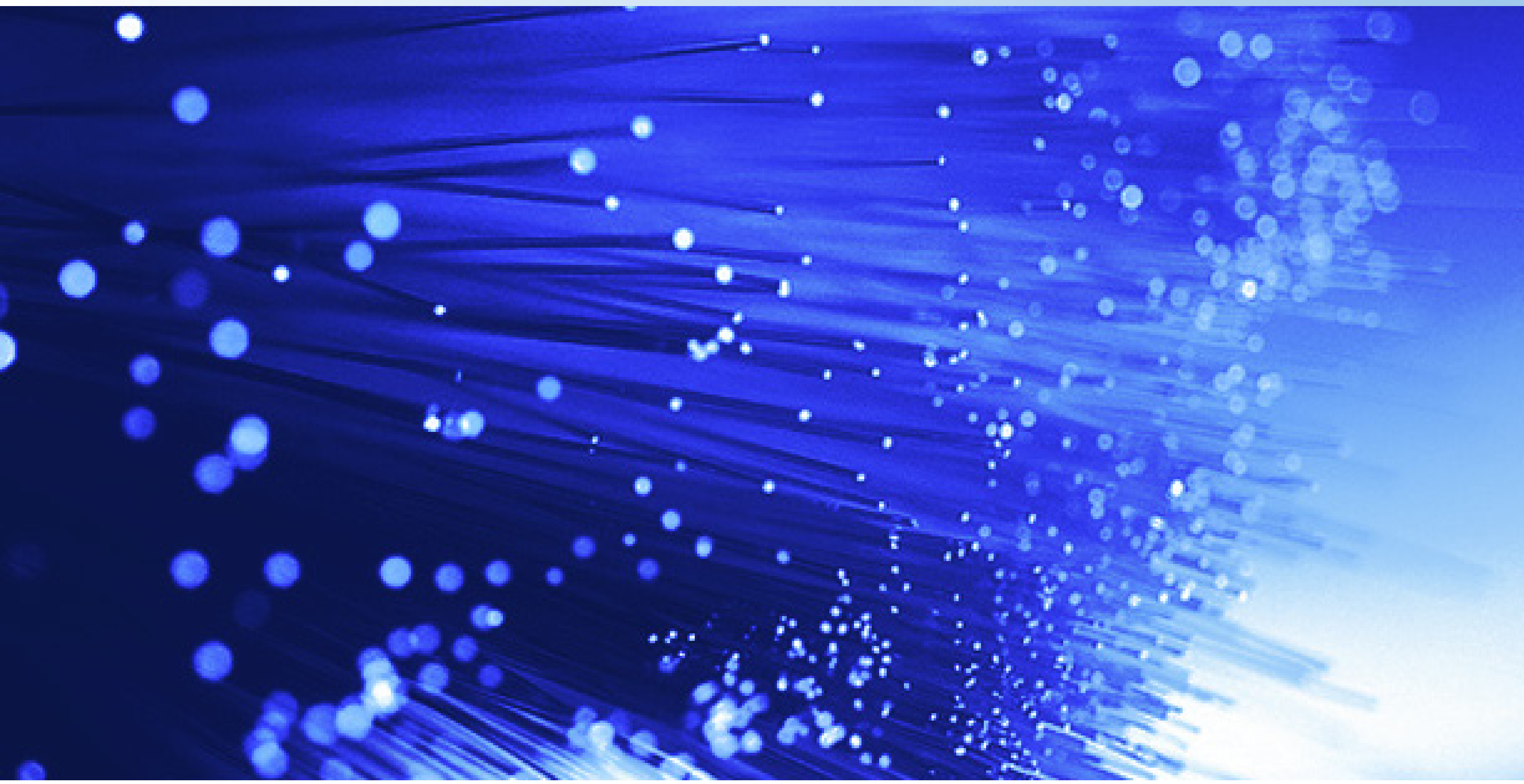
NEXT GENERATION CONNECTIVITY:

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



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FINAL REPORT

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Contributors

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Preface

Following Chairman Genachowski's commitment to evidence-based policy, the Federal Communications Commission requested the Berkman Center for Internet and Society at Harvard University to review international experiences with broadband and plans for next generation connectivity. The study was commissioned on July 14th, 2009. The Berkman Center did not receive funding from the FCC, but sought and received funding for this project from the Ford Foundation and the John D. and Catherine T. MacArthur Foundation.

We submitted a draft report on October 13, 2009. The draft included a review of current international benchmarking exercises, as well as new benchmarking measurements done by the Berkman Center using market analysis and actual measurement sources; an extensive qualitative review of county-by-country case studies; a review of current next generation plans, transposing those experiences, currently under review or in implementation in the observed countries; and reviews of wireless policies and government expenditures aimed to improve next generation connectivity.

Our most prominent initial findings, confirmed and extended in this final draft, were that U.S. broadband performance in the past decade has declined relative to other countries and is no better than middling. Our study expanded the well known observation with regard to penetration per 100 inhabitants, and examined and found the same to be true of penetration per household; subscriptions for mobile broadband; availability of nomadic access; as well as advertised speeds and actually measured speeds; and pricing at most tiers of service. Our study further identified the great extent to which open access policies played a role in establishing competitive broadband markets during the first-generation broadband transition in Europe and Japan, and the large degree to which contemporary transpositions of that experience were being integrated into current plans to preserve and assure competitive markets during the next generation transition.

The draft was posted by the FCC on October 14, 2009 for a comment period ending November 16, 2009. The draft drew extensive commentary, both positive and negative. Many comments were constructive and made very useful suggestions and critiques. These suggestions have been helpful in guiding additional research since the release of the draft report and in strengthening the current, final version of the report.

The primary changes between the original draft report and the final are: the inclusion of a new, extensive, formal literature review of the quantitative and qualitative literature on open access, in particular unbundling, and broadband performance and investment; expansion of the price and actual speed measurement benchmarking, as well as a slight refinement of assessing 3G growth; a new, compact review of the critiques of penetration per 100 measurements and responses to them that replaces the original focus on the density critique alone; new extensive case studies of the voluntary models of open access in the Netherlands and Switzerland; and a variety of discrete responses to useful comments we received on specific country studies.

The literature review in Part 4 finds the existing quantitative work to be sparse, often weak, and heavily influenced by industry funded work. We also identified a series of basic, pervasive limitations of cross-country econometric studies of broadband policy and performance. The qualitative work, on the other hand, exhibited less industry sponsorship, was less equivocal, and tended to support our own findings, as we reported them in our draft. This extensive new review replaces the narrower econometrics study we included in the original draft, which tried to highlight some of the same problems we explain in more depth and detail in this final draft by taking two papers on their own terms and data, and highlighting the specific problems as they were expressed there; we do, however, include a response to the primary critiques of that study in an annex to Part 4.

The new components of the benchmarking study expand the pricing study we conducted and add speed measurements by Akamai to the original Speedtest data we used. Both for prices and for speed, the new, expanded datasets are consistent with our original findings reported in the draft. In particular, our findings on speed find an identical ranking based on a completely different measurement technique and location; and our study of prices suggests an even grimmer picture than did our original findings. We also analyze mobile 3G penetration in terms of new subscribers per 100 inhabitants, rather than purely in terms of percent increase. Here, we find that U.S. growth is less robust by comparison to growth elsewhere compared to looking purely at percent growth from the lower existing base.

In the responses to our draft and in conversations since then, we found that our initial findings were misinterpreted as a recommendation for recreation of the unbundling regime of the late 1990s lock, stock, and barrel. Here, we therefore underscore the ways in which transposition of open access policies to next generation networks is not in fact simple copying, but involves a range of policies, some that rely more on coercive regulation, some that rely on combined municipal funding and supporting regulation, and some that rely primarily on voluntary or quasi-voluntary models. In particular, we added new case studies of the two voluntary or quasi-voluntary models of next generation open-access models: the cases of the KPN-Reggefiber joint venture in the Netherlands, and the case of Swisscom's Fibre Suisse project. Our charge was not to offer policy recommendations. The results of our study certainly could be read to offer strong, clear policy implications, and were misinterpreted in several comments to the draft study as offering specific, narrow, backwards-looking policy recommendations. This was not our intention, and we hope the new sections help to clarify this.

The basic large economies of scale of communications networks have not been repealed by the transition to digital communications networks. The failure of twentieth-century natural monopoly regulation pushed advanced economies everywhere to experiment with different models of achieving competition. The two primary methods have been an effort to leverage cable and telephone convergence: fostering competition between these two platforms in the broadband market; and using new regulatory techniques to enable competition over shared or partially shared infrastructure. These have been complemented in a few places by public investment in the public-utility-like facilities.

The transition to next generation connectivity is heightening the effect of the large economies of scale. In particular, the fiber-to-the-home networks that are likely to dominate future home connectivity involve very high costs of low-tech, labor-intensive elements like digging trenches, placing ducts, and pulling fibers through the walls of subscribers' homes. In the short term, the costs of fiber-to-the-home deployment are several times higher than the cost of cable upgrades to next generation speeds, which require mostly electronic upgrades. In the long term, fiber-to-the-home networks have vastly higher capacity and upgradeability. These facts to some extent undermine the business and technological convergence effects that played so central a role in the first-generation transition by weakening the efficacy of media convergence for sustaining a competitive market in digital media and communications carriage networks.

During the first broadband transition, a major assumption underlying the reliance on facilities-based competition was that cable and telephone infrastructures already in place needed relatively low and largely symmetric cost upgrades to provide Internet services. This meant that, at a minimum, there would be two facilities whose incremental upgrade costs were sufficiently low to be able to compete head-to-head in retail broadband markets. In addition, there were some hopes that the same would be true of power lines and wireless systems. Together these meant that technological convergence could underwrite competitive markets among players, each of whom invested in—and owned—their own complete facilities.

The necessity of massive physical investments to upgrade copper networks to fiber to the home, and the lower costs for cable to upgrade to next generation capacities, is undermining, to some extent, the comparability of fixed wire modes of access, and therefore the relaxation of natural monopoly characteristics. Furthermore, the vastly greater medium-term capacity of fiber and next generation cable relative to wireless, and the need to build new networks for fiber even where utilities are involved, suggest that alternative telecommunications pathways that are neither cable nor fiber are unlikely to emerge as low cost sources of facilities-based competition in most countries and markets. Together these facts are posing new challenges to policymakers concerned with next generation transition and the market structures that will prevail for next generation connectivity, and the extent to which facilities-based competition among fully-redundant next generation networks can be the core to a country's broadband competition policy.

Many countries with roughly similar, market-based, democratic societies are facing these great challenges of transitioning to next generation connectivity. There is much to learn from the approaches and experiences of other countries facing this common challenge. We hope our work will help the Commission in its planning.

Cambridge, Massachusetts
February 8, 2010

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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 focus on the quantity, quality, and price of Internet connectivity in the United States, by looking at: (a) how many people have fixed, mobile, and nomadic broadband, (b) what is it that they "have" technically, and (c) at what prices. For each measure we use more than one metric and more than one independent source or approach to measurement. For speeds we use actual measurements from two different companies, measuring in different locations in the network. For prices, we use three independent datasets, with close to 1000 observations. The results from these independent sources, using independent measurement approaches, bolster the level of confidence in our findings.

1.2.1 The United States is a middle-of-the-pack performer on most first generation broadband measures, but a weak performer on prices for high and next-generation speeds

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 picture is mixed, showing good performance on prices for the very low speed offerings, and very high prices, relatively, as speeds increase. The U.S. does reasonably well for the lowest prices available for the slowest speeds, below 1.5Mbps. Prices rise significantly as the offerings become those that are more "current generation": both in the 2-10Mbps category and the 10-32 Mbps high-speed category—where the US is 19th of 30 or 18th of the 28 that have high speed access, respectively. In prices for next generation speeds, the U.S. has the highest average prices from top-four providers in the OECD for speeds above 35Mbps, and is ranked 19th of 19 in that category. 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, Berkman studies on dimensions of penetration, speed (advertised and actual), and price (by tier of service defined by speed).

Penetration Metrics	Rank amongst OECD 30 countries	Speed metrics	Rank amongst OECD 30 countries	Price metrics	Rank amongst OECD 30 countries
Penetration per 100, OECD	15	Maximum advertised speed, OECD	9	Price for low speeds, combined	9
Household penetration, OECD	15	Average advertised speed, OECD	19	Price for med speeds, combined	19
3G penetration, Telegeography	19	Average speed, Akamai	11	Price for high speeds, combined	18
Wi-Fi hotspots per 100000, Jiwire	9	Median download, Speedtest. net	11	Price for next generation speeds, combined	19
		Median upload, Speedtest.net	5		
		Median latency, Speedtest.net	17		
		90% Download, Speedtest.net	11		
		90% Upload, Speedtest.net	7		

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

Note: Details in Part 3
Source: OECD, Telegeography, Jiwire, Akamai, Speedtest.net, Point Topic, Berkman Center analysis

1.2.2 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 beginning in 2001 and 2002. Open access has been largely treated as a closed issue in U.S. policy debates ever since. In Part 4 we offer an extensive survey of the literature on open access in the past decade. We find that the econometrics literature is basically divided on whether open access works or not, is surprisingly sparse and weak overall, and is heavily influenced by industry-sponsored work. We explain the severe limitations of many of the econometric studies, whether sponsored by interested parties or not. The existing qualitative work, which is capable of offering more nuanced analysis, tends more clearly to support the beneficial effects of open access, and is less influenced by industry-sponsored work.

In this study, we follow the qualitative work of others by offering new, up-to-date case studies of half of the OECD countries. 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. 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.

Transposing the experience of open access in the first generation to the next generation is taking a wide range of alternative forms. The shared core understanding is that the transition to next generation infrastructures re-emphasizes the high upfront costs involved in, or natural monopoly, characteristics of, telecommunications networks, and requires some form of shared infrastructure if competition is to be maintained in the teeth of such economies of scale. At one end of the spectrum is Australia, which is approaching this problem with a plan for a nationally funded fiber network, which will be privatized after completion to a fully open access carrier. The Swedish model, which involves extensive government and municipal funding together with functional separation, marks a large role for government investment that still leaves substantial room for private investment. In the middle are solutions built on the functional separation model introduced in the United Kingdom, and adopted since by Sweden, New Zealand, Australia, and Italy, that requires the carriage portions of the network to be functionally separated from the service provision. The French model involves lighter regulation, defining only narrow portions of the network—in particular ducts and in-building wiring—as open access elements for fiber networks. Finally, there are new emerging models of voluntary or quasi-voluntary shared infrastructure investment, in the Netherlands and Switzerland, whereby the carriers are adopting open access next generation networks as a business proposition, to share and spread the costs and risks of next generation deployments. We describe these approaches in detail in Part 4.

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. We provide a more complete overview of these theories and others, as well as the evidence available to support them, in Part 4.

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 the very nature of competition in next generation connectivity markets, 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 primarily qualitative. We 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 a study of pricing at the company level of 78 companies that offer high speed access. Our pricing study (Figure 4.4) shows that prices and speeds at the highest tiers of service follow a clear pattern. The highest prices for the lowest speeds are mostly 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,[1] where the price of entry into the market is the ability to build your own infrastructure. 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.

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

1 These North American companies are joined by most of the Norwegian highest-speed offerings, including Norway's incumbent telephone and cable company, as well as one power company. The sole lower-priced Norwegian next-generation offering is from an access-based entrant.

three licenses. We find high performers who imposed strict build-out 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 public 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 private investment fostered by 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, 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 might focus on the relative symmetry of data carriage capacity, assuming that end-users have as much to give as to receive.

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

2.1 High speed networks

2.1.1 Goals set in speed measures

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

2 Ofcom, 3 March 2009.

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

2.1.2 Dual targets

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

2.1.3 A focus on fiber

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

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

4 Federal Ministry of Economics and Technology, February 2009.

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

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

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

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

2.1.4 Capacity to support future applications

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

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

8 ERG(09)17, June 2009.

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

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

2.2 Ubiquitous seamless connectivity

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

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

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

2.3 Next generation connectivity: Recap

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

The primary differences between the two definitions include:

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

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

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

- Fiber: on fiber deployment the primary difference is between a carrier-centric view of how to deliver high-capacity as soon as possible, and a user-centric view of how to achieve the most end-user controllable architecture. The high capacity definition emphasizes the maximum total capacity of fiber, and may thus be willing to accept topologies that lower the costs for carriers, at the cost of accepting more single-firm controlled topologies, like PON. The user-centric view would tend to emphasize the long term benefit of giving users as much symmetric upload capacity at the edges as there is download, and a point-to-point fiber topology that enables more cost-effective upgrading and innovation on a per-user basis. The difference between the two on how to deploy fiber, as opposed to whether to focus primarily on fiber as opposed to mobile, should not be overstated: we discuss the implications of fiber network topology on competition and innovation in Section 4.11.3 below.

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

2.4 Universal access and next generation plans

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

2.5 Why do we want next generation connectivity?

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

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

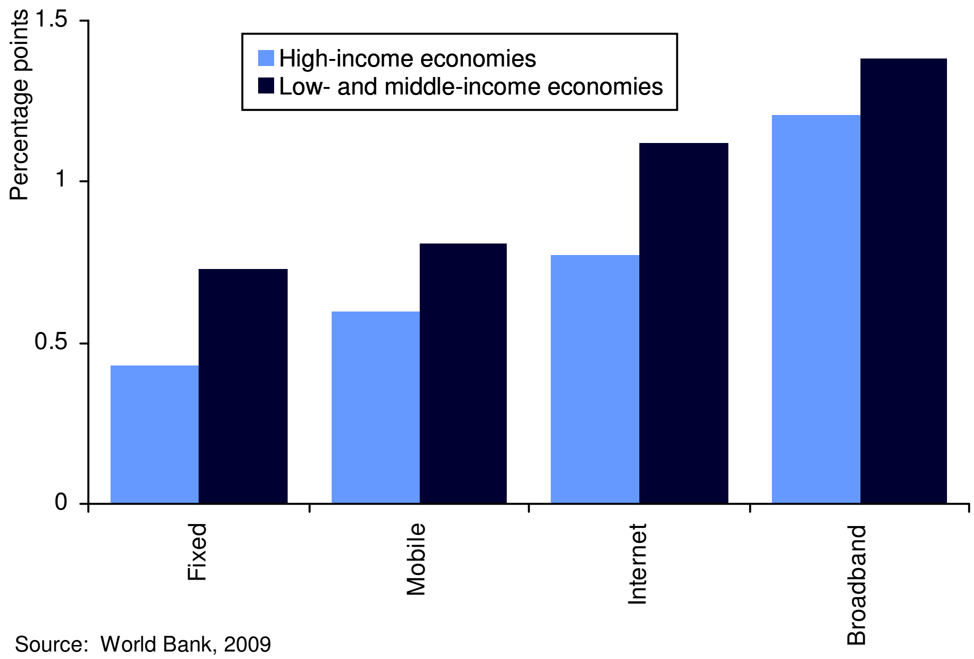
13 Bureau of Economic Analysis, July 31, 2009. http://www.bea.gov/newsreleases/national/gdp/gdpnewsrelease.htm

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

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

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

Figure 2.1. Growth effects of ICT

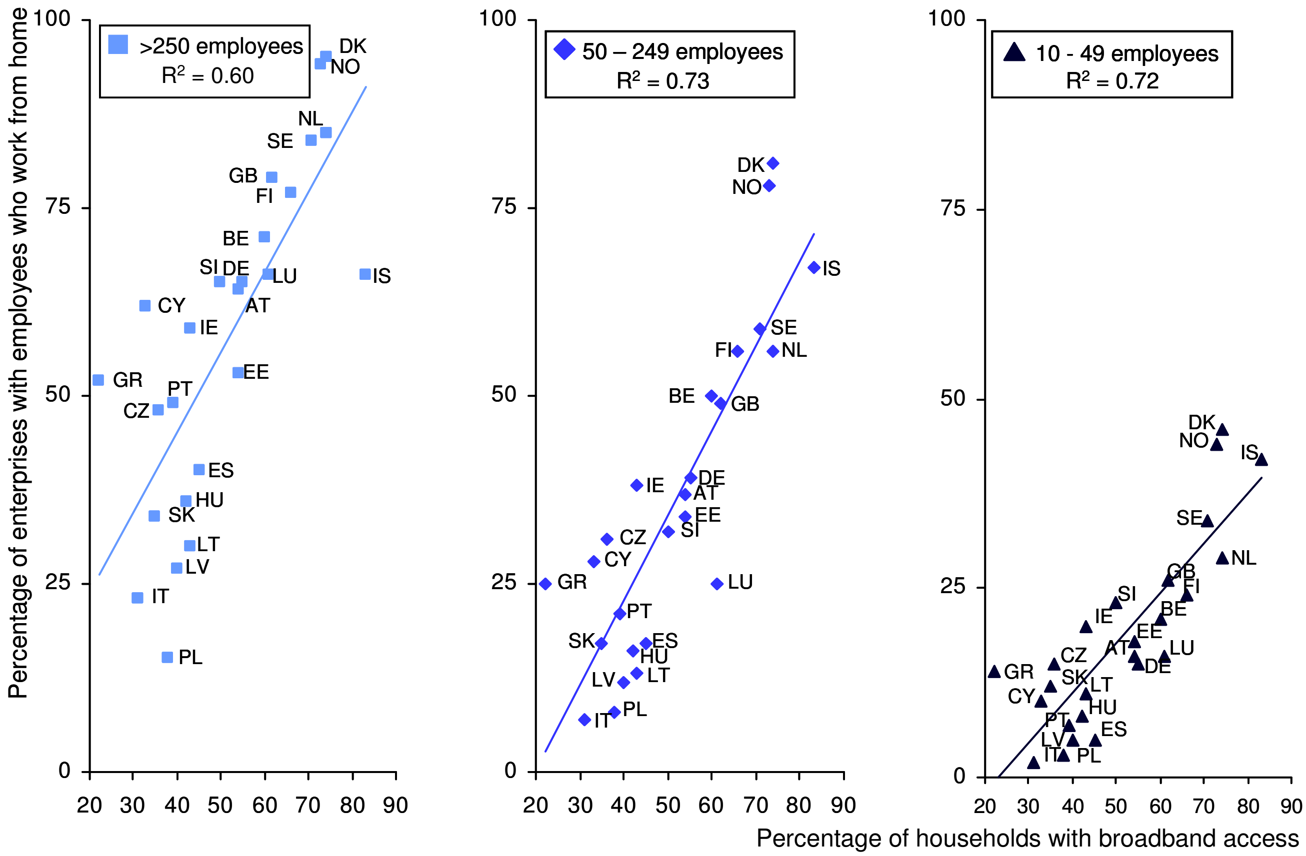


Source: World Bank, 2009
Note: The y-axis represents the percentage-point increase in economic growth per 10-percentage-point increase in telecommunications penetration. All results are statistically significant at the 1 percent level except for those for broadband in developing countries, which are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

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

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

Figure 2.2. Household broadband penetration and telecommuting

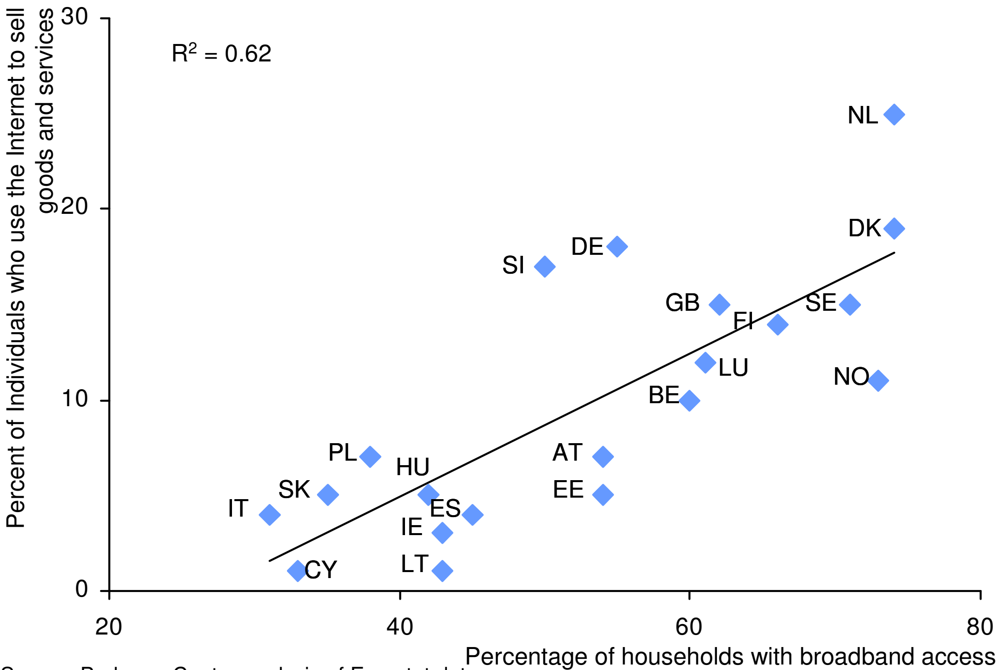


Source: Berkman Center analysis of Eurostat data

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

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

Figure 2.3. Household broadband penetration and individual entrepreneurship



Source: Berkman Center analysis of Eurostat data

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

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 defining a range of metrics that would allow us to identify countries that are appropriate examples from which we can learn: both 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 looking at the context 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 countries at comparable levels of economic development have faced similar problems and have adopted 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 allows us to discern whether there might be a lesson to be learned 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, these lessons are not easily distilled and transplanted to a different environment without modification and 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 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 have gathered and analyzed in order to fill in gaps and to evaluate 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 reanalysis of OECD data in combination with independently collected data gives us a strong degree of confidence in the results. 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.[15] 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 (U.S. ranks 3rd), produced in collaboration with the Insead Business School in France.

The principal difference between these two clusters of 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 as a percentage of the population and households, price ranges, speeds of access, etc. The ITU itself also collects and reports actual statistics on telecommunications and covers many more countries than the OECD. It therefore includes many comparators that are sufficiently different in wealth and technological state as to be noisier points of comparison, 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.

15 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), which creates a ranking based on a composite of penetration per households rather than per-inhabitant, speed, and price. The U.S. ranks 15th in this ranking. 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. The U.S. ranks third in this index. The report accompanying this index cites several factors as burdens on the U.S. ranking, including its relatively high burden of regulation and tax, the inefficacy of American law making, and 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, including Silicon Valley and the Research Triangle, its large pool of scientists and engineers, and the high quality of its universities.[16] 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; in business usage, the U.S. ranks 5th.

Similar to the WEF/INSEAD Readiness Index, the Waverman Connectivity Scorecard 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 are 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."[17] 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 and contribute to economic 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.

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

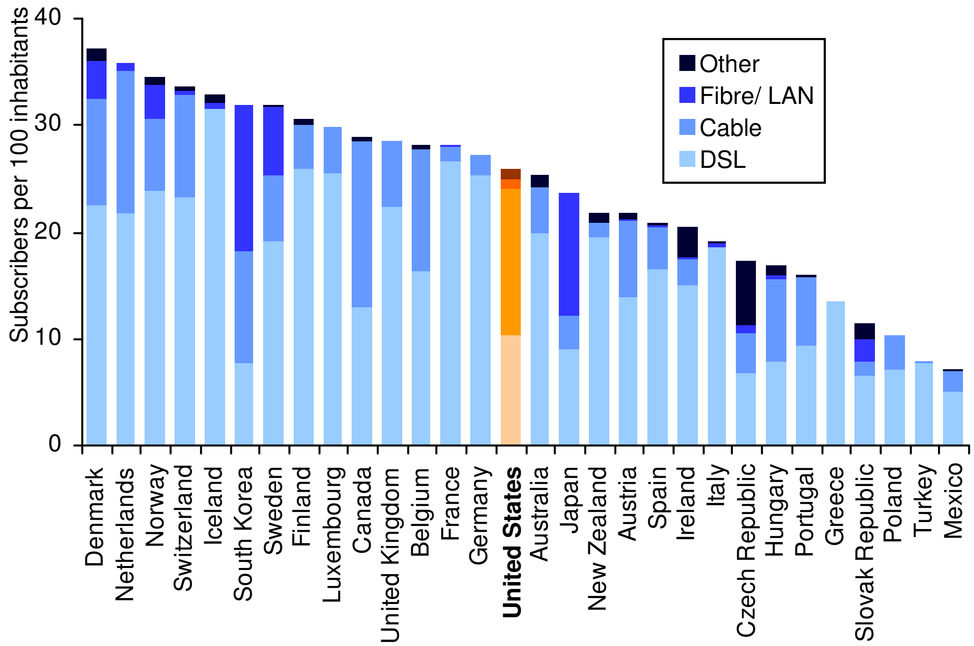
3.3 Penetration: Fixed

There are two commonly used methods to measure fixed broadband penetration rates: the number of subscriber lines per capita and the percentage of households with broadband connections. These metrics are based on significantly different perspectives on broadband connectivity and are based on very different data collection methods. They each have their strengths and weaknesses and both merit consideration. The subscriptions per capita measure, normally expressed as subscriptions per 100 inhabitants, includes both business and household subscriptions described as "broadband" by the carriers, and therefore provides a broader measure of connectivity than household measures. The data is collected from telecommunication carriers and reported by national telecommunications regulators. It is more frequently updated and has broader coverage than household measures, which are reported by national statistical agencies, rather than telecommunications regulators, and are based on household surveys which are more expensive and difficult to implement. The per capita broadband penetration measure has been collected for a longer period, and there are many fewer missing measurements for any given country over the past decade. On the other hand, the household subscription data is in several ways a cleaner measure of consumer connectivity, because fixed-line subscriptions are usually purchased per household. The subscriptions per capita measure is therefore more difficult to interpret and compare across countries as each subscription may cover several members of a given household and several employees of a business. Household data, however, omit business connections that are sold as "broadband connections" as opposed to various private line arrangements, and these are also an important part of broadband diffusion, particularly among small and medium sized businesses. Neither of these measures is, then, perfect. However, taken together, they offer a more robust and comprehensive view of Internet connectivity than either one does alone.

