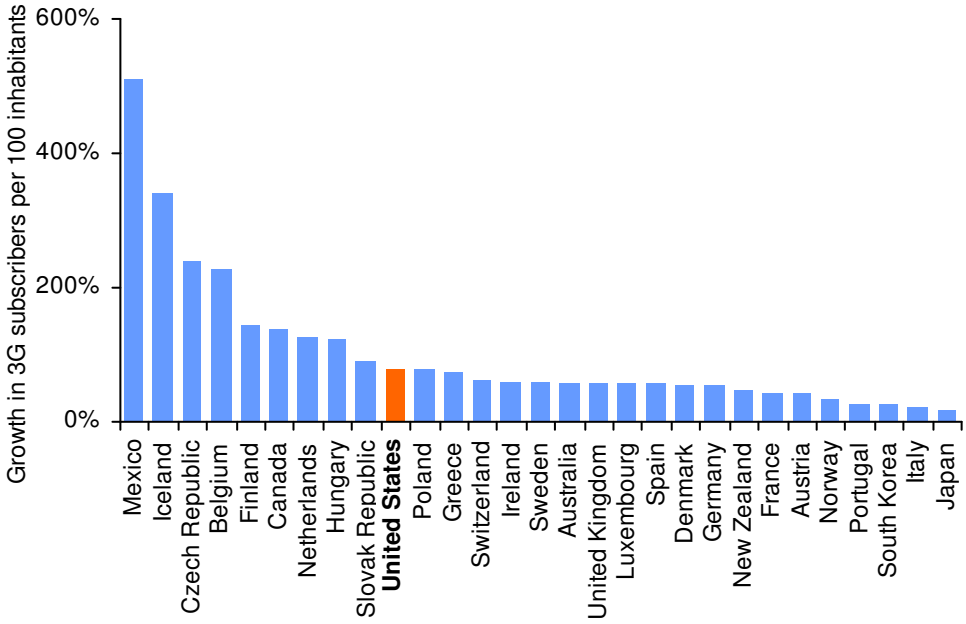


Source: GlobalComms 3.0

24 We use the Telegeography, GlobalComms database.

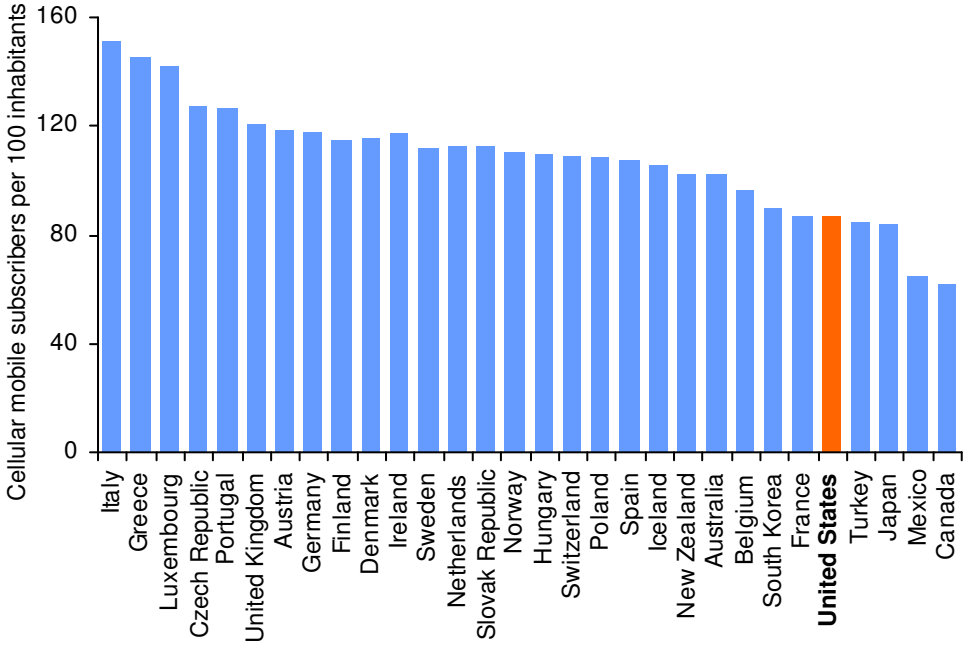
The OECD's reports subscriptions to mobile phones generally, and its effort to separate out 3G subscriptions seem to miss a lot. In mobile telephony subscriptions generally, the United States is 26th among the OECD 30 (Figure 3.12[25]). This position seems to skew strongly against countries with low levels of pre-paid card use: the United States (26th, 17% use pre-paid), Japan (28th, 2% pre-paid) and South Korea (24th, 2%). By contrast, countries with the highest numbers of mobile cellular subscribers per 100 inhabitants have much higher levels of pre-paid usage[26]: Italy (1st, 89%), Greece (2d, 71%), and Luxembourg (3d, 92%). These countries all have levels of penetration above 140%, reflecting the measurement difficulty posed by counting multiple accounts held by single subscribers in a pre-paid system. More importantly, these aggregate numbers by themselves do not reveal how much of the usage is for voice communications, and how much for data; and within data, how much is really mobile broadband as opposed to simpler, 2G-supportable applications.

Figure 3.11. Annual growth in 3G penetration



Source: GlobalComms 3.0

Figure 3.12. Cellular mobile penetration: 2G & 3G in OECD Report



Source: OECD, 2007

25 Figure 4.7 from the OECD Communications Outlook 2007, http://dx.doi.org/10.1787/620604300202).
26 OECD Communications Outlook 2009, Table 4.14.

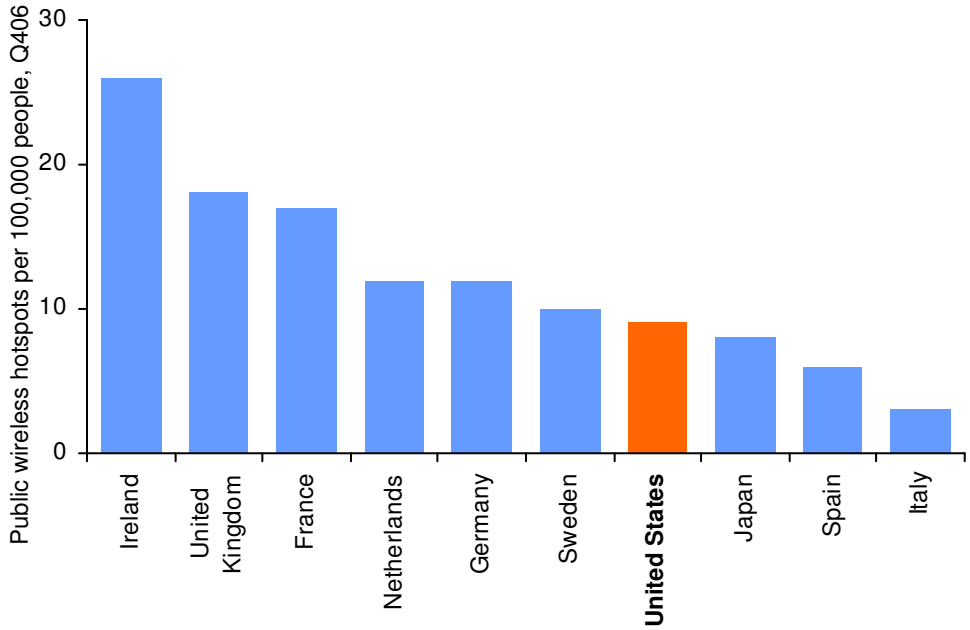
The OECD in its 2009 Communications Outlooks, tried to separate out 3G from 2G subscriptions.[27] 2G and what is sometimes called 2.5G are the second generation phones, capable of slower data speeds, which have been available in the United States for a while, and supported personal communications devices like Blackberry and iPhone until relatively recently. 3G networks have been rolled out by Verizon, AT&T, and Sprint, and are planned by T-Mobile, but are still currently focused in urban areas. Looking purely at the 3G levels of subscription as reported by the OECD, the United States would not rank in the top 20, and this is so also the case in that report for otherwise high performing countries like Norway, France, Belgium, Luxembourg and Canada. Upon examination, it appears that the OECD representation for 3G penetration reflects many missing values. Looking at a much smaller set of countries examined in 2008 by Britain's Ofcom,[28] which looked only at an ambiguous measure of "availability" (not actual subscriptions), the United States seems to have roughly similar levels of mobile broadband networks. In this report, Japan (100%) and the UK (92%) had higher potential coverage for 3G, but other countries were more closely bunched together. The Ofcom numbers certainly suggest that the numbers reported by the OECD for 3G in particular are too low across many of the countries. It is not clear, however, what "availability" means in this report, and whether it is calculated based on availability where the stated percent of the population resides, or works, or exists during some proportion of the day. As a result, we have more confidence in the data we presented above than we do in the OECD measure, and believe it to be more pertinent than the Ofcom availability measure, because we focus on subscriptions rather than areas of potential coverage. Future efforts to incorporate measurements of mobile broadband should include a broader set of market data sources, and emphasize validation from independent diverse sources.

3.4.2 Nomadic access: From Wi-Fi to ubiquity

If 3G is the evolutionary trajectory from the mobile phone, the alternative pathway to ubiquitous connectivity evolves from the wireless home network. Americans mostly know hotspots in airports, hotels, or cafes. Other emerging models include models like FoN, a company that allows users to register as members of a "club" of users who exchange free access to their Wi-Fi spots: every member can access the Internet nomadically when they are near any other member, and non-members can buy access when they are within reach of a member's connection. This model has recently been extended by several European companies to be integrated with fixed broadband subscriptions. Iliad/Free, in France, allows every Free subscriber (about 24% of the entire French broadband market) to connect nomadically through the service box of every other Free subscriber, as well as make free phone calls from any Wi-Fi enabled mobile phone. French mobile competitor SFR has a similar arrangement, and allows its subscribers to interconnect with FoN subscribers as well. In Sweden, both Telenor and TeliaSonera bundle their mobile broadband subscriptions with access to a large network of hotspots that each company operates, and in Telenor's case, to hotspots operated throughout Europe by pan-European hotspot provider The Cloud. We discuss these and other service innovations that form a part of the fixed-mobile convergence pattern in Parts 4 and 5. For now, we simply note that the European experience is pointing to the conclusion that Wi-Fi nomadic access is beginning to provide a trajectory toward complementing mobile broadband networks for ubiquitous access.

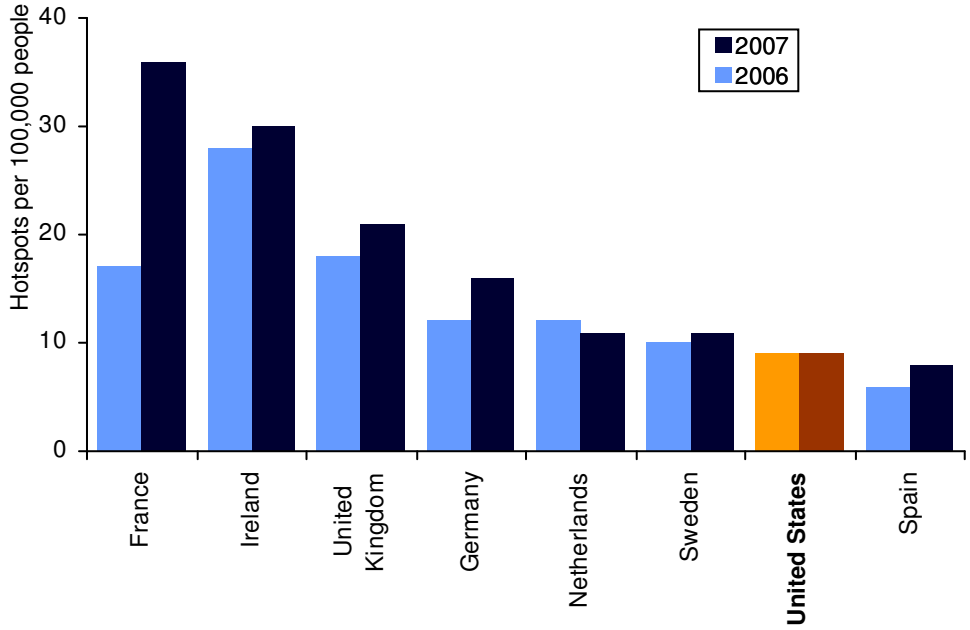
27 Fig. 4.7 and Table 4.12.
28 Ofcom, The International Communications Market 2008 (20 November 2008).

Figure 3.13. Public wireless hotspots, OECD



Source: OECD based on Informa telecoms and media

Figure 3.14. Public wireless hotspots, Ofcom



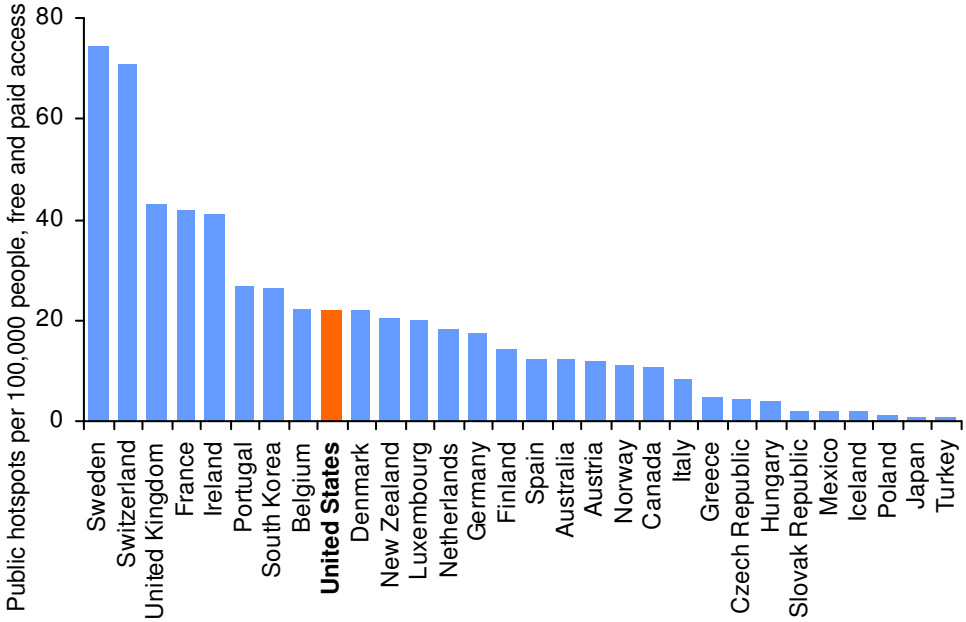
Source: Ofcom International Markets Report, 2008

We found no authoritative source of information for Wi-Fi hotspots. This is an area that requires greater effort at measurement and reporting. Two separate, older reports, one from the OECD based on information from Informa (Figure 3.13),[29] and the second from Ofcom based on IDATE and its own data collection (Figure 3.14),[30] have sufficiently similar values for 2006 that one can be reasonably confident that the estimates are acceptable for that period. Judging by these numbers and their congruence, the United States is 7th out of the 10 countries identified, in terms of hotspots per 100,000 population. Of particular interest in these reports is the enormous jump in number of Wi-Fi hotspots in France within one year, which Ofcom interprets to partly reflect 400 public Wi-Fi deployments in Paris in the summer of 2007, on a more traditional model, and partly reflecting the very early returns from the Free strategy. One should note that 400

29 See OECD, Broadband Growth and Policies in OECD Countries (2008). Fig. 2.4, p. 89.
30 Ofcom, The International Communications Market 2008 (20 November 2008). Fig 5.67, p. 242.

public hotspots translate into an increase of 0.4 hotspots per 100,000, implying that if these were indeed the two primary sources of increase, the Free strategy would account for practically the entire doubling effect.

Figure 3.15. Public wireless hotspots



Source: Jwire data

Because the data underlying these reports are old, and the changes clearly very rapid, we sought to identify a separate source of information to supplement and update these other sources. Our study uses information from marketing firm Jwire, which collects lists of Wi-Fi hotspots and makes them available to the public for search as part of its business of selling advertising linked to connection through hotspots. Because there is no full inventory of hotspots, we take these data with caution. The major incongruities that these data present from the older sources of data are for Japan, which Jwire data seems to severely undercount, unless Wi-Fi hotspots available two years ago in Japan have been dismantled, and Switzerland and Sweden, which have dramatically higher levels of availability per 100,000 population in the data we used for 2009 relative to the data Ofcom and the OECD used for 2006 and 2007. We gain some confidence in our findings, however, from qualitative review of the Wi-Fi market developments in Sweden and Switzerland. In Sweden, Telenor expanded nomadic access through its acquired subsidiary, Glocalnet, and contracted with The Cloud to build 800 hotspots, while incumbent TeliaSonera responded to this challenge by investing in more Wi-Fi hotspots. Its strategy was announced in mid-2007. In February of 2008 TeliaSonera announced an aim to double the number of hotspots in Sweden. It began to deploy hotspots in locations operated by the Svenska Spel gaming company. It now accounts for about a third of hotspots in Sweden and bundles unlimited access to its Surfzone Wi-Fi hotspots with its mobile broadband subscriptions. In Switzerland, Swisscom itself is a pan-European hotspot provider (Swisscom Eurospot), and since 2008 launched a collaboration with the Swiss railway system to offer Wi-Fi access in train stations and on trains. There was also a substantial push to deploy Wi-Fi hotspots during the European soccer championship in the summer of 2008, undertaken by a range of players: Swisscom itself, independent hotspot provider Trustive, and various municipal efforts, most successfully in Berne. We therefore think that with appropriate caution, the figures we report in Figure 3.15 are likely representative of available nomadic access in the covered countries. Data on this important development trajectory for ubiquitous access is otherwise limited, uncertain, and dated.

3.4.3 Conclusion

In looking at measures of penetration: household penetration, to emphasize the importance of home access to policy; per 100 inhabitants, to capture some small and medium enterprise use; mobile, and to some extent nomadic access, we can begin to identify a set of models for observation and learning. South Korea is a leading performer across all measures: leading household penetration, second on 3G, in the top quintile for per 100 inhabitants, and 7th for Wi-Fi Hotspots. Japan leads in 3G and is a top quintile performer for household penetration, but has lower results on per 100 inhabitants, and very low results on hotspots. We have some concerns about our data for Japan, however, because 3G and household penetration have some overlap, and the hotspot data is inconsistent with prior studies in ways for which we cannot account. The Nordic countries are all very strong performers, with Sweden in the first or second quintiles across the board, while Denmark and Norway show some weakness on 3G, and Finland, Norway, and Iceland show weakness in nomadic access. Switzerland has first quintile performance on the per 100 inhabitants measure and the nomadic access measure, but third quintile performance on 3G and per household penetration (although the Swiss per household data is a year older than most other countries in the set, and so understates its performance there, possibly significantly; this exhibits one disadvantage of the per household measure in that it depends on survey techniques that are harder to update as regularly as the subscription data on which the per 100 inhabitants measures, both fixed and mobile, are based). The Netherlands and Canada both do well on the fixed-broadband penetration front, but are substantially weaker on 3G; while Italy and Spain exhibit the inverse profile. Of the larger European countries, the United Kingdom is the steadiest performer on penetration, showing up in the second quintile in all measures except nomadic access, for which it is in the first quintile. France and Germany are solidly in the third quintile across the board, except for France's stellar performance on nomadic access. The United States is a third quintile performer for fixed penetration by both measures, a fourth quintile performer for 3G, and a second quintile performer in nomadic access. As we will see in the practices and policies chapters, these measures suggest a focus on South Korea and Japan, on the Nordic countries, on the United Kingdom among the larger European countries, and on the Netherlands and Canada for fixed, positively, and for 3G, negatively, and vice versa for Italy and Spain.

Table 3.2 provides an at-a-glance report of these various measures, providing both the actual rank and, through shading, the quintile it represents: from dark green for first quintile to dark red for fifth quintile. The ranking reflects a weighted aggregate quintile performance measure, reflecting an emphasis on fixed (60%) over mobile (40%), per-households (35%) over per 100 inhabitants (25%), and 3G (30%) over Wi-Fi (10%).

Table 3.2. Country rankings on various penetration measures.

	Country	Penetration per 100, OECD	Household penetration, OECD	3G penetration, GC	Wi-Fi hotspots per 100000, Jwire	Weighted average ranking
1	South Korea	6	1	2	7	3.15
2	Iceland	5	2	4	27	5.85
3	Sweden	7	7	6	1	6.1
4	Denmark	1	4	18	10	8.05
5	Finland	8	9	8	15	9.05
6	Japan	17	5	1	29	9.2
7	Luxembourg	9	10	9	12	9.65
8	Norway	3	6	17	19	9.85
9	United Kingdom	11	11	10	3	9.9
10	Switzerland	4	13	15	2	10.25
11	Netherlands	2	3	25	13	10.35
12	Australia	16	17	3	17	12.55
13	Belgium	12	12	20	8	14
14	Germany	14	15	13	14	14.05
15	France	13	18	14	4	14.15
16	Canada	10	8	26	20	15.1
17	United States	15	14	19	9	15.25
18	Spain	20	19	7	16	15.35
19	Austria	19	16	12	18	15.75
20	New Zealand	18	20	11	11	15.9
21	Italy	22	27	5	21	18.55
22	Ireland	21	22	22	5	20.05
23	Portugal	25	23	23	6	21.8
24	Slovak Republic	27	26	16	25	23.15
25	Hungary	24	21	27	24	23.85
26	Czech Republic	23	25	24	23	24
27	Greece	26	28	21	22	24.8
28	Poland	28	24	28	28	26.6
29	Mexico	30	29	29	26	28.95
30	Turkey	29	30	30	30	29.75

3.5 Capacity: Speed, fiber deployment, and emerging new actual measurements

The second quantity of interest in "broadband" is capacity: what is the capacity of the network that is being delivered to however many households or individuals in the population? The OECD still defines the threshold for broadband as any technology capable of delivering Internet connectivity at a speed of 256k download or better.[31] The ITU uses the same measure.[32] For purposes of its own data gathering purposes under Form 477, the FCC early defined "high speed" connectivity as Internet connectivity with speeds of at least 200kbps in at least one direction—effectively, downloading, given the service assumptions of providers about what users use their connections for—and as "advanced services" speeds of at least 200kbps in both directions. In the past five years, the Commission has also required carriers to report what percent of their lines provide between 200 kbps and 2.5 Mbps; 2.5Mbps and 10Mbps; 10-25, 25-100, and over 100Mbps. The Commission first reported using these more fine-grained data in its Fifth Report. While the more fine-grained data is important, conceptually, the FCC is collecting the same data as the data relied on by the OECD: peak download rates provided to the end user.

Two things must be noted in discussing capacity benchmarks. First, benchmarking capacity alone ignores the attribute of ubiquitous seamless connectivity. Second, using speed alone to measure the performance of a country's or region's network understates another major component of the definition of capacity: latency.[33] Latency is the degree to which a packet of data is likely to be delayed in arriving at its destination. It is irrelevant in some applications, like email or even when downloading a large file for later use. Other applications, like voice over IP (VoIP), require relatively little bandwidth, but are highly sensitive to latency—if we have to wait for a second between when we are done speaking and the other party hears what we said, the conversation falters. Most current benchmarks ignore latency. Moreover, because companies do not report latency, this measure is only available from actual measurements data, which still presents substantial difficulties for data cleaning and analysis. Following efforts by the Oxford Saïd Business School and the University of Oviedo, funded by Cisco Systems, we provide here analysis of actual measurements that do identify latency as one of their reported characteristics. We note, however, that the measurements for latency deviate substantially from other measures, including actual measurements of upload and download speeds from the same test platform, in ways that are difficult to interpret. We therefore report latency measures separately, without bundling them like the Oxford/Oviedo study, and we do so with great caution about the extent to which it is appropriate to use currently available measures to reflect actual user experience. Substantially more work needs to be done to validate and interpret actual latency measurements before they can provide a well-understood benchmark.

Despite its limitations, speed, usually stated in terms of theoretical or advertised download speed, sometimes upload, has been the basis of measurement in the past decade and it is, in some countries, currently used by governments to define their own national goals—Australia (100Mbps), Austria (25Mbps), Finland, (1 Mbps by 2010, 100 Mbps by 2015), Germany (50 Mbps), Spain (30Mbps), UK (2Mbps as universal service to 90% of population, 40-50Mbps in broad use).[34]

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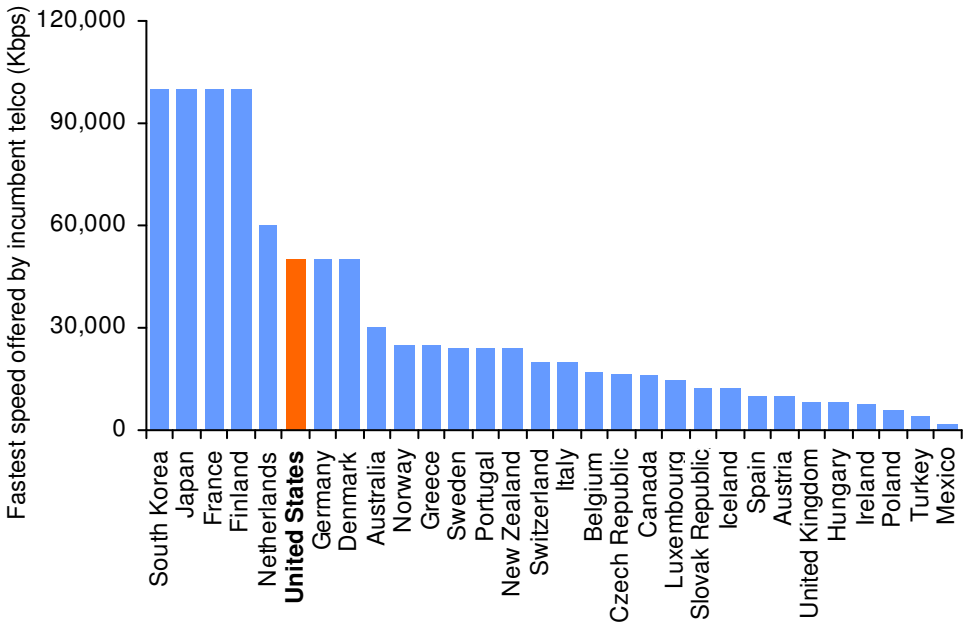
31 OECD Broadband Subscriber Criteria. http://www.oecd.org/document/46/0,3343,en_2649_34225_39575598_1_1_1_1,00.html

32 ITU IDI 2009 Annex 2, page 85.

33 Pepper presentation @ workshop on international comparisons August 18 2009. http://www.broadband.gov/docs/ws_int_lessons/ws_int_lessons_pepper.pdf.

34 OECD Impact of the Crisis on ICTs and the Role in Recovery (2009). http://www.oecd.org/dataoecd/33/20/43404360.pdf. (Table 3, p. 34).

Figure 3.16. Fastest speed offered by an incumbent



Source: OECD

By several measures Japan currently enjoys the fastest speeds among OECD countries. This is due both to high degree of fiber penetration, which is both theoretically and practically the highest-capacity medium currently used, and on higher speeds achieved over DSL and Cable. Japan is the first country where DOCSIS 3.0 has been deployed at its fastest current speed over cable modems (160Mbps by J:COM), it has been at the cutting edge of DSL speeds (100Mbps, various operators), and is the first country where 1 Gbps is publicly offered over fiber, from K-Opticom and KDDI. South Korea, France, and Finland follow right behind in terms of advertised speeds, with higher advertised speeds than other countries on average, as well as higher speeds over DSL and cable plants, respectively. As we describe below, Sweden jumps ahead to join Japan and South Korea when actual measurements, rather than advertised speeds, are used. The OECD reports several measures, including maximum advertised speed by the incumbent (Figure 3.16), where the United States is ranked in the second group of countries, after the four leaders, together with the Netherlands, Germany, and Denmark. This is due to the availability of 50Mbps service over fiber by Verizon and the implementation of DOCSIS 3.0 by some of the cable carriers.

3.5.1 Advertised download speeds

The average–as opposed to top–speed of offerings advertised in the United States is relatively lower. As Figure 3.17 shows, the United States ranks 19th by this measure. Countries that appear as learning models are Japan, South Korea, France, and Finland, as well as the Netherlands. Some of the countries that have higher levels of penetration than the United States, like Sweden, Norway, or the United Kingdom, also have higher average advertised speeds. Other countries, such as Germany, Portugal, Australia, and Italy, which do not have higher penetration levels than the United States, do appear to have higher average offered download speeds. On the other hand, Switzerland, Belgium, and Canada, which have higher penetration levels than the United States, have lower average advertised speeds.

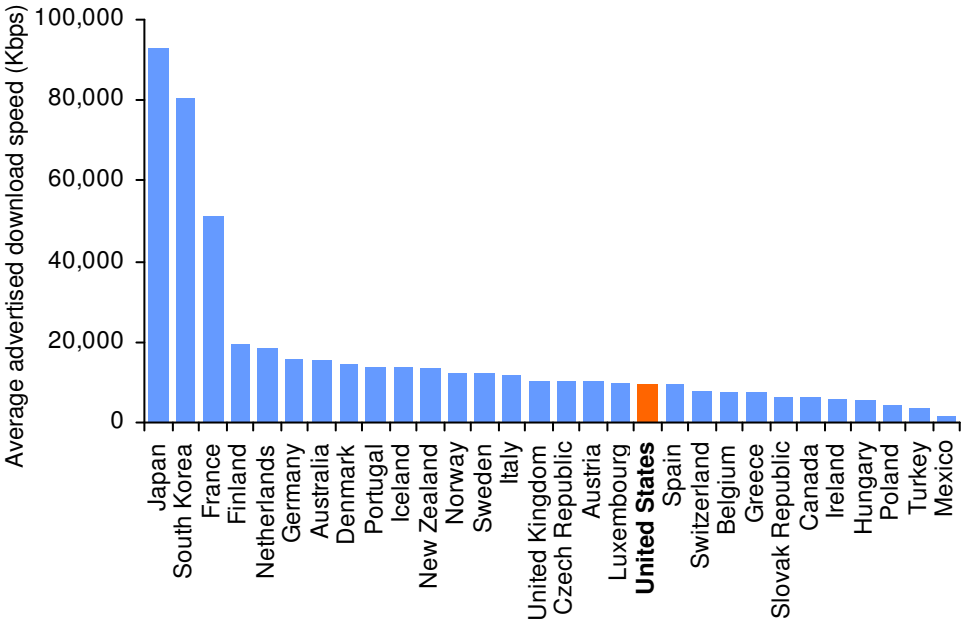
Advertised average download speeds are a coarse measure of capacity as actually used and experienced by users. As a result, several regulators have begun to address speed advertising, in an effort to move providers to implement measurement systems and offer a clear set of expectations for users of their actual likely speed. In 2008, both Finland and the United Kingdom published standards for expressing speeds of service that seek to reflect more accurately the actual likely transmission speeds that would be available. As we will see below, however, when we discuss actual speed measurement data, average

advertised speeds are highly correlated with actual speeds. Given the limitations of each approach, continued use of advertised speeds as part of the standard suite of benchmarks seems warranted.

3.5.2 Actual speed measurements

As we noted when discussing latency, the observation of differences between actual and advertised speeds leads to a set of efforts to develop measures of actual use. The two primary approaches currently in use involve either carrier-based testing or user-side testing. Carrier-based testing uses test equipment located at the premises of the carrier, or on identified clients in cooperation with a carrier, and is initially designed to help carriers understand their network. In the 2009 Communications Outlook, the OECD first reported actual speeds and compared them to advertised speeds. The data came from tests performed by a company called Epitiro in the United Kingdom, but apparently covered countries other than only OECD countries, and the OECD chose not to report the data by country. The primary findings reported were that (a) actual speeds are lower than advertised speeds, and (b) that different technologies underperformed their advertised speeds by different ratios. While the basic point about a persistent difference between advertised and observed prices is certainly true, the per-technology shortfall calculations vary widely by country, and the aggregate averages as measures of systematic performance characteristics of different technologies are not reliable. Our independent evaluation is that we should place little confidence in the aggregate, non-country-specific per-technology shortfall ratios reported in the OECD Communications Outlook 2009. We take no position on whether the weakness of the data is caused by shortfalls in the underlying data collection technique, or in the way it was aggregated and reported. There is no inherent reason for the former to be the case, but we were not permitted to independently report on the underlying data.

Figure 3.17. Average advertised speed



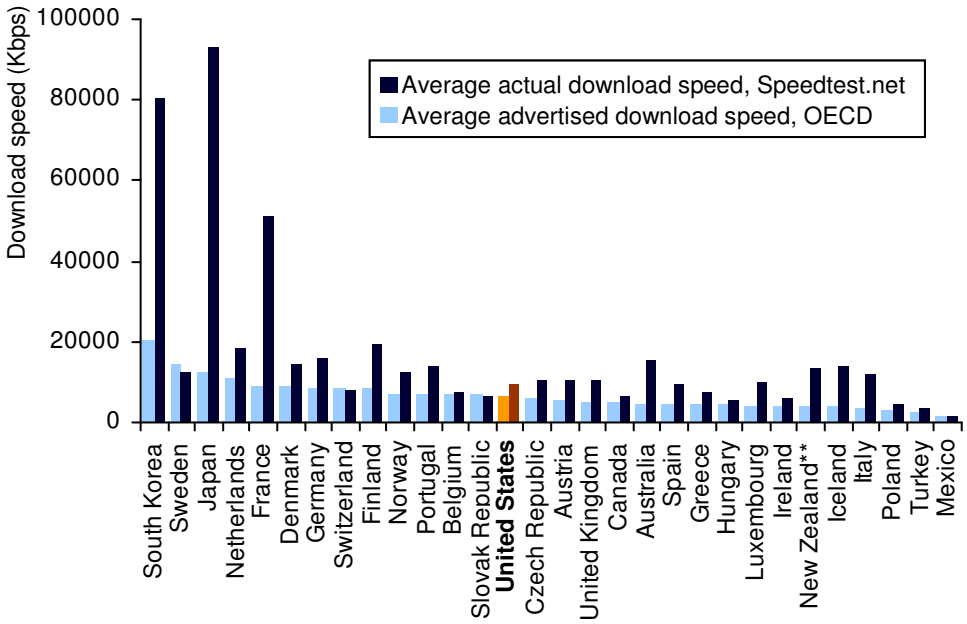
Source: OECD, 2008

The alternative source of actual measurements is distributed measurement on the user side. The idea is that users test their own speeds, and in the aggregate these provide millions of observations about actual downloading and uploading, as experienced by end users. The current most extensive dataset we have found implementing this approach is run mostly using Speedtest, a testing site developed by Ookla, a Montana company. The company provided the Berkman Center access to its global testing data from the fourth quarter of 2008, which is the equivalent period to the period described by the OECD 2009 report. We report here the results of our analyses of the Speedtest.net data.

Speedtest data is not perfect, but it offers an enormous database of actual tests, which provide insight into the speeds users experience on their computers. The dataset we analyzed included about 41 million actual tests from the OECD countries, from the fourth quarter of 2008. These provide the time of day, the ISP, the geographic location of the client and the server, measures of upload and download speeds and latency, as measured from the perspective of an application running on the end user's computer. Several confounding factors require that we interpret the data with caution. For example, users may be running a test through a wired connection or a wireless local area network; they may be plugged in directly to a modem or through a switch; or they may be running other bandwidth-hungry applications in the background. Users may be self-selecting because they have high speeds they want to test, and so the results may all be upwardly biased. Users who know enough to measure their bandwidth probably are above-average in their Internet skills, and again upwardly bias actual tests. All of these factors may pollute the results. Despite these limitations, the advantages of the Speedtest data include the size of the sample, the time over which it has been collected, the richness of the geographic specificity of the client and server location, and the addition of latency to upload and download speeds (although, as we mentioned, the latency data in particular is difficult to interpret). Together, these advantages suggest that these data are potentially useful for, at a minimum, offering an additional source of insight on actual performance of networks. Like carrier-side testing data, they are an element that should be explored as a component of future stable measurement platforms that the FCC should wish to implement, as it seeks to develop a continuous basis for observing the state of broadband deployment and to identify other best-practice models. A similar model of testing is currently being developed by other projects as well; for example, the M-Labs project seeks to provide a broader-yet set of measures of quality, however, project data was not yet ready for our use.

The actual speed test data confirms, in broad terms, the findings of the average advertised speeds: that Japan, South Korea, and the Netherlands are particularly high-performing countries. Actual test data particularly calls attention to Sweden's very high performance in fact, much more so than its advertised speeds alone would suggest, and confirms Portugal's surprisingly high performance on advertised speeds (by comparison to penetration) as consonant with high actually measured speeds. Moreover, from a U.S. specific perspective, actual measurement benchmarks look better for average download speeds, but worse for highest speeds. In average download speeds, the U.S. moves from the top of the fourth quintile to the middle of the third quintile. In speeds attained by the top 10% of users, however, the U.S. moves from being in the second group, but still at the bottom of the first quintile, in top advertised speeds, to just barely making the second quintile. We show the correlation between advertised speeds and actual speeds using the measure with the most comparable benchmark in existing data—average download speeds—in Figure 3.18.

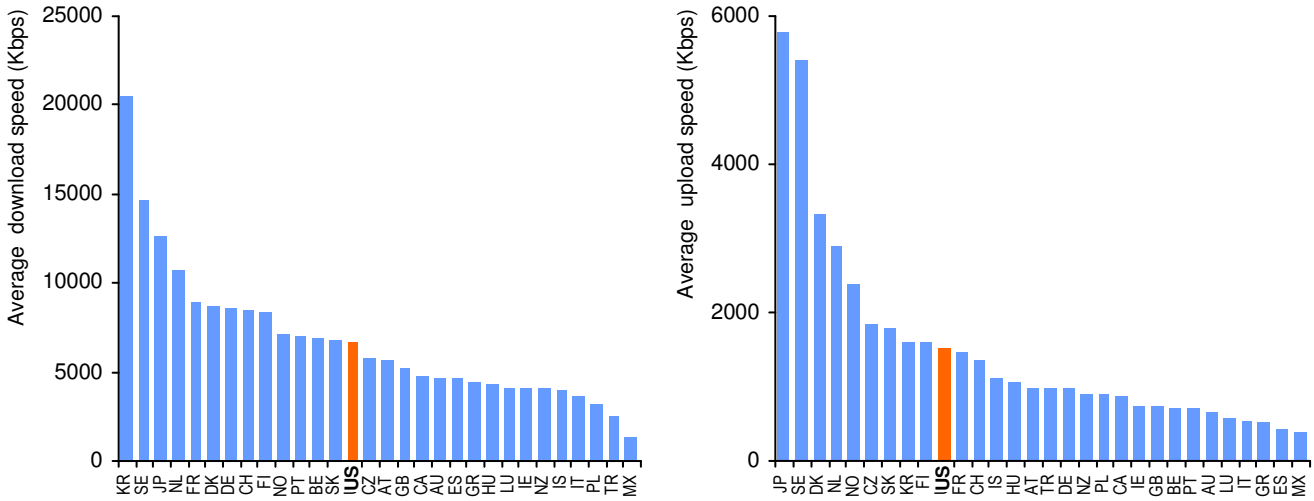
Figure 3.18. Average advertised speed versus actual download speed



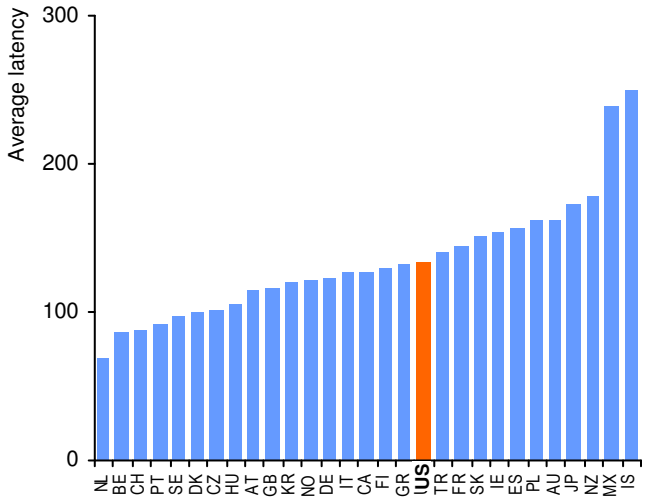
Source: OECD, Speedtest.net (provided by Ookla)

We observe a surprisingly high degree of correlation (R^2 0.52) between the average advertised speeds metric and the actual speed tests metric, but it is a correlation that is far from perfect. In figures 3.19a-i we show a series of correlation graphs that offer us some degree of confidence that the actual measurements are giving us a decent measure of relative country performance, even if we are uncertain as to whether the reported values in fact perfectly report actual user experiences. As these graphs show, average measurements are well correlated with median measurements, which in turn are well correlated with top 10% of users' measurements. In all cases, the results are cleaner and more certain for download and upload speeds, and noisier for latency measures. Nonetheless we report latency here too, at least to underscore the need for further inquiry into measuring and using latency as a significant additional factor in considering capacity measures. However, the noisiness of the data leads us to decline to follow the practice publicized by a study done by the Oxford Saïd Business School and the University of Oviedo, with Cisco System's funding, of meshing these measures into a "broadband quality score" (BQS). That study produced odd results for several countries of interest, such as locating the U.S. just ahead of Russia and Bulgaria, and the U.S., France, Norway, Belgium, and Finland behind Romania. These results may be caused by data limitations, such as the presence of non-residential testers (removing these data points is a difficult and expensive task, which we have only partly been able to implement for the results we report here, with the help of Ookla). However, our own, likely cleaner dataset still produced very counterintuitive results for latency, such as locating the United States between Greece and Turkey, both of which were ahead of France and Japan. We report the latency results here separately, and only with the caveat that they require substantial further analysis.

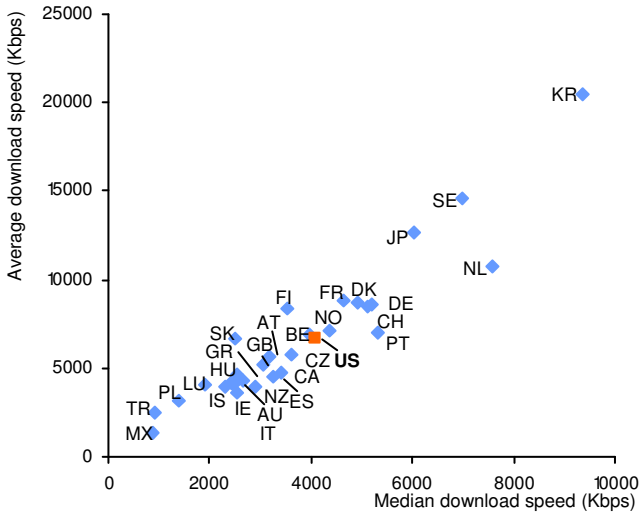
Figure 3.19a-i. Speedtest.net data

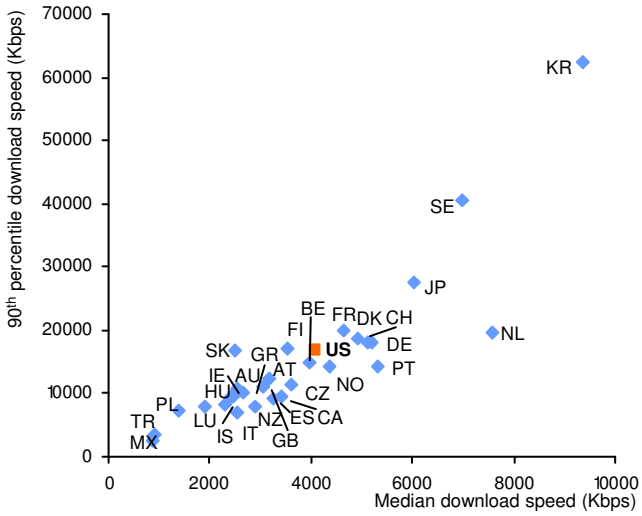


Source: Berkman Center analysis of Speedtest.net data

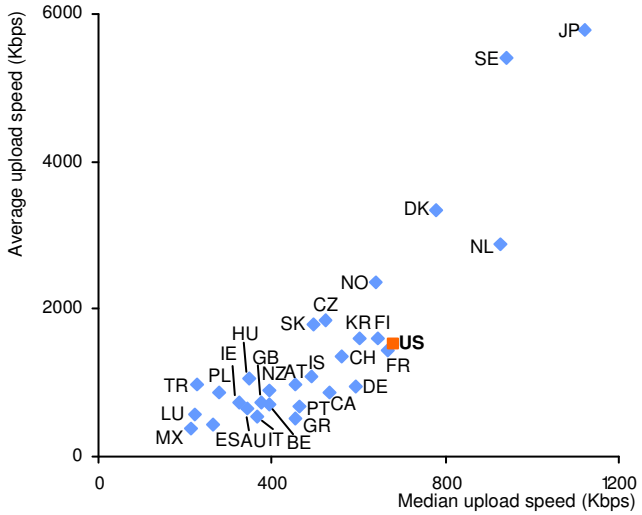


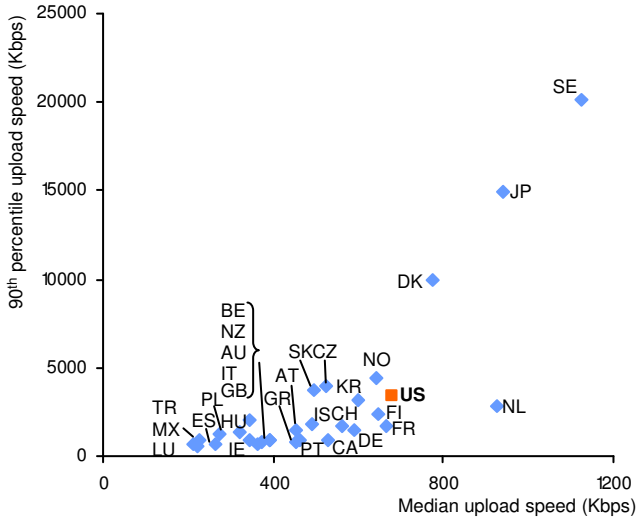
Source: Berkman Center analysis of Speedtest.net data



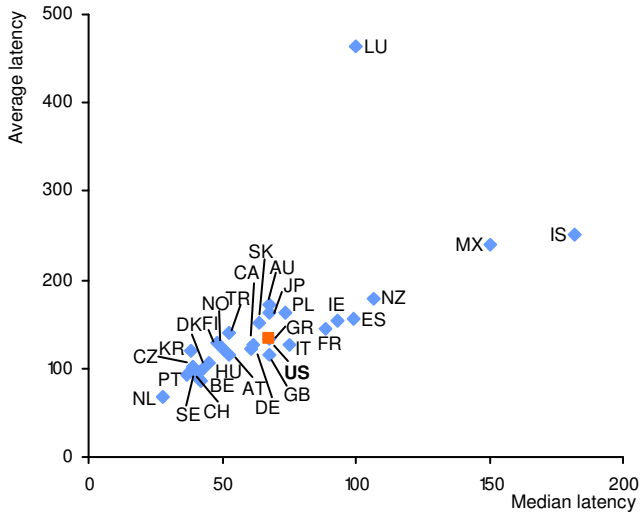


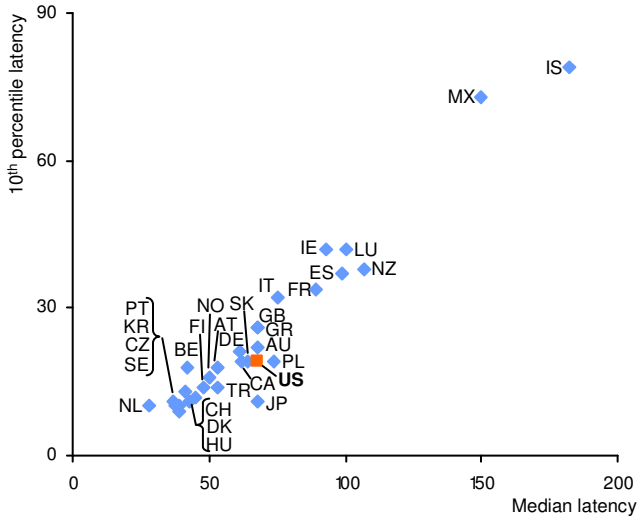
Source: Berkman Center analysis of Speedtest.net data





Source: Berkman Center analysis of Speedtest.net data





Source: Berkman Center analysis of Speedtest.net data

Another way of assessing the quality of capacity available in various countries, while keeping constant specific geographic differences, is to compare service in the major urban centers of different countries. We therefore analyzed the Speedtest data to identify upload and download speeds for each OECD country's capital city and its largest city, or where the two were one and the same, we added the second largest city as well. We found sufficient data for 55 cities using this method of selection. For average download speeds, we found that New York City is ranked 21st out of the 55 cities and Washington D.C. is ranked 36th. Both American cities in our sample did better on upload speeds, with New York City coming in at 13th and Washington D.C. at 25th for average upload speeds. The top 20 cities in each category are reported in Table 3.3.

Table 3.3. Top 20 cities in OECD countries by actual speed measurements, Q4 2008

Average download speed		Average upload speed	
1.	Busan	1.	Yokohama
2.	Seoul	2.	Stockholm
3.	Göteborg	3.	Tokyo
4.	Stockholm	4.	Göteborg
5.	Yokohama	5.	Kosice
6.	Amsterdam	6.	Copenhagen
7.	Paris	7.	Aarhus
8.	Tokyo	8.	Oslo
9.	Aarhus	9.	Amsterdam
10.	Helsinki	10.	Paris
11.	Rotterdam	11.	Espoo
12.	Hamburg	12.	Bergen
13.	Kosice	13.	New York
14.	Bern	14.	Helsinki
15.	Berlin	15.	Rotterdam
16.	Copenhagen	16.	Wellington
17.	Espoo	17.	Bratislava
18.	Lyon	18.	Prague
19.	Lisbon	19.	Bern
20.	Oslo	20.	Busan

3.5.3 Fiber deployment

One measure of the long-term construction of high-capacity networks is the deployment of optical fiber networks to the home or near the home. This is the technology used in the truly high capacity core of the network. DSL plant is both theoretically and practically more limited in its capacity. Its capacity has

increased in the past few years partly thanks to electronics, but partly also as a result of rolling fiber ever-closer to the home so as to shorten the copper path from the end of the fiber to the user. Cable plant too depends on hybrid fiber-coaxial networks, with the fiber relied upon to deliver the aggregate capacity to the neighborhood, and the coaxial cable to distribute it from there. DOCSIS 3.0, the new cable broadband standard, functions by binding more than one "channel" (what used to be the 6 MHz channels for TV) on the cable into a single high speed bitstream. This approach can substantially expand cable plant capacity for several more years, as it already has. But the broad consensus seems to be that the long-term fixed platform will likely be fiber, and cable plant too will likely become increasingly fiber-based over time. Given the theoretical, currently-practical, and long-term likely advantages of fiber infrastructure, it is plausible to look at the experience of other countries in fiber deployment.

As of December 2008, the OECD reported that 4% of U.S. broadband subscriptions were served by fiber to the home networks. Only six countries were reported as having a higher proportion of total broadband subscriptions to fiber: Japan (48%), South Korea (43%), Sweden (20%), the Slovak Republic (19%), Denmark (10%), and Norway (9%). The Czech Republic (4%) had an equal rate of fiber subscriptions. Our independent analysis suggests that the Slovak Republic's government report to the OECD erroneously reported houses passed by Orange Slovenska's then-recent fiber deployment, rather than subscriptions, resulting in an order-of-magnitude error.[35] As of December 2008 about 2% of actual subscriptions in the Slovak Republic were to fiber, leaving only five countries ahead of the U.S. Again, looking specifically at deployment of the most future-proof, high-capacity technology, Japan and South Korea emerge as high-performing outliers. Among the Nordic Countries, Sweden has clearly performed best and deserves special attention on this dimension, but Denmark and Norway clearly are also on a high-performance investment path to fiber. An argument might be made that with fiber, homes passed might be a better measure, because it would represent levels of new investment in a more future-proof technology. Several factors militate against this, as well as the poor data on the subject. First, actual subscriptions provide a less ambiguous metric. "Homes passed" might include a fiber to the neighborhood plant that is a mile from the homes in the neighborhood. Second, in some cases the last fiber drop will only be rolled out when the subscriber makes a commitment. In these situations subscribership indeed becomes the moment that the home genuinely gets connected by fiber. Third, given these concerns, and given that there are already countries where fiber subscriptions form an appreciable proportion of subscriptions, so that using this measure does not result in complete absence of data, moving to a fiber "homes passed" metric would simply mask these high performers, whose identification is a primary purpose of benchmarking.

3.5.4 Other metrics considered: Contention ratios

One of the factors affecting actual speed is what is often called "the middle mile," a portion of the network that connects the last mile, such as the local loop or cable head end, to the core of the network. Many network topologies adopted by broadband providers share this backhaul, or middle mile facility among multiple users. It is cheaper to build a higher capacity fiber connection to a local location, and split that capacity among multiple homes using existing infrastructure, like copper wires or cable. Even with fiber-to-the-home, the topology deployed currently by many of the carriers in many of the countries we observe is point-to-multipoint, which also brings a single shared fiber to the neighborhood, buries an

35 The Slovak Republic seemed to have reported the number of houses past by Orange's major deployment, in 12 Slovak cities, of fiber passing 270,000 houses. The same report also made it into the country studies published by the European Regulators Group, ERG (17) 2009. Market data suggests that the correct number is 13,000 subscriptions to Orange's service. Given that the Slovak Republic has the highest prices for high speed capacity in the OECD, an immediate uptake of 100% of the capacity just rolled out last year would be nothing short of miraculous. The initial uptake of 5%, followed by what appears to be a doubling of subscriptions as of the end of the second quarter of 2009, to 29,000, is impressive enough.

optical splitter in the ground or puts it in an above ground closet, and pulls additional fiber strands from that closet to homes. In several countries, the United Kingdom, the Czech Republic, and Ireland, some providers have begun to offer packages that are price differentiated by contention ratios—that is, by a measure of how many other subscribers share the backhaul with a given subscriber. The same download speed will offer a faster connection with a 20:1 contention ratio than with a 50:1 ratio. That is, when the same backhaul capacity is dedicated to 20 users rather than 50. Contention ratios then become a plausible measurement for benchmarking, although it is ambivalent because it already assumes a certain topology. We will return to the question of topology and policy in the concluding section of Part 4 of this report.

3.5.5 Conclusion

Looking at speed, as well as the limited information we have on other measures of capacity, the list of countries that offer potential sources of insight remains relatively stable. Japan and South Korea continue to be obvious targets of observation. So too the Nordic countries, with a special emphasis on Sweden, as well as the Netherlands, continue to be of interest. When speed, rather than penetration, is the focus, France becomes a very high performing country, and Germany and Portugal also do substantially better on advertised and observed speeds than their numbers on penetration would lead one to anticipate. Interestingly, neither of these latter two countries has any fiber deployment to speak of, and they differ dramatically in market structure—Portugal has roughly 60/40 split between DSL and Cable, whereas Germany has almost no mode of broadband delivery but DSL. Both have advertised speeds of roughly 50% faster than the United States, and both have higher average observed actual speeds. Among the relatively higher performers on penetration, Canada in particular shows up as weaker than it was on penetration, as do, to a lesser extent, the United Kingdom and Switzerland. As with penetration, we offer an at-a-glance table collecting our measures on speed in Table 3.4. Different measures of speed, emphasizing average advertised speeds (35%) over maximum advertised speeds (15%), treating median upload and download actual speed tests equally (15% each), with higher weight than median latency (10%), and a light emphasis on 90 percentile download and upload (5% each).

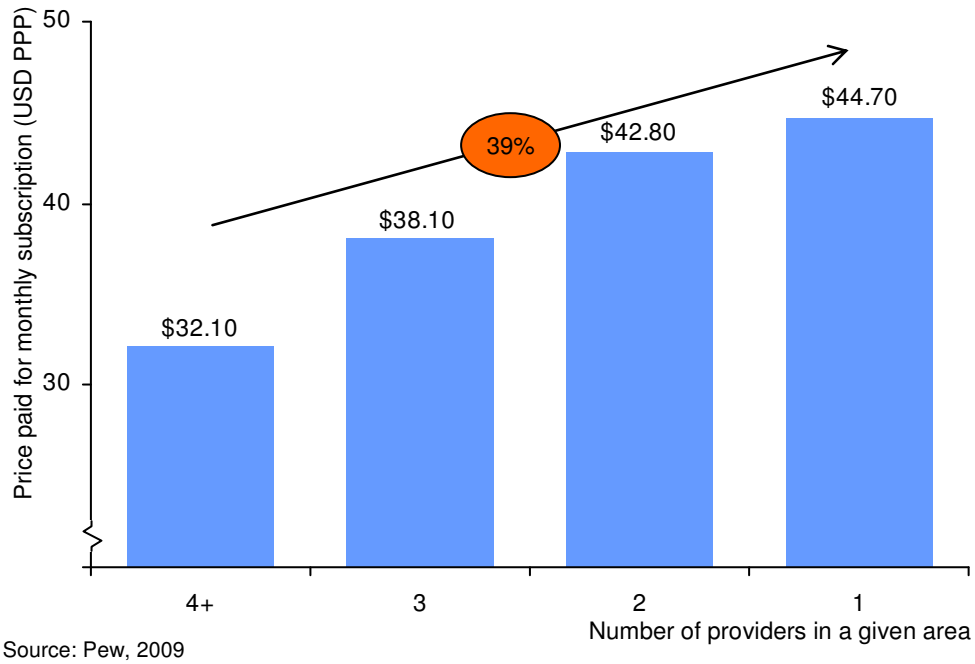
Table 3.4. Country rankings on various speed measures

	Country	Maximum speed, OECD	Average speed, OECD	Median download, speedtest.net	Median upload, speed test.net	Median latency, speed test.net	90% download, speedtest.net	90% upload, speed test.net	Weighted average rank
1	Japan	1	1	4	1	17	3	1	3.15
2	South Korea	3	2	1	9	3	1	8	3.40
3	Netherlands	8	5	2	3	1	5	9	4.50
4	Denmark	3	8	8	4	8	6	3	6.30
5	Sweden	3	13	3	2	4	2	2	6.35
6	Finland	2	4	14	7	10	9	10	6.80
7	France	3	3	9	6	24	4	13	7.00
8	Germany	9	6	6	10	14	7	16	8.40
9	Portugal	13	9	5	16	2	13	20	10.10
10	Norway	9	12	10	8	11	14	4	10.25
11	United States	9	19	11	5	17	11	7	13.00
12	Switzerland	17	21	7	11	6	8	14	14.30
13	Czech Republic	23	16	13	13	4	16	5	14.40
14	Iceland	3	10	26	15	30	24	12	14.90
15	Australia	14	7	22	24	17	18	24	15.25
16	Austria	16	17	17	17	12	15	15	16.15
17	New Zealand	17	11	19	19	28	25	23	17.30
18	United Kingdom	21	15	18	21	17	17	25	18.05
19	Belgium	25	22	12	19	7	12	21	18.45
20	Canada	17	25	15	12	15	22	19	18.90
21	Slovak Republic	23	24	23	14	16	10	6	19.80
22	Spain	9	20	16	27	26	23	29	20.00
23	Italy	25	14	21	22	23	28	27	20.15
24	Greece	20	23	20	18	17	19	26	20.70
25	Luxembourg	14	18	27	29	27	26	30	22.30
26	Hungary	25	27	25	23	9	20	11	22.85
27	Ireland	21	26	24	25	25	21	17	24.00
28	Poland	25	28	28	26	22	27	18	26.10
29	Turkey	29	29	29	28	12	29	22	26.80
30	Mexico	30	30	30	30	29	30	28	29.80

3.6 Price

Price is obviously an important characteristic of the state of broadband connectivity. On the consumption or access side, price determines affordability for purposes of diffusion to communities with poorer residents, or to higher-cost service areas. Price at the lower end of service offerings will affect overall diffusion rates. Price at the higher end will determine diffusion of, and transition to, the highest capacity, world-class services. On the supply side, price is also an indicator of levels of competition. While the importance of competition to lowering rates is hardly news, the recent Pew survey released in June, 2009[36] finds that U.S. broadband subscribers who report that four or more providers are available to them pay $32.10, where three broadband providers are available, that price rises to $38.10, where only two providers are available the price increases further to $42.80, or fully one-third more than where there are four or more providers, and where only one provider is available, the price reported increases further to $44.70, or 139% of the price reported by those who live in places with competitive services (See Figure 3.20). This does not necessarily mean that the price where there are only one or two providers reflects the absence of competition. It may be that the high prices reflect the high costs of providing service in a given area, which in turn results in a lower level of competition as competitors are dissuaded from entering these markets by the high costs of entry. To assume that prices reflect purely higher costs and not the lack of competition would be equally speculative. The difference is likely a combined effect of cost and lack of competition that varies by location. Teasing out the relative influence would require additional studies comparing properly selected areas with similar costs but different levels of competition, and presents an important future avenue of research.

Figure 3.20. Price and number of competitors as reported in Pew Survey



Source: Pew, 2009

3.6.1 ITU and OECD data on pricing of lowest available prices

In terms of entry-level price available from a major incumbent, the United States seems to be doing well. The ITU collects data that includes the least expensive entry-level broadband price offered by the incumbent telecommunications carrier.[37] It then ranks countries by the ratio of this low-cost price option to monthly GNI per capita. In this ranking the United States is ranked first. Measuring the lowest

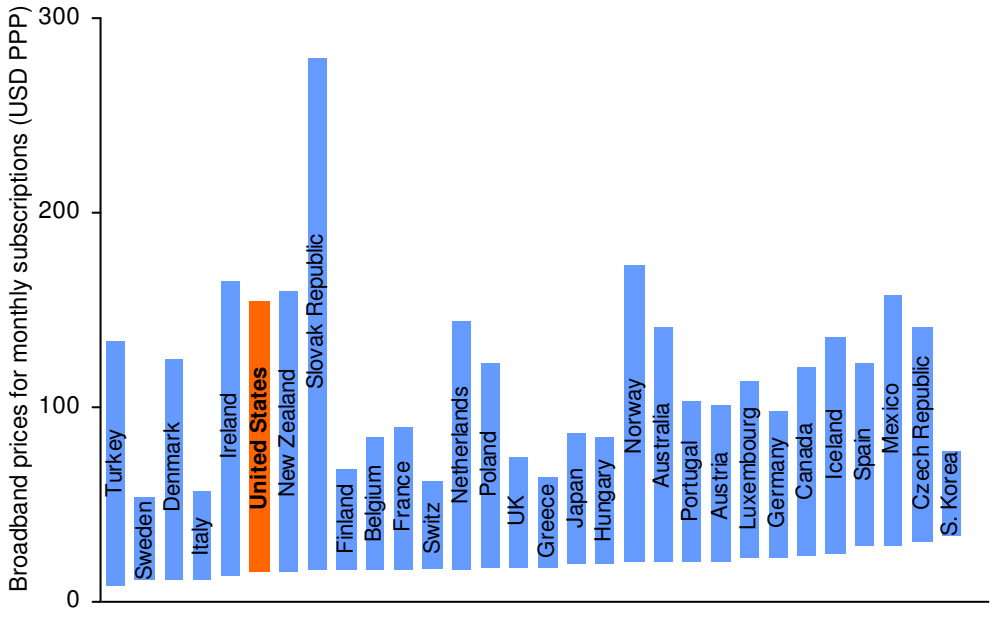
36 Pew Internet and American Life, John Horrigan, Home Broadband Adoption 2009. p. 17.
37 ITU-IDI 2009, Table 6.6, p. 67.

available price for an entry-level offering is useful as an initial step at identifying affordability. However, two problems in particular are presented by this measure. First, it looks only at offerings from the incumbent, or where that data is not available, one other provider. The ITU therefore reports the U.S. low-cost option to be lower than related OECD estimates, as the OECD surveys more providers in each country. And while the U.S. indeed performs well in entry-level price when more providers are considered (6th), the ITU reports higher entry level prices for Sweden, Denmark, Italy and Ireland, whereas all these countries in fact have lower entry-level offers from non-incumbent providers, according to the OECD. The ITU data assumes that the incumbent's offer represents well the lowest price offer, an assumption that does not fit with either our qualitative case studies or our company-level pricing study, reported in Part 4 below. Moreover, the ITU does not report anything for Turkey, the country with the lowest entry-level offer in the OECD data. The second problem with the ranking is that it is based on the GNI per capita rather than purchasing power parity, which is a better measure of relative affordability. Using PPP to generate the rankings does not, however, change the ranking of the United States, as long as one uses the ITU methodology of looking only at incumbent prices.

3.6.2 OECD pricing measures

The OECD collects and reports a wider range of price indicators, from a larger number of providers in each of its countries. Because an increasing number of providers bundle services, including voice and video, with their broadband offerings, the data are incomplete. One fact that is immediately obvious is that South Korea's high performance on penetration and capacity comes at a price: its subscribers who wish to receive cheap, low-speed entry level access have no options. No carrier offers speeds slower than 8Mbps, and the price range from the lowest to the highest offer available is narrower than in any other country. KT offers consumers the same rate irrespective of technology of delivery, whether fiber to the home (FttH), ADSL or VDSL. Given the near-universal household penetration (94%), one could say that high speed fixed broadband service has become a utility in South Korea. Everyone has it, and there is a relatively narrow choice about price or type of package. Other observations to point out regarding some of the countries that are among the common learning models is the relatively narrow range of prices in Sweden and Finland, as compared to Denmark and Norway, and the relatively high prices in Norway in general. From the perspective of the price of the lowest available offering, for speeds between 256k and 2Mbps, it appears that the United States compares well to other OECD countries.

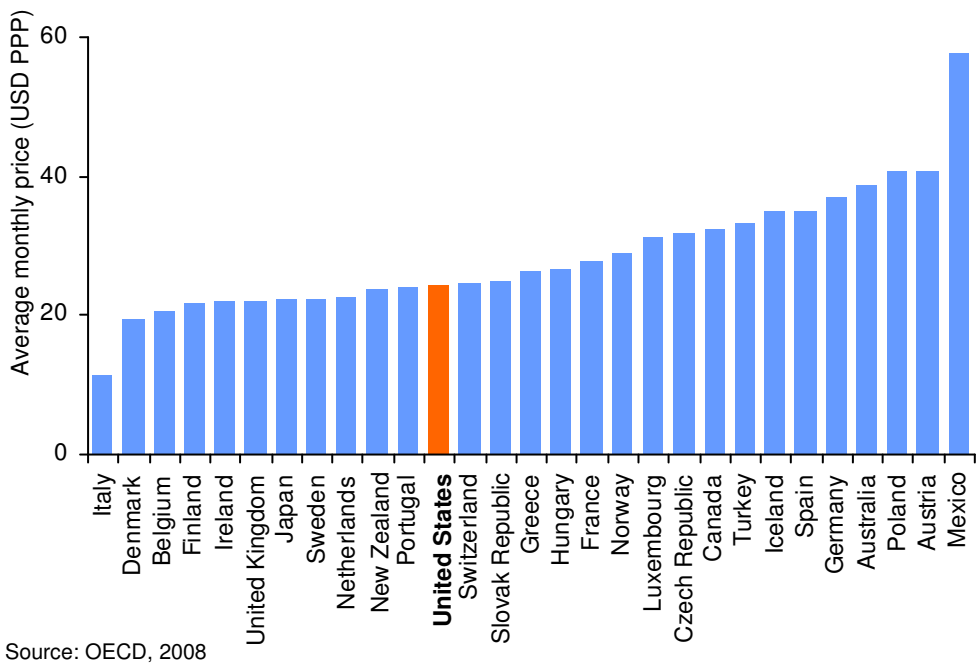
Figure 3.21. Range of broadband prices for monthly subscriptions



Source: OECD, 2008

Another measure commonly referred to when comparing pricing is price per megabit per second. Because neither the value of speed to consumers nor its cost to providers increases linearly with Mbps, these prices grossly reflect, on the low end, the prices of the highest-speed offerings available in a country and, on the high end, the price of the slowest speed offerings. They underscore the relative flexibility of offerings available in Japan and the fact that in South Korea the per-megabit price of capacity is dirt cheap in global terms. This way of viewing the data also allows us to see that the slowest, most expensive per-megabit prices in France are only slightly higher than prices in the United States, but the higher speed connections are ten times less expensive. The Nordic countries continue to present an attractive profile, although Norway clearly has higher prices, and it is important to try to understand why. So too the United Kingdom, where the lowest speed available is 2 Mbps, the highest 24Mbps, and the price, correspondingly, is somewhat higher than the lowest price in the U.S. at the low end and lower at the high end. Whether this makes the United Kingdom a good model for observation depends on whether one considers the cheaper 768kbps offerings available in the lowest tier in the United States to be "broadband" in a future-looking way. If the objective is to provide affordable access not to any kind of offering that meets the globally-used regulatory definition of "broadband," but actually to reasonably high capacity offerings by global standards of practice, then the United Kingdom certainly serves as a useful model. As with speed and entry-level prices however, Canada's performance merits caution when observing its policies. While penetration there is high, not only is speed lower, but prices too are high in every tier of service.

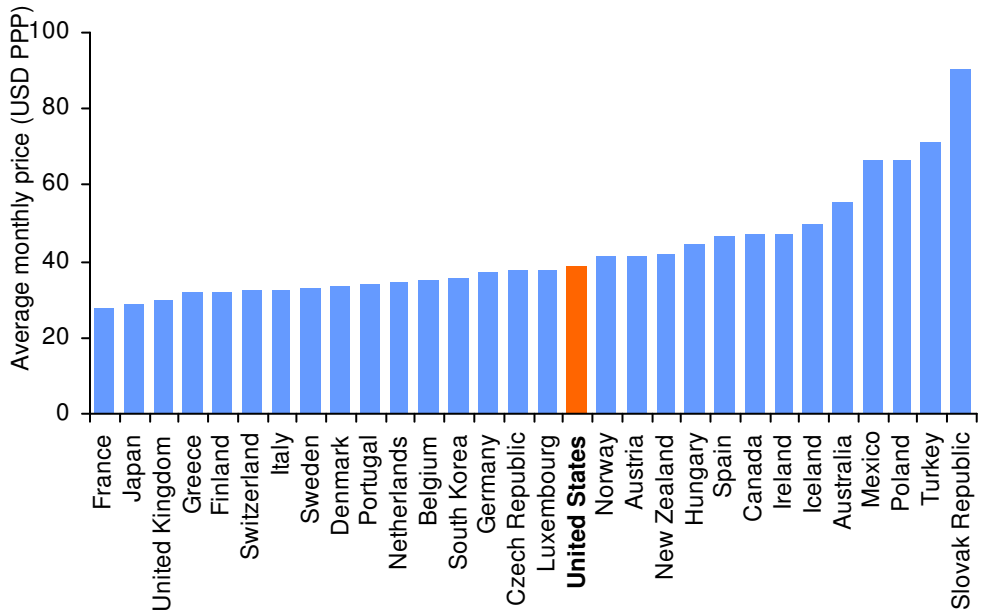
Figure 3.22. Average monthly price for low speed tier



Source: OECD, 2008

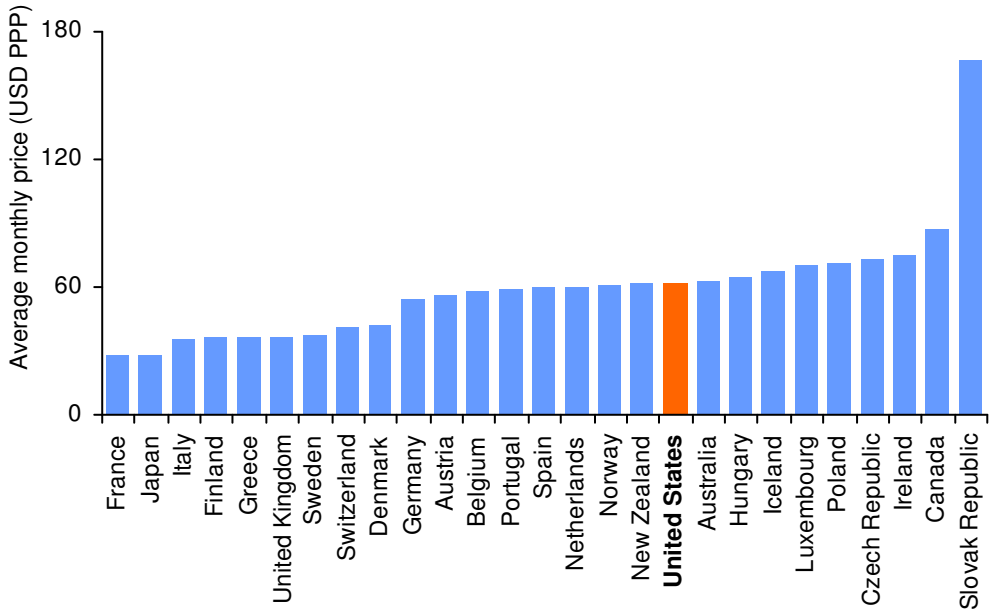
A more useful measure of price than the price per megabit per second, which reflects speed as an endogenous factor, is the OECD's ranking based on tier of service. The OECD surveys operators to create an average offering price for different tiers of service: low speed (256kbps – 2Mbps), medium-speed (2.5Mpbs-10Mbps), high speed (10Mpbs-32Mbps), and very-high speed connections (above 35Mbps). Looking at a range of speeds that fall within the definition of low, medium, and high, as opposed to solely at the minimal offer for the slowest speed, the United States is 12th for low speed, 17th for medium speeds, and 18th for high speeds. As for the ultra-high speeds, the good news is that the United States is on the list of only 12 OECD countries that have any kind of offering in that range (35Mbps and above) in the OECD dataset (our independent research added two more, both with more attractive prices than available in the U.S.). The bad news is that prices in the U.S. for this highest speed offering are higher than in any other OECD country where these speeds are available except Norway.