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 of 2009. These rankings have received the most attention and been subject to extensive criticism. Figure 3.1 represents the number of subscribers per 100 inhabitants in a country. 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. We will also look for countries with stark disparities 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 should be avoided.

Figure 3.1. Broadband penetration



Source: OECD 2008

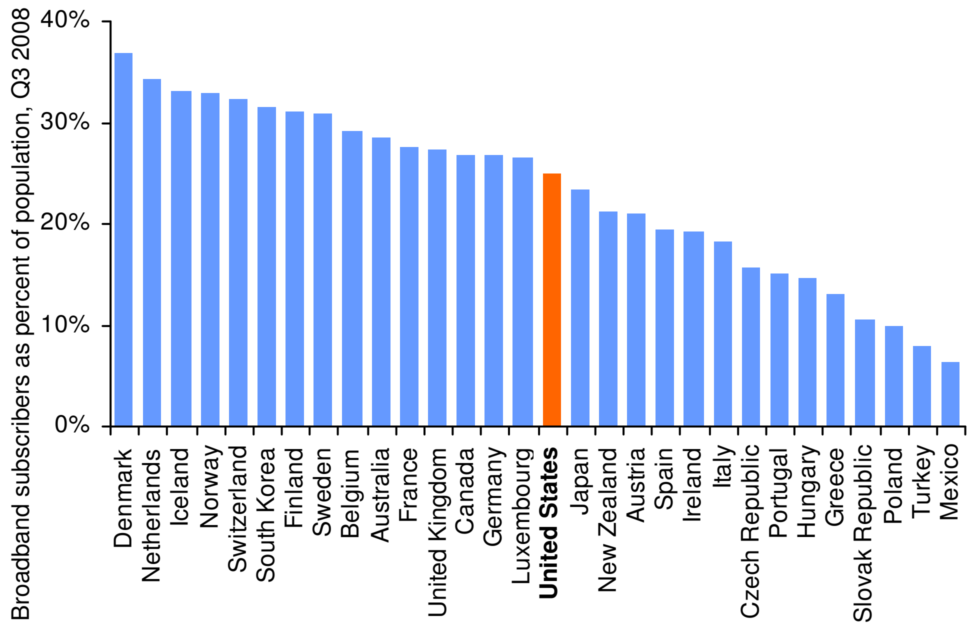
The ITU also tracks fixed broadband subscribers per 100 inhabitants as part of its ICT Development Index.[18] If we look only at OECD countries as reported in the ITU index for 2007, the United States switches places with Germany, edging ahead to 14th place.

The only substantial change from the OECD ranking 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.

A third measure of subscriptions per capita is available from an independent firm, TeleGeography. This market analysis data is based largely on reports by the companies directly to TeleGeography. In this dataset, the United States comes out 16th, instead of 15th (Figure 3.2). The rankings based on this independent market data are almost perfectly correlated the penetration rankings of the OECD, with an R^2 of 0.98 (Figure 3.3). The almost perfect correlation in reports to a market analysis firm and those reported to, and filtered through, national and international authorities suggests that the underlying subscription data is likely based on measures that are not greatly distorted, whether reported to government agencies or otherwise.

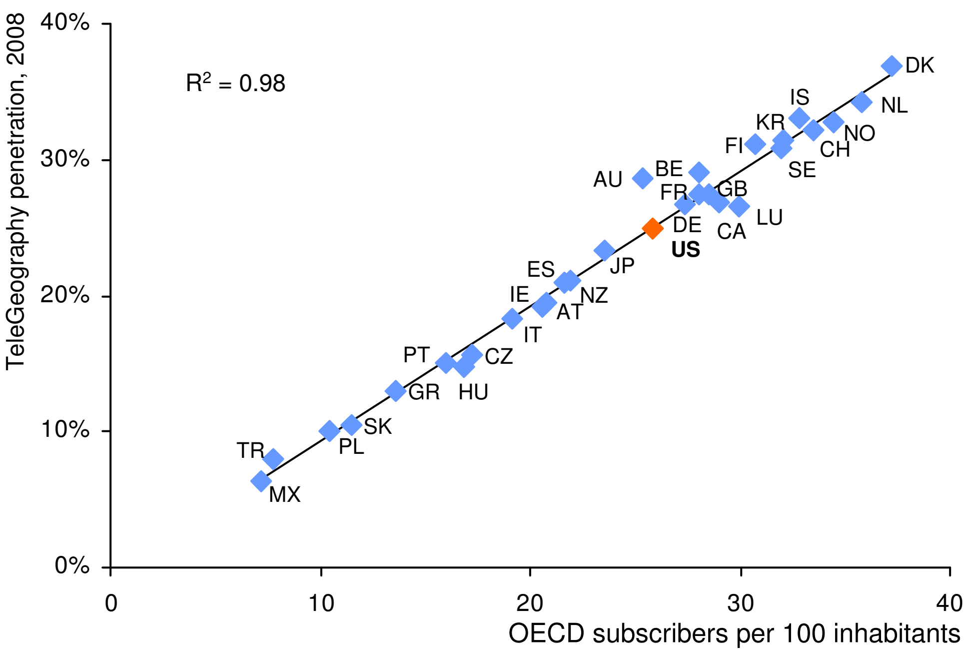
18 ITU, ICT-IDI, 2009, Indicator 7. Reported under Use Indicators, pp. 93-94.

Figure 3.2. Broadband penetration as reported in TeleGeography



Source: TeleGeography

Figure 3.3. Comparison of OECD and TeleGeography data

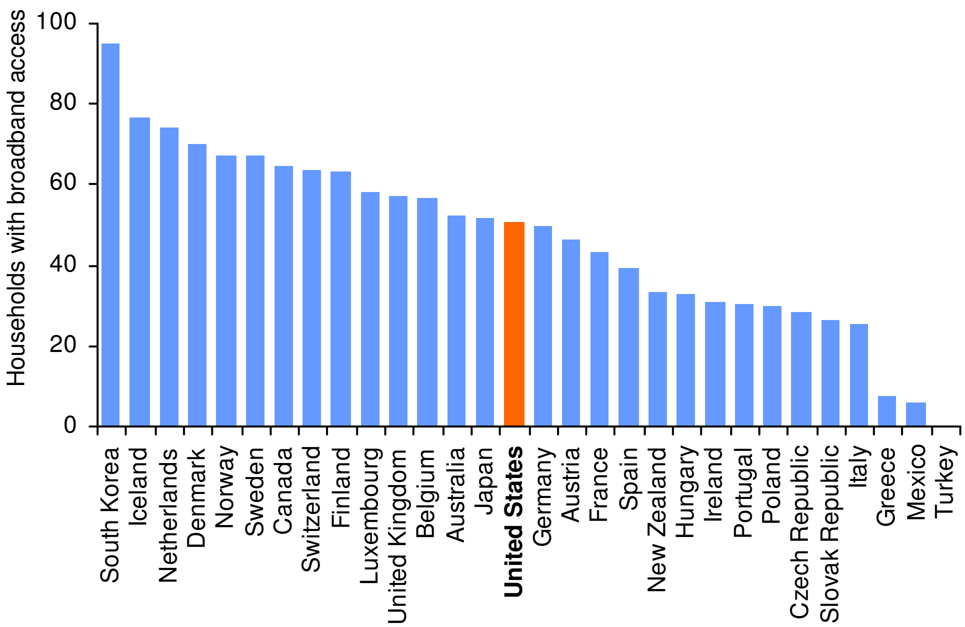


Source: Berkman Center analysis of OECD and TeleGeography broadband statistics

3.3.2 Measuring household penetration

When viewed by household penetration rates rather than per capita estimates, the international position of the U.S. is unchanged. The data here are older, because the most recent official estimate for the United States is the Current Population Survey conducted by the Census Bureau in the fall of 2007. Updated figures are unlikely to improve the U.S. standing. The most recent figures from the Pew Internet and American Life Project report that 60% of U.S. households have broadband access, citing surveys conducted in December 2009.[19] Statistics from Eurostat for 2009 report twelve countries with higher household penetration rates, not including Canada, Japan, South Korea and Switzerland.

Figure 3.4. Household broadband penetration rates



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

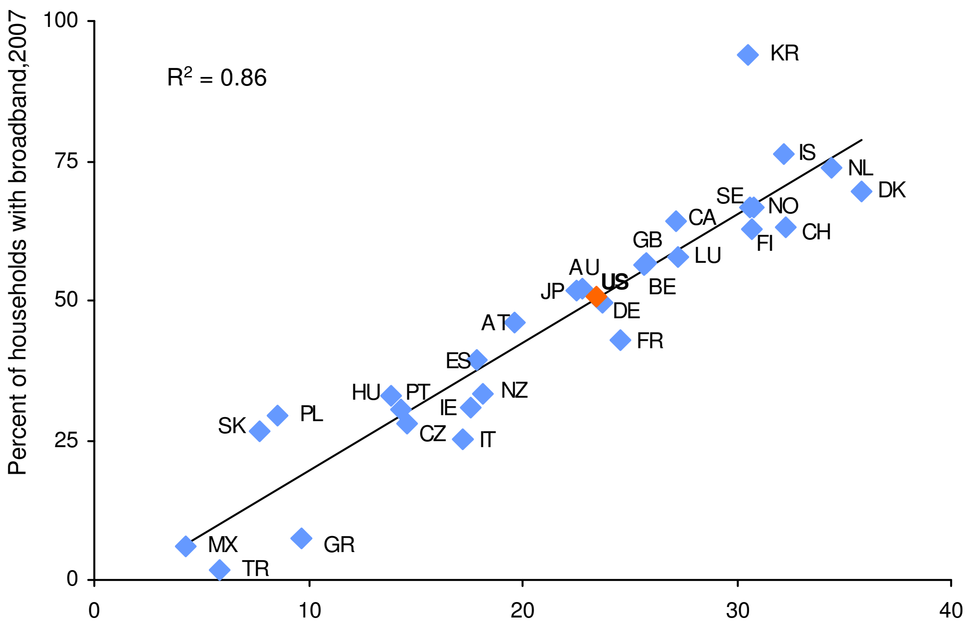
Using household subscription levels provides useful nuance, but does not fundamentally change the picture for most countries, including the U.S. As Figure 3.5 shows, the two measures are highly correlated and return the same basic result for most countries. This is not true for all countries. The country most heavily "penalized" by the use of a per capita rather than per household measure is South Korea.[20] Table 3.1 shows that the primary effects of looking at household penetration are to move South

19 Lee Rainie, Internet, Broadband and Cellphone Statistics, January 2010, Available at: http://www.pewinternet.org/Reports/2010/Internet-broadband-and-cell-phone-statistics.aspx

20 In our original draft, Japan too was considered a substantial under-performer in per capita terms when compared to household penetration. Since the publication of our original draft, the OECD updated its household data, adding 2007 data for some countries (including Switzerland) that had 2006 or earlier data available until recently. From the perspective of Japan, we explained in our original report that "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." The most recent OECD household data available attempts to correct for this overcounting by reporting only computer-based broadband use, therefore trying to control for the differences introduced

Korea back to the top of the list. There are slight movements in the rankings within the third quintile, with Japan and Australia moving ahead of the U.S., while France and Germany move to being lower than the U.S. Switzerland moves out of the top quintile to the second quintile, while Canada moves ahead within the second quintile. The U.S. position, however, remains unchanged.

Figure 3.5. Broadband penetration per 100 inhabitants and by households.



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

It is important to remember that the OECD collects and reports official data from the member states' official statistics agencies about household penetration rates, as well as data from telecommunications regulators about subscription rates. Arguments about the weakness of the data by pointing to different numbers from different survey organizations that show slightly different rankings is somewhat akin to saying that one does not agree with the BLS employment statistics for the last month, and prefers this or that market survey instead. It may make one's country look better on the rankings, but it simply is not a basis on which to form policy using long term comparable data.

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by the use of 3G for home service in Japan. Using that number, Japan is now 12th—slightly better than its per-capita penetration ranking, but not to the same extent as we reported in the original draft.

Table 3.1. Impact on country rank

Country	Per household rank	Per 100 rank	Change in rank
South Korea	1	8	⬇⬇⬇⬇⬇⬇⬇
Iceland	2	4	⬇⬇
Netherlands	3	2	⬆
Denmark	4	1	⬆⬆⬆
Norway	5	5	
Sweden	6	7	⬇
Canada	7	10	⬇⬇⬇
Switzerland	8	3	⬆⬆⬆⬆⬆
Finland	9	6	⬆⬆⬆
Luxembourg	10	9	⬆
United Kingdom	11	11	
Belgium	12	12	
Australia	13	16	⬇⬇⬇
Japan	14	17	⬇⬇⬇
United States	**15**	**15**	
Germany	16	14	⬆⬆
Austria	17	18	⬇
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	⬆

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 primary 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 most countries, except that it substantially understates penetration in South Korea, slightly understates penetration in Japan, Australia, Canada, Hungary, and Poland, substantially overstates penetration in Italy, France, and Switzerland, and slightly overstates penetration in Denmark, Finland, Germany, and the Czech Republic. It has no effect on U.S. standing.

Trends over time

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

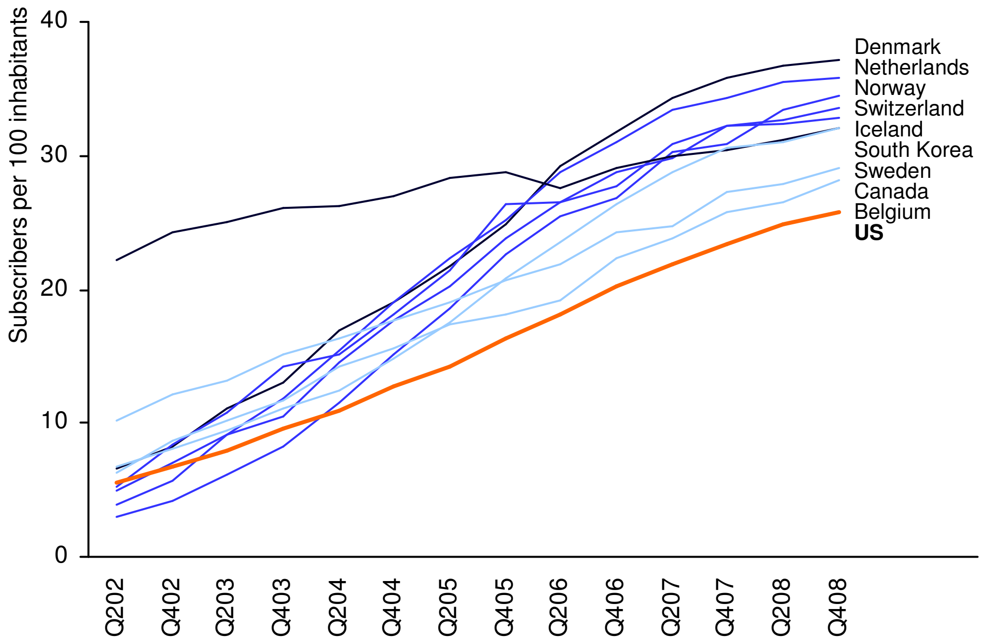
American relative decline in the pace and level of uptake of the first broadband transition. Figure 3.6 presents historical penetration rates from the second quarter of 2002 until the fourth quarter of 2008 for the top quintile performers in 2002, and the top quintile performers in 2008. Figure 3.7 presents a similar longer term comparison of the United States and the four largest European economies.

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.

Comparing penetration rates over time using household penetration rates is complicated by gaps in the available data. The available data, however, shows a pattern consistent with the trends seen in the per capita measure. As shown in Table 3.2, the US was between 7th and 10th place in 2003.[21] Four years later, in 2007, the US was 15th.

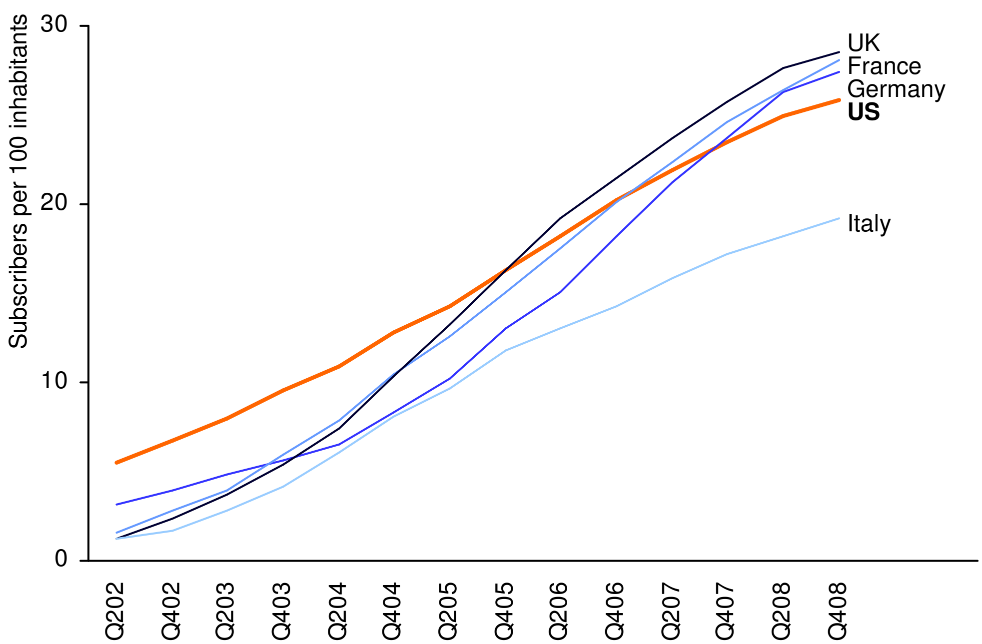
21 The actual U.S. position in 2003 depends on the penetration rate at the time for Belgium, Iceland, Sweden and Switzerland, countries that later showed up as clearly ahead of the U.S. in household penetration, but for which there was no 2003 data. It is clear that Australia, Finland, Luxembourg, and the UK have since surpassed the U.S. It is likely that subsequent data will show Germany among other countries passing the U.S. in household penetration rates.

Figure 3.6. 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

Figure 3.7. Large European economies penetration rates over the last 6 years.



Source: OECD 2008

Table 3.2. Trends in household broadband penetration rates over time.

	2000	2001	2002	2003	2004	2005	2006	2007	2008
South Korea	30.3	56.4	68.0	66.0	85.7	95.9	94.0	94.1	94.3
Iceland					45.4	63.5	72.1	76.1	83.2
Denmark				25.1	35.8	51.2	63.3	69.5	74.1
Netherlands				20.0		53.9	66.2	73.8	74.0
Norway				22.9	30.0	41.4	57.1	66.7	73.0
Sweden						40.2	51.0	66.6	70.7
Finland				12.4	21.3	36.1	52.9	62.9	66.1
Canada		21.6	29.3	35.5	44.1	50.1	57.9	64.2	
Switzerland							52.8	63.0	
United Kingdom				10.7	15.8	31.5	43.9	56.7	61.5
Luxembourg				7.4	16.3	33.4	44.1	57.8	61.0
Belgium						40.6	48.0	56.4	60.3
Japan				32.7	43.0	44.3	40.7	51.7	58.5
France							30.3	42.9	57.1
Germany				9.3	18.0	23.2	33.5	49.6	54.9
Austria				10.3	15.9	23.1	33.1	46.1	54.5
Australia					16.3	28.3	43.0	52.0	
United States	4.4	9.1		19.9				50.8	
Spain					15.0	20.8	29.3	39.2	44.6
Ireland				0.6	2.9	7.4	13.1	30.7	42.9
Hungary					5.8	10.9	22.0	33.0	42.3
Portugal				7.9	12.3	19.7	24.0	30.4	39.3
Poland					8.3	15.6	21.6	29.6	37.9
Czech Republic				1.5	4.5	5.1	16.6	28.1	36.4
Slovak Republic					3.6	7.1	11.4	26.5	35.3
New Zealand							33.2		
Italy						12.9	16.2	25.3	30.8
Greece				0.6	0.2	0.6	3.8	7.5	22.5
Mexico		0.3	0.4		1.9	2.2	4.2	6.1	9.8
Turkey					0.2	1.7			

Source: OECD, 2009

3.3.3 Critiques of penetration measures and international comparisons

The benchmarking exercises have been the subject of extensive criticism, particularly the OECD penetration per 100 rankings. The most common criticisms 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, and companies may misreport to their governments and governments misreport to multilateral organizations, in each case to make themselves look good; (3) Americans access broadband at work and in their educational institutions, and these are under-counted by the rankings; (4) the OECD rankings do not cover wireless connections, in particular 3G and publicly-available Wi-Fi connections; and (5) that differences in penetration rates are explained by differences in demand-side factors such as economic conditions, demography, and consumer preferences and by differences in geography, for example, high speed facilities are harder to deploy in sparsely populated countries, and the U.S. is less densely populated than the countries ahead of it in the rankings. We take up the critique regarding mobile broadband penetration in a separate section; mobile penetration is sufficiently important to be reported as an independent metric.

The most widely noted critique of the OECD per 100 rankings is that they penalize the United States, which has larger households than other countries. These critiques, whether well founded or not in theory, make little difference for assessing U.S. performance in the medium term given the fact that the U.S. occupies the same position if measured in terms of household penetration. The conceptual critique is sometimes combined with an effort to combine official estimates for some countries with unofficial estimates different from those reported by national agencies to the OECD, resulting in somewhat more generous evaluations of U.S. performance. It is important to remember that, while the two critiques are often combined, they are entirely distinct. If household adoption is a better standard of measurement, then the fact that the same source—OECD using official government data of the member states—reports the U.S. in virtually the same position in the international rankings using either measure should lay to rest the importance of the theoretical difference in using the two measures for US practical policymaking purposes, at least in the mid-term future before we reach full household saturation.[22]

Conceptually, we agree that observing household penetration is distinctly important, and indeed, likely more important than penetration per 100. Using and contrasting both per capita and household penetration measures offers a more complete picture, however. 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 use consumer-type offerings reported by carriers as broadband subscriptions. Unless one holds the position that small business use is irrelevant as a policy matter, one should be cautious about abandoning

22 A clever rendition of the argument preferring household to per-100 measure is that, because of its relatively high household sizes, the U.S. will rank 20th in the OECD if measured in per capita terms once every household and business in the OECD has a broadband connection (George S. Ford, Thomas M. Koutsky, and Lawrence J. Spiwak. July 2007. The Broadband Performance Index: A Policy-Relevant method of Comparing Broadband Adoption Among Countries. Phoenix Center Policy Paper Number 29). Even assuming that projection to be true, and that it will bias the results of the two measures to render the per-100 ultimately useless, the actual measurements, of actual penetration numbers, in the period before we reach such high levels of saturation, suggest that measurement of per 100 is in fact, as a practical matter, a good predictor of household penetration, and has additional desirable characteristics described in the text. The information lost by abandoning a regularly update, objective measure that also describes some relevant data (business use) that is not captured by the household measure is much greater than the clarity supposedly gained.

completely a measure that does reflect it for a measure that does not. Moreover, measures of household penetration are based on household surveys, not carrier-level subscription data reporting.[23] 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. Subscription data, on the other hand, is reported by carriers, on a quarterly basis, using simple objective criteria that result in consistent reporting (see Figure 3.3, for example). The reason to use both metrics is that, while we care about small business use as a measure of broadband policy and about regularly-updated data, 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 better.

Often combined with the conceptual argument are efforts to introduce alternative measurements of household penetration that show a more flattering position for the U.S. As we noted, these are entirely separate criticisms, and have nothing to do with whether households are the ideal measurement or not. The risk with these efforts is that different researchers can pick different resources, like picking friends in the crowd. The most widely noted version of this approach is Wallsten (2009).[24] This paper finds that the US is "somewhere between 8th and 10th place" in household penetration rates, looking at the end of 2007 as the benchmark year. It does so by comparing the data reported in a household survey by the EU that is not considered an official statistical publication,[25] some apparently formal sources for other countries, and survey data from the Pew Internet and American Life Project for the U.S. (Wallsten 2009 note 4). There exists, however, a report from the Census Bureau's Current Population Survey data,[26] as well as official European statistics from Eurostat for that period.[27] The author gives no reason to prefer the Pew data to that collected by the Census Bureau, which he had used in an earlier, May 2008 version of this paper. (Wallsten 2008, footnote 8). Pew reported for December 2007 54% household penetration. The Census Bureau reported 50.8%.[28] Relying on the E-Communications Household Survey, Wallsten (2009) describes the UK as having 47% household penetration and Belgium at 51% in 2007. This publication explicitly disclaims being an official source. The official Eurostat numbers in fact reported the UK as having had 57% penetration in 2007 and Belgium 56% for that year. The OECD household rankings for 2007 used the official source in each case, and its numbers comport with the original in each case. Together, these various effects combine to explain why in the OECD report from official sources for household penetration in 2007, the last year for which there are official numbers from the U.S., places the U.S. in 15th place, not "between 8th and 10th." Except where it is unavoidable, we are not convinced that combining disparate sources of survey data and techniques is a defensible practice if one wishes to develop a measure that is consistent and comparable across countries and time. Combining data sources has the potential to introduce substantial error as a result of methodological differences in survey data collection. The better practice is to rely on formal statistics, reported through

23 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).

24 Scott Wallsten. Understanding International Broadband Comparisons. 2009 Update. Technology Policy Institute, June 2009.

25 Special Eurobarometer: E-Communications Household Survey, June 2008 (reporting Fieldwork from November-December 2007.)

26 Networked Nation: Broadband in America. 2008. *citing* U.S. Census Bureau's Internet Use Supplement to the October 2007 Current Population Survey. The original Census data is Table 1119: Household Internet Usage, by Type of Internet Connection and State: 2007. available at: http://www.census.gov/compendia/statab/2010/tables/10s1119.xls.

27 Eurostat, Information Society Indicators, Households which have broadband access. Available at: http://epp.eurostat.ec.europa.eu/portal/page/portal/information_society/data/main_tables.

28 The location of the U.S. on Figure 1 in Wallsten 2009 appears consistent with his using the Pew value of 54%, for the US, ahead of Luxembourg, with 53%, which is ahead of Belgium 51%, and so forth.

standardized channels and national statistical agencies to the OECD, that provide greater comparability and consistency for policy makers over time, as is common for other baseline economic measures.

Another critique of the quality of per capita penetration data is that it comes through doubly distorting self-reporting. First, companies report to their national regulators, which national regulators then 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. However, the congruence of the three separate measures of per capita penetration—OECD, ITU, and TeleGeography—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. The correlation with household data is another signal that this critique is unlikely correct, because household penetration is based on household survey data, not on company reporting, and is reported by national statistics agencies, not by telecommunications regulators. Its high correlation with a measure of penetration that does depend on company reporting increases our confidence in the quality of at least the first prong of the double distortion: the company data as reported by the countries to the OECD.

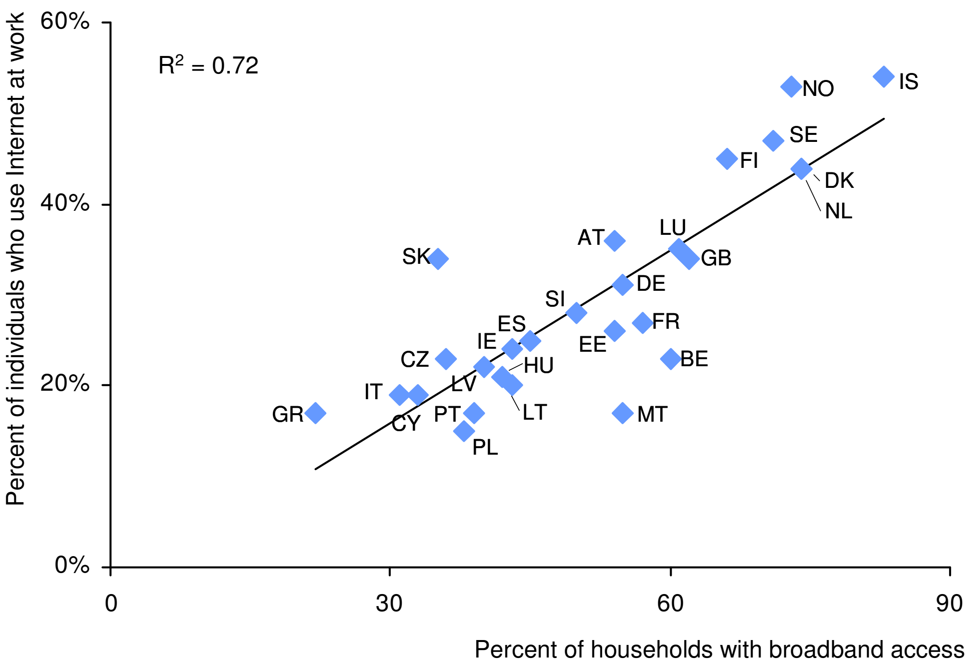
Another critique is that the OECD per capita measures undercount American broadband penetration because it does not count use at work in the numerator of the broadband per 100 metric. Given the relatively higher investment levels in information technology in the business sector in the United States, 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. business investments in ICT 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.[29] 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 98% for mid-sized businesses, and only then, for businesses with between 10-49 employees, do significant 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. Indeed, the paper that made the most extravagant claim, that the OECD data undercounts US connections by 70 million, makes that assumption in

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

claiming that the true number of Internet connections (the numerator in the per 100 metric) is 72 million connections larger than the FCC reports, counting every single work connection, while at the same time acknowledging, in a footnote, that only 14% of people who were not interested in having a home Internet connection cited work-based access as the reason.[30] Assuming even that every one of these was a true and complete statement of the reasons for non-subscription (a doubtful proposition given the limitations of self-awareness and the risk of framing in survey questions), the overwhelming majority of people who connect at work also connect at home, and there is no undercounting. Consistent with this proposition, European survey data suggests that within Europe at least, higher household broadband penetration is well correlated with higher individual use at work. See Figure 3.8. 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.

Figure 3.8. Internet use at work and broadband penetration.



Source: Berkman Center analysis of Eurostat data

The preponderance of available data indicates that the U.S. international position in fixed broadband connectivity has fallen over the past half decade. This is backed up by multiple sources of data and supported by both household penetration rates and per capita measures. The most important remaining question is why.

This question of "why" underlies one more common critique of the OECD penetration rankings and other similar measures. The argument is that much of the difference in broadband diffusion is a function of many factors unrelated to particular regulatory policies that promote or inhibit competition in broadband markets. This type of critique is directed not at the accuracy of the penetration rankings, but at their pertinence to policy. Before turning to addressing this claim, it is important to emphasize that the benchmarking exercise is not intended to provide causal explanations. While it is entirely reasonable to debate the causal sources of differences in outcomes among countries, a subject we turn to in Parts 4-6

30 Scott Wallsten, Understanding International Broadband Comparisons. Technology Policy Institute. May 2008. Page 8, footnote 4.

of this report, it is important to keep the data collection separate from the interpretation. Benchmarks that try to generate hypotheses and identify causal factors as part of the measurement process itself risk obscuring the straight, objective outcome measures.

Many factors influence the rate of adoption and ultimate reach of broadband connectivity in different countries.[31] These factors are likely to include geographic factors that affect costs, such as population density and terrain, variables that influence consumer demand, such as income, education, employment and individual preferences, and market factors, such as the composition and level of competition in the telecommunications sector. Broadband policy can in principal play an important role in shaping the influence of these factors. This might be manifest through programs and policies that promote demand, such as skills training. Public financing of infrastructure will have an impact on the incremental cost of construction for industry, and the level of competition can be affected by the presence or absence of policy and regulation aimed at facilitating competition, and its particular contours.

A conceptually sound argument based on the realization of the role of many factors in determining broadband penetration is that, when considering how to best promote greater broadband availability and adoption, we should be mindful of the distinction between the policy and non-policy determinants of broadband performance.[32] At the crux of this argument is that without properly accounting for the influence of non-policy factors in broadband performance, one might draw false conclusions about the efficacy of different broadband policies. A more shaky extension of this basic sound insight is that these factors explain so much of the overall performance of a country that policy plays no appreciable role. Several responses to the earlier draft of this study, for example, argued that the benchmarks provide no insight because the United States' performance on penetration is well-predicted by a variety of measures that are known to influence penetration, such as urban density, income, and education. Various versions of this argument can be found in several studies, although the details vary considerably from study to study.[33] The crux is that the U.S. "meets expectations:" that our penetration level is well predicted by our "natural endowment" and that policy need not seek to improve on this. There are several problems with this more ambitious claim on behalf of the non-policy factors.

First, these studies suffer from all the limitations that we observe in the cross country quantitative analyses of broadband performance, described in Part 4 below in detail, both in terms of data and methodology. These limitations make the results of these studies highly sensitive to model specification and to the choice of explanatory variables, and require that they be read with caution. Second, given that there are countries that consistently perform "above expectations" in these models, and these are mostly the countries that are usually found at the top of the distribution on the raw benchmarks, the question remains: what can policy makers do to enable the U.S. to join the class of over-performers, rather than being content with the "meets expectations" group. Third, as we noted, none of these studies pretend to show that they explain all of the variation in broadband penetration rates; studies that intend to capture the determinants of broadband adoption have explained as much as 75% to 85% of the variation in penetration level with non-policy variables).[34] For purposes of investing significant effort in getting the policy right, it is unnecessary to show that policy is primarily responsible for a country's

31 There is substantial overlap and coverage of this question in the literature we review in Part 4 of this report on open access and broadband penetration or investment, but we have not included here a full literature review of this aspect of the critique here.

32 Robert D. Atkinson, Daniel K. Correa and Julie A. Hedlund. Explaining International Broadband Leadership. May 2008. The Information Technology and Innovation Foundation.

33 See for example, Atkinson et al. cited in footnote 31 and Ford et al. cited in footnote 21. See also Robert W. Crandall and J. Gregory Sidak. Is Mandatory Unbundling the Key to Increasing Broadband Penetration in Mexico? A Survey of International Evidence. June 2007. Available at: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=996065

34 See examples cited in footnote 32.

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 may seem 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. Even if the effect of policy were half that amount, the effects would constitute an important policy goal with high payoff. Needless to say, we do not attempt to measure the total contribution of a given policy or practice we describe here. We simply note that even very small positive contributions from policy can have a significant medium to long-term impact. Policy matters.

A slightly different version of this argument posits that an under-studied and poorly-understood set of demand-side variables (variation which is not otherwise captured by income or income inequality) are responsible in part for U.S. broadband penetration rates.[35] The argument seems to be based on the premise that U.S. residents are generally less interested in the Internet than residents of higher performing countries in a way that is not impacted by policy. While personal preferences surely do play a role in adoption choices, and demand-side factors are in need of further study, this theory is difficult to assess. Given our own findings on the differences in speeds and prices, described below, and the obvious relationship between levels of competition and price, a less forced interpretation would be that demand is influenced by price and quality. People buy less of a low quality, high-priced good than they would buy of a higher quality good at lower prices. Better products at more affordable prices are precisely what competition is normally thought to provide. Middling speeds (quality) attached to middling or high prices would, without too much searching for mysterious, unobserved demand characteristics, lead one to predict the observed middling rates of adoption in the United States. And limited competition would lead one to predict lower quality, higher prices, and lower demand. Until that most natural hypothesis is eliminated, it seems forced to look for an answer in other, unobserved demand factors.

We therefore believe that future benchmarking exercises should always include speed and price measurements, as well as penetration, and we indeed use them here to complete our benchmarking exercise. First, however, we combine our extended penetration benchmarking exercise with a response to the last common critique of penetration measures: the claim that U.S. penetration numbers would look better if wireless penetration were included in the measure.

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

35 Wallsten (2009) cited in footnote 23.

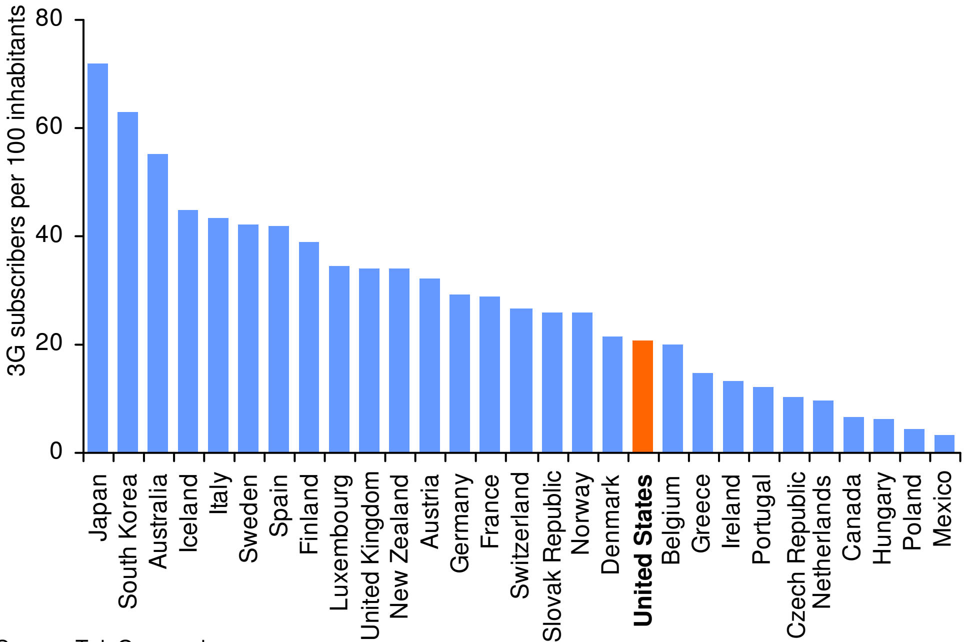
penetration was initially raised in the American context as a critique of the OECD penetration metrics. The argument was that the United States would rank higher if we accounted for wireless connectivity of both sorts instead of purely for fixed connection. Upon examination, that argument proves to be 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 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.[36] We found that the United States ranks 19th among OECD members in 3G subscriptions per 100 inhabitants (Figure 3.9). 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. When measured by percentage increase in subscriptions, U.S. growth of 3G subscriptions in was robust between the first quarter of 2008 and the first quarter of 2009, and indeed was the 10th highest in the OECD (Figure 3.10). However, this measure overstates the speed with which the laggards are catching up to the leaders, because it compares growth relative to very different bases. A better measure of the degree to which current low performers are catching up is a measure of number of new subscriptions per 100 inhabitants. Mexico offers an extreme example of the distortion of looking at growth as percent of penetration as opposed to growth as a function of new subscriptions per 100 inhabitants. Because its base is so low, Mexico shows the highest growth rate by the percent increase measure. Because it has in fact added very few new subscribers relative to the size of its population, Mexico is 27th of 30 OECD countries in rate of growth by the measure of new subscriptions per 100. (Figure 3.11.) By this better measure, the U.S. is 16th in the OECD for 3G growth.

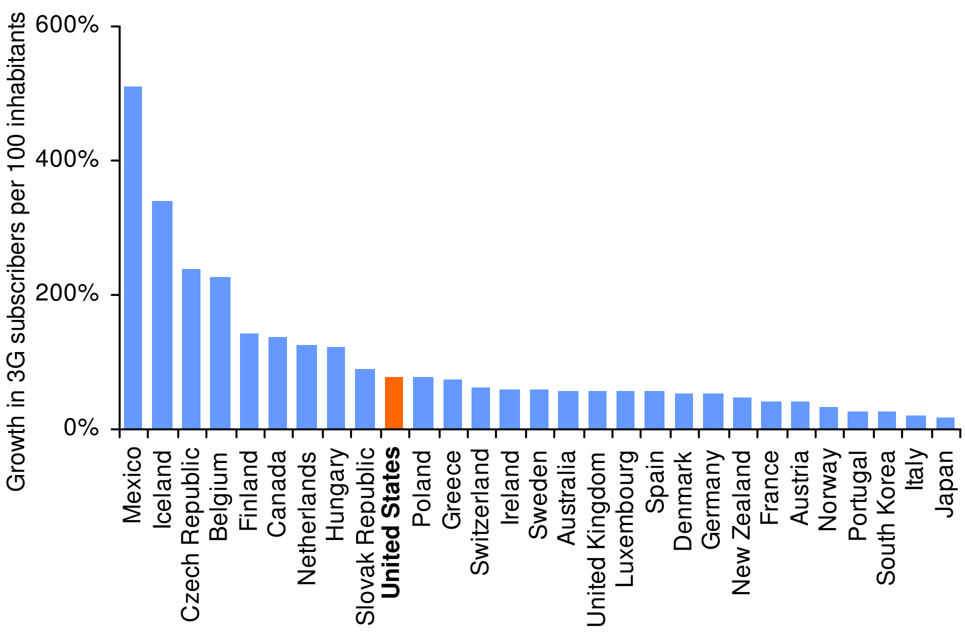
36 We use the TeleGeography, *GlobalComms database*.

Figure 3.9. 3G penetration.



Source: TeleGeography

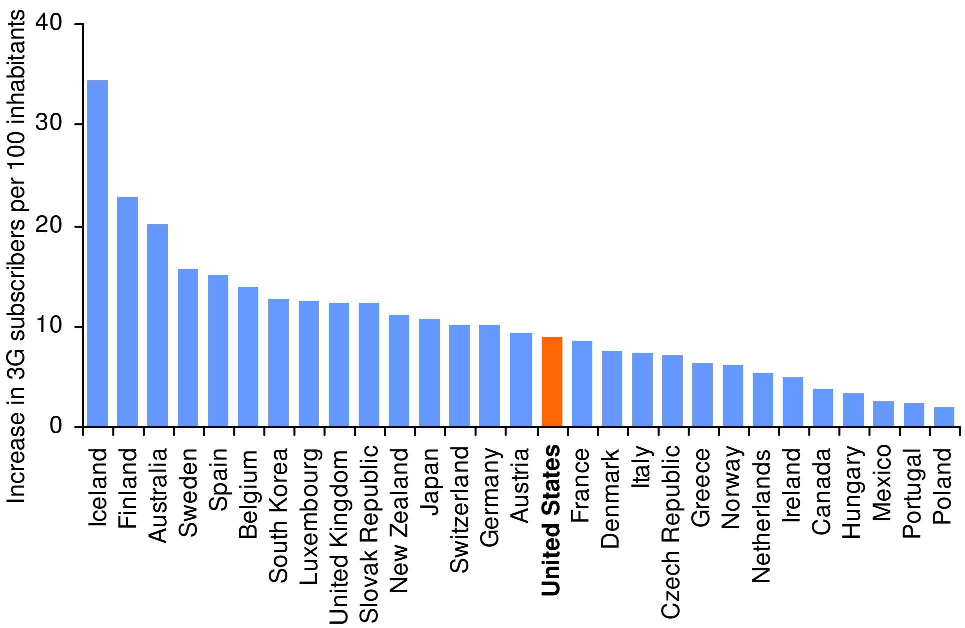
Figure 3.10. Annual growth in 3G penetration



Source: TeleGeography

Japan and South Korea are the highest performers, each with over 3 times as many 3G subscribers per 100 inhabitants as the United States, and both are still adding more subscribers per 100 inhabitants than is the U.S. 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 3.11. Annual increase in 3G penetration



Source: TeleGeography

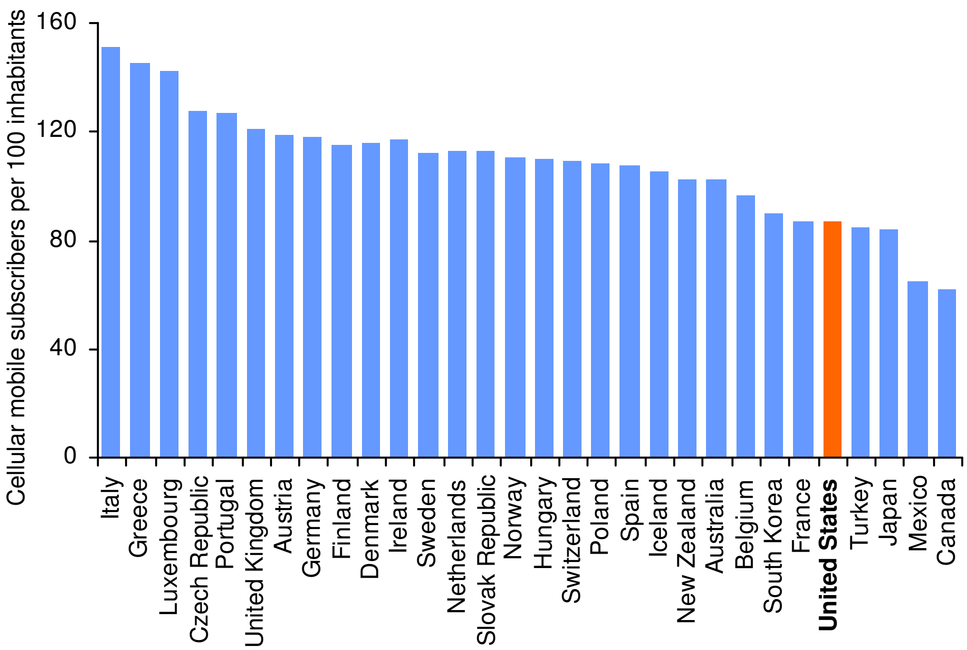
The OECD's reports subscriptions to mobile phones generally, and its effort to separate out 3G subscriptions seem to miss a lot. In mobile telephony subscriptions generally, the United States is 26th among the OECD 30 (Figure 3.12[37]). This position seems to skew strongly against countries with low 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[38]: 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.

The OECD in its 2009 Communications Outlooks, tried to separate out 3G from 2G subscriptions.[39] 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, Sprint, and 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 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,[40] 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 to

37 Figure 4.7 from the OECD Communications Outlook 2007, http://dx.doi.org/10.1787/620604300202).
38 OECD Communications Outlook 2009, Table 4.14.
39 Fig. 4.7 and Table 4.12.
40 Ofcom, The International Communications Market 2008 (20 November 2008).

the other countries surveyed there. 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.

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



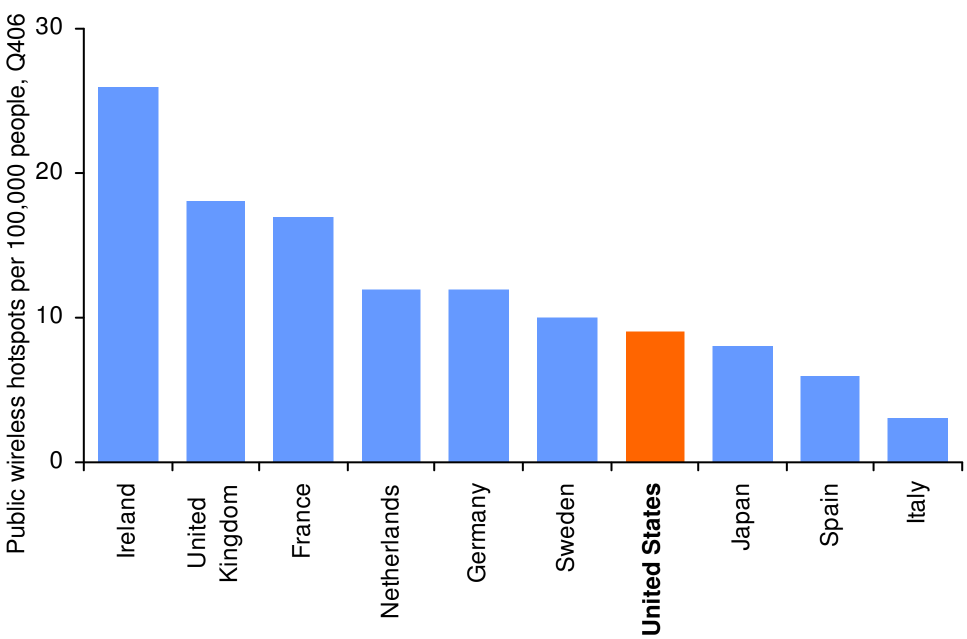
Source: OECD, 2007

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.

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),[41] and the second from Ofcom based on IDATE and its own data collection (Figure 3.14),[42] 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 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.

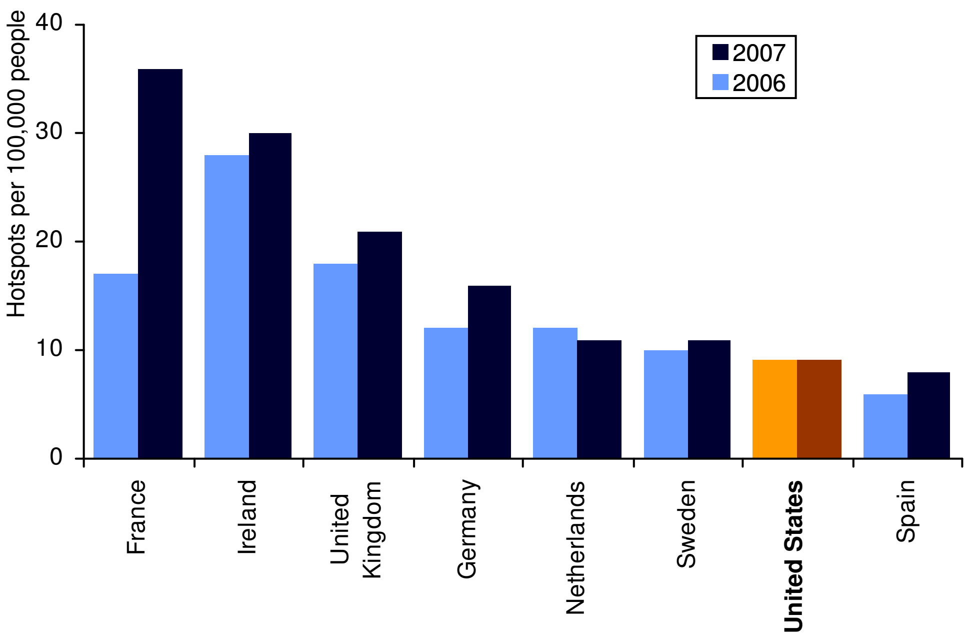
Figure 3.13. Public wireless hotspots, OECD



Source: OECD based on Informa telecoms and media

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

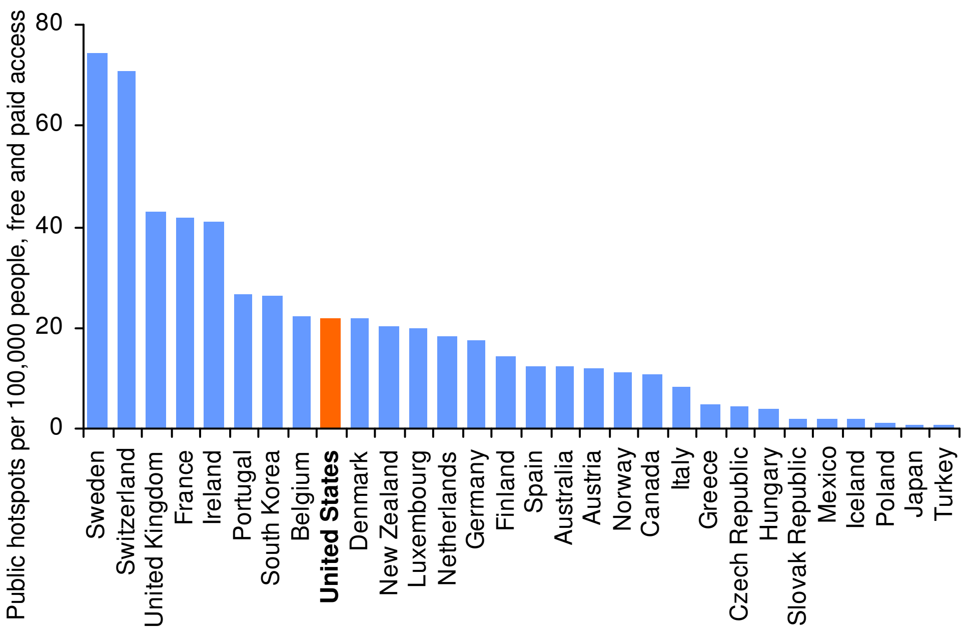
Figure 3.14. Public wireless hotspots, Ofcom



Source: Ofcom International Markets Report, 2008

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 Jiwire, 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 Jiwire 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.

Figure 3.15. Public wireless hotspots



Source: Jiwire data

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 second quintile for per household penetration. 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 3.3 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 3.3. Country rankings on various penetration measures.

	Country	Penetration per 100, OECD	Household penetration, OECD	3G penetration, TeleGeography	Wi-Fi hotspots per 100000, Jiwire	Weighted average ranking
1	South Korea	6	1	2	7	3.15
2	Sweden	7	6	6	1	5.75
3	Iceland	5	2	4	27	5.85
4	Denmark	1	4	18	10	8.05
5	Switzerland	4	8	15	2	8.5
6	Finland	8	9	8	15	9.05
7	Norway	3	5	17	19	9.5
8	Luxembourg	9	10	9	12	9.65
9	United Kingdom	11	11	10	3	9.9
10	Netherlands	2	3	25	13	10.35
11	Australia	16	13	3	17	11.15
12	Japan	17	14	1	29	12.35
13	Belgium	12	12	20	8	14
14	France	13	18	14	4	14.15
15	Germany	14	16	13	14	14.4
16	Canada	10	7	26	20	14.75
17	Spain	20	19	7	16	15.35
18	United States	15	15	19	9	15.6
19	New Zealand	18	20	11	11	15.9
20	Austria	19	17	12	18	16.1
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.[43] The ITU uses the same measure.[44] 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.[45] 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).[46]

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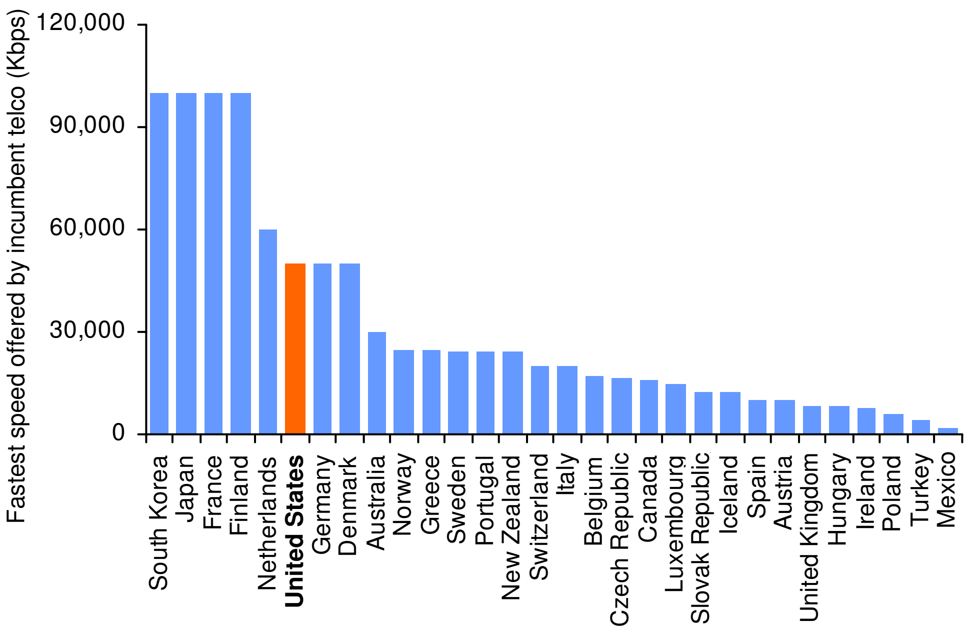
43 OECD Broadband Subscriber Criteria. http://www.oecd.org/document/46/0,3343,en_2649_34225_39575598_1_1_1_1,00.html

44 ITU IDI 2009 Annex 2, page 85.

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

46 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



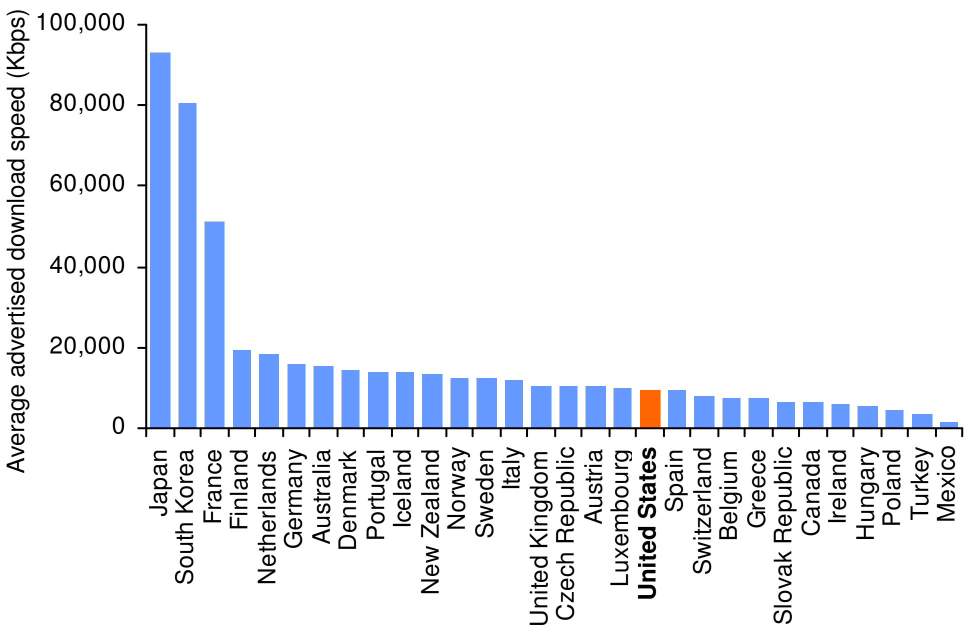
Source: OECD

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, 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 several 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.