Figure 3.23. Average monthly price for medium speed tier



Source: OECD, 2008

Figure 3.24. Average monthly price for high speed tier



Source: OECD, 2008

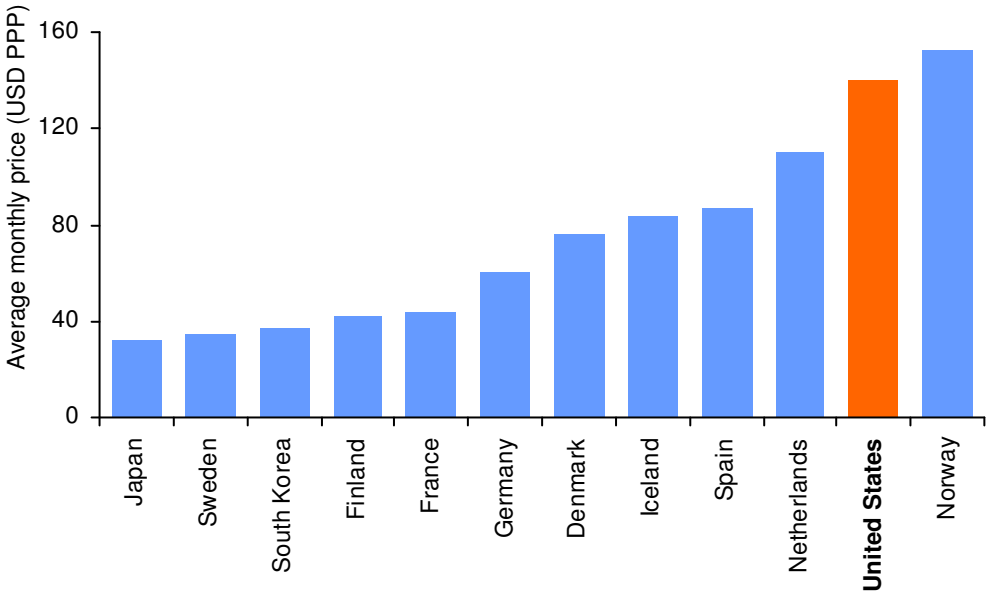
Looking over time, it is harder to determine the trend of price affordability in the U.S. The nature of packages and the reporting has been more variable than it has been for penetration per 100 inhabitants. Nonetheless, what we can say is that in 2001 the United States ranked first (that is, lowest price) in the price of 40 hours of Internet at peak times (the measure for consumer access) and 6th for 2Mbps private lines (the high speed measure used at the time).[38] In 2002 the United States, when comparing incumbent prices, was fifth behind Switzerland, Canada, Japan, and Sweden, although South Korea's offering was only marginally more expensive but twice as fast, and the UK's was just a hair more expensive.[39] In 2004, prices had dropped everywhere, and the U.S. was still 5th, with a slightly different mix of countries with better offers, and other countries in the very close neighborhood.[40] Today, as we saw, according to the OECD data the U.S. ranks 12th for low speeds, and 17th and 18th for medium and high speeds. In the categories of medium and high speeds, France has the best average prices, followed by the

38 OECD Measuring the Information Economy 2002, page 57.

39 OECD Communications Outlook 2005, Table 6.16. left hand columns. Prices for 256kbps were excluded from comparison to Verizon's 768kbps, but offerings of 512 kbps were included.

40 OECD Communications Outlook 2005, Table 6.16, right hand columns.

Figure 3.25. Average monthly price for very high speed tier



Source: OECD, 2008

usual suspects. The primary additions to potential observations are Italy and Greece, which have lower rates in the medium to high speeds. However, recall that both countries have very low levels of household penetration, and Greece also has very low levels of per inhabitant penetration, while Italy has very high levels of mobile phone and mobile broadband penetration. Low prices in Italy may therefore reflect a substitution to mobile broadband coupled, perhaps, with low costs because of urban density, in which case Italy becomes a less interesting target of observation for fixed broadband policy, but remains an interesting target for wireless and the ubiquity aspect of the next generation transition.

As with contention ratios, service-providers have begun offering differentiated pricing for different kinds of use patterns. Just as some operators began to price the same speed at different rates based on contention ratios to the middle-mile, so too in both Norway (over cable) and France (over fiber) subscribers can purchase higher upload speeds for an additional fee. Providers in some countries, although not in any of the high-performing countries, impose bit caps—or maximum data transferred per month—on their customers, and charge additional fees for additional files transferred. This practice is found in Australia, Belgium, Canada, Iceland, Ireland, New Zealand, and Turkey. Data caps are used by cable operators, but not DSL providers, in Portugal as well.[41]

3.6.3 Results of Berkman Center pricing study

Because price is so important and hard to get at, we developed our own analysis of prices available in the OECD countries, using market data from the GlobalComms database. Our analysis looked at prices offered in every tier of service by the top four providers in every country, on the assumption that these offerings will reasonably reflect the market prices in each of the countries and best capture the prices upon which consumers make decisions.

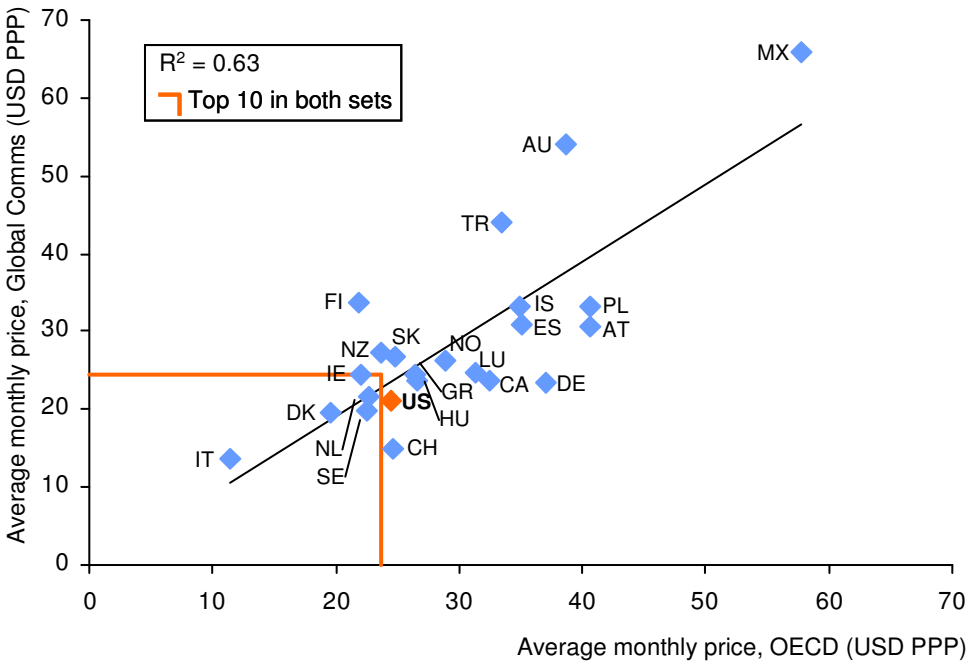
We report simple averages of these offers, for each country, in each tier of service. For countries with data caps, we excluded offers with data caps lower than 2 Gb per month. We chose that number because, although lower data caps may be a way of giving low end connectivity to subscribers who are interested in no more than email and web surfing, these do not provide a measure of what the price of broadband, and certainly broadband in a forward-looking sense, provides. We chose 2Gb per month as the lower

41 OECD Outlook 2009, Table 7.14.

bound of the offer we would include in our analysis because that was the lower end of the data usage rates quoted by U.S. cable firm Comcast as the median monthly usage of its subscribers.[42] (See Annex on pricing for a more detailed explanation of both our methods and our examination of the OECD data.)

Figure 3.26 through Figure 3.29 report the correlations between the rankings of countries based on the average offer we identified in each price tier, and the rankings created by the OECD in the same tier. Our findings are well correlated with those of the OECD for low speed tier prices (R^2 .63), highly correlated for the fastest service (R^2 0.87), and more moderately but significantly correlated for the middle (R^2 .45) and high speed (R^2 .47) tiers. Several of the countries in our dataset vary significantly from their rankings according to the OECD, suggesting that determining available pricing is difficult and noisy, and requires further sustained study. Notable differences include the fact that, consistent with the ITU data, and inconsistent with the OECD data, we find that prices in the United States for the very low tier offers are among the best in the OECD, third behind Switzerland and Italy. This reflects the availability of offers from Verizon, AT&T, Time Warner Cable and various smaller DSL providers at 768kbps for less than $20 a month. Our findings for the U.S. in the middle to high speed tiers are more consistent with the findings of the OECD—which is to say that U.S. prices in those tiers are middling to weak (17th for medium speed, and 19th for high). For the very highest speeds the U.S. has substantially higher prices than are available to residential customers in other countries where offerings of speeds over 35Mbps are available. By comparison, in France, 100 Mbps plus TV, unlimited national and international calling to 70 countries, and nomadic access to all other subscribers of the same provider are available from Free (which has 24% of French broadband subscribers) for $32.55 PPP, and SFR, which serves another 22% of the French market, has an identically-priced offer for roughly similar services. Other notable deviations in our study from the OECD data are that we found substantially better offers at the medium speeds in Sweden, Belgium, and Austria, and in the high speed tier we found substantially better offers in the UK, Germany, and Denmark. Our prices for Finland are systematically higher than those that the OECD found, reflecting various differences in the datasets that we describe in the Annex.

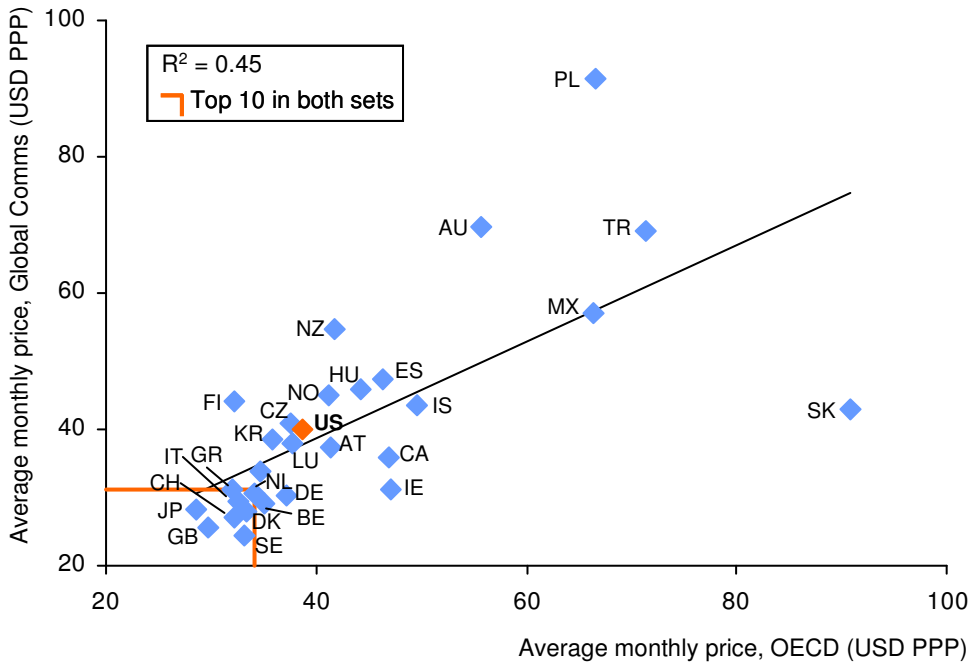
Figure 3.26. OECD versus GlobalComms pricing in low speed tier



Source: Berkman Center analysis of OECD and Global Comms 3.0 Broadband Statistics
Note: Belgium, UK, Japan, Portugal are top 10 players in OECD dataset but are not displayed because they lack data in GlobalComms

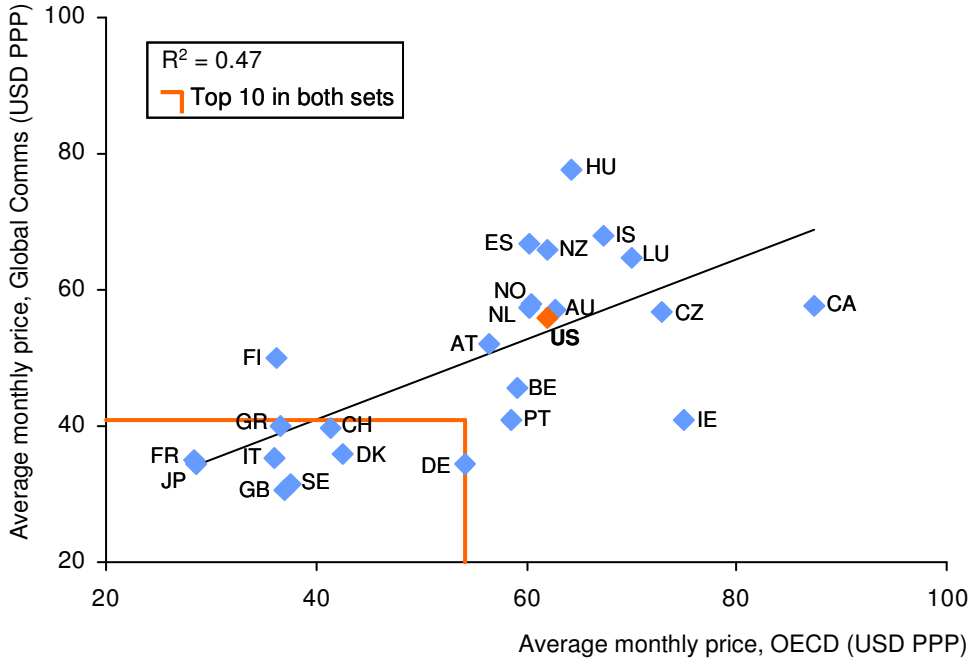
42 http://www.comcast.net/terms/network/amendment/ (last visited Sep. 4, 2009).

Figure 3.27. OECD versus GlobalComms pricing in medium speed tier



Source: Berkman Center analysis of OECD and Global Comms 3.0 Broadband Statistics
Note: France is the best ranked player in the OECD dataset but is not displayed here because it lacks data in the GlobalComms dataset

Figure 3.28. OECD versus GlobalComms pricing in high speed tier



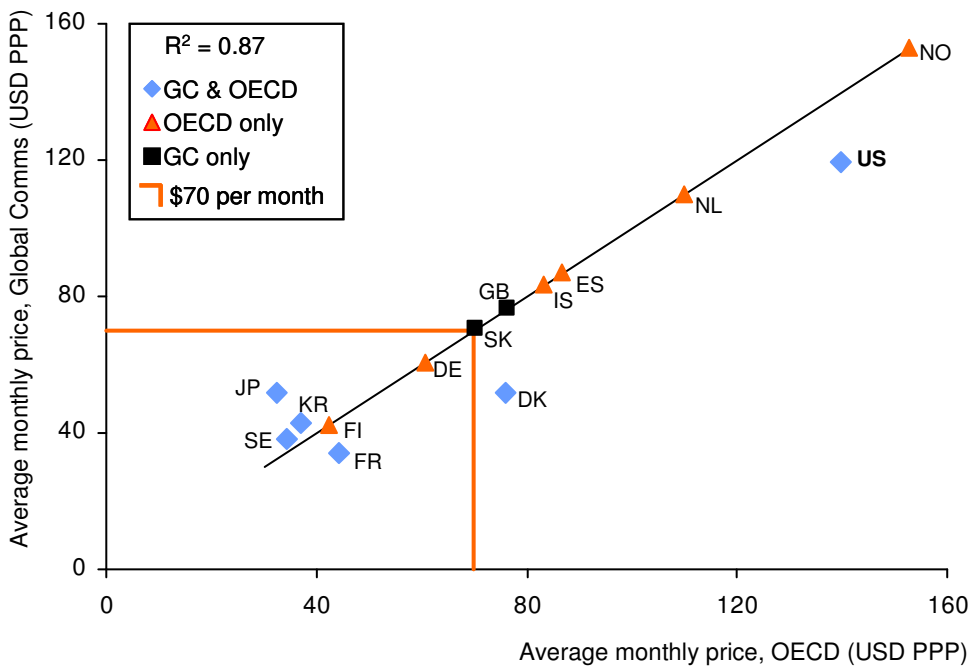
Source: Berkman Center analysis of OECD and Global Comms 3.0 Broadband Statistics
Note: Slovak Republic and Poland excluded as outliers

We cannot say that our dataset is methodologically more robust than the price data of the OECD. Instead, we believe that the relatively wide deviations reflect the difficulty of getting good price estimates, and emphasize the need to invest in collecting and verifying price data in the future. From a "rankings" horse-race perspective, our analysis has very little effect on the standing of the United States in all tiers of service that are of interest in forward-looking terms. From the more important perspective of identifying models for learning and observation, we suggest looking at those countries (identified by the lower left hand box in Figure 3.26 through Figure 3.29) that were in the top 10 in both our data and that of the OECD as clearly high performers, and taking that definition as a loose guide rather than a strict criterion.

3.6.4 Conclusion

International comparison suggests a mixed picture on prices in the United States. On the one hand, the lowest prices available for the lowest tier offerings are very good by comparison to other countries. On the other hand, average prices for other tiers, and the OECD's data–but not our independent analysis–suggest that on average prices at the lowest tiers are only middling. Our independent analysis suggests that for the lowest tiers of service, at speeds below 2Mbps, U.S. consumers see low average prices by comparison to most other OECD countries. Whether these data suggest that affordability of entry-level service is not a significant problem in the United States depends on two questions, one empirical the other aspirational. The empirical question is the degree to which the lowest available offers are more-or-less nationally available. That is a question to be addressed by the more fine-grained analysis of broadband availability contemplated by the American Recovery and Reinvestment Act. On qualitative inspection however, we found that our data for the U.S. in the low tiers suggests that the good U.S. ranking in that low end tier is likely representative of what is really available throughout much of the country at the low end, and is not an artifact of our methods for selecting offers from the market data. The aspirational, or policy judgment required, is whether the lowest currently-available speeds are the appropriate target for broadband policy and planning. To the extent that one believes that any level of connectivity counts, then the answer is yes. To the extent one adopts the proposition that higher capacity connections, up to a point at any given moment in time, are necessary for full enjoyment of the benefits of the then-prevalent and next-step technologies, then the answer would be no, and the most pertinent data would concern prices at the tier of service we consider to be the target of present policy making.

Figure 3.29. OECD versus GlobalComms pricing in very high speed tier



Source: Berkman Center analysis of OECD and Global Comms 3.0 Broadband Statistics

If we conceive of the benefits of broadband connectivity to include capacity-sensitive applications like voice and video over IP; if we consider telecommuting and individual, home-based Internet entrepreneurship as important applications, then the price of the slowest speeds and capacity possible is likely too low a target for policy benchmarking purposes. Once we consider medium and high speeds, the picture in the United States becomes less rosy. If the target of policy is to achieve near-universal availability of relatively high capacity connectivity, then it would be important to look at the experience of countries that have achieved better prices for higher capacity. These include Japan, South Korea, France, Sweden, Denmark, and the United Kingdom, as well as Italy, Germany, and Greece. Among the

countries that perform well by penetration standards, Norway, the Netherlands, and Canada seem to present less attractive models on the price dimension. We present our at-a-glance table as we did for the prior attributes, ordering the countries here by their relative performance on prices at the different speed tiers, each weighted equally (12.5%) to reflect no particular emphasis on one or another speed tier, or on the quality of OECD vs. Berkman pricing study.

Table 3.5. Country ranks on various price measures

	Country	Price low speed, OECD	Price low speed, OECD +GC	Price mid speed, OECD	Price mid speed, OECD +GC	Price high speed, OECD	Price high speed, OECD +GC	Price very high speed, OECD	Price very high speed, OECD+ GC	Weighted average rank
1	Japan	7	7	2	1	2	1	1	1	2.75
2	Sweden	8	4	8	2	8	4	2	2	4.75
3	Denmark	2	2	9	5	10	5	7	6	5.75
4	Finland	4	10	5	8	4	9	4	4	6.00
5	France	17	18	1	3	1	2	5	5	6.50
6	United Kingdom	6	13	3	6	6	7	N/A	9	10.00
7	Italy	1	1	7	11	3	3	N/A	N/A	10.75
8	Netherlands	9	8	11	13	16	17	10	12	12.00
9	South Korea	25	28	13	16	7	6	3	3	12.63
10	Switzerland	13	3	6	4	9	8	N/A	N/A	12.88
10	Germany	26	15	14	12	11	11	6	8	12.88
12	United States	12	5	17	18	19	14	11	13	13.63
13	Greece	15	19	4	14	5	10	N/A	N/A	15.88
14	Portugal	11	9	10	9	14	15	N/A	N/A	16.00
15	Belgium	3	23	12	7	13	12	N/A	N/A	16.25
16	Norway	18	17	18	20	17	16	12	N/A	18.50
17	Spain	24	25	22	26	15	18	9	11	18.75
18	Iceland	23	27	25	25	22	22	8	10	20.25
19	Slovak Republic	14	11	30	17	28	27	N/A	7	20.50
20	Austria	29	22	19	10	12	13	N/A	N/A	20.63
21	Luxembourg	19	12	16	15	23	23	N/A	N/A	21.00
22	Ireland	5	6	24	22	26	26	N/A	N/A	21.13
23	New Zealand	10	21	20	23	18	20	N/A	N/A	21.50
24	Hungary	16	14	21	24	21	25	N/A	N/A	22.63
25	Canada	21	16	23	19	27	21	N/A	N/A	23.38
26	Czech Republic	20	24	15	21	25	24	N/A	N/A	23.63
27	Australia	27	29	26	27	20	19	N/A	N/A	26.00
28	Poland	28	20	28	29	24	28	N/A	N/A	27.13
29	Turkey	22	26	29	30	N/A	N/A	N/A	N/A	28.38
30	Mexico	30	30	27	28	N/A	N/A	N/A	N/A	29.38

3.7 Summary benchmarking report

In this part we reported the results of a multi-dimensional benchmarking study, combining our own independent research and analysis with, primarily, OECD data. Our independent data sometimes confirm, sometimes refine, and sometimes disagree with OECD data in particular areas, such as low-tier service pricing or approaches to actual speed measurement. The degree of correlation between these two independent datasets and analyses adds to our confidence in the quality of both. Our core purpose throughout has been to identify which countries are stronger and which are weaker, along several dimensions of each of the three major attributes: penetration, capacity, and price. This approach resulted in greater nuance than is captured by more widely used broadband-specific benchmarks—most commonly the penetration per 100 inhabitants measure—and in a tighter focus on measures of interest than used in the wider, business-use oriented scorecards we discuss in Section 3.2. Throughout the report, at the end of each section, we offered an at-a-glance table that described how each country did along each of the several measures of each attribute, and how they ranked, in the aggregate, in terms of that attribute. Here we conclude by rolling all these attribute-specific tables into a single combined table, reported as Table 3.6, treating penetration, speed, and price as equally-weighted performance measures.

From the perspective of looking at the United States rank alone, our approach improves the position by two spots, but largely confirms and increases our level of confidence in the competence of the finding that the United States is, overall, a middle-of-the-pack performer. More interesting are the substantial changes in position of several countries often thought of as good performers to middling or even weak, and of middling performers to good. First, our balanced measures place South Korea and Japan where they are widely perceived to be—at the top of the list. More useful in terms of adding information, are the shifts in place for Canada, Switzerland, and Norway, all of which show up as weaker performers in our benchmarking study than commonly perceived. First, Canada's weak speed and price performance, as well as low 3G penetration, move it from a solid second quintile performer into the fourth quintile. They also move Norway and Switzerland out of the first quintile, mostly because of higher prices, lower speeds, and to a lesser extent because of lower 3G penetration. On the other hand, France comes out as a stronger performer, moving from the third to the second quintile, and the United Kingdom too improves its relative performance within the second quintile. As we move to the next parts of the report, we will be able to use the insights gained from the benchmarking exercise to add valence to our findings: that is, to interpret the practices and policies adopted by any given country in light of whether we understand that country to be a better or worse performer, either on a given attribute, or in the aggregate.

Table 3.6. Country ranks based on weighted average aggregates

	Country	Penetration	Speed	Price	Overall weighted average rank
1	Japan	6	1	1	2.67
2	Sweden	3	5	2	3.33
3	Denmark	4	4	3	3.67
4	South Korea	1	2	9	4.00
5	Finland	5	6	4	5.00
6	Netherlands	11	3	8	7.33
7	France	15	7	5	9.00
8	Switzerland	10	12	10	10.67
8	Germany	14	8	10	10.67
10	United Kingdom	9	18	6	11.00
11	Iceland	2	14	18	11.33
11	Norway	8	10	16	11.33
13	United States	17	11	12	13.33
14	Portugal	23	9	14	15.33
15	Belgium	13	19	15	15.67
16	Italy	21	23	7	17.00
17	Luxembourg	7	25	21	17.67
18	Australia	12	15	27	18.00
19	Austria	19	16	20	18.33
20	Spain	18	22	17	19.00
21	New Zealand	20	17	23	20.00
22	Canada	16	20	25	20.33
23	Greece	27	24	13	21.33
23	Slovak Republic	24	21	19	21.33
25	Czech Republic	26	13	26	21.67
26	Ireland	22	27	22	23.67
27	Hungary	25	26	24	25.00
28	Poland	28	28	28	28.00
29	Turkey	30	29	29	29.33
30	Mexico	29	30	30	29.67

3.8 Annex: Statistical Modeling of Poverty, Income, and Urbanicity on OECD Broadband Penetration per 100

3.8.1 The model

This analysis uses country-level data to investigate factors influencing broadband penetration rates in the 30 OECD countries. The dataset was constructed using the most recent numbers available from the OECD and UNDP, with broadband prices and total penetration reported from October 2008 and December 2008, respectively.

Ordinary least squares regression is employed, largely replicating Turner's 2006 analysis.[43] Predictors include national poverty, median income, percent of the population in urban areas, average years of formal education, and average broadband subscription price. The primary model specification is:

$$\text{total.penetration} = \beta_0 + \beta_1(\text{poverty}) + \beta_2(\text{median.income}) + \beta_3(\text{urban}) + \beta_4(\text{yrs.ed}) + \beta_5(\text{sub.price}) + \varepsilon_i$$

Due to well-founded concerns that broadband price is endogenous to the model, this model was also specified excluding price as a predictor. The results of these models are as follows:

Table

	Model Includes Price				Model Excludes Price			
	Coefficient	s.e.	*p*-value		Coefficient	s.e.	*p*-value	
Poverty	-0.54	0.21	0.019	*	-0.55	0.22	0.018	*
Percent in Urban Areas	0.20	0.08	0.019	*	0.18	0.0801	0.03	*
Median Income (Thousands)	0.65	0.15	0.000	***	0.72	0.15	0.000	***
Average Years Education	0.19	0.70	0.784		0.04	0.71	0.958	
Average Subscription Price	-0.11	0.07	0.140		x	x	x	
(Intercept)	4.58				1.47			
	n =30; $Adj\ R^2$ =.776				n =30; $Adj\ R^2$ =.764			

(***) $p < .001$; (**) $p < .01$; (*) $p < .05$

The findings indicate that including subscription price does not change the substantive results of the model. Although the coefficient on price is in the expected direction, it is not significant when controlling for other covariates. Poverty, percent in urban areas, and log median income are all significant predictors of broadband penetration. The effect of formal education is small and does not approach statistical significance. Examining various interaction terms between these covariates did not reveal any notable effects.

The model reveals a substantial and highly significant impact of median income on broadband penetration. A $5,000 rise in median income, for example, results in more than a 3% increase in the predicted penetration rate. Median income is measured in Purchasing Power Parity (PPP) US dollars and was computed by the OECD over the mid-2000 years. Median income was included as a linear

[43] Turner, Broadband Reality Check II 2006, Annex A.

(rather than logged) predictor after an inspection of the data showed a roughly linear relationship with broadband penetration, in addition to very little variation in the center of its distribution. It is worth noting that the findings are essentially unchanged when including GDP per capita (2008) rather than median income, or when taking the natural log of either of these variables.

This model estimates a significant and negative relationship between poverty and broadband penetration, with a 2% rise in poverty associated with a more than 1% decrease in penetration. The poverty measure used in this analysis represents the proportion of the population earning less than 50% of the national median income, and was computed by the OECD over the mid-2000 years. The relative nature of this measure means that it also captures inequality within countries, and the model's findings are similar to what is obtained when including the GINI measure of inequality rather than poverty.

This model estimates a smaller but also significant effect of "urbanicity" on broadband penetration. A 5% increase in the proportion of the population in urban areas results in a roughly 1% increase in the predicted penetration rate. The proportion of population in urban areas was computed by the UNDP for 2005.

This analysis found no evidence of an impact from average years of formal education, with coefficients not approaching statistical significance. This measure was computed by the OECD for 2004, and weighted to reflect differences between countries in standard years to graduation.

3.8.2 Assessing relative importance of predictors

Quantifying the relative importance of predictors in the model gives a sense of which factors are most important in determining broadband penetration. Because all predictors in the model are correlated to some extent, simply comparing R-squared coefficients from bivariate regressions yields inaccurate estimates of relative importance. Figures 3.30 and 3.31 show the contribution of each predictor to the total R-squared using the most common techniques to correct for correlated predictors.[44] This exercise suggests that between 50 to 80% of the variation explained by the model is explained by median income, with smaller and relatively similar proportions of the variation explained by poverty and urbanicity.

[44] LMG and PMVD methods are generally considered superior (see Gromping 2006). http://www.jstatsoft.org/v17/i01/paper

Figure 3.30

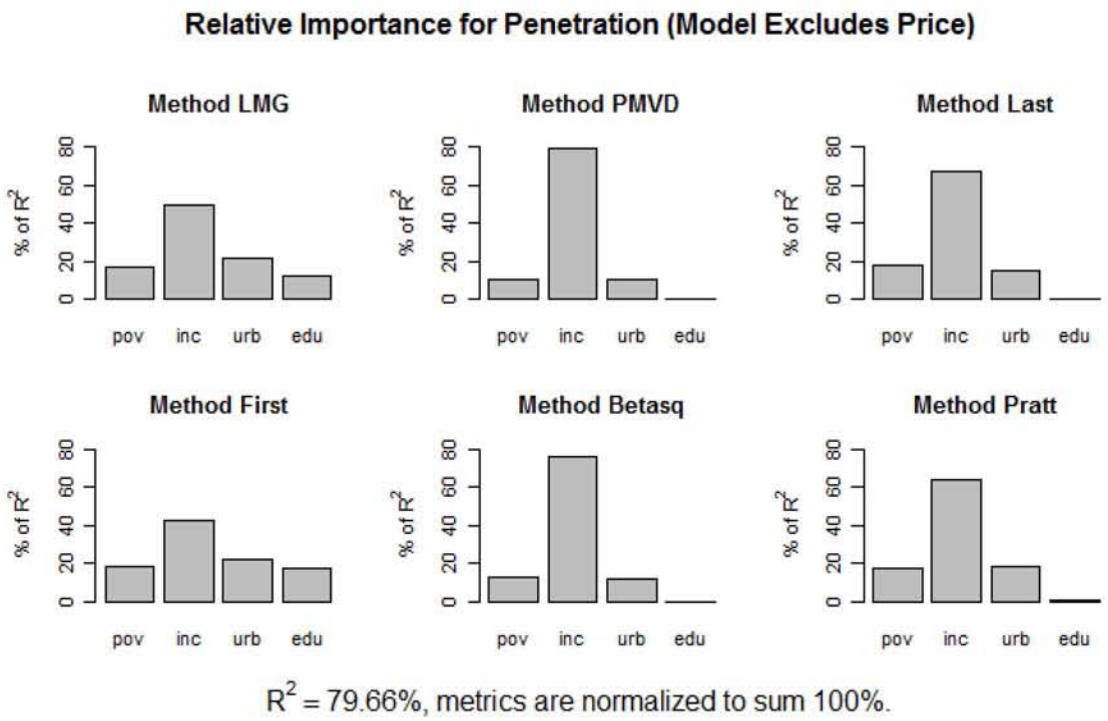
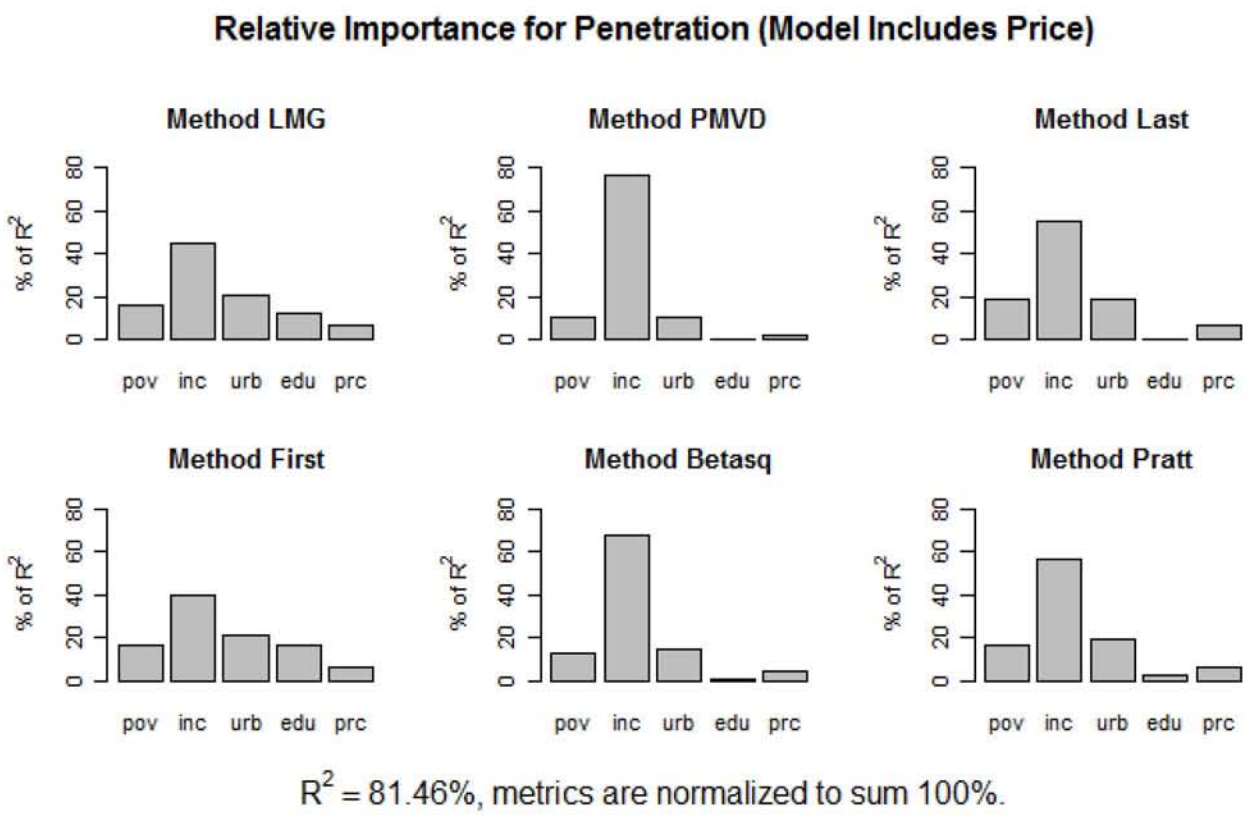


Figure 3.31



Evaluating influential data points

Among OECD countries, the United States ranks near the top in both median income and poverty. To test sensitivity of the findings, the model was run excluding the United States. Although *p*-values rise, especially for the poverty coefficient, neither the significance nor magnitudes of the estimates are affected.

Figure 3.32 plots standardized residuals from the models against leverage for each data point. Cook's distance, measuring the effect of deleting each observation, is less than .5 for each country. As the conventional threshold for closer examination of a data point's influence is a Cook's distance greater than 1, this suggests that no single country is driving the results.

Figure 3.32

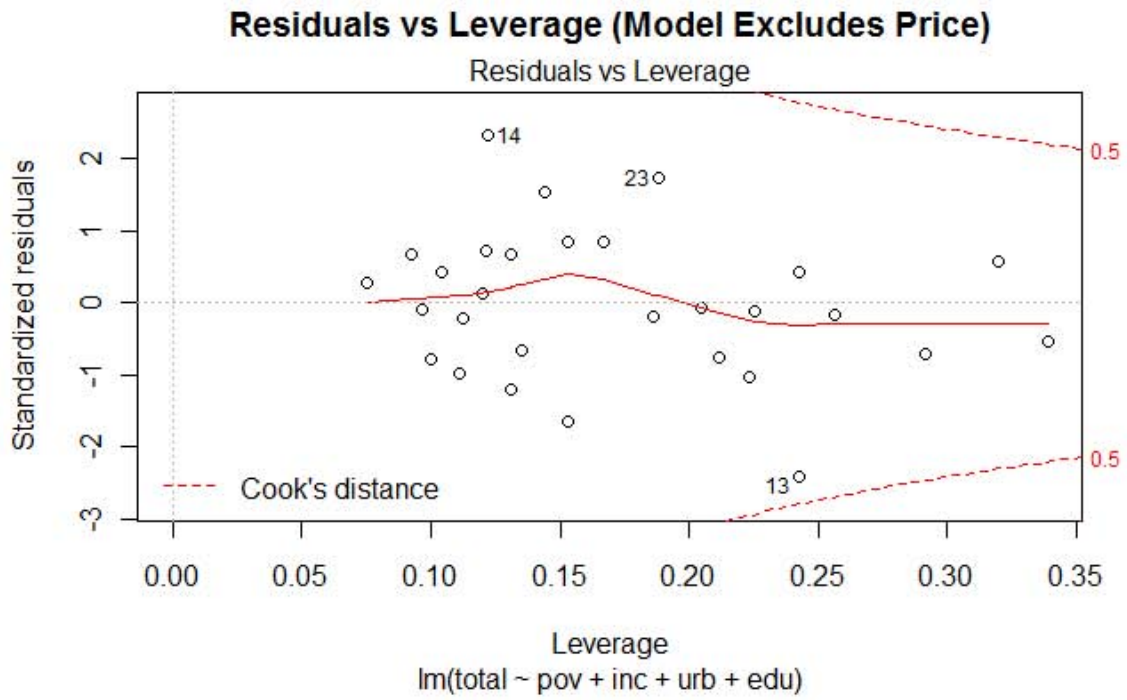
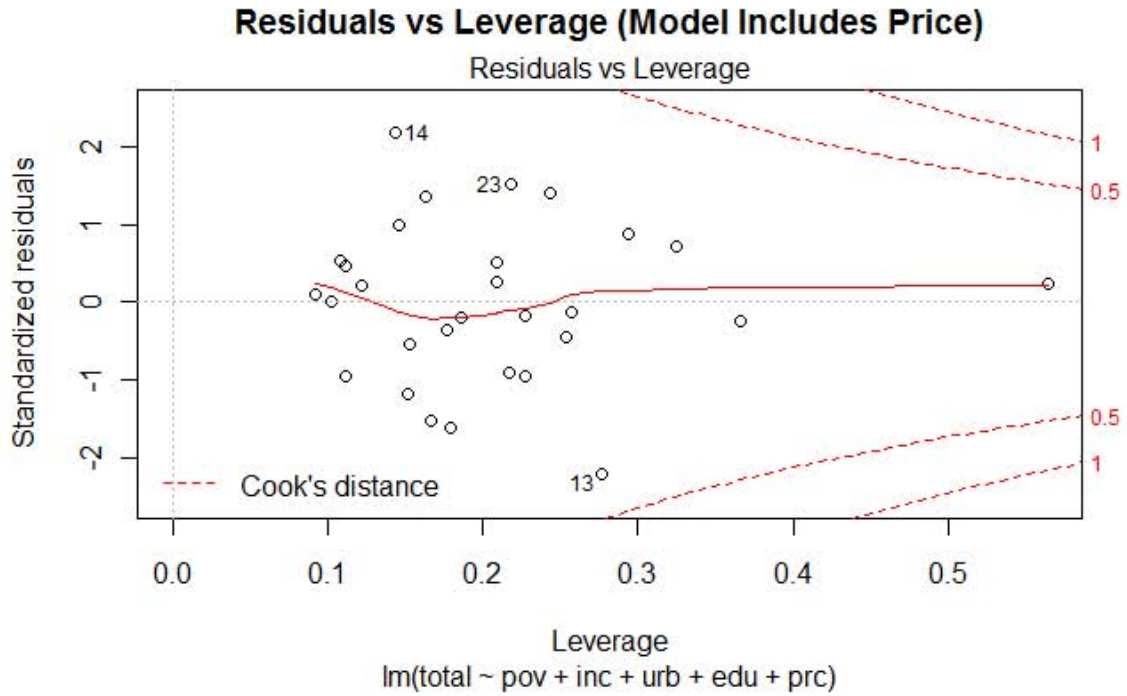


Figure 3.33


Residuals vs Leverage (Model Includes Price)
Residuals vs Leverage
Standardized residuals
Leverage
lm(total ~ pov + inc + urb + edu + prc)
Cook's distance
14
23
13
1
0.5
0.5
1
2
1
0
-1
-2
0.0
0.1
0.2
0.3
0.4
0.5

4 Policies and practices: Competition and access

This part and the two that follow it review the core policies and practices of other countries, and evaluate whether we can conclude that one or another policy intervention contributed to a country's broadband performance. These policies and practices fall into the two major categories of government action: regulation and public spending. They are focused on improving either the supply of, or the demand for, ubiquitous connectivity, or on assuring equitable access to the technological capabilities of the digitally networked environment. On the supply side, governments spend and invest in infrastructure or tailor their regulatory action so as to improve competition in telecommunications markets while preserving investment incentives. On the demand side, governments mostly spend improve skills, subsidize equipment and services, or act as buyers.

In our review, we found that a central aspect of policy has been the effort to foster competition in an imperfect and difficult market. This was true of the first broadband transition, and is at the center of many planning efforts for the next generation transition. Fostering competition entailed a shift from older-style regulated monopoly structures to a system that deploys its regulatory power to lower entry barriers by requiring open access to hard-to-replicate infrastructure elements. Both the degree to which national regulators were engaged and effective relative to usually recalcitrant incumbents, and the degree to which regulators emphasized protecting entrants appear to have been important. In wireless markets, the lessons are murkier. There are countries that have done well with policies that "should" not have worked—beauty contests or small numbers of allocations—and countries that have done poorly even though they acted early and auctioned four or five dedicated 3G licenses with adequate spectrum. There were also countries that had the inverse results. We review these in Part 5, but mostly suggest that this is an area that needs further study. In our review of investment policies, we found that major spending on infrastructure, either directly, as in South Korea and Sweden; through subsidies, subsidized loans, and tax breaks, as in South Korea and Japan; or through municipal-level requisitioning and public private partnerships, as in Sweden and the Netherlands, played a role. In Part 6 we review those general strategic investments, stimulus-specific investments, and municipal approaches, paying particular attention to the new European Commission guidelines aimed at considering the risk that government investments will crowd out market investments. We also review several innovative programs on the demand side in terms of skills training and subsidies to poorer users and higher cost areas.

A word on the question of whether government policy matters at all. A number of analyses (including our own analysis of urbanicity and poverty, as well as our econometric analysis of unbundling below) show that many factors other than government action predict broadband penetration, a primary metric for measuring broadband success. Clearly income, geography, and poverty all contribute to the difference between broadband penetration levels in different counties. These demand and supply factors will also influence price and speed. An extreme interpretation of these results would suggest that these factors explain so much of the overall performance of a country that policy plays no appreciable role. We do not find this assertion to be credible and find that the available data, both quantitative and qualitative, contradicts such a view. We note that it is unnecessary to show that policy is primarily responsible for a country's performance; it is sufficient to show that a policy can contribute positively and appreciably, at the margin, to a country's performance relative to that country's performance without that policy. For example, imagine a policy intervention whose effect is to add only 1% to penetration rates annually over the course of a decade. Looked at from the perspective of a single year, the effect seems insubstantial. Over the course of a decade, however, it would mean that a country will have 10% higher penetration than it would have had without the policy. If we accept the World Bank analysis that 10 points in penetration per 100 translates into 1.21% GDP growth, that becomes a very important effect indeed for any given single policy intervention. We do not in fact attempt to measure the total

contribution of a given policy or practice we describe here. We merely note that even very small positive contributions policy can make incrementally can have a significant medium to long-term impact.

4.1 Competition and access: Highlights

The most surprising finding in our analysis is that open access policies contributed to the success of many of the highest performers during the first broadband transition, and as a result are now at the core of future planning processes in Europe and Japan. Contrary to perceptions in the United States, there is extensive evidence to support the position, adopted almost universally by other advanced economies, that open access policies, where undertaken with serious regulatory engagement, contributed to broadband penetration, capacity, and affordability in the first generation of broadband. We review the evidence here at length. We consider the qualitative method we use throughout most of this part more appropriate for the complex underlying phenomena than purely econometric techniques, given the small number of countries and observation points. As a complement to our qualitative analysis we also conducted a re-analysis and refinement of the most recent econometric work on the effects of unbundling on penetration. We find that, consistent with the findings of this recent work, and inconsistent with a recent critique of it, econometric analysis supports the proposition that unbundling contributed to broadband penetration in OECD countries. Indeed, new analyses we perform on the existing data suggest that the effect was larger than previously thought, the confidence level higher, and the finding more robust.

Countries whose performance makes them valuable learning models are transposing what they learned about access from the first generation broadband transition to next generation connectivity. They present several interesting models of observation regarding how to implement such open access policies in various next generation topologies. We see models of active and passive component sharing; we see models of required sharing of the last drop; and we see competition policy adjusted to allow competitors, both incumbents and entrants, to cooperate in deploying new fiber plant. We also see a substantial recent move to adopt or consider adoption of the United Kingdom's imposition of functional separation between retail and wholesale divisions of incumbents, in order to facilitate competition based on open access to network components.

Table 4.1 summarizes the core lessons, and focuses on which of the case studies or sections is most pertinent to that lesson. The core lessons are also highlighted at the end of each discrete section or case study.

Table 4.1. Core lessons from international strategies

Core lesson	Case study or section
Open access policy, in particular unbundling, played an important role in facilitating competitive entry in many of the countries observed; In many cases, even where facilities-based alternatives were available, unbundling-based entrants played an important catalytic role in the competitive market; In some cases competition introduced through open access drove investment and improvement in speeds, technological progression, reduced prices, or service innovations.	Japan, Denmark, the Netherlands, Norway, Sweden, France, UK, New Zealand, Econometric study
An engaged regulator practically enforcing open access policy is more important than the formal adoption of the policy; incumbents resist access policies whether they are formerly government-owned or not	Japan, South Korea, France, Germany, UK, Canada, Econometric study
Broadband providers are regulated as carriers, and their carriage function is regulated and treated separately from their retail service function	All surveyed countries.
Access rules are now being applied to the next generation transition, particularly to fiber	Japan, South Korea, Sweden, Netherlands, France, UK, European Regulators Group/EU, New Zealand
Ubiquitous access has led regulators to accept increased vertical integration between mobile and fixed broadband providers. In some places this has also led to application of open access requirements to mobile broadband platforms	Japan, South Korea apply access; France, Germany experience greater integration but have not extended access
In the two earliest instances where functional separation was introduced, it had rapid effects on competitive entry, penetration, prices, and/or speeds	UK, New Zealand
Functional separation is increasingly adopted or considered to achieve open access into the next generation transition	UK, New Zealand, Sweden, Netherlands, Italy, Australia
Facilities-based competition usually complements, rather than substitutes for, access-based competition	Japan, South Korea, Denmark, Norway, Sweden, the Netherlands, UK, France, Germany, Italy, New Zealand
Entrepreneurial competitors have tended to enter through bitstream and unbundling access	Japan, South Korea, Denmark, Norway, Sweden, the Netherlands, France, UK
Where unbundling was formally available but weakly implemented competition was limited to facilities-based entrants, with weaker results	Germany, Canada
The anticipated high costs of next generation transition are pushing countries and companies to seek approaches to share costs, risks, and facilities, rather than focusing primarily on creating redundant facilities to assure competition	European Regulators Group, Netherlands, France, Germany, Switzerland, UK

4.2 Overview

Talking about "unbundling," or more broadly open access in the United States today is a bit like wearing bellbottoms or talking about a national healthcare system. We nonetheless open with this subject because it is impossible to discuss the international experience in the past decade, or to describe contemporary thinking in other countries about the next generation of high speed networks and ubiquitous connectivity without discussing access regulation. It would be no more plausible than discussing current policy debates about climate change, but not mentioning emissions caps and tradable permits. The most surprising findings to an American seeped in the current debate in the United States are the near consensus outside the United States on the value and importance of access regulation, the strength of the evidence supporting that consensus, and the central role allotted to transposition of that experience to next generation networks in current planning efforts.

Open access policies require telecommunications providers, mostly incumbents, to make available to their competitors, usually at regulated rates, various parts of their network or service, so that the competitors can begin to compete using these components as part of their service, without having to replicate the full investment that the incumbent originally made. The various types of access—unbundled local loop, shared access, bitstream access, or wholesale—differ primarily in how they trade off the level of investment a competitor must make to provide competing services, in exchange for the flexibility that the new entrant has in what improvements it may offer consumers. With unbundled local loop, the competitor leases the right to use the copper loops of the incumbent, and adds the electronics and switching. With shared access, the competitor leases only the right to use high frequency portions of the local loop, not those frequencies used for voice telephony. In both cases the competitor must invest in putting equipment deep in the network, so that it controls the technical characteristics of the DSL service, but to do so it must make substantial investments. Bitstream access gives entrants less control over the technical characteristics of the service, because the incumbent provisions the DSLAM, which in turn defines the parameters of what DSL services can be provided. It nonetheless offers more flexibility, and requires more investment, than wholesale offerings. With wholesale, the incumbent is providing a finished service, but selling it to competitors at wholesale rates. The entrant can try to improve administrative efficiency or marketing; compete on customer care, packaging or service bundling; or improve billing, but not innovate on the technical characteristics of the service.

The theory underlying open access obligations is that entry barriers in telecommunications markets are high and deter competitive entry. By requiring incumbents to sell, at regulated rates, the most expensive, and in the case of local loop and shared access, lowest-tech elements of their networks, regulators enable competitors to invest a fraction of the total cost of setting up a competing network, focus that investment on the more technology-sensitive and innovative elements of the network, and compete. In this model, regulated access provides one important pathway to make telecommunications markets more competitive than they could be if they rely solely on competition among the necessarily smaller number of companies that can fully replicate each other's infrastructure.

Some form of open access regulation has at this point been adopted by every country in the OECD except the United States, Mexico, and the Slovak Republic (which has been in the process of passing unbundling requirements for over two years, but has not yet done so). Mexico has the lowest penetration per 100, the slowest average advertised and actual speeds, and the highest prices for the low speeds that are on average available there. The Slovak Republic's fixed broadband penetration is 28th or

26th of 30 countries, and its residents pay the highest prices of any OECD country for medium speeds, and almost highest for the high speed services available to them.[45]

The United States is the country that invented the Internet, drove initial popularization through dial-up service on what functioned like an open access model, and was among the earliest to formally introduce open access policies as the centerpiece of the major, bipartisan, telecommunications reform in the almost unanimously approved Telecommunications Act of 1996. From the start however, implementation of unbundling was burdened and thwarted, largely by incumbents' resisting implementation through foot-dragging and litigation, but also by a judiciary highly skeptical of the theory behind unbundling, receptive to the arguments of the incumbents, and exhibiting little deference to the judgment of the FCC.

Our review of the experience of other countries shows that open access policies were gradually adopted throughout most other OECD countries over the course of the following decade. In some cases, this was done without appreciable incumbent resistance. The Nordic countries stand out in this regard. But in many cases, incumbents resisted open access as vigilantly as they had in the United States. France Telecom and its union were no less reluctant to share their rents with entrants than were the Baby Bells; nor was Deutsche Telekom. In various countries, the degree to which either the regulator or the European Union's pressure enabled a country to overcome this resistance was a factor in whether the policy then in fact became a reality. In some countries, the moment of the shift in the relative professionalism, independence, and power of the regulator in relation to the incumbent, and its will and capacity to engage in enforcing a competitive playing field, are widely seen as the moment of takeoff for their present generation broadband deployment. Japan's newly-reorganized MIC succeeded in overcoming a weakened NTT's resistance in 2001. The new regulatory change was followed almost immediately by entry of Softbank, using unbundled capacity, which in turn forced NTT to shift from a strategy focused on high-priced ISDN services to a highly-competitive DSL market. France succeeded in breaking through the resistance of France Telecom and its politically powerful unions in 2003. The change was followed almost immediately by the introduction of unbundled services by Iliad and neuf Telecom, who now hold about 46% of the French market between them. The best bundle currently available from Iliad's "Free" service includes 100Mbps service to the home, digital TV with HD and the ability to create your own private television channel for others to watch on their TV sets, unlimited voice telephony throughout France and to 70 other countries, including the U.S., and secure nomadic Wi-Fi access wherever one's laptop or Wi-Fi-enabled phone is within range of the Freebox of any other Free subscriber in the country (24% of the French market), for USD32.59 PPP a month.

Most of this part of our report reviews the experience of other countries as they implemented open access. The premise is that if open access policies work, they work through their effects on the actions of firms. Here we offer detailed qualitative case studies of open access and competition in fourteen countries. We describe how open access did, and did not, work through the choices of firms in broadband markets during the first transition, and what the regulatory and planning bodies in these countries are doing today to transpose their experience during the first broadband transition to the next generation. Where pertinent, we describe the political economy that surrounded the adoption of an effective access regime.

What we found in our review of the evidence is a pattern similar to what we described for Japan and France. In other countries that implemented open access successfully, like Sweden, Norway, Denmark,

45 On the other hand, the Slovak Republic has a respectable level of fiber connectivity relative to other OECD countries (slightly over 4% as of March 2009) due to a recent $40 million investment by Orange Slovenska in connecting fiber in 12 Slovak cities. This investment, and its meaning for the questions of investment incentives created by unbundling will be discussed below.

or the Netherlands, the policy enabled entrants like Softbank and Iliad to compete, and that competition quite clearly followed close on the heels of adoption of the policy and contributed to the creation of a more competitive market. In other countries that implemented open access more weakly, results were mixed. Canada in particular offers an example of half-hearted efforts to impose unbundling, and increasingly heavy reliance on competition between local telephone and cable incumbents. Its results, as our benchmarking study shows, have been weaker than those of other countries we review here. There are, of course, countries whose experience does not fit this model as neatly. Finland, which implemented unbundling early, enjoys fierce competition, but it does not appear that the competitors in fact made use of unbundling as part of their strategy. In South Korea unbundling was introduced late, after it had already reached high levels of service; its early entrants did rely on leased access to incumbent facilities—but not those of the telecommunications incumbent. We discuss these in the case studies themselves. Switzerland has been the strongest example of successful broadband performance without effective adoption of unbundling. Nonetheless, that success cannot unambiguously be attributed to the absence of regulation, because throughout most of the relevant period the Swiss regulator and Swisscom had been battling over the former's efforts to impose unbundling, as it ultimately succeeded in doing in 2007. The persistent shadow of regulation renders the case harder to interpret than would otherwise have been the case. Even after the imposition of unbundling on copper, for example, the continued debates over whether to extend unbundling to fiber may now be contributing, alongside competition from municipal power companies, to Swisscom's particularly innovative approach to sharing the costs and risks of investment in next generation roll out: inviting competitors to cooperate in laying four-fiber plants into each home and sharing the resultant infrastructure.

The United Kingdom's experience introduces an additional policy element. There, efforts to implement the most extensive form of open access—unbundling—met with subtle resistance from BT. As a result, although the UK had adopted unbundling in 2001, by late 2005 there were still only 200,000 unbundled loops in the entire country. At that point, Britain's regulator, Ofcom, forced BT to undertake functional separation: that is, create a separate unit, Openreach, that specialized in selling open access components to telecommunications providers, both to the retail operations of BT itself and to its competitors. The separation changes the incentives of the provider, and eases monitoring of its behavior. Functional separation was followed by a flurry of investment activity by entrants, resulting in the strengthening of competitors Carphone Warehouse, Tiscali UK, and BSkyB and their shift to competing over more flexible unbundled loops instead of almost solely through wholesale offerings. By the end of 2008, there were 5.5 million unbundled loops in the UK. Prices fell by over 16% each year between 2006-2008. While the UK's competitive market did not result in the very high speeds we see in France of Japan, our analysis of prices advertised by 59 companies in the countries we review here shows that the UK companies do have among the lowest prices in the high speed (as opposed to very high speed) category of services. In our benchmarking study, the UK now has prices that are among the top quintile of performers for all tiers of service but the very highest speeds. Following the UK's experience, New Zealand implemented functional separation in December of 2006 in a dramatic reversal of its consistent policy of regulatory abstention since 1989, and in response to its substantial under-performance on broadband penetration. Between the last quarter of 2006 and that of 2008 New Zealand saw its penetration per 100 rates jump, surpassing those of Austria, Italy, Spain, and Portugal; it saw speeds increase more than in any other OECD country, and the primary competitor to New Zealand Telecom, TelstraClear, invested in its own fiber ring connecting all of South Island's towns. Sweden and the Netherlands have now followed this path in preparation for the next generation transition, as has Italy, and Australia has just announced that it too will force its incumbent to undergo functional separation.

The experience of all these countries has led to a wide consensus outside the United States that open access policies played an important role in creating competitive broadband markets in those countries

that adopted and enforced them. As a result, current planning efforts emphasize transposition of the lessons learned about open access to the different topologies and cost structures of next generation networks as a core element of these countries' policy. The clearest documents in this regard are those produced by the European Regulators Group (ERG), which coordinates among the European regulators. The ERG has studied the lessons of its members extensively over the past several years, and has produced a series of reports on implementation and transposition. These include analysis of when "active access," that is, access akin to bitstream and wholesale, and when "passive access," or access to ducts and dark fiber, would be desirable, and consideration of when functional separation is sensible.

We follow the detailed qualitative analysis with a firm-level pricing study. The study looks at prices offered by the 59 companies that offer the very high speeds in the countries we review here, or if none do, the highest speeds otherwise available in the country. It incorporates both our own research and OECD data. It identifies companies by their status as incumbent telecommunications companies, cable operators, unbundling-based entrants, and utilities or other facilities-based entrants. We find that U.S. and Canadian companies–both telephone and cable incumbents–that occupy markets that rely on inter-modal competition, offer the lowest speeds at the highest prices. Japanese, French, and Swedish firms, including telephone incumbents and cable and unbundling-based entrants, offer the highest speeds and lowest prices, together with the more ambiguous cases of Finland and South Korea. The rest of the companies we observed occupy a middle ground.

We conclude the data presentation with an econometric re-analysis of the most recently analyzed dataset on adoption of unbundling and penetration per 100 inhabitants. We treat the econometric analysis as a useful adjunct to the qualitative analysis, rather than a replacement, because any analysis of such a small set of observations of questions of such great complexity and nuance, taking one measure of policy and one measure of performance, will of necessity overlook important factors. Nonetheless, we independently verified and tested the most recent dataset and analyses, and confirmed the results that supported the contribution of unbundling to penetration levels. Moreover, we performed influence points testing, which has not been done in past studies and is now common for cross-country comparisons. We found that most of the ambiguity about the effect of unbundling comes from the experience of Switzerland. Removing Switzerland substantially increases the confidence in, and contribution of, the effect of unbundling across all other countries. Taking poetic license, one might say that pointing at statistical ambiguity regarding the effect of unbundling across all OECD countries is primarily a way of using econometrics to say: "but look at Switzerland." Finally, we tested the effect of changing the values in the model to account not for the formal passage of unbundling rules, but for the dates on which these rules were in fact implemented on the ground in a serious, engaged way, reflecting what we found in our qualitative case studies (for example, moving the timing of the United Kingdom's implementation from when unbundling was formally adopted but remained practically unused, to the moment at which the imposition of functional separation on BT and the creation of Openreach in fact led to adoption of unbundling). We found that reflecting the realities of implementation in the data increases both the significance of unbundling and its predicted contribution to the levels of penetration.

We conclude this part with a detailed review of current efforts to transpose the experience of open access to the very different context of next generation connectivity.

4.3 The second generation Internet: From dial-up to broadband

During the 20th century telecommunications services were a monopoly business. Outside the United States, these monopolies were mostly state-owned. In the United States, AT&T became a de facto monopoly in the second decade of the century. The theory throughout this period was one of natural

monopoly. Because the fixed investments necessary to create a telecommunications network were so high, while the marginal costs to serve each subscriber over time relatively lower, and because it was valuable to subscribers to be connected to all other subscribers, it was thought to be most efficient to have a single network connect everyone, and then subject the carrier to regulation to assure that it would not abuse this monopoly by charging high prices for poor service.

By the end of the twentieth century this model was globally seen as a failure. The state-run telecommunications carriers were seen as inefficient and bloated. In the United States, the Bell System repeatedly outwitted the FCC and the Department of Justice, preventing competitors from entering into competitive lines of business that depended on the core, hard-to-replicate facilities of the local copper loop, like long-distance telephone service, the manufacture of telephone or office switches, or data processing at a distance, and continued to capture rents that, in theory, should have been regulated away. The global disenchantment with the idea of a well-regulated monopoly swept the industrialized nations. In the United States, AT&T was broken up in 1984. Its "daughter companies" operated under antitrust court supervision for over a decade, until Congress passed the Telecommunications Act of 1996 to modernize the law to fit the new competitive environment. In the rest of the world, national telephone companies were gradually privatized in the late 1980s and throughout the 1990s, although in many places the government still holds a non-controlling share–and an influential voice–in the resulting private companies.

The history is important because the quandaries presented by the transition from regulated monopoly to competition continue to be the core quandaries facing regulators everywhere as they ponder the next transition to a ubiquitously networked society. Just like now, the entry barriers to creating a second, independent, competitive telecommunications network were enormous. While these regulators were disenchanted with the idea of a well-regulated monopoly, they worried that competition was unlikely to emerge in many places, and where it did, it certainly would not be a perfectly efficient market. So a shift to inevitably imperfect competition was a second-best solution; just like regulated monopoly had been before it.

The core institutional innovation intended to square this circle—imperfect competition in a market for a network good with extraordinarily high upfront costs—was open access. The idea was that the incumbents—the former Bell companies here, Nippon Telegraph and Telephone (NTT) in Japan, British Telecom (BT) in the United Kingdom, and so forth—would be required by law to lease to newly entering competitors parts of their existing network on nondiscriminatory, regulated terms. This would lower the cost of entry and allow entrants to innovate in the electronics attached to the network, or in customer care systems or services they would offer, rather than investing in digging trenches and making holes in the walls of the houses of subscribers to pull their own, independent wiring. To give entrants flexibility, open access policies provided a menu of options for trading off investment for flexibility. Entrants could lease access to copper loops or portions of them, which were very expensive to build because of the high costs of digging trenches or pulling wires, but were not particularly technologically advanced. If they did so, they would have great flexibility in what electronics equipment to attach to these loops, but at the cost of having to invest heavily in their own equipment. In the alternative, incumbents were required to provide competitors with access to DSL service at different points in their networks, in ways that provided different tradeoffs. Because the incumbent had market power, the rates at which these components of the network were to be sold would be regulated so as to set them at a level that allowed the incumbent to recover its costs while leaving enough room for the entrant to make a retail profit. After a while, it was thought, the entrants would gain market share and brand recognition, they would be able to predict more reliably what their investment prospects were like, and they would increase their levels of investment deeper into the network. Throughout this period incumbents argued

that forcing them to sell to competitors at regulated rates reduced their own incentives to invest: Why invest, they would ask, if you know that you will be forced to share the benefits of the new networks you are building with competitors, at regulated rates?

4.4 Baseline: The United States

The Telecommunications Act of 1996 represented the most extensive overhaul of American communications law since the New Deal. It passed by a vote of 91 to 5 in the Senate, and 414 to 16 in the House of Representatives. Georgia Representative John Linder hailed it at the time as "the most deregulatory telecommunications legislation in history."[46] The basic problem it dealt with was how to transition from monopoly to competition. The most innovative idea at the core of the 1996 Act was that in order to enable competition to develop, incumbents would have to open up access to components of their networks to competitors. The Act introduced unbundling, interconnection, collocation, and wholesale access as elements of open access.

Unbundling in the 1996 Act initially had little to do with Internet access. It dealt mostly with letting new entrants enter telephone markets. Residential Internet was peripheral to the Act, and what there was of it was dial-up over voice telephone lines. Dial-up Internet was, as a practical matter, "open access" from the start, but not because of unbundling. Early on the FCC treated Internet Service Providers as regular businesses, like the corner grocery, instead of like telecommunications companies. That meant that the ISPs were allowed to "use" the carriers' network without paying a fee for every call carried. They too, like the grocery store and unlike other telecommunications carriers, could simply pay a flat monthly fee for business service. Things changed with the introduction of digital communications over copper, first ISDN and then DSL, because to compete in these new offerings, providers had to invest in reconditioning lines and installing new electronics equipment.

After the 1996 Act, the incumbents litigated many of its provisions. The FCC's efforts to define what elements of the network needed to be unbundled were struck down by the courts. Later, when DSL became important and the Commission tried to implement line sharing, or what in Europe came to be called shared access, the D.C. Circuit Court of Appeals struck the decision down.[47] In the meantime, around 1999-2000, as AT&T purchased major cable systems, a new question emerged—whether cable should be subject to the same kind of open access regulation. In several instances cable franchising authorities tried to do this; but the power to impose open access on cable operators was seen as residing in the FCC, not local authorities. Half a decade after the formal adoption of open access provisions, they still were not effectively implemented as the Internet access market began its broadband transition.

By the fall of 2001 a new FCC had changed course. Between that fall and the spring of 2002, the FCC passed a series of decisions that abandoned the effort to implement open access, and shifted the focus of American policy from the idea of regulated competition within each wire—competition over the copper plant of the telephone company and over the coaxial cable of the cable company—to competition between the owners of the two wires. The theory was that two competitors with a strong base in a technology they own were enough to discipline each other, and much preferable to the uncertainties of unbundling and the price regulation and continuous monitoring of anticompetitive abuses that it entailed. The two facilities-based competitors would drive each other to invest, would discipline any monopoly pricing, and would not suffer the negative incentives of knowing that some of their investments in upgraded networks would go to subsidize their competitors. At the time, this was not an unreasonable idea. Cable operators were leading the way in the broadband transition in the United States, while

46 142 CONG. REC. HI 145, 1146 (Feb. 1, 1996).
47 United States Telecom Association v. FCC, 290 F.3d 415 (D.C. Cir. 2002).

telephone companies were playing catch up. Exactly the same was true in neighboring Canada. In 2001 and 2002, when these decisions were being made, the United States had the fourth highest level of broadband penetration, while Canada had the second highest. The model of inter-modal competition (competition between firms, each of which uses a different technological mode to provide its service) seemed to work well.

Perhaps the most contested (at least legally) aspect of this decision was that it was done not by simply forbearing from regulation, but by changing the definition of what the cable and telecommunications carriers were doing when they offered broadband. The new decisions defined "broadband" as a single, integrated information service, rather than a combination of two distinct services: telecommunications carriage—carrying bits from place to place—and information service—doing everything else, like hosting a web site or providing a portal. This move too was litigated all the way to the Supreme Court.[48] The decision split the Court. Justice Thomas thought that, while the decision was not clearly right, it was not clearly wrong either, and the FCC had the power to make it. Justice Scalia, in dissent, thought the idea was as silly as saying that because a "pizza delivery" company offered both together one could say that the company didn't offer delivery, as well as pizza. He thought it was silly enough that the Court should reverse the decision and force the FCC to treat carriers as carriers, and then decide to forbear or not based on established categories in the Telecommunications Act, not based on an unguided and uncharted part of the Act, the residual that would apply if the Commission's interpretation were upheld.

In summary, resistance by incumbents and skepticism by the courts meant that the unbundling provisions of the 1996 Telecommunications Act were largely stillborn; certainly in their application to the emerging broadband market. In their stead, the FCC decided to embrace a theory that competition between the incumbent telephone companies and incumbent cable companies—inter-modal competition—introduced sufficient competition to discipline both. That decision was then upheld by a divided Supreme Court as permissible, if not necessarily advisable. Our review of the experiences of other countries during this past decade, relative to that of the United States, suggests that the original judgment made by Congress in the Telecommunications Act of 1996 represented the better course. The experience of other countries is complex, nuanced, and detailed. Not all of it lines up exactly with a single storyline, and not all of it unambiguously supports one conclusion. Still, as one works through the details, the weight of the evidence supports the conclusion that open access policies, where seriously implemented by an engaged regulator, contributed to a more competitive market and better outcomes. In turn, these policies and the experience with them now form the basis of much forward-looking planning throughout the world.

4.5 Japan and South Korea: Experiences of performance outliers

Across a range of broadband measures, Japan and South Korea represent outliers as high performers. The experience of Japan and its current plan provide measured support for consideration of an open access policy. The South Korean experience is more ambiguous on access, pointing more toward heavy government investment. Both suggest that a strong, professional regulator, exercising effective power over incumbent providers, can foster significant market development and competition.

48 NCTA v. Brand X, 545 U.S. 967 (2005).

4.5.1 Japan: The first transition

NTT was privatized in 1985, although the Japanese government continues to hold an interest in it. Up to that point, NTT was a powerful incumbent, which received appropriations directly from the Diet, whose staff was more professional and could overwhelm the more weakly staffed Ministry of Posts and Telecommunications (MPT), and which was backed by a coalition of equipment manufacturers that manufactured directly to NTT's specifications and were tightly bound to it. The decade following the privatization of NTT was a messy one.[49] MPT battled not only NTT over its efforts to break up the incumbent, as AT&T had been in the United States, and to force NTT to lower the interconnection rates it charged competitors, but also with Japan's fabled industrial policy ministry, MITI, over which government agency would have power over telecommunications. The battle continued for a decade until 1996, at which point NTT was able to escape breakup, but MPT had grown in power. In the following three years MPT pushed an agenda of further privatization of NTT, as well as deregulating some aspects of its telecommunications law to come into compliance with WTO requirements. In 1999, NTT was reorganized into one long distance company and two regional companies, NTT East and NTT West, while MPT was renamed the Ministry of Internal Affairs and Communications (MIC), with MITI-like capabilities, marking a new relationship between NTT and MIC, with authority finally shifting to the MIC.

In 1999 NTT was focused on building a high cost, per-minute fee-based ISDN service. Several new entrants, like Tokyo Metallic, tried to enter with DSL, but NTT was not at the time regulated to require it to provide the entrants with access, in that case collocation, to its physical network. Japan had no broadband to speak of, and the first efforts to start it failed. In 2000, the MIC created an IT Strategy Headquarters, created the e-Japan strategy, and received substantial regulatory powers in the Basic IT Law. In October of 2000, following an intervention by the Japanese trade authority, MIC promulgated a series of rules requiring collocation, and requiring NTT to publish a fee structure, to lease dark fiber at regulated rates, and to unbundle the last mile of its network to entrants. In 2001 the MIC created a public forum to resolve disputes between entrants and incumbents. That year, Softbank founded Yahoo!BB, based on leased access from NTT for backhaul and unbundled loops for access to consumers. Usen, a cable company, also at that time launched the first fiber effort in Japan, which was more facilities-based. Usen focused explicitly on high density areas with households and businesses, using its own facilities, but apparently also relying on the availability of NTT dark fiber to lease at low rates.[50] NTT was forced to abandon its ISDN-to-Fiber gradual move, and shift to DSL and fiber investments. NTT had already built much of the heart of the fiber infrastructure in the 1990s, with cheap government loans during the lost decade.