Figure 3.17. Average advertised speed



Source: OECD, 2008

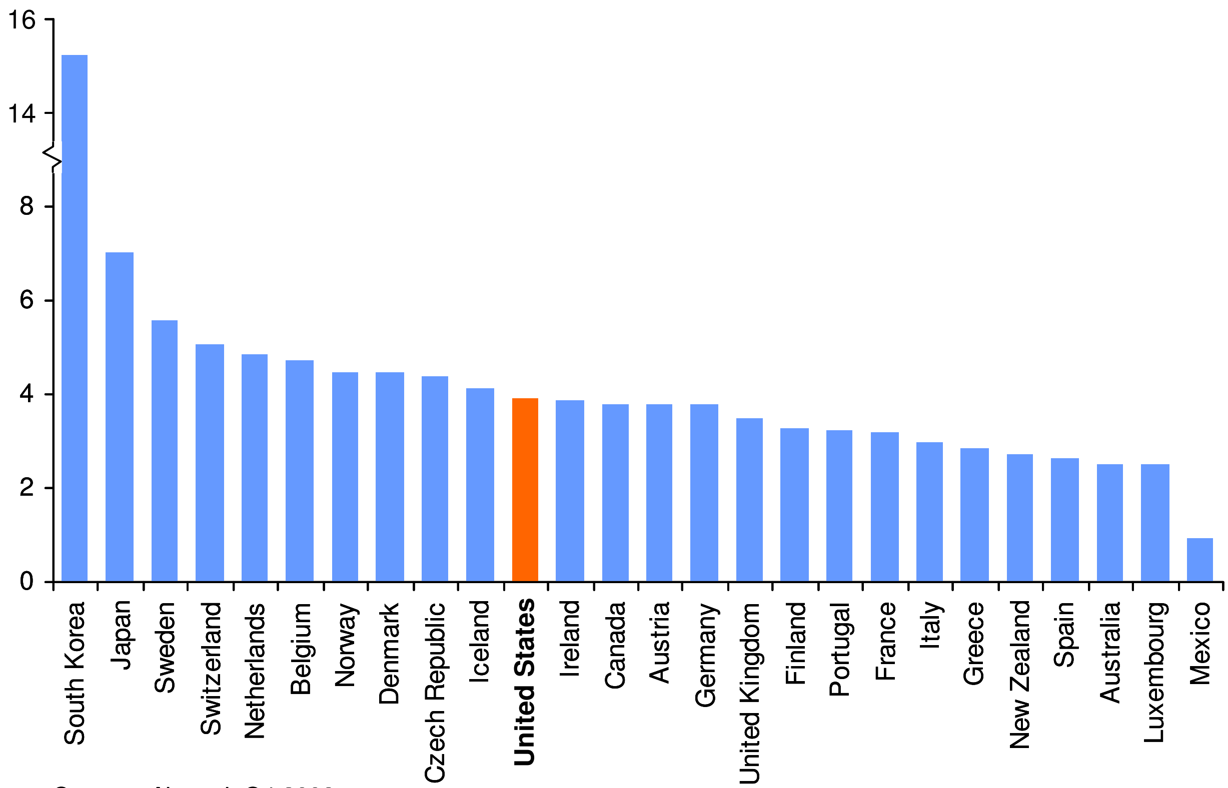
Advertised average download speeds are a coarse measure of capacity as actually used and experienced by users. As a result, several regulators have begun to address speed advertising, in an effort to move providers to implement measurement systems and offer a clear set of expectations for users of their 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 three primary approaches currently in use involve carrier-based testing, user-side testing, and in the network, third-party 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.

A source of publicly available speed measurement based on third-party measurements in the network is Akamai's *State of the Internet* report. We include here data from the report covering the 4th quarter of 2008, the same period for which we have OECD advertised speed data, and for which we analyzed end-user testing data using speedtest.net, as we describe below. Based on these measurements, the U.S. does better in actual speeds than advertised speeds. Nonetheless, the U.S. still ranks no better than 11th among OECD countries.

Figure 3.18. Average download speed



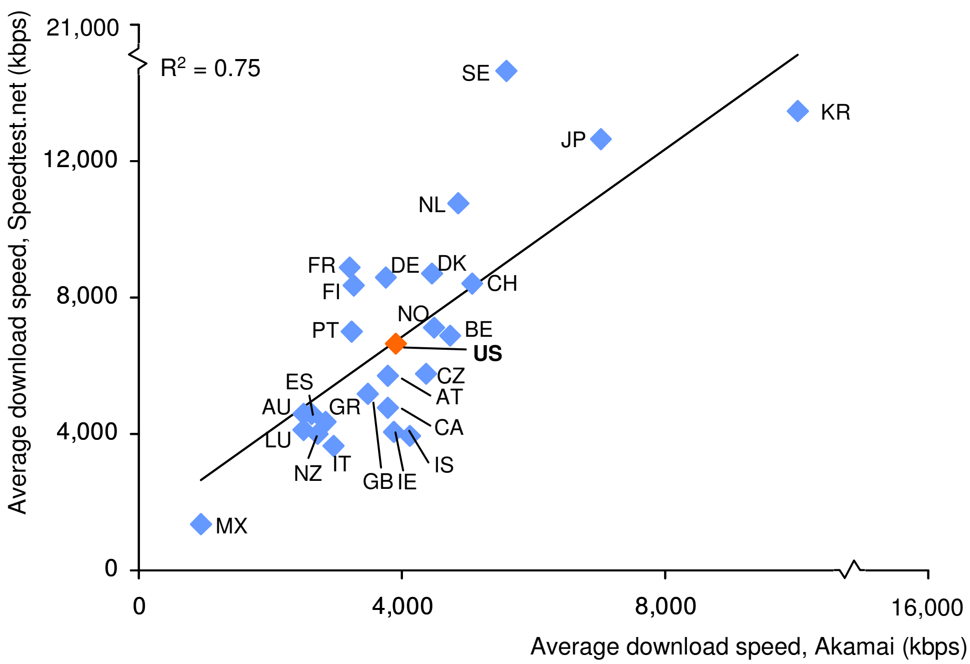
Source: Akamai, Q4 2008

The major 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). Moreover, the Speedtest data is highly correlated with the Akamai data (R^2=0.75). (Figure 3.19).

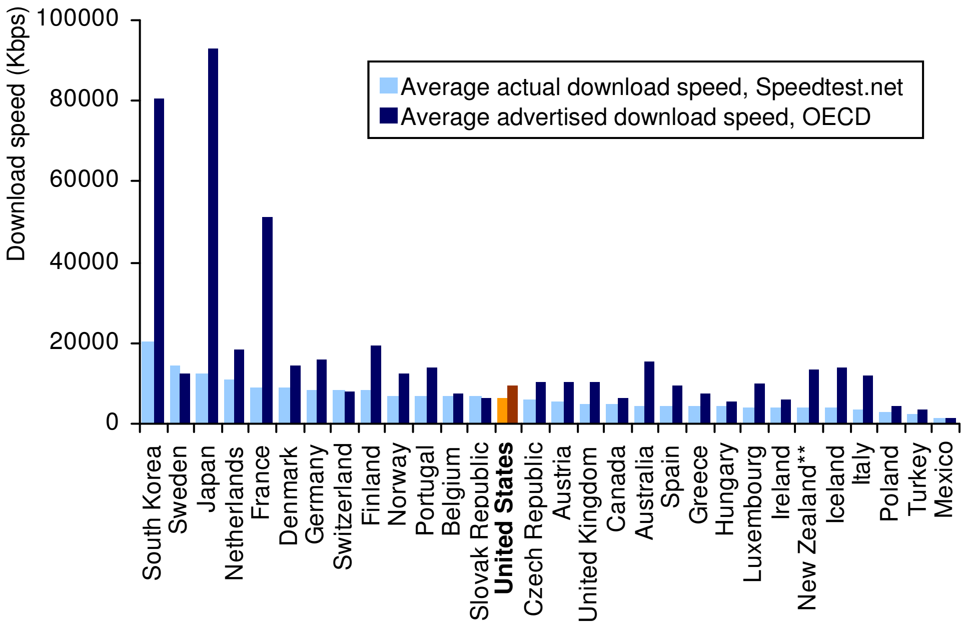
Figure 3.19. Comparison of Akamai and Speedtest.net download speeds



Source: Berkman Center analysis of Speedtest.net and Akamai data, Q4 2008
Note: Hungry, Poland, the Slovak Republic and Turkey not included in Akamai data set; Axes condensed, Korea at (15,239, 20,493); R^2 without Korea is 0.62

From the perspective of U.S. performance specifically, the average download speed measured by Akamai and those measured by Speedtest both showed the United States in the 11th spot in the OECD. When two datasets, from two entirely different companies, using measurement techniques and locations that are completely independent of each other, have such similar findings, our level of confidence in the observation is increased. Together, these advantages suggest that user-side testing data are potentially useful for offering an additional source of insight on actual performance of networks. Like carrier-side and in-the-network 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.

Figure 3.20. Average advertised speed versus actual download speed

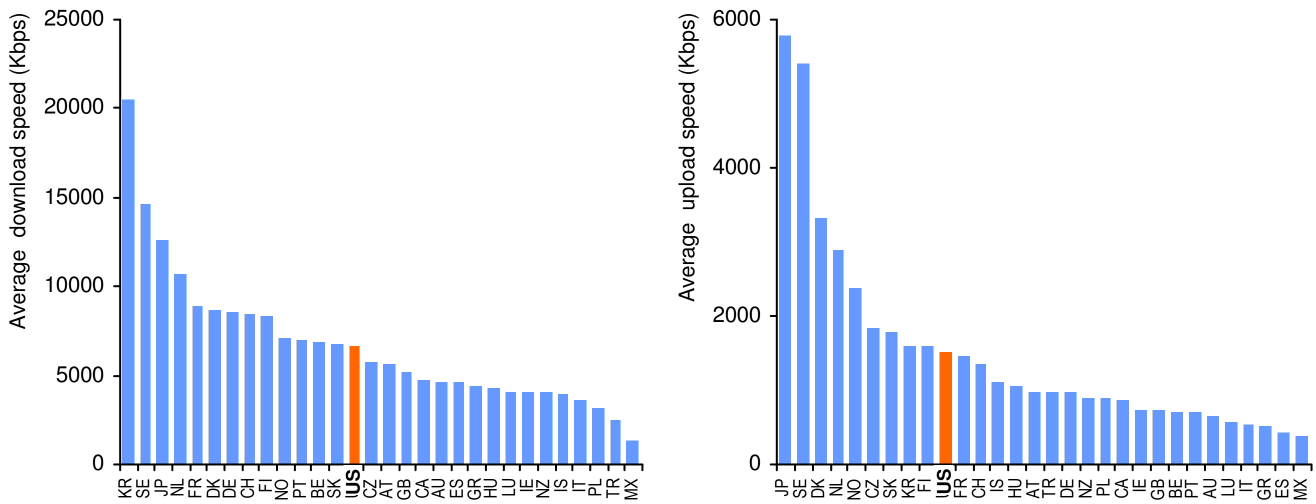


Source: OECD, Speedtest.net (provided by Ookla)

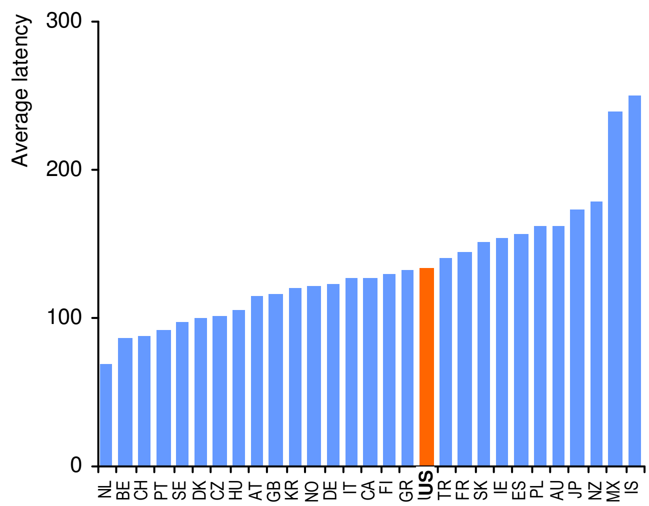
The actual speed test data confirms, in broad terms, the findings of the average advertised speeds: that Japan, South Korea, and the Netherlands are particularly high-performing countries. Actual test data particularly calls attention to Sweden's very high performance in fact, much more so than its advertised 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 advertised speeds alongside actual speeds using the measure with the most comparable benchmark in existing data—average download speeds—in Figure 3.20.

We observe a reasonably good 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 3.21a-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/Oviedo 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), or by the apparently significant amount of informal do-it-yourself fiber installments in Romania. However, our own, 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.

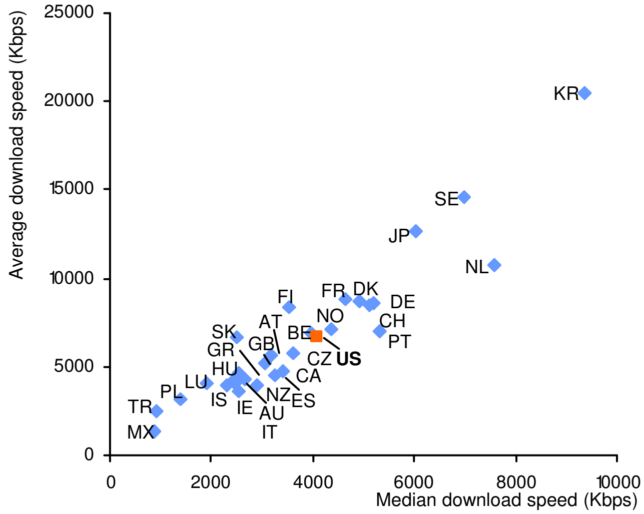
Figure 3.21a-i. Speedtest.net data

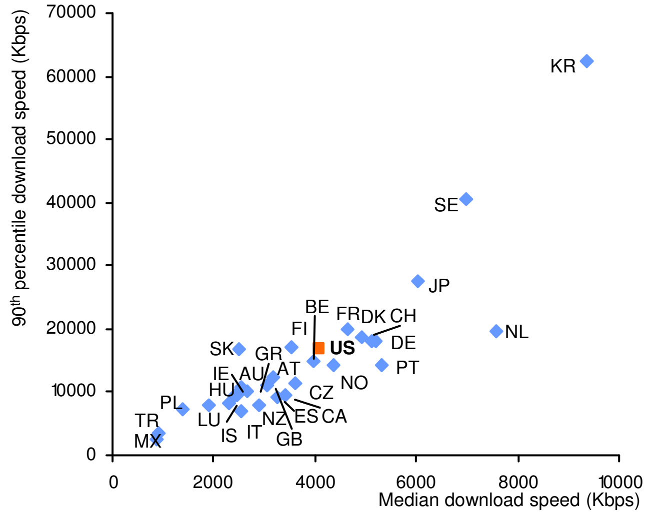


Source: Berkman Center analysis of Speedtest.net data

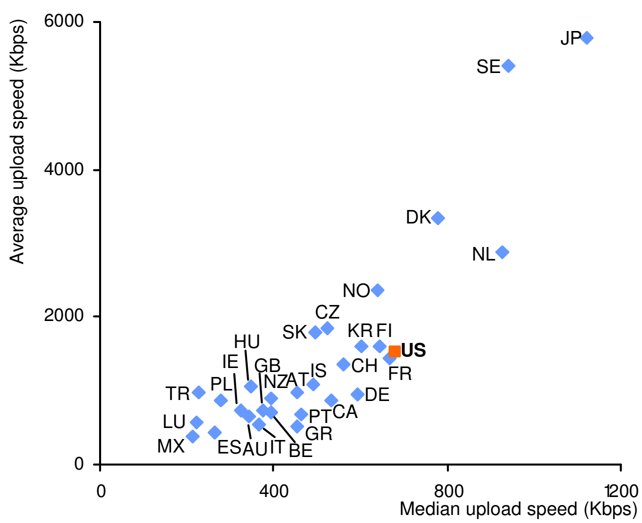


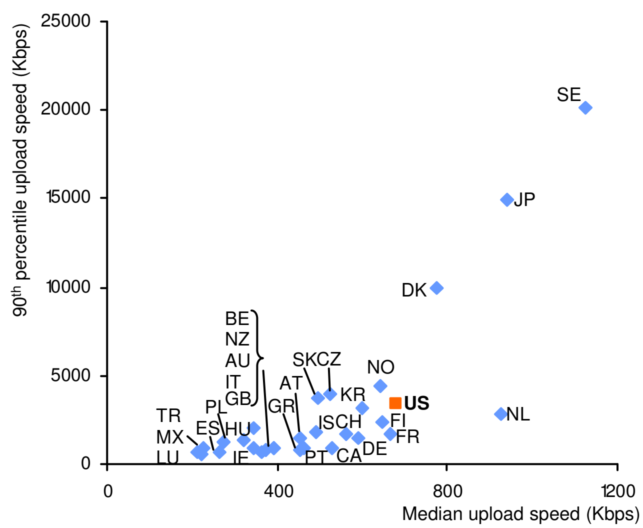
Source: Berkman Center analysis of Speedtest.net data



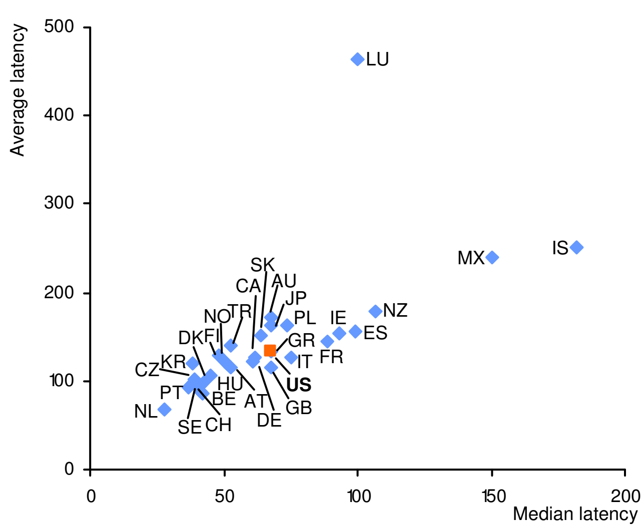


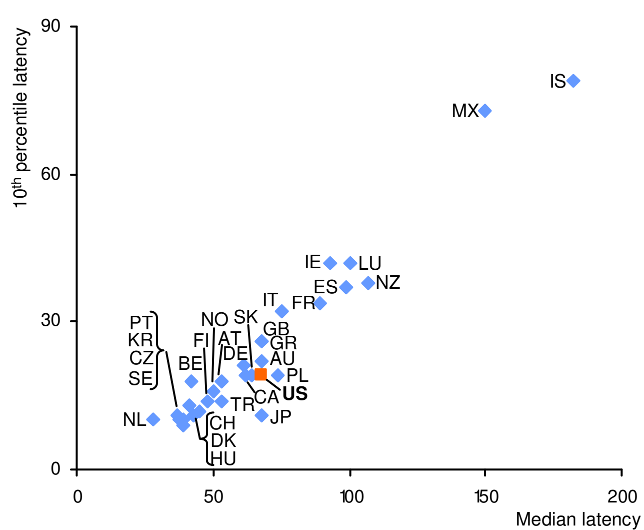
Source: Berkman Center analysis of Speedtest.net data





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 3.4.

Table 3.4. 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. 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, as the theoretical and long-term practical capacity of fiber to the home systems will be orders of magnitude larger than for cable systems. 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. Three-quarters of these connections were provided by Verizon FiOS. The remaining connections, about 1.1 million, are offered by small local incumbent and competitive providers, averaging about 1600 connections each. Neither AT&T nor Qwest have substantial Fiber-to-the-Home deployments,[47] nor do they appear to have plans to implement FTTH on a substantial basis.[48] 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.[49] 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. (although uptake in Slovakia in the past year suggests that the subscription rates are now as high as in the U.S. and the Czech Republic). 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. Cost estimates from various countries suggest that the cost of the last drop represents a substantial incremental investment. 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

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47 North American FTTH/FTTP Status, Fiber-to-the-Home Council: North America (2009).

48 Robert C. Atkinson & Ivy E. Schultz, Broadband in America: Where it is and Where is it Going (Columbia Institute of Tele-Information for the FCC November 11, 2009).

49 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.

of data, moving to a fiber "homes passed" metric would simply mask these high performers, whose identification is a primary purpose of benchmarking by this measure.

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 copper local loop, 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 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 had, until very recently, almost no mode of broadband delivery but DSL (cable now is growing faster, but still represents under 10% of all broadband subscriptions). Both have advertised speeds 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 3.5.

Different measures of speed are given roughly equal weight—with advertised speeds taking in total a bit more than one-third, emphasizing average advertised speeds (25%) over maximum advertised speeds (12%), and actual measurements split roughly equally between Akamai measurements (30%) and Speedtest measurements (33%) to allow the Speedtest data to be divided between its more diverse forms: treating median upload and download actual speed tests equally (10% each), with higher weight than median latency (5%), and a light emphasis on 90 percentile download and upload (4% each).[50]

50 Different weightings are, of course, possible. Our rankings are available online for others to tweak as they consider appropriate. We do note that the U.S. ranking is not particularly sensitive to removing advertised rates altogether, and relying on the actual speed measurements alone, although it is sensitive to the relative weight given to upload speeds as measured by Speedtest.net, where the U.S. is 5th or 7th. For example, if median upload speeds were the only benchmark the U.S. would rank 5th—its best showing under these data. It is not clear to us that there is a plausible argument in favor of emphasizing upload speeds of that particular test to such a degree as to substantially affect the rankings.

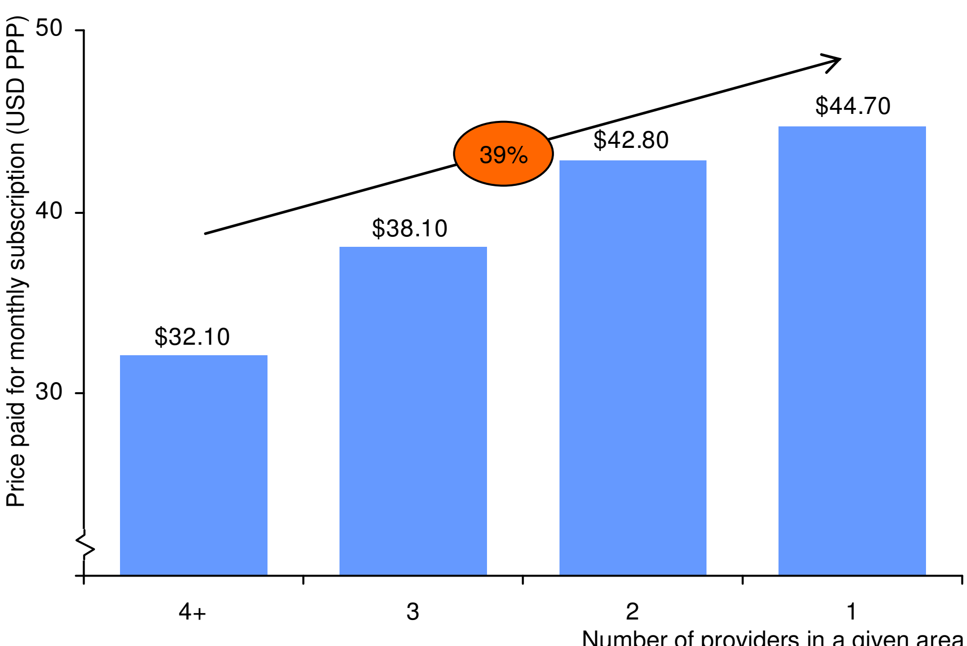
Table 3.5. Country rankings on various speed measures

	Country	Maximum advertised speed, OECD	Average advertised speed, OECD	Average speed, Akamai	Median download, Speedtest.net	Median upload, Speedtest.net	Median latency, Speedtest.net	90% Download, Speedtest.net	90% Upload, Speedtest.net	Weighted Average Rank
1	Japan	1	1	2	4	1	17	3	1	2.48
2	South Korea	3	2	1	1	9	3	1	8	2.67
3	Netherlands	8	5	5	2	3	1	5	9	4.82
4	Sweden	3	13	3	3	2	4	2	2	5.37
5	Denmark	3	8	8	8	4	8	6	3	6.72
6	Norway	9	12	7	10	8	11	14	4	9.25
7	Finland	2	4	17	14	7	10	9	10	9.70
8	France	3	3	19	9	6	24	4	13	10.19
9	Germany	9	6	15	6	10	14	7	16	10.30
10	Switzerland	17	21	4	7	11	6	8	14	11.47
11	United States	9	19	11	11	5	17	11	7	12.30
12	Portugal	13	9	18	5	16	2	13	20	12.73
13	Iceland	3	10	10	26	15	30	24	12	12.90
14	Czech Republic	23	16	9	13	13	4	16	5	13.10
15	Belgium	25	22	6	12	19	7	12	21	15.07
16	Austria	16	17	14	17	17	12	15	15	15.57
17	Canada	17	25	13	15	12	15	22	19	17.28
18	United Kingdom	21	15	16	18	21	17	17	25	17.50
19	Australia	14	7	24	22	24	17	18	24	17.76
20	New Zealand	17	11	22	19	19	28	25	23	18.51
21	Slovak Republic	23	24	#N/A	23	14	16	10	6	19.86
22	Italy	25	14	20	21	22	23	28	27	20.15
23	Ireland	21	26	12	24	25	25	21	17	20.29
24	Spain	9	20	23	16	27	26	23	29	20.66
25	Greece	20	23	21	20	18	17	19	26	20.90
26	Luxembourg	14	18	25	27	29	27	26	30	22.87
27	Hungary	25	27	#N/A	25	23	9	20	11	23.20
28	Poland	25	28	#N/A	28	26	22	27	18	26.14
29	Turkey	29	29	#N/A	29	28	12	29	22	27.24
30	Mexico	30	30	26	30	30	29	30	28	28.67

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[51] 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 3.22). 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 3.22. Price and number of competitors as reported in Pew Survey



Source: Pew, 2009

Here we provide an overview of the major existing efforts at international price comparisons, and then describe our own extensive new pricing study, which complements and substantially extends currently available information about international comparisons of prices at all tiers of broadband service. We

51 Pew Internet and American Life, John Horrigan, Home Broadband Adoption 2009. p. 17.

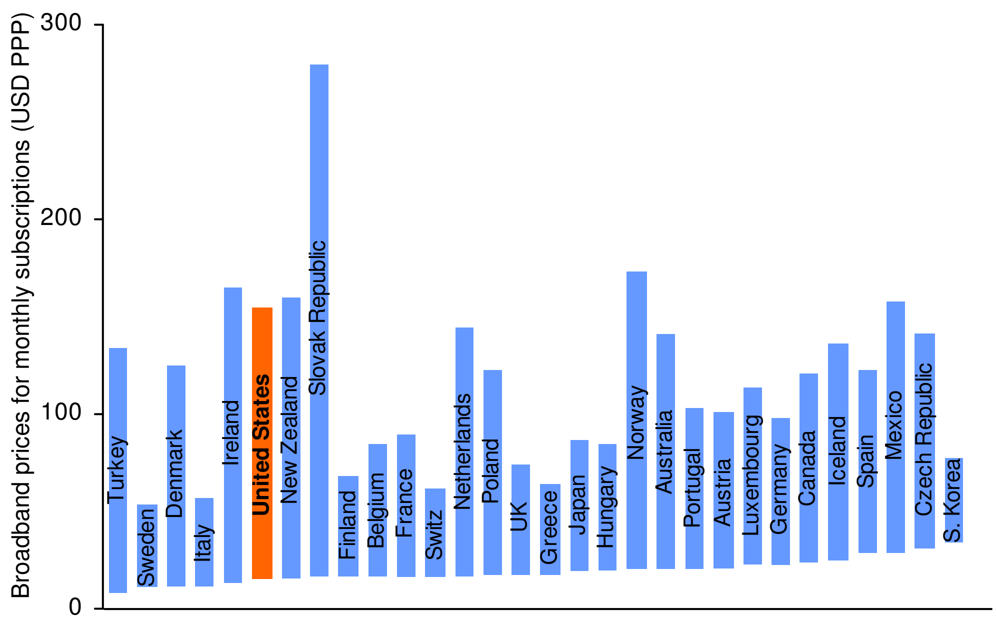
find that the U.S. does reasonably well at the very lowest speeds, but that prices increase substantially, by comparison to prices in other countries, for mid-, high, and very-high or next generation speeds. U.S. prices for next generation speeds are the highest, or near highest, in the world today. While there are many arguments about whether an unusual shape of demand in the U.S. accounts for middle-of-the-pack U.S. adoption rates, clearly as long as U.S. prices are middling to high relative to a set of countries, we should not expect U.S. consumers' adoption to be better than middling by comparison to adoption elsewhere in the countries that have lower prices.

3.6.1 ITU and OECD data on pricing of lowest available prices

The two major international sources of price data are the ITU and OECD. ITU data is, however, substantially more limited in its coverage, using only the single least expensive offering, from the national incumbent, as its point of comparison.[52] In terms of prices for the lowest-tier services available from a major incumbent, using that very narrow measure, the United States seems to be doing well. The ITU then ranks countries by the ratio of this low-cost price option from an incumbent to monthly GNI per capita. In this ranking the United States is ranked first. Measuring the lowest 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.

52 ITU-IDI 2009, Table 6.6, p. 67.

Figure 3.23. Range of broadband prices for monthly subscriptions



Source: OECD, 2008

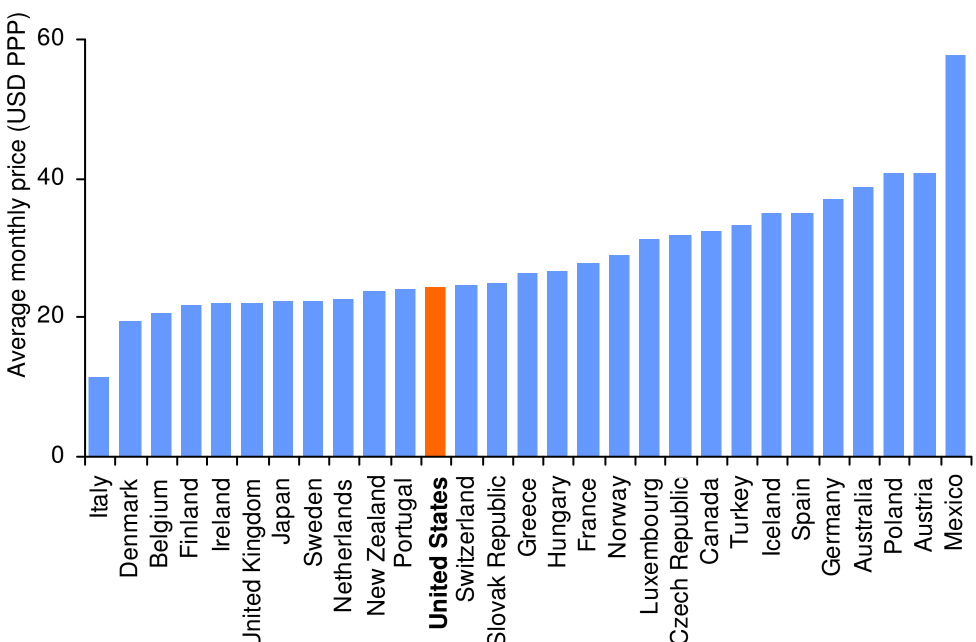
3.6.2 OECD pricing measures

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.

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.

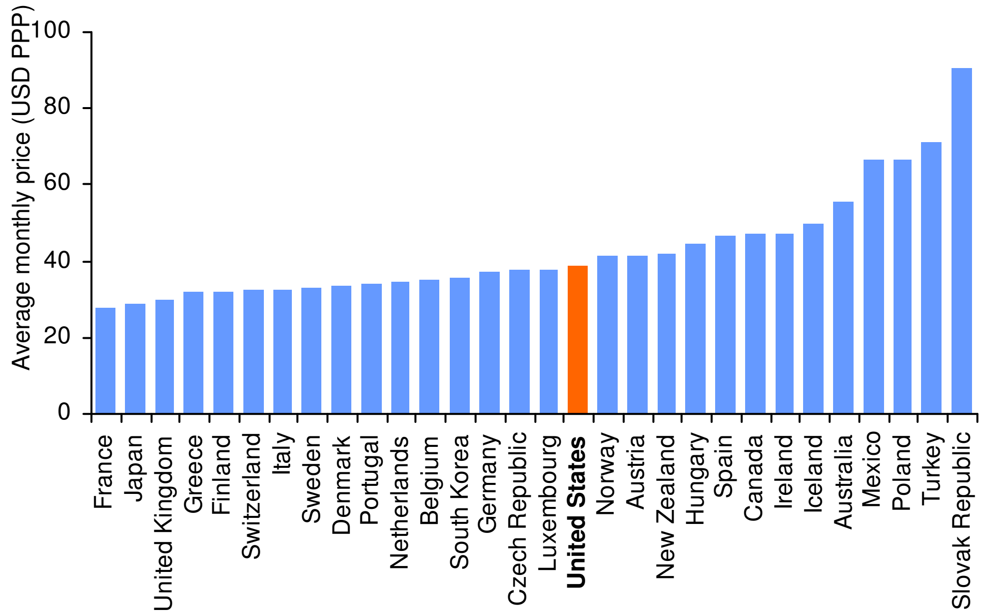
A more useful measure of price than the price per megabit per second, which reflects speed as an endogenous factor, is the OECD's ranking based on tier of service. The OECD surveys operators to create an average offering price for different tiers of service: low speed (256kbps – 2Mbps), medium-speed (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 next generation, very high speeds, the good news is that the United States is on the list of countries that have any kind of offering in that range (35Mbps and above) in the OECD dataset (the OECD identified 12 countries with such offers; our independent research added seven more). 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, according to the OECD, and the highest of 19 in our more extended study.

Figure 3.24. Average monthly price for low speed tier



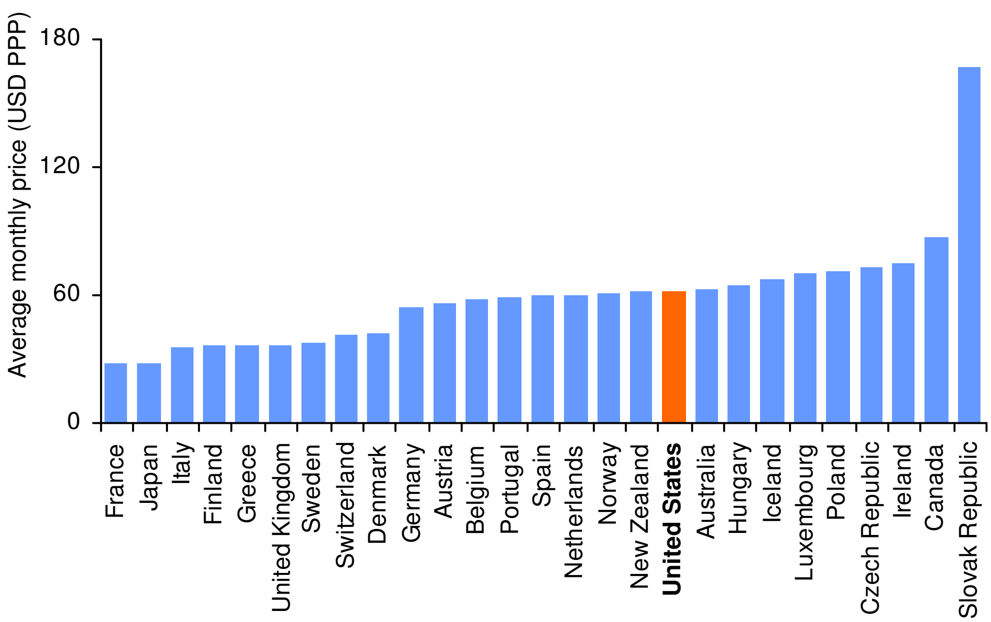
Source: OECD, 2008

Figure 3.25. Average monthly price for medium speed tier



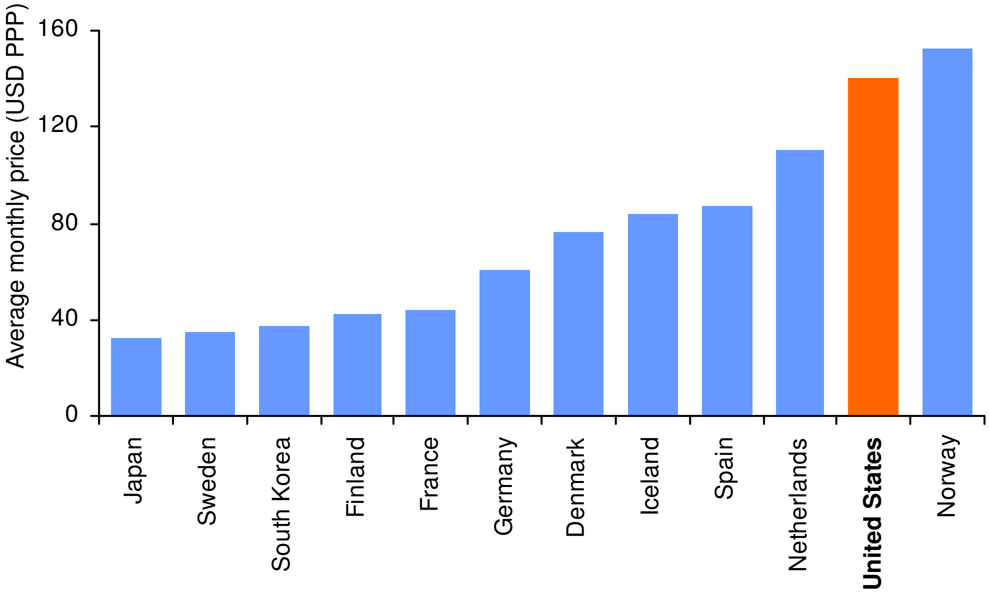
Source: OECD, 2008

Figure 3.26. Average monthly price for high speed tier



Source: OECD, 2008

Figure 3.27. Average monthly price for very 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).[53] 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.[54] 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.[55] 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 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 reflect the regionally uneven development—so that the areas in the northwest and around Rome that have competition and high-speed access are seeing low prices, but average prices and penetration are not in fact so low. We do not have the data necessary to determine whether that is what lies behind the Italian numbers. Prices may also 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.

53 OECD Measuring the Information Economy 2002, page 57.

54 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.

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

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.[56]

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 two distinct market analysis sources: TeleGeography and Point Topic. Using both of these, as well as the OECD study, we observed close to two thousand price offers in the OECD countries. Of these offers, we look 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, while offers from smaller, more marginal providers, who might be small providers in uncompetitive remote markets or who are not well known to customers, may provide offers that are uncharacteristically high or uncharacteristically low but do not play a large role in the market as actually perceived by most consumers on a national level.[57] On average these top four providers combined have 80% of their local markets (although in the U.S., with its regional competition, they account for only 60%).[58]

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 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.[59] (See Annex on pricing for a more detailed explanation of both our methods and our examination of the OECD data.) In total, our dataset included 950 unique observations, from 115 providers in 30 countries. In all, our study shows that U.S. prices are very good by international standards at the very low speeds, around 768kbps, but become more expensive at contemporary broadband speeds above 1.5Mbps. By the time we reach offers for speeds that are high (above 10Mbps), U.S. broadband prices are substantially higher than in many of the leading countries, and when we look at next-generation speeds (above 35Mbps) U.S.

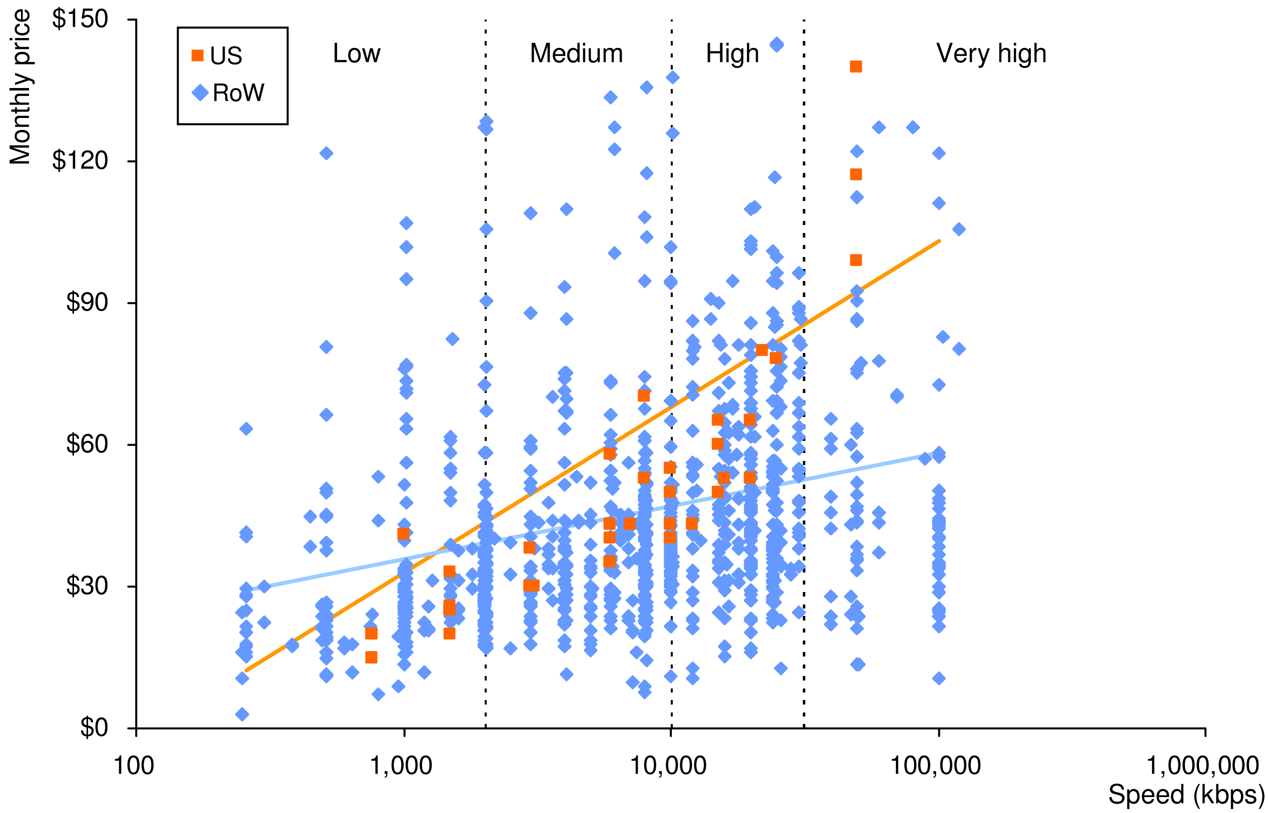
56 OECD Outlook 2009, Table 7.14.

57 Some commentary, particularly in Canada, on our draft report seems to have failed to notice that our analysis in Part 4 and our analysis here take different measurements. Here we look only at top four providers. There we take all firms with next generation offers, as well as firms with offers of over 10Mbps in countries that do not have next generation offers, and all U.S. firms with more than 2 million subscribers. This resulted in our October 2009 draft reporting no next generation offerings in Canada for the benchmarking exercise, but identifying an offer from Videotron in that tier in Part 4 of the draft. Rather than an inconsistency in our own data reporting, that difference reflects the fact that Videotron, while an important regional provider in Quebec, is not a nationally top four provider.

58 If we include all the U.S. providers in our dataset, we do get to roughly 80%. Doing so increases the prices for the cheapest and medium tiers by $11 in each case; and increases the price by $8 for the high speed tier. It does, however, decrease the price for next generation speeds by $8. The price decrease does not affect the U.S. standing in the next generation speed tier, as even the lower price is still higher than the next worst country in this tier, Canada. Moreover, if we apply the same methodology to Canada, then prices for Canada also improve, leaving the U.S. trailing further behind in terms of prices for next generation speeds.

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

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



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

prices are the highest among the 19 countries that have such offerings. Figure 3.28 shows the entire set of offers we reviewed, with offers by U.S. carriers marked in red, and offers from all other countries market in blue. The trend lines show the crossover point for U.S. prices and the higher trajectory of cost increases relative to other countries where higher speed service is available.

Figure 3.29 through Figure 3.32 report the combined results of our study, organized by tier of service. The annex shows and explains the methodology and sources, as well as the difference between the draft report, which included only the OECD and TeleGeography data, and the current dataset, which includes an additional independent market analysis dataset, Point Topic.

Figure 3.29. Low speed tier: OECD, TeleGeography, Point Topic combined data set

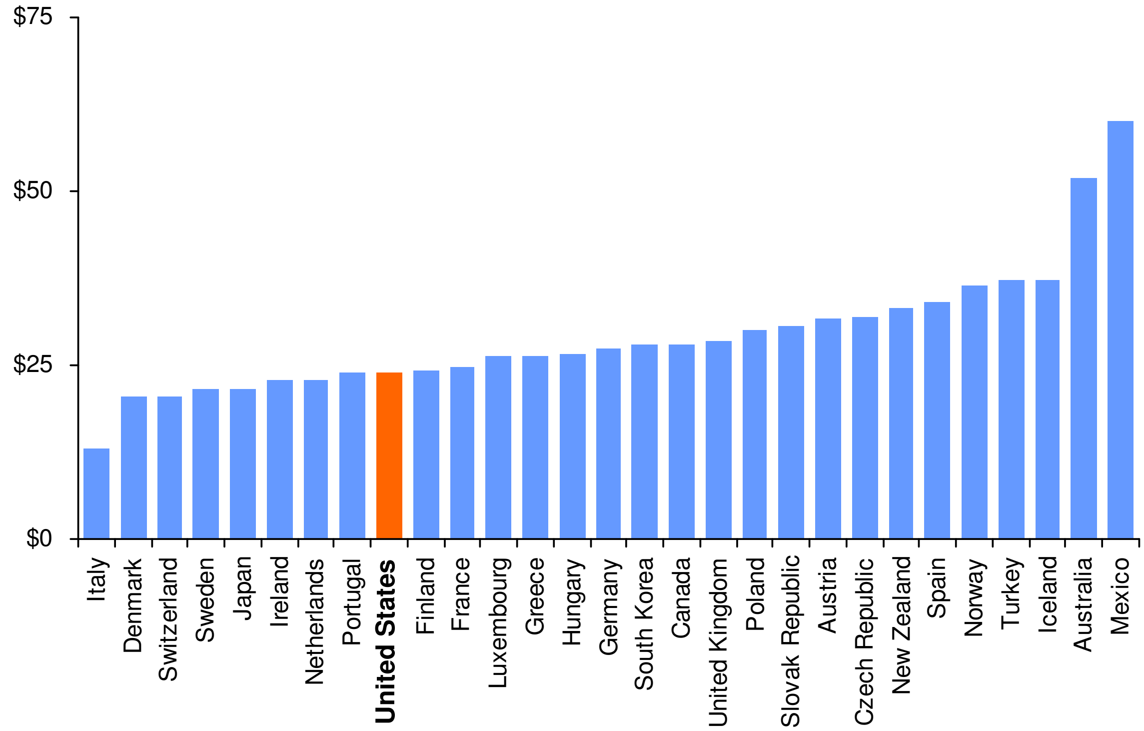


Figure 3.30. Medium speed tier: OECD, TeleGeography, Point Topic combined data set

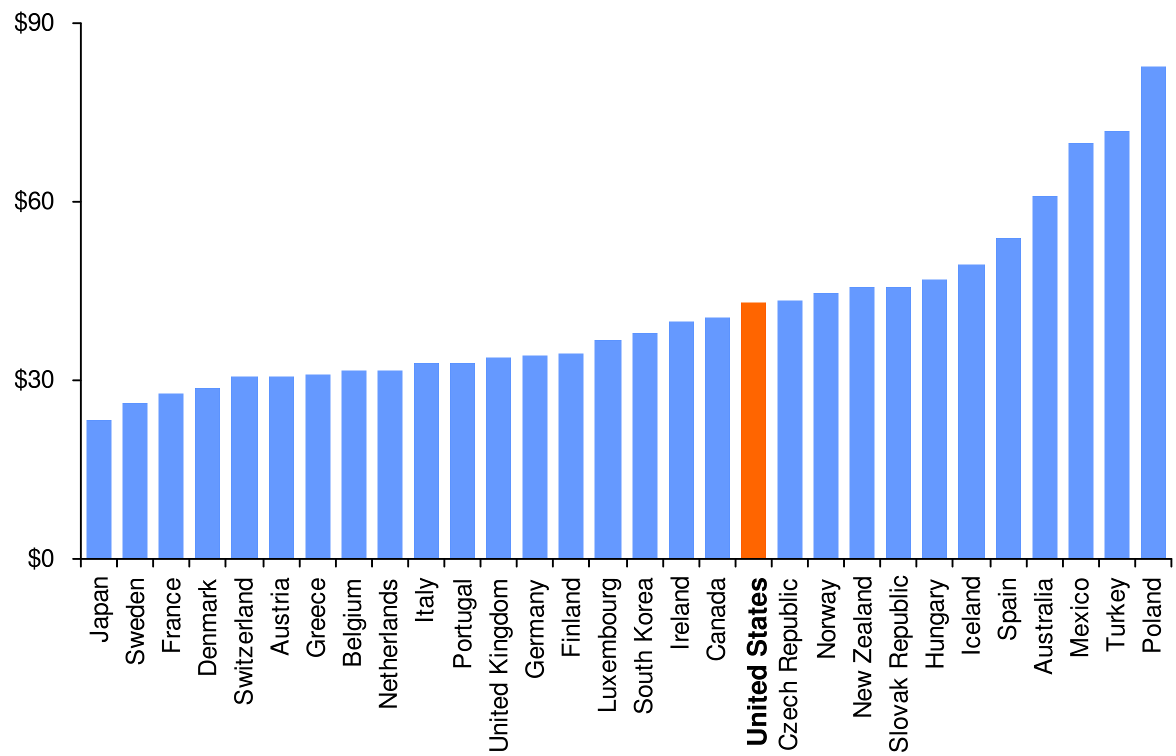
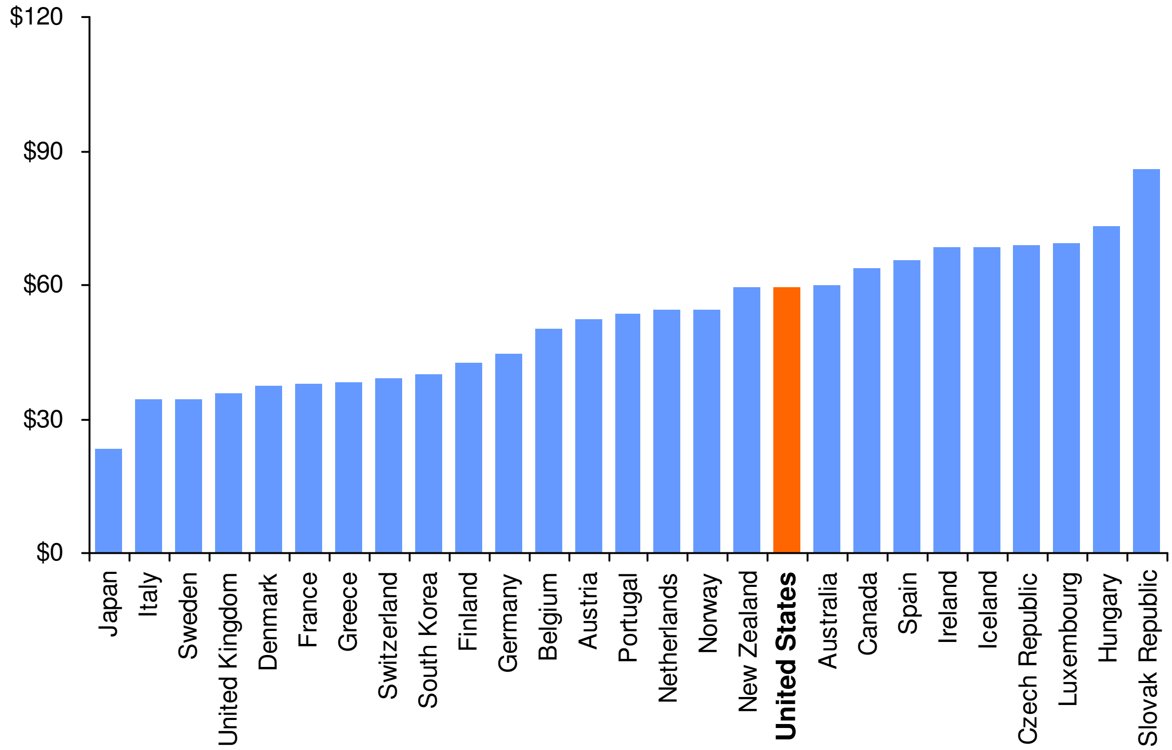
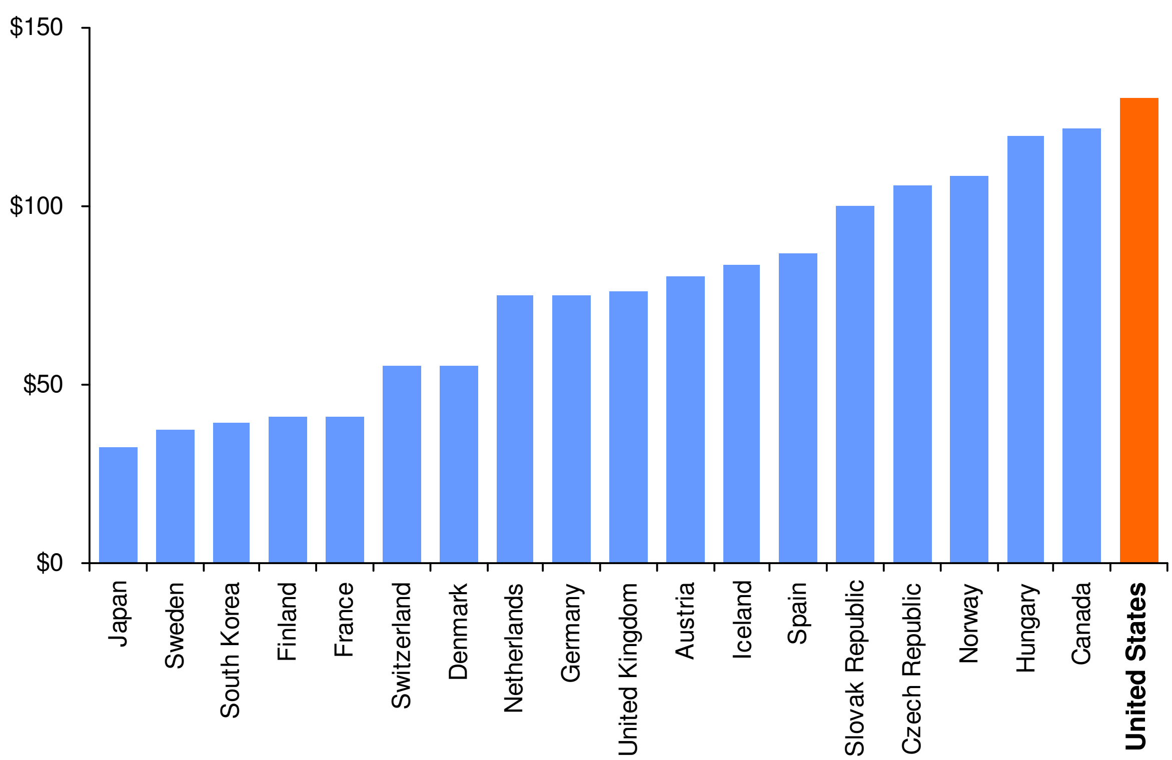


Figure 3.31. High speed tier: OECD, TeleGeography, Point Topic combined data set



Note: Poland not displayed

Figure 3.32. Next- generation speed tier: OECD, TeleGeography, Point Topic combined data set



Several of the countries in our dataset vary significantly, at least in one tier of service, from their rankings according to the OECD, suggesting that determining available pricing is difficult and noisy, and requires further sustained study. 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. For the U.S., the prices we found at the lower tier are lower than the OECD rankings, but nonetheless closer to the OECD ranking than the much narrower, best-incumbent-offer reported by the ITU. Our findings for the U.S. in the middle to high speed tiers are mostly consistent with the findings of the OECD—which is to say that U.S. prices in those tiers are middling to weak (19^{th} of 30 for medium speed, and 18^{th} of 28 for high). For the very highest, next-generation 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. Indeed, because our research adds observations in countries that showed no such offers in the OECD data set, and because we add several offers available in the worst performer in that study, Norway, that were not covered by the OECD study, the U.S. falls from 11^{th} of 12 in the OECD study to 19^{th} of 19 in our more complete survey. As our mode detailed, firm-level analysis describes in Section 4.10 below clarifies, Japan, Sweden, South Korea, Finland and France form a cluster of countries with distinctly better price-to-speed tradeoffs at the very highest end. In France, for example, 100 Mbps service, digital 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. Numericable offers 100Mbps service over cable, without the bundle, for EUR10 less, and France Telecom's bundled offer, which is less comprehensive, is about EUR10 more expensive. U.S. prices for bundles that include half the speed (50Mbps), without the international calling or the nomadic access, are three (introductory offers) to five times higher than those of Free or SFR.