What followed were several years of extensive competition, first in DSL, and then in fiber, leading to Japan's state today. In a 2006 paper, the director of the competition policy division in MIC, Yasu Taniwaki, presented the trajectory of events with a stark graph, reproduced here as Figure 4.1.[51] While we are skeptical of the strong, clear causal claim in such a complex dynamic, at a minimum we can learn how the Japanese regulators themselves understand the dynamic. What is clearly true is that unbundling enabled Yahoo!BB to enter the market with lower prices, aggressive marketing, free DSL modems and installation, and innovative new services, most disruptive of which was bundling free VoIP with broadband access as early as 2001. Today Yahoo!BB has slightly over a third of the DSL market, NTT has another third, and the remainder is shared among other providers, mostly KDDI and eAccess. Moreover, Softbank is now moving to invest in fiber, and has become a major player in fixed mobile

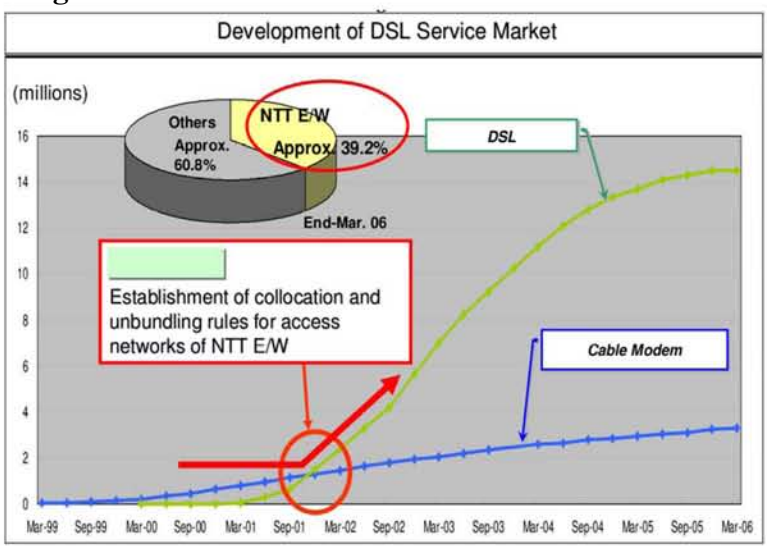
49 Kenji Kushida and Seung-Youn Oh, The Political Economies of Broadband Development in Japan, Asian Survey, 48(3) May/June 2007, 480-504.

50 USEN Annual Report 2001, Broadband Stream. (Verify veracity of this document)

51 Yasu Taniwaki, Broadband Competition Policy to Address the Transition to IP-Based Networks.

convergence by buying Vodafone's Japanese operations in 2006. In this case, unbundling or open access operated exactly as anticipated—it created low entry barriers for an entrant who was able to introduce extensive service innovations, create a brand, and become an aggressive competitor which helped drive investment away from monopoly-rent-extraction devices, like NTT's ISDN policy. That entrant continues to be a major force in the market almost a decade later.

Figure 4.1.



The story of fiber development, on the other hand, is more ambiguous in its implications for open access, and more supportive of the argument that facilities-based competitors are sufficient. The first fiber launch in Japan was by Usen, a cable music distribution network, largely based on its own facilities. While Usen still has about 7% of the fiber market, much more important was entry by power companies, in particular K-Opticom, a subsidiary of Kansai Electric Power. K-Opticom entered using its own facilities, built over the electric utility's conduits and poles. K-Opticom became the first company, in 2008, to offer 1Gpbs residential service. This part of the story supports the argument in favor of facilities-based competition, and against the need for open access. But even on the fiber side, focusing solely on facilities-based competition and ignoring the impact of open access would miss a part of the story. A major player in fiber today is KDDI, whose roots in the early 2000s were in mobile phones (through its au Corp brand), and wholesale carrier pre-selection of telephony (like Carphone Warehouse in the UK, as we will see.) KDDI expanded into fiber by purchasing Poweredcom, a fiber-delivery subsidiary of Tokyo Electric, and building its own fiber. It now offers service by combining its own fiber networks, those of some smaller cable providers, and, because it owns no DSL facilities of its own, offering various DSL services over the networks of other providers to complement its fiber facilities. KDDI's combination of facilities-based and open-access-based elements into its business model, as well as Softbank's entry into fiber services through its Hikari service, suggest that even in fiber the story in Japan is partly driven not only by the demand created on the DSL side, but also because some fiber entrants use unbundled DSL facilities to complement coverage in areas where these entrants' facilities have not yet been rolled out. Moreover, the overall level of investment in the fiber market questions the argument that open access deters investment. Despite early availability of unbundling for dark fiber, and Japan's continued commitment to assuring open access to the network layer independent of technology, NTT responded to the fiber challenge by investing and building out fiber (with support of low-cost loans from the government), and today has over half the fiber market in Japan.

The Japanese story is therefore nuanced. It does not suggest a single cause, but rather that a combination of government-subsidized loans, open access policies on the DSL side, and facilities-based competition, created both supply and demand for very high speed Internet access early on, and that this cycle led to further investments in both plants.

Japan: Thinking about a ubiquitously networked society

Japanese policy shares one assumption with the belief that underlay the FCC's decision to treat broadband providers as information services.[52] That assumption was that, going forward, carriage of bits would have to vertically integrate with higher-layer services and applications to work seamlessly and in an economically sustainable manner. Moreover, Japan's focus on a ubiquitously network society also contemplates "fixed mobile convergence." The policy conclusion that the Japanese MIC drew from this assumption, however, was exactly the opposite of the conclusion that the FCC drew. Rather than applying the anticipated integration to withdraw from access and carriage regulation, the MIC saw this anticipated business model as requiring the implementation of both open access at the network layer and net neutrality higher-up in the stack. These steps were intended to assure that the incumbent could be permitted to enter vertically integrated services (NTT East and West in collaboration with sister company NTT DoCoMo) while preventing it from undermining competition in any layer that depends on other layers, lower down in the stack. As a result, telecommunications carriers that carry more than 50% of subscriber lines in a given prefecture are required to offer equal treatment of all operators, including through offering price-regulated unbundling and interconnection of both fiber and copper. The price for the elements, in particular for fiber, is to be set so as to secure a profit for the incumbent that invested in the fiber. In this regard, the target of pricing policy is conceptually similar to the one used in the United Kingdom for BT and Openreach, where sustaining structural separation requires that pricing allow the company to invest specifically for sale to competitors. Moreover, following an 18-month dispute process, DoCoMo acquiesced in opening up its mobile network to competitor Japan Communications, and publishing leasing and interconnection terms more transparently. The result is the launch of two data-focused mobile virtual network operators (MVNOs) (Japan Communications and IIJ Mobile) with a higher degree of control over their network than traditional resellers. In order to support and permit further integration, the MIC set up a close annual review process, designating a watch list of potential points of bottleneck or anticompetitive limitations, to be reviewed and updated annually with the anticipation of swift regulatory intervention where anticompetitive practices are observed.

The critical insight here is that the Japanese approach sees a highly competent and intensely engaged regulator as an enabler of competition, rather than that a weak and removed regulator is what competition requires. Precisely to the extent that market conditions require market actors to integrate and innovate across dependent parts of the network and services, to that same extent the activity of the regulator allows dominant market actors to experiment with new operating arrangements while assuring competitors and entrants that they too can invest, because abuses by carriers who hold market power will be checked by the regulator. The system of observation is not based on clear ex ante definitions of regulated versus unregulated elements (say copper, or even fiber), but on continuously updated and reviewed actual dependencies between elements of the integrated services, followed by continuous updating of whether, and what, elements require access by dependent services to assure continuing competition. As a practical regulatory matter, this approach becomes part of the definition of net neutrality, which is understood as a mandate to ensure openness of the platform layer functions and openness of interfaces between layers, so that every user (end user and intermediate) should have equal access to every layer, based on well-defined technical standards that offer ready access to content and application layers.

52 Yasu Taniwaki, Broadband Competition Policy to Address the Transition to IP-Based Networks (2006); Taniwaki presentation 2008. Add here bibliography from case study. The book Broadband in Japan.

Core lessons from Japan

- The target of next generation policy is not one or another level of measured capacity, in terms of speed or applications supported, but a ubiquitously-networked society, focused on seamless user experience and centered on the needs of users, not carriers.

- A professional and engaged regulator can monitor and measure a market, and provide confidence in its capacity to diagnose and respond to abuses by market-dominant players.

- A regulator capable of continuous monitoring and updated response can permit greater latitude for business innovation, secure, for itself and competitors, that it will identify and be able to act upon anticompetitive abuses masked as innovations.

- Access to incumbent networks, at regulated rates, was a critical part of the most visible early introduction of broadband into Japan with Yahoo!BB and is considered in Japan to have played a major role in driving speed and price competition.

- Access has long been applied to fiber, as well as to copper, and this policy is extended into the future. It does not appear to be the case that fiber unbundling was an important factor for entrants in fiber, which were largely facilities-based entrants either in cable or in power. Copper unbundling that supported DSL was, however, important to the ability of important entrants like KDDI and Softbank to roll out services in areas where they did not yet have fiber coverage, mixing and matching capabilities and infrastructures to offer complete service.

- Access requirements do not seem to have stymied investment in fiber by NTT.

- Access and net neutrality are seen as part and parcel of the same commitment to permitting vertical integration and business innovation in the creation of ubiquitous access.

- Access to the physical and network layers and net neutrality above them are seen as ways of assuring innovation and competition while allowing incumbents to innovate and expand capacity as well.

- The move to ubiquitous, seamless connectivity as a goal appears to be in the process of being transposed into expanding some access requirements on the dominant mobile platform.

4.5.2 South Korea

The South Korean experience speaks more to government investment than to access regulation. By one assessment South Korea invested $24 billion in its first transition on connecting schools and government centers in the 1990s, over $70 billion in low-cost loans to providers, and over $12 billion per year from 2004-2007 on the transition to the next generation ubiquitous network.[53] It is not entirely clear how much of this is actual government subsidy, and how much is private investment. If these numbers are even roughly representative of actual investments, made by a country with higher urban density and a population roughly one-sixth the size of the United States, then what we say about access in this context is largely moot, given that what is considered to be a major investment by the United States was the $7.2 billion appropriated in the American Recovery and Reinvestment Act. As we will see in the discussion of investment, it is more likely that these numbers reflect a large proportion of private investment complementing the public investment, in which case it is not outlandishly large by standards of

53 Atkinson ITIF Report, pp. 24-25 (2008), and see note 97 there on sourcing.

American total investment, adjusted per capita. Moreover, South Korea is often given as an example of a country that developed fantastic speeds and penetration without access regulation, and so it is worthwhile looking at that aspect of its policies in the context of this section.

Unlike in Japan, the South Korean MIC was long the more powerful and professional partner in the relationship between the regulator and the incumbent, Korea Telecom. The first generation transition occurred largely under the Korea Information Infrastructure (KII) initiative, from 1995-2005.[54] Much of this program was about liberalization and permitting competitors into a market earlier dominated by a state-owned incumbent. In addition, the program emphasized investment. The program did not include a formal unbundling obligation imposed on KT until 2002, after South Korea had already moved from having practically no broadband to having by far the highest levels of penetration in the OECD.

Two elements of early South Korean broadband adoption make the assessment that South Korea is a story inconsistent with access interventions overstated. First, KT, like NTT, was focusing on ISDN as its approach to high-rent extraction. DSL was introduced by facilities-based entrants Thrunet and Hanaro. The catch in this story is that Thrunet relied partly on its own, government-funded infrastructure, and partly on leased access to cable facilities owned by Kepco, the state-owned Korean Electric Power Company. Hanaro too relied in part on its own DSL capabilities, but in part on leasing cable capacity from Kepco. For both companies, being able to lease capacity from an incumbent who was not itself permitted to offer direct broadband services to users played a significant role in their early deployment. It was only after Hanaro and Thrunet introduced broadband that KT was forced to abandon its ISDN strategy and shift to DSL. Once it did, its size and penetration allowed it to quickly capture a large market share, whereupon the South Korean MIC imposed unbundling obligations on KT in 2002. The ambiguity in this story is that, from the perspective of the entrants, they functioned under economic conditions of an open access policy—they built their entry in part on leasing facilities from an incumbent, rather than facing the entire entry cost of rolling their own facilities from the start. From the perspective of the incumbent, however, there was no "cost" in terms of investment incentives, because this was a government provider, investing government funds, without reference to likely long term competitive abilities. The most we can say from the South Korean experience, then, is that leased access to incumbent facilities spurred new entry; that the new entrant was the more innovative, just as Softbank Yahoo!BB had been in Japan, and that this entry spurred competition in the market and its transition to DSL. We cannot make a full assessment because the incumbent sharing the lines did not internalize the cost of the regulation, and so the theoretically predicted negative effects on it were not brought to bear on the outcome.

The second element from South Korea's first generation transition that bears on the access question is the role of collocation agreements with apartment complexes. What had killed Tokyo Metallic in 1999 was its inability to collocate—to put its electronics sufficiently within the network of the incumbent that it could efficiently deliver service to customers. In South Korea, however, large portions of the population live in huge apartment blocks, covering hundreds or even thousands of families. Unlike in practically every other country, in South Korea the apartment building owners locate and own the small exchanges for the building. The new entrants could, thus, enter into agreements with the apartment block owners to collocate their facilities on the premises. The South Korean government amplified this effect by creating as part of its Internet deployment strategy a building certification program, in which it granted certification to buildings as "connected" when they had high capacity wiring installed. The size of the multi-dwelling units makes access to their inside wiring the practical equivalent, in American or European terms, to a neighborhood developer or association owning the neighborhood fiber closet, rather than the incumbent doing so. They provided ample physical space to accommodate new entrants,

54 Kushida and Oh, supra; Izui Aizu, A Comparative Study of Broadband in Asia: Deployment and Policy, 2002

and had every incentive in the world to do so in order to introduce competition in telecommunications services for the neighborhood, or the building. The practical effect of the legal and urban design background facts was to replicate what required collocation rules to be put into effect in Japan, or, as we will see, in Europe. On a much smaller scale, achieving this in-building collocation and sharing of connection points for fiber is one of the regulatory reforms introduced in the past year in France.

Finally, as in Japan, in the last year the South Korean market has seen a substantial move toward fixed-mobile convergence. Mobile broadband leader SKT purchased the successor to Hanaro, SK Broadband. KT merged with the second largest mobile broadband provider, KFT. As a condition for approving these mergers, which cover over 80% of the wireless market and close to 70% of the fixed broadband market, each of the new merged entities will have to provide open access to its mobile data network. Because these orders are all from the first half of 2009, it is too soon to tell how, precisely, they will be implemented, and what effect they will in fact have on the ability of competitors to compete in handsets, network components, or value added services higher up in the stack. The development does suggest, however, increasing integration between fixed and mobile networks, consistent with the shift to a focus on ubiquity.

Core lessons from South Korea

- Large coordinated investment, much of it public, and high-density urban cores may confound any serious possibility of importing insights from South Korea. All other lessons should be taken with caution.

- The major market driver during the first transition was the introduction of new entrants, at least one of which relied on leased access to the plant of a government-owned cable incumbent. From the entrant's perspective it functioned as unbundled networks, or access to passive elements of a fiber network would. From the incumbent's perspective it functioned very differently because the incumbent here was government owned and not in the business of broadband provision.

- South Korea has had substantial facilities-based competition from cable and electricity.

- South Korea, like Japan, has begun to expand open access to its mobile data networks, while at the same time permitting its dominant players to integrate across the fixed-mobile connection.

4.6 The highest performers in Europe: Mid-sized, relatively homogeneous societies with (possibly) less contentious incumbents: the Nordic Countries and the Netherlands

The Nordic countries occupy five of the top 8 positions in penetration per 100 inhabitants, despite their low density and urbanicity. The Netherlands occupies the second position by that measure. By our own, more detailed and balanced measures, Norway and Iceland slip because of higher prices, but Sweden, Denmark, Finland, and the Netherlands occupy four of the top quintile spots, together with Japan and South Korea. High per capita GDP and median income, high education, low inequality all likely contribute to this performance, as does government investment in Sweden and to some extent the Netherlands. Iceland has a very small population which is extremely concentrated and urban, and we exclude it from our detailed studies here.

The four Nordic countries are reported to have had relatively smooth transitions from national ownership to privatized competition, in all cases with incumbents required to share their facilities with

entrants. Finland's market began with several regional monopolies rather than a single national monopoly, and has therefore had a different trajectory to competition. The Netherlands had what appears to be a bumpier implementation, but still smooth by comparison to the larger countries like France and Germany. We report here in some detail the particulars of the market conditions in each, because the details explain, much better than theory, how unbundling in the context of a smoothly regulated environment works.

4.6.1 The Nordic Countries: Cross platform competition and "investment ladder" through entrepreneurial entrants being bought out by neighboring national incumbents

In Denmark, Norway, and Sweden, unbundling and open access worked exactly as they "should" have, according to the underlying theory that supported unbundling. Innovative entrants opened up markets; some continued to operate; others were bought out by pan-European or pan-Nordic players and became the basis for entry by those players. The risks—that incumbents would disinvest, that entrants would never graduate to independent competitors—did not materialize. Finland is the outlier, and a puzzle. While it passed unbundling and enforced it, as best we can observe, unbundling has played little role in its development. Finland's fixed-line competition seemed to have developed from the former regional and national telephone monopolists entering the more densely populated parts of their rival's territories with their own fixed-line plant. More recently, these incumbent-entrants seem to have shifted to extending their reach through mobile broadband only, placing Finland in what its government considers a mini-crisis on long-term growth and spurring plans for government investment in less densely populated areas.

The Nordic countries appear to represent the case that a well functioning unbundling and open access regulatory regime, combined with well functioning markets and facilities-based competition, create a competitive market and deliver high levels of penetration and quality at, mostly, reasonable prices. Competition occurs between companies that each compete across multiple platforms, not between companies that use different platforms. Investment and expansion are opportunistic, wherever there is capacity to be bought or built, and companies mix-and-match unbundled and own copper with cable and fiber.

4.6.2 Denmark

Denmark introduced local loop unbundling in 1998. The primary sources of competition to the privatized former state company, TDC, are now owned by the privatized former national operators in the other three Nordic countries: the Swedish-Finnish merged incumbents, TeliaSonera, and the Norwegian Telenor. These large competitors entered the market in the last few years, in large part by acquiring local entrants that had begun to operate through local loop unbundling and bitstream access.

Telenor entered the Danish market by purchasing Danish DSL providers, Cybercity and Tele2, both of whom had their roots in unbundled and bitstream access. Cybercity was a dial-up ISP founded in 1995. It moved to provide broadband primarily over unbundled loops, and to a lesser extent over bitstream access, until it was acquired by Telenor in 2005. Tele2 was a Swedish company that launched voice telephony services in 1996. It entered the DSL market by purchasing Tiscali in 2003. Tiscali had been a competitive ISP that built its business model on local loop unbundling where it was available, in relatively high-revenue areas. By the time it was purchased by Tele2 in 2003, it was one of Denmark's leading four providers. Telenor bought Tele2 in 2007. TeliaSonera entered the Danish market through a combination of cable facilities-based competition and unbundled access. First, it entered in part by purchase of cable company Stofa. It also did so in part by purchasing DLG-Tele, an agricultural

cooperative that had entered the fixed telephony and DSL markets after the 1996 privatization and introduction of unbundling.

Danish competition today is a composite of large incumbents from neighboring countries entering each other's territories, buying up both copper and cable lines, rolling their own fiber as well. The DSL side of the story very much depends on unbundling, and fits the "investment ladder" story about unbundling, although with a twist. Unbundling attracted entrants like CyberCity or Tiscali. They used it to establish a customer base and presence, generated some competition to the incumbent (these entrants occupied on the order of 15% of the market) and ultimately, as the market matured, were purchased by larger established competitors who could combine these customers with their own infrastructure.[55] At the same time, however, competition developed over cable. But just like the entrants, here too the incumbent, TDC, owned both copper and cable. What we see in Denmark, then, is competition that includes cross-technology competition, but it is not run by a monopolist in either technology. Instead, each of the major competitors buys different bits and pieces of existing companies, using various technologies, to create coverage. Like the Japanese story, the Danish story is an "and/both" story. Competition developed both within each technological platform, and across platforms; to some extent benefiting from unbundling when it was available, and to some extent benefiting from relatively low levels of investment necessary to upgrade an existing infrastructure like cable, or, in Japan, using power ducts.

4.6.3 Sweden

Sweden introduced local loop unbundling in January of 2001. It also has large public investments and over 200 municipal initiatives. It has the highest fiber penetration of all the Nordic countries, and is behind only Japan and South Korea in levels of fiber deployment. The incumbent, TeliaSonera, is the largest broadband provider in the country, with about 40% of the market. While it accepted the regulator's requirement that it unbundle its copper loop, it fought the requirement that it offer unbundled bitstream access until it ultimately lost its appeals in 2007. As in Denmark, Telenor has moved in to become the second largest broadband provider (21.5%), competing with TeliaSonera throughout the country. As in Denmark, Telenor did so by buying several entrants, some of whom relied exclusively on unbundling to start up and build a customer base.

Telenor entered the Swedish residential market by buying a large block in Glocalnet. Glocalnet was launched in 1998 as a voice competitor, using wholesale purchase and repackaging voice, and then moved to offer broadband over unbundled copper from TeliaSonera. Telenor purchased Glocalnet, which now covers 90% of Swedish homes through unbundled DSL, in 2003. Telenor bought Bredbandsbolaget (B2 Bredband) in 2005, which by then was Sweden's second largest broadband provider. B2 Bredband itself bought unbundling-based provider BoStream a year earlier. B2 Bredband combined unbundled DSL with fiber over its own facilities to businesses and high end users. Telenor later bought Spray from Lycos. In all, Telenor combined, over the course of four years, several entrants, all of which depended either fully or mostly on unbundling to launch and sustain their business. It continues to combine both owned facilities, particularly fiber, and unbundled copper loop. In 2006-2007 Glocalnet launched Wi-Fi mesh networks in 24 cities, called "Glocalzone," and agreed with a pan-European hotspot provider, the Cloud, to roll out 800 hotspots in Sweden and give its subscribers access to 8000 hotspots throughout Europe. Telenor now bundles access to hotspots in Sweden's 20 largest cities with its mobile broadband offerings on the cellular side. Telenor also bought nationwide WiMax licenses in the 3.6-3.8GHz and in the 2.6Ghz bands in 2007 and 2008. The third largest broadband

55 Sources: Broadband Prices in Nordic Countries; Market research using GlobalComms and various news reports.

provider is Com Hem, which offers a cable alternative, covering 18% of the market. It represents the straight facilities-based, cable alternative.

The fourth provider, with 15.4% of the market, is Tele2, which launched in 1991 as the first dial-up ISP in Sweden. Tele2 combines all three major avenues for fixed broadband networks. It offers DSL service over unbundled local loop that it acquires from TeliaSonera. It increased its investment in these unbundled networks in 2005 to the point that since 2006 it has been selling access to components of unbundled local loops that it installed and owns to other providers, alongside its own retail services. It is also Sweden's third largest cable company, and offers broadband and triple play over its cable network. Finally, given the high level of municipal fiber networks in Sweden, Tele2 has fiber and fiber/DSL combination networks as the contracted provider in 30 municipal fiber networks throughout Sweden. More generally, Tele2 has focused on selling to government purchasers, as well as businesses, as an independent line of investment. Finally, Tele2 purchased nationwide WiMax licenses in May 2008, and plans to roll out WiMax networks to complement its other strategies.

Convinced by the perceived success of unbundling in fostering competition, investment, and innovation in its broadband markets, concerned about managing the transition to next generation networks, and possibly smarting from the long fought battle over bitstream access, the Swedish regulator PTS concluded that it would best manage the transition to next generation connectivity by imposing functional separation on its incumbent.[56] The PTS then "leaned" on TeliaSonera to accept functional separation in June of 2007. In September of that year, TeliaSonera announced its agreement, and by January 1, 2008, it formed TeliaSonera Skanova Access to provide services to its wholesale customers. In March 2008 the government proposed a bill that formalized the action by empowering the regulator to require functional separation; in the summer of 2008 legal guidelines implementing the law were put into effect.[57]

4.6.4 Norway

While Norway ranks high on penetration per 100, its overall performance based on our multidimensional benchmarking here is lower than that of the other Nordic countries. Norway introduced unbundling in 2001. The incumbent Telenor serves half the broadband market. The second largest broadband provider is NextGenTel, which was bought by TeliaSonera in 2006 and now has a 10% market share. NextGenTel was launched as a business-oriented ISP in March 2000, and expanded to the residential market using unbundled copper loops and bitstream access from Telenor, after the introduction of local loop unbundling. NextGenTel also owns and operates WiMax networks in some of Norway's harder-to-reach areas. TDC has also entered Norway, but has focused on providing high-end connectivity to businesses over its own facilities. In the broader broadband market, therefore, NextGenTel is followed by a clutch of smaller, 5-7% of market share sized competitors: Get, Ventelo/Norge, and Tele2 Norge.

Telenor's competitors are made up of both cable operators and entrants who, like NextGenTel, built their networks on unbundled elements. Get is the main competitor to Telenor's cable system, Canal Digital Kabel, and reaches about 7% of Norway's broadband market over its cable systems. Another of the 5-10% market share competitors is Tele2. In Norway, Tele2 is a subsidiary of the Swedish Tele2 (the Danish Tele2 subsidiary was bought by Telenor.), and was launched as a dial-up ISP in 1997. In August 2002 it began to offer DSL using wholesale access as a complement to voice telephony, which it also

56 http://www.pts.se/upload/Rapporter/Tele/2007/EN/Improved_broadband_competition_through_functional_separation_2007_18.pdf.

57 GlobalComms Sweden Country profile.

was offering on a resale model. In 2005 it began to roll out its own DSL service using unbundled elements, and in 2008 to switch customers over to its own facilities. This pattern of investment fits the investment ladder model, but may also be driven by the absence of wholesale bitstream access price regulation in Norway. At the same time, the absence of bistream access price regulation may contribute to the fact that Norway's prices are substantially higher than they are in the other Nordic countries. The third competitor in this cluster is Ventelo/Norge, a composite of a business-focused provider and two earlier entrants, BlueCom and Catch. While it is clear that the company combines own-infrastructure with unbundled and wholesale bitstream, as did its predecessors, the details are difficult to tease out. It appears that, like NextGenTel and Tele2, Venetelo/Norge also is built of a composite that, at least insofar as its residential business goes, was built on unbundling, bitstream, and wholesale access.

4.6.5 Finland

Finland was the first Nordic country to introduce unbundling, in 1996. Unbundling seems to have had little or no effect in the Finnish market, however. First, Finland's old telecommunications system was different from those of other European countries. It had a single long-distance and international monopoly, Sonera, which in 2002 combined with Swedish monopoly Telia to form TeliaSonera. It also had 27 local phone monopolies. Of these, two, Elisa and DNA, now operate as independent players. The other former local monopolies form the Finnet Group. Finland also has a cable company, Welho, which provides broadband, but covers less than 7% of the market. The aggregate national market is not highly concentrated. Elisa, the former local monopoly in Helsinki, is the largest, and TeliaSonera, the former long-distance monopolist, each has slightly less than 30% of the broadband market. The remainder is split between DNA, Finnet, and Welho. Because all of these players are former local monopolists, each is the incumbent in its own area. They then appear to selectively enter each other's markets: In Helsinki, Espoo, and Vantaa, it would be Elisa, TeliaSonera, and Welho, while in Oulu, a historically DNA incumbency, it would be Elisa, TeliaSonera, and DNA, and so forth for the various Finnet Group members. In the discussion of the Canadian market below, we see that a similar structure, where former incumbents can enter each other's markets, has not in fact resulted in significant competition. In Finland, on the other hand, it does appear likely that competition has indeed emerged. Finland has a high level of penetration, at some of the highest speeds available in the world, at prices that are among the five best prices, in every single speed range, in the OECD. Moreover, as we observe in our company-level pricing study (See Fig. 4.2), Elisa and TeliaSonera Finland have practically identical offerings at the very high speed tiers, which are in the same highest-speed level, low prices as the entrants (but not KT) in South Korea and France Telecom, and only somewhat higher prices than in Japan, France (entrants only), and Sweden (entrants). It is possible, however, that the impetus for this has been the high levels of investment and penetration of wireless mobile networks: Over 85% of the country is covered by 3.5G networks. Concerned that broadband providers would fail to invest further in fixed technology and rely too heavily on wireless mobile broadband that will not lead to sufficient long-term capacity, the government of Finland passed a resolution in September of 2008 committing to deliver 100 Mbps service to 99% of permanent residences by 2015. The practical consequence is a commitment to invest in government subsidies, where necessary, to reach that goal where market conditions appear not to be leading in that direction.

4.6.6 The Netherlands: From unbundling and facilities-based competition to shared next generation infrastructure

The Netherlands offers a case where facilities-based competitors use the incumbent's unbundled network elements to extend their reach, and offers particularly interesting observations about current approaches to competitors sharing capacity of newly constructed fiber plant on an open access model. The Dutch

experience combines substantial facilities-based competition with relatively early availability of unbundled access to drive competition.

The Netherlands has a very high level of cable penetration. Cable providers began to provide broadband early on. Cable broadband providers Zesko and UPC account for 36% of the market.

Competitive DSL providers seem to rely heavily on their own middle-mile facilities-based infrastructure, combined with last mile unbundled local loop from the incumbent KPN. Tele2-Versatel uses backhaul facilities from its telephony side, Versatel. A second DSL provider, BBned began to offer an alternative partial-facilities-based competitor as early as 2000, over its own telecommunications infrastructure, as well as offer its network for other providers to use on a wholesale basis. BBned is now owned by Telecom Italia, which uses its network to offer triple-play offerings, and offers DSL as BBned and Alice. Online is another provider, a subsidiary of T-Mobile Netherlands (that is, a subsidiary of Deutsche Telekom). Much of the competition in the broadband market is between different brands managed by discrete wholly-owned subsidiaries of KPN, which use the parent's network. The same was true for a while for the major cable provider, Zesko, until it began to consolidate its brand as Ziggo.

The presence of substantial facilities-based investment in the middle mile is complemented by unbundling in the last mile. KPN reported in the last year 3.7 million unbundled loops at Main Distribution Frames and 800,000 at the cabinet. Negotiations over next generation network deployment in 2007-2009 focused on how to retire 1,400 exchanges at which KPN competitors had collocated facilities. These data strongly support the conclusion that the DSL competitors combined their facilities with KPN's local loop through unbundling.

The Dutch experience seems, then, to suggest a clear example of a context in which unbundling complements facilities-based investment and competition. Current investment plans and agreements for the fiber transition suggest that this pattern of investment by both incumbents and entrants around a shared core set of facilities will continue.

OPTA, the Dutch regulator, is the first regulator in Europe to have implemented a requirement for fiber unbundling on regulated terms.[58] OPTA uses a price-cap approach, subject to three-year review, with levels backed out of the business case of KPN and Reggefiber (below) with an explicit commitment to leave enough headroom to make the positive business case for investing in an open fiber network. OPTA also set a deadline for KPN to reach agreement with its competitors on how it was to transition its network to next generation access, including the open access element, or face an OPTA-designed plan.

In 2008 telecommunications incumbent KPN responded by announcing a plan to roll out its next generation network on an open access model, using a joint venture to spread the risk and separate the functions of wholesale access for providers from retail. KPN concluded memoranda of understanding with Tele2-Versatel, BBned, and Orange Netherlands (which is moving from mobile to DSL to take advantage of fixed-mobile convergence) on the terms of next generation roll out and the sharing of facilities. The core of the plan, as it has been implemented since 2008, seems to be a self-imposed quasi-structural separation. In November of 2008 KPN entered an agreement with a private company that had been working on municipal and utility fiber deployments, Reggefiber, to deploy the fiber infrastructure in a number of towns and retain ownership in the cable. KPN will apparently own 41% of the stock of the new venture, which is expected to invest 6-7 billion Euro in rolling fiber out to the home, mostly using point-to-point topology, with occasional uses of VDSL2 topology. KPN will then provide service over that platform alongside, and on equal terms with, its competitors. Reggefiber has,

58 ERG (19) 2009. at pp 13, 17.

as part of this effort, increased its share of a public private partnership that was rolling out fiber in Amsterdam, Glasvezelnet Amsterdam (GNA) to 70%, increasing its share by buying shares from the city and housing corporations that are part of the project (see below, section on municipal investments). Unlike Deutsche Telekom, France Telecom, and Bell Canada, which have argued that the investments necessary to deploy next generation infrastructure require that they be allowed to exclude competitors, KPN has used the transition to the next generation of connectivity to decrease its share of the cost and risk in laying out the basic network, and coupled its investment with a structural commitment to implement open access. As in Sweden, and perhaps with Telecom Italia, and unlike in the UK and New Zealand, this was achieved not by explicit regulation, but by agreement between the incumbent and its competitors, backed by the threat of a regulatory solution if no such agreement was reached.

4.6.7 Core lessons from the Nordic countries and Netherlands

1. Facilities-based competition from cable and unbundling-based competition are complementary forms of competitive entry, not substitutes.

2. Entrepreneurial competitors mostly entered through wholesale and unbundling. Their "investment ladder" advancement was facilitated by being purchased by incumbents from nearby countries expanding into neighboring countries. In Finland, where there were several regional incumbents, competition developed through their expansion into each other's territories.

3. Competition occurred between companies across platforms, rather than between platforms where each platform was itself monopoly-owned. Entrants mixed-and-matched low-cost entry strategies whether upgrading cable, partnering with an electric utility, or acquiring an unbundling-based broadband entrant.

4. In Sweden and the Netherlands, the translation of the lessons of the past decade to the next generation transition have taken the form of imposing functional separation on the incumbent as it moves to deploy the next generation network. In both countries that approach was complemented by municipal efforts, as we will discuss in the section on municipal investments.

4.7 The larger European economies: Diverse responses to recalcitrant incumbents

France, Germany, the UK and Italy are much larger countries and economies, with (excepting the Netherlands) more diverse populations. In all of them, dealing with recalcitrant incumbents was a more pronounced part of the story. France and Germany represent in many cases symmetric stories, with a divergence point in 2002-2003 that offers a particularly sharp view of the differing effects of an engaged regulator genuinely improving conditions for competitors. The UK represents a different case yet, with an incumbent that was less directly confrontational, but that effectively succeeded in resisting unbundling until the regulator forced functional separation. Italy rounds out the group with an overall more ambiguous case, where it is unclear that unbundling played much of a role, where fixed broadband penetration is low, despite low prices, and where mobile broadband seems to have taken off and to a great extent substituted for fixed broadband.

4.7.1 France and Germany: Divergent responses to incumbent opposition

Despite having roughly similar GDP per capita (Germany slightly higher) and population concentration (France slightly higher), the two countries present quite different trajectories. In 2002-2003, France revamped its regulatory scheme to emphasize the needs of innovative entrants over those of incumbent

France Telecom. Germany did not. As a result, France Telecom's major competitors have a larger market share than do Deutsche Telekom's, present more entrepreneurial corporate profiles, and are among the most innovative in the world in terms of services and fixed-mobile-nomadic integration.

In 2002, France had half the penetration levels of Germany. Today, the two countries have similar levels of penetration, with France slightly ahead per population and slightly behind per household. In speed, France today is part of the small group of first tier countries with substantial offerings of 100 Mbps service. Four companies are now pulling fiber through Paris. Germany occupies the second tier, where 50Mbps speeds are the highest available residential offering. Average prices are lower in France for every tier of service, from the very low speed offerings to the very high speed offerings, than they are in Germany. France's prices for the mid- to high level offerings (2.5Mbps – 32Mbps) are the lowest in the world, and for the highest speeds tier, its prices are lower than anywhere but Japan. Levels of mobile cellular data access are similar, but nomadic access in France is about two and a half times as widespread as it is in Germany, the result of an innovative business model introduced by the competitors in fixed broadband. In our composite measures, both countries perform better than they are generally perceived to have performed based on the penetration metric alone. France is located in the 7th rank by our measures; Germany shares the 9$^{th/}$ and 10th slots with the UK.

France

If the United States was about a decade ahead of the main body of OECD countries on what we called deregulation and the Europeans call liberalization, France was about a decade behind. Throughout the 1990s, under the governments of both Presidents Mitterrand (left) and Chirac (right), France Telecom (FT) was left very much intact, the state kept a substantial investment in it and dragged its feet on easing competitor entry. In 2001, France's broadband penetration levels were less than one-quarter that of the United States, and about one-third of the average broadband penetration across the OECD countries.[59] Its broadband penetration rate per 100 inhabitants was 15th to the U.S. 4th.[60] In 2003, 86% of FT employees were still civil servants.

The French 1996 Telecommunications Act created the first independent telecommunications sector regulator in France, the ART. The ART was a five member commission whose members could not be removed during their 6 year term. However, the ART was a relatively weak regulator, by the standards of other European countries. Its core regulatory decisions, about network operations, interconnection, etc., required approval by the Minister for Economy, Finance, and Industry before becoming binding. Its decisions could be appealed in court, on both substantive and procedural grounds. FT used this power on several occasions to block ART efforts. On interconnection, the ART for the first few years could act only on complaints, not of its own accord, and its dispute resolution decisions were delayed and slow. As a 2003 OECD assessment of the state of regulatory reform in France put it: "There have been continuing criticisms about certain aspects of the ART's approach to dispute resolution, but the real problem appears to be the number of appeals against ART decisions and the lack of power to enforce decisions or unwillingness to implement sanctions where these are not respected."[61] The primary source of complaints was not so much explicit price abuses, but non-price abuses by FT, such as delays in interconnection and the use of imprecise terms, like using "average" delays rather than clear fixed commitments that would have allowed entrants to plan.

59 OECD, G7 historical penetration rates. http://www.oecd.org/dataoecd/22/14/39574797.xls.
60 OECD Measuring the Information Economy 2002, p. 39.
61 OECD Regulatory Reform in France: Regulatory Reform in the Telecommunications Sector (2003).

Change in France came largely as a result of European Union action. As part of the Lisbon Agenda aimed in part to make Europe "the most dynamic and competitive knowledge-based economy," the European Commission passed a Framework Directive in early 2002,[62] as well as a series of more specific directives, requiring member states, among other things, to adopt wholesale local loop unbundling, bitstream access, and leased lines into national law by July of 2003. Formally, French law had long been in compliance. Unbundling had come into effect in January of 2001. However, the ART did not pre-approve FT's reference offer, and did not effectively enforce it. In 2002 the European Commission brought an infringement action against the ART, forcing action on both requiring a reference offer and regulating the rates. By the end of 2002 France's regulated unbundling and shared access rates dropped, and were the second lowest in the EU, second only to Denmark.[63] Between February 2003 and January 2004, the number of unbundled loops in France grew from practically none to over 250,000.[64] In 2004 the French parliament concluded its revision of French law in response to the European regulatory framework, and approved a new set of powers and reorganization for the ART, which by 2005 concluded its transformation into the current regulator, ARCEP.[65]

Today, FT holds 47% of the French broadband market, has two major competitors, Iliad (Free) (24%) and SFR (with Neuf Cegetel) (22%), and one significant minor fourth, Numericable-Completel (5.5%).

Free built its business primarily through use of unbundled loops, and now combines both its own broadband service and that of Alice, originally Tiscali (a company that built unbundled services in several of the countries we studied), which it purchased from Telecom Italia in 2008. Free began to build its own network in 2000, but took off when it was able to roll out unbundled services in 2003, soon after effective regulations were put in place. It introduced a 30 Euro offering, and has since kept that price while extending the quality of the offerings and making that the reference price of competitive broadband services in France. In 2007, Free announced a municipal partnership with the city of Valenciennes, rolling out a 100Mpbs down / 50Mbps up network. More recently, as part of a Paris fiber project announced earlier, Free formally announced in May of 2008 a collaboration with the real estate industry association in Paris Ile-de-France to promote Free's FttH in buildings. Faced with the fast development of fiber, and with the importance of connections at the building and home level, in August of 2008 the French parliament passed a law requiring new building operators and co-owners to install fiber throughout the building, and to open this fiber plant to any FttH provider that wishes to reach residents. In existing buildings ARCEP has required that FttH providers cooperate to assure minimal disruption in construction while assuring equal access to the last fiber drop to all FttH providers. Free has announced its intentions to invest EUR1 billion by 2012, connecting 4 million French households to its FttH network.

Where it has rolled out fiber, Free offers a triple-plus play package that includes 100Mbs upload/50Mbps download, HDTV (including the ability to upload your own content onto a TV channel that can then be watched by family or friends in other cities), and unlimited voice calling nationally and to 70 international countries for EUR29.99 per month, or about USD32.59 PPP. Customers it reaches over unbundled networks rather than fiber networks receive the triple play offer with 28Mbps service, for the same price. In addition to the triple play packaged recognizable to Americans, Free subscribers also have as part of their package access to Wi-Fi hotspots whenever they are within reach of another Free subscriber's home, because the home Freebox that connects each subscriber to the service also acts as a hotspot for any Free subscriber. The Wi-Fi nomadic capabilities were added to what originally was

62 2002/12/EC.
63 OECD Regulatory Reform in France, Table 3.
64 OECD Regulatory Reform in France, Figure 2.
65 ARCEP timeline, http://www.arcep.fr/index.php?id=13&L=1#11131.

an innovative workaround to the fact that Free had not won any of France's original 3G wireless licenses, and refused to pay the government's reservation price in a later spectrum auction intended to give Free the opportunity to become another mobile broadband provider. In 2006, Free made it possible for users who owned Wi-Fi-enabled cellular handsets to make free calls as long as they were within reach of a Free Wi-Fi hotspot. Another workaround that Free has tried to pursue was its 2005 purchase of Altitude Telecom, the owner of the sole 3.5GHz WiMax license in France.

SFR is a mobile operator, owned by Vivendi Universal and Vodafone. In 2008 it took control of the primary wireline telephony competitor to FT, Neuf Cegetel, which in turn is the result of a 2005 merger between Neuf telecom and Cegetel. A January 2005 report on Neuf's then-proposed introduction of IPTV over DSL, Industry newsletter Light Reading reported: "Talking to Light Reading at last week's TVoverDSL 2005[66] event in Paris, François Paulus, director of the operator's networks division, says Neuf trialed TV-over-DSL in September 2002, but 'we wanted to own the customer, so we waited for unbundling,' which took off in France in 2004."[67] Neuf was described in that publication as "the most aggressive unbundler of the French local loop, having installed its own access equipment in more than 700 local exchanges, covering the majority of the French population." Perhaps the most interesting innovation that the new combined SFR is currently offering as its path to fixed-mobile convergence is its iPhone app, which allows customers to switch seamlessly from its 3G network to Wi-Fi boxes of SFR fixed broadband subscribers. While this may not do much for customers—who subscribe to unlimited data plans anyway—it appears to allow the company to reduce the load on its cellular data network. Neuf Cegetel launched its first fiber offering in 2007, and, like Free, now offers it for EUR29.99.

Numericable is the major cable telephony and broadband company in a country where cable penetration is low. While it covers almost 100% of the cable-served households in France, its share of the broadband market is only 5.5%. In 2008 it sought to expand its broadband coverage by using the Completel unbundled network (the two companies were bought a few months earlier by the Carlyle Group). It now offers broadband speeds of up to 100Mbps over its cable network for EUR19.90, and up to 20Mbps, bundled with television and free unlimited voice calls nationally and to 45 international destinations, over Completel's unbundled network, for EUR29.90.

France Telecom has responded to all this activity with higher investment and lower prices. Its prices are still higher for its triple-play offers than those of Free and SFR (USD48.70PPP for up to 100Mbps) (it also adds a EUR3 per month box rental and a 49EUR deposit on the box). It has increased its announced investment plans in fiber rollout from EUR270 million to between 3 and EUR4.5 billion, but hedged that it would not invest more than 2 billion if it did not attain sufficient market share. Like Free, FT too reached agreement with a major multi-unit building owners' association to install FttH in 800,000 French homes. At least one market analysis credits FT's broadband response as an important part of improving FT's financial performance, stating that "The success here has been attributed in the main to the rapid development of ADSL access, increased revenues gained from unbundling broadband lines and more recently, its commitment to fiber-based ultra-high speed technologies."[68]

Germany

Like France, Germany too was initially reluctant to regulate Deutsche Telekom (DT). As in France, after the formal enactment of access requirements, DT balked and resisted. Unlike France, Germany did not undergo a regulatory reform that realigned the relative power of the regulator and the incumbent.

66 http://www.upperside.fr/tvodsl2005/tvodsl2005intro.htm
67 http://www.lightreading.com/document.asp?doc_id=66872.
68 GlobalComms Company Overview (emphasis added).

Current market analyses of German entrants read very differently than do market analyses of French or Nordic entrants. DT was privatized in 1995, although as recently as 2004 the German government still held over 40% of the company's shares, and continues to be the company's second largest shareholder, owning just under 15% of the shares. The German 1996 Telecommunications Act created a somewhat more powerful regulator than France's original ART, particularly in that the German regulator, RegTP, was independent of any veto power by the Ministry of Economics and Labor. Despite this formal independence, a 2004 review of Germany's policies repeatedly reports concerns by competitors of conflict of interest between the government's interests as a shareholder and its power as regulator. Moreover, as in the United States, DT used judicial review to challenge and delay or prevent most major regulations related to access by, or prices charged to, competitors. In 1998 the RegTP enacted implementing regulations on network access, based on the 1996 Telecommunications Act. Actual implementation was mired in lack of transparent accounting, pricing games (e.g., charging competitors per-minute interconnection charges while offering its own customers low flat-rate DSL services), and long delivery times on competitors' orders (the longest in Europe in the early 2000s, 90 days in Germany to 21 days in France in 2001, which the French ART then required by further reduced to 14 days). When the European Commission brought action under the EU law to force clearer implementation, the German national courts blocked or delayed efforts by the RegTP to bring DT into compliance. Despite the existence of a legal requirement to offer unbundling since 1998, therefore, DT did not actually publish a reference offer until 2002, and then only in response to an enforcement action by the European Commission. The regulatory technique used to determine the rates, however, resulted in DT charging its competitors 13% more for wholesale leased access to its lines than it charged its own retail customers.[69] Again, it took more than another year before DT addressed this imbalance—by raising its retail rates. Germany was also among the last to implement bitstream access, the cheapest method of allowing competitors into the market, in September 2006. This new provision was passed by Germany's by-then reorganized and renamed regulator, the Federal Network Agency, BnetzA.[70] At the same time, however, the German parliament was considering a bill exempting DT from opening its VDSL network to competitors. As a recent market analysis report states: "The German parliament passed the bill in December [2006], stating it was necessary to protect domestic business interests and make DT's investments possible."[71] The European Commission sued the German government in the European Court of Justice after the bill became law in February of 2007, but the proceeding is likely to last until 2010.

Nothing captures the German regulatory experience better than comparing the language in two independent reviews from 2004 and 2008. In 2004, an OECD report on German regulatory reform diplomatically complemented RegTP, but then added: "However, RegTP has been less effective in seeing its decisions implemented and has been reluctant to investigate important issues such as wholesale mobile termination rates. DT has successfully used judicial review of regulatory decisions to delay, indeed block, the enforcement of regulatory decisions. While unbundling of the local loop was mandated back in 1997, through delays in the provision of leased lines, price-squeeze tactics, artificially low retail prices for DSL services, etc., DTAG has virtually precluded competition and retained or even recently established a dominant position such as in broadband services." In September of 2008, an independent review for the British Government, commissioned as part of its next generation planning process, described the experience of next generation access deployment in other countries. It opened its description of France with: "In France, fibre deployment is happening as result of fierce competition in

69 OECD Regulatory Review, p. 29.
70 Communications Outlook 2007.
71 GlobalComms DT Company Overview.

current generation broadband services." The description of Germany in the same report opens with: "In Germany, Deutsche Telekom has been engaged in a debate over regulatory forbearance."[72]

Germany was not able to convert its large installed cable plant, passing over two-thirds of homes, into a substantial source of competition. First, most of the cable plant was owned by DT. It was not until 2003, four years after the European Directive requiring national telecommunications incumbents to divest their cable holdings, that DT in fact sold off its cable holdings. Even then, however, the German regulatory regime for cable continued to impede the creation of effective national competitors over the cable plant. Germany now has no cable-based broadband competitors of significance.

A review of DT's primary competitors suggests that the need to build a facilities-based alternative from the ground up has limited entry to large, locally-anchored networks, and hampered their expansion beyond their original core regions. Two of DT's three primary competitors grew out of regional networks: Vodafone-owned Arcor (13% of the market) originated as a Stuttgart network, and expanded to several other major cities building out its own facilities as it went along. HansNet Telekomunikation (10%) began, and has largely remained, a Hamburg-based regional competitor. Arcor launched its own network for voice competition in 1998, and was bought by UK-based mobile carrier Vodafone in 2000. Its strategy has largely been to deploy its own network, and pursue only interconnection agreements, not unbundling agreements, with DT. In 2000-2001 it tried to roll out wireless broadband networks in 243 license areas, but abandoned the project as infeasible in 2002. In 2004-2005 the company upgraded its DSL facilities to allow faster speeds, and in 2005 re-started an experiment with WiMax in Kaiserslautern, to test whether it could extend its DSL offerings in parts of the town that its network could not reach. In late 2007 Arcor announced plans to invest billions in building its own VDSL network, and at the same time sued DT for its refusal to open up its last mile network. BnetzA found that the delays were a backlog caused by an increased demand among competitors that DT was managing, and then announced that it was abandoning the case because under the threat of suit DT had eliminated the backlog. In late 2008 Arcor began to pilot experiments for a VDSL network in two small towns in Thuringia. In June and July of 2009, DT and Vodafone apparently reached agreement to roll out pilot networks in cooperation in two towns. Arcor announced, however, that it was putting plans to roll out VDSL in other German cities on hold because it was not able to reach agreement with DT on access to DT's local networks in those areas.

HansNet is anchored in Hamburg, where it is a successful regional provider launched in 1995. In 2005 it rolled out broadband in eight major western cities and Berlin, but then abandoned plans to also expand to three eastern cities, citing DT's refusal to open up its nationwide VDSL network to competitors. Since 2006, HansNet has tried to compensate by contracting with other, smaller business oriented networks, Telefonica Deutscheland and QS Communications, to buy unbundled parts of their networks instead. Various public announcements suggest that DT's competitors were discussing combining to build an alternative VDSL network. It is difficult to assess, however, whether these are efforts to pressure DT to open its network, at least on a wholesale basis, and whether DT's announcement in the second quarter of 2009 that it would open its VDSL network on a wholesale basis is a way of staving off alternative investments or diffusing the regulatory pressure from the European Commission.

DT's final major competitor, United was, until recently, the second largest broadband provider. It became so purely be reselling DSL that it bought under very favorable terms from DT between 2004 and 2006. While it is difficult to know with greater precision, the circumstances suggest that DT created those terms so that it could reduce its above-90% market share in the face of potential regulatory pressure. The timing of DT's initial offer of wholesale rates to United is consistent with the negotiations

72 Francesco Caio, The Next Phase of Broadband UK: Action now for long term competitiveness (September 2008)

over the German revision of the telecommunications law. The facts that two years later, in 2006, BnetzA found that DT's terms to United were discriminating against smaller competing ISPs, and that when the discrimination was eliminated United began to shrink, are similarly suggestive. Today United is trying to expand again by reaching resale agreements with Arcor as well as continuing to resell DT services, and by buying up smaller resale ISPs.

Lessons from France and Germany

Germany and France present opposing stories on the role of regulatory engagement and open access obligations. Both countries had politically powerful, entrenched incumbents. Both countries began the 2000s with relatively weak performance in broadband. Both were prodded into action by the European Commission in 2002-2003. France in fact turned around and created an effective regulatory regime that forced FT to open its networks to competitors. These innovative entrants—Free and Neuf Telecom in particular—entered the market aggressively, investing in multiple access technologies, building customer base quickly, and rolling out innovative marketing packages. Germany faltered, permitting the incumbent to delay through court actions and bureaucratic foot dragging. This appears to have created investment uncertainty for its competitive entrants, and limited the primary entry possibilities to relatively large regional providers with, of necessity, a more cautious business mentality. Germany began the year 2002 with double the level of broadband penetration per 100 inhabitants that France had. By 2006 France had slightly overtaken Germany by that measure (although not in penetration per households). Average advertised prices in Germany are substantially higher across every category of service, from very low speeds to very high speeds. France is among the countries in the first tier of speed availability, with substantial availability of 100Mbps service. Germany is in the second tier, with offerings of 50Mbps characterizing the top range available to residential subscribers. A review of the company histories of those companies that generated the competitive environment in the two countries strongly suggests that unbundling and open access played a significant role in entry. A review of the regulatory histories and political economy of the two countries suggests that that difference, in turn, was driven by political will, regulatory engagement, and determination around the implementation of the network access framework that the EC passed in 2002.

Let us be clear: Germany is not in a crisis. Its size and wealth allow it to grow and expand its Internet capabilities nicely relative to much of the rest of the world. Indeed, Germany's penetration levels have grown to a point that in 2007 it outpaced the United States in penetration per 100 inhabitants. Germany's fast Internet residential offerings are every bit as fast as those available in the United States, and prices in Germany are lower than in the United States in every category of service except the very slowest speeds. Together these have meant that Germany's standing in our benchmarking study is better than in the penetration rankings more often used. But as a model for learning about how a country goes about fostering entrepreneurial innovation in network infrastructure for the next generation, France presents a more attractive target for learning than does Germany, which it outperforms in every category of interest.

In conclusion we can summarize the core lessons:

1. Contrary to arguments occasionally made in the United States, former government monopolies, just like private companies, have resisted regulations intended to ease entry by competitors likely to compete away their rents. This resistance comes from both management and unions.

2. Formal adoption of a given regulatory arrangement is not the end of the story. Effective engagement by a regulator, and effective implementation, are critical.

3. Lowering entry barriers by requiring the sale of facilities seems to enable different kinds of entrants than a purely facilities-based market. As in the case of Softbank, the French arrangement attracted entrepreneurial entrants that introduced radically new service models. The German approach, which limited entry to companies able to build their own facilities, seemed to produce more conservative entrants, which had a smaller impact on the market.

4.7.2 United Kingdom: From access to functional separation

In 2001, the United Kingdom's per household and per inhabitant penetration was one-seventh the level of penetration in the United States at that time. Starting from a low level, it is unsurprising that Britain's growth rate was faster, but in the first half of 2005 Britain still had slightly lower levels of penetration than the United States. Since the beginning of 2006 Britain has overtaken the United States in penetration, and is now ranked in the second quintile in both per 100 inhabitant and household penetration. Britain ranks 6th or third in prices for the low, medium, and high speed tiers of service. On the negative side, while BT is investing in new, next generation fiber infrastructure, the UK does not have fiber or really high speed DSL service to speak of. Its sole source of very high speed service is its sole major cable provider, Virgin Media, at 50Mbps.

The UK began its liberalization process earlier than any other country except the United States. Under the government of Prime Minister Margaret Thatcher in the 1980s, Mercury Communications Limited was licensed as a competitor to British Telecom (BT) two years before AT&T was broken up here. For the next decade, Britain had a formal duopoly. The theory behind this arrangement was that having only one competitor to the incumbent BT would allow it to build market share and develop the force necessary to challenge an incumbent as powerful as BT. A more open market would, it was thought, result in several new entrants, none of which would have the necessary scale. In 1984 Oftel, Britain's first independent telecommunications regulator, was created. In 1991 the duopoly policy was reviewed and abandoned. In 1995 Oftel reached an agreement with BT for accounting separation and interconnection, which had their most immediate effect on international calls competition based on access to BT's facilities in 1996. Between 1998 and 2000, Oftel issued a series of reports, and managed a series of consultations, on terms for BT's offering of wholesale access and unbundling. Initially, Oftel and BT were planning to include only wholesale access, but in response to the EU process that later produced the 2002 Directives discussed in the context of France and Germany, Oftel expanded the process to encompass local loop unbundling as well.

The unbundling process initially involved substantial consultation and negotiation. First, a one-year process of consultation from late 1998 to late 1999 resulted in an Oftel policy statement on access to bandwidth, slated to take effect 18 months later, in July 2001. The interim period was used for industry groups to meet and negotiate terms, locations, and methods of managing orders, with Oftel's apparently intensive engagement in facilitating the process. During 2000, the operators tried to negotiate the pace and locations at which collocation and unbundling would occur; BT invited offers, and then firm offers, and negotiated prioritization and locations of servicing these offers. Despite this persistent effort to facilitate agreement, industry actors in fact failed to agree on the program. Oftel found that it was forced to step in and make specific determination on points of disagreement. When some of the promised entrant offers did not materialize, the industry groups, with Oftel's active engagement, tried to restructure the locations targeted for roll out so as to assure a sufficient level of offers at relevant locations. By April 2001, the managed process of introduction of unbundling was suspended.

Oftel had found itself drawn in to levels of intervention in unbundling that it had not experienced or needed in other matters since the mid-1990s.[73] In 2002 and 2003, the British parliament passed two laws to reform British telecommunications law and its regulatory structure, creating the new Ofcom and defining its powers.[74] Ofcom began a process entitled the Strategic Review of Telecommunications in December of 2003, which it concluded in September of 2005. Its conclusion radically changed the legal demands on BT. At that point, BT signed a binding undertaking that placed the United Kingdom in a class of its own in terms of regulatory strategy. The undertaking imposed functional separation between BT's wholesale inputs business—that is, the business of selling those aspects of its network that are only used by telecommunications carriers—and its retail operations. The undertaking created Openreach, whose operations were separate from BT's, and which was under the obligation to deliver equal access under a concept called: "Equivalence of Inputs" (EOI). When Openreach delivers inputs–such as network elements–to other parts of BT, it must do so using the same systems, under the same terms, with the same timescales, as they provide them to all other non-BT carriers. This strategy is now being widely considered in Europe, and has since been adopted in New Zealand and Sweden, functionally implemented in the Netherlands and Italy and, more recently, announced in Australia.

Functional separation is intended to serve two functions. First, it creates a discrete unit whose incentives are simply to sell network inputs to whoever wants them. Because of the separation, it is expected to be neutral–in the business interest sense–among its customers, and has no reason to prefer BT over the competitors. Second, it is easier to monitor and benchmark its transactions, because these all occur at arms length—both with non-BT parties and with BT. The combined effect of the shift in incentives and ease of monitoring is expected to make a functionally separated network management unit a good remedy for a recalcitrant incumbent.

Following and in anticipation of this decision, several ISPs moved to increase their broadband capabilities relying on unbundling. In 2005 TV giant BSkyB bought the Easynet Group, offered free broadband to all its satellite TV subscribers and began to invest in and expand its LLU-based offerings. By 2009 it had close to 12% of the UK market, which it served by using close to 1200 unbundled exchanges. Italian-owned Tiscali UK began to migrate its wholesale broadband customers to unbundled networks in 2005 as well. In 2007 it expanded by buying Pipex Communications, and now has over 8% of the British market, and is in the midst of being purchased by Carphone Warehouse, a deal that will make the latter Britain's largest competitor to BT. Carphone Warehouse, as its name suggests, began its way as a reseller of mobile phone products, and later expanded as a reseller of fixed telephony capacity. In December of 2005 Carphone Warehouse bought Onetel, a broadband provider owned by a British energy company. It also bought the UK assets of Tele2 from Sweden. In October of 2006, Carphone Warehouse bought out the UK operations of AOL. Throughout this period Carphone Warehouse had been investing in building up unbundled local loop capacity, and by March of 2009 78% of its customers were served using combinations of its own investments and unbundled loops. In total, Britain's competitor-entrants who based their service on unbundled elements make up the largest components of the British market, for a total of over 36% of the broadband market. BT is second with 27%. Another 23% are served by Virgin Media, which consolidated several cable competitors and offers coverage to about 50% of UK homes over its cable system.

In its May 2009 review of the results of functional separation, Ofcom underscored several results it viewed as pertinent.[75] At the most basic level, the price of a basket of residential broadband services decreased by 16.3% per year between 2005 and 2007. Local loop unbundling became much more

73 All this from the 2002 OECD paper on regulator reform in telecomms in UK.
74 The Office of Communications Act of 2002 created Ofcom, and the Communications Act of 2003 defined its powers.
75 Ofcom. Impact of the Strategic Review of Telecommunications. May 2009.

efficiently provisioned. In the third quarter of 2005, just before the introduction of functional separation, competitors were leasing 200,000 lines under LLU. By the end of 2008 that number had risen to 5,500,000, and accounted for one third of all fixed broadband connections in Britain. LLU, which, recall, is the mode of sharing infrastructure with competitors that calls for more co-investment on the part of the competitors than wholesale or bitstream access, grew in part at the expense of bitstream access. During that three year period the number of houses in Britain that had access to at least one competing LLU-based operator rose from 40% to 83%, and these competitors were investing more in being able to take advantage of the newly-available network elements. BT, in turn, had announced new investments of 1.5 billion GBP in upgrading its network to next generation access services to deliver 40Mbps service to 40% of British homes by 2012. The Ofcom review is comprehensive and professional. It addresses consumer and business market uptake and satisfaction, as well as investment patterns by both incumbents and entrants. Given these results, Ofcom decided to retain the core features of its 2005 decision, with continuous monitoring and relatively small-scale course corrections and targeted adjustments.

From the perspective of the potential role of cable as a source of market competition, the British experience is an intermediate case between the U.S. and France. Unlike France, Britain has a significant cable network. It could, in principle, have been a candidate for regulatory abstention in the name of an effort to support intermodal competition between cable and telephone infrastructure. Instead, Ofcom chose a "both" approach. It enabled competition over the telecommunications/telephone network through unbundling, implemented by functional separation, while also preserving an opening for cable competition. The result has been a three- or more way competition in parts of the country covered by Virgin Media, and a two to three way competition in other parts where BT competes with one or two unbundled providers. Britain's other major cable company, Cable and Wireless, had a couple of false starts in cable broadband, but has not emerged as a major source of broadband alternative service in its service areas. In 2008 there was a brief period when it was thought that Virgin Media would offer services over Cable and Wireless facilities in those parts of the country in which it did not own cable plant. The deal seems to have collapsed, as Virgin Media announced that it decided to focus on upgrading the speed of its services over its own networks.

The UK experience raises various questions. It is fairly clear that aggressive investment to build capacity to use unbundled loops followed the third quarter of 2005, when functional separation was introduced. It is clear that this period of investment introduced new competitors, increased penetration, and decreased prices. It is also clear that cable offered a competitive alternative as well, although the UK firms have been late, by comparison to other countries, to introduce very high speed services. Whether a regime that would have applied a similar model to the cable infrastructure would have enabled cable to expand earlier, or whether it would have deterred investments in the first place, remains a matter of speculation. Whether BT's failure to invest in fiber infrastructure until the most recent announcements, and the relative unavailability of very high speed services in the UK is a vindication of the theory that unbundling deters investment, or whether Virgin Media's and BT's current investments in the face of very robust competition from entrants vindicate the idea that robust competition from entrants drives the facilities-based players to seek to differentiate themselves by even higher-capacity offerings, is also a matter for speculation.

Lessons from the United Kingdom

- Unbundling and open access are difficult to enforce

- Functional separation is a potential solution to this difficulty. It requires less direct monitoring

of, and intervention in, the day-to-day operations of the dominant incumbent

- The introduction of functional separation had a much more significant effect than the introduction of formal unbundling without effective enforcement

4.7.3 Italy: Low penetration, low prices, high mobile broadband

Italy represents an ambiguous case. It has among the lowest penetration rate per 100 inhabitants in fixed lines, and even lower standings in terms of per household penetration. On the other hand, it has low prices in every category of service, according to both the OECD price study and our own independent study, except that there are no very-high speed offerings in Italy. Italy also has the highest rate of mobile phone penetration in the OECD (although this number is skewed by the high use of pre-paid accounts, which are counted on a per-account as opposed to a per-person basis, and there is therefore well over 140% penetration). It has the fifth highest level of 3G penetration, although it was fourth in 2008, overtaken by Iceland this year, and the several countries right behind it had 3G penetration growth rates between two and three times higher than Italy's 20% growth.

Italy has no cable market to provide a source of facilities-based competition. Telecom Italia has 60% of the broadband market. Swisscom subsidiary FastWeb (13.4%), and independent entrants Wind (12.6%) and Tiscali (4.8%) are the other competitors of discernible size. Italy introduced unbundling formally in 2001, but revamped its structure, improved enforcement, and allowed for partial unbundling with the passage of the Electronic Communications Code in September of 2004, which was Italy's effort to implement the EU Framework Directive and other access directives. The regulated rates for unbundling in Italy are among the lowest in the world, and are almost as low as the rates in South Korea and Denmark, in terms of PPP. Wind explicitly emphasizes its reliance on unbundled loops. It accounted for 1.04 million unbundled DSL lines out of the 1.38 million unbundled DSL lines that Telecom Italia sold in 2008. Wind has its own national fiber-optic network, and metropolitan area fiber networks in 39 cities. It has announced plans to invest in, but does not yet supply, fiber-to-the-home services. Tiscali does not emphasize this avenue, but its precise mix of own- and unbundled facilities is unclear. FastWeb has concentrated on building an alternative infrastructure, focusing on business customers first (who accounted for 60% of its total sales in the first quarter of 2009). It had rolled out infrastructure in 100 towns in Italy by the end of 2006, where it offers DSL and FttH. It is unclear how much of its entire subscriber base is served by using Telecom Italia's infrastructure.

The Italian regulator began to consider whether to impose functional separation on Telecom Italia in 2006, in order to improve the quality of competitors' access to its facilities. In February of 2008, Telecom Italia announced its plans for functional separation to preempt regulatory action.[76] It was not until the end of 2008 that Agcom approved the details of the proposed separate division, Open Access.[77] At the same time, Agcom approved an increase in the rates for unbundling, although even these new, higher rates, remain among the lowest in the OECD. It is therefore too soon to tell whether the new arrangement will have any effect, and if so, in what direction. Looking forward to next generation deployment, FastWeb has indicated that it has agreed with Telecom Italia to build out in coordinated fashion, and to share their networks rather than install redundant capacity. This is consistent with Swisscom's strategy in Switzerland, as we describe below. All of these announcements and changes are, however, too recent to permit measurement of their effects.

76 http://www.globalinsight.com/SDA/SDADetail11538.htm.
77 GlobalComms country profile: Italy.

Italy, then, presents an interesting case; its results are mixed. Facilities-based competition is coming not from a relatively low-cost incumbent that already has access to ducts, like an incumbent cable or electric company, but from a business-oriented, cherry-picking technique utilized by FastWeb. Price competition in residential markets is therefore more likely to be coming from the lower cost competitor, Wind. This level of competition seems to be enough to keep prices at a low level, although penetration remains low as well. The other interesting story about Italy is on the wireless side, to which we will return in the next section. A major puzzle remains why Italy's levels of penetration are so low despite its low prices. One might speculate that mobile broadband is more consistent with Italian culture of urban street life, which would account for both the high uptake of mobile broadband and the low uptake of fixed. This would also be consistent with Spain's similar pattern of low fixed, high mobile, broadband penetration. But such a conclusion, without further research, is mere speculation.

4.8 Regulatory abstention (and hesitation): Switzerland, New Zealand, and Canada

The major alternative path to implementing some form of open access or unbundling was to explicitly commit to abstain from doing so. Regulatory abstention would be justified on the basis that it secures investment incentives for incumbents, who would know they can invest in building out their networks without risk of being forced to share the benefits of their investments with competitors. This was the path taken in the United States since the fall of 2001. This was the path taken, most aggressively and purely, by New Zealand from the late 1980s until 2006. More tentatively, but with greater success, this is also the path that describes the Swiss experience. Neither Switzerland nor New Zealand implemented unbundling throughout most of the first generation transition to broadband. Both switched to unbundling and some form of open access in 2006-2007. In New Zealand's case, this was from a sense of failure of the policy. In Switzerland's, the move was the culmination of a long regulatory battle, which ended in introduction of unbundling after Switzerland had already done well, under its first generation policy, along dimensions of penetration and pricing. As we note in our re-analysis and sensitivity testing of the most recent econometric analysis of OECD data below, the statistical uncertainty about the effects of unbundling in the OECD is strongly influenced by Switzerland; in that removing Switzerland reduces the ambiguity and makes unbundling a stronger predictor of penetration. Switzerland has now implemented unbundling, and Swisscom has now developed an innovative model for sharing the costs and benefits of investing in upgrading to fiber-to-the-home. We include a discussion of Canada in this section, even though Canada is not a case of regulatory abstention but of regulatory hesitation. In Canada's case, this meant that unbundling was originally introduced with a limited time horizon and very generous-to-incumbents regulated rates. In 2008, the same policy was extended to fiber, but again, with a limited time horizon. Both in the first generation transition, and today Canada has some of the highest regulated rates for unbundling anywhere in the OECD. Because of these features, Canada looks like a case where the concern for incumbent investment incentives, without quite reaching to the level of abstention, resulted in a weaker version of unbundling than was implemented in many of the other countries we reviewed here.

4.8.1 Switzerland

Switzerland has the fourth highest level of penetration per 100 inhabitants, although its per household penetration is lower. It has relatively low prices for medium and high speed, but higher prices for low speed offerings and no very high-speed offerings. In speed offerings Switzerland ranks in the third quintile of OECD countries for advertised offers, but is in the second quintile for median actually measured speeds. In mobile cellular broadband, 3G penetration is in the third quintile, but Switzerland is a leader in nomadic access and hotspots, sharing with Sweden a much higher level of penetration than

their next-best competitors, the UK and France. In our aggregate measure, Switzerland shows up 8th, lower than it does by the traditionally salient measure, but still a strong performer.

Broadband was launched in Switzerland by Cablecom, and Cablecom (19% of the market) itself, and other local smaller cable companies still occupy over 20% of the market. Cable's entry into broadband forced Swisscom to introduce DSL technology in 2001, and has been the main source of competition. The only other significant competitor (just under 10%) is Sunrise Communications, which is a reseller of Swisscom DSL, and is itself a recent composite of what until recently were the two primary resellers of Swisscom service: TDC Switzerland and Tele2. After unbundling was introduced in 2007, Sunrise, now owned by Denmark's TDC, began to invest in building unbundled local loop capacity, but between 2001 and 2007 the two companies that make up Sunrise relied exclusively on reselling wholesale broadband capacity acquired from Swisscom. Over the years Swisscom has been highly effective at blocking efforts to require that it open its network up to competitors beyond the wholesale access it was making available to Sunrise and similar, smaller resellers. The history of cable entry, the relatively good performance in all but speed, and the long period during which Switzerland had not adopted unbundling, makes the Swiss case the best evidence in support of the argument that competition between cable and telephone incumbents is sufficient to drive investment, penetration, and a modicum of price competition.

There is one potential wrinkle in this story of success without unbundling: that Swisscom operated under steady efforts to impose unbundling for several years before unbundling was actually introduced. Under those circumstances, it is hard to tell *a priori* whether an incumbent would dig its heels in, resist entry, and extract rents for as long as it is able to hold out, or whether it would provide greater openness to competitors and better services, so as to establish the point that the proposed regulation is unnecessary. Our other case studies mostly suggest that the incumbent can be expected to resist entry, rather than try to behave more competitively, but it is at least possible that some of Swisscom's strong performance is explained by efforts to reduce the pressures to regulate it. Such behavior would be consistent with, for example, Deutsche Telekom's apparent offers of unusually good wholesale rates to reseller United, which helped DT reduce its market share during consideration of the new telecommunications law in Germany. Despite this potential confounder, Switzerland does appear to represent the one significant example of high performance under inter-modal competition not complemented by open access.