3.6.4 Conclusion

International price comparison suggests a mixed, but overall weaker picture for the U.S. than do either penetration or speed comparisons. The relatively good news is that the lowest prices available for the lowest tier offerings are quite good by comparison to other countries, placing the U.S. solidly in the second quintile of performers. The bad news is that U.S. average prices for other tiers are in the fourth quintile for medium to high speeds, and at the very bottom of the heap for next generation speeds. Whether the data about the availability of relatively affordable slow speed offerings 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 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 an unequivocal no, and the most pertinent data would concern prices at the tier of service we consider to be the target of present policy making.

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 current medium and high speeds, as well as prices for next generation speeds, the picture in the United States becomes significantly 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 a concluding at-a-glance table, as we did for the prior attributes, but we separate out next-generation speeds from current generation speeds because a third of OECD countries have no next generation offerings in our data set. Table 3.6 reports values for all OECD countries, and orders them by their relative performance on prices at the low, medium, and high current-generation speed tiers, each weighted equally (33%) to reflect no particular emphasis on one or another speed tier. Table 3.7 reports values only for those 19 countries that have next generation offerings (above 35Mbps) available.

Table 3.6. Country ranks on price for current-generation speeds

	Country	Price for low speeds, combined	Price for med speeds, combined	Price for high speeds, combined	Weighted average rank
1	Japan	5	1	1	2.3
2	Sweden	4	2	3	3.0
3	Denmark	2	4	5	3.7
4	Italy	1	10	2	4.3
5	Switzerland	3	5	8	5.3
6	France	11	3	6	6.7
7	Greece	13	7	7	9.0
8	Belgium	#N/A	8	12	10.0
9	Netherlands	7	9	15	10.3
10	Portugal	8	11	14	11.0
11	Finland	10	14	10	11.3
11	United Kingdom	18	12	4	11.3
13	Germany	15	13	11	13.0
14	Austria	21	6	13	13.3
15	South Korea	16	16	9	13.7
16	Ireland	6	17	22	15.0
17	**United States**	**9**	**19**	**18**	**15.3**
18	Luxembourg	12	15	25	17.3
19	Canada	17	18	20	18.3
20	Norway	25	21	16	20.7
20	New Zealand	23	22	17	20.7
22	Hungary	14	24	26	21.3
23	Czech Republic	22	20	24	22.0
24	Slovak Republic	20	23	27	23.3
25	Spain	24	26	21	23.7
26	Australia	28	27	19	24.7
27	Iceland	27	25	23	25.0
28	Poland	19	30	28	25.7
29	Turkey	26	29	29	28.0
30	Mexico	29	28	29	28.7

Table 3.7. Country ranks on price for next generation speeds

Country	Price for next generation speeds, combined
Japan	1
Sweden	2
South Korea	3
Finland	4
France	5
Switzerland	6
Denmark	7
Netherlands	8
Germany	9
United Kingdom	10
Austria	11
Iceland	12
Spain	13
Slovak Republic	14
Czech Republic	15
Norway	16
Hungary	17
Canada	18
United States	**19**

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 3.8, treating penetration, speed, and price as equally-weighted performance measures.

From the perspective of looking at the United States rank alone, our approach drops the U.S. by one spot, 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—in the top cluster, alongside Sweden, Denmark, the Netherlands and Finland. It does, however, emphasize that South Korea's approach comes at the cost of having relatively high prices. 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 Switzerland out of the first quintile, mostly because of lower 3G penetration and speeds, and underscore the extent to which Norway's prices are high by both regional and international measures. On the other hand, France comes out as a stronger performer, moving from the third to the second quintile, as does Germany to a slightly lesser extent; Italy moves from the fourth to the third quintile because of excellent prices, Portugal from fifth to third quintile, because of both speeds and prices. Luxembourg, Australia, and Iceland all show weaker performances on the combined measure than they do on the penetration measure alone, because of relatively high prices and low speeds. 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 3.8. Country ranks based on weighted average aggregates

	Country	Penetration	Speed	Price	Overall Weighted Average Rank
1	Sweden	2	5	2	3.12
2	Denmark	4	7	3	4.57
3	Japan	12	2	1	5.16
4	South Korea	1	3	15	6.22
5	Switzerland	5	11	5	7.16
6	Netherlands	10	5	9	7.94
7	Finland	6	10	11	8.90
8	France	14	10	6	10.06
9	Belgium	13	15	8	12.02
10	Norway	7	9	20	12.08
11	United Kingdom	9	18	11	12.50
12	Germany	15	10	13	12.77
13	Iceland	3	13	27	14.30
14	Italy	21	20	4	15.05
15	Portugal	23	13	10	15.24
16	United States	18	12	17	15.77
17	Luxembourg	8	23	18	16.29
18	Austria	20	16	14	16.52
19	Canada	16	17	19	17.43
20	Australia	11	18	26	18.25
21	Greece	27	21	7	18.30
22	New Zealand	19	19	20	19.17
23	Ireland	22	20	16	19.43
24	Czech Republic	26	13	23	20.70
25	Spain	17	21	25	20.89
26	Slovak Republic	24	20	24	22.62
27	Hungary	25	23	22	23.40
28	Poland	28	26	28	27.38
29	Turkey	30	27	29	28.75
30	Mexico	29	29	30	29.22

4 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.

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 begin our study with an extensive review of the literature on open access policy, both quantitative and qualitative. Our review shows that the econometrics literature that depends on cross-country studies is generally weak; its results are substantially more evenly distributed between studies that suggest that open access policies fail or harm penetration or investment and those that suggest that open access policies support those outcomes. We also find that the econometrics literature is heavily influenced by work sponsored by interested industry parties, which requires added caution. Qualitative work we review here tends to support the beneficial effects of open access more substantially than it supports the opposite claim, and tends to have less corporate sponsored elements. We follow the literature review with our own extensive set of qualitative case studies. 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.

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. We emphasize here to avoid misunderstanding: Recognition that access-based competition played an important role in the first broadband transition does not translate into a commitment to re-enact precisely those policies tailored to sharing of the already-sunk and existing copper infrastructure that typified the first broadband transition. Throughout the countries we reviewed, those lessons are being transposed to a new reality, where new investments in fiber to the home plant create different challenges. The core lesson retained, however, is that shared use of certain high-cost, slow-moving facilities lowers the entry barriers to the market in high-speed connectivity to the home. By finding a way to allow service- and electronics-level competitors to enter the market without fully replicating a redundant, expensive, labor- and capital-intensive physical infrastructure of trenches, ducts, and holes in walls, countries we observed are trying to introduce competition into markets that otherwise could sustain one, and in any case no more than two, competitors per market.

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, where facilities-based alternatives are available, access-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
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
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
Unbundled access can also be used by incumbents from neighboring countries or regions to enter adjacent markets and introduce competition; in some cases they do so by acquiring initially entrepreneurial entrants	Denmark; Norway; Sweden, Finland; Germany
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 facilities-based competition; they aim to mitigate the loss of facilities-based competition with a range of new models of open access and shared facilities, tailored to fiber	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 unfashionable, and, it appears, controversial. 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 and its effect on market structure and competition. 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.[60]

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 of 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 seem to stand out in this regard, although the recent imposition of functional separation on Sweden's incumbent suggests that even there the path has been bumpy. 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.

Much 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.

60 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.

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, 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 some cases, open access allowed incumbents from neighboring countries to enter and consolidate some of these entrants into more powerful entrants. The Nordic incumbents, Telenor, TeliaSonera, and TDC have followed that model. In Finland, open access has been used by the long distance incumbent, Sonera (now TeliaSonera), as it was initially by AT&T and MCI in the United States before the FCC abandoned open access regulation, for competitive entry. In other countries that implemented open access more weakly, results were mixed. Canada in particular offers an example of halfhearted 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. In South Korea unbundling was introduced late, after it had already reached high levels of service. In this regard, it is an example of a case where high urban density and government investment were sufficient to generate facilities-based competition. Nonetheless, even in South Korea the early entrants relied on open access to *cable* facilities, rather than unbundling of telephone infrastructure as elsewhere. We discuss these below, in the case studies themselves. Switzerland has been the strongest example of successful broadband performance without effective adoption of unbundling. Nonetheless, that case is rendered ambiguous by the fact that Swisscom is majority-owned by the Swiss government, and that the Swiss regulator and Swisscom had been battling over the former's efforts to impose unbundling, as it ultimately succeeded in doing in 2007. Even after the imposition of unbundling on copper there are continued debates over whether to extend unbundling to fiber. Moreover, responding to competition from both cable companies and publicly-owned municipal power companies, Swisscom's new fiber strategy adopts a voluntary open access model for fiber, so as to share the costs and risks of investment in next generation roll out. Swisscom has been negotiating cooperative arrangements with competitors for 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, which specializes 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 or Japan, our analysis of prices advertised by 78 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 save for 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, Italy, and Australia have now followed this path in preparation for the next generation transition, and the Netherlands has nudged its incumbent into what is effectively an equivalent arrangement, through a new joint-venture that is deploying open access fiber.

The experience of all these countries has led to a wide consensus (not shared by the incumbents in many of those countries) 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 78 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 data from 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, joined by Norwegian power companies. Japanese, French, Swedish, and Finnish firms, including telephone incumbents, cable companies, and access-based entrants, offer the highest speeds and lowest prices, together with South Korea. The rest of the companies we observed occupy a middle ground.

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. We include here, in particular, a review of the European Regulators Group efforts, instances of narrow regulation, like the French emphasis on in-building fiber plant sharing, instances of very foundational regulation, like functional separation introduced in the UK, but also case studies of the voluntary infrastructure-sharing models developed in the Netherlands and Switzerland. The range of approaches for transposition is significant. We also note that some of the responses take the form of government funding and are therefore treated in part 6 under government investment. However, Amsterdam CityNet described there is on its way to being largely privatized to Reggefiber, and the Australian National Broadband Network is intended to be privatized under an open access regime within a few years of deployment. These examples emphasize the wide range of avenues used to transposing the lessons of the first broadband transition to the next generation transition, without imagining that the universe of options is limited to either staying the course or adopting the unbundling policies of the late 1990s lock, stock, and barrel. It may well be that different types of policies may fit different specific regional market conditions in different regions throughout the country. Our role here has not been to provide a single recommendation, but to survey the range of options and lessons that can be learned from them.

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 in the U.S., 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? The theoretical and empirical debates continued throughout the first decade of the 21st century, as academics and consultants made their contributions to clarifying, and sometimes to obfuscating, the case.

4.4 Review of the literature on the effects of unbundling on performance and investment

We review here 57 studies, dividing the papers into three categories: quantitative studies that focus on broadband penetration, quantitative studies that discuss broadband investment, and qualitative studies, most of which cover a single country or comparison of a small number of countries. This review is based in part on a recent literature review published in *Telecommunications Policy*[61] and comments filed in response to our draft report, supplemented by our own research.

Fifteen of the papers we reviewed analyze the effects of unbundling on penetration. Of these, three rely on data from before 2001, when most of the relevant cross-country variation began, or exhibit methodological weakness. Of these fifteen, six papers find positive effects of unbundling on penetration, three found negative effects, and six had indeterminate findings—they found either no effect or both positive and negative effects.

We have reviewed twenty-three papers related to unbundling and investment. In this set we included all the papers characterized as empirical investigations of investment and unbundling in the recent Cambini and Jiang (2009) review, which is the most recent authoritative review. Several of these are not empirical at all, but are rather conceptual; some include fatal methodological flaws, deeper than the broader limitations of the approach as a whole. Of these twenty-three papers, two show positive effects on investment by incumbents or entrants; one shows positive and negative effects; two report no findings; and one reports negative findings. The remaining seventeen papers are either conceptual or modeling exercises, rather than empirical studies, or have serious methodological flaws. The papers we categorize in this group are divided equally (8 and 8) between finding negative and positive effects on investment. One paper that reviews the literature up until 2006 concludes "Almost ten years have passed since the Telecommunications Act transformed telecommunications regulation in the United States and economists still do not have a thorough understanding (theoretically or empirically) of how local loop unbundling affects investment."[62]

We note that twenty of the thirty-eight quantitative or theoretical papers we reviewed are self-published. At least sixteen of the thirty-eight are directly sponsored by a corporate sponsor with direct interest in the outcomes of the research. The papers on investment exhibit this characteristic at a particularly high rate. Thirteen of twenty-three are sponsored by a party with direct commercial interest in the outcome. While the work should obviously be read on its merits, it is appropriate to note the conflict of interest, as

61 Cambini, C. and Jiang, Y. Broadband investment and regulation: A literature review. Telecommunications Policy (2009). 33 559-574.

62 Guthrie, Graeme. Regulating Infrastructure: The Impact on Risk and Investment. Journal of Economic Literature. 44(4): 925-972 at 969.

many of the original papers do, but the Cambini and Jiang literature review does not, and to exercise a higher degree of caution when reading these papers.

Given the limitations of the quantitative cross-country studies, discussed in a later section, we place particular emphasis on qualitative research, which is able to take account of the nuance and local variation to a much greater degree, although it is not, of course, without its own limitations. We reviewed nineteen qualitative papers or book chapters, none of which were self-published, three of which had industry sponsorship. Of these papers, ten identified open access policies as having positive effects on broadband deployment and prices. Two papers (both industry sponsored) identified negative or no effects where positive effects would be anticipated. One found both negative and positive findings. Six found no effect, or focused on the political economy rather than on the outcomes.

Given this state of the literature, the present unstated consensus in U.S. telecommunications policy circles that open access is a theory in disrepute is without foundation in evidence. Quite the contrary, open access should be a continued subject of study, experimentation, and observation as one among the many tools in the toolbox of telecommunications policy.

We now turn to a description of the conceptual models that inform this literature.

4.4.1 Conceptual models of the relationship between open access and investment

Five basic relationships have been proposed in the literature for the relationship between investments and access regulation, and a sixth emerges as a possible framework from our own case studies and review.

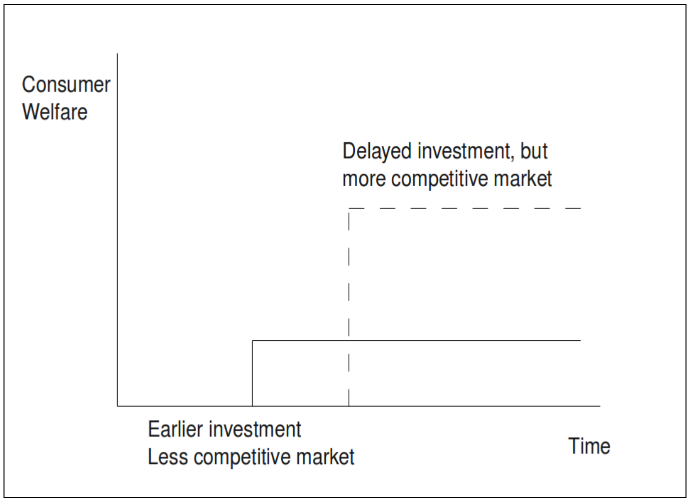
The simple theory that underlies the claim that access rules undermine investment argues that incumbents will not invest in their networks if they are forced to share their networks at inappropriately low rates. This includes two components. First, if the rates are set below costs, the negative effects are obvious, as investment will immediately have a negative value. Hausman (1998) argues that the sunk-cost nature of many of the core network investments made by incumbents, and changing technology, can systematically lead forward-looking price regulation to be too low. Second, the fixed and sunk costs make the investments in broadband infrastructure analogous to investments in innovation (Hausman 1998; Gayle and Weisman 2007), and so the innovation is pursued in expectation of rents derived from a non-competitive market (See also Pyndick 2007). The investment is driven by the expectation of rents from the downstream product, just as investment in innovation is driven by patents that exclude competition, in a downstream product market that is less competitive than it would be with access regulations in place. According to this theory, incumbents would invest less when they are subject to unbundling, unless the prices for the elements would compensate them for all the unsuccessful innovations they installed. We note, however, that just as in innovation economics, if the prices are too high they will deter entry by entrants, and the welfare and innovation benefits that would come from that entry would be lost (Gayle and Weisman 2007).[63] As a result, whether unbundling will or will not undermine investment, and what rates would induce the most dynamically efficient levels of investments by both, depends on the effects on both incumbents' and entrants' incentives.

The second approach similarly posits that investment will undermine investment incentives, but also accepts that unbundling and open access improves competition, and during the period after investment, consumer welfare is enhanced by the more competitive environment that uses the infrastructure (Hoffler

63 Gayle, P., & Weisman, D. (2007). Efficiency trade-off in designing competition policy for the telecommunication industry. Review of Network Economics, 6(3), 322–341.

2007). Figure 4.1 describes this relationship conceptually (Alter 2009). The basic trade-off for infrastructure that represents a very long term investment, as in the case of the passive elements of next generation networks, such as the trenches, ducts, holes, and dark fiber which may persist for twenty or thirty years, is the cost of delayed deployment compared to the value of increased welfare over the lifetime of the installed infrastructure.

Figure 4.1. Tradeoff between time of investment and welfare generated by the investment over its lifetime. Based on Alter 2009



The third, best-known theory in favor of unbundling is what was in the U.S. referred to as stepping-stone, and what is referred to now in Europe as "investment ladder," introduced by Cave and Vogelsang (2003).[64] The basic idea is that entrants will initially enter the market using wholesale access and later move into unbundled loop access, initially leasing those aspects that are hardest for them to replicate. Then, over time, entrants may be able to build a brand and customer base and shift over to compete on their own facilities to free themselves of dependence on their competitor. We will turn to the empirical literature testing these various hypotheses shortly, but we first note that our own case studies do lend some support to the investment ladder theory, but suggest that there is room for further theoretical development. In the Nordic countries, investment ladder seems to have worked through investments in the form of consolidation by the neighboring incumbents entering each other's territories, in part by buying existing facilities from cable and power plant owners, combining with unbundling providers, and expanding their reach. In Japan, Softbank's moves into mobile and (very recently) fiber are consistent with the theory; and in France, the current (small) actual investments and (large) planned investments by Iliad in fiber, as well as the large investments in fiber in the core of the network by Neuf and Cegetel (Fevrier and Sraer 2007) are also consistent with that theory. There is stronger evidence for a less complete version of investment ladder, or for its existence at an early stage, indicated by the move from bitstream—which allows entry with lower investment but less flexibility—to unbundling, which requires more investment on the part of the entrant and gives it greater flexibility to use the electronics it prefers and to innovate in services. Data gathering by the organization of European entrants, ECTA, on the relative use of bitstream versus unbundling lines over the past few years shows that in a majority of countries for which there is data, unbundling is increasing at the expense of bitstream while total entrant lines are also increasing. This includes in particular the UK after functional separation, as well as Austria, Denmark, Finland, France, Germany, and Italy.

64 Cave, M., & Vogelsang, I. (2003). How access pricing and entry interact. Telecommunications Policy, 27(10–11), 717–727.

A fourth theory suggests that greater competition will spur investment. It suggests that low cost unbundled elements lower the costs to entrants, who in turn can offer lower cost and more differentiated products to consumers. These low cost, new products increase the consumption of communications services which in turn improves incumbents' cash flow as long as the rates are not set too low (Chang, Koski, and Mujamdar 2003; Friederiszick, H., Grajek, M. & Roller, L. 2008)

A fifth, new conceptual framework is proposed by Bauer (2010).[65] Bauer offers a neo-Schumpeterian model that sees regulatory policy as playing a role in a market dynamic in which many players, both regulated and non-regulated entities, react to a set of regulations. On the question of the relationship between open access or market-structuring regulation and investment, Bauer (2010) relies on a neo-Schumpeterian innovation model that suggests that the market structure most conducive to long-term, dynamic investment is one where there is neither too much concentration, nor too much competition. Instead, a small set of large firms, with smaller firms constantly contesting, but with sufficient scope to provide a serious threat, is most conducive to dynamic investment. How to reach that state may vary from country to country, and is unlikely to be a single, one-shot decision, but will require continuous updating and "fine tuning" over time. The basic neo-Schumpeterian model is consistent with the experience of countries that have a small number of moderately sized competitors to a large incumbent—such as in Japan, France, the Nordic countries—along with the tendency in the past few years for larger players to consolidate several smaller entrants—be it Telenor in Sweden, Carphone Warehouse in the UK, or SFR in France. It is also consistent with the findings of Jung et al. (2008), that while a larger market share of entrants positively effects incumbent investment, the number of entrants does not. The core question that this model presents for the U.S. is whether two is a sufficiently large number of competitors to sustain that dynamic, or whether the regulatory toolbox needs to include a set of tools that can increase the number of competitors and allow for the entry of newer, more agile competitors (Fransman 2006). It is important to note that while critics of unbundling will often quote evidence of consolidation in the entrant market as evidence against the feasibility of competition, this framework would actually interpret such evidence as a maturation of the entrants.

Finally, our own case studies, described below, and our synthesis of the various theories that support open access, as well as our observations of current plans for infrastructure sharing in Switzerland, the Netherlands, and perhaps in Germany and the adoption of functional separation in the UK, Sweden, New Zealand, Australia, and Italy (and voluntary effective separation in the Netherlands), suggest that as a practical matter regulators are edging away from investment ladder and towards a quite different theory, which has not been well articulated in the literature. These cases seem to suggest that much of the competition is carried on not by replicating the trenches and ducts, holes and poles, but by sharing a single, non-redundant high-capacity basic physical infrastructure, and investing in electronics or optics and innovation in processes and services. Open access allows separating out portions of the infrastructure that are slow moving, trenches, ducts, holes in walls, and making those either monopoly of duopoly at most, but allowing competition in electronics, optics, and services on top of that slower moving shared core. This theory would be supported by Chang et al. 2003; Jung et al. 2008, Hoffler 2007; Alter 2009; and Bauer 2010. The basic idea is that open access and unbundling is not necessarily a pathway to the development of completely redundant facilities, but might be channeled towards complementary investments around a shared common set of slow-moving, extremely high cost elements: the passive infrastructure. Facilities-based competition that grows out of the happenstance of existing incumbent infrastructure would then contribute to competition, but it would complement, rather than substitute, for competition over the shared facilities as well. Completely redundant facilities are a good, but socially costly, hedge against regulatory failure. In principle there is nothing about the

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65 Bauer, J., Regulation, Public Policy, and Investment in Communications Infrastructure. *Forthcoming* Telecommunications Policy. 34. 2010.

physical limitations of a trench, or a fiber optic cable that makes duplication of this infrastructure a pre-condition for competition. Rather, it is the concern that regulation will fail to detect anticompetitive behavior by the owner and operator of the shared infrastructure that the duplication insures against. Whether that insurance is worth the enormous social cost of redundant infrastructure, or the long term cost of reducing entry only to those actors able to fully duplicate facilities, is far from clear.

4.4.2 General notes on the empirical literature

Systematic limitations in cross-country econometric models

This section describes the systematic weaknesses of cross-country econometric studies that seek to identify causal explanations regarding the complex interactions that contribute to the impact of regulatory policies on the diffusion of broadband. The attractiveness and potential value of conducting quantitative, multivariate analysis of broadband policy is understandable. However, we conclude after extensive review that the quantitative analysis from a majority of these studies, particularly the cross-country econometric studies, does not offer meaningful guidance for policymakers.

The challenge of quantitative broadband policy analysis is to estimate the impact of policy choices on outcomes, most commonly Internet penetration or investment levels. In order to do so, the analysis must control for a large number of variables that are correlated with policy choices and have an influence on penetration or investment rates. This requires a solid theoretical basis for specifying a model and sufficient data to estimate the model. In most cases, neither of these requirements is met.

There are a large number of potential factors that influence broadband adoption and investment decisions. These may include income, demography, geography, local market conditions, financial markets, strategic behavior by firms as part of the regulatory negotiation problems, strategic behavior by regulators, existing technologies and infrastructure, inter-platform competition, the structure and composition of the telecommunications sector, and regional variation within countries, among many others.

Cross-country econometric studies are based generally on data from the 30 OECD countries or a set of EU countries. For each country, six observations over time are typically available. This is simply too few observations to tease out the interaction of these many factors. This factor alone is enough to severely curtail the utility of such studies. There are, however, several other issues.

A necessary step in quantitative policy analysis is finding an adequate measure of the relevant policy variables. However, many of the policy variables of greatest interest are difficult to observe and characterize. Assessing the level of regulatory intervention requires a measure of its effective implementation, rather than just the statement of policy goals and intentions. The policy of greatest interest here, unbundling, is often specified as a binary variable, obscuring important distinctions in the policy approaches taken across different countries. Others have proposed a variable that measures the time since the implementation of a policy to capture the learning, adjustment and investment period that companies and regulators need to settle into a new policy environment. This too glosses over important policy differences across countries. More fine-grained measures of different policy sets, even if available, compound the problem of few observations. Moreover, objective measures of policy implementation are generally unavailable.

Measures of another key variable, inter-platform competition are also highly imperfect. Inter-platform competition is typically measured by comparing the shares of the overall broadband market that are captured by different technologies, e.g. cable versus DSL. This is quite different from measuring the extent of head-to-head inter-platform competition in retail markets. Furthermore, not all technology platforms are distinct competitors, and countries differ in the degree to which the different technology platforms are used as anchors for competing firms, as opposed to being used by firms that combine platforms and compete across platforms; the extent to which this occurs is different in different countries.