Swisscom's current plans to invest in upgrading to fiber seem to be driven not by the introduction of unbundling in 2007, which is not applicable to fiber, but by a combination of DOCSIS 3.0 upgrades by cable companies, and early efforts by power companies, like Ewt in Zurich, to enter with their own fiber plant, to be offered to Internet service providers on an open access model. Many of these small electric utilities muscling in to fiber are municipally owned, in whole or in part, and their investments are driven by a commitment to provide core infrastructure that is open, by the will to improve the efficiency of their grids, and by the relatively lower cost of deploying fiber over an existing civil engineering plant—their own power network. This version of the story of next generation investment in Switzerland again lends support to the theory that intermodal competition is sufficient to spur investment, although with some nuance as to the potential role of public investment. However, given that extension of unbundling to fiber is very much a live regulatory debate in Switzerland, and that part of the debate also encompasses expanding the powers of the regulator more generally, it is again somewhat less clear cut of a case than it otherwise would have been. It is possible that Swisscom's current fiber strategy in some measure represents an effort to reduce the risk of regulation by presenting a more attractive profile as a responsible dominant player that acts cooperatively without the need for direct *ex ante* regulation.

Irrespective of what combination of forces precisely is driving it, Swisscom's response to the challenge of transitioning to next generation connectivity has been an innovative and interesting one. While it has not been implemented yet, it has been announced and is apparently being piloted currently. The idea is

to share the large part of the cost—the civil engineering and fiber laying part—by pulling four fibers to every home over the same civil engineering project. Swisscom would keep one fiber and sell/share the others in one of four ways. First, owners of ducts, like cable companies and electric utilities, could each role out similar four-fiber plants in different areas, and then exchange capacity so that each one would own and control a fiber into each home throughout all of the areas connected. If the networks were of largely similar size, they would not pay each other—much like peering arrangements in Internet carriage. Second, companies with the cash up front but without ducts and construction capacity could spread the deployment risk by paying up front for a fiber into the home which, upon completion, would become theirs. Third, companies without ducts or up front cash could later buy access on a distinct passive fiber, which would give them control equivalent to what they would get from unbundled access over copper. And fourth, companies that didn't want any of this could just buy active fiber high speed connectivity capacity wholesale, and resell it to subscribers. The critical idea here is that by pre-positioning distinct, excess passive infrastructure, competitors could credibly commit to share the highest fixed-cost, most future-proof elements in an architecture that would then be hard for them to manipulate anticompetitively. They would then use this architecture to draw investment and spread the cost and risk of next generation deployment. Needless to say, this is not a test that has been run, but it does present an interesting model that is distinct from both the public private partnerships we see in some Swedish and Dutch municipalities, and the functionally-separated single platform provider based on the UK model.

4.8.2 New Zealand

The other country that self-consciously chose not to impose unbundling regulations was New Zealand. New Zealand completed privatization of its nationally-owned incumbent in 1989, and decided not to impose sector-specific regulation, relying instead on general competition law to prevent anticompetitive abuses. Because of its unique approach, it was cited in the late 1990s as a unique example of right-thinking regulatory policy, which depended on the idea that market-driven competition would deliver the goods once regulators simply got out of the way. The desired beneficial results of competition in a liberalized market were not quick to follow. By 2001 New Zealand did decide to implement a sector-specific regime. This new regime, however, was a very reticent one. As late as December 2003 the Commerce Commission in New Zealand explicitly decided not to impose unbundling on Telecom New Zealand, arguing that the cost and risks outweighed the benefits. The only source of competition was TelstraClear, the New Zealand subsidiary of Australian Telstra, which depended on developing its own hybrid fiber-coaxial plant–that is, on cable–and on a non-regulated resale agreement it reached with New Zealand Telecom that allowed it to expand its coverage from its cable customers to a national footprint. The results of this market structure and regulatory approach were not spectacular. Throughout the 2000s, from 2001 up to and including the end of 2006, New Zealand's broadband penetration ranked 21st or 22d in the OECD, ahead of Mexico, Turkey, Greece, the states that had joined the OECD after being set free of the communist bloc—Poland, Hungary, the Czech Republic and the Slovak Republic—and Ireland.

In April of 2006 the New Zealand parliament decided to change direction, proposing new legislation that would impose unbundling requirements on New Zealand Telecom. In November the legislation was further revised to require that the company functionally separate its carriage from its retail services. The new telecommunications law implementing these requirements passed in December of 2006. The network now is subject to unbundling, and Telecom New Zealand has separated into three divisions: Chorus, which is responsible for network infrastructure and upgrading to next generation connectivity, and Telecom Retail and Telecom Wholesale. In anticipation of this legislation, TelstraClear reversed its 2005 statements about withdrawing from its plans to invest beyond its then-existing urban areas (an

announcement one assumes was itself intended to add political pressure to changing the regulatory regime). While TelstraClear originally worked with cable infrastructure, by December of 2008 about 70% of TelstraClear's customers were DSL subscribers. Vodafone, New Zealand's largest mobile phone provider, acquired iHug, a competitive DSL provider, in October of 2006, and began to offer triple-play bundles (fixed, broadband, and mobile) at discounted rates with its mobile offerings. In January of 2008 TelstraClear concluded a new fiber ring on South Island, connecting the island's main towns with its fiber backbone.

These investments by Vodafone and Telstra, combine with rankings data to suggest that the regulatory shift had its intended effect. Between December of 2006, when the new law was enacted, and December of 2008, when the OECD last reported penetration levels, New Zealand's ranking in penetration per 100 had jumped from 22d to 18th, surpassing that of Austria, Italy, Spain, and Portugal. We do not have similarly fresh data on changes in per-household penetration, although in 2006, when New Zealand was 22d in the per-inhabitant ranking, it was 16th in per-household rankings, just behind the United States. We do not have sufficiently comparable household penetration data to establish whether New Zealand saw a similar relative improvement in its ranking in per-household penetration, although one market analysis suggests that it did not.[78] During the period between 2006 and 2008, New Zealand also had by far the largest increase among OECD countries in speeds offered by an incumbent.[79] Prices, on the other hand, dropped only very slightly. We do not have sufficient historical data to compare New Zealand's current performance on our more balanced, multidimensional benchmarks. Like the UK in 2005, separation of network from information services was a critical component of New Zealand's strategy for dealing with a recalcitrant and politically effective incumbent that successfully resisted competition over its network. And, as with the UK in 2005, performance relative to other OECD countries that had not made a similar shift at the same time improved appreciably, at least along the dimensions of penetration per 100 inhabitants and advertised speed.[80]

4.8.3 Canada: Regulatory hesitation and a robust facilities-based alternative

We close our access-related case studies with Canada, a country that represents an ambiguous case. It was a very early broadband adopter, relying primarily on facilities-based competition between cable and incumbent telephone companies. As early as 2000, broadband subscriptions were already 31% of all Internet subscriptions.[81] As if December of 2003, Canada had the second highest level of Internet penetration per 100 inhabitants in the OECD, second only to South Korea, and third highest, after South Korea and Japan, by the per-household measure. At that time, there were 1.29 cable broadband subscribers for every DSL subscriber.

Upon declaring that it is imposing unbundling in 1997, the CRTC announced that it would phase unbundling out by 2002. The thought was that the shadow of removal of the regulatory crutch would lead competitors to invest in their own facilities, but would not deter them from entering the market in the first place. The CRTC also used a price determination method that was different than the approach used by other regulators, relying not on long run incremental cost, but on incremental cost plus a 25% markup to allow the incumbents to make a profit on their unbundled loops. The theory there was to avoid investment disincentives to the incumbents. By 2001, however, unbundling was not being

78 http://www.reuters.com/article/pressRelease/idUS153081+18-Jun-2009+BW20090618.

79 OECD Communications Outlook 2009, Figure 7.12.

80 On our more diverse set of measures, New Zealand does not show up as a particularly strong performer; because we do not have a pre-2006 measurement, however, it is hard to use our measures to show movement between 2006 and 2008, and the relatively old data on households would also tend to mask positive effects of the policy change.

81 CRTC Communications Monitoring Report August 2009). pages 213-226.

adopted. The CRTC then extended unbundling indefinitely. In 2002, it cut back the markup on pricing to 15%, but kept the methodology. In 2008, the CRTC completed a comprehensive review and decided to extend its unbundling rules, and apply them to fiber as well. Again, this determination is subject to phase out, just as the original implementation had been.[82]

The Canadian market is largely typified by facilities-based competition, not by unbundled access. The major players are the former telephone incumbents: Bell Canada (22.44% of the market) and Telus (12.09%), and the major cable companies: Rogers (17.73%) and Shaw (17.76%) in different parts of the English speaking provinces, and Videotron (11.52%) in Quebec. Unlike in Finland, where the former regional monopolists seem to have entered each other's regions, in Canada that trend seemed to have receded after showing some signs of life in the early 2000s.[83] In August 2009 the CRTC reported that the market share of revenue captured by incumbent telecommunications service providers operating outside their territory (residential and business) declined from 23% of market share in 2003 to 12% of market share in 2007. The share of revenues from residential broadband captured by all entrants, both non-incumbents and incumbents out-of-territory efforts, declined from 16% in 2004 to 8% in 2008. These numbers seem to suggest that the early observations of incumbents venturing out of their historical areas have been reversed, and that the incumbents are retrenching in their own historical territories. There are no smaller entrants of note, although there are a couple of hundred smaller ISPs, over half of whom resell ISP services offered by the incumbents, alongside several local utility companies, municipalities, and some ISPs using wireless technologies. None of these has appeared as a substantial competitor to the five major incumbents.

It is not entirely clear why Canada, despite its implementation of local loop unbundling, has seen no competitive entry beyond the incumbents. It is certainly possible that the very early market presence of strong incumbents, in two technologies, crowded the market and deterred investors. It is also possible that Canada's rate regulation approach made a difference. Looking at 2008 data as reported by the OECD, Canada's commitment to a cost-plus-markup approach is uncharacteristic of other countries, where long run costs as well as less crisply defined concepts like "cost orientation plus reasonable profit" (Netherlands) are used. The result, in any event, is that by comparison to high performers for which the OECD reported data in the Communications Outlook 2009, Canada's monthly rates for local loop are high. As of September 2008, the monthly price of an unbundled local loop in Canada, excluding prices for remote areas or the most dense downtown areas, in terms of PPP, was roughly 70% higher than in South Korea and Denmark, almost 50% higher than in Italy, 30% higher than in Japan, France, or Norway, and 25% higher than in Finland or the UK. Indeed, Canada has the highest monthly charge for access to an unbundled local loop of any OECD country. Combined with the presence of strong incumbents and the Canadian regulator's practice of promising to sunset the requirement of opening access to core facilities—originally copper loops, now fiber—it is possible that the investment environment is too expensive and too uncertain for non-incumbent entrants.

The presence of strong facilities-based competition should have, however, obviated concerns about the state of Canadian broadband policy. The CRTC indeed opens its August 2009 Communications Monitoring report with a self-congratulatory reference to the fact that Canada has the highest level of penetration of all the G7 countries. While factually true, an alternative view of Canada's performance might look at several factors. In December of 2003, Canada had the second highest level of broadband penetration per 100, second only to South Korea. By September of 2008, it ranked 10th by the same

82 CRTC 2008 decision.

83 Jerry A. Hausman and J. Gregory Sidak, Did Mandatory Unbundling Achieve its Purpose: Empirical Evidence from Five Countries, MIT Econ. Working Papers No. 04-40, where the authors note the ILEC entry into each other's territories as a hopeful direction for investment in facilities based competition. See at p. 60

measure. Its numbers on speed and price are worse. In terms of top speeds available, Canada ranked 19th in the OECD. In terms of prices, Canada ranks 21st for the lowest speeds and 23d for middling speeds. It ranks next to last in prices of high speeds (only the Slovak Republic has higher prices in that tier of service), and it does not appear in the rankings for prices of very high speeds, because there were no offerings of service speeds of 35Mbps or higher in Canada in September of 2008. Our company-level pricing study for the highest-speed offers in the countries we observe here locates almost all of the Canadian companies in the cluster with the slowest speeds and highest prices. Given these benchmark measures, the lessons of the Canadian experience do not seem as positive as the CRTC report presents them. On our composite measure, Canada occupies the 22nd spot. Early aggressive facilities-based competition certainly made Canada an early starter, but it does not seem to have enabled it to maintain its standing. Indeed, the decline in its standing in its best-performing measure, penetration per 100 inhabitants, was worse over this period (2nd to 10th) than was the decline of U.S. performance by that measure over the same time period (10th to 15th).

4.8.4 Lessons from Switzerland, New Zealand, and Canada

- Switzerland's experience suggests that, under the right conditions, a country can do very well without effectively enforced open access regulation. The clarity of the case is somewhat muddied by the fact that Swisscom operated throughout much of this period under the threat of regulation. Moreover, both our qualitative analysis here and the following econometric analysis strongly suggest that the Swiss experience is unusual.

- The purest form of regulatory abstention was attempted in New Zealand for over a decade and a half. It was considered a failure there, and was reversed 180 degrees in 2006. Early results of the reversal seem to have been quick and positive.

- Both countries that have been the longest standing proponents of regulatory abstention, Switzerland and New Zealand, have now shifted to adopting unbundling.

- In looking forward to the next generation transition, New Zealand is relying on functional separation, while Switzerland's incumbent has developed an innovative voluntary arrangement to share the cost and risk of fiber deployment while securing to competitors access to the new facilities. This approach depends on joint investment in the civil engineering side of the deployment, building substantial over-capacity (four separate fibers to each home) which can then be physically divided among the participating carriers, and virtually divided with later-introduced competitors.

- The Canadian experience suggests, consistent with the experience of the larger European countries, that formal adoption of unbundling is insufficient to achieve competition. In Canada, formal unbundling was coupled with regulatory uncertainty introduced by the threat of sunset, and high regulated rates.

- Like the United States, Canada relies primarily on its strong cable/telecom facilities-based competition, rather than on unbundling-based entry. Its performance has lagged over the past few years, and it is now a fourth quintile performer in capacity and price, and dropped from first to second quintile on penetration between 2003 and 2008.

- The Canadian experience suggest that reliance purely on competition between strong cable incumbents and strong telephony incumbents may be insufficient to sustain high penetration or

achieve high capacity and low competitive prices in the long term.

4.9 Firm-level price and speed data

Our focus throughout this qualitative analysis of the effects of open access has been on the role of particular firms: incumbents, open-access-based entrants, or cable and other facilities-based competitors. We emphasized the ways in which different firms responded to different regulatory interventions, and how each affected the other firms in its market. Here we offer another look into the behavior of firms, through objective measures of price and speed offered. We particularly focus offerings that are farthest along in the transition to next generation connectivity: the highest-end speeds offered by the 59 firms in the countries we studied.

We use company level data reported in the Communications Outlook 2009, as we did in Section 3.6. To these data we add independent pricing data obtained from the GlobalComms database, as we did in Section 3.6., but analyze it at a firm-level resolution. In our own dataset, we take the best prices for the highest-speed offerings in each country, by market share. This allows us to identify what the majority of subscribers in these countries in fact see as the range of prices for high-speed offerings available to them. In this study we included all companies offering very high speed offerings (that is, over 35Mbps), from both the OECD and our own datasets, and added from our own research the best, highest speed offerings from all U.S. providers with more than 2 million subscribers. This biases the results somewhat in favor of the U.S. providers, because our basic data sets, both from the OECD and GlobalComms, do not include very high-speed offerings from major companies that have begun to offer very high speeds in the past 6 months, like Cox, Charter, or Comcast. So we are comparing in these data formal offers from one year ago for other countries, to offers from U.S. firms, a year later. Although the results are therefore somewhat biased in favor of the U.S. companies, they nonetheless allow us to offer a more fine-grained comparison of the relative speed and price offerings of individual companies, which together make up the aggregate. Moreover, the scale is skewed against showing the extraordinarily high performance of K-Opticom, and had we used the method we used for the U.S. firms, we would have a similar offer, slightly lower priced, from KDDI. So the graphic presentation of our data understates the degree to which the low-price, high-speed characteristics of the Japanese market's best offerings outperform the other firms in our dataset.

The data is presented in a graph so that the bottom left hand corner is where slower, more expensive offerings will arise. The upper right hand corner is where faster, cheaper offers are found. These are the two diametrically opposed basins of attraction. The upper left hand corner is where companies that compete primarily on price, not on price-speed combinations, will show up. However, this portion of the graph masks the fact that many of the companies that appear in the upper right hand corner would also appear as very competitive on the upper left hand corner, if we included their lower-tier, slower offers as well as well as their highest-speed offerings. In other words, being “higher” on the left hand than on the right does not mean you really are cheaper across all offerings, only that you do not even have a very high speed offering, and your best speed offering is cheaper than the best very-high speed offering elsewhere.

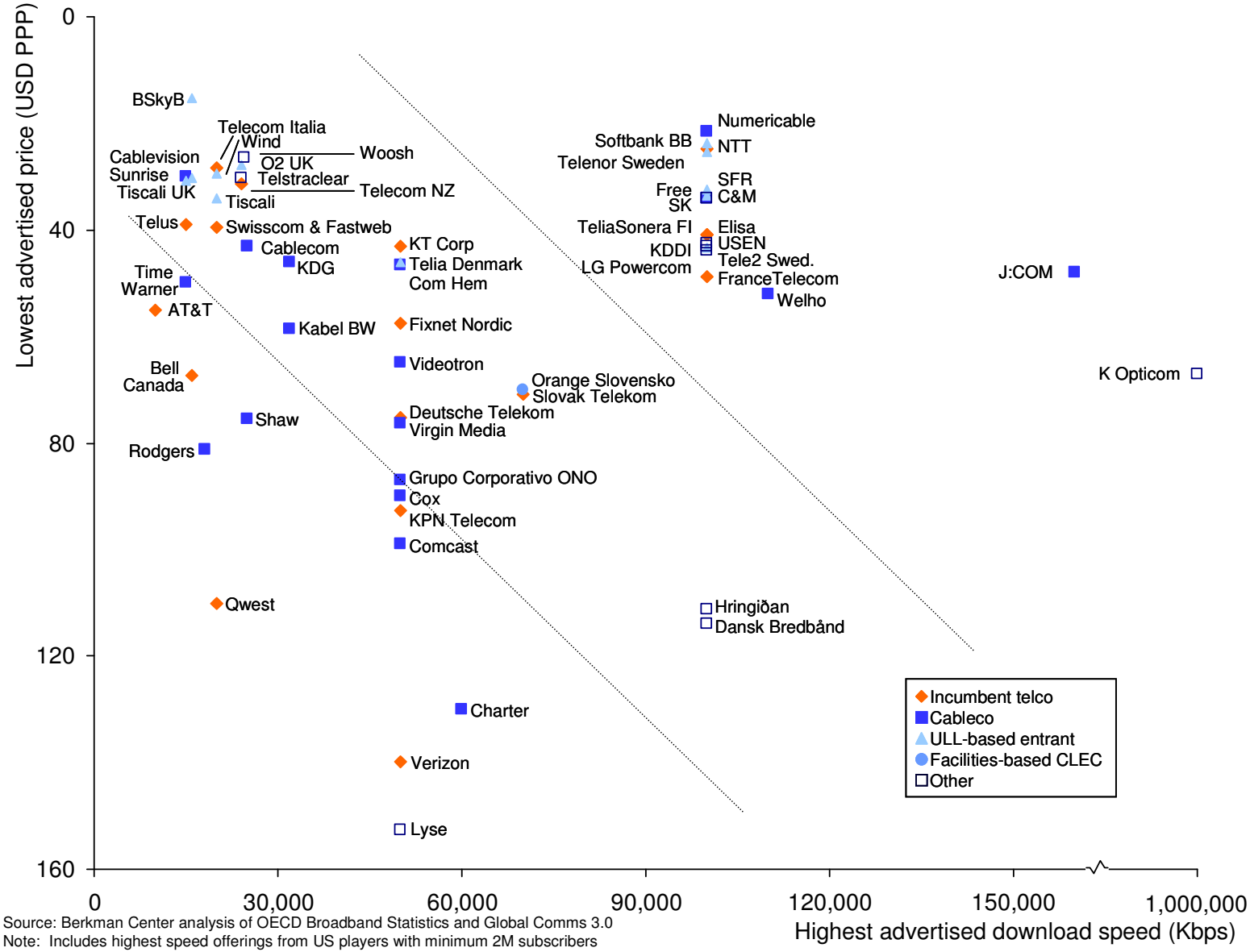
What we find is, unsurprisingly, that companies, rather than technologies, compete. And companies compete against their national competitors, not against hypothetical best performance feasible given a technology. Even though we use newer U.S. data, we find that if we draw a line running from the Y-axis to the X-axis through the offers of Time Warner Cable and Cox, we find to the left and below that line almost all North American companies, except Telus and Cablevision, which have cheaper moderately-high speed offers, and Videotron, which has a moderately priced 50Mbps offering. Only KPN, the

Dutch incumbent, which is slightly below that line, and Lyse, a local utility-based fiber provider in southern Norway, occupy that lower left triangle together with AT&T, Verizon, Qwest, Comcast, Charter, Time Warner, and Cox, from the U.S., and Bell Canada, Shaw, and Rogers, from Canada. All the North American companies below and to the left of that line are incumbent telephone companies and incumbent cable companies functioning in a regulatory system that relies exclusively or primarily on inter-modal competition.

At the other end, we see a natural separation between a middle swath of performers and the cluster of firms that offer high-speed, low-priced offerings. The latter group, in the upper right hand corner, includes unbundling-based providers Free and SFR, alongside their incumbent provider France Telecom and cable competitor Numericable. We see here unbundling-based Softbank offering identical offerings to its incumbent, NTT, joined by KDDI and Usen that seemed to mix existing infrastructure (electric utility and cable, respectively) with unbundling, and cable company J:COM offering 160 Mbps and K-Opticom offering 1GBPs at moderate prices. Next we see unbundling-based Telenor Sweden and Tele2 Sweden, although in our older dataset TeliaSonera Sweden does not join them. However, using the same technique we used for the U.S. firms, TeliaSonera Sweden would have showed up, in its offerings through buildings and municipalities, roughly where TeliaSonera Finland appears. Incumbents TeliaSonera Finland and Elisa are collocated in that corner, as is Finnish cable provider Welho. Similarly, South Korean entrants SK, LG Powercom, and cable provider C&M all show up in the upper right hand corner, although KT appears not to be meeting their price/speed offerings.

The pattern appears to be clear: Firms compete in national markets. Almost all the companies that offer the highest prices for the lowest speeds in our dataset operate in countries that rely on inter-modal competition: the United States and Canada. Companies that are in the upper right corner of the graph hand all function in countries that either clearly enabled some of these particular competitors through effective enforcement of open access—Japan, France, and Sweden—or in countries that enforced open access, but where there are sufficient confounders to make the specific effect of unbundling more ambiguous: South Korea and Finland. The open access countries saw firms adopt unbundling as an entry strategy, and these firms today continue to exist, directly or through successor firms, and continue to offer high speeds at low prices. The difference between offerings of telecommunications and cable providers France Telecom and Numericable, or NTT and J:COM, on the one hand, and Verizon, AT&T, and Qwest, and Comcast, Charter, and Time Warner, on the other hand, may well be the catalytic role played, as we describe in the case studies, by access-based providers like Free and SFR (Neuf Cegetel), or Softbank and KDDI.

Figure 4.2. Best price for highest speed offering



Source: Berkman Center analysis of OECD Broadband Statistics and Global Comms 3.0
Note: Includes highest speed offerings from US players with minimum 2M subscribers

4.10 Econometric analysis

Most of the work on the effects of open access on broadband measures has not relied on the kind of qualitative market and regulatory analysis we have offered here.[84] Instead, it has focused on econometric analysis of the OECD data, generally trying to test whether one of a small number of variables—urban concentration, GDP per capita, education, age, etc., as well as the existence of facilities based competition and unbundling regulations—can explain variation in a given measure of outcomes—penetration per 100 inhabitants. We are cautious about the results of such analyses because of the small number of countries, the small number of observations, the thin specification of the variables, and the potential interaction effects among these variables, as well as other unobserved variables. Nonetheless, this mode of analysis has been an important source of insight and debate, and properly placed in context of the qualitative analysis, can offer valuable insights. Here, we offer an independent assessment. Our conclusion is that unbundling had a positive and significant effect on levels of penetration; that this effect was somewhat larger, more statistically significant, and more robust than previously thought; and that some of the ambiguity in prior studies can be attributed to the large influence that Switzerland's experience had in dampening the observed effect of unbundling.

Several econometric studies have attempted to estimate whether local loop unbundling has had an effect on broadband penetration rates, and if so whether the effect was positive or negative, large or small. Bauer et al (2003), using 2001 data, found no effect of unbundling. Cava-Ferreruela and Alabau-Munoz (2006), analyzing 2000-2002 data, found statistically significant and large effects for platform competition, and significant but smaller effects for unbundling. Wallsten (2006)[85] analyzing 1999-2003 data found no significant effect for unbundling, negative effect for sub-loop unbundling, a positive effect for collocation, but a negative effect for price-regulated collocation. Grosso (2006), analyzing 2001-2004 data, found positive effects for both platform competition and unbundling, and Garcia-Murillo (2003),[86] analyzing 2001 data, found that unbundling had an effect only in middle-income, but not high-income, countries. The study using the most recent data was done by John de Ridder from the OECD, using data from 2005 and a comparison of changes between 2002 and 2005. De Ridder's analysis found that unbundling had a statistically significant but modest effect, and that competition between platforms (DSL and cable) and the price of broadband and Internet more generally had significant effects. A recent paper by Boyle, Howell, and Zhang (2008) re-analyzed de Ridder's data using a particularly robustness-seeking mixed-effects technique, and found that unbundling had no statistically significant effect, and even where it did have an effect, the size of the effect was in their view minuscule—accounting for an 0.6% increase in penetration as compared to a 6% increase simply from the passage of time—that is, the fact that over time more people adopt broadband penetration regardless of other factors.

Because the de Ridder paper offers the most recent data and extensive analysis; and because it was subject to recent direct methodological critique and re-analysis of the data by the critics, it offered an excellent target for independent review. De Ridder provided access the original data set. The critique and its method were publicly available. We did several things to form our independent evaluation of the data. (See Annex). First, we re-ran the analysis as de Ridder specified to see if we replicated his results.

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84 Exceptions that do rely, as we do, on a combination of quantitative and qualitative analysis, and offer valuable insights, are Atkinson ITIF report 2008, which offers a nice balance of quantitative measures and extensive country-specific qualitative data, and the older work, from 2004, by Jerry Hausman and Greg Sidak, comparing five major countries with a good bit of detail. Jerry A. Hausman and J. Gregory Sidak, Did Mandatory Unbundling Achieve its Purpose: Empirical Evidence from Five Countries, MIT Econ. Working Papers No. 04-40

85 Scott Wallsten, Broadband and Unbundling Regulations in OECD Countries. Working Paper 06-16, June 2006. AEI-Brookings Joint Center for Regulatory Studies.

86 Martha Garcia-Murillo, Broadband Deployment: The Impact of Unbundling

We did. Second, we re-ran the critique, to see if we could produce their results. We replicated their results on the specific equations they tested. In the process, we learned that the critique's analysis understated the effects of unbundling in several ways.

First, we believe the robustness of the estimator used in the critique came at an unnecessary expense of power in the data. The critique was correct that "country-effect" must be modeled to explain correlations of residuals in this panel data, and de Ritter's dummy variable insufficiently accounts for the realized information that certain countries are always above or below average, despite the covariates we have accounted for. However, of models that implement random effects, the "within-groups" estimator chosen in the critique discards information in the data that can be gleaned from between-country differences. This provides complete robustness against any adverse unknown correlation in errors, but analysis of the structure of the dataset led us to believe that the correlation structure is relatively safe and homoscedastic, and that the information contained in between-country effects is too substantial to be ignored.

Second, even using the critique's analysis, unbundling only loses its significance when run in equations that also include the price of DSL. However, there is reason to think that price of DSL is endogenous to the presence of unbundling. That is, if unbundling increases competition, and competition decreases prices, and you observe a country with lower prices doing well, you might think that the cause is the prices–not the presence of the rule–and would miss the interaction between the two. We tested this possibility and found that unbundling and DSL price do partly explain each other, and found an adjusted-R^2 of 37%: in other words, there is an interaction between the two, although they do not completely explain each other. Running the critique's specification without the partially endogenous factor of DSL price, even under the method recommended by the critique, yields a significant effect for unbundling. Running the mixed-effects method recommended by the critique looking only at facilities-based competition and at urban concentration improves the accuracy of the assessment. It shows, furthermore, that urban concentration and unbundling each have a significant effect (more significant and larger than was shown in de Ridder's original analysis), while facilities-based competition has a much smaller, though still statistically significant, effect.

Using a more appropriate mixed-effects model, we performed two new analyses. First, we did an influence points analysis, which is becoming common in cross-country comparisons. In this test we remove each time one country, and re-ran the regression, to see whether there is one country that has a particularly large effect on the total result. In this analysis we found that indeed there is such a country, and it is Switzerland. As we saw in the qualitative analysis, Switzerland is a significant example of successful broadband deployment without the passage of unbundling rules. Removing Switzerland from the data set substantially increases both the significance and the effect size of unbundling. In short, the ambiguity about the effect of unbundling in prior econometric studies is in some measure an oblique way of pointing at Switzerland's experience.

The second transformation we engaged in was to replace the variables describing the introduction of unbundling with variables that mark the time of introduction of effective unbundling as we found it in our analysis of the political economy aspects in the qualitative analysis. For example, France would lose a year, or its unbundling value would be reduced, for the postponement until 2003 of actual implementation. So too the Netherlands, instead of being reported as having had unbundling for 9 years, from formal introduction, is reduced to 5 years to reflect the prohibition on naked DSL provisioning until 2001. While some of these countries, like the Netherlands, are countries with high penetration that had their high values for unbundling reduced (thereby tending to make unbundling appear less important in the model), other countries with lower performance also had their values reduced. The US and the UK are both reduced to having no unbundling by 2005, in the US because the litigation, and FCC 2001-

2002 decisions to abandon unbundling would have had their effect during the observed period of 2002-2005, and in the UK to reflect the factual absence of unbundling until the September 2005 decision on functional separation (only 200,000 loops unbundled between formal introduction in 2001 and 2005, growing to 5.5 million between December of 2005 and December 2008, after the separation). Similarly, high-performer South Korea is seen as having had unbundling since 1997, instead of since 2002, reflecting the earlier availability of access to cable on which Thrunet and Hanaro built their entry. These latter changes would tend to strengthen the explanatory power of unbundling. The changes and the justifications for each are set out in Table 2.2 in the Annex. When we ran these new, case-study-based values for unbundling, the significance of unbundling increased, the effect size increased, and the analysis was robust to the elimination of any given country, including Switzerland.

Moreover, in performing our analysis we noticed that both de Ridder and his critics understated the effect size of unbundling. In both papers the authors report the effect of unbundling as the effect of "GUYRS" on the outcome, and the effect of simple passage of time (DUMMY) as the pure effect of time. However, DUMMY reports growth over three years, while GUYRS represents growth per year. In effect, both those models were comparing the effect of the passage of time to one-third of the effect size of unbundling during the same period, and finding the latter small. Correctly treated as growth-per-year, and adjusted to reflect the actual implementation, suggests that having effectively enforced unbundling regulations in place adds about 1% per year, or about 3% of penetration growth over the 3 years, relative to a 7%-12% increase from all other factors over the same period. While unbundling does not explain the entire growth differential, then, it appears to have a statistically significant, robust, effect, of about 1% per year of effective enforcement. In any given year, such an effect may not be considered significant. However, if our analysis is correct, then adding unbundling could, over a decade after introduction, add 10% penetration points. When one recalls that the World Bank study, described in Section 2.5 above, found that a 10 point increase in penetration per 100 translated into 1.21% growth in GDP, and that total GDP growth in the United States between 1997 and 2008 averaged 2.8%, one might consider the long term benefits to growth caused even by increasing penetration by 1 per 100 every year, over and above the effect of all other influences, to be an effect worth considering. This of course assumes that there are no other positive spillovers from high penetration, not captured by GDP growth. We do not, however, suggest that it is appropriate to extrapolate a decade's worth of effect beyond the observed period.

The econometric analysis lends support, then, to the proposition that the experience of other countries in the OECD is that unbundling rules, effectively enforced, increase penetration. This is consistent with the results of our qualitative analysis. Furthermore, our re-analysis of the data suggests that much of the ambiguity in prior analyses is explained to a large extent by Switzerland's experience. While we too agree that Switzerland's experience is an example that it is possible under certain circumstances to do well without unbundling, we see here that econometric analysis has been reflecting that qualitative caution, rather than a broader ambiguity in the results across many countries.

4.11 Looking forward by looking back: Current efforts to transpose first generation access to the next generation transition

Several assumptions about the next generation transition and how it is different, and solutions to transposing the experience of the last transition to the next, are emerging in Europe, Japan, and South Korea. In Europe, the need to share a coherent view, so as to coordinate regulatory responses across national agencies that are independent of each other, has resulted in a particularly crisp analysis by the European Regulators Group (ERG). The ERG is an EU-created body of national regulatory agencies (NRAs) that coordinates among all the national regulatory bodies of the member states, as well as those

of the non-EU EFTA countries and countries on the EU accession list. It produces annual best-practices reports, and its decisions inform the European Commission's implementation and enforcement decisions on questions of communications policy. In other words, although it is not itself a regulator, its decisions reflect the collective experience of its members, and have direct influence over the body that does have enforcement power over the national regulators. The need to communicate among the regulators and with the Commission requires the ERG to produce explicit, coherent analyses, and make its work a particularly valuable source of insight. We anchor our description of current lessons being learned and applied by other countries in the ERG report on Next Generation Access from June of 2009, and supplement it with particular national examples as well as with, in particular, the Japanese and South Korean experience on mobile. Note that this section describes current thinking in these countries. We do not offer our own opinion as to the substance or desirability of these assumptions or solutions.

4.11.1 Assumptions

Following is a list of assumptions that are currently stated in the ERG and several of the European national reports, with additional focus on ubiquity from Japan:

a) The costs of deploying will be high; and investment will entail risk.

b) Facilities-based competition is good, but even where it exists should be combined with service/wholesale and mixed (unbundled-like) models of investment and service competition to impose market discipline on network owners.

c) Fiber networks have several diverse topologies, some more conducive than others to "deep" competition, that is, competition based on investment in electronics connected to physical infrastructure on the unbundled model. Where topology is not conducive to such deep competition, service-level, or wholesale models of access, like bitstream access, must be assured, and potential abuse curbed.

d) Finding models of spreading risk, sharing costs, or absorbing it publicly are productive avenues for pursuit in the construction of next generation networks. This might include public investment, particularly of the form of local level public private partnerships, or various approaches to sharing investment and infrastructure among competitors.

e) Ubiquity requires integration of fixed, mobile, and nomadic networks. This supports permitting greater vertical integration between fixed and mobile networks, coupled with greater access regulation.

4.11.2 High cost

Putting new infrastructure in place, particularly replacing current copper plant with fiber is expensive. Much of the expense is in relatively low-tech "civil engineering" work: digging trenches, locating ducts; getting into homes. The cost of the fiber itself, and of the electronics, is minuscule relative to the cost of the low-tech, high labor components. Coupled with the extremely high capacity of fiber networks, European future-oriented analyses are concerned that economies of scale and scope make investment in multiple redundant networks risky and potentially unjustifiable even in many urban areas. The concern is more starkly expressed for higher-cost areas, with a potentially smaller number of subscribers to justify the cost. This suggests in current analysis by the ERG that, while facilities-based competition is in principle desirable, because it limits the dependence of competitors on another's infrastructure and the relative effectiveness of regulation to prevent abuses, competition over shared facilities will play at least

as important a role in next generation networks as it did in the first transition. The ERG therefore suggests that the benefits of competition, even over an incumbent's facilities, are considered sufficiently important to justify the potential dampening effect on the rate of roll out. Ofcom reached a similar conclusion in its super-fast broadband report. Given the high entry barriers on the one hand, and the benefits of service-level competition on the other hand (whether or not one considers the case for unbundling and access regulation established by the studies presented here, European regulators quite clearly do treat the case as established), European countries are aiming their sights on how to extend the same basic lesson they learned in the first generation transition from dial-up to broadband to the transition from broadband to next generation networks.

4.11.3 Topologies

Current European plans focus on three topologies used to role out networks that count as "next generation." The difference between them depends on (1) how close to the home the fiber gets, and (2) the extent to which capacity is shared among multiple subscribers.

Where fiber is drawn from the local exchange only to a cabinet in the neighborhood, and the rest of the way is distributed by copper, this topology is called Fiber-to-the-Cabinet (FttC). Its maximum speeds are slower, and it is effectively a version of DSL (VDSL) with the fiber pulled closer to the home, and the copper loops shortened. It offers the architecture that is cheapest for the incumbent to deploy, provides the lowest speeds, and is the least future-proof. The degree to which it is hard or easy to open up to competition on an unbundled basis depends on certain physical features, such as the size of the neighborhood cabinet. To the extent that it is physically difficult to locate the equipment of an entrant in the neighborhood, this architecture leaves entrants in a position more akin to resale than to unbundling in terms of their ability to invest in the network and retain control over critical aspects of the subscriber's experience. It is in large measure seen as an interim measure, to pull higher-speed capacity closer to the neighborhood and the home, as part of an incremental, long-term upgrade to fiber all the way to the home.

Two topologies already pull fiber all the way to the home. The first is point-to-point, where each home has its own dedicated fiber optic cable to the Internet point of presence (POP). In Amsterdam, for example, this means that 10,000 homes are connected to a single POP, each by its fiber, with symmetric capacity. This is the most flexible architecture in terms of deploying future network upgrades, because it allows electronics to be changed in a single location, without additional civil engineering expenses, both for large numbers of households at a time and on a per-household basis. It is also the most competition-friendly for the same reason, because it allows competitors to connect at various places and add their own innovative electronics more readily, for each individual subscriber, at a relatively central location. The second is passive optical network (PON), where shared fiber capacity is again pulled to the neighborhood, but instead of distributing it through copper, the shared capacity is fed into an optical splitter in the neighborhood and then split into individual fibers going into each home. Each splitter might serve anywhere from as few as 8 to as many as 128 homes. It is seen as an intermediate solution between FttC and point-to-point full fiber connections. PON networks are more difficult to unbundle because the optical splitters are usually buried in the neighborhood, making the cost of collocation and unbundling at the relevant point much higher per-subscriber (distributed between 8 or 32 subscribers, instead of among 10,000). The European discussions, influenced by a September 2008 report to Ofcom by Britain's Broadband Stakeholders Group, generally assume that PON networks are about five times more expensive to deploy than FttC networks, while point-to-point networks are yet an additional 15% more expensive than PON networks.[87] Experience with the Amsterdam CityNet network suggests that

87 ERG (17) 2009, pp. 7-8.

the difference in price between PON and point-to-point networks is more contingent on the particular availability and history of existing plant, and that the British report was based on assumptions about reuse by Openreach of certain BT facilities. We have not made an independent cost analysis to distinguish between these claims, although we do note that the important difference—the much higher cost of FttH over FttC—is not disputed, and that a difference of 15% in cost may be insufficient to change a policymaker's preference between two topologies, if the one that costs 15% more is indeed a thirty-year infrastructure that is both more competition-friendly and more future-proof.

Based on Amsterdam's experience the Dutch incumbent's new joint venture with Reggefiber is deploying a point-to-point topology. The CityNet experience, like the British Broadband Stakeholders Group report, suggests that the overwhelming portion of the cost is in the physical, lower-tech portions of the work. That project calculates that the cost of fiber was about 8%-9% of the total costs, other materials, such as for ducts, were another 18%, and the remainder were labor. Unsurprisingly, in more densely populated, multi-dwelling units areas, like city centers, the proportion of labor for indoor wiring is higher, and the inverse is true in less dense areas for smaller houses. In France, where deployment is primarily in urban areas, and the in-building wiring is to be shared between competitors, France Telecom has nonetheless chosen to deploy a GPON topology. Iliad/Free, on the other hand, is deploying point-to-point topology in very similar geographic areas, lending support to concerns that the choice of PON topology may be driven in part by efforts to hamper competitors' use of the incumbent's network; although it may also be explained by a different time horizon that the companies take in how future-proof to make their networks.

The core points on topology are:

- Fiber-to-the-home, whether PON or point-to-point, is about five times more expensive than FttC, VDSL, or hybrid fiber coaxial cable architectures

- Which topology is chosen affects the relative ease of permitting competitors to enter with their own electronics, as opposed to by depending more heavily on active components owned and managed by the incumbent

- FttC and PON are both architectures that are less amenable to sharing facilities over time; the cost difference between PON and point-to-point likely exists, but does not appear to be large.

4.11.4 Reducing or sharing the costs of future proof, more competitive topologies

An important part of the discussion in Europe revolves around how to reduce redundant investment in the civil works aspect of fiber deployment—the digging up of streets and the like. The UK study for the Broadband Stakeholder Group estimated that street works account for 75% of the cost of PON deployments, and 80% of point-to-point deployments.[88] A major part of European efforts is aimed at reducing or sharing those costs and the risks associated with investing such large sums in a new technology with unproven (though predicted) demand. (In South Korea and Japan, this problem was primarily approached through substantial government subsidies. Japan in particular also enjoyed entry by electric utilities, whose existing infrastructure was characterized in the UK report as reducing the civil works costs of fiber to the home deployment by 23%.[89])

88 Caio at Figure 2, page 18, and at page 13.
89 ERG (17) 2009, p. 8.

Public-private partnerships.

An important part of the strategies for investment in fiber infrastructure has been the implementation of public private partnerships. In Sweden, government funds in municipalities support requisitioning of open access networks, with a preference for private provisioning and services over municipally-requisitioned dark fiber and ducts, but with a safety valve for municipal investment in case no companies want to light up the fiber. A similar model is developing in many places in France, not least following the example of Hauts de Seine, whose then-Chairman of General Council, Nicolas Sarkozy, proposed subsidies for a public-private rollout in that wealthy part of Greater Paris. A similar public-private model, Amsterdam's CityNet, recently became more private than public when the City and the social housing corporations who co-owned it with private investors transferred much of their holdings to the new venture between KPN and Reggefiber.

An avenue used in Sweden and the Netherlands is a form of customer pre-commitment through local cooperatives, which reduces up-front investment as well as take-up risk. One example described in the UK report is of the town of Neunen, in the Netherlands. Each household in the cooperative pays a one-off commitment/membership fee (20EUR). Each household can then decide whether to buy a connection, which cost 2100 EUR in the original deployments, and whose price was later decreased to 1500 EUR. With a government subsidy of 800EUR to each connection fee, the up front cost to a subscriber was 700EUR, or about $810 PPP, The government also subsidized the full cost of a subscription for one year. The community contracted with Reggefiber to provide the fiber to the home network. Thereafter, a triple play package cost 39.39 EUR per month. The model aggregates demand, reduces risk to the developer, speeds uptake of subscribership, and directs the rate and direction of rollout to where there is ability and willingness to pay for it. Needless to say, given the role of government subsidies, a different decisional model about where to roll out could be influenced through a subsidy policy.

Private joint ventures on an open access model.

Two primary models are being explored in Europe for joint private investment. As we saw in the discussion of the Netherlands above, the Dutch model effectively creates a general-purpose separate joint venture for deploying fiber, which would result in a single open access network that would gain its return on investment by selling capacity to competitors.

The Swiss model is more project-specific. Here Swisscom is laying out four separate fibers with each deployment, and is inviting three kinds of complementary investments from competitors. The first are in the form of reciprocal four-fiber deployments by other competitors who do have ducts (effectively, electric utilities). These would then be exchanged in a straight, no-cash “my second fiber for yours” trade, allowing each competitor access to its own fiber over the other's deployed infrastructure. If there is substantial imbalance in relative contributions, Swisscom assumes that there can be additional adjustment payments. The second type of competitor investment is in the form of up-front cash contributions by competitors who do not have ducts, but who help reduce Swisscom's exposure in exchange for a fiber of their own. The third entails long-term commitments by competitors who want unbundled access, again, reducing the risk inherent in the investment in exchange for lower wholesale rates over the period agreed. Competitors who want to provide none of these risk- and cost-sharing participations will be able to buy capacity at higher, short-term commitment rates. Enabling this kind of collaboration requires both approval from competition authorities, and oversight to assure that the joint investors do not exclude others, but the over-provisioning is thought to ease that task. Deutsche Telekom too has announced several cooperative ventures with regional competitors along similar lines. With EWE Tel it will deploy in 4 cities, EWE TEL in 5, and each company will have access to the

other's network in all nine cities. Similar projects are under way with local competitors in Aachen and Cologne.

Regulated deployment and open access for the last drop and in-building wiring.

The French regulation of the past year has been focused on the cost of the final drop, or last 100 meters, rather than on the cost of middle mile or last mile. Up to the final drop, competitors have access to France Telecom's ducts, pursuant to a regulation passed in July of 2008 by ARCEP.[90] Moreover, France decided to leap frog to fiber in its urban areas, Paris in particular, by opening up its sewer system to competitors to pull fiber, thereby avoiding much of the civil engineering cost.

In August of 2008, the French legislature passed a new law about final drops. The first part of the law requires developers of new construction to deploy fiber throughout the building or construction, and to make that fiber plant available to all competing operators on a non-discriminatory basis. This takes advantage of the fact that the incremental cost of pulling ducts through a house when it is in construction is much lower than opening walls and pulling wire when the construction is completed. This part of the law is similar to the practice that has been common in South Korea, as we saw, and that the South Korean government facilitated by offering formal public certification programs that certified buildings as "connected" when they were wired for high speed connectivity available to operators. The second part of the law, which has been the subject of consultation and implementation by ARCEP since, involves structured cooperation between competitors. The idea is that the disruption of running multiple fiber plants, at different times, through a building is too great. As a practical matter, that would mean that whoever gets to a building first would have a monopoly over that building unless required to share the facility, because owners would not permit the disruption repeatedly. Building owners in existing buildings therefore have a responsibility, when they contract with a given provider, to provision access to that in-building fiber plant to competitors on a non-discriminatory basis. The competitors share the in-building plant of whichever provider the building owner selected to implement the internal wiring.

4.11.5 Access for non-investors: Passive and active

Part of the task of transposing a regulatory regime from copper networks to fiber involves abstracting what it was about the old regulatory regime that worked. As part of this analysis, the Europeans have emphasized the distinction between active and passive access.[91] "Passive" elements are inert pieces of equipment that just carry electronics powered, generated, and directed elsewhere. This includes duct access, dark fiber, fiber unbundling in PON and point-to-point networks, in-house wiring and cables, and, where copper is still used for part of the network, copper loops. "Active" services are like wholesale and bitstream access—electronic signals over the passive networks. As with bitstream and unbundled access, a competitor using active components will need to invest less to get up and running, but will have less flexibility to innovate in services and technology. A competitor using passive components will need greater investments, but gain greater flexibility and independence to innovate.

Ofcom's statement on superfast Internet suggests that active access will play an important role in next generation connectivity.[92] Because Ofcom is regulating a functionally separated incumbent, it appears to express less concern with monitoring for abuse, and emphasizes the importance of defining the range of services that need to be included as open access components. These will, according to Ofcom's plans, include a wider range of active products, and Ofcom has used its convening power to get industry

90 ARCEP Decisions no. 08-0835 and no. 08-0836 of 24 July 2008.
91 ERG(17) 2009; Next Phase of Broadband in UK;
92 Ofcom Superfast statement pp.

players together to negotiate the kinds of active services they need in order to permit and facilitate competition. Furthermore, Ofcom sees passive fiber access and duct access as important elements of a next generation competitive environment. Ofcom gives the companies the freedom to negotiate rates for these services, but monitors these negotiations to assure that they permit reasonable rates of return reflecting the appropriate level of risk, as the UK regulator puts it. This idea of a "risk premium" in rates imposed on active and passive elements sold to competitors is more widely considered in Europe as an important consideration in implementing access to next generation networks.[93]

The Dutch regulator OPTA is the first in Europe to impose unbundling of the fiber loop as a regulatory requirement. It also used its power to shepherd through a joint venture of KPN and Reggefiber that would role out open access networks. The joint venture is the only one outside of Slovenia to aim to roll out a fully point-to-point national network. As we mentioned, this is the topology most conducive to open access and passive product unbundling as well as active product wholesale services. France, Portugal, Germany, and Spain have all imposed on their incumbents, but not their entrants, a requirement to offer access to ducts, although current European efforts are to make these obligations symmetrical between incumbents and the newer companies.[94] Spain, like France, has required building owners and the providers they contract with to share in-building wiring. Denmark for now has no separate next generation regulatory treatment, but because the incumbent seems to be rolling out a FttC or VDSL service, its infrastructure is subject to unbundling like the copper plant built on the same architecture, and it is required to provide access to backhaul services as well.[95] The approach in France and Germany has been to change little for now, but include fiber in the definition of the markets as to which unbundling and bitstream access are required. Vodafone now plans to compete using Deutsche Telekom's VDSL platform on an active-product, or wholesale basis.

Another concern in Europe that is of less concern in the United State involves the transition from unbundled copper loops to fiber. These involve recognition that entrants made substantial investments based on being able to connect to copper local loop, and these investments will be stranded once the incumbent moves to fiber and ceases to maintain the loops. These are treated as transition problems focused on how long the incumbent would be required to maintain the loops and main distribution frames so as to allow the competitors to migrate. Most European countries have required the incumbent to phase out exchanges slowly, giving advance notice, and to provide clear plans to competitors about future roll outs so these can adjust their investment and reinvestment appropriately.

4.11.6 Functional separation.

Several European regulators have considered functional separation as one potential approach to deal with the likely increased need for access to active components, where competitors' dependence on the provider is potentially high. The UK's positive experience prompted reconsideration of the costs and benefits of such an approach, and not only in New Zealand. The German regulator undertook one such review, but has not adopted it. The ERG issued a cautious opinion on the subject in 2007, cautioning European regulators to consider local conditions, incumbent recalcitrance, and potential effects on investment.[96] In June of 2007 the Swedish regulator decided to follow the example of the UK, and imposed functional separation on TeliaSonera, which has been functioning with a separate access subsidiary since January 1, 2008. The Italian regulator, Agcom, leaned on Telecom Italy to functionally separate its wholesale from retail divisions, and TI indeed, after over two years of negotiations, created a

93 ERG (17) 2009 at pp 19-20.
94 ERG(17)2009 p. 23-24.
95 ERG (17) 2009 p. 59.
96 ERG (07) 44.

separate open access division. And we have seen that the Dutch incumbent, KPN, has entered into a joint venture that effectively separates it from the point-to-point fiber, open access network that it will build and use. The changes in Sweden, the Netherlands, and Italy are too recent to have yielded observable results, positive or negative. Similarly, it is of course too soon to evaluate the September 15, 2009 announcement by the Australian government of a new law requiring Australia's incumbent, Telstra, to undertake structural separation voluntarily, or force it to undergo functional separation.

4.11.7 Fixed-mobile convergence and access to mobile networks

The shift to ubiquitous access has, to a substantial degree, led to mergers between fixed broadband firms and mobile broadband providers. In France, SFR, the mobile provider, bought Neuf Cegetel, the fixed broadband service. Free, on the other hand, did not bid on a 3G license, and has instead expanded its reach through its innovative nomadic access sharing approach—where the network interface devices it furnishes its consumers serve also as nomadic access points for all Free subscribers who come within range of each other. In the Slovak Republic, the major investment in Fiber comes from Orange, France Telecom's mobile subsidiary which is the largest mobile player in the Slovak Republic. In Germany, Deutsche Telekom owns T-Mobile, which deploys not only 3G networks but an extensive network of hotspots. Similarly, in Sweden, Telenor, one of the entrants, has rolled out substantial nomadic infrastructure through its local Glocalnet subsidiary, called Glocalzone. Telenor now bundles access to hotspots in Sweden's 20 largest cities with its mobile broadband offerings on the cellular side. Telenor also bought nationwide WiMax licenses in the 3.6-3.8GHz and in the 2.6Ghz bands in 2007 and 2008.

In Japan, KDDI made this move first, anchored in their au Corp mobile brand and expanding through purchases and alliances to offer fiber and high-speed DSL services as well. Softbank Yahoo!BB bought Vodafone Japan in 2006, creating Softbank Mobile, and recently the MIC is permitting NTT East and West to cooperate with NTT DoCoMo. Similarly, in South Korea, in only the last year the same move occurred in both directions: the largest mobile provider, SKT, purchased the successor of Hanaro; and very soon thereafter, KT, the incumbent fixed telecommunications provider and leader in the fixed broadband market, merged with KFT, the second largest mobile player. Between them the two firms have over 80% of the wireless market and over 70% of the fixed-broadband market. On a more aspirational model, the most recent annual report from ARCEP, in France, sets as one of the rights to be offered to a fourth 3G licensee, should one emerge (earlier efforts to get a 3G fourth provider failed, when Free/Iliad was the only bidder, and it refused to pay the government's reservation price), would be to give the new fourth provider access to the facilities of the existing three 3G operators in France for purposes of collocating its 3G network equipment. In Italy, two of the three major mobile data players, Telecom Italia mobile and Vodafone, have a six year agreement to share access sites for existing and future mobile networks, sharing poles, cables, electrical, and air-conditioning equipment. In Australia, Optus and Vodafone reached similar agreements, as did Telstra and H3G. These latter market-based agreements suggest that infrastructure sharing is valuable even in the lower-cost setting of mobile networks. They raise the question, however, as to whether there is need for regulation to achieve these kinds of sharing benefits in less competitive mobile broadband markets than Italy or Australia.

How one treats this trend depends on whether one focuses purely on high capacity to the home or on ubiquitous connectivity. From the high-capacity only perspective, the trend is worrisome. It would mean that potential competitors are being eliminated through consolidation. In South Korea, for example, the dominant mobile and fixed broadband providers were prevented from bundling their offerings until 2007, because of the concern with reducing competition. If, on the other hand, one is focused on ubiquitous, seamless connectivity, then one sees fixed, mobile, and nomadic access as complements, and sees the kinds of integrations occurring as desirable moves in that direction. No

single program reflects that trajectory more clearly than SFR's, which allows SFR subscribers to connect to data seamlessly, either over their own home network when at home (an approach increasingly used under the term "femtocells" by mobile providers more generally, to avoid the high landline connection charges where wireline providers still charge them), or over their 3G network where no SFR subscriber is within reach, or over the Wi-Fi box and fixed line of any other SFR subscriber, when they are in reach. All of this allows the subscriber to receive unlimited data service over whichever portion of SFR's network is most readily available.

The potential problem, of course, arises when a new entrant faces not only the physical costs of implementing a fixed network, but must effectively bundle mobile data connectivity as well. Japan and South Korea now appear to have extended the solution of open access from the fixed to the mobile arena, although the solution is in an ad hoc mode. In Japan, it mostly took the form of a MIC-arbitrated arrangement between NTT DoCoMo and Japan Communications, allowing the latter to lease circuits and capacity on its mobile network. The MIC has since required NTT DoCoMo to publish standard leasing fees for entrants, although these are largely wholesale entrants, not unbundling-like entrants. In South Korea, because both acquisitions involved dominant players—one in wireless, the other in fixed—the open access requirements were imposed as part of the merger approvals. As a condition of merger approval, both companies must now open their mobile data networks to competitors.

The core lesson from these cases suggests that the shift from a policy focus on high-capacity fixed broadband to the home, to ubiquitous, seamless access, requires two seemingly opposite moves. The first would tend to reduce potential competition by permitting vertical integration between fixed and mobile service providers, thereby removing one avenue for facilities-based competition in high capacity data to the home. The second would tend to increase competition over the small set of discrete facilities-based channels to each subscriber, both fixed and mobile, by opening the entire converged fixed-mobile network to access by competitors: to both the fixed and mobile components.

4.12 Annex: Pricing

This annex details the two pricing studies that we carried out: the first as part of the benchmarking exercise in this report (Part 3)and the second as part of our evaluation of the effects of open access policies in Part 4 (Competition and Access). Our benchmarking pricing study sought to validate, complement, and complete the results of the OECD pricing data set using an independent market data set.[97] We found that the data sets are somewhat correlated, but due to the thinness of the data, the analysis is very sensitive to variations between the two sets. As a result we combined the two sets to present a fuller picture of the data and compared the results to the original. Our firm-level pricing study for the highest-speed service tier sought to identify the prices and speeds of offerings, throughout the OECD, that are furthest along toward next generation networks in their capacity.

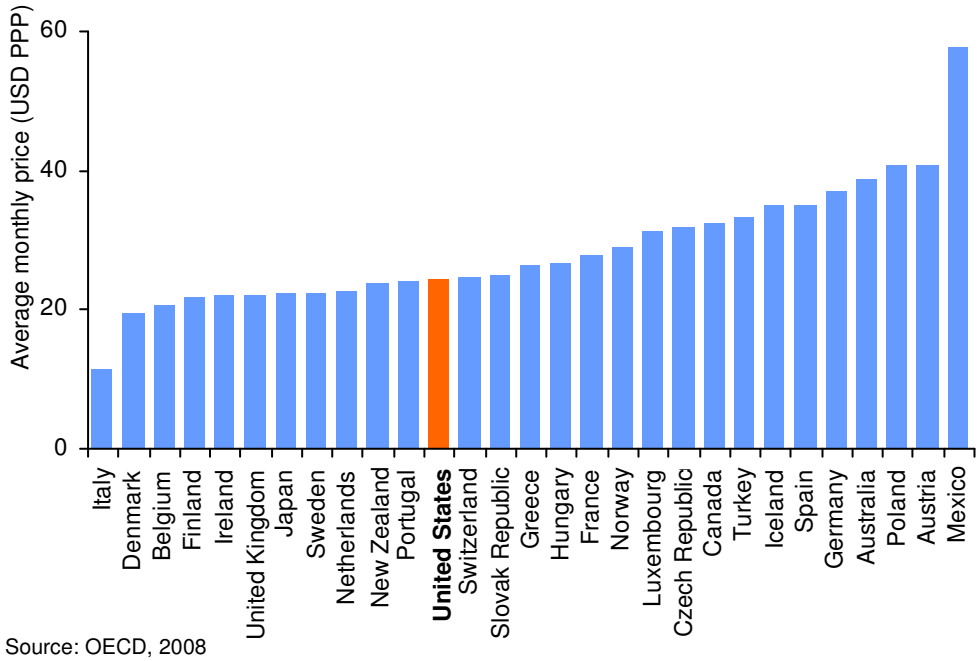
4.12.1 OECD pricing data set

The OECD pricing data set includes 631 consumer broadband offerings surveyed in September 2008 from broadband providers in OECD countries.[98] These offerings are categorized based on the speed of the connection: low (256Kbps to 2Mbps), medium (2.5Mbps to 10Mbps), high (10Mbps to 32Mbps) and very high (greater than 35Mbps). We prefer using this approach to describe the pricing data because the OECD measure of price-per-megabit-per-second includes speed as an endogenous factor and, therefore, double-counts the availability of high speed service tiers within the pricing benchmark. Breaking down prices based on tiers provides a more direct representation of the price-to-performance tradeoffs that consumers makes than the composite totals do.

Graphs of the average price from the OECD pricing data set are shown in Figures 4.3 through 4.6. These results are computed using a simple average of all the offerings in the data set for that country in that tier.

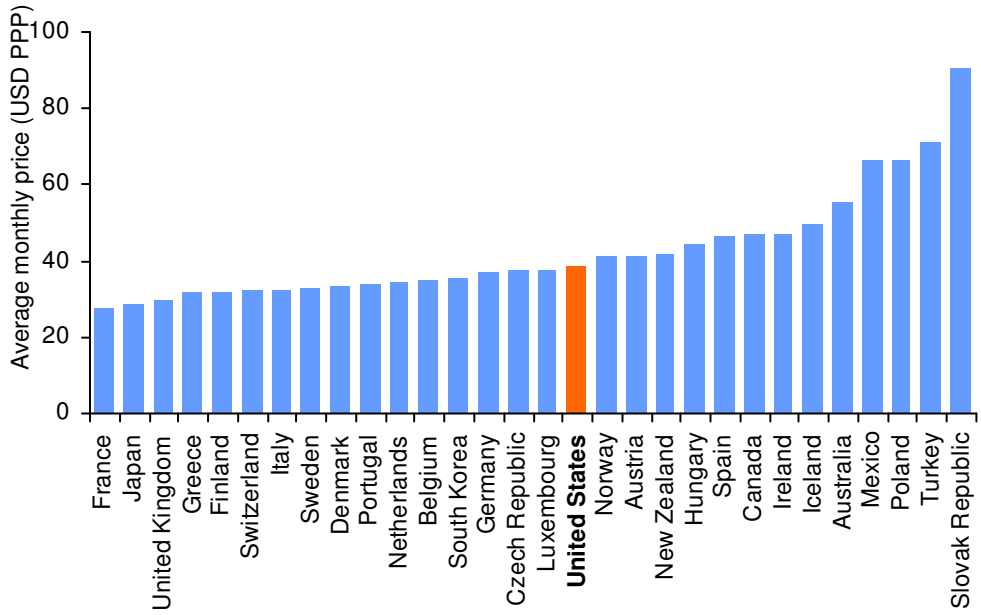
[97] TeleGeography's GlobalComms 3.0 data set
[98] OECD (2009) *Communications Outlook 2009*. Table 7.4, p 302-309.

Figure 4.3. Average monthly price for low speed tier, OECD



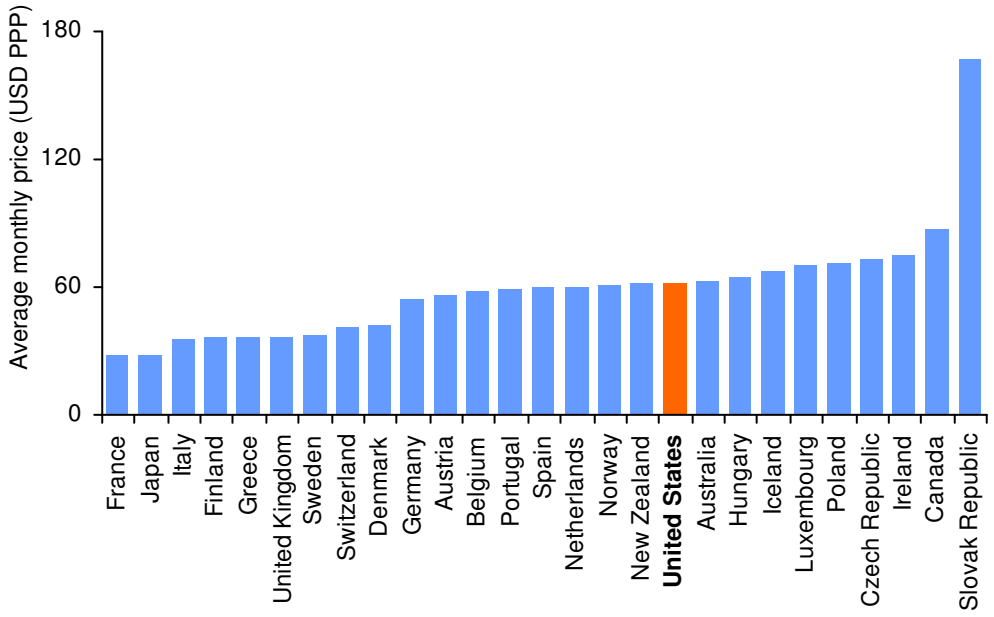
Source: OECD, 2008

Figure 4.4. Average monthly price for medium speed tier, OECD



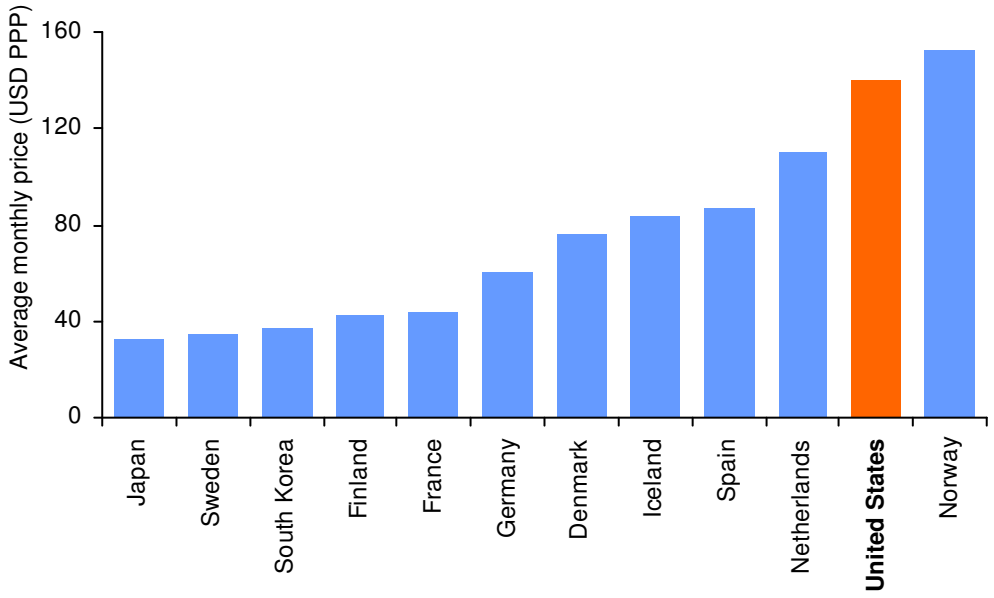
Source: OECD, 2008

Figure 4.5. Average monthly price for high speed tier, OECD



Source: OECD, 2008

Figure 4.6. Average monthly price for very high speed tier, OECD



Source: OECD, 2008

4.12.2 Berkman study using the GlobalComms data set

Methodology

The objective of this analysis is to examine, validate, and complement the results of the OECD data set, starting with a review of their methodology and then comparing OECD measures with an independent study. The OECD includes a wide range of providers in their data, regardless of size and market share. Close inspection of the data reveals that firms with a small share of the market have a disproportionate influence on the average price than most consumers would expect based on the number of subscription plans available to them. We constructed an alternative measure that considers only the top four providers from each country. On average these top four providers combined have 80% of their local markets. The United States had the lowest percentage of market covered by those top four at just under 60% of market share. Our analysis takes a straight average of offerings from only those top four providers and disregards the rest.

The second change we made to the OECD methodology was to remove any offerings with data caps of less than 2 GB per month. We chose 2 GB per month as the lower bound because that was the lower end of the data usage rates quoted by U.S. cable firm Comcast as the median monthly usage of its subscribers.[99] The impact of this change in methodology was clear in countries, such as Australia and New Zealand, where caps are a common way to address the low-price market. In these countries we saw entry level prices rise over the original OECD average price, but we believe that these prices are more comparable to prices from other countries where data caps are not prevalent.

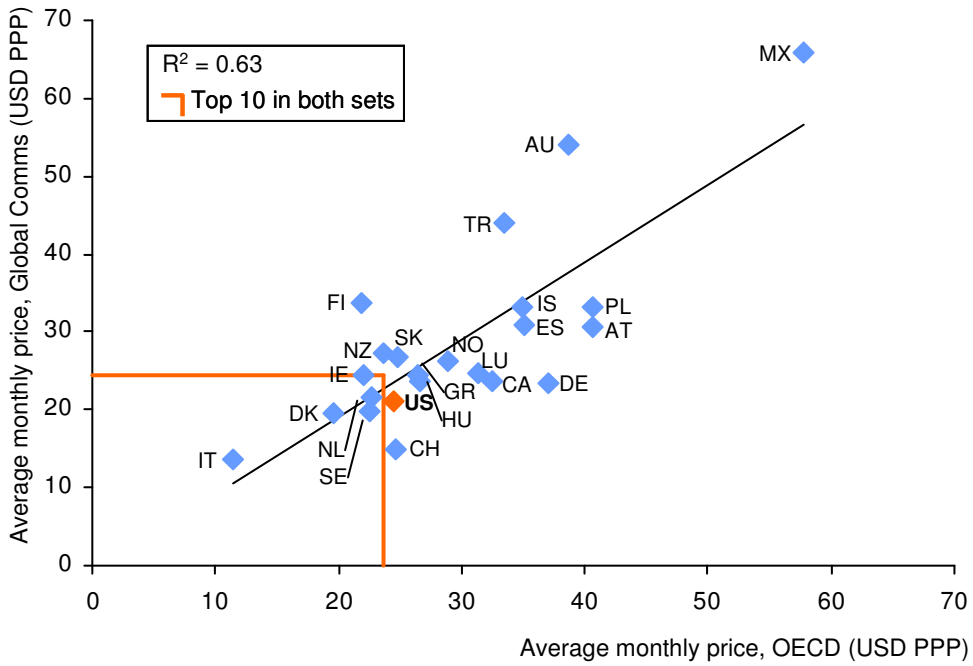
We applied this new methodology to the GlobalComms 3.0 market database. GlobalComms is a regularly updated database of international broadband statistics, maintained by the widely-cited and long-time industry analysis group Telegeography, a division of PriMetrica, Inc. The firm states that the data comes from primary sources wherever possible (e.g., the operators), and secondarily from national regulatory agencies, international statistics organizations, and other sources. It covers both wireline and wireless services and is used by companies worldwide to perform market analysis. The data set we constructed out of the GlobalComms database contained 529 offerings observed between February 2008 and July 2009. We also added to this database a recent offering in the very high speed tier from Comcast in the United States, based on our own research, to reflect the introduction of new offerings based on DOCSIS 3.0 from U.S. cable providers, which were not otherwise reflected in either of the data sets we examined. Including this offering lowered the average price in the United States in the very high speed tier.

Results

We graphed the two data sets to see how similar or different the resulting averages are, and the results are shown in Figures 4.7 through 4.10.