The adoption of broadband Internet is subject to time diffusion effects, as with other new technologies. These general time diffusion effects are hard to separate out from the time effects of other factors, such as the quality of regulatory enforcement or the maturation of competition.[66]

Many of the variables of greatest interest are jointly determined (this is commonly referred to as "endogeneity" in the econometric literature). For example, multiple companies are more likely to compete in markets where there is high demand for broadband services. A modeling approach that seeks to explain high penetration by the existence of competitors without accounting for the simultaneous determination of these variables will render biased and unreliable results. More complex structural equation models and instrumental variable approaches are the standard remedy for these issues. However, such estimation techniques require more data and effective instrumental variables; neither of these is generally available in cross-country studies. Country or region-specific studies that have access to use richer micro-level data are better able to surmount this obstacle. A reduced-form modeling strategy, which drops the endogenous variables from the list of explanatory variables, helps to mitigate this specific problem, but at the cost of dropping many of the variables of prime interest. Panel data analysis is often able to overcome the specific problem of unobserved variables, but can not resolve all of the issues mentioned here.

Another issue with cross-country quantitative models is that they are often driven by the experiences of a small number of countries. This issue stems back to the fundamental data problem.

The issue of inadequate data alone is enough to cast serious doubts over the ultimate effectiveness of cross-country broadband policy studies. After careful review of the various cross-country studies and methodologies, we have concluded that the quantitative results from these studies offer little useful guidance to policy-makers, although several of these studies are well written, are carried out by highly competent researchers, and contain excellent background materials and perspectives well worth reading. This conclusion will come as no surprise to scholars from other fields that have a history with such analytical approaches. The study of economic growth, in particular, has seen innumerable cross-country econometric studies drawing on much richer data and highly sophisticated estimation approaches. Even there, this general approach has been out of favor for well over a decade.[67]

Given the shortcomings of quantitative cross-country studies, future quantitative studies are best carried out where more granular data is available, which is typically within a single country. Two recent studies, Alter (2009) and Sraer (2008), are good examples of such an approach. While quantitative work can be a powerful heuristic tool for researchers to identify areas for further scrutiny, investing faith in

66 Glenn Boyle, Bronwyn E. Howell and Wei Zhang. July 2008. "Catching Up in Broadband Regressions: Does Local Loop Unbundling Really Lead to Material Increases in OECD Broadband Uptake?" Available at: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1184339

67 See for example, Levine, Ross, and David Renelt, "A Sensitivity Analysis of Cross-Country Growth Regressions," American Economic Review, September, 82(4), 1992, 942-63. Durlauf, S. N., Johnson, P. A., & Temple, J. R. (2005). "Growth econometrics" In P. Aghion & S. Durlauf (Eds.), *Handbook of Economic Growth.* Elsevier. William Easterly, "National Economic Policies and Economic Growth: A Reappaisal" In P. Aghion & S. Durlauf (Eds.), *Handbook of Economic Growth*. Elsevier. Dani Rodrik, (2005) "Why We Learn Nothing from Regressing Economic Growth on Policies" Available at: http://www.hks.harvard.edu/fs/drodrik/policy%20regressions.pdf

the numerical results rather than the much richer historical and qualitative information is misguided. We believe that a more instructive alternative approach to international comparisons is qualitative case studies. This is the approach that we have chosen for this study.

A note about the role of industry-sponsored research into telecommunications policy

We organize our review based on year of publication and type of author or sponsor. We do so because, as we worked through the review, it became clear to us that the genre of literature review tends to "wash out" the disclosures that many of the authors properly make in their papers. We cluster the reviews in each of the sections into three groups: government employees and commissioned reports; academic work, as well as work in think tanks where there is no clear evidence of direct industry sponsorship; and industry-sponsored work. This is most important in the section on unbundling and investment, where more than half the papers widely cited as pertinent were sponsored by industry. While we think that all work should be considered, as in many other disciplines, where empirical work is written to the specifications of a party with a direct commercial interest in the outcome, the work needs to be handled with a high degree of skepticism. This is true for the econometrics work in particular, because of its high sensitivity to the precise technique and model used, and the opacity of its techniques to the vast majority of policy makers. In the telecommunications literature, there appears to be no general ethical disclosure requirement (although much of the work does properly disclose its sponsor), and no practice of giving substantially different treatment to papers written by interested parties, including those papers that are not only industry sponsored, but are also self-published and not refereed. Such papers are treated on par with peer-reviewed academic papers that were done without industry funding not only in other similar submissions, but even in the most recent comprehensive peer-reviewed literature review. We believe the Commission would do well to institute a set of rules or expectations about what sorts of disclosure would be required about a paper's funding before it can be seriously considered in the development of an evidence-based policy.

4.4.3 Econometrics studies of unbundling and broadband penetration

Here we offer a review of 15 quantitative papers that focus on the impact of broadband policies. A majority of these papers are saddled with the methodological issues associated with cross-country models described earlier. Of these papers, we found six papers that found an unambiguously positive impact of unbundling on penetration and three that had a negative impact, while the other six found either evidence in favor of both propositions or were unable to uncover any relationship.[68] All of the papers that studied inter-platform competition concluded that it had a positive impact on penetration levels. Three of the papers reviewed in this section were sponsored by industry. A majority of these papers are self-published by the authors or organizations for which they work. Six of the papers appear to have been in peer-reviewed publications.

68 This set of papers overlaps substantially with the 12 papers reviewed by Empiris, LLC, on behalf of both the National Cable and Telecommunications Association and the United States Telecom Association in response to our draft study. They come to remarkably different conclusions from our own assessment of the same literature: "the incontrovertible fact is that open access policies have not been shown to increase broadband adoption, availability, or infrastructure investment. To the contrary, the bulk of the available evidence points in the opposite direction." This response, filed by longstanding participants in the debates over telecommunications policy in the U.S., helps to illustrate why we were surprised by our findings. It well represents the state of the literature and sense of the U.S. telecommunications policy community in the past few years that open access policies had been academically disproved.

Table 4.2. Papers on Unbundling and Broadband Penetration

Citation	Published=1 Self-pub=0	Sponsor	Impact of inter-platform competition on penetration	Impact of open access policies on penetration +, -, +/-, 0	Comments
Government / Int'l organization					
Grosso 2006	0	Australian Competition Authority	N/A	+	OECD 30, 1999-2005.
Denni & Gruber 2007	~1 (not clear whether refereed)	EU Investment Bank; Italian competition authority	+ platform competition strongly positive	0, +/- small number of largish entrants beneficial	U.S. data only from 2001-2004; period with strong incentives to game regulatory system (U.S.)
De Ridder 2007	0	OECD	+ / 0	+	OECD 30; 2002, 2005; uses multiple factors; seeks to identify the effects of unbundling over time
Sraer 2008	0	ARCEP; academic	N/A	+	French data from 2006; micro-data from 1500 exchanges in France; strong instruments on entrant investment and penetration
Academic/ Think tank					
Bauer et al 2003	0	N/A		0	Old data (2001 and pre-); early innovative effort to quantify effects; Uses broad policy baskets; no policies significant
Garcia-Murillo 2005	~1	N/A	N/A	+	Older data (pre-2001). ~100 countries. Unbundling positive and significant for middle income countries, not low income countries; logit and OLS regressions, various models; not significant in some.
Distaso, Lupi, and Manteni (2006)	1	N/A	+ platform competition strongly positive	+ low LLU rates increase penetration	Paper emphasizes the inter-platform competition effects. Findings support mixed strategies
Wallsten (2006)	0	N/A	N/A	+/- different forms of open access have positive, negative, or no correlation with penetration	Paper sets out different types of unbundling regimes; finds that different forms, with different specifications, show up as alternatively significantly positive; insignificant; or negative.

Citation	Published=1 Self-pub=0	Sponsor	Impact of inter-platform competition on penetration	Impact of open access policies on penetration +, -, +/-, 0	Comments
Cava-Ferreruela and Alabau-Munoz (2006)	1	N/A	+	0/+	Older data (2000-2002); "Cable" represents houses passed, not actual cable upgraded to broadband; LLU formal application trends positive, not significant; likely reflects strong role of cable in early success of U.S. & Canada.
Hoffler (2007)	1	N/A	+	+ lower LLU prices increase penetration	Analyzes welfare effects of facilities based competition; suggests duplicative investment in facilities may impose more welfare costs than provide gains
Boyle, Howell, and Zhang (2008)	0	N/A	N/A	0	Authors point out that it is systematically impossible to separate the effects of straight diffusion time from the effects of unbundling over time
Hazlett & Caliskan (2008)	1	N/A	N/A	-	Fails to account for time diffusion effects; mistaken characterization of legal regime used as instrument
Industry supported					
Aron and Burnstein (2003)	0	LECG		- higher-penetration where both cable and telco present	Old data (pre-2001); finds higher penetration where cable present, during period when cable primary mode of delivery
Waverman 2007	0	ETNO		-	Lobbying document; emphasizes that unbundling-based access undermines investment in cable
Bouckaert et al (2008)	0	Belgacom	+	0/- resale decreases penetration; unbundling has no effect	Very weak significance on all; case study component suggest learning from French and Dutch markets that unbundling is better than resale-based competition

Unbundling and Penetration: Government-sponsored Studies

Grosso (2006)[69] is a working paper by a researcher at the Australian competition authority. It uses OECD data from 2001-2004, and reports a positive effect for unbundling on penetration significant at the 1% level.

Denni and Gruber (2007)[70] is a paper in a journal published by the market analysis firm IDATE. It analyzes data from the U.S. from 2001-2004, that is, exactly the period during which the FCC and the incumbents were battling over whether to eliminate unbundling altogether, between the initial introduction of the idea of inter-modal competition and its final approval in *Brand X* and the Triennial Review process. The authors find unambiguously that inter-platform competition is beneficial for diffusion. They find that intra-platform competition is beneficial to diffusion only if the number of firms entering through unbundling is not too large: "in the case of ADSL lowering the market share of the incumbent is beneficial as long as the market detained by the entrants is not too fragmented." The authors use the Herfindahl index to measure inter-platform competition, but refer to technologies market-shares as opposed to firm's market share (this is less fatal in the U.S. context, as in this paper, than it is in real international comparisons, as is used for example in another of the papers, (Waverman et al 2007), where it masks the fact that in some high performing countries cross-technology-platform competition is used to complement unbundling-based competition, rather than as its alternative). This paper looks at U.S. data alone, from a period of intense political maneuvering around the negative investment effects of open access, and so potentially reflects strategic behavior on the part of either incumbents or regulators, rather than any real incentives effect.

De Ridder 2007 was discussed extensively in our draft report, as well as in the comments. Authored by an economist at OECD and published by OECD, that report seeks to identify the effects of diverse variables on penetration. The paper finds a significant positive effect on penetration from the years since unbundling was enacted. It was critiqued in Boyle et al. 2008; we discussed both the paper and the critique, confirming in the main de Ridder's findings in our draft report; our discussion was in turn critiqued in the comments; we provide a response to a version in the annex to this part.

Sraer (2008)[71] is a working paper by an academic; based on work done for the French regulator, ARCEP. Using sophisticated analysis and instruments, and fine-grained data from 1,500 local exchanges in France, representing over 70% of the French market, collected in 2006, Sraer finds that unbundling-based entry by even one entrant results in an increase in penetration of between 1.1% in the short term and 5.9% in the medium term. This represents almost a full standard deviation in penetration rate. The underlying data in the paper shows that unbundling-based entrants invest in their own fiber backbones and complementary investments to the incumbents' local loop. Moreover, the paper shows that while the effect is partly driven by price competition, a large part of it cannot be explained by price, suggesting that quality or marketing efforts in the competitive market play a role in increasing adoption.

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69 Marcelo Grosso, "Determinants of Broadband Penetration in OECD Nations," Working Paper, Regulatory Development Branch, Australian Competition and Consumer Commission (2006).

70 The Empiris declaration cites this as Denni and Gruber 2005. That unpublished conference paper was later published in a market analysis firm's publication, IDATE's Communications and Strategies. M. Denni and Gruber H., The Diffusion of Broadband Telecommunications in the U.S. Communications and Strategies (IDATE) No. 68, 4th Q, 2007, 139-157.

71 David Sraer. 2008. Local Loop Unbundling and Broadband Penetration. Unpublished MS.

Unbundling and Penetration: Academic and Think Tank

Two widely-cited early papers use older data, from before 2001. These early efforts were innovative for their time, but because unbundling began in earnest as a policy only at around that period, the use of the older data necessarily limits the degree to which the data can provide strong insights. Bauer et al. (2003),[72] an unpublished conference paper, was an effort to use OECD data for 26 countries to extract lessons about policy. It tried to account for a very large set of potential causes, and used relatively broad baskets to classify countries into one of several regulatory categories. Given these broad baskets, the wide range of potential explanatory variables, and limited observations, it is not entirely surprising that the study did not find statistical significance for any of the policy variables. The second academic paper that relies on old data, Garcia-Murillo (2005),[73] is a paper published in an IDATE journal. The paper analyzes data from about 100 countries, from very early in the development of broadband. It includes price as well as unbundling, which creates difficulties. It finds particular significance in middle income countries, not in higher-income countries, although it is important to recall that 2001 is prior to effective implementation in many countries, both high and middle income.

Distaso, Lupi, and Manteni (2006)[74] is a paper published in a peer-reviewed journal that develops a theoretical model that predicts that inter-platform competition will be more important than intra-platform competition. The authors then test this model on 14 countries. It is important to note here that the paper defines "penetration" not by actual uptake by consumers, but rather by percentage of all lines upgraded to transmit high-speed data. Consistent with their model, the authors find that inter-platform competition is a significant driver of broadband adoption. This is not controversial; no one who supports unbundling denies that inter-platform competition, in addition to unbundling, is beneficial. Distaso et al also find a significant association between lower unbundling prices and higher levels of penetration. Conceptually, this is not surprising: lower unbundling rates attract competitors, greater retail competition leads to lower prices and better services, which in turn increase demand. Because of this finding, and the noncontroversial claim that inter-platform competition contributes to penetration, Distaso et al. is more supportive of unbundling than of the proposition that it does not matter, much less that it is harmful.

Wallsten (2006)[75] is a think tank working paper that is often cited as empirical support for the proposition that unbundling has no effect or is negative. The characterization of this paper as providing evidence that unbundling does not work is surprising. In the original paper, the author describes his findings thus:

> I begin by estimating a simple ordinary least squares regression without any fixed effects. The first three columns of Table 1 show the results of this series of regressions. Full unbundling (LLU) is significantly positively correlated with broadband penetration. Including also bitstream and subloop unbundling changes the results somewhat: LLU remains positive and significant, bitstream is not statistically significant, and subloop unbundling is negative and significant. Including year fixed effects to control for the general increasing trend in broadband penetration has little impact on the other coefficients. This series of regressions

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72 Bauer, J. M., Kim, J. H., & Wildman, S. S. (2003). Broadband uptake in the OECD countries: policy lessons and unexplained patterns. Paper presented at the 14th European regional conference of the International Telecommunication Society, Helsinki, Finland. August 23–24.

73 Martha Garcia-Murillo, "International Broadband Deployment: The Impact of Unbundling," Communications & Strategies 57 (2005)

74 Distaso, W., Lupi, P., and Manenti, F. Platform competition and broadband uptake: Theory and empirical evidence from the European Union. Information Economics and Policy. 18(1) 87-106.

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

> seems to suggest that local loop unbundling is correlated with higher broadband penetration over time, while the more extensive subloop unbundling reduces growth in broadband penetration.
>
> [After explaining that density has a significant impact on penetration, independent of regulation, Wallsten continues:]
>
> Table 2 shows the results of a similar, but more extensive, set of regressions controlling for country and year fixed effects. Here, LLU by itself is not significant. The results on the LLU coefficient are, in general, ambiguous in this set of regressions. Under some specifications it is positive and significant, under some it is insignificant, and under one it is negative and significant. Bitstream access is positive, but is not always statistically significant. Subloop unbundling—the most extensive type of unbundling included here—is negative and statistically significant under all specifications.
>
> Unbundling regulations typically coincide with other regulations on collocation and wholesale pricing. Including these additional regulation variables causes the coefficient on LLU to become insignificant (and in one case negative and significant), while bitstream access becomes just barely significant at the 10 percent level or insignificant. Subloop unbundling remains negative and significant. The coefficient on commingling is positively correlated with broadband penetration though it is insignificant in a few cases. Virtual collocation is negatively correlated with penetration. Regulatory approval of line rental charges is positively correlated with penetration though not always significantly, and approval of collocation charges is negatively correlated, though again, not always significantly. (Wallsten 2006 12-13).

In its discussion, the paper begins with its findings on subloop unbundling and price-regulation of collocation, concluding that "These results support opponents' view of unbundling by suggesting that extensive unbundling (like the sort mandated in the U.S.) has a deleterious effect on broadband investment." The paper immediately follows this conclusion, however, with the acknowledgement that "Other results, however, suggest that regulation can also be an important tool in promoting broadband adoption. Rules that might be interpreted as making it more difficult for the incumbent to exercise market power—but without putting the incumbent at a disadvantage—seem to foster broadband adoption" (Wallsten 2006, at 16). The recent literature review, Cambini and Jiang (2009, described below), similarly categorizes Wallsten in the set of papers that tend to support unbundling, concluding their analysis of the paper thus: "Results show that if it is true that extensive obligations on the incumbent reduce broadband penetration, regulation per se could also be an important tool in promoting broadband adoption and milder regulations ensuring easier interconnection with the incumbent can increase penetration and investment."[76] In other words: if one sees sub-loop unbundling as excessive regulation, less intrusive forms of access regulations are shown to be an important tool in promoting broadband adoption. As with the other studies in this section, this paper suffers from the limitations of quantitative cross-country policy analysis described earlier. In particular here, it is unclear if the explanatory policy variables reflect actual policies or are merely reflective of policy aspirations at the time.

Cava-Ferreruela and Alabau-Munoz (2006)[77] is published in a peer refereed journal with no industry sponsorship. It uses panel data from 2000 and 2002, still reflecting mostly older data. The authors find that inter-platform competition has a statistically significant effect on broadband penetration among

76 Cambini and Jiang, at 568.

77 Inmaculada Cava-Ferreruela & Antonio Alabau-Munoz, "Broadband Policy Assessment: A Cross-National Empirical Analysis," Telecommunications Policy 30 (2006) .

OECD countries. They define "cable" broadly, however, to include all cable TV, whether or not upgraded for broadband. Their positive findings therefore suggest that countries with cable TV and the possibility of cable-based competition do better, and cannot separate out countries that actually have cable broadband competition. In the extreme case, this would include Germany, a country with high television cable penetration, but where cable broadband only began to grow long after that study was concluded. Moreover, their analysis shows that countries with mandated unbundling and actual loops used for unbundling have higher penetration, but the effect is not statistically significant using their specifications. This is also a paper from a very early period, when the U.S. and Canada were both doing extremely well, and both had high cable penetration. While we have not re-analyzed their data for this review, this observation would make the data a good candidate to test for the degree to which the early, cable-based lead of these two major countries influenced the results.

Hoffler (2007)[78] is by an academic, published in a refereed journal. It shows no indications of industry involvement. The paper uses data from 16 European countries, between 2000 and 2004. The paper has results that are similar to those of Distaso et al. 2005, focusing on broadband performance and, to a lesser extent, investment. The paper finds that head-to-head competition between cable and telephone infrastructures has the highest effect on broadband penetration, and estimates the contribution of cable competition as an increase of about 2% in penetration, with about 4% attributed to the presence of cable in the countries where cable had the strongest presence. The paper also finds that lower unbundling rates have a statistically significant effect on broadband penetration. The interesting additional twist in this paper is more theoretical than empirical—the author estimates whether the benefits of inter-platform competition, in terms of broadband penetration, are worth the costs of redundant investment in infrastructure. Using price and capital expenditures data from the period from his 16 European countries, the author calculates that the total welfare effect of inter-platform competition was at best neutral, and quite possibly negative because the welfare losses of duplicating facilities were not offset by sufficiently large welfare gains from the added facilities-based competition.

Boyle, Howell, and Zhang (2008) is a think tank paper.[79] It criticizes De Ridder 2007, and was discussed extensively in the original draft of our report.[80] Its core claim is that it is not feasible to separate out the effects of simple passage of time on the diffusion of broadband from the effects of regulation over time. We agree with the broad claim about the systematic difficulty of separating out the effects of technology diffusion over time from the increased effects of regulation over time, although we disagreed in our original report with the technique used to apply that insight to De Ridder's data and analysis.

Hazlett and Caliskan (2008)[81] is an academic paper with no observable sponsorship. It provides an excellent illustration of two of the major difficulties presented in econometric studies of the causal role of policy on penetration: separating out policy from technological diffusion rates, and separating out whether and when a rule is technically adopted from whether and when the rule is in fact subject to effective regulatory implementation. The paper seeks to estimate the impact of changes in the regulation of access to telco infrastructure as a natural experiment in studying the effect of regulation on penetration. To do so, the authors compare adoption rates of different broadband technologies in the U.S. under regulatory regimes that change over time. First, they observe that cable broadband was

78 Höffler, F. (2007). Costs and benefits from infrastructural competition: Estimating welfare effects from broadband access competition. Telecommunications Policy, 31(6–7), 401–418.

79 The New Zealand Institute for the Study of Competition and Regulation is funded by Telecom New Zealand along with several other companies.

80 Howell submitted a response to our draft report critical of the econometric methods employed there.

81 Hazlett, Thomas and Anil Caliskan. 2008. Natural Experiments in U.S. Broadband Regulation, Review of Network Economics. 7(4) 460-480.

subject to no access obligations throughout their study period. Second, DSL was subject to three different regulatory regimes over this period: before February 2003, when the FCC formally eliminated DSL line-sharing rules; from February 2003 until August 2005, when line-sharing was no longer required, but the incumbent telcos were still regulated as carriers; and after August 2005, when telcos, like cable companies, were no longer treated as telecommunications carriers for Internet service, but as information services. The hypothesis is that, if unbundling and line sharing increases penetration, then one should see higher growth rates in DSL than in cable from the 1996 Act on; that one should see higher growth rates during the period of line sharing, and lower growth rates after line sharing was abandoned, as well as after carriage is ultimately abandoned in 2005. The papers primary findings are focused on the effects of line sharing. The authors take the growth rate between Q1 1999 and Q1 2003, and use that growth rate to project what the expected level of penetration would have been in Q4 2006 had the same growth rates continued, and claim that DSL penetration was in fact 65% higher than projecting forward the growth rate from Q1 1999 to Q1 2003, while cable was only 11% higher. They rely on this relatively higher deviation from trend by DSL to reject the hypothesis that abandoning unbundling would have a negative impact on DSL penetration growth rates.

First, the paper presents an excellent example of the difficulty that econometrics faces in separating out time diffusion effects from policy effects. What the paper assumes away is that the two technologies were at different stages of what is known to be a nonlinear diffusion curve, or an S curve, where early in the development of a technology its diffusion proceeds slowly, as it catches on, its diffusion rate increases to the sharp incline part of the curve, and as the technology matures and has already been adopted in much of the market, its growth rate again flattens out. As the paper notes, cable modem service was introduced in the U.S. as early as 1995. DSL started much later. The FCC's first 706 Report[82] from 1999, for example, reports that there were, at the time, 350,000 cable modem subscribers in the U.S., but only 25,000 DSL subscribers. The Report describes DSL as a technology in the early stages of deployment: “BOCs and GTE have announced plans to offer broadband to approximately twenty million homes this year. SBC has announced a 'massive rollout' of ADSL, targeting more than 500 central offices and 9.5 million residential and business customers by year-end. In Bell Atlantic's service area, ADSL is available now to some customers in the Washington, D.C., area and in Pittsburgh, with plans to add Philadelphia and the Hudson waterfront of New Jersey next year. ”[83] This was the state of relative deployment during the last report before the FCC adopted its November 1999 line sharing order, which announced the regime purportedly tested in the Hazlett and Caliskan paper. The two technologies were clearly at different places on their diffusion curve during the period of observations from which the projections are made. Projecting forward from the beginning stage of a technology diffusion curve will, of necessity, understate the anticipated level of diffusion into the future. When the baseline for the projection is from a later stage in the diffusion of a technology that follows an S curve, but while its diffusion is still accelerating, the projection will deviate less from the later-observed results—consistent with Hazlett and Caliskan's observations about cable penetration deviating only 11% above their prediction. When the projection is from the earlier part of the curve, the anticipated underestimation would be much greater, as indeed they encounter. In this regard, if one observes the market shares of cable and DSL in Switzerland (See below, country case study on Switzerland), which had no unbundling throughout the relevant period, one again sees the same pattern—early diffusion of broadband over cable, followed by later introduction of DSL and then massive growth of the later DSL technology leading to its overtaking cable. South Korea experienced a similar pattern (although cable entry there was itself open access; the telco lines used for DSL were not unbundled until 2002). In both Switzerland and South Korea the pattern is complex to interpret because of the strength of the national incumbent as the main DSL-based player. The reference to the two here is

82 First 706 Report, Docket No. 98-146. January 28, 1999.

83 Id., at the text associated with footnotes 85-90.

merely to provide baseline reference for the fact that it is unlikely that the later adoption of DSL was itself the result of the regulatory regime, but rather reflected the relative technological state in which cable and telephone lines existed in the late 1990s. Cable's upgrade path to broadband occurred earlier than the telcos' migration path, which had a later start and later climb up the diffusion S curve for DSL.

Second, the paper is an excellent example of the difficulties of identifying the effects of regulation stemming from the difference between formal or technical adoption of a regulation, and its effective implementation. The Line Sharing order that provides the core instrument for Hazlett and Caliskan was passed in November 1999, two or three quarters after the beginning of the time series that the authors apparently use as their source of projection: Q1 1999. Moreover, the order was immediately challenged. It was vacated and remanded to the FCC in May 2002,[84] almost a year before the formal abandonment by the FCC that Hazlett and Caliskan use as the end point for their "instrument." In other words, during 6 or 7 out of 17 quarters that they treat as being under the line sharing regime, in fact that regime is not in place; and this does not account for any reticence on the part of entrants to invest in entry while the suit is pending throughout the formal existence of the rule, as well as the clear signals from the FCC as early as late 2001 early 2002 that it was going to change regulatory direction (see discussion of U.S. as baseline case, below).

Unbundling and Penetration: Industry sponsored

Aron and Burnstein (LECG 2003)[85] is a self-published paper produced by a consulting firm that essentially finds the entirely unsurprising fact that there was higher broadband penetration in the U.S. where cable and telco provisioning occurred. This finding is expected given that the data is from 2001 and the early dominance of cable broadband in the U.S. before 2001. Their results are potentially skewed by a failure to control for endogeneity as the causation in this specification is not clearly unidirectional.

Waverman et al. (2007)[86] is a consultancy report produced for ETNO, the lobbying organization of the European telecommunications incumbents, as part of the European policy debate over levels of access regulation. Its executive summary makes very clear that it was written in response to the European Commissioned study by London Economics and PriceWaterhouseCooper (2006), that had concluded that "Results of our regression model show that better performing regulatory regimes, as measured by the OECD regulatory index, contribute to higher investment levels. "[87] The Waverman et al document focuses on the effects of unbundling on the rates of subscription to alternative access platform. In its executive summary, that report states:

> More intense access regulation, as measured by a lower LLU price, stimulates intra-platform competition and may cause the overall broadband market to expand. However, it also causes a substitution away from broadband offered over alternative access platforms to copper-based platforms. Thus, lower access prices may lead to a reduction in the total number of subscribers who take up broadband offered over alternative infrastructures if the substitution effect

84 290 F.3d 415. (D.C. Cir. 2002).

85 Debra J. Aron and David E. Burnstein, "Broadband Adoption in the United States: An Empirical Analysis," Abstract, (2003)

86 Waverman, Leonard, Meloria Meschi, Benoit Rellier, and Kalyan Dasgupta. 2007. Access Regulation and Infrastructure Investment in the Telecommunications Sector: An Empirical Investigation. LECG Ltd.

87 London Economics and PriceWaterhouseCoopers, "An Assessment of the Regulatory Framework for Electronic Communications—Growth and Investment in the EU e-Communications Sector", Final Report to the European Commission, July 2006. (Note that the London Economics document underscored this conclusion even though its regression model only showed that regulatory indexes were significant at the 13% level, which would not normally be considered statistically significant.)

> dominates the market-expansion effect. Our analysis tests for the strength of the substitution and market expansion effects of lower LLU prices, and quantifies the reduction in the number of subscriber lines served over alternative access infrastructures.