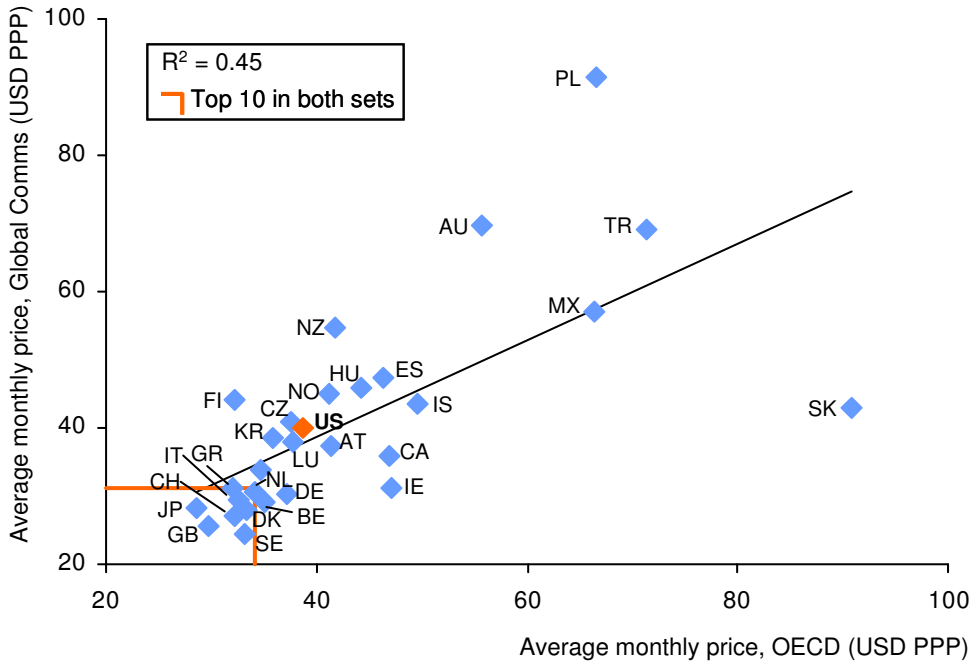
[99] http://www.comcast.net/terms/network/amendment/ (last visited Sept 4, 2009)

Figure 4.7. OCED versus GlobalComms pricing in low speed tier



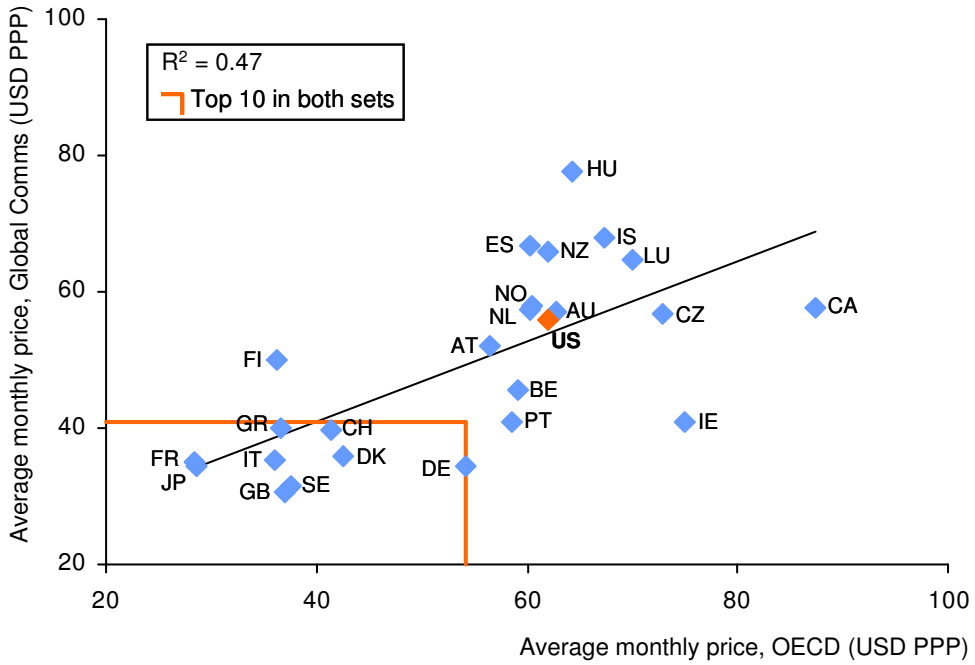
Source: Berkman Center analysis of OECD and Global Comms 3.0 Broadband Statistics
Note: Belgium, UK, Japan, Portugal are top 10 players in OECD dataset but are not displayed because they lack data in GlobalComms

Figure 4.8. OECD versus GlobalComms pricing in medium speed tier



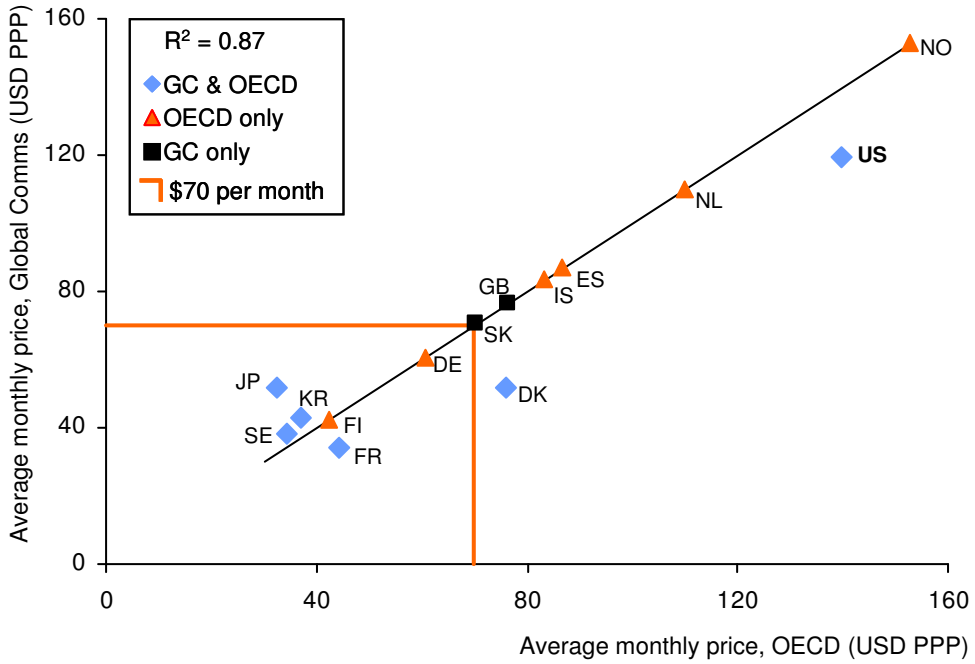
Source: Berkman Center analysis of OECD and Global Comms 3.0 Broadband Statistics
Note: France is the best ranked player in the OECD dataset but is not displayed here because it lacks data in the GlobalComms dataset

Figure 4.9. OECD versus GlobalComms pricing in high speed tier



Source: Berkman Center analysis of OECD and Global Comms 3.0 Broadband Statistics
Note: Slovak Republic and Poland excluded as outliers

Figure 4.10. OECD versus GlobalComms pricing in very high speed tier



Source: Berkman Center analysis of OECD and Global Comms 3.0 Broadband Statistics

In the low, medium, and high speed graphs, if a country did not have a data point in both data sets, then it was not displayed. For example, Belgium is ranked third in the low speed tier for price, but it does not appear on the low speed correlation graph because, although Belgium does have three data points in the GlobalComms data set in that speed tier, none of them is from a top four provider. The orange box in the lower left hand corner of each graph indicates the cut-off point for the top ten countries on each axis. In the very high speed graph, because there are so few data points, all of the data points from both sets are shown, and the orange box was drawn at $70 per month.

Each of these graphs shows differing degrees of significant correlation. The significance of the correlation across the tiers gives us some added measure of confidence in the quality of each of the pricing studies. Some of the variation between the data sets may be accounted for by fluctuations in currency exchange rates, given the time elapsed during which the offerings were surveyed. Similarly prices may have changed throughout that time period. Finally, although each of these data sets has many data points, with 30 countries and 4 tiers, the average number of points per result in each data set is between 4 and 5. Variation in even a single offering can have a large impact on the resulting average.

Looking at a few countries in particular highlights the sensitivity of this analysis. Finland has a consistently higher average price in the GlobalComms data set than the OECD data set. The OECD data set has many more offerings listed for Finland than does the GlobalComms data set. This includes several offerings at lower speeds and lower prices which pull the OECD average down relative to the GlobalComms average. Additionally, some of the offerings appear to be for the same service but at a higher price in the GlobalComms data set. Poland presents similar difficulties. The GlobalComms data set includes several providers with much higher price points than the OECD data set, which pulls the GlobalComms average up relative to the OECD average. In Switzerland, GlobalComms has a low speed offering at just $3 per month which drops the average from $20 to $14.

Key take-aways

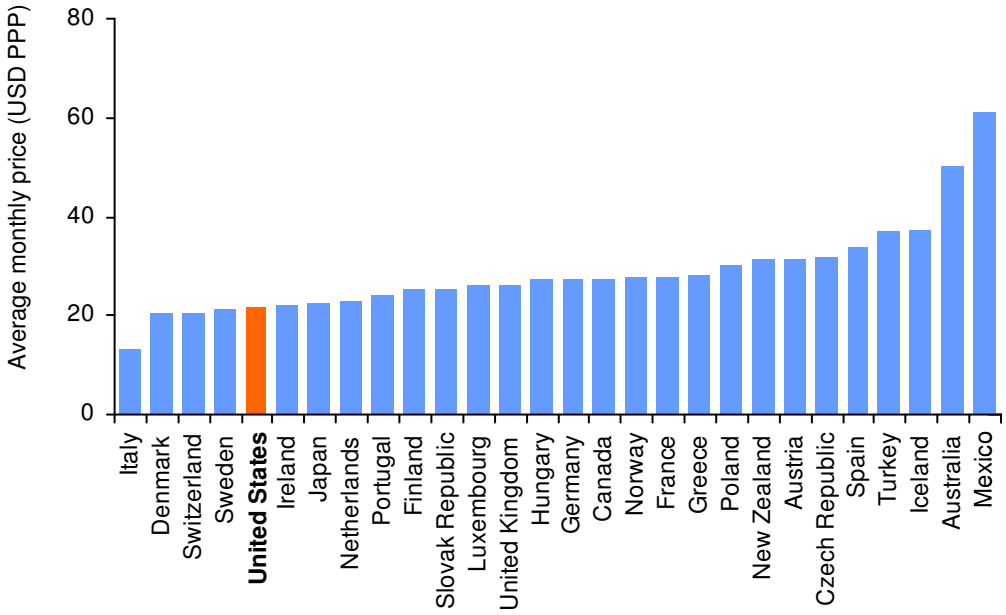
There are two key findings from this analysis. First, a country that has been identified in the top ten in both data sets (those that fall within the orange box), can confidently be labeled as a high performer in that speed tier. Denmark, Ireland, Italy, the Netherlands, and Sweden all reside in the top ten in both data sets for the low speed tier. Denmark, Italy, Greece, Japan, Portugal, Sweden, Switzerland, and the United Kingdom are all in the top ten for the medium speed tier. Denmark, France, Germany, Greece, Italy, Japan, Sweden, Switzerland, and the United Kingdom are all strong performers in the high speed tier.

Second, there is no clear optimal data set between these two. Both the OECD and GlobalComms data sets are similar in their aims and methods, and though they are clearly correlated, they also clearly have some distinct data within them. Given this, we decided to combine both data sets to yield a set with many more samples on which to apply our methodology.

4.12.3 The combined data set

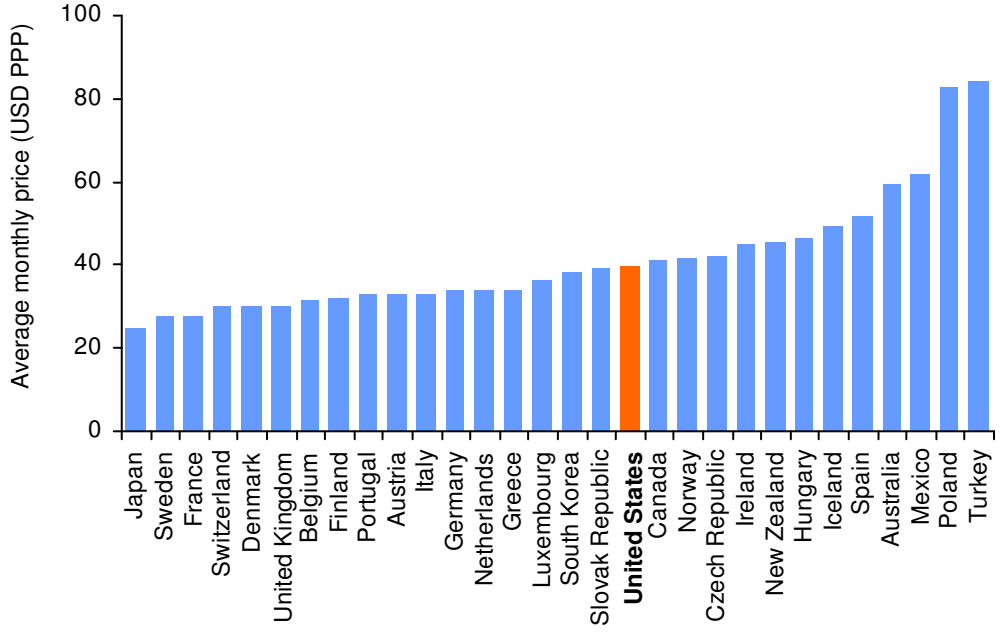
The combination of the OECD and the GlobalComms data sets revealed nearly 150 duplicate offerings which were manually tagged and removed from the combined set. Where there was a duplication, we kept the OECD offering. The resulting set had nearly 1000 entries. Of those, 277 were excluded in our methodology for being from a non-top four provider or having a data cap of less than 2 GB. The results of this data set are shown in Figures 4.11 through 4.14.

Figure 4.11. Combined pricing set in low speed tier



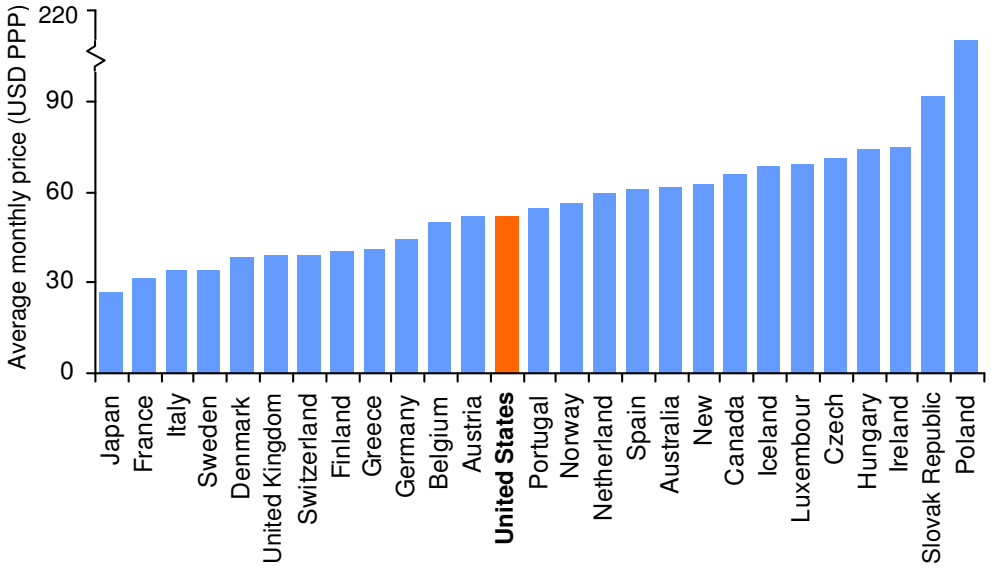
Source: Berkman Center analysis of OECD and Global Comms 3.0 broadband statistics

Figure 4.12. Combined pricing set in medium speed tier



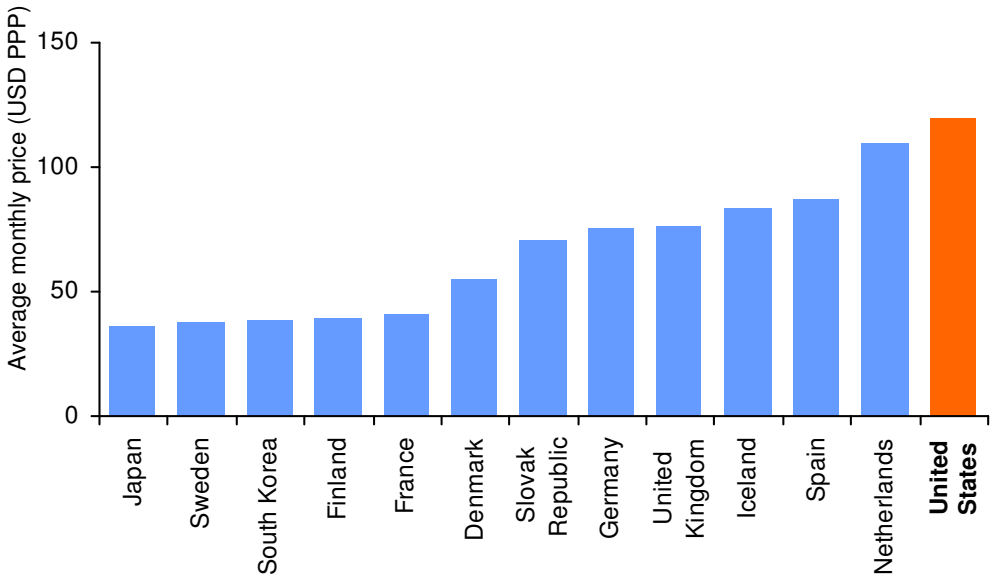
Source: Berkman Center analysis of OECD and Global Comms 3.0 broadband statistics

Figure 4.13. Combined pricing set in high speed tier



Source: Berkman Center analysis of OECD and Global Comms 3.0 broadband statistics

Figure 4.14. Combined pricing set on very high speed tier



Source: Berkman Center analysis of OECD and Global Comms 3.0 broadband statistics

In the low speed tier, the United States moves up seven places, from 12th ranked in the original OECD ranking, to 5th here. This is due primarily to the methodological change that excludes some higher-price, smaller-competitor offerings, which results in a drop in the average price by $3. We see many other big movers, including New Zealand which falls by eleven places, Germany and Switzerland which both improve by ten places, Luxembourg and Poland which both improve by seven places and the United

Kingdom which falls seven. New Zealand is impacted by the removal of the low-price, sub-2GB cap offerings. Adding the GlobalComms data set results in two new lower price options affecting the German average. The OECD data set includes only two offerings from Luxembourg in this tier. The GlobalComms data set adds another three unique offerings from two other carriers at more competitive prices. Poland adds some more competitive offerings from top four carriers and removes some less competitive offerings from non-top four carriers. The United Kingdom still suffers from a lack of data in the low speed tier. This may be a factor of the sparseness of the data sets or could be a sign that there are fewer options in the United Kingdom in this speed tier.

In the medium speed tier, merging the data sets has little impact on the United States, moving it from 17th to 18th. There are fewer big movers at this speed; however, the Slovak Republic improves by thirteen places, Austria improves by nine, and Greece falls by ten. Both the Slovak Republic and Austria, similar to the United States in the low speed tier, have offerings in the OECD data set from a few smaller providers with higher prices that are excluded in our methodology. Greece's change in rankings is more due to other countries' movement than its own. Greece's average price increases slightly (from $32 in OECD set to $34 in the combined set), but it suffers a large fall in the rankings as several other countries improve their average prices.

In the high speed tier, the United States' average price falls by $10 resulting in a five place improvement in the rankings. This change in price is mostly a result of excluding higher price options from the 7th largest provider, Qwest. In this tier, we do not see any countries shift more than a quintile in one direction or the other.

In the very high speed tier, the United States falls two spots as the Slovak Republic and the United Kingdom are added to the mix of countries with very high speed offerings. Norway is notably missing since its one offering in this tier was from a non-top four carrier, Lyse.

In conclusion, we found that both the OECD and GlobalComms data sets suffer from sparse data as we cut by country and speed tier. Combining the two data sets yields a somewhat more robust set, but further work into a more comprehensive data set that accurately represents the options available to consumers and is less sensitive to variation would be necessary to further delve into this question.

4.12.4 Firm-level offerings at the highest-speed tiers

As part of our analysis of competition and access regulation, we used our combined data set to identify specifically the discrete prices and speed offerings made by firms in OECD countries at the highest speeds. The source was the combined data set from GlobalComms and the OECD. From this data set we selected all offerings that fell into the very high speed tier, that is, offerings above 35Mbps, anywhere in the OECD. Where a firm had multiple offerings in this tier, we selected the lowest price for the highest speed offering. For this analysis we did not restrict offerings to only top four firms. To these we added the highest available speed offered in each of the countries for which we focused on in Part 4 (Competition and Access), where there were no offerings in the very high speed tier (Canada, Germany, Italy, New Zealand, Switzerland, and the United Kingdom). To these we added the results of our own independent Web-based search for what were the best prices, at the best speeds, available from all U.S. broadband providers that were identified in the GlobalComms data set as having over 2 million subscribers. For these we included the lowest-priced, highest-speed offering we could from either the firm's Web site or news reports about a firm's launch of an offer.

Because our initial examination identified the offerings of U.S. firms as among the lowest speed and highest priced, and because we have a particular interest in understanding prices in the United States, we

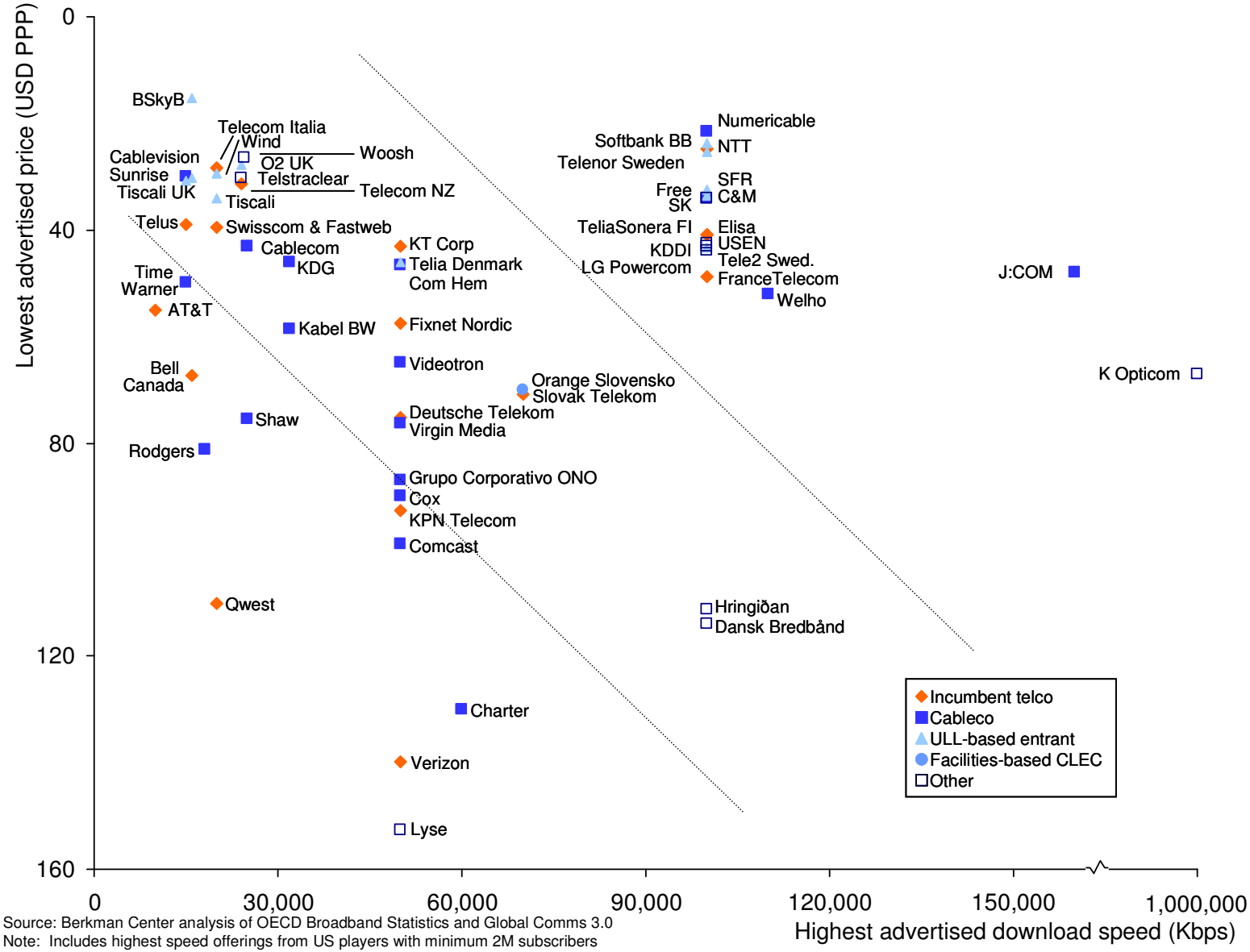
decided to complement our initial findings with these additional, independent searches to assure that we were not missing much better offerings available in the United States. As a result, we indeed include more offerings at the highest speeds, and substantially better-priced offerings than were available purely by examining our combined data set as described in Part 4 above. The results, as we describe them here, are therefore highly biased in favor of U.S. firms. We found, for example, that were we to use the same methods in Japan, we would have to include another offering from KDDI that is as fast as K-Opticom's 1Gbps offer, at an even lower price, and TeliaSonera Sweden would join the group of highest-speed, lowest-price offerings. We, nonetheless, chose to report the more expanded U.S. set because even with the strong bias in favor of U.S. firms our initial important finding, of high prices and low speeds, holds, and because the few discrete observations we made for firms elsewhere also tended to cohere with observations we found in the data set.

Our methodology resulted in 59 observed offerings. We then used the company profiles and our own research to characterize each firm in our data set as an incumbent telephone company, a cable company, an unbundling-based entrant, a facilities-based telecommunications provider, that is, a provider that came in and built its own telecommunications facilities not based on existing infrastructure like cable or power, and "other," which includes primarily power companies. For companies like Telenor, Norway's incumbent, we characterized offerings from Telenor in Sweden as made by an entrant, not an incumbent, because that is its role in the Swedish market. Where a firm uses mixed approaches, but we knew precisely how it provided the particular offer, we characterized the firm using that technique. Numericable in France, for example, is characterized as a cable company in our findings here, because although it also offerings unbundling-based DSL services at the high speed tier, using its newly acquired Completel unit, the offering we report here, in the very high speed tier, is available only over its cable lines.

Conclusion

Our complete findings are described in the main text. In brief, we found that the highest prices and lowest speed combinations occur in North America, where there are no unbundling-based entrants, and where both the United States, formally, and Canada, practically, have come to rely on inter-modal competition, in most cases between at most two regional competitors in any given regional market. Conversely, the lowest prices and highest speeds are offered by firms that occupy a market with unbundling-based entrants alongside incumbent telecommunications companies and facilities-based competitors, both cable and power. Furthermore, the very tight clustering of offerings in France, Japan, Sweden, South Korea, and Finland suggests highly competitive markets that are functioning at more or less the frontier of the feasible, particularly given the tight clustering of price/speed offerings across firms in these many different markets. This becomes particularly obvious when compared to the more scattered offerings by U.S. firms ranging from the bottom left to top left quadrants. The presence of the French firms, where there is so little facilities-based competition, all in the top right hand quadrant suggests that open access and, in particular, unbundling, rather than facilities-based competition, is a major driver of the effect. But the national character of markets is also observable from the tight clustering of Swisscom, Fastweb, Cablecom, and Sunrise in the top left hand quadrant for Switzerland, the near-identical offerings by Orange Slovenska and Slovak Telecom, and the emphasis of British firms BSkyB, Tiscali UK, and O2 UK on lower speeds.

Figure 4.15. Best price for highest speed offering



Source: Berkman Center analysis of OECD Broadband Statistics and Global Comms 3.0
Note: Includes highest speed offerings from US players with minimum 2M subscribers

4.13 Annex: Unbundling econometric analysis

4.13.1 2007 de Ridder paper

The de Ridder report (OECD, 2007) collects 11 possible covariates to predict QTOT, the total broadband usage in the 30 OECD countries. The first data set uses 2005 compiled data, and the second dataset, called the Panel dataset, includes both 2002 and 2005 data. The covariate treatment of deliberate interest is a variable GUYRS, which represents the total number of years since a country adopted unbundling.

The analysis technique was unweighted least squares linear regression, and a "step down"[100] method was applied. The demand variables (Price in terms of log of DSL price, GDP per capita, education, any-speed Internet saturation, and weather) were analyzed separately from the supply variables. The supply variables include: LNPDSL – the price of DSL in log; UURB – the percentage of population that resides in urban areas; CFAC – the amount of competition, represented by the percentage of non-DSL lines in QTOT; and GUYRS – the number of years since adoption of unbundling. Since the regressions including GUYRS are the only ones of interest, we will restrict our analysis to those results.

When the Panel data was used, all $30 \times 2 - 6 = 54$ data points (6 data points from 2002 were deemed to be unreliable) were used together in a series of OLS regressions, and a dummy variable to represent the difference in years. The covariate treatment of deliberate interest is the variable GUYRS. The coefficient of the dummy variable can be interpreted as the average amount of growth in broadband penetration throughout the OECD, controlling for changes in other variables that occurred over the three year period between 2002 and 2005.

According to de Ridder, there are a number of significant findings regarding GUYRS:

1 In 2005 data alone, when Price of DSL is included, GUYRS is not significant. GUYRS is significant in two regressions, when included with UURB + CFAC and with UURB alone. These achieve about 52% adjusted R^2, and pin the effect of policy at about 1.25, or about an additional 1.25% use of broadband per year of policy adoption.

2 Price in the 2005 datasets has a negative effect, and comparatively around 2%. Because this is $\log_e$-price as measured, broadband use increases ($0.69 \times 2.5 =$) 1.7% for every halving in the price of DSL.

3 When Panel data is used, including 2002 and 2005 data in a model, GUYRS is significant for several regressions, including one large supply model when Price is used (PDSL + UURB + CFAC + GUYRS + DUMMY). In this model, the $t - stat = 3.17$ significant GUYRS variable is measured to have a 0.596% effect for every year of adoption, but it has its most value an alternative regression (CFAC + GUYRS + DUMMY), where it has a 0.94% effect and the adj-R^2 is 62%.

100 By "Step Down," we mean that de Ridder tends to start with the largest possible model (or the largest possible demand and the largest possible supply model), finds the linear regression coefficients, and then chooses smaller models in a succession.

Critique of de Ridder

The 2008 New Zealand Institute (Boyle, 2008) critique of de Ridder focuses on the Panel data and critiques the regression:

QTOT ← (PDSL + UURB + CFAC + GUYRS + DUMMY)

The critique focuses on regressions with both Log-price-of-DSL and GUYRS. Their results can be summarized as follows:

1. When a Robust regression in the Arellano and Peterson sense is used, the GUYRS in this regression has fallen out of significance, into a non-statistically-significant 0.6% estimate.

2. An effect of 0.6% per year of adoption is a small effect compared to the three year dummy variable, which correspondingly adds about 7% broadband penetration over the three year period.

Implementation issues in the critique

The Arellano method (Arellano, 1987) is not necessarily standard, considering that the Peterson paper (Peterson, 2007) advertising it came out the same year as the de Ridder paper was published. We agree that a linear regression is inadequate for the Panel data, and believe that country effects must be modeled within the analysis as a significant source of correlated error. However, the Arellano estimate as described is an exclusively within-group estimator. In the OECD Panel data, there are only at maximum two points of data per group (i.e., country), and six countries have only one source of data. A within-group estimate subtracts out the group-effect by fitting a regression based upon deviation in covariates about a group mean. In this data set, within-groups, there is little variation in the covariates. For most data, the GUYRS variable for 2005 is exactly three years more than the 2002 data. This means the variable is nearly computationally identical to the dummy variable, which is a 0 for 2002 and a 1 for 2005 data. We seek to learn about between group variation, to compare countries with little or no GUYRS to those with more years of unbundling.

We used a mixed effects model:

$$\underbrace{Y_{it}}_{QTOT} = \beta_0 + \underbrace{X_{it}}_{Covariates} \underbrace{\beta}_{FixedEffects} + \underbrace{Z_i}_{GroupEffectCountryi} + \varepsilon_{it}$$

Where country effects are pre-supposed to be independently distributed $Z_i \sim N(0, \tau^2)$. Error terms ε_{it} could be correlated within country. The R-package "lme4" implementation of mixed effects regression was used to get the point estimate for $\hat{\beta}$. To use more robust scores for the standard error, a White-based variance estimate was used by calculating fixed-model residuals:

$$\hat{u}_{it} = Y_{it} - X_{it}\hat{\beta}^{LME4}$$

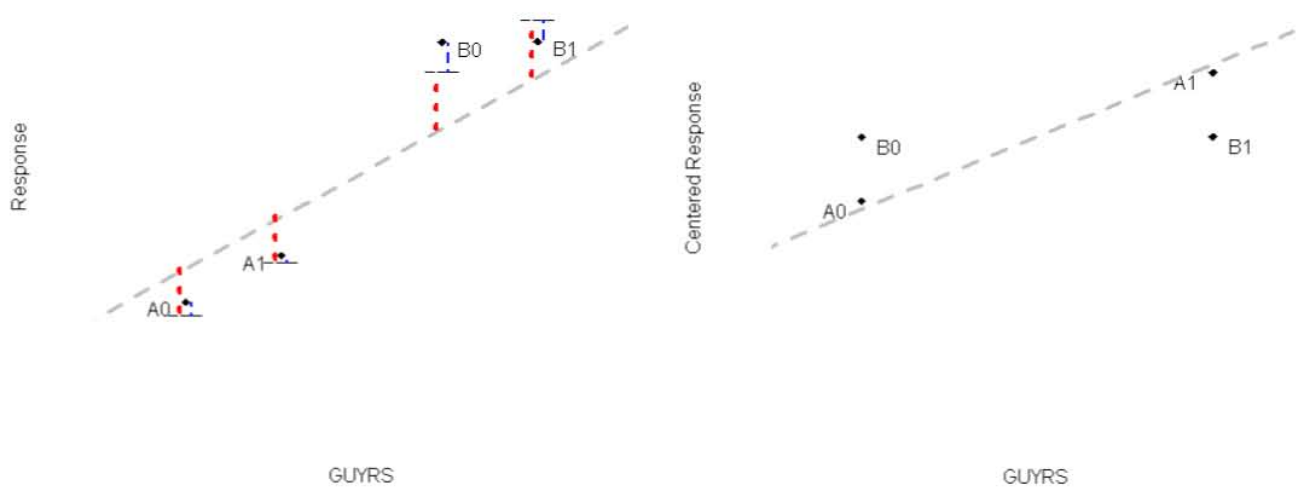
Thus $\hat{u}_{it}$ is an estimate for $Z_{it} + \varepsilon_{it}$. The Sandwich estimator used for S.E. $\left(\hat{\beta}\right)$ was then:

$$\hat{V}ar\left(\hat{\beta}^{LME4}\right) = (X^T X)^{-1}\left\{\sum_{it} X_{it}^T \hat{u}_{it}^2 X_{it}\right\}(X^T X)^{-1}$$

We then have replaced the Arellano estimator variance term $\left(X_{i0}^T X_{i1}^T\right)\begin{bmatrix}\hat{\varepsilon}_{i0}^2 & \hat{\varepsilon}_{i0}\hat{\varepsilon}_{i1} \\ \hat{\varepsilon}_{i0}\hat{\varepsilon}_{i1} & \hat{\varepsilon}_{i1}^2\end{bmatrix}\begin{pmatrix}X_{i0} \\ X_{i1}\end{pmatrix}$ with sum $\hat{u}_{i0}^2 X_{i0}^T X_{i0} + \hat{u}_{i0}^2 X_{i1}^T X_{i1}$. If correlation amongst residual errors comes from error in measuring the country effect, this error estimate accounts for $\hat{Z}_i$ within-country error.

Still, the standard errors are not as large as the Arellano estimates, and the error for the GUYRS coefficient, whose information is concentrated in between-country effects, is smaller.

Figure 4.16. Difference between within groups estimator and usual mixed effects estimator. Both the within groups estimator and the mixed effects estimator are trying to estimate a linear model with normally distributed groups effects. Consider, the data simulated here with a true line of slope 1 and two groups of data points, the Group A and the Group B which are significantly separated on the GUYRS scale. The standard deviation for the country effect is four times the usual noise. A usual mixed effects regression would try to assess a noise distribution for the country effects (red lines) and produce estimates for the country effect along with the linear regression factors. A within groups estimate deletes country effect from the model by separating out the mean X values and Y values within each country and replotting the data points on a centered scale. In the case of the GUYRS variable, which had significant between country variation, this can lead to an estimator with a very wide variance. Arguably, with only two countries, it is very difficult to perceive an effect. A linear regression for the plot on the left would over estimate the true effect. A linear regression for the within groups plot on the right would under-estimate the true effect. However, when the country count gets larger, 30 in our dataset, the mixed effects estimate will produce a GUYRS coefficient estimate with much less standard error than an estimator that did not use between groups information. Later tests performed attempted to assess the robustness of the mixed effects regression that we have posed. We feel confident that the only country whose removal generated a large change in the point estimate was Switzerland, and removing Switzerland would have produced a much larger coefficient effect, not a smaller one.



Collinearity and endogeneity in the GUYRS

Significant focus has been placed on de Ridder's Panel regression:

$$\underbrace{Y_{it}}_{QTOT} = \beta_0 + (LNPDSL)_{it}\beta_1 + (UURB)_{it}\beta_2 + (CFAC)_{it}\beta_3 + (GUYRS)_{it}\beta_4 + (DUMMY)_{it}\beta_5 + \varepsilon_{it}$$

In this linear model, both the log of the DSL price (LNPDSL), and competition as measured in amount of alternate sources to broadband (CFAC) are included, along with the variable GUYRS. Later regressions also included SIP, the overall nationwide Internet penetration, both broadband and dialup. De Ridder found a residual positive effect for GUYRS. However, GUYRS arguably has an effect on the price of DSL (the reverse could also be argued), as well as the amount of competition or Internet penetration. If GUYRS were to solely increase broadband use by reducing price, then one would fully expect β_{GUYRS} to be negligible in this model. Instead, the positive $\hat{\beta}_{GUYRS}$ estimate describes the residual effect, after taking into account price, that unbundling has on broadband use. Explaining this residual mechanism could be difficult; it may be that consumers find it easier to obtain broadband now that a preferred company offers it.

When using linear regressions it is often difficult to explain a causal effect from observed correlations. In natural experiments of this sort, a procedure of matched-pairs analysis, such as in (Rubin, 1974), matching countries with similar levels of other covariates though different values of treatment (in this case the GUYRS level), and measuring the difference in response between pairs, is a better standard. However, the OECD data set is small, and the pre-supposed treatment variable GUYRS is measured on a continuous scale. Rather than eliminate the former analyses, we checked to see whether linear regressions could be deemed appropriate. We attempted to predict treatment variable GUYRS from the rest of the covariates, to test for unbalance. If other covariates of the predictors are too high, we can assume we need either matching or a more advanced model. Here is the result of a linear regression predicting GUYRS based upon other variables:

	Estimate	Std. Error	T value	Pr(>|t|)
Intercept	-1.7034	8.0822	-0.21	0.8350
LNPDSL	-0.9575	0.3393	-2.82	0.0099
UURB	-0.0303	0.0411	-0.74	0.4681
CFAC	0.0247	0.0267	0.92	0.3661
AGE	0.3950	0.2543	1.55	0.1346
SIP	0.0332	0.0455	0.73	0.4729
SUN	-0.2201	0.3810	-0.58	0.5694

The adjusted R^2 of this regression is 37%, meaning that still 63% of variation in GUYRS cannot be accounted for with the other variables. We see that the price of DSL is the only significant predictor in this model. However, when Switzerland is removed from the model, the adjusted R^2 rises to near 60%. Switzerland has many covariates similar to high GUYRS countries, specifically a low price for broadband, though it did not adopt unbundling.

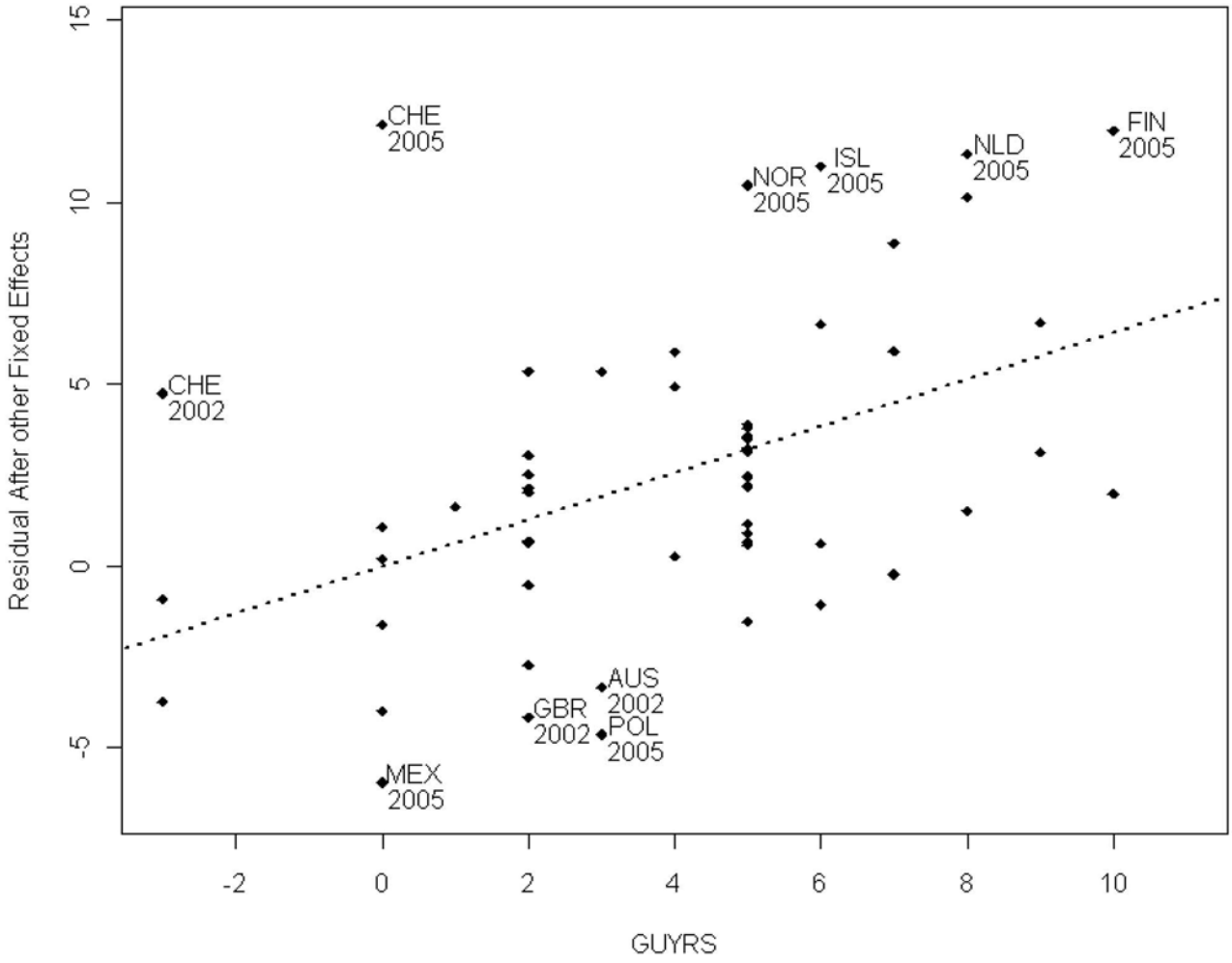
We take from this analysis a caveat that GUYRS influence on broadband penetration might still act mainly through price, but that there is enough balance on price that a linear regression might identify a residual direct effect.

Relating dummy estimate to GUYRS/year

As stated earlier, the GUYRS variable is measured in years from adoption of unbundling regulation. The dummy variable in the Panel regressions represents the gain in Broadband between the years 2002 and 2005. Thus the dummy variable is a three year effect. It is still true that a ≈ 0.6% effect per year for GUYRS is dwarfed by a ≈ 7% effect for the dummy, though it should be noted that for a fair comparison, the GUYRS estimate should be multiplied by 3.

Arguably, it is appropriate to measure GUYRS as a linear effect in time. Using mixed effects regression for QTOT as a function of (LNPDSL + UURB + CFAC + GUYRS + "random-Country Effect") we see that the GUYRS residual effect in Figure A.2 does seem to be well described by a linear effect. However, for a more robust analysis, we will give output for GUYRS as measured as a 0 or 1 variable, 0 if the country had not adopted the policy at the time, 1 if it did.

Figure 4.17. A mixed effects regression was used to predict QTOT, using LNDSL, CFAC, UURB, GUYRS, and a random country-group effect. This plot is the residual noise (using the measured effects for all fixed variables other than GUYRS) as a function of the GUYRS variable measured in years. A linear trend seems sufficient to explain a percentage of this variation.



The other issue is the negative values for GUYRS, which were used in the de Ridder analysis and the critique, which described GUYRS 2002 levels with negative values. This seems inappropriate. Countries did not gain a GUYRS effect when they moved from -3 values of adoption to 0. Both the 2002 and the 2005 value should be zero for countries that had no unbundling in either 2002 or 2005.

4.13.2 Revised analyses

Original GUYRS variable

We first reanalyzed the same regressions of de-Ritter's report (OECD, 2007), using a non-negative GUYRS variable, and our robust mixed-effects analysis for the Panel data. We ran the same series of 2002-2005 Panel regressions covered in de Ridder, plus one additional regression QTOT ← UURB + CFAC + GUYRS + DUMMY, with a mixed effects regression, and with GUYRS correctly coded for negative values, we see that GUYRS is largely significant in most models, as long as both Age and SIP (the overall rate of Internet penetration) are not included in a large-as-possible model.

Table 4.2 . This table relates linear regressions for the original de Ridder analysis using 2005 data only. Since 2005 GUYRS values do not contain negative values; our analysis is identical to de Ridder's on this dataset.

	Regression #1			Regression #2			Regression #3		
Intercept	-5.35	(6.97)	[-0.767]	-19.59	(7.171)	[-2.732]	-19.02	(7.056)	[-2.695]
LNPDSL	-2.79	(0.743)	[-3.756]						
UURB	0.32	(0.077)	[4.092]	0.35	(0.094)	[3.713]	0.35	(0.093)	[3.811]
CFAC	0.06	(0.051)	[1.112]	0.04	(0.062)	[0.697]			
GUYRS	0.57	(0.347)	[1.655]	1.29	(0.357)	[3.597]	1.33	(0.347)	[3.84]
LNPREL									
AGE									
SIP									
R-Squared	0.72	0.672%-adjs		0.56	0.507%-adjs		0.55	0.517%-adjs	

	Regression #4			Regression #5		
Intercept	-22.72	(10.155)	[-2.238]	-35.33	(13.549)	[-2.608]
LNPDSL						
UURB	0.19	(0.057)	[3.407]	0.3	(0.072)	[4.17]
CFAC						
GUYRS						
LNPREL	-2.37	(0.485)	[-4.883]	-3.57	(0.577)	[-6.191]
AGE	0.52	(0.353)	[1.473]	0.92	(0.474)	[1.934]
SIP	0.3	(0.06)	[4.94]			
R-Squared	0.87	0.852%-adjs		0.75	0.72%-adjs	

Table 4.3 A table of coefficient magnitudes, standard errors, and *t*-statistics performing 6 multiple mixed-effects regressions predicting QTOT total broadband penetration for the 30 OECD data set (30 (2005) + 24 (2002) = 54 data points.

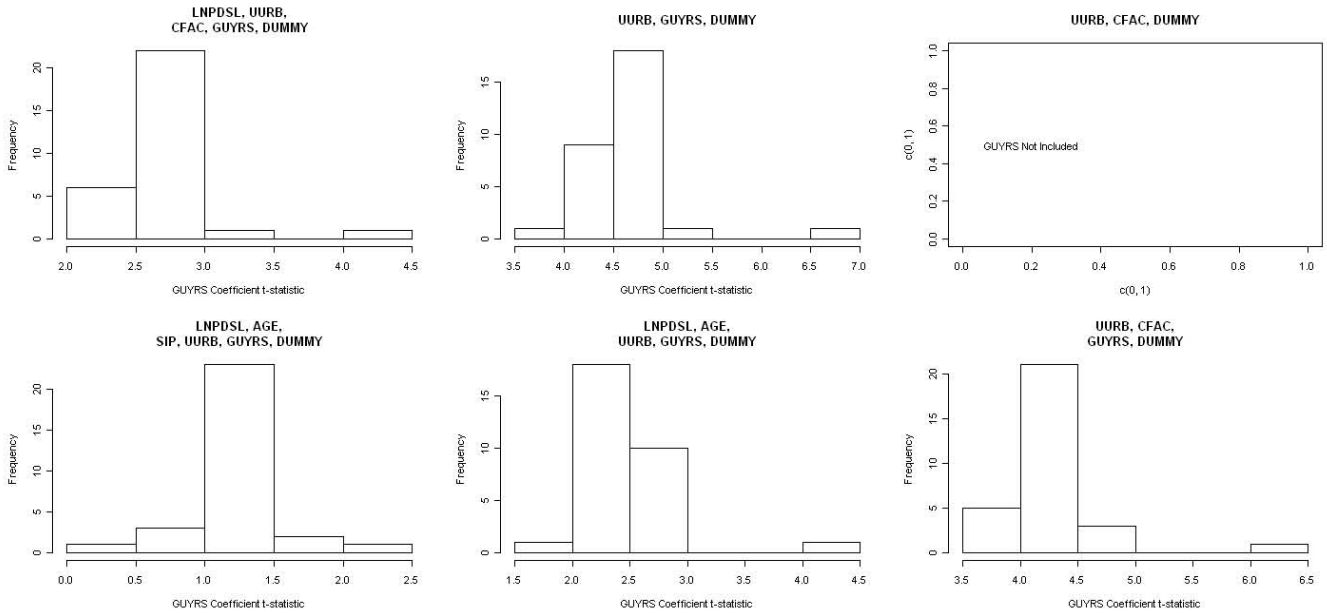
	Regression #1			Regression #2			Regression #3			Regression #4		
Intercept	-12.04	(4.824)	[-2.496]	-20.9	(3.793)	[-5.509]	-25.07	(6.238)	[-4.019]	-23.72	(7.408)	[-3.202]
Dummy	7.44	(1.339)	[5.557]	7.75	(1.387)	[5.583]	12.21	(1.522)	[8.024]	8.22	(1.118)	[7.349]
LNPDSL	-1.98	(0.458)	[-4.323]							-1.75	(0.342)	[-5.118]
UURB	0.27	(0.048)	[5.588]	0.29	(0.049)	[5.942]	0.33	(0.072)	[4.605]	0.16	(0.04)	[4.114]
CFAC	0.05	(0.021)	[2.476]				0.08	(0.029)	[2.706]			
GUYRS	0.64	(0.266)	[2.427]	1.11	(0.255)	[4.366]				0.25	(0.214)	[1.153]
AGE										0.58	(0.273)	[2.111]
SIP										0.21	(0.048)	[4.407]
R-squared	0.76	0.734%-adjs		0.68	0.661%-adjs		0.52	0.487%-adjs		0.84	0.823%-adjs	

	Regression #5			Regression #6		
Intercept	-29.9	(9.464)	[-3.159]	-24.02	(4.292)	[-5.597]
Dummy	6.79	(1.22)	[5.569]	8.77	(1.51)	[5.809]
LNPDSL	-2	(0.401)	[-4.982]			
UURB	0.24	(0.048)	[5.055]	0.3	(0.051)	[5.865]
CFAC				0.06	(0.026)	[2.283]
GUYRS	0.59	(0.252)	[2.337]	1.08	(0.263)	[4.12]
AGE	0.78	(0.356)	[2.202]			
SIP						
R-squared	0.78	0.751%-adjs		0.68	0.65%-adjs	

Since GUYRS is correlated with the price of DSL and Internet Penetration, one needs to ask whether a regression with both terms included is worthwhile. If GUYRS were to act to change broadband use by lowering the price of broadband, then using LNPDSL in the model might confuse the effect. Since GUYRS has significant *t*-statistics even in models when the price is included, we now seek an explanatory mechanism for this residual effect. Because we have limited ourselves to DSL prices, this residual effect might come from reduced prices in other broadband options, or the generation of competition might lead to increased access to regions that were previously under-supplied with broadband. Since the regression with both price of DSL and Internet Penetration in the model has a non-significant GUYRS effect, this combination may be the best way to interpret how a legal unbundling results in increased broadband usage.

Finally, we point out the sensitivity of these model measurements for the GUYRS variable in Figure 2.1. One of the main influential points on this regression is Switzerland's effect. The inclusion of Switzerland in the dataset tends to reduce the *t*-statistic for GUYRS, since it is a country that did not adopt unbundling, though it has significant broadband usage. Eliminating Switzerland may result in a doubling of the *t*-statistic for some of these regressions. However, no single country has as large a single effect in supporting the model. Other than in Regression #5 (LNPDSL + AGE + UURB + GUYRS + DUMMY), where eliminating Finland from the dataset results in a non-significant regression, the significant *t*-statistics seem to be robust to outliers.

Figure 4.18 . Histograms of *t*-statistics for the GUYRS coefficient in the six regressions from Table 4.3. In each histogram, the thirty regressions (each eliminating one country from the dataset) are taken, the t-statistics for the GUYRS coefficient is collected, and the distribution of these t-statistics are plotted in the histogram. Regression #3 (UURB+CFAC+DUMMY), on the top right, does not include the GUYRS variable. In these regressions, eliminating Finland, Iceland, Not-Applicable, Japan, Finland, and Iceland, respectively, results in the lowest possible t-statistic. In Regression #5 (LNPDSL + AGE + UURB+GUYRS+DUMMY), eliminating Finland is enough to take the GUYRS coefficient out of statistical significance. In no other regression does taking out a data point significantly alter the regression. However, the country of Switzerland seems to have a significant dampening effect on regressions #1, #2, #5, and #6. Switzerland represents the right most outlier in those histograms. Eliminating Switzerland results in much more significant models than when it is included.



4.13.3 An alternate GUYRS variable

After collection and review, a replacement set for the original GUYRS variable has been proposed. A change to this variable results in many more countries defined to have GUYRS = 0 than before.

Table 4.4. Performing the linear regressions on the 2005 dataset using the alternate specification for GUYRS. Now GUYRS seems to have larger effects.

	Regression #1			Regression #2			Regression #3		
Intercept	-11.16	(6.514)	[-1.713]	-21.14	(5.693)	[-3.713]	-20.36	(5.675)	[-3.588]
LNPDSL	-1.87	(0.738)	[-2.528]						
UURB	0.35	(0.069)	[5.104]	0.39	(0.074)	[5.25]	0.4	(0.074)	[5.357]
CFAC	0.06	(0.044)	[1.311]	0.05	(0.049)	[1.113]			
GUYRS	1.1	(0.34)	[3.239]	1.67	(0.278)	[6.006]	1.71	(0.278)	[6.14]
LNPREL									
AGE									
SIP									
R-Squared	0.78 0.744%-adjs			0.72 0.691%-adjs			0.71 0.688%-adjs		

	Regression #4			Regression #5		
Intercept	-22.72	(10.155)	[-2.238]	-35.33	(13.549)	[-2.608]
LNPDSL						
UURB	0.19	(0.057)	[3.407]	0.3	(0.072)	[4.17]
CFAC						
GUYRS						
LNPREL	-2.37	(0.485)	[-4.883]	-3.57	(0.577)	[-6.191]
AGE	0.52	(0.353)	[1.473]	0.92	(0.474)	[1.934]
SIP	0.3	(0.06)	[4.94]			
R-Squared	0.87 0.852%-adjs			0.75 0.72%-adjs		

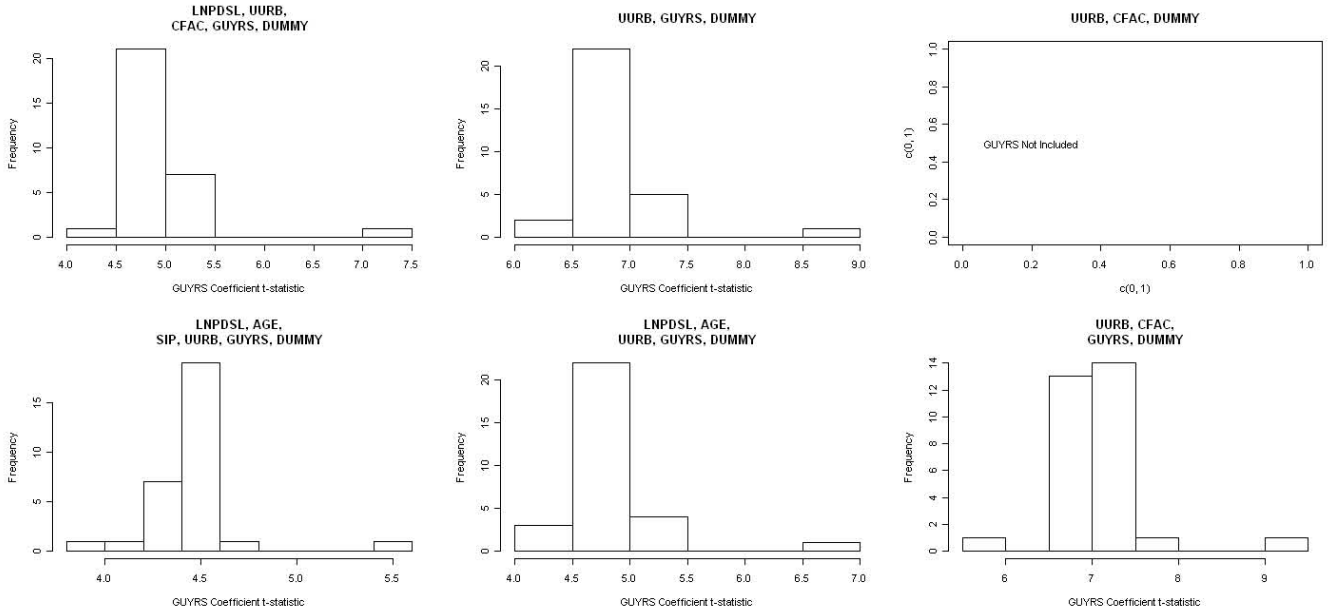
With this alternate specification, GUYRS now has *t*-statistics greater than 3 in all regressions where it is included. The effect is enlarged to approximately 1% of broadband penetration per year of adoption of unbundling. As a comparison, the dummy variable, which represents 3 years of effect, generates about 7 to 12% increase in broadband over three years, or 2 to 4% per year.

Table 4.5. A running of the Panel regressions from Table 4.3, now with the Alternate GUYRS specification. GUYRS is much more significant in all regressions.

	Regression #1			Regression #2			Regression #3			Regression #4		
Intercept	-13.97	(3.719)	[-3.755]	-20.18	(3.229)	[-6.251]	-25.07	(6.238)	[-4.019]	-28.81	(6.064)	[-4.752]
Dummy	6.8	(1.117)	[6.087]	6.95	(1.249)	[5.563]	12.21	(1.522)	[8.024]	7.3	(1.015)	[7.196]
LNPDSL	-1.67	(0.367)	[-4.532]							-1.43	(0.253)	[-5.66]
UURB	0.29	(0.033)	[8.936]	0.32	(0.04)	[7.82]	0.33	(0.072)	[4.605]	0.2	(0.039)	[5.081]
CFAC	0.06	(0.017)	[3.717]				0.08	(0.029)	[2.706]			
GUYRS	0.98	(0.155)	[6.306]	1.27	(0.174)	[7.312]				0.64	(0.154)	[4.183]
AGE										0.68	(0.207)	[3.31]
SIP										0.17	(0.048)	[3.537]
R-squared	0.83 0.81%-adjs			0.75 0.734%-adjs			0.52 0.487%-adjs			0.88 0.862%-adjs		

	Regression #5			Regression #6		
Intercept	-34.49	(7.881)	[-4.377]	-23.86	(2.842)	[-8.396]
Dummy	6.07	(1.034)	[5.865]	7.95	(1.213)	[6.554]
LNPDSL	-1.67	(0.299)	[-5.575]			
UURB	0.26	(0.038)	[6.766]	0.33	(0.033)	[9.844]
CFAC				0.07	(0.022)	[3.118]
GUYRS	0.91	(0.154)	[5.886]	1.32	(0.163)	[8.102]
AGE	0.9	(0.253)	[3.543]			
SIP						
R-squared	0.84 0.819%-adjs			0.77 0.753%-adjs		

Figure 4.19. Using the alternate specification, we inspect here the sensitivity to countries for the Panel regressions in Table 4.4, in the same manner as Figure 4.18. We see that Switzerland again has a strong effect toward making the regressions more significant, but no single country will either make or break this regression, suggesting a more robust regression for all GUYRS estimates.



Alternate GUYRS variable, zero or one

The Years specification for GUYRS unbundling may not be the best representation of the effect of unbundling adoption. As an alternative, we code countries that have adopted unbundling as a 1, and countries before adoption as a 0. Using the new specification to define unbundling countries, the Panel regressions now appear as:

Table 4.6 . The 2005 table using GUYRS as a 0 or 1 variable, using the alternate values

	Regression #1			Regression #2			Regression #3		
Intercept	-4.9	(6.536)	[-0.75]	-19.21	(7.404)	[-2.594]	-18.59	(7.287)	[-2.552]
LNPDSL	-2.9	(0.66)	[-4.398]						
UURB	0.33	(0.075)	[4.334]	0.38	(0.097)	[3.881]	0.38	(0.096)	[3.995]
CFAC	0.05	(0.049)	[1.082]	0.05	(0.065)	[0.715]			
GUYRS 0/1	3.81	(1.804)	[2.112]	6.99	(2.159)	[3.237]	7.29	(2.099)	[3.474]
LNPREL									
AGE									
SIP									
R-Squared	0.73 0.692%-adjs			0.53 0.474%-adjs			0.52 0.484%-adjs		

	Regression #4			Regression #5		
Intercept	-22.72	(10.155)	[-2.238]	-35.33	(13.549)	[-2.608]
LNPDSL						
UURB	0.19	(0.057)	[3.407]	0.3	(0.072)	[4.17]
CFAC						
GUYRS 0/1						
LNPREL	-2.37	(0.485)	[-4.883]	-3.57	(0.577)	[-6.191]
AGE	0.52	(0.353)	[1.473]	0.92	(0.474)	[1.934]
SIP	0.3	(0.06)	[4.94]			
R-Squared	0.87 0.852%-adjs			0.75 0.72%-adjs		

Table 4.7. The new definition of GUYRS is modified to have only 1 or 0 values for unbundling adoption. These are the fits for the six mixed effects regressions from previous Table 4.3 and Table 4.5

	Regression #1			Regression #2			Regression #3			Regression #4		
Intercept	-11.88	(5.115)	[-2.322]	-22.23	(4.062)	[-5.473]	-25.07	(6.238)	[-4.019]	-28.96	(6.977)	[-4.15]
Dummy	8.6	(1.297)	[6.629]	10.29	(1.184)	[8.69]	12.21	(1.522)	[8.024]	8.68	(0.97)	[8.952]
LNPDSL	-2.23	(0.458)	[-4.87]							-1.7	(0.304)	[-5.584]
UURB	0.28	(0.045)	[6.083]	0.31	(0.05)	[6.144]	0.33	(0.072)	[4.605]	0.17	(0.039)	[4.452]
CFAC	0.06	(0.018)	[3.064]				0.08	(0.029)	[2.706]			
GUYRS 0/1	3.84	(1.026)	[3.737]	5.38	(1.25)	[4.308]				2.89	(0.832)	[3.471]
AGE										0.72	(0.233)	[3.068]
SIP										0.19	(0.043)	[4.474]
R-squared	0.78 0.76%-adjs			0.66 0.637%-adjs			0.52 0.487%-adjs			0.87 0.848%-adjs		

	Regression #5			Regression #6		
Intercept	-35.69	(8.635)	[-4.133]	-25.72	(4.437)	[-5.796]
Dummy	7.85	(1.115)	[7.037]	11.4	(1.269)	[8.98]
LNPDSL	-2.15	(0.366)	[-5.88]			
UURB	0.24	(0.045)	[5.373]	0.32	(0.05)	[6.358]
CFAC				0.06	(0.026)	[2.502]
GUYRS 0/1	4.03	(0.97)	[4.158]	5.2	(1.231)	[4.225]
AGE	0.99	(0.271)	[3.647]			
SIP						
R-squared	0.81 0.785%-adjs			0.67 0.64%-adjs		

Using sensitivity analysis, we see that in this case, Switzerland's effect is not quite as large. In the five regressions that include GUYRS, the greatest effect on the GUYRS *t*-statistic can be found from Switzerland, Switzerland, Mexico, Switzerland, and Finland, respectively. Removing a country does not take away the significance from the GUYRS variable.

Figure 4.20. As in Figure 4.19, it seems that the GUYRS coefficients for the regressions in Table 4.7 have some outlier countries. However, this country is not always Switzerland.

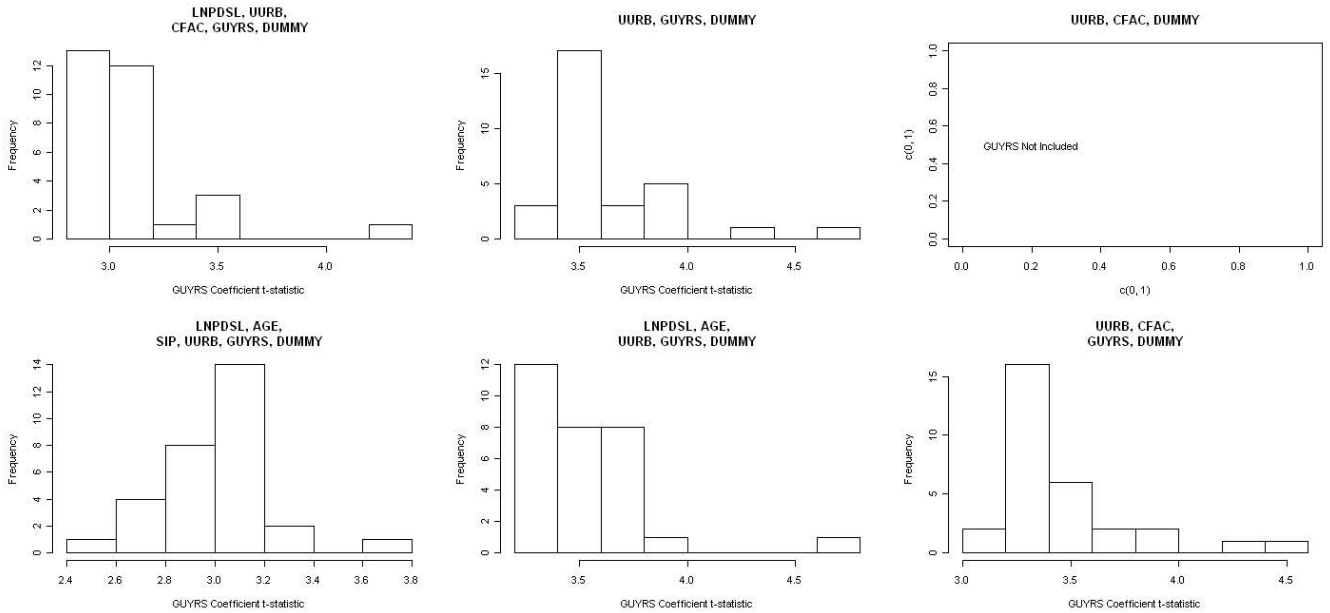


Table 4.8. Alternative values for GUYRS based on actual adoption patterns

Australia	6	1	Reflects the resistance by Telstra, and the high prices until the competition notice issued in March 2004 by ACCC, which reportedly led to lower prices.
Austria	7	5	Reflects that Austria Telekom failed to comply with the 1999 Order that seems to be the basis of the 7 year designation here; instead it was in 2001 in response to the EC directive that Telkom Austria did some more unbundling, and when UPC actually was able to enter using unbundling.
Belgium	5	0	Reflects continuing complaints, to this day, about absence of LLU; all entrants who are not facilities based, about 22% of the market, are resellers. This suggests no real competition on network management, which may explain the data cap anomaly.
Canada	9	5	Reflects initial sunset and high LLU rates, followed by the 2001 decision to extend LLU indefinitely and reduction in service charges.
Czech Rep.	2	2	No change
Denmark	8	8	No change
Finland	10	10	No change
France	5	4	Reflects delayed implementation between formal adoption in 2001 and actual implementation following EU action in 2002
Germany	8	0	Reflects DT resistance and BnetzA lack of capacity

Country	Original GUYRS	Alternative value	Justification for alternative value
Greece	5	0	Reflects the fact that only in May of 2007 was LLU regulation changed, and a new framework put in place that seems to have resulted in a shift of some of the wholesale/carrier pre-selection model operators shifting to more unbundling
Hungary	4	4	Insufficient data to form an opinion
Iceland	6	6	No change.
Ireland	5	0	Eirecom litigated extensively to delay the regulator, and succeeded in delaying implementation of unbundling throughout the relevant period.
Italy	5	5	Data is ambiguous about quality of implementation; insufficient data to argue that there was in fact no real LLU uptake
Japan	9	6	Reduces the period to reflect the weakness of MPT until the passage of the new requirements by MIC in 2000
South Korea	4	9	Reflects the fact that Thrunet entered over access to incumbent facilities—cable owned by Kepco.
Luxembourg	5	0	Justified by claim that incumbent effectively only offers an unregulated wholesale product to competitors, with no effective enforcement to the contrary
Mexico	0	0	No change.
Netherlands	9	5	Reflects exclusion of competitors from naked DSL until 2001.
New Zealand	0	0	NZ changed only after 2005
Norway	5	5	No change.
Poland	3	0	Reflects the fact that Netia only enters unbundling in 2007, and Multimedia Polska Stillhas had to get an ad hoc decision from the regulator as late as August of 2007 on its unbundling arrangement with incumbent TP Group. That a regulator still needs to rule on a negotiation is a good sign that LLU has not been implemented seriously.
Portugal	5	3	2002 citation by EU of Portugal as a particular site of lack of compliance with the unbundling directives.
Slovak Rep.	0	0	Should remain 0. LLU never passed, only promised. Still not passed.
Spain	5	4	Reflects the April 2002 new reference offer reducing LLU rates by 30%.
Sweden	5	5	No change.
Switzerland	0	0	No change.
Turkey	0	0	No change.
UK	5	0	Reflects unobserved BT resistance that led to massive jump in unbundled loop usage after functional separation implemented in 2005
US	10	0	Reflects 2001-02 FCC decisions to shift to intermodal competition

4.13.4 References

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5 Mobile broadband

A central part of next generation transition planning has been the integration of mobile broadband with fixed broadband networks. Where ubiquitous access is the emphasis, wireless broadband communications provide the critical component of mobile and nomadic access. The ability to be connected seamlessly everywhere is the driving force behind an emphasis on fixed-mobile convergence. Where basic fixed access competition is the concern, wireless is seen as a potential additional, lower-cost provider that can increase competition in broadband access to the home. And where concerns over equity and access in remote locations are the major focus, wireless technologies are seen as a major potential solution because of their lower costs.

The United States is in the fourth quintile of OECD countries in terms of 3G penetration. While the growth rate in U.S. subscriptions is high, and is 10th in the OECD, several countries with higher growth rates currently have lower levels of penetration than does the U.S. Because of this, it is unclear whether our current performance in 3G penetration will improve or decline in the near future.

It is difficult to pin down a particular policy or practice responsible for better performance in mobile broadband penetration. The primary regulatory differences between the United States and countries that are high-performing in the area of mobile data appear to be the later introduction of 3G-specific allocations in the United States, and the relative regional fragmentation of the licenses. In Europe, Japan, South Korea, and Australia, national regulators auctioned or awarded in beauty contests between three and five nationwide licenses intended specifically for 3G services. In the United States, the AWS auction (the first 3G-specific auction) was concluded five or six years later, in the latter half of 2006.

Because of the flexibility of licenses granted earlier, however, it is not correct to treat the 2006 AWS auction as the critical point of 3G licensing in the U.S. Most prominently, Verizon Wireless was the first U.S. mobile carrier to introduce 3G services; it did so in 2003 and continues to make flexible use of its allocations in the 800 and 1900 MHz bands for delivering 3G services. Similarly, Sprint Nextel, Leap Wireless, and Alltel use one or both of those bands for 3G services. On the other hand, AT&T Wireless and T-Mobile use only the later-allocated 1.7MHz or 2.1MHz bands for 3G services. It is certainly possible that the need to upgrade earlier equipment on the same channels, the uncertainty of when new spectrum would be available (the spectrum ultimately awarded in 2006 was first identified five years earlier), and the regional fragmentation contributed to relatively slow and uneven rollout. A clear benefit of the flexible allocations aspect of American policy, however, emerges when one considers that the most salient concern currently reported by European regulators is transitioning GSM spectrum, the 900 and 1800 MHz bands, over to 3G. The U.S. policy of flexible allocation *ex ante* allowed licensees to make that transition for themselves early on.

Nomadic access seems to have developed not from spectrum policies but from business models and public interventions. We noted in the prior chapter how competitive entrants, like Free in France or Telenor in Sweden, or incumbents like Swisscom and BT through Openzone, are innovating with new service models to extend their network using nomadic access. Similarly, we see public, municipal efforts contributing to the availability of nomadic access. This does not appear to be the result of any country-specific spectrum policy differences that we have observed. We therefore do not further elaborate here on our earlier emphasis on nomadic access in the context of benchmarking and access.

The tentative nature of our descriptions of wireless broadband policy is perhaps best captured by the European Regulator's Group June 2009 report on next generation transition. Regarding wireless policy, the ERG stated: "It would appear, however, that at this point is too soon to give a definite solution to or

present best practices to problems identified by NRAs and Member States on how to handle future transitional problems. The main reason for this is that while regulators are considering different ways to handle transitional issues, there is still little actual practice as such."[101] In this report, the ERG reported the primary current challenges faced by the European regulators as:

1. Refarming the 900 and 1800 MHz band originally allocated to 2G, GSM services. The problems here are:

    - The original grants do not permit the grantees to offer 3G services

    - Adding flexibility would give the original grantees an unfair advantage over competitors who have higher-frequency allocations, and would therefore face higher infrastructure costs with more base stations to deliver equivalent services

2. 790-862 MHz: the digital dividend spectrum, released by the transition to digital TV

3. 2.6 GHz band and 3.4-3.8GHz bands, both relatively less contentious but require increased regulatory flexibility to achieve their use, and in some cases to free them from incumbent occupants, including government users

These kinds of challenges are familiar to Americans, even if the specific frequencies are slightly different. The primary insight to be gained is from the difficulties raised by refarming the GSM bands. In theory, because of the flexible definitions of personal communications services allocations, the United States does not have a similar problem. We note, however, that the difficulty presented is as much about assuring that after the transition the countries continue to have a competitive market. The early advantage of Verizon in deploying 3G services may or may not be due to its ability to reuse its 800 and 1900 MHz bands. If it is, and if the advantage persists, then competitive imbalance may turn out to be a price the United States is paying for its early flexibility. This is a question that should require future observation.

We approach the 3G question using the same approach we used for our analysis of competition and access. We consider country-level case studies of firm behavior to identify the likely effects of policies that recur as important to shaping the market. Our review leads us to identify no definitive driver of high 3G penetration. We see countries with very different strategies and market structures doing well, and other countries without obviously different policies doing worse. Countries with auctions, for example, have done both well, and poorly. Countries with beauty contests have similarly performed on both sides of this divide. Countries with four or five simultaneous allocations have done well, and poorly. South Korea did very well even with what was initially a two-player allocation, for all practical purposes. Our primary conclusion is therefore that there is substantial need for additional study of mobile wireless policies and business models, to be extended to both mobile cellular architectures and nomadic access.

Of the top ten countries in terms of 3G penetration, four substantially outperform their fixed broadband penetration: Italy, 5th in 3G but 22nd in fixed; Spain, 7th in 3G by 20th in fixed; Australia, 3rd in 3G but 16th in fixed; and New Zealand, equal with the UK at 10th in 3G, but 18th in fixed. The top two countries, Japan and South Korea, are the overall high performers, as are Sweden (6th) and Finland (8th). Of these, only Sweden and the UK are truly high performers on nomadic access as well, with South

101 ERG (08) 60 rev 1; RSPG09-277, European Regulators Group and Radio Spectrum Policy Group Joint Publication, ERG-RSPG Report on transitional radio spectrum issues, June 2009, pp 23-24.

Korea making a respectable showing in that dimension as well. Here, we cover the consistently high performers first, then move to cover the low-fixed, high-mobile performers, and the low-mobile, high fixed performers (the Netherlands and Canada). We then look at the differences among the Nordic countries, where Sweden and Finland have substantially higher mobile broadband penetration than Norway and Denmark.

5.1 The consistently high performers: Japan and South Korea

Just as they do in fiber infrastructure, Japan and South Korea lead the world in 3G penetration as well. Japan has over close to 72 3G subscriptions per 100 inhabitants, and South Korea has 63. By comparison, the United States has 20.6 3G subscriptions per 100 inhabitants.

Japan awarded three identical, 2x20MHz paired spectrum blocks in a beauty contest to NTT DoCoMo, KDDI's au Corp, and Vodafone in June of 2000. NTT DoCoMo launched the world's first 3G network in 2001. DoCoMo still holds over 70% of 3G subscriptions. Vodafone was purchased by Softbank in 2006. Since then, Softbank Mobile has emphasized lower prices and cross-selling with its broadband service, and has invested in cellular infrastructure, more than doubling the number of base stations between 2006 and 2008 relative to the number it originally purchased from Vodafone. Softbank Mobile added more subscribers to its network in 2008 than either NTT DoCoMo or KDDI au Corp. The three-way competition, with smaller entrant eMobile (a division of eAccess, the owner of AOL Japan) well behind, has emphasized very high speed data and mobile video and music distribution, as well as lower prices. All the carriers no longer sell 2G services, and all are pushing to develop and launch 4G technologies.

On the regulatory front, the MIC has responded to the competitive structure of the 3G market by allocating more spectrum to 4G services in the 1.7 GHz range, as well as the bands originally intended to be allocated in the 1.5 GHz range, so as to expand the number of 4G licenses it intends to issue from three to four. This is intended to allow all four mobile carriers, including eMobile, to compete in the 4G market.

The South Korean experience must be treated with caution, as it appears to be a particularly salient example of the managed economy model of regulation. The South Korean MIC auctioned two identical 20 MHz blocks for 3G licenses in December 2000, to SKT and KTF (majority owned by KT). It then granted a third license to LGT in mid 2001, and actually awarded the three licenses simultaneously in November of 2001. LGT did not deploy at all, and was fined for the interim reservation period. In 2006, when the providers were not rolling out networks beyond Seoul, the MIC threatened them with fines. Investment followed throughout the country. Throughout 2006 the MIC fined SKT, KTF, and LGT for price fixing and illegal handset subsidies.

The most interesting move in South Korea is the shift, since 2007, toward encouraging fixed-mobile convergence. All carriers were permitted to integrate with fixed line providers, in moves described earlier in the Competition and Access part. This vertical integration was, as in Japan, accompanied by a requirement that the mobile carriers open their data networks to competitors. These requirements do not yet appear to have been implemented, and it is therefore too soon to tell what their effect on competition, availability, price, and service innovation in mobile data will be.

5.2 High mobile, low fixed performers

Italy, Spain, Australia, and New Zealand all substantially outperform their fixed-line penetration when it comes to mobile broadband networks.

Italy auctioned five identical licenses in October of 2000, each providing 2x10MHz paired and 1x5 unpaired blocks to each licensee. There were only five contenders, after one potential bidder, Blu, withdrew. Of the five licensees, Ipse 2000, a subsidiary of Spain's Telefonica Moviles, failed to deploy, and had its license revoked in 2006. The remaining four licensees: Telecom Italia Mobile, Vodafone Italy, Wind, and 3 Italia (owned by Hong Kong-based Hutchison-Whampoa) remain in intense competition today. 3 Italia launched 3G services first, in March 2003; while it remains the smallest of the four providers in terms of total mobile subscribers, it continues to be the largest 3G provider, with 34% of the 3G market, followed by Vodafone and Telecom Italia (29% each), and Wind making up the small remainder.

The major regulatory tension of the past few years has involved the initial prohibition, in 2006, on Telecom Italia and Vodafone from offering integrated fixed-mobile packages, which was later reversed in 2007. Now, TI, Vodafone, and Wind all offer bundled packages for their fixed and mobile offerings. Moreover, since June of 2008 Vodafone also bundles access to its Wi-Fi hotspots throughout Italy. Trying to match these owners of fixed and mobile platforms, fixed broadband providers FastWeb and Tiscali are both offering 3G services, which they buy wholesale from primary mobile network operators.

The current primary challenges that the Italian regulator reported to the ERG were the “refarming” of the 900 and 1800 MHz GSM bands, and the reassignment from defense use to civilian use of allocations at 3.5GHz. The former is widely reported throughout Europe, and primarily raises the concern that reassignment to some providers, but not others, would enable those who have the new, lower-frequency spectrum to offer lower-cost services, with fewer cell sites and better coverage, thereby upsetting the competitive structure of the market. The 3.5GHz band appears to primarily involve internal politics of budget compensation to the Defense department for the lost frequencies. Neither issue is resolved as yet. As noted in the Access and Competition part, the Italian providers Telecom Italia and Vodafone have entered voluntary agreements to share cell infrastructure so as to reduce the costs of their 3G networks.

In 2000, Spain awarded four identical, 2x15MHz paired, plus 1x5MHz unpaired blocks in a beauty contest to Telefonica (the Spanish incumbent), Vodafone, Orange (a subsidiary of France Telecom) and Xfera, a consortium whose members included Vivendi and TeliaSonera. Launch was slow initially, and in 2004 the Spanish authorities permitted the competitors to share infrastructure in order to reduce costs of deployment. Vodafone, Telefonica, and Orange all launched 3G services that year, and HSDPA 3.5G in 2006, while Xfera struggled internally and ultimately launched only in 2006. The Spanish regulator reported to the ERG that its major transition issue concerned how to transition 900MHz and 1800MHz to 3G without distorting competition. Telefonica and Vodafone do have 900MHz allocations, while Orange and Xfera do not.

Australia conducted a more fragmented auction than any of the prior countries we have reviewed, resulting in the emergence of four 3G licensees: Telstra, Vodafone, Optus (a subsidiary of Singaporean Sing-Tel) and Hutchison 3G Australia (H3G), each holding somewhat different amounts and configurations of spectrum dedicated to 3G services. Two additional smaller winners of the 2001 licenses, Personal Broadband Australia and 3G Investments, did not develop into substantial players in the Australian market.

The difference in Australia's initial approach does not seem to have dampened competition. All four national licensees from 2001 were active participants in the 3G market until H3G and Vodafone merged in June 2009. H3G was the first to launch 3G services in 2003. In response, Optus and Vodafone signed a collaboration agreement, in which they agreed to share their infrastructure, like cell towers, so as to lower the cost of deployment and speed up construction of their competing networks. Incumbent Telstra signed a similar, 50/50 deal with H3G. The deals raised concerns in the regulator that the alliances were pulling the country's 3G market into an effective duopoly, but the regulator then took no apparent public action against these alliances. All four (now three) players in the 3G market claim to have near 100% coverage for the Australian population, although the Australian's government's contentious relationship with Telstra, which took its most recent major step with the announced national broadband network plan and the requirement that Telstra undertake structural separation, also spilled over to lawsuits over coverage, over dropping of CDMA service before 3G service was in fact universally available, and over advertising practices.

New Zealand's relatively high 3G penetration followed a substantially different path. As with the other countries surveyed, New Zealand allocated blocks of spectrum for five 3G licenses in January of 2001. One of the blocks was awarded to the Maori Spectrum Trust's Huataki. The other four were auctioned. No bidder in the auction was permitted to own more than 15MHz of spectrum. Of these four, only two emerged as real competitors: Vodafone and Telecom New Zealand's mobile arm. The other two, Telstra and Clear, merged in late 2001, but still failed to launch 3G services after two false starts. The New Zealand 3G market is now relatively evenly split between the leader, Vodafone, and New Zealand Telecom. In the meantime, several efforts to build a third provider in the spectrum block awarded Huataki have not materialized. Despite the spectrum caps, and new efforts that resulted in redistribution of 900/1800 MHz spectrum from Vodafone and Telecom Mobile to Huataki as part of plans to reuse the 2G spectrum, no third provider has emerged in New Zealand.

New Zealand's market therefore has two 3G players, unlike the other countries we have observed, which have mostly four, or in the case of South Korea and in large measure Japan, three providers. Whether New Zealand's high mobile penetration rate results from the fact that its fixed broadband market has long been uncompetitive; whether it is the small size of the market (although New Zealand is no smaller than Norway or Finland); or whether competition between two providers is not much less effective than three or four providers to achieve high penetration remains unresolved by the New Zealand example.

5.3 Low mobile, high fixed countries

Two countries stand out as top ten performers in fixed broadband penetration who find themselves in the bottom quintile in the OECD in terms of 3G penetration. These countries are the Netherlands and Canada. Both currently have lower penetration, but higher growth rates, than the United States.

The market structure and trajectory in the Netherlands appear no different than those of the higher-penetration countries. The Dutch regulator allocated five standard UMTS licenses to the existing mobile phone providers: KPN Mobile, Vodafone, Orange, T-Mobile, and O2. KPN bought O2 in 2005. T-Mobile bought Orange in 2007. The remaining three competitors are all active in the 3G market. They appear to be offering and competing on a wide range of services, including mobile video and integration with hotspots. Nonetheless, the number of 3G subscribers reported in the Netherlands is lower than in the majority of OECD countries. The Netherlands has a reasonably high degree of 2G penetration, and two of its major players, KPN Mobile and Vodafone, paid the Dutch government to extend their GSM licenses for an additional three years to last until 2013, the same year that their other competitors' 2G licenses expire. These all suggest that the Dutch competitors are continuing to focus on

their 2G and 2.5G offerings, and that this may be slowing transition to 3G. The major 3G players began rolling out mobile TV offerings over the 3G and 3.5G networks since 2007. It may be that the Netherlands' anemic performance in mobile broadband is transitory. It did see a 125% growth between the first quarter of 2008 and the first quarter of 2009. While the gap may be closing, the experience of the Netherlands certainly diminishes any claims that there might be a simple recipe for success in the mobile sector.

Canada's wireless mobile broadband market and regulatory environment are the most similar to those of the United States, but with poorer results. Like the United States, Canada had flexible allocations in the mid-1990s that formed the basis of its 3G transition, well before Industry Canada got around to auctioning 3G-specific licenses (called, like in the U.S., Advanced Wireless Services) in the past year. Like the United States, Canada had many regional licenses. Its wireless market is nonetheless dominated by three national players, which together account for 95% of wireless customers, rendering much of the activity surrounding these three practically moot. As in the United States, the three players are extensions of fixed-broadband incumbents, except that in Canada one of these is a cable operator—Rogers. The other two are Bell Canada and Telus. As in the United States, Canada too has had two distinct technologies, but there the rollout has been inverted. In the U.S., Verizon was first with its 1xEV-DO Rev A version of mobile broadband, and continues to lead the market with it. In Canada this was the choice of Bell Canada and Telus. Rogers, however, using the European-compatible W-CDMA/HSDPA standard, now leads the market. Because the latter allowed Rogers to be the only provider to offer mobile video calling, Bell Canada and Telus are both moving in a joint effort to roll out their own W-CDMA/HSDPA network, apparently in a bid to compete more effectively with Rogers. In the meantime, all these players purchased additional spectrum in the recent AWS auctions, preparing for rolling out 4G services when these become feasible. Several potential entrants purchased spectrum in those auctions as well; most prominently from the perspective of fixed-mobile convergence, these included the other two regional cable operators, Shaw and Videotron. They also included a new entrant, Globalive, an extension of a long-distance reseller. In all, these new entrants may revitalize the Canadian market, but this is, of course, speculative.

Were Canada the only example of a negative mismatch, we might have suggested that regional fragmentation and the absence of a single, globally-compatible standard were determinative. However, given the similarly weak performance in the Netherlands, with its almost identical structure to that of other, higher-performing European mobile data markets, this is a difficult conclusion to sustain. Instead, we simply note here the necessity of further and deeper study into mobile broadband. In theory, a beauty contest that results in three players, such as in the case of Japan, should do poorly by comparison to an auction of flexible licenses that results in many players of diverse sizes. The result, when looking at Japan and Canada, was the opposite. Why, and what exactly we in the United States can learn from these disparate performances, should be the subject of further study.

5.4 The Nordic countries

The Nordic countries present an interesting case because all four are high performers on fixed broadband, but Sweden and Finland have much higher 3G penetration than Norway and Denmark. Norway and Denmark each have slightly higher penetration rates, at 21% and 25%, than does the United States (20%). Both countries, however, have had slower growth rates in the past year. Sweden (42%) and Finland (38.8%) both have much higher current rates, and while Sweden's growth rate is slightly lower than in the United States, Finland's 3G penetration growth rate has been almost twice as high as that of the U.S.

Sweden awarded four licenses to provide 3G service in December of 2000, each for a nominal license fee of $11,000. The licenses were awarded in a beauty contest, and in a unique move, Sweden awarded none of these licenses to its incumbent, Telia. Instead, they went to Swedish entrant Tele2, Vodafone Sweden, Hi3G (the Hutchison-Whamopoa entrant), and Orange Svierge. Telia re-entered the market soon thereafter by entering a joint venture with Tele2, named Svenska UMTS-Nat.

The licenses were conditioned on by far the most aggressive roll out requirements, requiring the licensees to roll out 3G service to 99.98% of the population within two years of the original grant. While none of the licensees indeed met this ambitious target, the following few years saw several efforts by the licensees to extend the period, and by the regulator to threaten fines and injunctions. Through this dynamic, and with explicit permission to share facilities (TeliaSonera with Tele2, Vodafone with Hi3G) so as to reduce costs, 98% of the population was covered by 3G network coverage by the middle of 2006. The cost was that Orange dropped out of the grueling race in 2002, and had its license revoked in 2004.

Since 2003, Hi3G has played the role of catalyst in the Swedish market. It was the first to roll out 3G service in May 2003; it was later the first to roll out higher speed HSDPA services in November of 2006, just as the 3G network coverage reached the high levels required by the regulator. In each case, it was followed within six months to a year by TeliaSonera and Tele2's joint venture, and then by Vodafone. In each case, lower prices, bundling of handsets, and new applications played a role in attracting subscribers. In 2007 Hi3G launched higher upload speeds with HSUPA, and in 2008 higher download and upload speeds yet by deploying HSPA+.

In May 2008 the Swedish regulator attempted to push forward the next generation transition by awarding four 4G licenses in the 2.6GHz range, which are technology neutral, and whose licensees, TeliaSonera, Telenor, Tele2, Hi3G and Intel, claim they will use both for Long Term Evolution (LTE) mobile and WiMax services. It is also working to reallocate the 900 MHz GSM spectrum, and channels cleared by the digital TV transition in 790-862MHz, to mobile broadband.

In all, the Swedish story is one of: four concessions through a beauty contest; aggressively defined and enforced rollout requirements, and fierce innovative competition from those players who survived the grueling process.

Finland held the first 3G auction in 1999, distributing six UMTS licenses. Of these, however, only three became nationwide providers—the licenses originally assigned to Telia and Sonera, one of which was sold to DNA of Finnet Group when TeliaSonera was formed, and to Elisa. Of the remaining three, two never took off, and one is a regional licensee in the Aland islands. Unlike the Swedish authority, the Finnish FICORA did not impose any deployment requirements, except that all networks be operational by January 2001. This requirement was met only experimentally, and it was not until October of 2004 when TeliaSonera launched the first commercial 3G network in 20 cities. Elisa launched in only eight cities a month later, and DNA launched a year later, in three cities. By April of 2006 take-up was still slow, and the regulator allowed bundling of 3G phones with subscriptions, increasing take-up. In late 2006 to mid-2007 the Finnish regulator engaged in a series of calls to the providers to lower and coordinate their rates, which was apparently followed not by price competition but by a coordinated lowering of prices. In 2007 the Finnish regulator was the first in Europe to permit providers to offer 3G services in the 900 MHz band. It is difficult to disentangle which of these acts had an effect of increasing growth and moving Finland from a weaker performer, more in line with Norway and Denmark, to a strong performer like Sweden. Finland saw 3G penetration growth rates of over 80% between 2007 and 2008, and 144% between 2008 and 2009, leading it now to occupy a position in the

top 10 countries in terms of 3G penetration. In April of 2009, the Finnish regulator granted TeliaSonera, Elisa, and DNA additional 1800MHz bands in which to launch 4G, LTE services.

Norway awarded four identical 2X15 plus 5 licenses in December of 2000, apparently in a beauty contest. Two of its licensees failed however, leaving only Telenor and Norway's first mobile telephony entrant, NetCom (now owned by TeliaSonera), in play. It imposed much weaker roll out requirements than did Sweden, and quickly relaxed even those in 2003. Hi3G bought one of the two unused licenses and was given several years to begin to roll out its network; it has not done so yet, and has now received extensions until 2012. The fourth license was sold in a sealed bid with only one bidder, to the third facilities-based GSM provider, Mobile Norway, which teamed up with mobile reseller Tele2. It has not yet rolled out its 3G services. In all, the Norwegian market seems to have begun anemically with two failed launches and delayed launches by the remaining providers; part of what is puzzling about this picture is that several of the same players, most prominently TeliaSonera and Hutchison-Whamopoa, have been extremely active and aggressive in the Swedish and Finnish markets, but much less so in the Norwegian market.

Finally, Denmark awarded four identical nationwide UMTS licenses in September of 2001. They were nominally "auctioned," although all four were awarded for an identical price to Hi3G, incumbent TDC's Mobile Nordic, Telia Denmark, and Orange, which was later bought out by Telenor. The build-out requirements were less stringent than Sweden's, but more so than Finland or Norway. Denmark also prohibited its providers from sharing infrastructure. Hi3G was the only 3G provider until the end of 2005, when Mobile Nordic rolled out 3G services. It took another year for Telenor to roll out 3G service. Hi3G was also the first to launch HSDPA, and remains the leader in speeds and subscriptions, with 36% of the 3G market. As in Norway, much of the market jockeying in Denmark has taken the form of acquisition of resellers, or mobile virtual network operators (MVNOs).

Observing the Nordic countries leaves one with more questions than answers. The most successful of the bunch, Sweden, used a beauty contest and aggressive regulatory deadlines to push investment. The second most successful, Finland, used auctions and a very light regulatory touch of a while, followed by more of an emphasis on price regulation and freeing up more spectrum. Norway and Denmark mostly followed intermediate strategies, with only middling success by global standards.

5.5 Mobile broadband: conclusions

Our conclusions with regard to mobile broadband strategies is that more study is needed. We observe successes and failures with beauty contests and auctions. We observe successes and failures with loose and tight rollout requirements. We observe successes and failures with flexible allocations and inflexible allocations. We cannot say that allocating 20 or 40 more MHZ to 3G resulted in better or worse results, whether these were translated into a fifth national licensee or in larger allocations per licensee. The subject is intensely important, will play a central role in the transition to ubiquitous connectivity, and is poorly understood.

We do see, however, increasing trends to fixed mobile convergence, with the owners of mobile licenses buying fixed broadband providers, or vice versa; and shared physical facilities to reduce deployment costs. In several cases, both in this section and in the section on competition and access in the fixed lined, we see that mobile cellular, nomadic, and fixed services are being integrated to form the experience of seamless, ubiquitous access for subscribers. In each case, these are trends that might raise concerns of competition policy, where potential competitors combine, but where there appear to be good reasons having to do with shifting to seamless connectivity. A major consideration in future planning

will be how to allow these kinds of integrations that promote seamless, ubiquitous access, without undermining competition.

5.6 Nomadic access

By "nomadic access" we mean wireless access to the Internet using non-cellular technologies, mainly Wi-Fi, where the user logs in to some form of wireless extension of an existing fixed network connection. Nomadic access is provided mostly as what we know as Wi-Fi hotspots. As a matter of spectrum policy, it depends on permission to operate unlicensed devices, rather than on a license to operate a network or particular service in a defined slice of spectrum over which the licensee exerts exclusive control. American consumers are familiar with nomadic access in airports, coffee shops or other public spaces, and in city spaces where municipalities themselves, or non-profits, have set up public Wi-Fi access areas. Internationally, we observe several models for making wireless nomadic connectivity that go beyond this kind of free-standing Wi-Fi hotspot to provide an element in a user's mobile connectivity options. Most of the innovation here is not technical or institutional, but in services. All the top countries in this domain, and in terms of hotspots per 100,000, are European countries. The practices are largely described in the competition and access chapter. Here we merely recapitulate to locate the European experience with fixed-nomadic developments.

What appears to be the most important trajectory that is different from what we see in the United States are the uses that French broadband provider Free and fixed-mobile broadband provider SFR are doing with their systems. Unlike hotspot providers, whether in a given locale or of a national footprint, Free and SFR do not deploy special hotspots with their own dedicated connections. Instead, they configure their fixed broadband end user equipment in the user's home, as a dual system: one capable of providing a secure home network to the subscriber, and the other, at the same time, providing a hotspot for permitted users. In the case of these two companies, these permitted users are other subscribers of the same carrier. In Free's case, at least, the fixed home network traffic has priority in situations where it competes for congested capacity with the nomadic users. In the case of Free, this offering also allows mobile phone users whose phones have Wi-Fi capabilities to make mobile voice calls. The combination of nomadic mobile broadband and phone allows Free to function in competition to the increasing fixed-mobile converged platform of France Telecom/Orange, and SFR, itself a mobile provider that more recently through its neuf Cegetel purchase also offers fixed broadband connectivity. SFR seems to use this nomadic capability to complement and balance the load on its 3G network, by routing calls and data uses from handheld devices over either the firm's 3G network, or over its fixed-plus-nomadic network, at least whenever a subscriber is within reach of another subscriber. The interesting feature of this approach is that it offers a very direct and simple path to blanket all areas with substantial residential penetration with nomadic access, without developing an additional standalone mesh networking or other extension technique.

An alternative approach that continues to build nomadic access through extension of home broadband networks is the model adopted by FoN. Here, end users become members of a club with hundreds of thousands of members. Each member can use the Wi-Fi box of any other member. Others can buy access instead of using in exchange for their own capacity. Again, the advantages are similar to those of the Free or SFR model, but the implementation does not depend on any given carrier adopting the program. Instead, users can opt in themselves by installing the necessary equipment in their home, connected to their broadband network.

Beyond the user-side versions like FoN, we also see carrier-side bundling of more traditional hotspots model with their broadband offering. Telenor Sweden combines the Wi-Fi network created by one of

the broadband entrants it purchased, Glocalzone, its own hotspots, and a newer set of hotspots it contracted with pan-European wife hotspot provider The Cloud, which include 800 spots in Sweden, and another 8,000 throughout Europe. Together, these provide coverage in 24 of Sweden's cities, and Telenor bundles free access to all these nomadic access points with its mobile broadband subscriptions. In response, TeliaSonera Sweden also bundles its nomadic access network, which covers over 2,200 hotspots throughout Sweden, with its mobile broadband offerings. Beyond these bundled offers, Swisscom, which has a large network of Wi-Fi hotspots, offers lower rates for Wi-Fi hotspot use for both fixed-broadband and mobile subscribers. British Telecom provides a separate offering, Openzone, sold on a separate monthly subscription or bundled with mobile roaming minutes.

Nomadic access is at present very much a poor relation to mobile broadband over cellular networks. The hotspots model has developed as a relatively expensive, occasional access mode, or as a way for municipalities, in particular, to make specific city spaces, like parks or squares, Internet friendly. We are beginning, however, to see models that leverage existing fixed-broadband connections to provide more comprehensive coverage, at lower-cost. These new approaches, most clearly those offered by FoN, on the one hand, and Free and SFR, on the other, suggest a development trajectory that could make nomadic broadband components an important element of ubiquitous, seamless connectivity.

6 Policies and practices: Public investments

The American Recovery and Reinvestment Act appropriated USD7.2 billion to development of broadband networks throughout the United States. In this part, we survey similar stimulus-type investments in other countries, as well as investments by countries that have been supporting the construction of networks on the supply side, or fostering demand for broadband on the demand side, over a longer time period and as part of a strategic focus on broadband, rather than as a specific response to the economic crisis.

Some countries, most prominently South Korea, Japan, and Sweden, have had long-standing investments in rolling out infrastructure both to urban centers and to wider populations. In Europe, government investments are constrained by European Union rules limiting state aid, which were put in place originally to prevent national governments from using their funds to aid local industries in contravention of the single market. This has meant relatively constrained programs with an emphasis either on unserved populations or on company- and technology-neutral public tenders. More generally, getting numbers on actual public investments is difficult. The OECD reports total investments in public infrastructure, but does not separate what is publicly funded from what is privately funded. South Korea often announces total investment that includes both government and government-mandated private investment, an arrangement that has no real parallel in the United States. With Japan, much of the public support has come in the form of loan guarantees and low-cost loans, the costs and value of which are not readily available. These difficulties are not unique to other countries. One would be hard-pressed to describe all the government investments of the United States in Internet infrastructure, from Defense Advance Research Projects Agency (DARPA) funding of early Internet development through every bond issued by a local municipality to support rollout by its rural electric utility. Describing levels of long-term investment is therefore a less certain exercise than describing immediate stimulus-style responses. The descriptions we offer here should therefore be taken more as illustrations of the kinds of investments made than as a comprehensive and exhaustive catalog.

Here we offer a description of major supply-side national investments in infrastructure, followed by a major example of municipal investment and how it was dealt with in Europe. The section on supply-side investments ends with the European guidelines on state investment in broadband, issued September 17, 2009. It is followed by a description of demand-side spending programs.

6.1 Major public investments

By far the most ambitious public investment program, an outlier by all accounts, is the current Australian government's announced investment in building a 100Mbps fiber-to-the-home network to 90% of its citizens, complemented by wireless and satellite technologies for the remaining population that lives too remotely to be served by fiber. Public reports of this plan suggested an investment level of AUD43 billion, or somewhat over USD34 billion. In comparative terms, adjusted for population size, this would mean the equivalent of somewhat less than a half trillion dollar investment by the United States. In terms of proportion of GDP, it would be the equivalent of a one-time investment of 4.24% of annual GDP. Again, this would be the approximate equivalent of a USD600 billion investment. Upon inspection, the news reporting on this plan substantially overstates the public funds commitment.[102] The announcement followed a smaller, unsuccessful public tender for the construction of a publicly-supported national network. The Australian government then announced that it would invest in, and form, a public-private partnership whose goal would be to roll out the national fiber network. The total

102 http://www.minister.dbcde.gov.au/media/media_releases/2009/022.

cost of the project over eight years is projected to be up to 43 billion AUS. The initial actual investment of the government would be a reallocation of funds appropriated under a 2007 plan, AUD4.7 billion, or about USD3.175 billion in purchasing power parity terms. Furthermore, the government plans to issue infrastructure bonds for 6.3 billion Australian dollars, for a total investment in the public-private partnership of AUD11 billion, or $7.43 billion PPP. When one adjusts for the size of the Australian population, the Australian government's commitment would be the equivalent of a U.S. government investment of USD107 billion to build fiber to the home networks to 90% of the U.S. population. If one counts solely the committed funds from 2007, this would be the equivalent of about USD46 billion.

The other major country cited for massive direct public investments is South Korea. The most expansive descriptions of what the South Korean government invested[103] place that number at USD24 billion for the KII-Government phase in the late 1990s, 1.76 billion in low cost loans to the private providers, 16.3 billion from 2000 to 2006, 25.5 billion, public and private investment, from 2004 to 2007, and another 18 billion public and private from 2008 to 2010. This is about USD85 billion in total, which is higher, but on the same order as a USD70 billion number also occasionally proffered as the South Korean investment, public and private, in broadband deployment. As already mentioned, these numbers bundle public and private investment in ways that makes it difficult to tease them apart. In U.S. terms, adjusted for population size, the total investment since the mid-1990s would translate into about USD443 billion, again, roughly commensurate with the purported Australian commitment. But again, as in Australia, these numbers are more representative of investments in the total costs of deployment, rather than actual government outlays. The current South Korean plan, for example, calls for an additional USD27 billion to be spent between now and 2012. Only USD1 billion of this amount will be spent directly by the government.[104] As such, while these numbers sound outlandishly large as specifically government expenditures, they are well below the total (overwhelmingly private) investment in public telecommunications facilities in the United States since 1997, which has been over USD750 billion.[105] The question for our purposes here is, in all these cases, what is the proportion of public funds spent.

By contrast to the less certain numbers elsewhere, it is quite clear that public authorities in Sweden spent about USD817 million between 2001-2007.[106] In per capita terms, that is just over USD90, which translates into about USD27.6 billion dollars. In terms of percent of annual GDP, it is about one quarter of one percent of Sweden's GDP, spent over six years. In U.S. terms, this would translate into a commitment of just under USD35 billion dollars over six years. This number is lower than, but roughly consistent with, some of the proposals for stimulus spending on broadband infrastructure in the United States.[107]

6.2 Stimulus investments

Like the U.S. Congress, other countries have announced or committed funds, often as part of broader investment encouragement, to support the next generation transition. The following table summarizes these investments.

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103 The most comprehensive description of past investments that we have found is Atkinson et al, ITIF, Explaining International Broadband Leadership (2008).

104 OECD, Working Party on Information Economy, The Impact of the Crisis on ICTs and Their Role in the Recovery, Aug 17, 2009. p. 34. (OECD Impact of Crisis on ICTs)

105 OECD Communications Outlook 2009 Table 4.17.

106 Ministry of Enterprise, Energy, and Communications Sweden, June 4 2009 presentation; ITIF Broadband Report, 2008, p. 25.

107 Derek Turner, Down Payment on Our Digital Future, Free Press 2008. http://www.freepress.net/files/DownPayment_DigitalFuture.pdf

Table 6.1. Public investment in broadband from around the world

	Planned investment	Government share	Govt share in US terms, pop. adjusted, in millions USD[108]
Australia	AUD43B	4.7B AUD (reallocated funds) 6.3B AUD (anticipated bonds)	45,853 61,463
Austria	EUR125M	EUR25M	1,050
Canada	CAD225M	CAD225M	1,677
Finland	EUR66M	EUR66M	3,920
France	EUR750M	Unknown	Unknown
EU	EUR1B	EUR1B	912
Germany	EUR150M	EUR150M (uncertain)	657
Italy	EUR1.25B	EUR1.25 (not yet committed)	7,770
Japan	JPY185B	JPY185B	3,820
South Korea	USD27B	~USD1B	6,330
Luxembourg	EUR195M	EUR195M	126,000
New Zealand	NZD1.7B	NZD850M (not yet committed)	58,300
Portugal	EUR50M + EUR61M	EUR111M	4,700
United Kingdom	GBP200M + GBP150-175M per year	GBP200M + GBP150-175M per year	1,530 + 1,150-1,340 per year
United States	USD7.2B	USD7.2B	7,200

Looking at the investments reported as stimulus responses to the financial crisis in August of 2009 alone, the United States has made one of the larger public commitments to next generation broadband. Luxembourg is an outlier in terms of per-capita investment, but its minuscule size and extreme wealth make it a largely irrelevant comparator. Australia and New Zealand have both made major public announcements about plans to make major government investments, but we are not certain at this point what the level of funds actually committed in New Zealand will be, or what the ultimate result of the bonds issuance in Australia will be. Both of these plans, should they be put into effect as announced, will outstrip on a per capita basis even Sweden's investments in the first half of this decade and place the two countries as among the most publicly-funded networks in the world. Italy has not yet appropriated sums equivalent to those that the U.S. has committed (on a per-capita basis), but has announced plans to do so. The South Korean government's share of investments planned for the coming three years is similar to the U.S. recovery investment, but needs to be taken on the background of the already very large investment that government has made in both the first generation and next generation transitions. The other major investors are Finland, Japan, Portugal, and the United Kingdom, all of which have invested about half or a bit more than half on a per capita basis than the American Recovery and Reinvestment Act appropriated. Of this group only the U.K., with its new tax on copper loops intended

108 This number converts local currency investment to PPP dollars, divided by the population size to reach per-inhabitant investment, multiplied by 307 million to simulate what a similar per-population investment in the United States would be. The initial numbers are taken from OECD Impact of Crisis on ICTs, Aug 2009, p. 34.

to provide a large annual infusion to next generation roll out, on the order of what would be the equivalent of a USD1.15 to 1.35 billion per year, has chosen a path that will ultimately lead it to higher direct public investments, should it continue this policy for five more years.

Observing both longer term and stimulus investments, it appears that the United States has spent more in the stimulus mode than most other nations, but less than the most publicly-funded nations, in particular Sweden, as well as South Korea and Japan. We note only that these three nations are, by a wide margin, the leaders in fiber deployment. To the extent that one sees the long-term trajectory of the fixed element of next generation networks to be in fiber closer to — and ultimately at — the home, we can perhaps say that substantial government investments seem to be associated with approaching that goal more rapidly.

6.3 Municipal investments

There has been substantial attention given to municipal and regional efforts as a pathway for private intervention. In the United States, various stories from Burlington, Vermont to Bristol, Virginia at the municipal level, have suggested that municipal and regional investments may provide an appropriate and productive pathway for public investment. The finances of local and regional projects are difficult to capture comprehensively in a way that would allow genuine, aggregate comparisons of levels of investments. False starts are unlikely to be reported systematically. As a result, making a strong analysis of the relative effectiveness of municipal initiatives is beyond the scope of our analysis. We treat the examples more as inspiration for a future, more detailed study, and for efforts to create learning networks and systems for synthesizing and communicating best-practices.

The role of municipalities has been the most extensive and systematic in Sweden.[109] Of Sweden's roughly 290 municipalities, over 200 have been engaged in some form of public support for, or tendering of, broadband deployment. They have been the conduit of over USD 250 million, or the rough equivalent of what a USD12 billion investment would mean in U.S. per capita terms. They added their own funds to these national funds, at a level that accounts for about 11% of total investment in broadband deployment from 2001-2007. The basic model of the Swedish municipal investment is that the municipality builds passive capacity, or dark fiber, and leases it out to private providers who then compete on services and electronics, and do so through operator-neutral public tenders put in place for constructing the capacity. The model is applied both in major cities, like Stockholm, and in smaller towns, including surrounding countryside.

The most recent annual report by the Swedish regulatory authority suggests that municipalities will continue to play a central role in the country's next generation broadband strategy. Specifically, the Swedish Post and Telecom agency (PTS) noted that municipalities would begin to integrate communications infrastructure planning into their urban planning programs. A particular target would be to identify pockets of unavailability on a very local level, and to ensure that these are covered by connectivity. To support efforts in that direction, while limiting the reporting burdens on carriers, the national authority would collect information about network services and availability on a comprehensive, geographic basis, and make that information available to municipalities to include in their local and urban planning processes and in their network deployment tenders. Moreover, the Swedish report suggested that as part of their task, one major role municipalities can play going forward is to minimize the difficulties of obtaining permits to site equipment and access ducts. In all, the Swedish experience has worked substantially through local authorities, in collaboration with the national

109 Sources: Ministry of Enterprise, Energy, and Communications Sweden, June 4 2009 presentation; ITIF Broadband Report, 2008, p. 25; EU Guidelines for State Aid, Sept 2009.

government, and has included funneling of national funds, application of local funds, and the integration of local planning powers with funding and expenditure to attain near-universal coverage.

Perhaps the most ambitious — and for a while, contentious — municipal project has been Amsterdam's CityNet.[110] The project is deemed ambitious because its ultimate aim was to provide a fiber-to-the-home network throughout the city, and controversial because its deployment sparked a political and legal battle with, in particular, the Dutch cable broadband industry, and was in some measure the impetus for the very recent European Commission guidelines on state aid to broadband deployment, which are discussed below. The project has also been successful because it has been deployed and is being extended; because it was upheld when challenged in the European Union, and has now created the model for potential municipal investment in next generation infrastructure even in the presence of robust market-based competition; and because its success has led the Dutch government to reverse an earlier reticence to allow similar municipal investments elsewhere in the Netherlands.

The plan initially called for connecting 37,000 households, with longer term plans to roll out to all 400,000 households in Amsterdam (comprising about 5.5% of Dutch households). The network was to be a point-to-point fiber network, in which about 10,000 households would be connected directly, each by its own fiber, to each Internet point of presence (POP). The system was to operate in three distinct layers. The first layer was called the "passive network infrastructure." It included ducts, fiber, and street cabinets. The second layer was the active wholesale layer. It included network management, control, and maintenance systems such as switches, routers, and optical splitters. It was to be managed and maintained by a wholesale network operator working on a contract from the city. The third layer was the retail layer, which would consist of providers who would buy capacity, on a non-discriminatory basis, from the two lower layers, and provide retail services to customers. They would invest each in their own service platform: equipment, services, and billing/customer care. The first, passive layer, is owned by a partnership called Glasvezelnet Amsterdam (GNA). Its members are: the City of Amsterdam, with a one-third share; five social housing corporations (a non-profit model of housing ownership of apartment buildings), which owned about one-third of the apartments in the covered area, owned a one-third share of GNA; and the remaining third was equally divided in two one-sixth shares between two for-profit investors, ING real-estate, a subsidiary of ING, and Reggefiber, a Dutch company whose business it has been to build open fiber networks. The shares reflected the actual share of investments made by each of the parties in the EUR18 million project.

GNA issued a tender to construct passive networks to dig and construct the ducts, and pull the fiber. This tender was issued to construction companies, and GNA retained ownership over the ducts, fiber, and cabinets. GNA also issued a public tender for the concession to operate the wholesale layer. The contract was awarded to a subsidiary of Telcom Italia, BBned. BBned was to invest in active wholesale layer components, which it would then own and operate while also operating, but not owning, the passive layer. The contract required BBned to remit fees per connected household to GNA, and to sell wholesale access services to third party service providers on an open access, nondiscriminatory basis. These retail providers would sell services to end users and pay fees to GNA. BBned itself had retail affiliates that would sell such services.

In the European Union case, Dutch cable operators UPC and ONO, as well as France Telecom and Swedish cable operator Com Hem, intervened to persuade the Commission that the public investment would undermine market provisioning and that, unlike in smaller and more remote municipalities, the investment was unjustified in an urban center already served by commercial operators. European cases

110 Sources: EC c(2007) 6072, European Commission Final Decision on the State Aid Case C 53/2006, Investment by the City of Amsterdam in a fiber-to-the-home (FttH) network; Herman Wagter, BH_CityNet presentation, 2009;

on state aid arise from the concern that states will undermine the common market purposes of the Union by helping their own companies against potential entrants from other countries. Given the substantial history of state enterprises in several European countries, the Commission polices government investments fairly closely to assure an efficient, pan-European market. Following this concern, state-aid cases aim to make sure that, where there is government investment in a project of this sort — particularly in an context where, as in Amsterdam, there is indeed plenty of market investment to go around — it is done on terms that would have been reasonable for a market investor (even if the particular market investors serving the same market did not choose to make a similarly-structured investment).

Factors that helped persuade the European Commission that Amsterdam's investment in GNA was a kind of investment that a private company might have made provide useful insight into what a model of legitimate municipal investment (that would not undermine market provisioning) might look like. The elements that the Commission reviewed included:

a) the co-investment by two private companies, on equal terms, one a real-estate development firm that had plausible reason to invest in improving the broadband infrastructure of its real estate holdings and the other a company specializing in open fiber infrastructure;

b) the fact that the investment was in passive elements, which were expected to last for thirty years and therefore could be sustained with the relatively lower rates of return expected by GNA;

c) the fact that the City of Amsterdam was to be reimbursed all of its pre-project investments, with interest, as part of the project costs, all of which were ultimately intended to be paid from user fees paid by the wholesale users, and ultimately the retail subscribers;

d) a close review of the business plan: the Commission submitted the GNA business plans to one independent review by PriceWaterhouseCoopers, and the Dutch authorities submitted a report from a consulting firm and Delft University, both of which confirmed that the GNA business plan was sound, that the internal rate of return for the project was "within the market expectations for companies active in the telecommunications market," and that it was robust to a wide range of sensitivity tests based on penetration rates, cost evaluations, and other market contingencies.

The assessment of the business soundness of the model, made by the Commission in December of 2007, was later borne out when Reggefiber, as part of its joint venture with incumbent KPN, bought out much of the shares of the city and the social housing corporations, raising its ownership stake to 70% in February of 2009. By that point, the project had already rolled out to 43,000 homes (more than originally planned), and was planning to roll out to 100,000 more homes beginning in the summer of 2009.[111]

The nature of the European Commission's decision provided, perhaps unsurprisingly, a boost to the model of municipal fiber-to-the-home investments in the Netherlands. Following the battles over Amsterdam, the cable companies in the Netherlands persuaded the Dutch parliament to limit the ability of municipalities to invest in fiber-to-the-home facilities where there were market actors in the market already. The Commission's decision has led the current Dutch government to reverse course on that decision, and to initiate a process to support municipal efforts built on the Amsterdam model.

111 Telegeography CommsUpdate, February 5, 2009. *KPN-Reggefiber acquire majority interest in Amsterdam FTTH network.*

6.4 The new European guidelines

In part as a result of the Dutch experience and experiences elsewhere, like in Sweden, and in part in response to the new wave of stimulus investments, the European Commission took up more generally the problem of state aid to broadband deployment. It published its final decision on September 17th, 2009.[112] The general starting point of the European Commission is that it has "taken an overwhelmingly favorable view towards State measures for broadband deployment for rural and underserved areas, whilst being more critical for aid measures in areas where a broadband infrastructure already exists and competition takes place."[113] The Commission appeared particularly concerned to prevent crowding out of market provisioning where market provisioning was feasible.

One arm of acceptable public investment is the arm established in the City of Amsterdam case: that is to say, where the municipality is investing pursuant to a business plan that is within what would be normal for a market actor in this market to do. This can be proven either by co-investment by private, commercial actors on equally advantageous and risk-susceptible terms (that is, the public investor cannot seek to attract complementary investments by absorbing an unfair share of the risk not reflected in the distribution of returns), or by an independent evaluation of the municipality's business plan as consistent with industry practices.

The second arm of acceptable public investment occurs where a public investment, municipal or by a higher-level of government, is justified as provisioning a public good, or in the language of EU law, a "service of general economic interest" (SGEI). This is primarily intended to apply to investments in unserved and underserved areas. Indeed, the decision very clearly states that it will have a strong presumption against treating a publicly-owned and invested network intended to create a third network alongside two already-existing facilities-based competitors, each offering triple-play offerings (so called "black areas") as acceptable under this arm of the public-goods-provisioning rationale . To the contrary, it sees so called "white areas," areas with no provider, as a proper target of state investment. As such, this section seems applicable precisely to the kinds of investments in unserved and underserved areas that are the core of the American Recovery and Reinvestment Act. (In "gray areas," where there is only one provider and no real prospect of a second one entering within three years, the Commission takes an intermediate view, preferring access regulation where feasible, and public investment in an alternative network as a fall back option where *de facto* monopoly in an area cannot be attenuated by effective regulation.) The Commission's requirements for such an investment are particularly enlightening, both about the assumptions they exhibit regarding where competition is likely and most productive, and because of the way in which they integrate the task of transposing the lessons of the first generation broadband transition to the next generation investments.

One important requirement that the EC places on even those investments it deems acceptable is that they not be coupled with a formal promise of exclusivity, or monopoly licensing provision. The opinion rejects the idea that, over and above subsidies, any company providing service in these unserved or underserved areas needs a monopoly right over provisioning. It also requires technological neutrality, and open tenders for any such investments.

One of the most interesting aspects of these guidelines is their effort to limit the range of what is offered publicly, and use it, to the extent possible, to provide a platform over which competitive, market-based services higher up in the stack will be offered. This part of the EC opinion therefore serves as a particularly interesting window into current European thinking about integrating the natural-monopoly

112 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.

113 *Id*. Section 2.1.

attributes of at least some broadband markets with the possibility that at least some layer of services will be competitive, riding on top of a shared platform. It also provides a window into current thinking about access, competition, and transposition of the first generation transition with the next generation transition. We reproduce here the whole of the relevant part of the holding, including its very interesting footnotes.

> (27) Given the state of competition that has been achieved since the liberalisation of the electronic communications sector in the Community, and in particular the competition that exists today on the retail broadband market, a publicly-funded network set up within the context of an SGEI should be available for all interested operators. Accordingly, the recognition of an SGEI mission for broadband deployment should be based on the provision of a passive, neutral34 and open access infrastructure. Such a network should provide access seekers with all possible forms of network access and allow effective competition at the retail level, ensuring the provision of competitive and affordable services to end-users.35 Therefore, the SGEI mission should only cover the deployment of a broadband network providing universal connectivity and the provision of the related wholesale access services, without including retail communication services36. Where the provider of the SGEI mission is also a vertically integrated broadband operator, adequate safeguards should be put in place to avoid any conflict of interest, undue discrimination and any other hidden indirect advantages.37
>
> Notes:
>
> 34 A network should be technologically neutral and thus enable access seekers to use any of the available technologies to provide services to end users. Although such a requirement may be of limited application in relation to the deployment of an ADSL network infrastructure, this may not be the case in relation to a NGA, fibre-based network where operators may use different fibre technologies to provide services to end- users (i.e., point-to-point or G-PON).
>
> 35 For example, an ADSL network should provide bitstream and full unbundling, whereas a NGA fibre-based network should provide at least access to dark fibre, bitstream, and if a FTTC network is being deployed, access to sub loop unbundling.
>
> 36 This limitation is justified by the fact that, once a broadband network providing universal connectivity has been deployed, the market forces are normally sufficient to provide communication services to all users at a competitive price.
>
> 37 Such safeguards may include, in particular, an obligation of accounting separation, and may also include the setting up of a structurally and legally separate entity from the vertically integrated operator. Such entity should have sole responsibility for complying with and delivering the SGEI mission assigned to it.

To justify a public investment, the EC requires that states engage in detailed local mapping of availability, need, and rollout; that they use an open tender process; that they accept the most economically advantageous offer (which need not be the lowest bid); that the tenders be technologically neutral; that, where possible, they use existing infrastructure (except where the recalcitrance of the local monopolist is part of the problem); that the successful bidder offer its network for wholesale services to other providers at rates that are benchmarked against wholesale rates in other, competitive areas, and; that the tenders or laws pursuant to which a tender is made include claw back provisions allowing the state to seek restitution of profits found to have been excessive following such price benchmarking exercises.

Finally, the newly-minted European decision explicitly embraces the dual-goals approach taken by some countries, which seek, independently, to reach their entire population with broadband networks, and large portions of their populations with next generation connectivity. The Commission accepts as legitimate the possibility that European countries will invest in next generation access networks, beyond their investments in bringing first generation broadband to their entire populations, even in urban areas, where doing so is seen as speeding up deployment and acquiring the social spillover benefits on a faster schedule than current private firms appear ready to follow. The Commission treats the presence or absence of immediate plans to deploy such Next Generation Access networks (NGAs) in the near (three year) future as a distinct "market" for purposes of designating "black," "white," and "gray" areas—in other words, making it much easier, for many more regions and municipalities, to claim "white" or "gray" status than would have been possible were the measure the existence of two facilities-based competitors offering first-generation broadband networks, like xDSL (and presumably less-than DOCSIS 3.0 cable, though that is not made explicit in the opinion; the opinion does explicitly treat ADSL 2+ that provides 24Mbps service as not falling within the definition of "next generation"). One path the Commission envisions for this process is the passage of rules: rules requiring new construction buildings or infrastructure (like roads, sewage plants, energy, or transportation projects) to include fiber connections; acquisition of rights of way for use by communications networks; requirements on existing private network operators to coordinate their civil works or share infrastructure; or requirements to share poles and ducts. Moreover, the Commission contemplates that investments in civil works like pulling ducts, as well as regional investments intended to increase the competitive attractiveness of either under-developed or technology-cluster regions, by providing high-end infrastructure, will also be considered acceptable as long as they comply with the other constraints placed by the Commission.

The critical point of this part of the opinion however, is that the European Commission will treat investment in speeding up deployment of networks capable of very high speed service as a distinct market, and as justifying investment to speed up deployment even in areas where there are two facilities-based competitors who are offering triple-play packages over networks that offer below 24Mbps service. (The precise cutoff between what counts as NGAs and what does not is not clearly specified; but 24Mbps is clearly not treated as NGA.) The Commission will presume that these existing providers do have such plans, but member states can rebut that presumption by showing that those existing competitors do not have explicit business plans to upgrade their service to next generation levels within three years. In that case, the Commission will treat even such areas as "gray" or "white" areas (as appropriate given the actual plans of the present broadband providers) in terms of next generation access networks.

In all events, the networks constructed with public aid will have to comply with all the requirements stated above, with the Commission's special emphasis that:

> An "open access" obligation is all the more crucial in order to deal with the temporary substitution between the services offered by existing ADSL operators and those offered by future NGA network operators. An open access obligation will ensure that ADSL operators can migrate their customers to a NGA network as soon as a subsidised network is in place and thus start planning their own future investments without suffering any real competitive handicap.
>
> In addition, whatever the type of the NGA network architecture that will benefit from State aid, it should support effective and full unbundling and satisfy all different types of network access that operators may seek (including but not limited to access to ducts, fibre and bitstream). In this respect it should be noted that "multiple fibre" architecture allows full independence between access seekers to provide high-speed broadband offers and is therefore conducive to long-term sustainable competition. In

addition, the deployment of NGA networks based on multiple fibre lines supports both "point-to-point" and "point- to-multipoint" topologies and is therefore technology neutral. [114]

6.5 Demand side programs: Subsidies and skills training

In addition to the supply-side subsidies, several of the countries we have studied have developed various demand-side interventions to increase not only the supply of broadband, but demand for it as well.

As on the supply side, the most systematic and extensive demand-side program was implemented in South Korea. Its elements included:

- Extensive skills training to large swaths of the population, free or on highly subsidized terms. The relevant populations included the elderly, military personnel, and farmers.

- Most extensive and visible among the adult population training programs was the Cyber 21 training program that targeted housewives.[115] The program consisted of a week-long, 20 hour course, subsidized through over a thousand training institutions so that courses cost about USD30.[116] Take up was dramatic, with one report noting over 70,000 participants in the first ten days. Several discussions of South Korean programs at the time seem to mention this program as one that had a serious impact.

- Funding and constructing thousands of public access sites, where residents were given free access and training

- Subsidized provision of personal computers to low income families. Initially, this was done through low-cost loans, and later the government directly purchased computers and leased them for four years to low income families, while at the same time paying the full cost of broadband service for these families for five years

- Free personal computers in every school in the country

- 50,000 free computers were given to low-income students with good grades

- Curriculum and school assignments were developed so that having a connection and knowing how to use it became an integral part of going to school. It was how you got your homework done

- Including digital literacy measures in college entry metrics, so that having high performance on digital literacy metrics enhanced one's likelihood of getting a better higher education

- In the housing market, the government initiated a building certification program whereby it issued a certificate of connectivity to buildings that were well wired and ready to receive and distribute broadband. These became the basis for building owners to compete in the real estate market

114 EU Guidelines, English version, page 23-24.
115 Kushida and Oh.
116 Atkinson et al, 2008, p. 38.

No other country that we observed has engaged in as extensive a set of policies. In various countries we saw bits and pieces of programs reminiscent of elements of the South Korean program. These include:

- *Adult skills training*: in the United Kingdom, the Train to Gain program, which is a workplace training program, has worked with over 127,000 employers and provided training for over a million workers. The Swedish government ran training programs for small business owners about use of ICTs in their business. The German government too offers consulting and prizes for innovative uses of ICTs and training in them for small and medium businesses.

- *Funding and constructing public access sites in various communities*: Canada's Community Access Program constructs and offers training through community technology centers

- *Subsidies for home personal computers*: The Swedish government throughout the early 2000s allowed employers to provide personal computers to employees on a pre-tax basis; the British government provided cheap financing for families to lease computers over a four year period

- *School-based interventions*:

    - *Broadband connections and computers at school*: Sweden, Canada, France, the United Kingdom Germany, and Australia all fund connections for schools, which are made available to the schools either free or at very low rates

    - *Schoolteacher training*: Sweden and the United Kingdom both invested heavily in teacher training programs

    - *Curriculum development and digital learning objects*: Sweden, the United Kingdom, and Australia have all invested in developing online curriculum offerings and learning tools

    - *Real-estate market deployment*: On the housing side, France worked not through carrots—like the South Korean certification program—but through requirements: of installation of open wires in new construction, and of requirements of shared facilities whenever an existing building is wired under contract with one of the fiber providers.

While the United States adopted subsidies to school deployment of Internet connectivity through the E-rate program since the Telecommunications Act of 1996, the heavy emphasis on skills training is an important lesson carried by these international studies. Least known in the American debate have been the heavy investments in adult education. One important pathway seems to have been investment in workplace-based training programs, both for employees and for small and medium sized business owners is an interesting observation. Better known and clearly important is the extent to which investment in skills training, including intensive teacher training, rather than merely in hardware and connectivity, was central in several other countries to the school-based programs.

A. Denmark

Introduction

Denmark is among the world's leading nations in broadband penetration, even though some of the country's regions are sparsely populated. Early liberalization of the telecommunications market and LLU did not keep former monopoly telco TDC from taking the lion's share of the broadband market. DSL is still the leading technology but alternative platforms are on the rise. The government has emphasized the public sector's role in demand for broadband while not making any direct investments on the supply side. The regulatory framework poses very low barriers to entry into the broadband market while newly introduced sharing of costs for shared future infrastructure is supposed to attract new investment. 4G licenses are to be auctioned in 2010.

Market highlights

Overall, 69.5% of households in Denmark have broadband access.[117]

	Fiber / LAN	Cable	DSL	Other	Overall [118]
Subscriptions per 100 people [119]	3.6	9.9	22.6	1.1	37.2

Penetration metrics	Rank	Speed metrics	Rank	Price metrics	Rank
Penetration per 100, OECD	1	Maximum speed, OECD	3	Price low speed, OECD	2
Household penetration, OECD	4	Average speed, OECD	8	Price low speed, OECD+GC	2
3G penetration, GC	18	Median download, speedtest.net	8	Price mid speed, OECD	9
Wi-Fi hotspots per 100,000, Jwire	10	Median upload, speedtest.net	4	Price mid speed, OECD+ GC	5
		Median latency, speedtest.net	8	Price high speed, OECD	10
		90% download, speedtest.net	6	Price high speed, OECD+GC	5
		90% upload, speedtest.net	3	Price very high speed, OECD	7
				Price very high speed, OECD+GC	6

1st quintile
2nd quintile
3rd quintile
4th quintile
5th quintile

Note: Details in Part 3
Source: OECD, GlobalComms, Jwire, Speedtest.net, Berkman Center analysis

117 OECD Broadband Portal, Table 2a, from EU Community Survey, from 2007.
118 Does not include 3G Wireless. Since subscriptions are shared within a household, this number will never be 100.
119 OECD Broadband Portal, Table 1d, as reported by individual governments, as of 2008.

Broadband development to date

The development of broadband in Denmark started with liberalization of telco services and the abolition of the exclusive right of Tele Denmark (now TDC) to establish broadband networks within the boundaries of the municipalities in 1995.[120] Estimates of early broadband subscriptions differ significantly. According to a report to the National IT and Telecom Agency (IT- og Telestyrelsen), by December 31st, 1999, almost 10% of Danish households and SMEs were connected by broadband through ISDN[121], which was the leading technology at that time, while access via xDSL and cable was still rare.[122] In a recent economic report, IT- og Telestyrelsen estimates the number of broadband subscriptions to have been a mere 0.5 per 100 inhabitants for the year 2000.[123]

ISDN was soon passed by DSL. Denmark adopted local loop unbundling in 1998 and line sharing was required in 2001, resulting in a rise of new entrants in the market for DSL.[124] In 2002, when broadband subscriptions had risen to 8.3 per 100 inhabitants,[125] DSL subscribers accounted for more than two thirds of Denmark's 445,842 broadband subscribers; a large majority of the other third connected via cable. By 2005, broadband penetration had gone up to 24.7 subscriptions per 100 inhabitants[126] and there were 826,181 xDSL subscriptions and 364,803 cable subscriptions with capacities of at least 144kbit/s.[127] From January 2001 to January 2005, the cost of household ADSL service decreased by over 45%.[128]

In 2008, DSL was still the most important technology for broadband access, although alternative platforms have gained momentum. The number of FTTx connections (such as fiber-to-the-home) has grown from 30,000 in 2006 to 108,000 in 2008, making it the fastest growing alternative technology.[129] At the same time, with only 16,882 subscribers at the end of 2008, WiMAX was not a yet a significant alternative option to DSL or cable broadband.[130] There are currently four 3G licenses in use, which together cover a spectrum from 1900 to 1980 Mhz and from 2110 to 2170 Mhz.[131] 4G licenses in the 2.5 GHz band are expected to be auctioned in March 2010.[132]

Market share and key players

Even though the fixed-line market was completely liberalized in 1996,[133] the successor of Denmark's monopoly fixed-line operator was still the dominant player at the end of 2008.[134] In the broadband

120 OECD, Regulatory Reform in Denmark, Regulatory Reform in the Telecommunications Industry, 2000, p.7.
121 Whether ISDN should be considered broadband is certainly debatable.
122 Eirwen Nichols et al., The Status of Broadband Services For Consumers and SMES, A Report to Telestyrelsen, October 2000, p.5.
123 IT- og Telestyrelsen, Economic Key Figures 2008, June 2009, p.12.
124 Sherille Ismail and Irene Wu, Broadband Internet Access in OECD Countries: A Comparative Analysis, October 2003, p. 14.
125 Ibid, p.4.
126 IT- og Telestyrelsen, Economic Key Figures 2008, June 2009, p.12.
127 IT- og Telestyrelsen, Tele Yearbook - 2005, p.26.
128 The Danish Government, IT and Telecommunications Policy Report 2005, March 2005, p.10.
129 GlobalComms Denmark, p.16.
130 GlobalComms Denmark, p.16.
131 http://en.itst.dk/copy_of_frequencies/licences/3g-licences/
132 http://en.itst.dk/copy_of_frequencies/licences/Auctions-and-calls-for-tenders/2-5-ghz/expected-time-table
133 i.e. Tele Denmark's exclusive rights to provide telephony services, leased lines, mobile communications, cable television, etc were removed. See: OECD, Regulatory Reform in Denmark, Regulatory Reform in the Telecommunications Industry, p.7 et sq.
134 Fixnet Nordic controls a share of 82.1% of all subscriber lines. See: GlobalComms Denmark, p.3.

market, TDC (now Fixnet Nordic) had accumulated 1.16 million broadband subscribers by the end of March 2009.[135] This equals a market share of 56.6%, which is split between its DSL and cable (sold under the YouSee brand) divisions. In 2009 TDC also acquired Fullrate, which had a market share of 3.7%. TDC's main competitor in the broadband market is Telenor who offers DSL, VPN and VoIP services and whose share is 14%. Telia Denmark accounts for 9% of the market, which it serves via various subsidiaries using DSL and fiber-optic cable.

The growing market for FTTH is lead by independent Dansk Bredband with 18.8% and Energi Midt with 16.5%. Two other providers follow with just above 10% market share.[136] Three-quarters of WiMAX connections are operated by Danske Telecom (owned by Call Me which is part of Telia Denmark). ELRO, a utility provider has announced to aim for nationwide deployment of WiMAX services by 2010.[137]

The market for 3G connections is lead by Hi3G with a share of 36.2%. It was the first provider to operate a 3G network and is expected to roll out HSPA+ later in 2009.[138] Mobile Nordic (owned by TDC) follows with 30% of the market. Telenor Denmark has 21.6% of the 3G subscriptions and Telia 12.6%.[139]

Regulatory framework

Broadband and the telecommunication industry does not fall under one single law but is regulated by several different acts, including primarily the Act on Competitive Conditions and Consumer Interests in the Telecommunications Market, the Act on Cable Laying Access and Expropriation etc. for Telecommunications Purposes, and the Act on Radio Frequencies.

The regulatory framework poses very low barriers to entry.[140] Neither licenses nor registration with the regulating body are needed, except for operating fixed-wireless connections. The main focus of legislation is on the promotion of competition in the telecommunications market.

The National IT and Telecom Agency (IT- og Telestyrelsen) regulates and supervises the telecommunication industry. As a division of the Ministry of Science, Technology, and Innovation, it also frames and conducts initiatives and implements national IT and telecom policies. Ex-post regulation by the agency follows comprehensive market analyses and has often taken aim in the years after liberalization at interconnection and LLU prices.

As a member of the EU, Denmark is also obliged to implement the EU Framework Directive, which in Article 8.2 requires that "competition in the provision of electronic communications networks, electronic communications services and associated facilities and services" is promoted by "(a) ensuring that users, including disabled users, derive maximum benefit in terms of choice, price, and quality; (b) ensuring that there is no distortion or restriction of competition in the electronic communications sector; (c) encouraging efficient investment in infrastructure, and promoting innovation".

135 GlobalComms Denmark, p.16.
136 Ibid.
137 Ibid.
138 GlobalComms Denmark, p.9.
139 GlobalComms Denmark, p.16.
140 A fact that caused existing telcos to call for a stricter regime, see: GlobalComms Denmark, p.15.

Broadband strategy

Denmark's broadband development is based on a plan issued by the Danish Government in 2001.[141] The plan laid out the ambitious aim "that Denmark should be the world's leading IT nation."[142] One of the goals articulated in the plan is to "have fast, cheap and secure internet for support and further development of the Danish welfare society." Even in 2009, Denmark sees great potential and advantages in being a leader in the digital world and "the Government's target is for all Danes to have broadband access by the end of 2010 at the latest."[143]

Believing in the market's ability to provide the infrastructure for digital leadership,[144] the broadband strategy called for the analysis and monitoring of the market and the behavior of the demand side actors and giving consumers enough information about products and prices while regulation and interventions should "contribute towards a high competition and security level in the IT and telecommunications sector."[145]

The strategy by which Denmark seeks to achieve this is based on four principles: a market-driven infrastructure without the use of public funding, technology neutrality in the regulation of the market, transparent regulation, and the public sector as a contributing force behind demand for IT.[146] The Danish broadband strategy has been described as a "soft-intervention" strategy, which is "characterized by low government involvement in broadband infrastructure deployment" as it relies "on market forces to ensure broadband supply."[147]

To boost demand, Danish Government decided to invest in public sector IT and IT services where the following criteria are met: increased prosperity and productivity; better public service and welfare; increased efficiency in the public sector; skills development within and via IT; and an IT-related boost of the Danish cultural heritage and media production.[148] As the broadband plan from 2001 puts it: "Increased penetration of fast internet connections will require a wider range of relevant content on the web - there must be something worthwhile."[149] The strategy also suggests that public-private partnerships should be established for the development of new public IT services for the citizens.[150] A couple of regional and municipal initiatives have reached out to the private sector for a rollout of fiber.[151]

Denmark's broadband strategy has proven to be successful; Denmark leads the OECD in broadband penetration rates[152] and the price for a monthly broadband subscription can be as low as USD 6.06.[153]

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141 In its brochure "VISION 2015: 100 megabits for all", the Danish Energy Association argues that there is an urgent need for a new broadband strategy if economic growth and jobs are to be secured. http://www.danishenergyassociation.com/Theme/Broadband.aspx

142 http://en.vtu.dk/files/publications/2001/from-hardware-to-content-strategy-for-fast-cheap-and-secure/html/inde0002.htm

143 The Danish Government, IT and Telecommunications Policy Report 2009, March 2009, p.6.

144 if demand is high enough

145 http://en.vtu.dk/files/publications/2001/from-hardware-to-content-strategy-for-fast-cheap-and-secure/html/inde0009.htm

146 IT- og Telestyrelsen, Comments on FCC GN Docket No. 09-47, June 2009, p.1.

147 Inmaculada Cava-Ferreruela and Antonio Alabau-Muñoz, Broadband policy assessment: A cross-national empirical analysis, in: Telecommunications Policy 30 (2006) 445–463, p.447.

148 http://en.vtu.dk/files/publications/2001/from-hardware-to-content-strategy-for-fast-cheap-and-secure/html/inde0009.htm

149 Ibid.

150 http://en.vtu.dk/files/publications/2001/from-hardware-to-content-strategy-for-fast-cheap-and-secure/html/inde0010.htm

151 see section: Government investment in infrastructure

152 OECD, Broadband Growth and Policies in OECD Countries 2008, 2008, p.35.

153 OECD, Broadband Growth and Policies in OECD Countries 2008, 2008, p.42.

However, the fastest download speeds offered by the incumbent provider are lower than those found in many other countries[154] and prices for fast connections are still relatively high.[155]

Policy interventions and outcomes

Government investment in infrastructure

In accordance with its broadband strategy, which emphasizes a market based approach to broadband development, the Danish central government has neither invested substantially in the deployment of backbone infrastructure nor carried out any other major investments in broadband networks for business and residential connectivity. Instead, it has applied a philosophy of establishing fast IT infrastructure in the public sector which in turn boosts public sector demand for broadband connections. Although 21,000 households and businesses still had no access to broadband in 2008,[156] the government remains committed to its policy of not funding any broadband infrastructure[157] but rather supporting demand through the promotion of IT use in the public sector, education and research programs.

However, there have been a couple of public-private partnerships for broadband deployment on a regional and municipal level. The most notable of these are Djursland.net and Aarhus Network. The former was established in 2001 and covered 8 municipalities, which rented fiber optic capacity from the county and extended the coverage by radio to remote areas. In the latter, the municipality of Aarhus contracted Netdesign to rollout and operate a fiber optic network based on an open network model intended to eventually cover 1,500 localities.[158]

Skill building, education, and demand programs

Denmark has invested considerable energy in improving the technological proficiency of its populace, initiating a number of government programs designed to promote the use of information technology and enhance user skills. In 1993, an educational network was established, linking[159] primary and secondary schools as well as universities to a conference and learning environment and later to the internet.[160] In 1997, research institutions were able to connect to Forskningsnettet, a research network, which in 1999 allowed downstream speeds of up to 10 Mbit/s.[161]

The Danish Government has found it crucial for the nation's "ability to utilize the strong growth potential found everywhere in the country" that "knowledge should be put to work in the Danish regions."[162] In a regional action plan in combination with the Finance Act for 2005, about DKK 130 million have been allocated to be spent on a number of regional technology centers.[163]

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154 OECD, Broadband Growth and Policies in OECD Countries 2008, 2008, p.44.
155 OECD, Broadband Growth and Policies in OECD Countries 2008, 2008, p.43
156 The Danish Government, IT and Telecommunications Policy Report 2009, March 2009, p.8.
157 IT- og Telestyrelsen, Comments on FCC GN Docket No. 09-47,June 2009, p.1.
158 IT- og Telestyrelsen, Mapping of Broadband Access Services in Denmark- Status by mid-2004, English summary, December 2004, p.10 et sq.
159 Technically, Sektornet is a VPN on Tele Denmark's IP net, see: http://cordis.europa.eu/infowin/acts/analysys/products/thematic/flexwork/3-4/3-4.htm
160 http://en.vtu.dk/files/publications/2001/from-hardware-to-content-strategy-for-fast-cheap-and-secure/html/inde0007.htm
161 Ibid.
162 The Danish Government, IT and Telecommunications Policy Report 2006, March 2006, p.10.
163 The Danish Government, IT and Telecommunications Policy Report 2006, March 2006, p.22.

In 2002, a government proposal was adopted, which " gives the employee the right to a tax allowance of up to DKK 3,500 each year against the cost of having a computer made available at home by his/her employer. The scheme requires the employer to contribute 25 per cent of the costs. In addition, data communications access paid for by the employer will be tax free, provided the employee has access to the employer's network from home."[164]

IT skills are fostered by nine new ICT programs introduced in 2006 at the university level. By 2007, enrollment to ICT university programs had risen by 24% from the previous year.[165] For the period from 2004 to 2007, DKK 370 million have been granted to municipalities to buy and install PCs for the youngest students, provided that the municipalities pay at least the same amount.[166]

In 2008, a requirement for the use of open standards in the public sector came into force, along with the use of open document formats. Some years before, government and municipalities jointly created "eDay2", which was an initiative to "ensure that private citizens and businesses can communicate safely with public authorities with digital signatures no later than February 1, 2005."[167] In 2009, 50% of basic public services for citizens were available online in Denmark and 86% for enterprises."[168]

Another notable part in Denmark's IT policy is the action plan for green IT by which the Ministry of Science, Technology and Innovation seeks to reduce energy costs and CO_2 emissions in the public sector.[169]

Competition policy

As an early adopter of local loop unbundling, Denmark has actively pursued open access policies to promote competition in broadband markets. The principal instrument that guides competition policy in the telecommunications sector is the Act on Competitive Conditions and Consumer Interest in the Telecommunications Market, which is applied by Telestyrelsen (in some cases in consultation with the Danish Competition Authority).

Two principles govern policy regarding interconnection: "Firstly, the principle that all providers of public telecommunications networks or telecommunications services are under an obligation to negotiate between them agreements on exchange of traffic, with a view to ensuring mutual access to their telecommunications networks or telecommunications services. Secondly, based on the desire to facilitate the establishment of an effective telecommunications sector driven by competition, the principle that a number of special requirements should be set for providers of telecommunications networks or telecommunications services who have significant market power in a given submarket within the telecommunications sector, or who control a special competitive bottleneck resource."[170] Those requirements for operators with significant market power include - among others - the obligation to meet interconnection requests on non-discriminatory terms and at cost-related prices.

164 The Ministry of Science, Technology and Innovation, IT for All - IT and Telecommunications Policy and Action Plan 2002.
165 The Danish Government, IT and Telecommunications Policy Report 2008, March 2008, p.13.
166 The Danish Government, IT and Telecommunications Policy Report 2008, March 2008, p.9.
167 The Danish Government, IT and Telecommunications Policy Report 2005, March 2005, p.5.
168 European Commission, Europe's Digital Competitiveness Report, Country Profiles 2009, August 2009, p.18.
169 See: The Ministry of Science, Technology and Innovation, Green IT Guidelines for public authorities, December 2008.
170 Act on Competitive Conditions and Consumer Interest in the Telecommunications Market, Chapter IV, p.172.

The Act on Competitive Conditions and Consumer Interest in the Telecommunications Market also contains provisions on Universal Service Obligation. TDC was appointed universal service provider for six years (possibly extended by another two years) from 1 January 2009.[171]

Prices for local loop unbundling "are set by Telestyrelsen in cooperation with industry players and are based on long run average incremental costs."[172] In order to promote competition and lower costs for high downstream speeds, in 2006 and 2007, the regulatory body "decided to reduce TDC's wholesale prices for broadband.[173] In March 2009 the regulator's plan to require Fixnet Nordic (TDC) to give competitors wholesale access to its cable network was backed by the European Commission.[174]

In December 2008, a bill was passed, which requires companies that share the use of the network to also share the cost of the infrastructure. The Ministry hopes this "will result both in incentives to invest in new technology and also in competition between the services on the existing telecommunications networks."[175] No accounts of operators requesting competitors to share the cost of future infrastructure are publicly available.

In the field of mobile broadband, the Act on the Establishment and Joint Utilization of Masts for Radiocommunications gives operators the right to use an antenna mast that is owned by a competitor and sets out rules for compensation and sharing of costs.

Network non-discrimination

Network neutrality is not currently at the center of any political debates. Yet it has been the topic of an international conference arranged by the Ministry of Science, Technology and Innovation on 30 September 30th, 2008. According to the Government's IT and Telecommunications Policy Report from March 2009, "Denmark will continue its endeavors to guarantee an open internet for all."[176]

Spectrum policy

The Frequency Act requires the Minister for Science, Technology and Innovation to issue a mandate, which serves as a framework for Telestyrelsen to manage the spectrum of radio frequencies.[177] Frequencies are allocated by way of auctions. The Frequency Act was revised in 2007 and a new Frequency Act is expected to enter into force on 1 January 2010 allowing the market to trade frequencies and thereby allocating them more efficiently.[178] The new act will also implement technology neutrality in the use of frequencies and provisions that ban hoarding and anti-competitive behavior.[179]

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171 The Danish Government, IT and Telecommunications Policy Report 2009, March 2009, p.9.
172 GlobalComms Denmark, p. 16.
173 The Danish Government, IT and Telecommunications Policy Report 2008, March 2008, p.8.
174 http://europa.eu/rapid/pressReleasesAction.do?reference=IP/09/394&format=HTML&aged=0&language=EN&guiLanguage=nl
175 The Danish Government, IT and Telecommunications Policy Report 2009, March 2009, p.10.
176 The Danish Government, IT and Telecommunications Policy Report 2009, March 2009, p.9.
177 http://en.itst.dk/copy_of_frequencies/frequency-legislation/executive-orders-under-the-frequency-act/the-spectrum-policy-framework-mandate
178 The Danish Government, IT and Telecommunications Policy Report 2009, March 2009, p.10.
179 European Commission, Progress Report on the Single European Electronic Communications Market 2008 (14th Report), Country Chapter Denmark, March 2009, p.8.

An auction of additional spectrum is slated for the end of 2009, following a 2008 decision by the Ministry of Science, Technology and Innovation to issue licenses in the 2500-2690 MHz and 2010-2025 MHz bands for fixed and mobile broadband services.[180]

180 The Danish Government, IT and Telecommunications Policy Report 2009, March 2009

B. France

Introduction

The development of broadband access in France has been driven primarily by the deployment of DSL. Broadband penetration rates increased markedly after a shift in the regulatory environment and the implementation of local loop bundling. This allowed competitors access to the network of France Telecom and helped to drive down broadband prices in France; consumer broadband prices in France are now among the most affordable in the world. Average broadband speeds in France also place it among the leaders. France is not among the highest performers in terms of broadband penetration rates. However, after strong improvements over the past six years, broadband penetration rates in France are now higher than the OECD average.

The broadband strategy in France has historically relied on private investment and the promotion of market competition. Competition in broadband markets has helped to spur innovation in retail markets, particularly in broadband offering that combine fixed and mobile coverage. This appears likely to change, as the French government has announced its intention to help finance the deployment of fiber networks. The current broadband policy debate in France focuses on the issues of access and sharing of fiber networks. Each of the major players is investing in fiber infrastructure.

Market highlights

Overall, 42.9% of households in France have broadband access.[181]

	Fiber / LAN	Cable	DSL	Other	Overall
Subscriptions per 100 people [182]	0.1	1.4	26.6	0.0	28.0[183]

181 OECD Broadband Portal, Table 2a, from EU Community Survey, from 2007.
182 OECD Broadband Portal, Table 1d, supplied by the French government, as of 2008.
183 This number does not include 3G Wireless. Since subscriptions are shared in a household, it will always be below 100.

Penetration metrics	Rank	Speed metrics	Rank	Price metrics	Rank
Penetration per 100, OECD	13	Maximum speed, OECD	3	Price low speed, OECD	17
Household penetration, OECD	18	Average speed, OECD	3	Price low speed, OECD+GC	18
3G penetration, GC	14	Median download, speedtest.net	9	Price mid speed, OECD	1
Wi-Fi hotspots per 100,000, Jwire	4	Median upload, speedtest.net	6	Price mid speed, OECD+ GC	3
		Median latency, speedtest.net	24	Price high speed, OECD	1
		90% download, speedtest.net	4	Price high speed, OECD+GC	2
		90% upload, speedtest.net	13	Price very high speed, OECD	5
				Price very high speed, OECD+GC	5

1st quintile
2nd quintile
3rd quintile
4th quintile
5th quintile

Note: Details in Part 3
Source: OECD, GlobalComms, Jwire, Speedtest.net, Berkman Center analysis

Broadband development to date

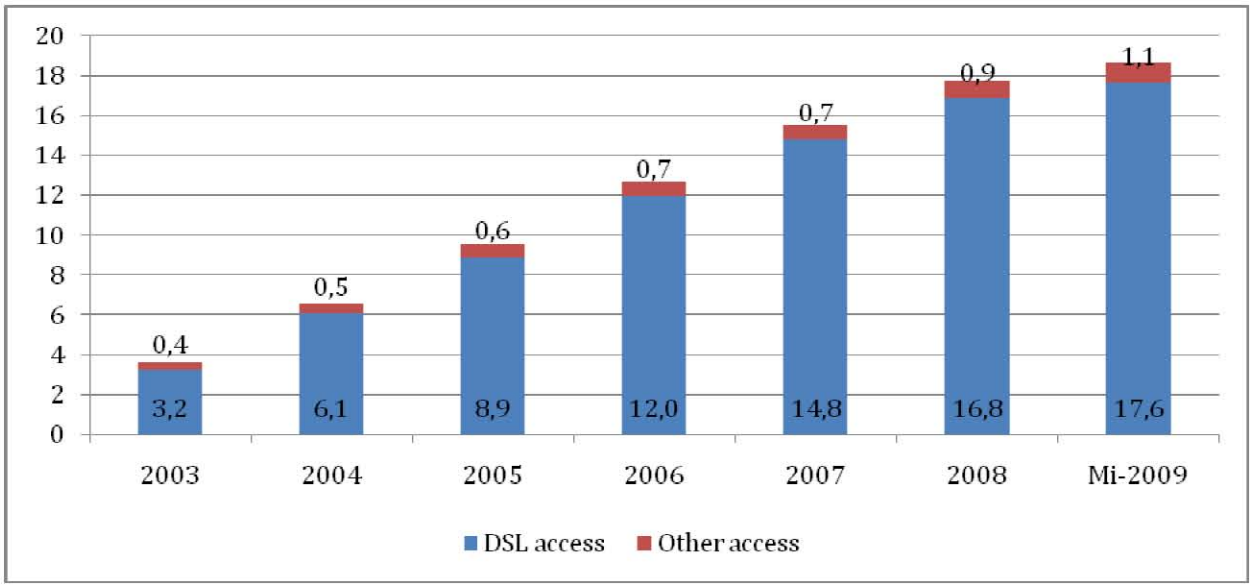
Compared to its European neighbors, France was slow to adopt widespread broadband Internet. In 2001, penetration rates in France stood at about one-third of the overall average for OECD countries.[184] However, following an overhaul of the regulatory regime, broadband penetration rates in France have improved substantially over the past six years. Broadband penetration rates in France are now approximately 25% higher than the OECD average.

Broadband connectivity in France has been driven primarily through the use of DSL connections via the France Telecom (FT) network. DSL subscriptions make up 95% of all broadband connections in France. The implementation of local loop unbundling (LLU) of FT networks has allowed Iliad/Free and Neuf/SFR to establish themselves as major competitors to FT in broadband markets. The largest cable telephony and broadband cable company, Numericable, controls a vast majority of the broadband cable market. However, this constitutes only about 5% of the overall broadband market. Cable networks have been deployed only in big cities, explaining the low global market share of the technology. The wireless broadband is offered as a complementary service by DSL operators and has emerged as a result of the convergence between fixed and mobile broadband access, rather than as an autonomous technology. For example, subscribers to Iliad's broadband service (sold under the brand Free) have access to the service box of other Free subscribers to form a subscriber-based system of nomadic access. Similarly, SFR enables its customers to connect wirelessly via FoN subscribers.

Broadband connectivity is accessible to 99% of the overall population in France, and 97% of residents in rural areas (compared to European averages of 93% and 70%).[185]

184 OECD, G7 historical penetration rates. http://www.oecd.org/dataoecd/22/14/39574797.xls.
185 http://europa.eu/rapid/pressReleasesAction.do?reference=IP/09/343&format=HTML&aged=0&language=EN&guiLanguage=en

Broadband subscriptions in France (2003-2009, in millions)



Source: Author's calculations using ARCEP data

Despite commitments by several of the major broadband companies—including FT, Free, and SFR—to invest in fiber roll-out, fiber-based broadband connections remain marginal in France. Iliad, the parent company of Free, announced EUR 1 billion investment to construct 4 million connections until end of 2012.[186] They intended to provide the connections in Paris by the first semester of 2007. France Telecom has also committed to investing in fiber roll-out.

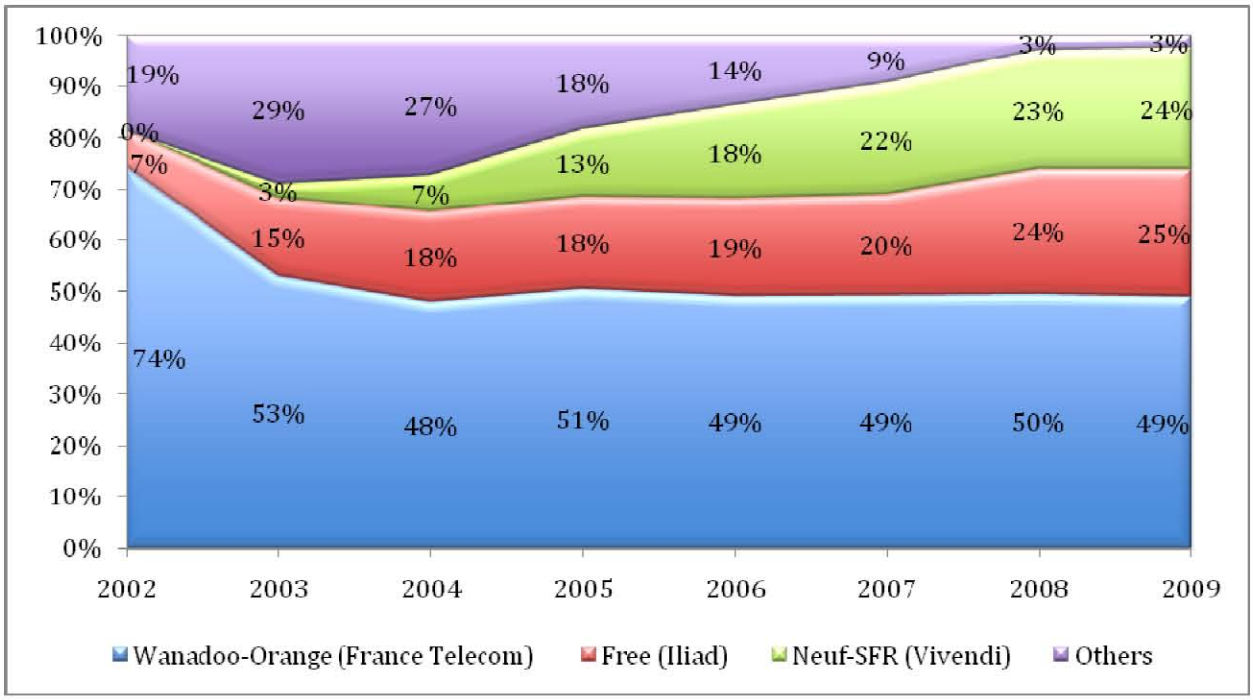
The investments in fiber roll-out have been somewhat delayed due to the public controversy regarding access to the infrastructure of France Telecom. Therefore, broadband through fiber has not developed as fast as initially expected. By December 2008, only 550,000 households had access to fiber connections in their building,[187] and the number of subscribers remains very low: among 170,000 of all the very high-speed connections, only 40,000 were through fiber.[188]

Key players and market share

The historical state-monopolist, France Telecom (FT) remains the leader of the market, although its share of the market dropped substantially following the implementation of local loop unbundling. The FT subsidiary Orange currently holds approximately 50% of the DSL market. (Figure xx).

186 Iliad, Press Release, September11, 2006.
187 ARCEP, Annual Report, 2008.
188 ARCEP, « Tableau de bord du Très Haut Débit au 31 décembre 2008 ». Published July 4, 2009

Market share of DSL operators in France (2002-2009)



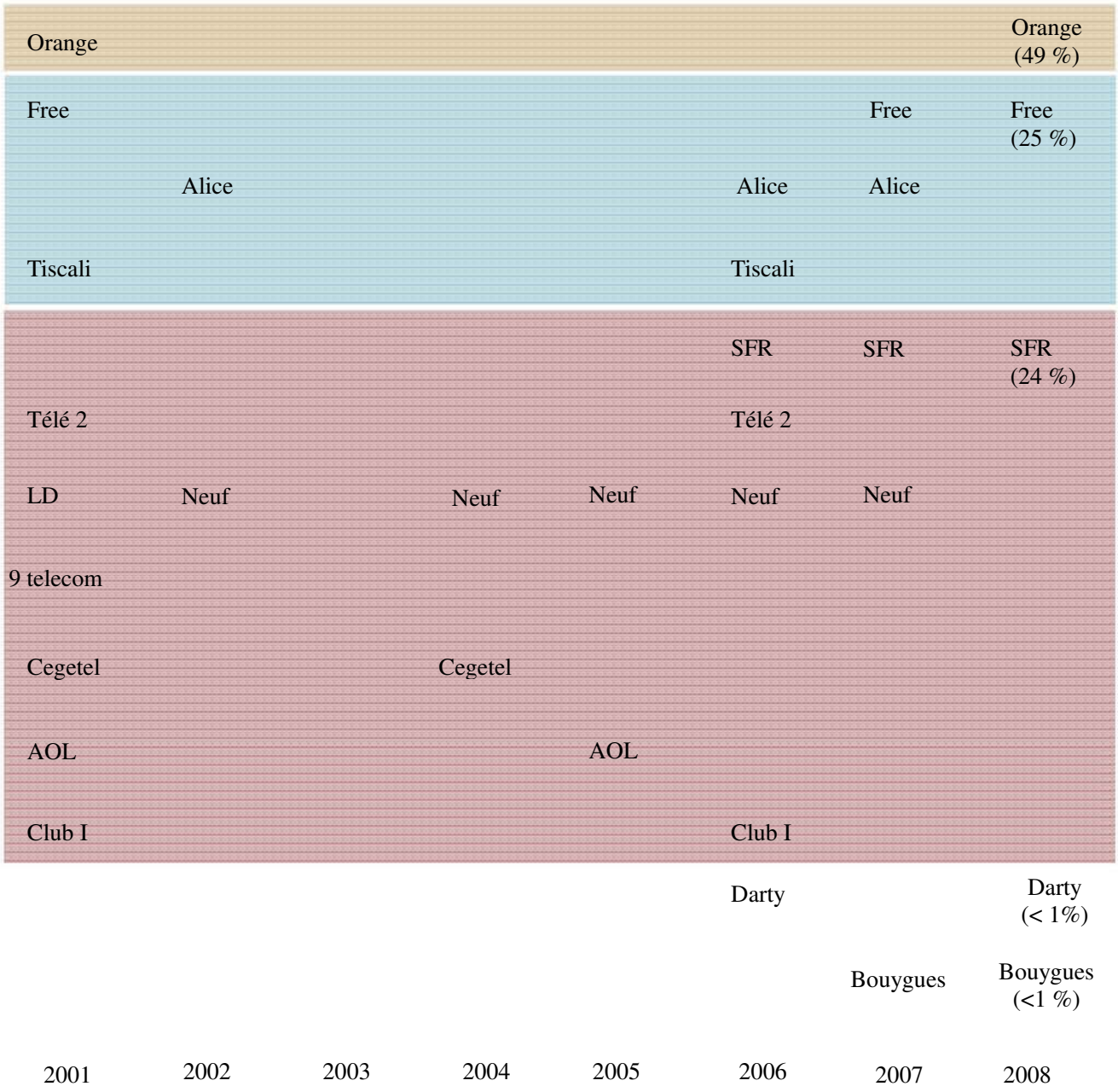
Source: Financial company communication, press releases (collected by Microeconomix)

Between 2001 and 2004, following the regulatory decrease in wholesale prices, several new operators entered the market and gained increasing market share. Building upon unbundled access, Free and SFR have each captured approximately one quarter of the DSL market.

A number of mergers over the past several years have contributed to an increase in market concentration. The last wave of corporate acquisitions in 2008 (Figure xx) consolidated the position of FT-Orange's two principal challengers, Free and SFR-Neuf.

Two recent entrants to the broadband sector, Bouygues and Darty, have adopted distinct market strategies. Bouygues, a telecommunication company, offers convergence of voice and data for their subscribers through broadband access. Darty, a large retailer specializing in household electronics, entered as a virtual operator in 2007. It was not previously active in the telecommunication sector.

Mergers and acquisitions on the French DSL market (2001-2009)



Source: Microeconomix

Only one of the top three operators, Free, was not active in the telecommunication sector before its entry in the broadband market. Iliad is a start-up that introduced an offer for broadband access through ADSL at EUR 30 per month in 2002, and did not change their price even when adding more services, such as unlimited VoIP and TV, to their offer. According to the OECD, this price for broadband access was the best in Europe in 2005.[189] This price has become the reference point for the French broadband market,

189 OECD (2006), DSTI/ICCP/TISP(2005)12, 20

and has helped to drive down broadband costs in France as other operators have been forced to follow suit.[190]

Regulatory framework

The Law of 26 July 1996 opened the telecommunications sector to full competition and mandated the creation of the regulatory authority, ART (*Autorité de Régulation des Telecommunications*), which was subsequently established on January 5th 1997. ART is an independent administrative authority tasked with regulating the liberalization of the telecommunications sector. In 2005, the French Parliament made ART responsible for regulating postal activities; the authority thereby became ARCEP (*Autorité de Régulation des Communications Electroniques et des Postes*).

As in other European markets, the French regulatory framework is driven by implementation of European directives on liberalisation of telecommunications sector, with the Framework Directive 2002/21/EC as a starting point. ARCEP has relied primarily on *ex ante* intervention into wholesale broadband markets. Through access rules and the regulation of tariffs, ARCEP actions have been aimed at ensuring that France Telecom's rivals could compete effectively against the previously state-owned monopolist, which controlled household access via the copper network.

Between 2000 and 2002, the principal regulatory issue centered on the reference offer made by France Telecom to other operators for wholesale access and the co-localisation of operators in DSLAM rooms. These activities were intended to satisfy local loop unbundling requirements, which had been mandated by the European Parliament and the Council in 2000.[191] As with each member state, France was responsible for the implementation of this law within its own legal system. In 2002, the European Commission started a non-compliance procedure by opening infringement proceeding against France regarding the Regulation on Unbundling of the Local Loop.[192] The European Commission indicated that the reference offer from incumbent operators should be sufficiently unbundled to allow competitors to pay only for what they use. In addition, they must provide a breakdown of costs for the sub-loop so that an operator can install equipment closer to customers' premises than the local exchange.

The infringement proceedings opened by the European Commission modified substantially the behavior of ART, which then introduced sub-loop unbundling and significantly reduced the rate charged for local loop access. Although the monthly rental fee became the lowest in Europe after Denmark, the total monthly cost per unbundled loop, including the connection fee, whether full or shared, was still high; in 2003, France was 9th in the EU for full unbundled loop and 6th for shared access.[193]

However, price was not the only consideration. ARCEP also moved to dismantle other obstacles to access unrelated to price. It defined in detail a number of service quality indicators and put forward a protocol for migration to unbundled loops to ensure that the incumbent and new entrants could work together. This included setting precise time limits, forcing FT to disclose the plans of its telephony

190 Iliad has increasingly relied full unbundling to recover revenue generated by telephony. A significant portion of Iliad's profit is due to fixed-to-mobile calls, because of high interconnection rates. These interconnection rates used to be very high in Europe, but after the intervention of regulators they fell from 40 to 7 cents. FT's prices on these services have been decreasing at the same time, whereas the prices set by the alternative ISP have stayed at a very high level. The regulator expected that the fall in wholesale prices would lead to a similar decrease in retail prices due to competition, but this has not happened. Iliad's business model could not be replicated in countries without such an interconnection regime.

191 Regulation 2887/2000 of 18 December 2000 on unbundled access to the local loop, OJ L 336, 30/12/2000, 4.

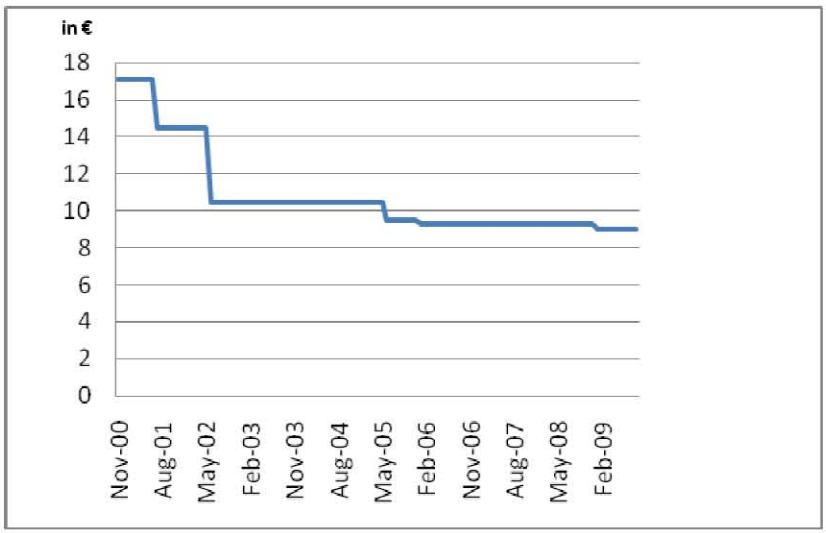
192 European Commission, Press Release nr IP/02/445, March 20, 2002.

193 EU Telecommunications Regulatory Package – 9th Implementation Report – Annex 1, 2003. See figures 63 to 66.

exchanges ("*centraux téléphoniques*" in French), and setting the exact price of an hour of work on LLU.[194] This was aimed at preventing the incumbent from continuing the delaying tactics it was alleged to have undertaken in the past in order to gain an advantage in the DSL market.[195]

The regulatory focus on LLU, along with interconnection, has had a clear impact on the provision of broadband in France. LLU represents 60% of broadband access bought on the wholesale market, and represents more than 90% of the growth in the first quarter of 2009.[196] For setting tariffs, in 2005 ARCEP launched a consultation process devoted to pricing of the local-loop and published a methodology in December 2005. The current cost accounting method was chosen to evaluate the investment in local loop assets. The total cost of unbundling is defined as the sum of the local loop costs (which includes a capital cost and an operation cost), the costs of services, and a fraction of FT's common costs. FT is required to base its regulated prices on this total cost accounting method. The figure below reports the downward evolution of France Telecom' prices agreed by ARCEP between 2000 and 2009.

LLU price on wholesale access French market (2000-2009)



Most of the recent debates regarding the regulatory framework concern the implementation of fiber networks. ARCEP has stated that France Telecom's civil engineering infrastructure, including the underground infrastructure that hosts the local loop, is the critical element in the deployment of a new fiber local loop. This civil engineering infrastructure has been defined as an essential facility, and France Telecom is thereby required to provide access to it. ARCEP has also stated that it will seek to avoid duplication of installation in buildings, but without eliminating competition at the service level.

194 OECD Regulatory Reform in France: Regulatory Reform in the Telecommunications Sector (2003).

195 On this issue, the misadventures of an early ISP, Mangousta, with FT should be mentioned. Mangousta was launched in 1999 and was one of the first DSL providers in France. Even if FT was obligated to deliver DSL access through resale or unbundling, it prevented the small company from entering some of their telephone exchanges, and even damaged the installations of their new competitor. This eventually led to the bankruptcy of Mangousta. The managers of this ephemeral ISP brought the case before the European Commission and as FT feared the imposition of a considerable fine, they chose to settle the case directly with the managers and paid them compensation that covered slightly more than their initial investment.

196 ARCEP, "Tableau de bord des offres de gros du haut débit par DSL", June 2, 2009.

Operators will need to share the terminating sections of their fibre optic network. Debate over the specific modalities for rolling out and sharing new fiber deployments are on-going.

Broadband Plan

In 2008, the Prime Minister F. Fillon created a new ministry dedicated to the digital economy. E. Besson was appointed as a minister of State "in charge of the development of digital economy." He was later replaced by N. Kosciusko-Morizet, who remains the current minister of State.

In 2008, E. Besson presented the new broadband strategy for France "France Numérique 2012." This plan aims, among numerous other goals, to provide universal access to broadband Internet throughout France before the end of 2010. To achieve this goal, the French government will contract at a local level with private operators to provide universal access for the 2 to 3% of citizens who do not have broadband access, with the specification that connectivity should be no less than 512 kbps and at a cost of no more than EUR 35 per month. The plan also provides new financial and administrative tools for local governments' investment in network infrastructure. Since the initial release of the strategy, targets are being redefined towards higher speeds and an applications-based definition of targets in addition to pursuing fixed-mobile convergence.[197]

The initial plan within the "France Numérique 2012" strategy was to organize a call for tender for the supply of the universal broadband access by January 2010. The call for tender was intended to occur in the first quarter of 2009, but has been postponed due to the economic slow-down.

Policy interventions and outcomes

Government investment in infrastructure

The government has never directly invested in infrastructure, whether for DSL or fiber technologies, but limited its role to setting the regulatory framework through the creation of an independent regulatory authority (ART, later ARCEP)..

Investments in infrastructure have been made at the local level. Using the loans from the Caisse des Dépôts et Consignations (CDC), the financial arm of the French state, many local governments have developed broadband infrastructure in the areas without adequate broadband coverage in order to reduce the disparity between urban and urban broadband penetration rates.

Public investments in services must conform with European guidelines and the scope of authorized public intervention depends on the level of service offered by private operators. In the "white zone", where no private operators provide broadband service, public intervention is a classical response to market failure. Local governments may subsidize the building of networks and may also directly provide broadband access according to Act 2004-575 on Confidence in the Digital Economy.[198] Local government may be permitted to become minority investors in these projects and contract with private operators, either through a "public service delegation" or public-private partnerships. For example, the governments of Oise, Pyrénées Atlantique, Loiret, and Alsace have established public network projects

197 http://www.arcep.fr/fileadmin/reprise/communiques/communiques/2009/comnq-nkm-fibre-100709.pdf.
198 This act improves the prevention and enforcement system on the Internet.

by leasing unbundled local loops and installing DSLAM.[199] 85 of the 102 projects launched so far cover each more than 60.000 inhabitants.[200]

The relevance of public intervention in the "grey zone" has been widely discussed. The "grey zone" refers to local DSL markets where the incumbent operator remains the only provider of broadband access. Local government can argue that the competition is too low, and build an alternative network to promote an effective competition in the market. However, these public subsidies have to fulfill the European rules regarding public subsidies. In 2007, under the Community State Aid rules, the European Commission approved the funding by Sicoval (an association of municipalities on the south-east side of Toulouse) of a very high-speed telecommunications network exclusively serving businesses and public organizations on its territory.

Investments in the "grey zone" yield litigation risk. For example, the municipality of Paris wanted to offer free wireless network "Paris Wi-Fi", so it organized a call for tender for the supply of the infrastructure and later proceeded with the investment. France Telecom, after it had not been selected in a call for tender, brought an action against the municipality in an administrative French court in March 2007(on the basis of the L 1425-1 article of "Code General des Collectivités territoriales"[201]). Thus far, France Telecom has not been successful in its litigation and "Paris Wi-Fi" continues to operate.

Despite these difficulties, new loans from the CDC will be made available through the plan "France Numérique 2012" and local governments may be permitted to become minority investors.

Public investment in broadband access infrastructure will likely increase in the future through the deployment of fiber networks. Projects estimated to cost EUR 25 to 40 billion are expected to be partially financed with public funding 2010.[202] This plan for publicly-backed financing, announced by President Sarkozy in 2009, aims to rebuild and redesign French industry with a clear focus on high-tech industry. The amount has not been set, but the bond could be the range of EUR 80 to 100 billion.

Competition policy

The French competition law follows common European standards concerning the abuse of market power, collusion, and mergers. France's competition policy is in line with European Commission's approach of decentralized *ex post* enforcement through national institutions. In 2008, national regulatory institutions were restructured with most of the responsibilities concerning the competition law given to *Autorité de la Concurrence.* This new authority has the capacity to proceed with its own investigations and make decisions in all the fields of the competition law. The Ministry of the Economy remains responsible for consolidations that fall below a certain threshold.

The decision by French authorities to address the anticompetitive practices of FT regarding broadband access had a profound impact on broadband markets in France. They penalized the incumbent operator for practices aimed at pre-empting the emerging DSL market between 2001 and 2002 and benefiting its Wanadoo subsidiary. Their practices included predatory prices,[203] discriminatory conditions in access to

199 OECD, "Working Party on Telecommunication and Information Services Policies: The Development of Broadband Access in Rural and Remote Areas," Directorate for Science, Technology, and Industry, Committee for Information, Computer and Communications Policy (Geneva, Switzerland) May 10, 2004, 23.

200 French Government, « Plan de développement de l'économie numérique, France Numérique 2012 », October 2008.

201 Available online at : http://www.legifrance.gouv.fr/affichCodeArticle.do?cidTexte=LEGITEXT000006070633&idArticle=LEGIARTI000006389450&dateTexte=20080222

202 Les Echos, September 11, 2009.

203 Decision by the EU Commission of 16 July 2003, imposing a €10M fine on FT.

the local loop,[204] and smear campaigns[205] against the alternative operator. The incumbent was also accused of impeding effective competition in broadband markets in overseas departments through margin squeeze. In bringing its case against FT, the French competition authority argued that the low penetration of broadband access was a direct consequence of the practice.

The competitive analysis of mergers has been especially relevant in two recent cases: SFR-Télé 2[206] and SFR-Neuf.[207] Interestingly, the planned operations raised concerns about the possible dominant position of the new entity not in DSL markets but in pay-TV markets. The two operations were approved in the light of commitments by SFR and Vivendi to ensure access to Vivendi TV content by other DSL operators.

Spectrum policy

The 1996 Telecommunications Act set up the Agence Nationale des Fréquences (ANFR), a body responsible for planning, monitoring, and coordinating spectrum usage in France. The ARCEP assumes the authority for determining rates for spectrum license fees and administrative taxes. France has used comparative selection procedures (commonly referred to as a "beauty contest") to allocate spectrum licenses for the telecommunication sector, including 3G licenses. Initially four licenses were offered for tender at the price of EUR 4.95 billion. This was perceived as too high by a number of operators, and only two licenses were awarded in June 2001, to FT and SFR. In December 2001, the government decided to change the license price in order to allocate the remaining 2 licenses, with the modifications also applicable to the two existing license holders. The price was reduced to EUR 619 million with an additional tax of 1% on revenue from 3G activities.[208] Only Bouygues Telecom applied for a license and was awarded a concession in September 2002.[209]

In July 2006, ARCEP decided to allocate a fourth 3G license, and Iliad indicated that it was interested in acquiring it. After considerable negotiation over the financial details, Iliad declined ARCEP's offer. In January 2009, the French government decided to split the blocks of frequency on offer into three lots of 5MHz, with one reserved for a new entrant with a price of EUR 206 million. Illiad is officially a candidate since August 2009. The tender is still pending.

The national plan, "France Numérique 2012," proposes the reallocation the 790-862MHz band, which was used previously for analog TV, to fixed and mobile broadband. This part of the "digital dividend" will be used in coordination with the other European countries.

204 Decision 05-D-59 (Conseil de la concurrence 7 November 2005), imposing a €80M fine on FT.
205 Decision 07-D-33 (Conseil de la concurrence 15 October 2007), imposing a €45M fine on FT.
206 http://ec.europa.eu/competition/mergers/cases/decisions/m4504_20070718_20600_en.pdf
207 http://www.dgccrf.bercy.gouv.fr/boccrf/2008/08_04bis/c2007_181_sfr_9cegetel.pdf
208 OECD Regulatory Reform in France: Regulatory Reform in the Telecommunications Sector (2003).
209 GlobalComms, DT Company Overview (updated March 2009).

C. Japan

Introduction

Japan is often cited as a global leader in broadband technology, speed, and price. The Japanese government has maintained and adapted an aggressive broadband policy since the late 1990s, which has included low-interest loans and tax deductions for infrastructure build-out. Both NTT, The formerly government-run monopoly, and MIC, the regulatory agency, were reorganized in 1999 in order to facilitate removal of legacy technology-specific regulations and to add safeguards to ensure competition. Competition in DSL was strongly influenced by entry of Softbank BB into the Japanese market, using unbundled access to NTT's network. High demand and a growing market attracted cable and power companies, which spurred fiber deployment. Today, regulators have embraced a user-centric policy framework that focuses on ubiquitous access and a "layers-based" regulatory framework. The government aims to encourage facilities-based competition with access to poles and rights-of-way. WiMax is not widely deployed, but 3G wireless penetration is high, with providers evolving to 4G. KDDI is expanding Wi-Fi integration as an aspect of fixed-mobile convergence.

Market highlights

Overall, 67.6% of households in Japan have broadband access.[210]

	Fiber / LAN	Cable	DSL	Other	Overall[211]
Subscriptions per 100 people [212]	11.3	3.2	9.1	0	23.6

Penetration metrics	Rank	Speed metrics	Rank	Price metrics	Rank
Penetration per 100, OECD	17	Maximum speed, OECD	1	Price low speed, OECD	7
Household penetration, OECD	5	Average speed, OECD	1	Price low speed, OECD+GC	7
3G penetration, GC	1	Median download, speedtest.net	4	Price mid speed, OECD	2
Wi-Fi hotspots per 100,000, Jwire	29	Median upload, speedtest.net	1	Price mid speed, OECD+ GC	1
		Median latency, speedtest.net	17	Price high speed, OECD	2
		90% download, speedtest.net	3	Price high speed, OECD+GC	1
		90% upload, speedtest.net	1	Price very high speed, OECD	1
				Price very high speed, OECD+GC	1

1st quintile
2nd quintile
3rd quintile
4th quintile
5th quintile

Note: Details in Part 3
Source: OECD, GlobalComms, Jwire, Speedtest.net, Berkman Center analysis

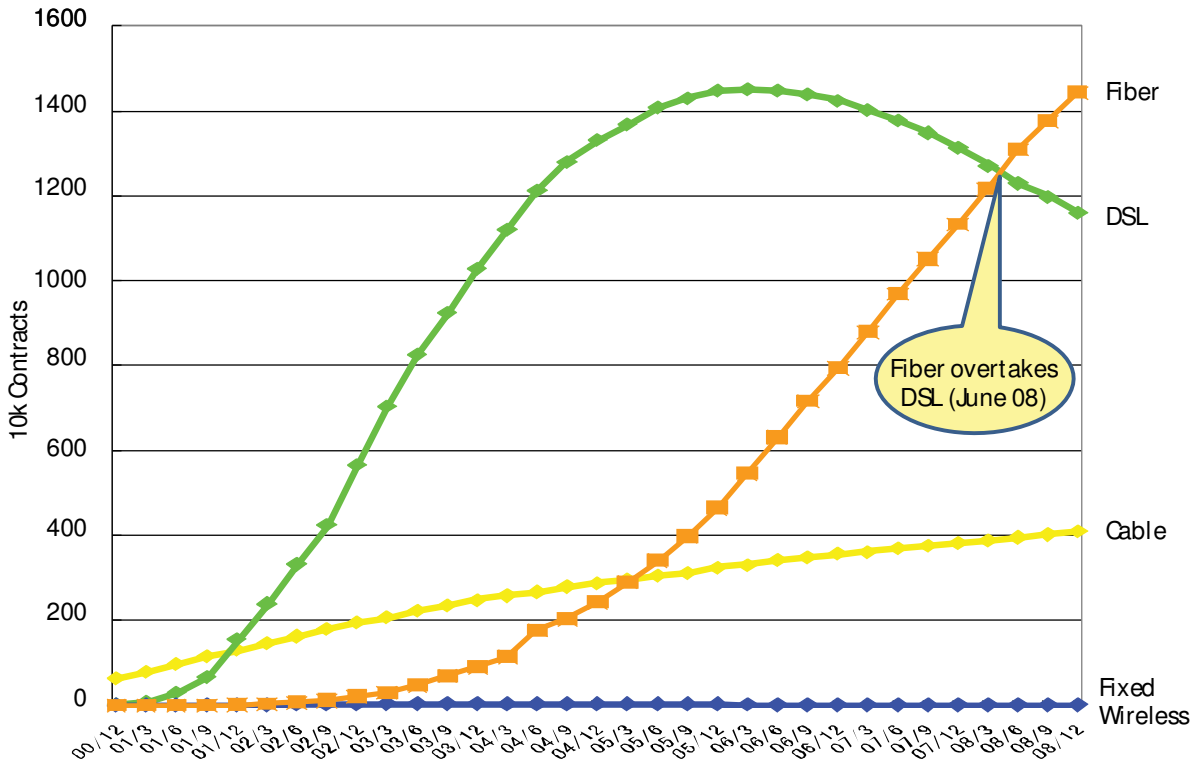
210 OECD Broadband Portal, Table 1e, from EC Community Survey, as of 2007.
211 Does not include 3G Wireless. Since subscriptions are shared within a household, this number will never be 100.
212 OECD Broadband Portal, Table 1d, data supplied by Japanese Government, as of 2008.

Broadband development to date

Cable was the leading source of broadband access early in Japan, but it was eclipsed by the rapid growth of DSL. DSL took off after the establishment of local loop unbundling, interconnection, and "dark fiber" backbone leasing rules for dominant firms were established in 2000 and 2001. New entrants like Softbank took advantage of these rules to roll out DSL that was both faster and cheaper than NTT's service. NTT's service has to date focused on more expensive ISDN services. As DSL proved successful, others entered the market and NTT followed suit, triggering a period of aggressive price-slashing and deployment.[213]

By this time, NTT's fiber network had begun to reach most urban households, and the company planned to charge a premium for a proprietary non-IP service. However, it quickly faced facilities-based IP competition from utility company subsidiaries like K-Opticom and TEPCO. This pushed NTT to abandon their proprietary plans and compete on open Internet service.[214] NTT's fiber-to-the-home facilities are bound by unbundling and interconnection rules due to their status as a dominant wireline carrier, and thus NTT is also subject to service-based competition from firms like Softbank.

Market Share by Technology (Source: Japan MIC)



213 Yasu Taniwaki, Broadband Competition Policy to Address the Transition to IP-Based Networks: Experiences and Challenges in Japan, Tokyo, Japan: International Foundation for Information Technology, October 2006.

214 Takanori Ida, Broadband Economics: Lessons from Japan, Routledge, 2009.

The next phase of service development likely involves packaging of fiber/DSL and 3.5/4G mobile wireless to provide ubiquitous service – ultra high-speed from the home and increasingly high speed mobile. These partnerships will likely take the form of NTT East/West with NTT DoCoMo, Softbank BB with SoftBank mobile, and the utility subsidiaries with KDDI/au.

Market share and key players

NTT's legacy as a formally state-owned monopoly continues to be reflected in its market share, which hovers above 50% in the wireline access business. Softbank is the largest competitor, with approximately 14% of the market made up primarily of DSL subscriptions (although fiber subscribership continues to grow), followed by eAccess (DSL). The remaining competitors include a diversity of DSL and fiber competitors that take advantage of the interconnection and unbundling of NTT's network, as well as the emergent facilities-based fiber competitors.[215]

In the wireless market, NTT likewise commands about 50% market share through its wireless arm, DoCoMo. However, the remainder of the market is less fragmented, with au (KDDI) commanding nearly 30% of the market and Softbank Mobile capturing most of the remainder.[216] However, new entrant eMobile (owned by eAccess) has aggressively deployed its W-CDMA network, and recently became the first to roll out HSPA+ services that offer a theoretical maximum of 21Mbps.[217] All four competitors are on track to begin 4G LTE service in 2010 or 2011, with DoCoMo and Softbank likely to skip HSPA+ and go straight to LTE.[218] Recent rules have facilitated the entry of Mobile Virtual Network Operators. Several companies have WiMax deployments planned or in trial, but these currently have relatively small market share.

Regulatory framework

Wireline broadband access falls under Japan's Telecommunications Business Law, regardless of the technology in question. This regulatory approach reflects a "layers" oriented approach that distinguishes between physical (access), service, platform, and content. Jurisdiction belongs to the Ministry of Internal Affairs and Communications (MIC), which is exploring how to further transition the underlying legal structures to an explicitly layers-based approach. The result of this framework is that competition, speed, availability, and discrimination are examined within each layer, but integration between services in different layers is not prohibited. The MIC sees this as a deregulatory approach that nevertheless maintains market and social safeguards.

Wireless services fall under a separate regulatory regime that includes interconnection stipulations and equal treatment of operators, depending on market share. However, the MIC seems to be interested in unifying its regimes using the layered approach.[219] This might help rationalize assessment of the increasingly vertically integrated wireline and wireless markets. These vertically integrated offerings are not considered substitutable, but instead components of new "Fixed Mobile Convergence" services that introduce new competitive considerations.

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215 GlobalComms Database, updated March 2009.
216 GlobalComms Database, updated March 2009.
217 http://www.emobile.jp/cgi-bin/press.cgi?id=671
218 http://www.rethink-wireless.com/index.asp?article_id=1544
219 MIC, Presentation by Kiyoshi Mori on ICT Policy in Japan at PTC'08 30th Anniversary Conference, January 13, 2008. <http://www.ptc.org/ptc08/participants/speakers/papers/MoriFinalSlides.pdf>

Political economy

The history of the telecommunications political economy in Japan is the history of the battle between the government and NTT. After NTT was privatized in 1985, the company began to wrestle with its regulator, the Ministry of Posts and Telecommunications (MPT). MPT argued for the breakup of NTT in 1990 and 1996, and, although it never succeeded, it did manage to force NTT to be transformed into a holding company and to give certain concessions. MPT was reorganized into the Ministry of Internal Affairs and Communications (MIC) in 1999. At the same time, the Cabinet Office charged with IT promotion was strengthened and began to push back against NTT as well. One of the key issues was interconnection, since the government sets the price and terms of use for competitors that enter the market and use NTT lines. However, these measures did not address the needs of new competitors like eAccess that sought to collocate their equipment within NTT's facilities. The government took further steps to encourage greater competition as Japan lost its global lead in connectivity. In 2000, the new "Basic IT Law" gave the government clear jurisdiction and a mandate. In the same year, the Fair Trade Commission issued a warning to NTT and the MIC compelled NTT to define its terms of collocation, and the ministry required NTT to provide access to its dark fiber and local loop. Japan has evolved from a relatively static but weak "managed regulation" approach to a "strategically liberalized" structure in which the government permits vertical and horizontal integration while facilitating competitive entry to the marketplace.[220]

Broadband strategy

As Japan took major steps to empower its regulatory agencies and to establish new competition rules, the Cabinet Office and the MIC cooperated on broadband strategy. In November 2000, the government issued its "Basic IT Strategy" that described Japan as "backwards" with respect to IT, and proposed a high-level strategy.[221] In January 2001, in order to enable the rapid and efficient implementation of its strategy, the Japanese government set up the IT Strategy Headquarters. The headquarters is led by the Prime Minister and consists of all Cabinet members plus a number of industry experts. Soon after its inception, the IT Strategic headquarters announced the "e-Japan Strategy,"[222] a policy program that focused on broadband infrastructure and also set specific penetration and price targets. In 2003, the e-Japan Strategy II was adopted, which noted that many of the infrastructure targets of the initial e-Japan Strategy had been met, and turned to usage and uptake.[223] It promoted the use of ICTs in areas such as medical care, food, living, small business financing, employment, and government services. In 2004, the MIC launched a new "u-Japan strategy."[224] That strategy is based on the vision that networks should be ubiquitous – available anytime, anywhere, to anyone. These goals were echoed in the complementary "New IT Reform Strategy" released by the IT Strategy Headquarters in 2006.[225] Each of these initiatives began with high-level targets, was backed up by a strong executive and regulatory bureaucracy, and was reinforced in a series of more granular policy packages.[226]

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220 Kenji E. Kushida and Seung-Youn Oh. The Political Economies of Broadband Development in Korea and Japan. Asian Survey, 47(3): 481-504, 2007.

221 http://www.kantei.go.jp/foreign/it/council/basic_it.html

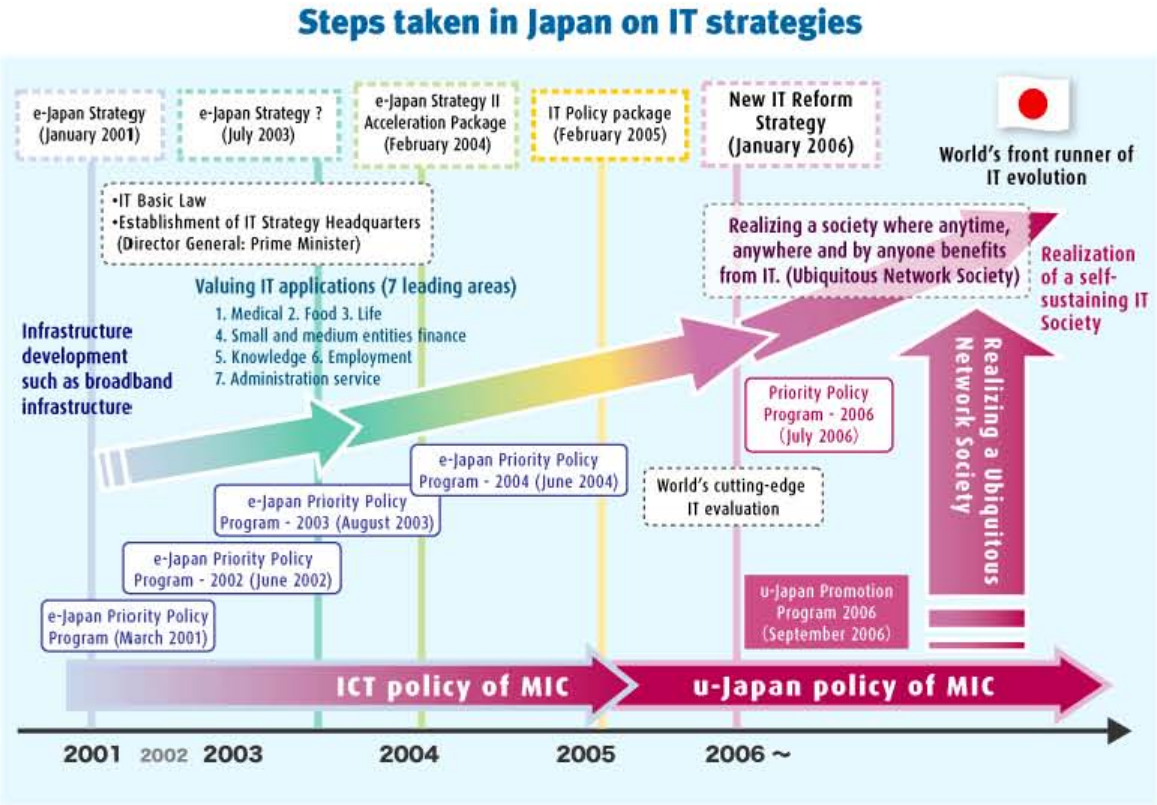
222 http://www.kantei.go.jp/foreign/it/network/0122full_e.html

223 http://www.kantei.go.jp/foreign/policy/it/0702senryaku_e.pdf

224 http://www.soumu.go.jp/menu_seisaku/ict/u-japan_en/index.html

225 http://www.kantei.go.jp/foreign/policy/it/index_e.html

226 http://www.kantei.go.jp/foreign/it_e.html and http://www.soumu.go.jp/menu_seisaku/ict/u-japan_en/index.html



(Source: Japan MIC)

Policy interventions and outcomes

Government investment in infrastructure

The Japanese government has offered loans and tax deductions designed to incentivize broadband build-out since the mid 1990s, but its efforts dramatically accelerated in 2000 as the Basic IT Law went into effect and the national strategies began. The policies introduced over the next several years included a series of tax incentives, including a highly accelerated depreciation schedule for capital investments in telecommunications. These incentives were described at a 2007 ITIF event, along with lowered fixed asset taxes for designated network equipment.[227] The government-owned Bank of Japan also began to guarantee loans for network infrastructure, which allowed relevant companies to borrow money more cheaply.[228] In order to support underserved areas and stimulate infrastructure development, a grant-in-aid system for promoting local telecommunication infrastructure was created in 2006, which has disbursed funds every year to date since its inception. The 2008 "Strategy on the Digital Divide" built on these efforts, and also sought to eliminate "zero broadband" areas. As part of its economic recovery efforts, Japan has committed 185 billion Yen (1.9 billion USD) to, "…eliminating the digital divide, promoting the development of wireless broadband and fostering digital terrestrial broadcasting."[229]

227 "Understanding the Japanese Broadband Miracle," presentation at the Information Technology and Innovation Foundation, April 4, 2007 <http://www.itif.org/files/Ebihara_Japanese_Broadband.pdf>

228 Thomas Bleha, "Down to the Wire," Foreign Affairs, May/June 2005 <www.foreignaffairs.org/20050501faessay84311/thomas-bleha/down-to-the-wire.html>

229 OECD, The Impact of the Crisis on ICTs and Their Role in the Recovery, July 2009. <http://www.oecd.org/dataoecd/33/20/43404360.pdf>

Skill building, education, and demand programs

Several of the policy packages that were part of Japan's national broadband strategies have included skills and demand programs. For instance, the u-Japan strategy described one of its goals as, "By 2010, 80% of the population to appreciate the role of ICT in solving social problems." It then spelled out specific policy interventions to promote the use of information technology in health care, public security, education, and the environment.[230] The government also aggressively pushed its services online, resulting in a high percentage of internet-based citizen-to-government transactions.

Popular services from the private sector have also stimulated broadband demand. For example, IP-based digital video is offered by most major providers, including Softbank's DSL video service. VoIP rapidly gained popularity and helped motivate adoption. Likewise, content from the entertainment and gaming industries has motivated consumers to subscribe to higher tiers of broadband service.

Competition policy

The government generally views competition in a layered model, and tends to work more aggressively to preserve competition at the physical layer. After the long battle to break up NTT resulted in a compromise that left the company intact, the government focused heavily on these service-based competition measures. This motivated copper unbundling, dark fiber open access, and the 2009 rules intended to ensure unbundling of Next Generation Networks (NGNs). The government sees no evidence that these policies have diminished NTT's incentives to invest in infrastructure.[231]

The government has not fundamentally restricted horizontal or vertical integration of services. As the Fixed Mobile Convergence trend continues, mobile companies are likely to work closely with wireline providers. Likewise, providers might increasingly integrate vertically. Potential market abuses are dealt with through open access to the physical layer as well as a strong ex-post dispute resolution system. Much of this is outlined in the "New Competition Promotion Program 2010."[232]

The Telecommunications Business Dispute Settlement Commission is charged with realizing fair and effective competition in the telecommunications business sector and the quick and efficient settlement of disputes based on the Telecommunications Business Law. The Commission conducts mediation or arbitration pursuant to an application by a telecommunications carrier. It deliberates and reports to the Minister when there is an enquiry concerning an order for consultation or an award to the Commission. The Commission also makes the necessary recommendations relating to rule development to the Minister.[233]

Network non-discrimination

The Japanese government has articulated clear principles of neutrality that will guide its policy making process and evaluation of network providers, including:

- Free access to the content and application layer;

230 http://www.soumu.go.jp/menu_seisaku/ict/u-japan_en/new_pckg02_menu.html
231 Comments to the FCC by the Government of Japan, FCC Docket 09-51.
232 New Competition Promotion Program 2010, 19 September 2006, Ministry of Internal Affairs and Communications (MIC), http://www.soumu.go.jp/main_sosiki/joho_tsusin/eng/pdf/060928_1.pdf
233 TBDSC Secretariat, Overview of Telecommunications Business Dispute Settlement Commission, June 2009, http://www.soumu.go.jp/main_sosiki/hunso/english/pdf/overview.pdf

- Use of networks at an affordable price;
- Free connection with any terminal that meets technical standards.[234]

These principles drive specific interventions that seek to preserve open access between layers, and especially access to the lower telecommunications layer. The MIC delivered a "Report on Network Neutrality" in September of 2007, which outlines a framework to maintain "fairness in network cost sharing," and "fairness in network use." [235] It acknowledged that it might be the case that content-neutral traffic shaping could address congestion issues, but the MIC sought further comment on "packet shaping guidelines." Overall, the report notes that in the context of unbundling and open access provisions, some of the discrimination concerns were mitigated by effective facilities-based or service-based competition.

Spectrum policy

Japan has relied heavily on a licensed model of spectrum use, and has used comparative hearings as the means of allocation. One exception to the licensed model has been Wi-Fi, but even in this case the government originally intended to charge fees for operation and to require firms to obtain a license, but later backed down. On the mobile side, the government typically seeks proposals from interested providers and chooses the winners, who are then required to pay standard fees. This approach has the advantage of making spectrum available relatively quickly, but the well-known disadvantage of working outside of the dynamic market. Japan has been criticized for continued reliance on "beauty contests," and continues to face pressure to adopt an auction-based model.[236] The 4G LTE licenses were nevertheless allocated to four providers, as determined by the government.[237] The new regime has promised to consider auctions, "as appropriate."[238] Japanese broadcasters have been resistant to unlicensed operation in TV "white spaces," and the conversation has not progressed. The MIC conducts a yearly survey of actual radio use, and adjusts its policy accordingly in the "Action Plan for Radio Spectrum Reallocation."[239]

234 Yoshihiro Katagiri, Recent Regulatory Reform in Japanese Telecommunications, April 24, 2008. http://www.wik.org/content/erc/Katagiri%20Reg%20Reform%20in%20Japan%20(for%20WIK)rev.pdf

235 http://www.soumu.go.jp/main_sosiki/joho_tsusin/eng/pdf/070900_1.pdf ("informal" English translation)

236 Matsunaga, Hironori. Assignment of exclusive spectrum licenses in Japan : use of an auction for the licensee selection process. Thesis (S.M.), Massachusetts Institute of Technology, Engineering Systems Division, Technology and Policy Program, 2006. http://hdl.handle.net/1721.1/34521

237 http://www.soumu.go.jp/menu_news/s-news/2009/090123_8.html (The Japanese government refers to these as "3.9G" licenses.)

238 http://www.dpj.or.jp/policy/manifesto/seisaku2009/06.html

239 http://www.soumu.go.jp/main_sosiki/joho_tsusin/eng/Releases/Telecommunications/news081107_2.html

D. South Korea

Introduction

Due to a regulatory regime based on competition, privatization, and aggressive government programs focused on boosting demand, South Korea has become a world leader in broadband by several measures.[240] After the privatization of the state-run telecommunications provider (Korea Telecom, or KT) and the encouragement of new entrants into the broadband market in the late 1990s, DSL and cable broadband services expanded rapidly. KT has since regained its majority market share in fixed broadband, and both the fixed and mobile markets have consolidated in recent years. Nonetheless, South Korea maintains a competitive mobile broadband market, with three companies offering 3G service across the country. The government has provided substantial loans to support network deployment, funded public information technology training programs, and encouraged broadband access through a building certification program. The South Korean government is now promoting the Broadband Convergence Network and the IT839 programs, both of which envision the convergence of wireline, wireless, and RFID networks to allow ubiquitous connectivity through a panoply of mobile and fixed devices.

Market highlights

Overall, 94.1% of households in South Korea have broadband access.[241]

	Fiber / LAN	Cable	DSL	Other	Overall [242]
Subscriptions per 100 people [243]	13.8	10.5	7.7	0.0	32.00

Penetration metrics	Rank	Speed metrics	Rank	Price metrics	Rank
Penetration per 100, OECD	6	Maximum speed, OECD	3	Price low speed, OECD	25
Household penetration, OECD	1	Average speed, OECD	2	Price low speed, OECD+GC	28
3G penetration, GC	2	Median download, speedtest.net	1	Price mid speed, OECD	13
Wi-Fi hotspots per 100,000, Jwire	7	Median upload, speedtest.net	9	Price mid speed, OECD+ GC	16
		Median latency, speedtest.net	3	Price high speed, OECD	7
		90% download, speedtest.net	1	Price high speed, OECD+GC	6
		90% upload, speedtest.net	5	Price very high speed, OECD	3
				Price very high speed, OECD+GC	3

1st quintile
2nd quintile
3rd quintile
4th quintile
5th quintile

Note: Details in Part 3
Source: OECD, GlobalComms, Jwire, Speedtest.net, Berkman Center analysis

240 Jyoti Choudrie, Anastasia Papazafeiropolous, and Heejin Lee, "A web of stakeholders: a case of broadband diffusion in South Korea," Journal of Information Technology 18 (December 2003), 281.
241 "OECD Broadband Portal", Table 2a, 2007. This includes broadband access modes such as xDSL, cable, other fixed and wireless broadband via computers, and mobile phone access.
242 This table does not include 3G Wireless. Since subscriptions are shared within a household, this number will never be 100.
243 OECD Broadband Portal, Table 1d, supplied by the Korean government, as of 2008

Broadband development to date

South Korea began its broadband rollout in the late 1990s with the rapid expansion of both cable broadband access and DSL using copper infrastructure. Cable broadband access grew with the entry of Thrunet into the broadband market. Thrunet used cable plant leased from Kepco, the government-owned power company that owned cable facilities but did not provide broadband.[244] Hanaro Telecom entered the market in 1997 and, like other new entrants, found that competing against incumbent KT in the data sector was more profitable than competing in the wireline telephone market. Hanaro sparked a price war by offering broadband DSL as a free addition to wireline telephone service.[245] In response, KT abandoned its ISDN plans and invested in DSL. By 2002, 70 out of 100 South Korean households had broadband subscriptions.[246] By that time, KT had gained a majority share in the broadband market[247] due to its geographic reach and competitive pricing.[248] It was only then that the South Korea regulator mandated unbundling of local loop network elements.[249]

Over 80 % of Koreans live in dense, urban housing, an arrangement that has produced significant economies of scale for the expansion of broadband service.[250] Moreover, because landlords, rather than incumbent KT, own local loop facilities, competitive carriers are able to negotiate with multi-dwelling unit owners rather than KT.[251] Today, South Korea is moving toward a fiber-to-the-home (FTTH) model. Although development has been slowed by high costs, ADSL and VDSL subscriptions continue to decline as Ethernet connections to fiber nodes grow in popularity .[252]

By the end of 2007, fiber connections constituted one-third of all South Korean Internet connections.[253] The South Korean government is now promoting the Broadband Convergence Network and the IT839 program, both of which envision the convergence of wireline, wireless, and RFID networks to allow ubiquitous connectivity through a panoply of mobile and fixed devices.[254] The combined plan calls for a network aimed to support a list of eight services, three infrastructures, and nine growth engines. By 2013, the program expects speeds of both fixed and wireless broadband to be up to 10 times faster than at the beginning of 2009.[255]

By mid-2005, the rollout of W-CDMA mobile networks had stalled in South Korea. Following regulatory intervention, South Korea's two largest mobile providers accelerated the deployment of W-CDMA, and by March 2007, SK Telecom offered HSDPA service nationwide, along with competitor KTF Corp.

By March 2008, three companies were offering 3G wireless service in South Korea, two using a combination of 1xEV-DO and W-CDMA technologies and one with a more recently deployed EV-DO

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244 Robert D. Atkinson, Daniel K. Correa, and Julie A. Hedlund, "Explaining International Broadband Leadership," ITIF, F3, May 2008. See also, Kenji Kushida and Seung-Youn Oh, "The Political Economies of Broadband Development in Korea and Japan," Asian Survey, Vol. XLVII, 2007. 494.
245 Kushida and Oh. 495.
246 Ibid. 483.
247 Heejin Lee, Robert M. O'Keefe, and Kyounglim Yun, "The Growth of Broadband and Electronic Commerce in South Korea: Contributing Factors", The Information Society, 19:81 (2003), 86-91.
248 Kusida and Oh. 496.
249 Robert D. Atkinson, et al. F3; OECD Directorate for Science, Technology and Industry, "Developments in Local Loop Unbundling", 10 September 2003. 17- 20.
250 DTI Global Watch Mission Report "Exploiting the Broadband Opportunity: Lessons from South Korea and Japan", December 2005, 23. Available at: http://www.broadbanduk.org/content/view/182/7/1/1/; "The Growth of Broadband and Electronic Commerce in South Korea," 88-89.
251 Robert D. Atkinson, et al. F3.
252 Ibid.
253 Ibid.
254 Ibid.
255 Globalcomms, South Korea Country Overview, 13.

Rev A network.[256] As of May 2009, KTF offered 5.76 Mbps service in major South Korean cities.[257] In 2008, the Korean Communications Commission announced plans to allocate various blocks of 700MHz, 800MHz, and 900MHz spectrum from SK Telecom to smaller operators.[258] Since then, wireless penetration in South Korea has reached 94 percent.[259] South Korea is the only country in which 100% of mobile phones subscriptions are 3G.

The South Korean government licensed spectrum for WiMax in the 2.3 GHz band in 2005. In April of that year, Hanaro Telecom returned its license in light of doubts raised by investors regarding the business case for WiMax technology.[260] KT Corp launched WiMax service in South Korea, called WiBro (wireless broadband), in 2006.[261] Following intensive marketing by KT in 2007, the service gained 10,000 subscribers per month in 2008 and, according to one report, is expected to serve 2.5 million people by 2011. Today, two providers, KT and SKT, provide mobile WiMax service in South Korea.[262] In late 2008, the KCC endorsed a voice-over-WiMax standard that may speed deployment of voice service over WiMax in 2009.

Market share and key players

Despite losing customers to new entrants such as Hanaro Telecom in the late 1990s, the former state-run monopolist KT rebounded; as of 2005, KT enjoyed approximately a 52 percent share in the fixed broadband market of 130 ISPs.[263] However, despite the plethora of providers, as of 2006, three companies controlled 85 percent of the market.[264] By 2007, fiber, DSL, and cable service each held roughly one-third of the fixed broadband market, with cable service including leased access over power lines.[265]

The wireline and wireless broadband markets have experienced some consolidation in recent years. For example, in February 2008, South Korea's largest mobile provider, SK Telecom, purchased Hanaro Telecom, which held a 23 percent fixed broadband market share as of 2005.[266] KT merged with second-largest mobile provider KTF in 2009, to form KT.

Competition in the South Korean wireless market is intense. SK Telecom controls approximately 50 percent of the market and holds one of three 3G spectrum licenses. Rival KTF Corp holds a 3G license and controls approximately 31 percent of the market. LG Telecom, the smallest 3G license-holder, controls approximately 18 percent of the market, and although its relatively late network deployment has put it at a competitive disadvantage vis-à-vis KTF Corp and SK Telecom, its exclusive use of EV-DO

256 Ibid. 7.
257 Ibid. 7-8.
258 Ibid. 6-7.
259 Ibid. 9.
260 Tammy Parker, "WiBro is first step in WiMAX," *Mobile Communications International*, 1 June 2005. Available at http://www.allbusiness.com/computer-electronic/communications-equipment/969991-1.html
261 Michelle Robart, "Over 2.5 Million Mobile WiMAX Users in South Korea by 2011," *TMCnet*, 27 June 2008. Available at http://4g-wirelessevolution.tmcnet.com/topics/4g-wirelessevolution/articles/32612-year-2011-more-than-25m-south-korean-mobile.htm
262 Ibid.
263 DTI Global Watch Mission Report. 23.
264 Robert D. Atkinson, et al. F3.
265 Ibid. 25.
266 Globalcomms. 3.

Rev A—which has a lower deployment cost than the W-CDMA networks utilized by its competitors—may allow LG Telecom to pass savings to customers.[267]

In 2008, wireless network costs grew and subscriber growth slowed. In response, South Korean wireless operators have begun to offer bundled services in conjunction with fixed line partner companies.[268] In April 2009, Korean regulators ordered KTF to open its mobile data network to third party services and providers as a term of KTF's merger with KT. SK Telecom must also open its mobile data network per government fiat.[269]

Regulatory framework

In March 1992, the Korea Communications Commission was established under the Framework Act on Telecommunications, which was originally enacted in December 1983. The creation of the KCC coincided with the initiation of a competition policy that emphasized deregulation and privatization in South Korean telecommunications markets.[270] In 2008, the KCC absorbed the Korean Broadcasting Commission and the Ministry of Information and Communication (MIC) in an effort to vest regulatory authority for various communications media in a single body.[271] The KCC oversees competition, consumer protection, and arbitration of unfair practices in the regulated industries.[272]

South Korea categorizes service providers as facilities-based providers, resale providers, or value-added service (VAS) providers.[273] These classifications govern the type of services providers may offer and other legal obligations, such as contribution to the universal services fund. In 2009, the KCC announced that it would begin working on a new regulatory framework to take account of IP-based services.[274]

In South Korea, mobile network operators must hold spectrum licenses, and the KCC is expected to announce new methods of spectrum allocation by the end of 2009. Few regulatory barriers, however, bar entrance into the fixed broadband market.[275] As of 2002, the Korean government mandated unbundling of local loop facilities, and between 2008 and 2009, required the two largest mobile data network operators to open their networks to third party services and providers.[276]

Political economy

The first major step in the privatization and deregulation of South Korean telecommunications markets took place between 1987 to 2002 with the privatization of KTA, the state-owned incumbent wireline provider.[277] The government, with strong support from elected officials, gradually divested itself of KTA, later renamed KT, and concluded a bargaining agreement with KTA's labor union to limit foreign ownership.[278] Mid-1990s legislation gave the MIC strong regulatory authority, and the president appointed IT experts to serve as MIC ministers.[279]

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267 Ibid. 9.
268 Ibid. 8-9.
269 Ibid.
270 Lee, et al. 84.
271 Ibid. 6.
272 Globalcomms. 2.
273 Ibid. 12.
274 Ibid.
275 Lee, et al. 87.
276 Globalcomms, "South Korea Country Overview,". 8-9.
277 Kenji Kushida and Seung-Youn Oh, "The Political Economies of Broadband Development in Korea and Japan, *Asian Survey*, Vol. XLVII, 2007. 490.
278 Ibid. 491.
279 Ibid.

Despite its emphasis on privatization and deregulation, the KCC has proven an aggressive regulator. Prior to 2007, Korean regulators resisted SK Telecom's and KT's desire to offer bundled services by citing the providers' dominant market positions in the mobile and wireline markets, respectively. Though the regulatory bodies clashed on this issue, the ban was dropped in April 2007. In an effort to accelerate the deployment of converged services, further rate deregulation of bundled services followed.[280] The KCC has issued numerous fines for price fixing in the leased line, landline, and broadband sectors and for uncompetitive trade practices. In 2008, the KCC temporarily banned KT from new broadband signups in response to that company's illegal sharing of customer information with telemarketers. The Korean government limits foreign direct ownership of telecommunications companies to 49 percent.

Broadband strategy

In 1987, South Korea passed the Framework Act on Information Promotion in support of the development of information technology.[281] This legislation established the National Information Society Agency (NIA) to oversee network construction.

Since the early 1990s, South Korea's broadband deployment strategy has focused on the cultivation of a "knowledge-based society."[282] In 1993, the NIA launched the plan for the Korea Information Infrastructure (KII), which ran from 1995 to 2005.[283] In 1995, South Korea enacted legislation to drive the KII comprehensive plan for a national broadband backbone.[284] After KII, South Korea implemented a series of 5-year programs to invest government funds in broadband deployment. The country also provided network build-out incentives for providers and used public education projects targeting specific demographics, including military personnel, farmers, and housewives, to bolster broadband demand and use.[285] In addition, the government has provided tax breaks to businesses that invest in broadband communications systems.[286]

More recent government programs, including IT839 and the Broadband Convergence Network, promote network convergence and investment in emerging technologies by Korean companies that may export technology overseas.[287] Through these programs, the Korean government has provided over $70 billion in loans to service providers.[288] Korea also required KT, as a term of its privatization, to provide broadband service of at least 1 Mbps to all homes and villages. The "Digital Divide Closing Plan" provided loans of $926 million between 2001 and 2005 to offset the cost of connecting all 144 telecom service districts to the national broadband backbone.[289]

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280 Globalcomms. 2.
281 Robert D. Atkinson, et al. . F1.
282 Lee, et al. 84.
283 See Choongok Lee and Sylvia M. Chan-Olmsted, "Competitive advantage of broadband Internet: a comparative study between South Korea and the United States," Telecommunications Policy 28 (2004). 58-59.
284 Lee, et al. 84.
285 Ibid. 87.
286 Robert D. Atkinson, et al. F2.
287 DTI Global Watch Mission Report. 15.
288 Robert D. Atkinson, et al. F2.
289 Ibid.

Policy interventions and outcomes

Government investment in infrastructure

As noted in the previous section, South Korea has provided numerous loans to broadband service providers in support of the deployment of broadband networks. These include: an initial $77 million in preferred loans to facilities-based providers in 1999, an additional $77 million in loans for non-urban areas in 2000,[290] $70 billion in loans through the IT839 and Broadband Convergence Network programs, (an investment that recipients pledged to match), and $926 million for rural broadband to KT as a condition of its privatization. In 1997, the government began the Cyber Building Certificate system, under which residential and commercial buildings are certified as providing specified tiers of broadband access speeds.[291] This program has motivated builders to invest in broadband, as many Koreans apparently want to live in buildings with high-speed broadband capacity.[292]

Skill building, education, and demand programs

South Korea has long sought to boost demand in the information technology sector via various government-supported educational programs, such as the PC for Everyone program in 1996, a computer literacy program in 1998, and Cyber Korea 21, a program focused on digital literacy, in 1999.[293] South Korea's Ten Million Internet Education project sought to expose 10 million people to various Internet programs in 2000; that year, 3.4 million people learned basic Internet skills.[294] The government has also deployed educational programs targeted at specific demographic groups, such as the One Million Housewife Digital Literacy Education Project,[295] and provided Internet training subsidies targeting 2 million people in 2002.[296] South Korea has also funded and constructed thousands of free public access sites and provided personal computers in every school in the country.

Competition policy

Competition policy has governed South Korean telecommunications regulatory approaches from the late 1980s especially in the wake of the privatization of KTA (later renamed KT). In 1997, the MIC instituted procedures for selecting a competitor to challenge KT, which Hanaro Telecom won.[297] Competition in the broadband market exploded in the late 1990s with the entrance of Hanaro and cable provider Thrunet, but re-regulation following KT's resurgence shows that the government has kept a close eye on market competition.[298] The government identified KT's dominance as a barrier to competition and, since 2004, has subjected the company to stricter regulations relative to its competitors.[299]

South Korea did not mandate the unbundling of local loop network elements until 2002, well after DSL and cable broadband offerings had gained significant ground.[300] The relatively late unbundling mandate

290 Jyoti Choudrie, Anastasia Papazafeiropolous, and Heejin Lee," A web of stakeholders: a case of broadband diffusion in South Korea," Journal of Information Technology 18 (December 2003). 285.
291 Lee, et al. 87-88.
292 Choudrie, et al. 285.
293 Robert D. Atkinson, et al. F3.
294 Lee, et al. 84.
295 Kushida and Oh. 497.
296 Ibid.
297 Arnold Picot and Christian Wernick, "The Role of Government in Broadband Access", Telecommunications Policy 31 (2007). 669.
298 Kushida and Oh, 498.
299 Ibid.
300 Robert D. Atkinson, et al. F3. Also see:"Developments in Local Loop Unbundling", *OECD Directorate for Science, Technology and Industry*, 10 September 2003. 17, 20.

partly reflects the strong platform-based competition that characterized the South Korean market in the early years of broadband development. The absence of unbundling in Korean broadband development should not, however, be overstated, given that initial entry by Thrunet depended on infrastructure leased from Kepco, the government-owned cable company, which was required to lease access to its cable facilities.[301] South Korea has also mandated open access conditions on cable providers[302] and the opening of South Korea's two largest mobile data networks.[303]

Network non-discrimination

South Korea has no strict network non-discrimination rules but has mandated open access and line-sharing, which may have obviated the need for a more rigorous net-neutrality regime.[304] Despite these policies, however, South Korea has not been free from non-discrimination controversy in recent years. In 2006, for example, several network operators slowed or blocked Hanaro Telecom's new IPTV service, claiming it consumed excessive bandwidth. The KCC forced the affected companies to negotiate but made no lasting policy declaration.[305]

Spectrum policy

In 2006, the Korea Radio Promotion Agency (KORPA) was established to manage South Korean radio spectrum.[306] Wireless operators require a spectrum license from the KCC to offer wireless service, though only three mobile network operators hold licenses, which permit both 2G and 3G services. 3G licenses were allocated by auction in 2001. The two winners, SK Telecom and KTF Telecom, were allocated the B-band at 1940 MHz to 1960 MHz and the C-band at 1960 MHz-1980 MHz, respectively.[307] LG Telecom, which failed to win a license at auction, was later awarded the A-band at 1920 MHz-1940 MHz.[308] Spectrum licenses run for 10 years, after which providers can apply for renewal. The MIC has revoked operators' spectrum concessions for failing to launch services and has demanded payments from operators to reserve unused frequencies.[309]

Other spectrum allocations include the following: KTF holds spectrum in the 1700 MHz band, which it uses for 2.5G CDMA services. It also holds spectrum in the 2100 MHz band, which it uses for 3.5G W-CDMA services. LG Telecom holds 1700 MHz spectrum for 2.5G and 3.5G CDMA and EV-DO Rev A services. SK Telecom holds 800 MHz spectrum for 2.5G and 3G CDMA services and 2100 MHz spectrum for 3G and 3.5G W-CDMA services.[310]

Wireless regulation in South Korea is currently in flux. South Korean regulators are now considering allowing mobile virtual network operators (MVNOs) to offer services using license-holders' networks.[311] Moreover, the KCC is in the midst of an 800 MHz redistribution resulting from SK Telecom's previous monopoly over the desirable 800 MHz band. In 2011, SK Telecom will be forced to give 20 MHz of its 800MHz band spectrum to smaller operators, which will receive a total of 40 MHz.

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301 See Kushida and Oh. 494.
302 Ibid.
303 Globalcomms. 8-9.
304 Brad Reed, "What the U.S. can learn from International Net Neutrality, Broadband Policies," *Network World*, February 12, 2009. Available at http://www.networkworld.com/news/2009/021209-international-net-neutrality.html
305 Scott Walsten and Stephanie Hausladen, "Net Neutrality, Unbundling, and their Effects on International Investment in Next-Generation Networks," *Review of Network Economics* 8 (March 2009). 111.
306 Globalcomms. 6.
307 Ibid.
308 Ibid.
309 Ibid.
310 Ibid. 8.
311 Ibid. 6.

KTF and LG Telecom may be forced to relinquish their 1.8Ghz licenses in exchange for 800 MHz spectrum concessions.[312]

312 Ibid.

E. The Netherlands

Introduction

The Netherlands has been a global leader in broadband deployment, with longstanding high rates of penetration and near-ubiquitous wireline availability via both DSL and cable. In line with EU rules, the Dutch government has unbundled both copper and fiber lines to the home. Cable television was widely deployed at the advent of broadband, which led to a high rate of cable modem subscriptions. Former government telco monopolist KPN was forced to migrate from ISDN to DSL in order to compete.

Strong competition between the platforms persists today. The copper infrastructure was largely built out by KPN, but the initial cable build-out was often done locally and later purchased by cable firms. Amsterdam has served as a prime example of municipal public-private partnerships in Fiber-to-the-Home initiatives. 3G deployment and adoption has been slower than in similar countries. An auction for additional 2.6GHz and 3.5GHz spectrum, which might serve as the platform for 4G evolution, was delayed until Q1 2010.

Market highlights

Overall, 73.8% of households in the Netherlands have broadband access.[313]

	Fiber / LAN	Cable	DSL	Other	Overall [314]
Subscriptions per 100 people [315]	0.6	13.4	21.8	0.0	35.8

Penetration metrics	Rank	Speed metrics	Rank	Price metrics	Rank
Penetration per 100, OECD	2	Maximum speed, OECD	8	Price low speed, OECD	9
Household penetration, OECD	3	Average speed, OECD	5	Price low speed, OECD+GC	8
3G penetration, GC	25	Median download, speedtest.net	2	Price mid speed, OECD	11
Wi-Fi hotspots per 100,000, Jwire	13	Median upload, speedtest.net	3	Price mid speed, OECD+ GC	13
		Median latency, speedtest.net	1	Price high speed, OECD	16
		90% download, speedtest.net	5	Price high speed, OECD+GC	17
		90% upload, speedtest.net	9	Price very high speed, OECD	10
				Price very high speed, OECD+GC	12

1st quintile
2nd quintile
3rd quintile
4th quintile
5th quintile

Note: Details in Part 3
Source: OECD, GlobalComms, Jwire, Speedtest.net, Berkman Center analysis

313 OECD Broadband Portal, Table 2a, from EU Community Survey, from 2007. Some recent estimates near 90%.
314 Does not include 3G Wireless. Since subscriptions are shared within a household, this number will never be 100.
315 OECD Broadband Portal, Table 1d, supplied by the Dutch government, as of 2008.

Broadband development to date

The earliest Internet access in the Netherlands that surpassed dial-up speeds was ISDN, offered over KPN's copper loop. Following EC policy and regulatory initiatives, the government liberalized the sector over the period of 1996-1997. It removed restrictions on offering telecommunications services and introduced various network access requirements.

ISDN service doubled from 1997 to 1998, reaching over 1.5 million lines (mostly business).[316] During this same period, cable providers began to offer broadband Internet service. Cable television infrastructure was already widespread, having been deployed by municipalities or public associations in many cases. These groups built and owned the infrastructure, proving its viability and would often subsequently sell the facilities to larger companies years later. Cable modem subscribership rapidly surpassed the user base of ISDN. KPN was forced to respond by introducing ADSL, and spent the next several years catching up with the cable.

Some copper local loop unbundling had been mandated by OPTA as early as 1997, but the regulator did not initially implement "full unbundling."[317] By 2002, however, the Netherlands was in compliance with the European Commission unbundling regulations. That same year, KPN was forced to offer bitstream access as well. Since then, the cost of unbundled copper services has dropped dramatically. DSL overtook cable in 2003, enjoying roughly a 60% share of subscribership since.[318] In the meantime, the many smaller cable operators were mostly consolidated in companies like Ziggo and UPC.

Fiber has been slower to deploy in the Netherlands than in some other countries, in part due to the ability of the cable and copper infrastructure to be stretched to support higher speeds.

As FTTH trials commenced in the mid 2000s, cable providers upgraded their networks to support higher speeds. The major cable companies are now in the process of deploying Euro DOCSIS 3.0, which aspires to speeds of 60-120Mbps.

KPN and its competitors have deployed ADSL2+ and are in the process of rolling out VDSL in an effort to remain competitive with lower-end fiber offerings. KPN has executed its FTTH strategy in narrowly targeted fashion, but ultimately intends to abandon its copper infrastructure. The company recently formed a joint venture with fiber infrastructure owner Reggefiber. Reggefiber subsequently gained a majority stake in the Amsterdam CityNet project, which has become a model case for public investment pushing the commercial viability of Fiber-to-the-Home. To date, European Commission rules on state aid have made the government skittish to invest in fiber – in contrast with the municipally-aided cable build-out that helped fuel the initial broadband energy in the country. However, this stance may be shifting.

Wireless penetration is very high, but 3G build-out and adoption has lagged behind many European and Asian countries. 3G deployment ramped up later than many other nations. The number of 3G subscriptions as a percentage of all mobile subscriptions is less than half that of neighboring countries Belgium and Germany.[319] Intel-backed Worldmax is the only company that has deployed WiMax, and it serves only some areas of Amsterdam. Its plans for future build-out are unclear.

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316 Nico van Eijk, "Broadband Services and Local Loop Unbundling in the Netherlands," IEEE Communications Magazine October 1999, p. 2-5.

317 OECD, "Developments in Local Loop Unbundling," DSTI/ICCP/TISP(2002)5/FINAL, September 10, 2003.

318 Telegeography GlobalComms Database, March 2009.

319 Telegeography GlobalComms Database, March 2009.

Market share and key players

DSL enjoys a roughly 60% market share, with alternative (non-KPN) DSL providers capturing somewhere between 10% and 20% of the DSL market.[320] Tele2-Versatel is the leading unbundled DSL provider using ADSL2+ for speeds of up to 24 Mbps, including TV service. In August of 2009, Tele2 announced the rapid rollout of their VDSL2 network, which is designed to provide download speeds of up to 60Mbps and is intended to be available to a million homes in 2010. The next-closest competitor, BBned has an established ADSL/VDSL network capable of slightly slower speeds and has not yet announced plans to migrate to VDSL2. BBned embraces an "open provisioning" model in which partners can also provide Internet service over their network. BBned's owner, Telecom Italia, has stated its intention to sell the company but no buyers have yet surfaced.

With about a 40% market share overall, cable providers have maintained a strong presence. Over the years, the municipal networks and smaller commercial entities have been acquired by larger entities. Today two firms – Zesko and UPC – capture most of the cable market, with the few remaining regional operators maintaining a small share. Zesko acquired several smaller providers in 2008 and, via its Ziggo brand, serves roughly double the number of subscribers as UPC.

Fiber-to-the-Home still constitutes a small portion of broadband subscriptions nationwide, but it is showing some signs of more rapid growth. KPN has stated its intentions to build out fiber nationwide and phase out its copper infrastructure.[321] This process has accelerated with KPN's joint venture with leading fiber operator Reggefiber (KPN has a 41% stake in the company). The Amsterdam CityNet project is an example of a fiber public-private partnership that won buy-in from commercial providers.[322] In Phase 1 of the project, serving 43,000 homes, Draka Comteq won the rights to build out the "passive" physical layer of the network, and BBned won the rights to provide the "active" internet service. In Phase 2, Reggefiber/KPN won the rights to provide these services to another 100,000 homes and also acquired a majority stake in the group that owns the fiber project.[323]

In the 3G wireless market, KPN commands about a 50% share, with the remainder split fairly evenly between T-Mobile and Vodafone. Five providers narrowed to these three when, in 2005 KPN, acquired Telefort(O2) and in 2007 T-Mobile acquired Orange. There is an active MVNO market, serving over 3 million customers.

In 2010, the government will auction six new licenses in the 2.6GHz and 3.5GHz range. It is unclear at this stage whether any of these new frequencies are likely to be used for WiMax, or if instead they will all be used for UMTS (3G or LTE) service.[324]

Regulatory framework

Wireline regulation in the Netherlands is primarily done via the OPTA (Independent Post and Telecommunications Authority), with help from competition authority NMa and some additional

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320 Telegeography GlobalComms Database, March 2009.

321 KPN has negotiated a Memorandum of Understanding (MoU) with the major retail providers currently using its copper infrastructure, especially its MDF access points. This MoU facilitates their interconnection at alternative locations and contributes to the associated costs of transition. http://www.kpn.com/corporate/en/Press/pressrel/KPN-signs-MoUs-for-alternatives-to-MDF-Access-with-Tele2Versatel-Orange-and-BBNed.htm and http://www2.opta.nl/asp/en/publications/document.asp?id=2354

322 Norbert Gaal, Lambros Papadias and Alexander Riedl, "Citynet Amsterdam: an application of the market economy investor principle in the electronic communications sector," EC Competition Policy Newsletter 2008, 1.

323 http://www.telegeography.com/cu/article.php?article_id=27124

324 http://it.tmcnet.com/news/2009/09/21/4380464.htm

oversight from the Ministry of Economic Affairs. Wireless is also regulated primarily by the OPTA, but the Agentschap Telecom does frequency allocations.

In the 1990s, the government shifted from a regulated monopoly model to a liberalized approach that allowed open competition across sectors. In 2004, a revised Telecommunications Act went into effect, which (among other things) brought the Netherlands into line with the EU Regulatory Framework. European Commission law and regulation control a great deal of what the national regulatory agencies are permitted to do.

The Dutch government describes its approach as being market-oriented.[325] This commitment is implemented through engaged regulation: unbundling and competitive requirements, and regular reviews by the regulator. OPTA has set maximum prices for unbundled services, and reviews these and other requirements on a regular schedule to determine whether significant market power is being used to extract rents that are substantially higher than actual costs.[326] Similarly, NMa worked with OPTA to achieve competitive concessions before approving the KNP/Reggefiber joint venture.[327] OPTA has indicated a willingness to apply a light touch when firms choose an open model that permits competition.[328]

Political economy

Much of the political economy in the Netherlands involves the regulator's attempt to balance the benefits of the incumbent's infrastructure and the creation of incentives to stimulate competitive entry. OPTA and KPN regularly spar over terms of interconnection, tariffs, and the like. The regulator has generally managed to carve out jurisdictional and enforcement powers to mandate the terms of competition in the presence of significant market power (which almost invariably is assumed to exist in the case of KPN, but not others). These efforts have controlled profits for KPN and encouraged opportunistic entry by alternatives.

As with all European Union states, there is an additional level of political economy at work. OPTA, and the government as a whole, does not have complete latitude to set the terms of regulation. The European Commission sets guidelines and recommendations across Europe, and differences often emerge. For instance, OPTA and the EC have recently debated the economic models used for fiber unbundling.[329] Municipal fiber deployments have also been subject to approval at the EC level, under its state aid guidelines. More broadly, the Commission is in the process of drafting a Recommendation on access to Next Generation Access (NGA) networks.[330] This will shape the relative power of national level regulatory agencies and broadband providers across Europe.

Broadband strategy

The broadband strategy of the Netherlands has been roughly articulated in a series of documents released by the government or government-convened expert panels. These planning documents are

325 See, e.g., http://www.opta.nl/nl/actueel/recente-publicaties/publicatie/?id=3015

326 http://www.opta.nl/nl/actueel/alle-publicaties/publicatie/?id=2957

327 NMa Decision 6397.

328 "In recent years new parties have opted to establish fiber optic networks, such as building companies, municipalities, and housing cooperatives. Many of these investors employ an open model: service providers may compete with each other in the network. The extent to which OPTA intervenes depends directly on the extent to which this model is open." OPTA, Focus on 2009, http://www2.opta.nl/asp/en/publications/document.asp?id=2826.

329 European Commission, Case NL/2009/0868, Letters of February 17, 2009 and May 20, 2009.

330 http://ec.europa.eu/information_society/policy/ecomm/library/public_consult/nga_2/index_en.htm

largely coherent in their vision and prescriptions, but because they are authored by various groups, they often differ in particulars or emphasis. Broadband is generally defined as consisting of a lower tier from 1Mbps to 10Mbps, and a higher tier that supports the full range of broadband activities.

One coordinated national effort to define broadband strategy was the 2002 document, "Nederland Breedbandland."[331] The government convened an "expert panel" of industry leaders and academics, which outlined a high-level multi-year plan. The group recognized the high capital costs of next-generation infrastructure build-out and embraced a diversity of financial strategies. This is included the note that, "In geographical areas where market parties will not invest in new infrastructure themselves, public-private partnership can be a powerful instrument in encouraging the development of broadband," and that, "In most cases, a particular neighbourhood will be financed by a combination of various stakeholders, such as a housing association and local traders and public bodies." It also explained, "The Government will have to continue to place the role of competition in the broadband market at the forefront of its incentive policy. This means, inter alia, that the unbundling of networks and open, transparent and non-discriminating access for service providers will be basic principles in developing new business models for local broadband networks."

In 2004, the Ministry of Economic Affairs published an outline of broadband strategy going forward.[332] The paper echoed many of the conclusions of the expert panel's document, including an emphasis on the municipal role in build-out, the need for open access to physical infrastructure, and the importance of coordinating standards nationwide. It recommended several action areas, including government-funded research, guidelines for municipalities and provinces, direct stimulus for local broadband build-out, a public-private convening group, and a variety of knowledge-sharing initiatives. A new convening group, NBL sought to develop a platform for knowledge-sharing in the Dutch "kennisbank" (knowledge bank) model.[333] The government also supported a project called "Connecting the Dots" that sought to support best practices sharing between local initiatives. The recommendations included the creation of the E-Norm Task Force, which brought together industry players to establish a reference model for broadband technology.[334] The paper also established an "impulse committee" on broadband, which published more detailed guidelines for implementing the Ministry's vision.[335] Some of these guidelines were ultimately implemented, while others (such as subsidies) were not.

Much of the on-the-ground strategizing in the wireline market has taken place at the local level. The overall structure of broadband strategy in the Netherlands consists of high-level decisions or vision-setting on the national level with substantial latitude for localized solutions.

Policy interventions and outcomes

Government investment in infrastructure

Historically, the Dutch government has offered considerable aid for the build-out of new technologies. This was inherent in the era of the public monopolist, but the government has also actively invested in cable and fiber. In the "Kenniswijk" (Knowledge District) project, the government designated one

331 http://www.expertgroepbreedband.nl/

332 Ministry of Economic Affairs (NL) "The Broadband Paper; A question of pace and better utilisation" (May, 2004)

333 http://www.nederlandbreedbandland.nl/ (The group has the same name as the 2002 panel report, but is distinct)

334 Jan Burgmeijer, "Interoperability of Services in an Open Broadband Market: Cases from The Netherlands," B@Home WP0, Deliverable D0.9, 2006. http://www.freeband.nl/FreebandKC/keywords?document=File-65402

335 Bekkers, R., S. Maltha, J. Poort & S. van Geffen, "Naar een nationale strategie voor breedband, Advies van de Impulscommissie Breedband," Utrecht, 2004.

geographical region as a test bed for residential fiber rollout. From 2000 to 2005, it offered subsidies up to 50% of the cost of build-out and helped with the formation of public-private partnerships.[336] This included the fairly successful OnsNet project.

However, government-funded models have been cast into doubt in recent years, and measures at both the EU level and the national level have sought to limit state investment in the interest of avoiding market distortion. From the time of the updated EU Regulatory Framework in 2002, there has been confusion regarding what would be permitted under state aid guidelines. For example, in 2005, the European Commission ruled against public investment by the city of Appingedam,[337] but permitted a public-private joint venture in Amsterdam a year later.[338]

From 2004 to 2007, Dutch parliament debated various revisions to the Telecom Act. Ultimately, new language introduced limits on municipal entry or ownership of infrastructure, above and beyond the EC limitations. Some existing municipal investment projects were allowed, and other communities found ways to work within the rules to encourage local deployment. For example, the Amsterdam CityNet project appears poised to serve upwards of 140,000 households using a model in which the city is a partner with private firms.[339] Nevertheless many municipal projects have slowed.[340]

The Commission recently clarified its position, appearing to support a relatively liberal set of scenarios in which government investment will be permitted.[341] Some important distinctions, like which networks will be considered "Next Generation," remain unclear. Secretary of Economic Affairs Frank Heemskerk has indicated broader support for municipal investment and for revisions to the Telecommunications Act to facilitate this.[342] The explanatory text accompanying these revisions notes, "The current economic situation makes reconsideration of the statutory restrictions necessary. The possibilities for governments to responsibly contribute to economic growth should not be limited more than is absolutely necessary. One such possibility is to encourage the construction of broadband networks… Cases such as Amsterdam fiber show that the involvement of a municipality can be the proverbial push in the back. Right now lenders have become reluctant by the economic crisis, but the involvement of municipalities can be an important incentive for banks and other lenders to participate."[343]

Competition policy

The overarching competition philosophy of the Netherlands consists of managed facilities-based competition. These competitive facilities do not include the access networks in the last mile, but rather the backbone up to the unbundled copper or fiber lines to the home. OPTA has maintained unbundling controls on the incumbent, and has extended these controls to new fiber networks.

OPTA also recently took steps to force cable providers to open access to their networks for television service (but not broadband).[344] However, this has also affected the broadband market, because it has

336 Kramer, R. D., Lopez, A., and Koonen, A. M., "Municipal broadband access networks in the Netherlands - three successful cases, and how New Europe may benefit," Proceedings of the 1st international Conference on Access Networks, Athens, Greece, September 4-6, 2006. AcessNets '06, vol. 267. ACM, New York, NY, 12.

337 Decision on the measure C 35/2005 (ex. N 59/2005), October 20, 2005.

338 Decision on the measure C 53/2006 (ex N 262/2005), December 12, 2006.

339 http://fibresystems.org/cws/article/magazine/37080

340 For more detailed context, see: Sadowski, B. M., et al., "Providing Incentives for Private Investment in Municipal Broadband Networks: Evidence from the Netherlands," Telecommunications Policy, 2009. (in press)

341 http://europa.eu/rapid/pressReleasesAction.do?reference=IP/09/1332

342 http://www.fd.nl/artikel/12868632/ruim-baan-snel-internet-gemeenten

343 Dutch Lower House. (September 23, 2009). Kammerstukken 32127, nr. 3.

344 http://europa.eu/rapid/pressReleasesAction.do?reference=IP/09/245 (On October 24, 2006, Dutch Parliament voted in

enabled DSL-based providers such as Tele2 to announce plans for more robust triple-play offerings.[345] Generally speaking, the competition policy of the Netherlands seeks to refrain from regulation except in cases of significant market power, per EC guidelines.

Network non-discrimination

Network discrimination has not been a prominent issue in the Netherlands. There has, however, been recent discussion of the issue in the context of cable operator UPC's protocol-specific bandwidth caps.[346] The Dutch consumer organization Consumentbond has accused UPC of unfair business practices due to lack of disclosure of traffic management practices.

Much of the debate around network non-discrimination is occurring at the European Union level, as the so-called "Telecoms Package" (a review of the existing set of EU directives for electronic communications from 2002) is hammered out. In a recent round of debate, some new language was introduced that appeared to permit network discrimination in some cases. The French advocacy organization La Quadrature du Net has organized resistance to this language in EU countries, but it remains to be seen what will be contained in the final language.[347]

Spectrum policy

The Dutch government has relied on auctions for all recent spectrum allocations. The last major auction, for 3G frequencies, took place in 2000. Historically, auctions in the Netherlands have not realized the high prices seen by other European countries. In 2009, Agentschap Telecom, announced a new auction of 2.6GHz and 3.5GHz frequencies, but after some resistance and complications, the auction was postponed until 2010. The government also added a requirement that 20% of the bandwidth be auctioned to new entrants.[348] After the government's protracted battle with KPN over whether the company could keep the warehoused 2G spectrum that was acquired in the Telfort buy-out, KPN returned the spectrum to the government for re-auction in 2010.[349] This outcome was the result of the Dutch government's desire to have all allocated spectrum actively in use.

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favor of a more expansive cable unbundling proposal, but this never progressed to implementation. Kammerstukken 30800 XIII, nr. 18)

345 http://www.broadbandtvnews.com/2009/02/11/ec-gives-green-light-for-dutch-open-cable/

346 http://yro.slashdot.org/story/09/08/23/1921206/First-European-Provider-To-Break-Net-Neutrality

347 http://www.laquadrature.net/Telecoms_package

348 http://www.telegeography.com/cu/article.php?article_id=28137

349 http://www.telecompaper.com/news/article.aspx?cid=684135

F. Sweden

Introduction

Sweden committed a decade ago to providing comprehensive national broadband coverage and has subsequently emerged as one of the top performers in broadband provision and adoption, scoring well in terms of broadband penetration, speed, and affordability. The Swedish government has been actively involved in rolling out broadband infrastructure through public investments, both at the federal and municipal levels, and public-private partnerships that have contributed to the deployment of a broadband internet infrastructure that now reaches 98% of the country's residential population.

Swedish regulators have intervened at several junctures in broadband markets to enact strong open access rules in the telecommunications sector, starting with the introduction of a local loop unbundling requirement in 2001. This was consolidated further in 2004 with a mandate that TeliaSonera, the incumbent telecommunications company, provide bitstream access for broadband entrants. In 2007, the regulatory authority went a significant step further, forcing TeliaSonera to functionally separate its network and retail internet services divisions. Open access provisions in Sweden now apply both to the copper and high-speed fiber infrastructure.

Sweden's open access policies have helped shape a market structure in which the four larger companies—which together account for 95% of subscriptions—compete across several platforms, including copper, cable, fiber, and wireless. As reflected in the price offerings and consumer options, the level of competition in Swedish broadband markets is strong. Sweden has been a leader in deploying fiber in municipal networks in various combinations of public and private sector involvement. Sweden ranks third in the world in fiber/LAN connections behind South Korea and Japan, with over 450,000 subscribers. Future broadband plans include expanding the reach of fiber networks and achieving full residential internet access at speeds of 2 Mbs or higher.

Market highlights

Overall, 66.6% in Sweden have broadband access.[350]

	Fiber / LAN	Cable	DSL	Other	Overall [351]
Subscriptions per 100 people [352]	6.5	6.2	19.1	0.2	32.0

350 OECD Broadband Portal, Table 2a, from EU Community Survey, from 2007.
351 Does not include 3G Wireless. Since subscriptions are shared within a household, this number will never be 100.
352 OECD Broadband Portal, Table 1d, as reported by individual governments, as of 2008.

Penetration metrics	Rank	Speed metrics	Rank	Price metrics	Rank
Penetration per 100, OECD	7	Max adv. speed, OECD	3	Price low speed, OECD	8
Household penetration, OECD	7	Avg. adv. speed, OECD	13	Price low speed, OECD+GC	4
3G penetration, GC	6	Median download, speedtest.net	3	Price mid speed, OECD	8
Wi-Fi hotspots per 100,000, Jwire	1	Median upload, speedtest.net	2	Price mid speed, OECD+ GC	2
		Median latency, speedtest.net	4	Price high speed, OECD	8
		90% download, speedtest.net	2	Price high speed, OECD+GC	4
		90% upload, speedtest.net	2	Price very high speed, OECD	2
				Price very high speed, OECD+GC	2

1st quintile
2nd quintile
3rd quintile
4th quintile
5th quintile

Note: Details in Part 3
Source: OECD, GlobalComms, Jwire, Speedtest.net, Berkman Center analysis

Broadband development to date

Over the past decade, internet use in Sweden has shifted rapidly from a reliance on low bandwidth dial-up to higher speed services. In 2001, the number of broadband users tripled; by the end of year, about 455,000 private customers "were connected to the internet via some form of access with higher transmission capacity."[353] DSL and cable respectively accounted for 9% and 4% of internet customers.[354] Internet penetration among households with a capacity of 2Mbps or more was at 2.6% in 2001.[355] In 2002, subscriptions for IP telephony in broadband networks were introduced.[356] Household penetration of fixed internet connections in 2003 was up to 20% while household penetration for connections with capacities of 2 Mbps or more had increased to 4%.[357]

Household broadband use surged from 2004 to 2005 as the number of households with internet access of 2 Mbps or more grew by 40% to serve 21% of households. The overall rate of fixed connections stood at 39%.[358] By January 2005, all municipalities had a connection to the national backbone and interurban networks and "all urban areas with more than 3,000 inhabitants have a local network in some part of the urban area."[359] The rise in broadband users coincided with a continued increase in the number of independent ISPs competing for the residential and business markets, which cut into the incumbent's market share. Two cable companies, Com Hem and UPC, together accounted for 16% of the consumer market. Other entrants took advantage of Swedish policies that opened up the TeliaSonera's network to competitors. Two of these entrants, Bredbandsbolaget (B2) and Glocalnet, had accumulated 20% and 6% of the market.

In 2000, Sweden issued four UMTS wireless licenses for a nominal fee, although these licenses came with an aggressive deployment requirement that over 99% of the population have access within two years. Interestingly, the four recipients of the licenses—Tele2, Vodafone Sweden, Hi3G, and Orange

353 The Swedish Telecommunications Market 2001, p.32 et sq.
354 The Swedish Telecommunications Market 2005, p.78
355 The Swedish Telecommunications Market 2001, p.61.
356 The Swedish Telecommunications Market 2003, p. 19.
357 The Swedish Telecommunications Market 2003, table 33, p.81.
358 The Swedish Telecommunications Market 2005, table 32, p.81.
359 http://www.pts.se/en-gb/Documents/Reports/Internet/2005/Broadband-in-Sweden-2005---PTS-ER-200524/

Svierge—did not include the incumbent Telia. (Telia subsequently entered in to a joint venture with Tele2 to return to the market.) The ambitious coverage targets were not met. By 2005, three of the four licenses were in use and only 90% of the targeted coverage had been achieved.[360] Even though the coverage targets were not met, Sweden still had the best 3G coverage in Europe.

In 2008, broadband subscriptions in Sweden greatly outnumbered ISDN or dial-up connections with DSL technology constituting 41% of all subscriptions. Mobile broadband Internet subscriptions accounted for 21% of the total while fiber and fiber-LAN subscriptions had risen to 14%.[361] The total number of broadband internet subscriptions had grown by 20% over the previous year and subscriptions with 2 Mbps (fixed and mobile) grew by 45%.[362] Household fixed broadband penetration was 60% in 2008. Among broadband subscribers, 83% had connections of 2 Mbps downstream or higher, up from 69% a year earlier.[363] There were 153 local fiber/LAN broadband networks and more than 98% of the population was covered by a high-speed network.[364] In the wireless market, there were approximately 3.5 million UMTS and CDMA 2000 subscriptions.[365]

Market share and key players

The Swedish market for local, long-distance and international telephony was liberalized in 1993 opening up telecommunications markets to competition.[366] In 1996, three years after liberalization, the government-owned former monopoly operator, Telia, had a share of 71% of the telecommunications market.[367] At that point, Telia was the only operator in Sweden that offered a public ISDN network.[368]

In 2002, Telia merged with the Finnish state telecommunications company, Sonera, to form TeliaSonera. The TeliaSonera merger followed a failed merger attempt with the Norwegian telecommunications company, Telenor, which is now is its largest competitor in Sweden. The governments of Sweden and Finland still hold minority ownership stakes in the company, which is still the dominant fixed line and mobile operator in Sweden. In mid-2008, TeliaSonera held 39% of the market for broadband subscriptions.[369]

Telenor expanded its presence in Sweden through the purchase of several local broadband services, including Bredbandsbolaget (B2) and Glocalnet. Both of these companies established themselves in the Swedish market by accessing consumers on existing infrastructure made available to them through Sweden's open network policies. Telenor currently accounts for about one fifth of the broadband market in Sweden. The cable television provider, ComHem—a former subsidiary of TeliaSonera—offers consumers broadband service over its cable network as well as triple play options. Com Hem, which in 2006 had acquired its largest rival in the cable market, UPC, now accounts for 18% of the broadband market. Tele2, the Stockholm-based telecommunications company, serves 15% of the broadband market. Together, these four companies account for 95% of household broadband subscriptions in Sweden; the rest of the market is shared by several smaller players.

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360 The Swedish Telecommunications Market 2005, p.30.
361 The Swedish Telecommunications Market 2008, table 15, p.93
362 The Swedish Telecommunications Market 2008, table 34, p.98
363 The Swedish Telecommunications Market 2008, table 34 (cont.), p.99
364 GlobalComms Sweden, p.15.
365 The Swedish Telecommunications Market 2008, table 15, p.74.
366 GlobalComms Sweden, p.2.
367 The Swedish Telecommunications Market 1996, p.10.
368 The Swedish Telecommunications Market 1996, p.19.
369 GlobalComms Sweden, p. 15.

DSL connections account for over 40% of household broadband connection. Fiber and fiber-LAN networks have a slightly bigger share of the market than cable, holding 14% and 13%, respectively.[370] Sweden trails only South Korea and Japan in household fiber penetration rates.

TeliaSonera is the largest single owner of fiber, accounting for approximately 45% of the whole optical-fiber coverage in 2009. Publicly-owned fiber-infrastructure in the hands of government, the Swedish National Rail Administration, Vattenfall, Svenska Kraftnät, and municipal enterprises jointly accounted for 45% of the total.[371] Municipal networks alone control 20 to 25% of the coverage.[372] Among the more than 150 local fiber/LAN networks in 2008, a majority are owned by municipal authorities or municipally run companies.[373]

The market for wireless broadband, which grew by 229% from mid-2007 to mid-2008,[374] is also dominated by TeliaSonera with 39% of active subscriptions, ahead of Tele2, Hi3G Access and Telenor with 25%, 19% and 15%, respectively.[375] Each of the four major players operate 3.5G networks and are expected to deploy 4G service in 2010. [376] Tele2 has also secured a 2.6GHz license to be used for WiMAX services.[377]

Regulatory framework

The 2003 Electronic Communications Act (EkomL) lays out the regulatory structure for all electronic communication networks and services in Sweden, covering both wireline and wireless communications systems. The passage of this act, enacted during a period of rapid growth in broadband, reinforced Sweden's policy commitment to carry out tough regulatory action in order to promote wide-scale broadband internet coverage and adoption.

The act of 2003 aimed to "ensure that electronic communications are as accessible and efficient as possible and are open to free competition." The act further states, "We wish to give an authority power to force market-dominating companies to allow competitors access to their networks or to limit their prices to the end-customer to what is reasonable."[378]

The passage of this new telecommunications act strengthened and expanded the regulatory authority of the Swedish Post and Telecom Agency (PTS, short for Post och Telestyrelsen) to intervene where market players with significant market power were hindering competition for broadband services. In essence, the legislation aimed to open communications markets by attenuating the market power of TeliaSonera.

PTS, which is overseen by the Ministry of Enterprise, Energy, and Communications, also acts as an adviser to the government with respect to broadband development and IT strategy. The Swedish legal and regulatory framework for the IT sector is influenced substantially by EU policy; competition laws and EU legislation such as the Framework Directive are of particular salience to the telecommunications sector.

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370 The Swedish Telecommunications Market 2008, table 30, p.93
371 http://www.pts.se/en-gb/Documents/Reports/Internet/2009/Dark-fibre---one-year-later---PTS-ER-200924/
372 Dark Fibre, Market and State of Competition, p.22 et sq.
373 GlobalComms Sweden, p.15.
374 GlobalComms Sweden, p.15
375 GlobalComms Sweden, p.8.
376 GlobalComms Sweden, p.11 et sq.
377 GlobalComms Sweden, p.12.
378 http://www.regeringen.se/content/1/c6/01/84/54/5ae98894.pdf

Political economy

The political economy of Sweden's broadband industry is dominated by the interplay between state controlled former monopoly TeliaSonera and industry watchdog PTS. As the incumbent telecommunication provider, TeliaSonera owned a large majority of the nation's copper and fiber networks and benefited from significant market power in different industry sectors. The PTS in turn began to exert its regulatory power to promote competition by ordering local loop unbundling or through price setting. TeliaSonera has consistently sought to maintain its competitive advantage and preserve control over its network infrastructure, resisting PTS plans to open the incumbent's networks to competitors. Frustrated with the slow progress in opening up TeliaSonera's networks to other entrants, PTS has progressively enacted a series of more stringent open access measures designed to enhance competition.

TeliaSonera is not alone in benefiting from (former) public ownership: B2 used a strategic partnership with the National Swedish Rail Administration to gain access to the railway communication infrastructure.[379] Municipalities and publicly-owned companies have joined forces to build local fiber networks, thereby adding to the picture of a sector heavily influenced not only by regulatory power struggles but also by cooperative public-private partnerships.

Broadband strategy

Sweden initiated its current broadband policy more than a decade ago. With the 1999 release of IT Bill 1999/2000:86, the country embarked on a plan to create "an information society for all." The policy described a reliance on market forces in conjunction with public-private partnerships to deploy broadband across the large and sparsely populated country.

The Swedish Government formed an ICT commission and embraced its recommendation to fund a fiber network.[380] In addition to national projects, the Government allocated funds to regional and local broadband projects, allowing "operators to choose their preferred access platform…to best suit each region targeted."[381] Involving municipalities and regional operators had already been part of the national broadband infrastructure program of the IT bill.

An updated IT policy, published in 2004, lays out three central objectives:

- IT must contribute to a better quality of life and help improve and simplify everyday life for people and companies.
- IT must be used to promote sustainable growth.
- An effective and secure physical infrastructure for IT, with high transmission capacity, must be available in all parts of the country so as to give people access to, among other things, interactive public e-services. [382]

The bill refers to public confidence in IT and coordination as two essential conditions required to achieve these objectives, with the first condition supported by education and countering threats to

379 Explaining International Broadband Leadership, Appendix G: Sweden, p.G3.
380 Broadband Stimulation in France, Ireland, and Sweden, p.15.
381 GlobalComms Sweden, 14.
382 See: From an IT policy for society to a policy for the information society, Summary of the Swedish Government Bill 2004/05:175, p. 7 et sq.

security. The plan calls for the state to take responsibility in organizational, logistical, and technical issues in order to meet the coordination objective. [383]

Operating in its policy role, PTS published its own strategic plan in 2007, entitled "Proposal for Swedish broadband strategy." This document established as a goal that the entire Swedish population should have access to infrastructure with at least 2 Mbps downstream capacity by 2010.[384] To meet this short-term objective, public-private partnerships and government funding are critical to increased broadband access, as has been the case in the past.[385]

Policy interventions and outcomes

Government investment in infrastructure

In 1999, the Swedish government committed over EUR 600 million for the installation of a national backbone, "which has resulted in the deployment of some 200 metro networks in more than one hundred towns."[386] The roll out was carried out by Svenska Kraftnät, the Swedish National Grid operator.[387] The government allocated an additional EUR 700 million to regional and local broadband projects.[388] Tax breaks were also used as an incentive to promote the spread of broadband.[389] Consistent with the stated goal of coordinating public and private investments, private operators spent an estimated USD 1 billion between 2001 and 2007 as part of the process.[390]

PTS recommends that the government should continue to support the rollout of broadband infrastructure by providing an additional SEK 1.1 billion (over USD 150 million at current exchange rates), half of which could be covered by funds associated with the EU structural funds and rural development plans.[391] Without this financial support from central Government, PTS believes it is "unreasonable to assume that commercial forces alone are sufficient to achieve the objective of broadband for all by 2010 and that the possibility of imposing obligations on a party to provide universal services cannot be viewed as a means of achieving this objective."[392]

An early notable government-funded project is the dark-fiber network funded by the city of Stockholm in 1994. This project, Stokab, was initiated after the refusal of the private sector operator, Telia, to provide fiber capacity. Stokab later expanded its operations to other municipalities and the model became a key piece of Sweden's broadband infrastructure policy.[393]

Skill building, education, and demand programs

In addition to the large public investments in infrastructure, the Swedish government also supports initiatives to promote demand for broadband access by fostering digital literacy, increasing access to

383 From an IT policy for society to a policy for the information society, Summary of the Swedish Government Bill 2004/05:175, p. 8 et sq
384 p.22 et sq.
385 Proposal for Swedish broadband strategy, p.54. See also section "Government investment in infrastructure"
386 http://www.bbwo.org.uk/broadband-3045
387 Ibid.
388 GlobalComms Sweden, 14.
389 Explaining International Broadband Leadership, Appendix G: Sweden, p.G2.
390 Ibid.
391 Proposal for Swedish broadband strategy, p.54.
392 Proposal for Swedish broadband strategy, p.66.
393 http://www.ictregulationtoolkit.org/en/PracticeNote.aspx?id=3244

personal computers, and encouraging the use of broadband for education.[394] As early as 1998, tax breaks were introduced for companies that supplied employees with personal computers.[395] In a later push for digital literacy in education, the government "introduced a USD 25 million project to raise IT literacy among schoolteachers."[396] In addition, the government also carries out initiatives pursuing quality and sustainable growth—two other sub-goals of its IT policy—by promoting, for example, improvement of e-services in the health care sector and promotion of IT skills in SMEs, which, among other things, are likely to boost demand for broadband. [397]

Competition policy

Swedish government regulators have acted aggressively to open up broadband markets to competition with a focus on providing competitors access to TeliaSonera's network. Unbundling was introduced in 2001, though it was slow to take hold. In 2003, PTS ordered TeliaSonera to lower the wholesale price for access to its network, asserting that TeliaSonera had engaged in discriminatory pricing practices that favored some operator over others. In 2004, TeliaSonera accepted a PTS ruling clarifying further unbundling requirements of its last mile copper network, but chose to appeal to the courts the ruling that required it to provide wholesale bitstream access to its competitors. TeliaSonera eventually complied with this mandate in 2007 after losing in the courts.[398] The rulings at the time did not include TeliaSonera's fiber-optic network. However, TeliaSonera's copper network remains an issue of critical interest for PTS and one of three principal topics of the agency's 2007 "Proposal for Swedish broadband strategy".[399] Another important ruling by PTS in 2005 required TeliaSonera to offer naked DSL in 2005 so customers would have the option to take telephony and internet services from different operators.[400]

In 2007, PTS submitted a statutory proposal for non-discrimination and openness in the local loop which states that, "the market that currently deals predominantly with access to TeliaSonera's metallic loop is not a functioning marketplace…the authority can conclude that there is neither sufficient transparency nor equal treatment in the market. The current situation falls far short of the goals of effective and competition-neutral access, nor does it establish adequate conditions to gradually loosen the regulation to promote competition on the route to more sustainable competition."[401] PTS proposes as a remedy "that the ability of the public authority to impose functional separation on a dominant stakeholder should be introduced, meaning that the parts of the operation representing bottleneck resources should be separated from the rest of the organization."[402] TeliaSonera announced its agreement to comply with this quasi-voluntary functional separation and in early 2008 created a subsidiary, TeliaSonera Skanova Access, to serve wholesale customers. This arrangement was reinforced later in the year with the passage of legislation and regulations to implement this policy.

394 Explaining International Broadband Leadership, Appendix G: Sweden, p.G4.
395 Swedish commitment to broadband both in the cities and in the countryside, p.13
396 Explaining International Broadband Leadership, Appendix G: Sweden, p.G4.
397 see From an IT policy for society to a policy for the information society, Summary of the Swedish Government Bill 2004/05:175
398 GlobalComms Sweden, p.15
399 Proposal for Swedish broadband strategy, p19 et sq.
400 Explaining International Broadband Leadership, Appendix G: Sweden, p.G3.
401 Improved broadband competition through functional separation, p.59.
402 Improved broadband competition through functional separation, p.79.

Network non-discrimination

Network neutrality violations have not been the source of any complaints to PTS and the agency therefore has not seen any reason to take action in this space.[403] Of possible relevance, the Electronic Communications Act in Chapter 6, Section 17 prohibits processing of a message by others than the relevant users or in special situations.

Spectrum policy

In 2006, PTS produced a spectrum policy, in which the agency makes the following recommendations (inter alia): neutrality of service and technology, licenses should be allocated by auction, "second-hand trading shall be promoted," and "spectrum allocation shall be harmonized with other countries as far as this is possible."[404]

Licenses may be awarded to cover either the whole nation, a region, or a municipality, while bidders are limited to a maximum of one license per municipality. Contrary to requirements that came with the 3G licenses, authorities have not attached any rollout obligations to the licenses auctioned recently.[405]

In its 2009 Strategic Policy paper, PTS makes the liberalization of spectrum management a priority, and "covers lowered entry barriers and measures to facilitate technology and market development by formulating conditions for using and liberalizing frequencies. One important objective for 2009 is for market players to have access to more spectrum than last year, on terms that are technology and service neutral."

403 Network neutrality, memorandum, p.7.
404 PTS spectrum policy, p.6.
405 GlobalComms Sweden, p.14.

G. Switzerland

Introduction

Switzerland has experienced strong results in broadband deployment, despite taking a substantially different approach than other countries that have performed well in this space. Switzerland has relied primarily on inter-platform competition between the incumbent telecommunications company that offers DSL and cable companies. Unlike the majority of its European neighbors, Switzerland has been slow to implement local loop unbundling, formally adopting this policy only in 2007. However, it is difficult to attribute their success solely to a regulatory abstention given the consistent efforts of the national regulatory authority to implement local loop unbundling since 2003.

The political discourse about broadband over the past two years has centered around three core themes: firstly, the likely effects of local loop unbundling as introduced in 2007; secondly, a possible amendment to the Law on Telecommunications to allow ex-ante regulation and to recast the regulatory framework into one that is technology-neutral; and thirdly, extension of the regulatory power of the Federal Communications Commission (ComCom) to the regulation of fiber networks.

Switzerland is moving towards an innovative strategy for sharing the costs and risks of deploying the next generation of higher capacity infrastructure for the country, adopting a cooperative approach to deploy fiber directly to homes in Switzerland and to provide subscribers with access to multiple service providers through the same infrastructure.

Market highlights

Overall, 52.8% of households in Switzerland have broadband access.[406]

	Fiber / LAN	Cable	DSL	Other	Overall [407]
Subscriptions per 100 people [408]	0.4	9.7	23.2	0.3	33.5

406 OECD Broadband Portal, Table 2a, from EU Community Survey, from 2006.
407 Does not include 3G Wireless. Since subscriptions are shared within a household, this number will never be 100.
408 OECD Broadband Portal, Table 1d, supplied by the Swiss government, as of 2008.

Penetration metrics	Rank	Speed metrics	Rank	Price metrics	Rank
Penetration per 100, OECD	4	Maximum speed, OECD	17	Price low speed, OECD	13
Household penetration, OECD	13	Average speed, OECD	21	Price low speed, OECD+GC	3
3G penetration, GC	15	Median download, speedtest.net	7	Price mid speed, OECD	6
Wi-Fi hotspots per 100,000, Jwire	2	Median upload, speedtest.net	11	Price mid speed, OECD+ GC	4
		Median latency, speedtest.net	6	Price high speed, OECD	9
		90% download, speedtest.net	8	Price high speed, OECD+GC	8
		90% upload, speedtest.net	14	Price very high speed, OECD	N/A
				Price very high speed, OECD+GC	N/A

1st quintile
2nd quintile
3rd quintile
4th quintile
5th quintile

Note: Details in Part 3
Source: OECD, GlobalComms, Jwire, Speedtest.net, Berkman Center analysis

Broadband development to date

DSL is by far the most popular broadband access technology in Switzerland, accounting for more than two-thirds of subscriptions in 2009.[409] Cable ranked second with somewhat less than a third of broadband connections, a great majority of which are provided by Cablecom. The rising popularity of DSL reflects a marked change in Swiss broadband markets; in 2002, cable held a majority of the broadband market with a 56% share. The historic popularity of cable modems may be explained by the existence of cable TV networks in most parts of the country at the time of liberalization of the telecommunications market in 1998. In addition, cable companies were the first operators to roll out commercial high-speed Internet in 2000. Swisscom, in contrast, only made limited efforts to introduce ADSL in 1998 and did not start its commercial roll-out until 2001.[410] In July 2003, Switzerland witnessed a relatively equal split between cable and DSL. Since then, however, the market has shifted substantially with the spread of DSL. Observers attribute this decline of cable modem access to several factors, including broader coverage (currently, about 98% of all households can be reached with DSL, compared to 93% reached by cable)[411] and advertising campaigns launched by the resellers of the Swisscom wholesale products.[412] Swisscom has for many years offered wholesale products to its direct competitors for resale. However, according to analyses by the independent regulator ComCom, Swisscom's resale products offered by its competitors are not able to effectively compete with Swisscom. The new entrants were not able to establish a competitive position in the liberalized telecommunications market (see Figure 1).[413] Swisscom's main competitor Cablecom, by contrast, was arguably not able to maintain momentum—even based upon the initial advantage of broad TV penetration—since it is covering less than 55% of the cable TV market (Switzerland has about 40 regional or local cable-providers).[414] Cablecom is currently seeking to catch up by investing in higher

409 OFCOM (2009). *The Swiss telecommunications market- an international comparison: Extract from the 14th European Union Implementation report extended to include Switzerland*. p. 106.
410 GlobalComm (2009). *Country overview Swiss section. Broadband Market Commentary*.
411 OECD (2009). *Communications Outlook 2009*. p. 136/205.
412 OFCOM (2009). *The Swiss telecommunications market- an international comparison: Extract from the 14th European Union Implementation report extended to include Switzerland*. p. 106.
413 ComCom (2008). *Annual report* 2007. p. 10.
414 GlobalComm (2009). *Country overview Swiss section. Broadband Market Commentary*.

performance cable technology (DOCSIS 3.0),[415] which will make it possible to offer consumers download speeds of 100 Mbs or higher.[416]

Although optical fiber connections are not as widespread as in other European countries, there has been much activity in that area recently that illustrates fiber's growth potential. Swisscom already operates a network with optical fiber lines, although this network usually ends at street cabinets (FTTC, fiber-to-the-cabinet) and doesn't yet extend to homes or small and medium-sized enterprises. However, more than 10 local power utilities—mostly (but not exclusively) owned by municipalities and cantons—have announced plans to invest in fiber-to-the-home (FTTH) networks. These relatively small power companies are becoming new players in the broadband market and have challenged Swisscom, which, in response, announced plans in 2008 to bring fiber to 100,000 homes by the end of 2009 along with large investments in fiber-to-the-home networks over the next six years. The strategic rationale for the movement of the small power companies into this market is multifaceted. One of the main reasons put forward is that power companies are facing the challenge to maintain client loyalty in a liberalized and therefore increasingly competitive energy market environment, where consumers will be able to switch easily from one provider to another. Such advanced services in combination with increased user choice require a reliable and high-quality communication infrastructure in order to monitor and manage the customer relationship, often referred to as "smart metering."[417] In addition, power companies often have the technical expertise at hand to deploy such networks, since they already maintain their own broadband network between power plants. Further, the conduits that bring power lines to homes often have enough space remaining to accommodate additional fiber cable. These several factors result in low market entry costs for power companies. Also, the broadband business is similar to their core business and therefore recognized by the utility companies as an attractive opportunity.[418] Finally, the ownership structure of many of the power companies matters: cities and municipalities, which are often owners or shareholders of such companies, view open access telecommunications infrastructure as a key factor for the attractiveness of their location and argue that open access should become part of the universal service concept.[419]

In addition to these developments, the federal regulatory authority of the telecommunications industry, ComCom, launched a series of fiber-to-the-home roundtable talks to coordinate plans of potential investors, broadband providers, and other interest groups. By October 2009, the participants of the roundtables had agreed on technical standards to deploy new fiber into buildings, which will make it easy for customers to switch providers and will ensure that different network and service providers can reach customers.[420]

In 2000, ComCom awarded four 3G licenses. Three of them were sold to existing telecommunication companies (Swisscom, Sunrise, and Orange) and one to a newcomer (3G Mobile AG, formerly Sonera) for a total amount of about USD 29.5 million. In 2002, ComCom was forced to relax the deadline set for the launch of the 3G licenses, since the operators weren't able to meet the conditions set forth in the licenses. In the wireless market, 3G (UMTS/HSPA) is currently the fastest growing technology, covering 60% of the country in 2008.[421] Nevertheless, the penetration rate is still low compared to the

415 http://www.cablecom.ch/en/index/kabelanschluss/netupgrade.htm?setlang=4 (last visited 9 September 2009).
416 Neue Zürcher Zeitung (4 July 2009). *Interventionsgelüste im Telekommarkt*. p. 19.
417 Staub, Richard (2009). *Glasfaserkabel für alle Haushalte*. in: Elektrotechnik (May 2009). p. 62-63.
418 City Council of St. Gallen (2008). *Vorlage Stadtparlament: Pilotprojekt für Breitbandnetz auf der Basis "Fibre tot he Home" (FTTH).* p. 6-7.
419 City Council of St. Gallen (2008). *Vorlage Stadtparlament: Pilotprojekt für Breitbandnetz auf der Basis "Fibre tot he Home" (FTTH).* p. 1.
420 http://www.comcom.admin.ch/aktuell/00429/00457/00560/index.html?lang=en&msg-id=29395
421 ComCom (2009*). Annual Report* 2008. p. 21.

OECD average (20% in 2007).[422] In 2006, ComCom revoked the 3G license from 3G Mobile AG as the company couldn't meet the conditions stipulated in the license.[423] Swisscom recently announced plans to invest in HSPA+ in the next several years. Handsets supporting this technology are expected to be sold in 2010.[424] At the end of 2008, five GSM-licenses were in use (Swisscom, Sunrise, Orange, Tele2, and In&Phone), with coverage of nearly 100% of the population.[425]

WiMAX still plays a marginal role in the broadband market. In 2007, a license was awarded to Inquam Broadband.[426] The provider is expected to launch a mobile WiMAX service.[427] Swisscom decided in 2008 to use satellite connection for universal access services rather than WiMAX.

Satellite Connections (Eutelsat) are used to provide broadband connections to remote areas that cannot be served with DSL or cable networks. The market share of this technology within Switzerland is small, and, with DSL coverage of about 98%, the situation is unlikely to change in the near future.

Although the Swiss government hasn't developed any policy concerning the deployment of wireless hotspots, the telecom industry has been actively investing in the spread of hotspots. Again, Swisscom is the major player in the field and has installed over 1,200 wireless hotspots in Switzerland, especially around railway stations. Furthermore, the federal railway company (SBB) is working closely with Swisscom to enable consumers to surf the Internet during their travels.[428] On a local level, there are a growing number of open wireless city networks, which provide city centers with Internet free of charge.[429]

Market share and key players

Swisscom is by far the most important provider of wireline and wireless services in the Swiss market. The company is the former national telephone company. Although the liberalization of the telecommunications market took place in 1998,[430] the federal government still holds a 55% stake in the company.[431] Complete privatization had been planned at that time, but the Swiss parliament decided against a full implementation in 2006.[432] Since 1998, four major wireline and wireless providers have competed with Swisscom in the broadband market, namely Sunrise (formerly TDC Switzerland), Tele2 (now merged with Sunrise), Cablecom, and Orange.

In 2007, ComCom awarded Swisscom with a 10-year universal service license. The license contains, among other things, the obligation to provide broadband connections to all households and serve all geographic areas of Switzerland. The minimum transmission rate is set to 600/100kbits/s and a maximum price was set at CHF 69 per month.[433] However, the consequences of this obligation are quite

422 OECD (2009). *Communications Outlook* 2009. p. 103.
423 ComCom (2007). *Annual Report* 2006. p. 20.
424 http://www.computerworld.ch/aktuell/news/49049/ (last visited 6 September 2009).
425 ComCom (2009). *Annual Report* 2008. p. 21.
426 http://www.news.admin.ch/message/index.html?lang=en&msg-id=12434 (last visited 10 September 2009).
427 GlobalComm (2009). *Country overview Swiss Section: Broadband Market Commentary*.
428 http://www.swisscom.ch/FxRes/Files/PWLAN/online_im_zug.pdf (last visited 11 September 2009).
429 http://www.openwireless.ch/ (last visited 11 September 2009).
430 GlobalComms (2009). *Country overview Swiss Section. Wireline Timeline*.
431 OECD (2009). *Communications Outlook 2009*. p. 46.
432 http://www.parlament.ch/ab/frameset/d/n/4712/221326/d_n_4712_221326_221327.htm (last visited 8 September 2009).
433 ComCom (2006). *Annual Report* 2007. p. 24.

limited due to the fact that the broadband network already reaches 98% of Swiss households.[434] The universal service obligation does not stipulate any specific requirements for access technologies.[435]

The broadband market share of Swisscom is 55.3%, representing more than twice the share of its closest competitor, Cablecom (19.2%). In the summer of 2008, Sunrise had a market share of 12.8%. Sunrise later merged with its previous competitor Tele2, allowing the company to extend its market share to over 18% at the end of 2008.[436]

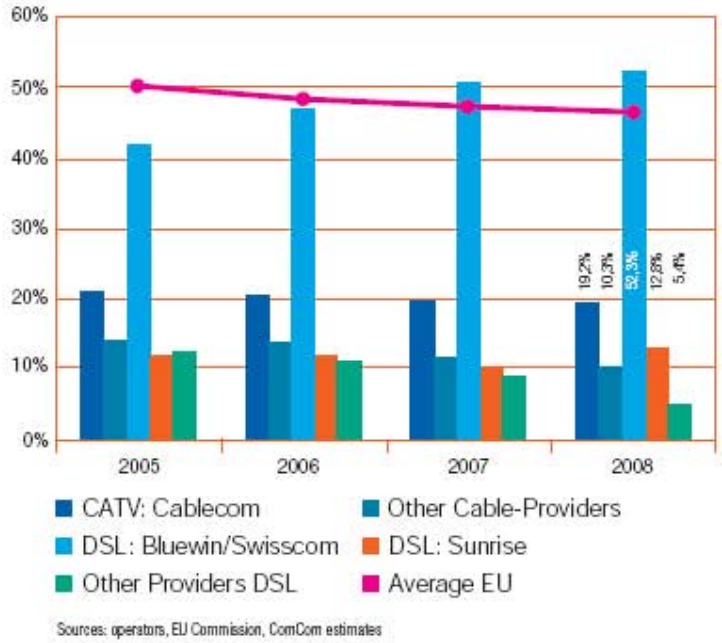

Figure 1: Market shares of broadband connections in Switzerland and in the EU, December 2008[437]

Swisscom was the only provider that increased its market share in 2008 (not taking into account Sunrise's merger with Tele2); direct competitors were unable to hold their market shares. This is remarkable, as Swisscom is one of the few incumbents in Europe that is outperforming its newly entered competitors.[438] The dynamism of Swisscom can partially be explained by strong management with high public and political visibility, coupled with a very solid financial background.[439] Observers argue that the fiber-to-the-home roll-out is somehow linked with the decision taken by Federal Council in 2005, according to which Swisscom is not allowed to make major investments in foreign companies as long as the Swiss government is its majority shareholder.[440] Swisscom's high customer satisfaction rates may also contribute to their success and may help explain why better prices alone are often not incentive

434 OFCOM (2007). *Annual Report* 2008. p. 14.
435 ComCom (2009). *Annual Report* 2008. p. 21.
436 ComCom (2009). *Annual Report* 2008. p. 13.
437 ComCom (2009). *Annual Report* 2008. p. 11.
438 ComCom (2009). *Annual Report* 2008. p. 10.
439 http://www.swisscom.ch/GHQ/content/Investor_Relations/Ergebnisse_und_Berichte/Kennzahlen_Finanzergebnis/Wichtiges_in_Kuerze/?lang=en (last visited 17 September 2009).
440 http://www.admin.ch/ch/d/gg/pc/documents/1365/VL_Bericht_d.pdf (last visited 17 September 2009).

enough for consumers to change telecommunication providers. Overall, the company's image and customer trust in its reliability seem to contribute significantly to Swisscom's ongoing success.[441]

As already mentioned, new players are currently entering the Swiss market, as local power providers start to invest in fiber-to-the-home networks. As a result of this increased competition, Swisscom recently announced investments of over USD 2.64 billion in fiber-to-the-home connections over the next six years ("Fibre Suisse").[442] Swisscom's multi-fiber strategy is based on the deployment of four fibers to each home. One of these fibers would be used by Swisscom itself, the other three could be bought or rented by other providers.[443] Sunrise—Swisscom's strongest competitor—has entered a nation-wide cooperation with the former monopolist, agreeing to buy Swisscom's wholesale fiber products.[444] The multi-fiber network is expected to reduce Swisscom's deployment costs and protect its market share. According to experts, the multi-fiber approach taken by Swisscom may even help the company to avoid regulation as it offers non-discriminatory access to competitors.[445]

In the wireless market, Swisscom has the largest market share (62% in March 2009), followed by Sunrise and Orange with 21 and 18%, respectively. In 2005, new competition in the corporate communications market came from In&Phone as they had been awarded a GSM-1800 license. In the same year, the two main Swiss retailers Migros and Coop launched their own products in cooperation with Swisscom and Orange.[446]

Regulatory framework

Although Switzerland is not a member of the European Union, the regulation of the Swiss telecommunications market is highly influenced by the EU telecommunications framework. The legislative framework is intended to serve the goal of universal service: broad access to reliable and affordable telecommunication services.

The most important law governing the telecommunications market in Switzerland is the Law on Telecommunications (LTC) and the corresponding Ordinance on Telecommunications and Services (TIO).[447] Since its amendment in 2007, key elements of the LTC regime include local loop unbundling and an ex-post mechanism to set prices for network access. According to this ex-post approach, which is a target of considerable criticism, ComCom is only permitted to intervene in response to a respective request by a telecom company and under the condition that negotiations between the relevant competitors have failed for three months. The LTC establishes ComCom as the independent regulator for the Swiss telecommunications market. ComCom is attached to the Federal Office of Communication (OFCOM).

Optical fiber networks are not within the scope of LTC and remain therefore unregulated—a fact that has triggered discussions about the need to amend the LTC, as mentioned earlier.[448] In light of this regulatory vacuum, ComCom has taken on the role of a facilitator, in addition to the role of a regulator,

441 NZZ am Sonntag (18 November 2007). *"Preisvergleich mit Ausland hinkt"*. Interview with Carsten Schloter, CEO of Swisscom. p. 5.
442 GlobalComms (2009). *Country overview Swiss Section: Broadband Market Commentary*.
443 GlobalComms (2009). *Country overview Swiss Section: Broadband Market Commentary*.
444 Neue Zürcher Zeitung (31 March 2009). *Wenn Stromer ins Telefongeschäft einsteigen*. p. 21.
445 GlobalComms (2009). *Country overview Swiss Section: Broadband Market Commentary*.
446 GlobalComms (2009). *Country overview Swiss Section: Wireless Market Commentary.*
447 GlobalComms (2009). *Country overview Swiss Section: Broadband Regulations.*
448 Sonntag Zeitung (3 May 2009). "*EW sollen Technik und Angebote vereinheitlichen*". Interview with Marc Furrer, head of the independent regulator ComCom. p. 57.

and has recently organized a series of fiber-to-the-home roundtables to explore soft-law approaches to standardize and coordinate the roll-out of additional fiber infrastructure among the different stakeholders.[449]

Experts are calling for another amendment of the LTC to correct for deficiencies that they claim lead to uncertainty on the market and result in a sub-optimal environment for future investments. According to critics of the current regime, the reliance on ex-post regulatory mechanisms prevents regulators from taking the necessary steps to ensure a well functioning market. Moreover, they assert that the regulations should be technology-neutral, as opposed to the current regulatory structure that varies by technology. For example, ComCom is currently unable to intervene and impose solutions to market problems related to fiber networks.[450]

Political economy

The political economy of broadband policy in Switzerland revolves primarily around the efforts of Swiss regulators, with the support of newer entrants into the telecommunication markets, to secure additional regulatory powers that would allow them to act more forcefully in opening up Swisscom's infrastructure to competitors. The struggle over local loop unbundling, described in more detail below, dragged on for many years before Swisscom was ultimately forced to open its copper wire to its competitors.

Today, a newer version of the same debate is underway regarding further amendments to the LTC that would offer regulators expanded power to intervene in broadband markets, again pitting entrants against the incumbent. Swisscom seeks to avoid any further regulations, whereas its competitors, including the local power providers, want further amendment of the LTC to regulate fiber deployment. The disagreement over the practical and philosophical aspects of regulatory policy is occurring both in the marketplace and within government.[451] On the one hand, ComCom is pushing for another amendment, whereas, on the other hand, the Federal Council argues that such a step would be premature in the light of the fact that the LTC was amended in 2007. In the meantime, independent experts are calling for a public mandate.[452] The outcome of this political debate is still open and hard to predict; no decisions have been made so far.

Occupying the far side of the political landscape is an ongoing process characterized not by antagonism but by cooperation. These recent round-table discussions, facilitated by ComCom and bringing together the most important stakeholders, including Swisscom, seek to frame a coordinated approach to deploying the next generation of fiber-to–the-home networks that will offer excellent transmission rates and be open to multiple service providers.

Broadband strategy

The Federal Council formulated an initial Strategy for a Swiss Information Society in 1998, which was updated and enhanced in 2006. The Federal Council's paper sets forth the basic principles of such a society and identifies the areas where action is most urgent. These guidelines are intended to inform the development of agency- and department-specific sub-strategies. In 2008, the Federal Council decided to

449 ComCom (2009). *Fibre to the home: third round table*. press release found on http://www.comcom.admin.ch/aktuell/00429/00457/00560/index.html?lang=en&msg-id=26690 (last visited 10 September 2009).

450 ComCom (2009). *Annual Report* 2008. p. 5-6.

451 Sonntags Zeitung (31 August 2008). *Aus allen Lobbyisten-Rohren*. p. 65.

452 NZZ am Sonntag (14 December 2008). *Dünne Glasfasern sorgen bei Firmen für dicke Luft; Telekom-Unternehmen kämpfen mit harten Bandagen um die Gunst der Politik*. p. 36.

renew the mandate of the Interdepartmental Information Society Committee (ISSC). The committee has until 2011 to implement the Federal Council's strategic goals.[453]

The Swiss strategy regarding broadband development has four core areas and principles:[454]

- Universal Service: An economical, reliable, and high-quality technical infrastructure should be offered to all in Switzerland.
- Non-discriminatory Access: Equal and unimpeded access to information and communication technologies should be granted to all.
- Federalism: Clear legal regulations and voluntary cooperation should eliminate inefficiencies typical for a federal country.
- Cooperation: The government seeks to promote and facilitate an effective partnership among government, business, civil society, and science.

Surprisingly, Switzerland has not yet formulated a more explicit and detailed strategy on broadband infrastructure at the federal level. However, OFCOM and ComCom are reportedly working on a white paper describing their broadband policies. The document is expected to be released in spring 2010.

On the local level, cities such as Zurich and St. Gallen have built strategic partnerships with local power utilities and broadband service providers to deploy fiber-to-the-home networks. These initiatives are long-term engagements (in the case of Zurich, for ten years) to develop and guarantee a non-discriminatory and open core infrastructure.[455]

Policy interventions and outcomes

Government investment in infrastructure

The Swiss federal government does not directly invest in broadband infrastructure. The primary task of the government is to build a sound regulatory framework that creates incentives and favorable conditions for market development.

In contrast to many other countries, the Swiss government has not made a commitment to use parts of the country's stimulus packages to invest in the national broadband infrastructure.[456] A motion by a Swiss parliamentarian asked the Federal Council to support the regional development of the fiber roll-out. The Federal Council responded that it was too early to consider such measures.

At the local level, by contrast, there have been several initiatives aimed at strengthening the country's broadband infrastructure. For instance, in a 2008 vote, the people of Zurich approved a public loan of

453 http://www.bakom.admin.ch/dokumentation/medieninformationen/00471/index.html?lang=en&msg-id=23627 (last visited 17 September 2009).
454 Federal Council (2006). *Strategy of the Federal Council for an Information Society in Switzerland*. p. 2-3.
455 http://www.stadt-zuerich.ch/content/dam/stzh/portal/Deutsch/Abstimmungen%20%26%20Wahlen/070311/Abstimmungszeitung_1_07.pdf (last visited 10 September 2009).
456 http://www.stadt-zuerich.ch/content/dam/stzh/portal/Deutsch/Abstimmungen%20%26%20Wahlen/070311/Abstimmungszeitung_1_07.pdf (last visited 10 September 2009).

over CHF 200 million to support the local power company in providing fiber-to-the-home to all households. At the same time, several private-public partnerships were formed in about nine cities and villages in Switzerland, aimed at building open wireless networks (WLAN). The local utility provider owned by the City of St. Gallen, for example, invested about USD 150,000 in a local open wireless initiative.[457]

Skill building, education, and demand programs

The federal government has introduced a variety of different programs and strategies to support development towards an open information society. However, due to the strong federal system, cantons play a key role when it comes to educational or cultural initiatives and measures. Nevertheless, the following examples are illustrative of the variety of national initiatives:

e-Health:

The goal of this initiative is to formulate measures to gradually establish an electronic patient file and a portal with quality-assured online information and access to patient files by 2015. The strategy was implemented in 2007 with the intention of contributing to the development of a health system that is more reliable, more cost-efficient, and of higher quality. One objective is to help patients to better inform themselves of health care choices based on quality-assured information. In addition, the parliament took first steps toward introducing a national insurance card. This card will not only store information about the patient's insurance, but will also include specific health data that could be used by health care providers. [458]

e-Government strategy:

Designed as a joint strategy of the confederation, the cantons, and the municipalities, this initiative seeks to pursue three main objectives: "the economy carries out transactions with the authorities electronically; the authorities have optimized their processes and deal with each other electronically and the population can carry out important, frequent or time-consuming, transactions with the authorities electronically."[459]

e-Inclusion:

The aim of this project is to build a network for people who would normally be excluded from the information society, i.e., to bridge participation gaps. Since 2006, the Coordination Office Information Society has promoted different projects that provide support to “digital have-nots” and help them to acquire the skills needed to participate in the information society. The Swiss Integration Network's members have committed themselves to launch their own projects and support the implementation of the initiative.[460]

Competition policy

Broadband competition in Switzerland has been most active at the intermodal level, principally between cable operators, led by Cablecom, and the incumbent, Swisscom, offering DSL service over copper lines. Proponents of intermodal competition can point to the fact that a large majority of Swiss

457 http://sg.openwireless.ch/finanzierung (last visited 10 September 2009).
458 http://www.bakom.admin.ch/themen/infosociety/01689/index.html?lang=en (last visited 8 September 2009).
459 http://www.bakom.admin.ch/themen/infosociety/01688/index.html?lang=en (last visited 8 September 2009).
460 http://www.bakom.admin.ch/themen/infosociety/02104/index.html?lang=en (last visited 8 September 2009).

households have access to both cable and DSL connections. Moreover, competition from cable service providers is likely to have played an important role in Swisscom's decision to invest in upgrading its Internet offerings, seen by some as a direct response to the entry of cable operators into broadband markets. More recently, Cablecom has started the process of upgrading its system to offer increased transmission rates with Swisscom responding with investments in fiber.

Despite these signs of viable competition among different proprietary platforms, Swiss regulators, in step with their European counterparts, have also pursued open access policies. The Swiss government decided to open the "last mile." Reasons can be found in the telecommunications market: Swisscom, the former monopolist, was still dominating the market and new entrants were struggling to find a way into the market. Swisscom's dominance was particularly overwhelming in the wireline telecommunication market. Although the situation looked better on the broadband market, where competition came from a relatively strong cable provider, the main problem was the dependence of the service providers on Swisscom's wholesale products. The Federal Council feared that this fact could have negative effects on future innovation in the broadband market.[461]

Following a public consultation process in 2002, the Swiss Federal Council issued a decree in 2003 requiring local loop unbundling of Swisscom's network. After several years of resistance from Swisscom and regulatory uncertainty, an amendment to the Law of Telecommunications was completed in 2007 that would begin the implementation of opening up the incumbent's copper network to its competitors. This includes unbundled access to the local loop, bitstream access for four years, access to leased lines, and access to cable ducts. These policies apply only to the copper wire network.[462] As of January 2009, Swisscom had signed eight contracts with other operators and 31,000 access lines were effectively unbundled.[463] The Federal Administrative Court confirmed in February 2009 that Swisscom is a dominant player and must therefore offer cost-oriented bitstream access.

In 2008, ComCom set the price for unbundling the local loop for the first time. Price will be reduced to CHF 18.18 (about USD 17) from the price charged by Swisscom of CHF 23.50 (about USD 22). In addition to the price setting for fully unbundled access to the local loop, the conditions for co-use of resources at the main distribution frame (co-location) and the interconnection were regulated as well.[464]

Network non-discrimination

Net neutrality has not become a major issue in Switzerland. No complaints regarding discriminatory practices have been lodged with ComCom, and the agency has therefore not taken any action in this respect. None of the relevant agencies of the Swiss government, such as the Federal Council, ComCom, and OFCOM, have made any official statement regarding their position on network neutrality.

On a local level, the fiber deployment in the city of Zurich aims to avoid monopolization of the new network by granting all service providers discrimination-free access. Consumers are empowered to decide which provider they want to use.

461 Federal Council (2003). *Botschaft zur Änderung des Fernmeldegesetzes (FMG).* p. 7656-7957.
462 OECD (2009). Communications Outlook 2009. p. 55.
463 OFCOM (2009). The Swiss telecommunications market- an international comparison: Extract from the 14th European Union Implementation report extended to include Switzerland. p. 102.
464 OFCOM (2007). Annual Report 2008. p. 6/16.

Spectrum policy

Spectrum policy in Switzerland has been structured on the auction of licenses to competitive bidders. However, the anticipated level of competition for licenses has been disappointing. ComCom, the agency that is responsible for allocating licenses, decided in 1999 to reward the four UMTS licenses with an auction procedure, with a minimum price at CHF 50 million. Initially, ten telecom companies showed interest. Due to the difficult market situation in 2000, six companies decided to withdraw their initial offers. As a consequence, the four licenses were awarded to the four remaining companies for the minimum price.[465] A similar situation arose in the award process for the broadband wireless access (BWA) licenses. ComCom sought to auction three licenses in 2006. However, Swisscom was the only company interested in this license after several competitors decided not to participate. In 2007, another BWA license was awarded for CHF 5.8 million, again to a sole bidder, Inquam Broadband.[466]

ComCom is currently preparing for a coordinated reallocation of the most important mobile phone frequencies which become available again in 2013 and 2016.

465 ComCom (2001). Bericht der Eidgenössischen Kommunikationskommission (ComCom) zuhanden des Bundespräsidenten betreffend die Vergabe der IMT-2000/UMTS-Konzessionen in der Schweiz. p. 2-9.

466 GlobalComms (2009). Country overview Swiss section: Broadband Market Commentary.