In other words, this document does not make a clear case that open access policies reduce competition or broadband access in the countries in which it is implemented. Instead, it falls back on hypothetical analysis of "what if" to produce hypothetical numbers of lost investment in alternative infrastructures. Essentially, what the report stands for is that open access policies increase competition in markets, and reduces the broadband market share of cable operators. That a larger market share for cable operators is itself a desirable policy goal is assumed, because of the assumed benefits of inter-platform competition. But the paper is not written in a way that allows one to confirm or deny the possibility that this loss of subscribers for the cable operators is not more than made up for by the gains for consumers and entrants. The most the report can say is that Europe will lose investment, arguing that for "a hypothetical 'Europe' (defined in Section 5), the lost long-term investment in alternative access platforms exceeds 10 billion Euros as a result of just a 10 percent LLU price reduction. "[88]

Bouckaert et al (2008)[89] is a self-published paper supported by the Belgian telecommunications incumbent, Belgacom. It looks at the Belgian market, compares it to the French and Dutch markets, and also conducts an analysis of 20 European members of the OECD countries. This smaller number of countries, of necessity, weakens the analysis. Most of the conclusions, to the extent significant, are significant only at the 10% level. These conclusions are: (a) that inter-platform competition increases broadband penetration; (b) that resale at regulated rates has a negative impact on penetration; and that (c) they can identify no significant effect, positive or negative, for unbundling. Furthermore, the authors claim that "intra-platform competition may even reduce investment incentives," although their study does not actually measure or reflect investment. They do claim that lower prices and higher speeds increase penetration, but do not attempt to explain those with regard to the presence or absence of entry.

Unbundling and Penetration: Conclusion

In this section we reviewed 15 papers that studied the relationship between unbundling and broadband penetration. Of these 15, three reported unambiguous negative effects. Of these three, two were industry sponsored, one of which used old data and the other of which used hypothetical projections; the third, which was not industry sponsored, was methodologically flawed. Six of the papers found unambiguous positive effects. The remaining six papers were indeterminate.

4.4.4 Econometrics studies of open access, unbundling, and investment

There is substantially more literature, and more emphasis in the literature, placed on a particular causal model for the purported negative effects of unbundling: that is, the claim that unbundling in particular, and open access regulation more generally, undermines investment incentives. Several of the industry comments to our October 2009 draft report criticized us for focusing only on performance outcomes—price, quality, and penetration—and not on investment. These criticisms alleged that substantial literature supports the proposition that unbundling decreases investment, and in doing so cited a just-published literature review in Telecommunications Policy to support the argument. That literature review is indeed the state-of-the-art on this subject, and given the weight afforded to it by the comments, we will use it as the foundation of our own literature review. We do note, however, that the review

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88 Waverman et al p. 4.

89 Bouckaert, J., Van Dijk, T., & Verboven, F. (2008). Regulation and broadband penetration—what is required to regain speed in Belgium?. Belgium: University of Antwerp and Leuven. Available at: /http://www.ua.ac.be/download.aspx?c=jan.bouckaert&n=72967&ct=68422&e=184390 .

includes several papers that are perhaps inappropriately located in a literature review given their apparent roots in policy advocacy rather than impartial research. Nevertheless, we include them here only because they are included in that review. Upon reviewing the underlying papers, we largely concur with Cambini and Jiang's (2009)[90] own assessment:

> "The picture that emerges is not conclusive, and further research is still needed, both theoretically and empirically, to better understand the real impact of regulatory incentives on investments."[91]

Contrary, then, to the widely held background assumption in the telecommunications policy community in United States, as well as to industry claims in response to the draft publication of our study, the econometrics literature provides no definitive answer, and leads us back to affirming the centrality of the qualitative case studies. The theory that unbundling deters investment is not proven by the empirical econometrics literature or the theoretical literature. Neither, however, have any of the alternative theories that attempt to explain why unbundling would work been proven by econometrics. We are left to account for the fact that the United States has been doing less well since it abandoned open access than countries that effectively pursued various versions of open access over the last few years, and with rich, detailed case studies that explain what role open access played in making those markets that have performed better.

There are few peer refereed papers on the question of unbundling and investment. Many of the oft-cited papers are self-published. Moreover, this part of the literature exhibits a particularly large proportion of industry-sponsored research; over half the papers received industry support. Unfortunately, as the Cambini and Jiang (2009) literature review exhibits, papers by consulting firms explicitly funded by market-participants—either incumbents or entrants—are intermingled with academic papers with no distinction. Worse, the literature review effectively "launders" papers written by academics with appropriate conflict-of-interest disclosures, so that by the time they are discussed in the literature review that disclosure is no longer visible to the reader who encounters the results only by way of the review.

Twenty three papers are described in Cambini and Jiang (2009) as empirical papers bearing on the relationship between open access regulation and investment. As you will see in this review, not all of these in fact are empirical, but we will include them in this section because it is important to clarify their status, given their recent characterization as empirical papers on investment. Of those papers, we discuss Hausman and Sidak 2005 in the section on qualitative case studies, and included Wallsten 2006 and Hoffler 2007, both noted in the Cambini and Jiang review, in the penetration effects section, where each thematically belongs, rather than here.

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90 Cambini, C. and Jiang, Y. Broadband investment and regulation: A literature review. Telecommunications Policy (2009). 33 559-574.

91 Cambini and Jiang, at 559.

Table 4.3. Papers on unbundling effects on investment.[92]

Citation	Pub=1 Self-pub=0	Sponsor	Access on incumbent investment	Access on entrant investment	Comments
Government / Int'l organization					
London Economics & PriceWaterhouseCoopers (2006)	0	EU Commission	~+	~+	This study seeks to show that effective regulation increases investment. Uses surveys and annual reports data. Econometrics weaker than descriptive evidence.
Fevrier and Sraer (2007)	0	ARCEP		0	Highly granular data from 1500 French exchanges. No negative effects on entrant investments.
Academic/ Think tank					
Hausman 1998 (&1997)	1	N/A	- TSLRIC pricing will undermine incumbent investment because of sunk costs		Theoretical study.
Christodoulos and Vlahos (2001)	1	N/A	+ mix of LLU and facilities-based best; through increasing LLU prices over time	+ mix of LLU and facilities-based best; through increasing LLU prices over time	Theoretical study.
Chang, Koski, and Majumdar (2003)	1	N/A	+/- lower access prices correlated with more digital lines in U.S.; lower investment in EU		More data on U.S.; weaker data on EU. Uses interconnection rates, rather than unbundling.

92 We include here several papers that are not empirical that were described as such in Cambini and Jiang 2009 or mentioned in comments to our draft as in this category. We identify the papers that are theoretical, not empirical, in the comments.

Citation	Pub=1 Self-pub=0	Sponsor	Access on incumbent investment	Access on entrant investment	Comments
Guthrie (2006)	1	N/A	+/- various outcomes	+/- various outcomes	Theoretical; critical review of literature to 2006; concludes that impact on investment or welfare unknown theoretically or empirically at that time
Jung et. al (2008)	1	N/A	+ Market share of entrants, in particular access-based entrants, increased investment, but number of entrants did not	+ Market share, but not number, of entrants, effected positively	Suggests that a relatively small number of entrants with credible staying power: using lower cost unbundling to enter, and remaining through lack of dissipation by excessive entry, most beneficial to investment by both incumbents and entrants
Wallsten and Hausladen 2009	1	N/A	-	-	Heavily influenced by Lithuania and Estonia; problems with specifications; discussed in body of memo
Foros et al (2009)	1	N/A	+		Theoretical study.
Alter 2009	1	N/A	- delays investment; small negative welfare effects		Detailed micro-level data from Kentucky; investment delay likely strategic; negative welfare effects small
Industry Supported					
Crandall and Singer 2003	0	Criterion Economics	-		Numeric examples and hypothetical investment losses. Primarily critique of a different paper on jobs-creation
Ingraham and Sidak (2003)	1 (student edited journal)	Criterion Economics	- Two incumbents had higher volatility than market in tech-bubble crash; two did not		Highly questionable paper. Shows increased volatility in Verizon and Bell South stock higher than major indexes, SBC not higher; and hides in footnotes that Qwest also not higher. All during periods of stock bubble crash
Phoenix Center Bull. No. 5	0	AT&T (as entrant)	+		Criticized at the time by consultants for the other side; conclusions not pursued by authors later
Phoenix Center Bull. No. 6	0	AT&T (as entrant)	+		Criticized at the time by consultants for the other side; conclusions not pursued by authors later

Citation	Pub=1 Self-pub=0	Sponsor	Access on incumbent investment	Access on entrant investment	Comments
Crandall, Ingraham, and Singer (2003)	1	Criterion Economics	- Higher LLU prices lead to higher CLEC investment in own-facilities		Primarily theoretical; more limited data
Ford and Spiwak 2004	0	Phoenix Center / AT&T			Zip-code level broadband availability; significant at 10% level; this is not an investment paper at all; but a penetration paper with low significance and weak data
Hazlett and Bazelon (2005)	0	Verizon / Analysis Group	-	-	Heavy emphasis on lower investments post tech-bubble crash; weak causal connection to LLU
Zarakas et al (2005)	0	Brattle Group / AT&T?		+ LLU but with higher prices increase innovation	Agent-based simulation; not real data; heroic assumptions (3 facilities-based competitors; all with 100% immediate uptake for all investments)
Willig (2006)	0	AT&T	0/+		Not new evidence; discusses other work in a conceptual framework
Waverman and Dasgupta (2006)	0	France Telecom	-	-	Conceptual rather than evidence-based.
Pyndick (2007)	1	Verizon	-		Theoretical paper that reconfirms Hausman 1998 using option value.
Cadman 2007	0	ECTA	+	+	Part of same exchange with London Economics and Waverman 2007; uses more powerful econometric techniques than either of the other two pieces in that exchange
Friederiszick, H., Grajek, M., & Roller, L. (2008)	0	Deutsche Telekom	0 No effect on incumbent investment in fixed line, or in mobile	- Unbundling lowers investment by fixed line entrants; no effect on mobile entrants	Suggests that the absence of an effect on incumbent investment reflects that competition driving innovation and service increases demand to a point of compensating incumbents for the lower margin

Access, unbundling, and investment: Government sponsored

London Economics and PriceWaterhouseCooper (2006)[93] is a consultancy study, commissioned by the European Commission. It began a flurry of other papers, here represented by Waverman et al 2007 and Cadman 2007. It sought to evaluate the levels of investment by incumbents and entrants, and their determinants. The data reflected company annual reports and the results of a survey of companies. The report concluded that "Results of our regression model show that better performing regulatory regimes, as measured by the OECD regulatory index, contribute to higher investment levels." However, the descriptive data was more consistent with that statement than the econometrics, which showed significance only at a level slightly below what would conventionally count as weakly significant.

Fevrier and Sraer (2007) is an unpublished piece by academics who conducted a report for the French regulator, ARCEP. It uses highly granular data from 1500 Central Offices in the French market, and develops a sophisticated econometric model to study the effects of unbundling on entrant investment. Although it begins with outlining the game-theoretical prediction that entrants would "soften" their investment to avoid too harsh a level of competition in the second stage, their data suggests that unbundling does not in fact reduce entrant investment as the model would predict.

Access, unbundling, and investment: Academic and think tank

Hausman (1998)[94] is a restatement of portions of a 1997 Brookings paper that was included as a separate paper in Cambini and Jiang. The paper is a theoretical paper, not empirical. It argues that the fact that many of the investments incumbents make in the core of their networks cannot be reallocated to other uses when the regulated rate drops, their sunk-cost nature, given changing technology and reduced costs over time, will systematically lead cost-based price regulation to be too low. Hausman argues that fixed and sunk costs make these investments similar to investments in innovation, and incumbents would invest less when they are subject to unbundling, unless the prices for the elements would compensate them for all the unsuccessful innovations they install when entrants buy the successful network elements. This paper, while interesting in its own right on the question of the appropriate rates at which unbundling should be applied, does not speak to the question of whether unbundling, priced using a method other than TSLRIC (the technique discussed there), would in itself reduce investment.

Christodoulos and Vlahos (2001)[95] is a peer-refereed theoretical paper. It uses agent-based simulation to test three hypothetical cases: a market with only infrastructure-based competition, a market with only service-level (or wholesale) competition, and a market with unbundling. The paper concludes, "that a 'mix' of infrastructure and service competition, like the one promoted in the Netherlands, stimulates investment by both incumbents and entrants and offers better consumer benefits." It achieves this by initially offering low ULL prices to stimulate service entry and offer price competition fairly early on. However, it also provides an explicit way in which the ULL prices increase to forward-looking prices, allowing entrants to assess whether they should stay in the market and invest in their own infrastructure

93 London Economics and PriceWaterhouseCoopers, "An Assessment of the Regulatory Framework for Electronic Communications—Growth and Investment in the EU e-Communications Sector", Final Report to the European Commission, July 2006.

94 Cambini and Jiang list Hausman, Pakes, and Rosston (1997) (Brookings paper; non-refereed) and Hausman (1998) (book chapter) as Cambini and Jiang as two papers in the text. In the Table in that paper, they are both more correctly described as (Hausman 1998), though the table oddly refers to them twice: they are the same paper in relevant part (the 1997 piece includes additional discussions not pertinent here; the 1998 paper is the relevant subset). Hausman, J. (1998). The effect of sunk costs in telecommunications regulation. In J. Alleman & E. Noam (Eds.), Topics in regulatory Economics and Policy: The New Investment Theory of Real Options and Its Implication for Telecommunications Economics, Vol.34 (pp.191–204). NewYork: Springer.

95 Christodoulou, K., & Vlahous, K. (2001). Implications of regulation for entry and investment in the local loop. Telecommunications Policy, 25(10–11), 743–757.

or, should they not be as efficient, exit the market." As in the case of the Hausman paper, this is not an empirical paper, but a theoretical paper. It supports the proposition that some form of unbundling is beneficial, emphasizing the details of implementation as the relevant policy lever, in particular pricing, rather than the principle that open access regulation, properly designed, is superior to purely facilities-based competition. Its simulations are certainly consistent with the experience of the European countries we studied and Japan; although its emphasis on the beneficial effects of sunset and increasing rates is questioned by the experience of Canada. In this regard, the paper may understate the degree to which sunset periods that are too short will have an effect equivalent to unbundling prices that are too high and deter competitor entry.

Chang, Koski, and Majumdar (2003)[96] is a refereed journal article. The paper analyzes separately data from the U.S. on investment by ILECs under unbundling; and data from Europe. The U.S. data measured the ratio of fiber to total lines (this is long before fiber to the home; fiber here is in the network); and, separately, digitalization, or the ratio of digital to total fixed lines. In both cases, the target was to estimate the impact of regulation on investment in technological upgrading. The panel used included data from 41 local exchange carriers for a 5-year period from 1994-1998. Unlike many other of the studies here, it did test for influential points and removed outliers from the data. The weakness is that the paper uses access charges for interconnection as the measure of the open access regulatory intervention. While conceptually similar—in that interconnection is a form of (minimal) required access to the incumbents' network—interconnection pricing is not a perfect stand in for unbundling. The study finds that lower prices do not have a significant impact on fiber, but do have a positive significant correlation with digitization of lines. The authors hypothesize that the lower prices lead to greater competition, which in turn leads to lower consumer prices, higher usage, and higher cash flow to the incumbents, who in turn can reinvest it in increasing the capacity of the network to carry the new, higher demand. Their analysis cannot test that causal hypothesis. It does show a positive correlation between lower access prices and investment in leading edge technology of the time. The paper's results for Europe, however, trend in the opposite direction—suggesting that cost-based pricing methods and higher access prices induced higher investment. However, the paper's authors caution that their data on Europe is, as they put it, "relatively sparse, meagre and likely to be insufficient," and cannot account that for the period they were observing, one-third of the countries did not have an independent regulatory agency. The paper, then, overall offers stronger support for a positive effect of lower access prices on investment than for a negative effect, but is not conclusive.

Guthrie (2006)[97] is a refereed journal article by an academic with no industry support. It provides an exhaustive review of the theoretical literature on various forms of regulation, in particular price and access, of infrastructure industries, particularly power and telecommunications. Guthrie reviews the various arguments, considering a range of models, from those that predict delayed investment as a result of open access, where market conditions characterize investment as a waiting game, to models that predict excessively early investment, where firms find themselves in a preemption game. The author concludes: "First, the impact of access price levels on investment is not yet fully understood, even in the relatively simple situations described here. Second, even less is known about the overall impact on welfare. For example, even if higher access prices would accelerate investment, is this necessarily good for welfare?" (965). Guthrie concludes this 2006 article with the statement: "Almost ten years have passed since the Telecommunications Act transformed telecommunications regulation in the United

96 Chang, H., Koski, H., & Majumdar, S. (2003). Regulation and investment behaviour in the telecommunications sector: Policies and patterns in U.S. and Europe. Telecommunications Policy, 27(10–11), 677–699.

97 Guthrie, Graeme. Regulating Infrastructure: The Impact on Risk and Investment. Journal of Economic Literature. 44(4): 925-972.

States and economists still do not have a thorough understanding (theoretically or empirically) of how local loop unbundling affects investment. " (969)

Jung et al (2008)[98] is a refereed journal article that does not appear to have been sponsored by an interested party.[99] It uses panel and dynamic panel analysis from the U.S. market between 1997 and 2002. It finds that the market share of competitive entrants was positively correlated to investment by incumbents—that is, the larger the market share of entrants, the higher the investment—an effect statistically significant at the 1% level; that this continued to be true at the 1% level of significance for UNE-based entrants, but its significance was only at the 10% level for facilities-based entrants; that the number of CLECs was negatively-related to incumbent investment, and that when dynamic modeling was used the significance remained, but dropped to the 10% level. In other words, the results of this study are most consistent with the claim that the market share of entrants, particularly entrants with a serious prospect of successful entry, was positively correlated with incumbent investment. A small number of entrants increases the likelihood that these entrants will not foreclose each others' markets; unbundling-based access predicts faster entry than facilities based entry. In combination, these factors suggest that a direct and immediate threat of entry that might stabilize into sustained competition will result in higher investments by incumbents. This is indeed consistent with our findings in the case studies, where the entrants began either as a small number, as in Japan, or consolidated into a small number, as in the Nordic countries, France, or the UK after functional separation was introduced. It is also consistent with the approach in Bauer (2010).

Wallsten and Hausladen (2009)[100] is a recent study of the effects of unbundling on deployment of fiber-to-the-home in Europe. It has been cited frequently by industry comments to the initial draft of our report as evidence that open access policies clearly harmed, rather than helped, next generation connectivity. The paper is published in a peer-reviewed journal with no apparent industry backing. The paper analyzes data from 27 European countries, from 2002 to 2007, and claims to find a negative correlation between the presence of effective unbundling, as measured by the number of unbundled loops per capita, and the deployment of fiber to the home, as measured by FTTH subscriptions per capita.

Taking the actual model used by Wallsten and Hausladen without any critique, the paper is highly sensitive to specific country effects. Specifically, because Lithuania and Estonia, two post-soviet Baltic republics with dynamic governments and markets have no unbundling and substantial fiber deployments, their results drive the outcomes. In the annex to this part, we include replications of Wallsten and Hausladen Table 3a, in each case removing one country. What is important is to observe the effect of removing each country on the coefficients for unbundling to entrant and incumbent fiber (and similarly for bitstream.) The coefficient on incumbent fiber remains roughly -0.04, as it is in the original, when any single country is removed, except Estonia. When Estonia is removed, the coefficient is 0.000. Estonia is driving the entire result for effects of unbundling on incumbent fiber, reflecting the big moves by Elion, the wireline arm of the formerly state-owned incumbent, now majority owned by TeliaSonera, into fiber, leapfrogging the Soviet-era copper infrastructure. The coefficient on entrant

98 Jung, I., Gayle, P. G., & Lehman, D. E. (2008). Competition and investment in telecommunications. Applied Economics, 40(3), 303–313.

99 Its first author's affiliation is listed as SK Telecom in Korea, which is now a facilities-based entrant. However, the study is U.S. focused; the results, if anything, are least favorable to facilities-based entrants, and there is no disclosure of funding or support from SK Telecom. In combination, these factors lead us to categorize this paper as not industry sponsored.

100 Wallsten, S. and Hausladen, S. Net-Neutrality, Unbundling, and their Effects on International Investment in Next-Generation Networks. Review of Network Economics 8(1) 90-112. March 2009. Scott Wallsten was gracious enough to provide us with the data.

fiber remains within 5% to 10% of its original value in the table when removing any single country, except that it drops 40% when removing Lithuania, from -0.103 to -0.062,[101] and it drops about 25% when removing Estonia, to -0.079. Removing both of these fast-growing post-Soviet Baltic republics eliminates almost three-quarters of the effect, dropping the coefficient from -0.103 to -0.031.A similar relationship holds for the impact of bitstream. Estonia and Lithuania are essentially driving the results. To grasp the problem intuitively, however, one need not go to the regressions. Below is a copy of Figure 4 from Wallsten and Hausladen. It is easy to observe with the naked eye that Estonia and Lithuania have a highly unusual share of fiber (yellow), relative to virtually non-existent unbundling (blue).

Figure 4.2. Broadband Connections per Capita, Wallsten and Hausladen, 2009

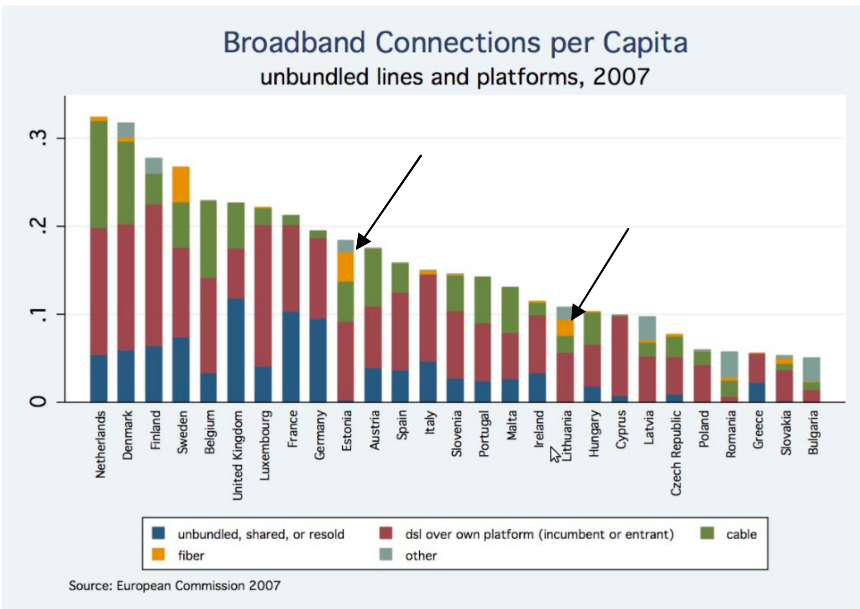

Figure 4: Broadband connections per capita

Rather than providing new insights into the relationship between fiber investments and unbundling, the quantitative analysis obscures the basic observation that these small post-Soviet countries share an unusual mix of broadband access conditions.

Second, it is important to understand that fiber subscription rates are co-determined by subscriber demand, as well as by supplier costs and investments. The most obvious confounder here is that if incumbents and entrants, in fierce competition though extensive use of combining their own fiber or electronics with incumbent copper loops, are successfully delivering 28 or 50 Mbps service at low prices, demand for fiber will be delayed. It is far from obvious that the welfare implications of delay in fiber deployment because of substitution to high speed, low cost DSL are negative.

Third, when treating cross-country data over time, as here, country-level clustering is appropriate. Without clustering, the model treats each year as an entirely new observation, as though the random unobserved effects in country X in year 1 are entirely independent of the random unobserved effects in

101 It is not entirely clear whose investments these entrant investments reflect, given that reports on Lithuanian fiber investment identify TEO LT, the incumbent, now majority-owned by TeliaSonera, as the primary source of fiber investment, alongside an EU-funded rural fiber project, RAIN.

that same country X in year 2.[102] Correcting this problem in the model results in larger standard deviations, smaller t-statistics, and loss of statistical significance even with Lithuania and Estonia in the dataset.

Table 3a: Without Lithuania

VARIABLES	(1) Entrant Fiber per Cap	(2) Incumbent Fiber per Cap	(3) Entrant Fiber per Cap	(4) Incumbent Fiber per Cap
Unbundled Lines per Cap	-0.062	-0.046		
	(0.042)	(0.049)		
GDP per Cap	0.009	0.025	-0.050	0.011
	(0.174)	(0.062)	(0.248)	(0.091)
Bitstream Lines per Cap			-0.188	-0.070
			(0.137)	(0.060)
Constant	0.004	0.001	0.007	0.001
	(0.005)	(0.002)	(0.007)	(0.003)
Observations	235	235	224	224
Number of Countries	26	26	25	25
Adjusted R-squared	0.15	0.05	0.20	0.05

Robust standard errors in parentheses
*** p<0.001, ** p<0.01, * p<0.05, @ p<0.1

Table 3a: Without Estonia

VARIABLES	(1) Entrant Fiber per Cap	(2) Incumbent Fiber per Cap	(3) Entrant Fiber per Cap	(4) Incumbent Fiber per Cap
Unbundled Lines per Cap	-0.079	0.000		
	(0.054)	(0.003)		
GDP per Cap	-0.043	0.027@	-0.087	0.021
	(0.142)	(0.015)	(0.211)	(0.017)
Bitstream Lines per Cap			-0.177	-0.015
			(0.134)	(0.014)
Constant	0.006	-0.001	0.008	-0.000
	(0.005)	(0.000)	(0.007)	(0.001)
Observations	235	235	224	224
Number of Countries	26	26	25	25

102 "Heteroskedasticity-Robust Standard Errors for Fixed Effect Panel Data Regression", James H. Stock and Mark Watson, Econometrica, January 2008, Vol. 76, No. 1, pp. 155-174.); Petersen, Mitchell A. "Estimating Standard Errors in Finance Panel Data Sets: Comparing Approaches." *Review of Financial Studies*. Volume 22, Number 1, 2009.

Adjusted R-squared	0.15	0.02	0.18	0.05

Robust standard errors in parentheses
*** p<0.001, ** p<0.01, * p<0.05, @ p<0.1

Table 3a without Lithuania and Estonia

VARIABLES	(1) Entrant Fiber per Cap	(2) Incumbent Fiber per Cap	(3) Entrant Fiber per Cap	(4) Incumbent Fiber per Cap
Unbundled Lines per Cap	-0.031	-0.000		
	(0.031)	(0.003)		
GDP per Cap	0.020	0.026@	-0.028	0.019
	(0.144)	(0.015)	(0.197)	(0.017)
Bitstream Lines per Cap			-0.138	-0.016
			(0.136)	(0.016)
Constant	0.003	-0.001	0.005	-0.000
	(0.004)	(0.000)	(0.006)	(0.001)
Observations	226	226	215	215
Number of Countries	25	25	24	24
Adjusted R-squared	0.11	0.02	0.15	0.06

Robust standard errors in parentheses
*** p<0.001, ** p<0.01, * p<0.05, @ p<0.1

Fourth, the use of unbundled access share as an explanatory variable is problematic. This variable is itself the result of a complex set of demand and supply relationships that match consumers with broadband providers shaped by government policy. This variable is jointly determined with the other broadband shares such as the share of broadband connections that are cable and fiber and does not thereby constitute an appropriate explanatory variable.

In conclusion, the Wallsten and Hausladen (2009) paper at most can be brought as evidence to focus attention on the positive experience of Lithuania and Estonia that have successfully and admirably emerged from their post-Soviet experience with increasingly advanced fiber networks.

Alter (2009)[103] is a refereed, academic paper. It uses micro-data from Kentucky and Bell South investments to quantify the effect of unbundling and regulatory jockeying on investment. The paper suggests that (a) investment is indeed postponed under unbundling; (b) the pattern of investment suggests strategic postponement more strongly than non-strategic; and (c) the welfare costs of delayed investment are not huge, and it is unclear whether they would outweigh the benefits of a more competitive market, even with delayed investment.

Foros et al (2009)[104] is an article in a refereed journal, authored by academics with EU science funding. It is a theoretical model, not an empirical model. The model takes a duopoly facilities-based market as its baseline, and explains the parameters under which "platform sponsors," that is, platform owners that provide access, either voluntarily or because of open access regulatory requirements, have an incentive to invest more in their network given the presence of access-based entrants. Their analysis combines

103 Alter, A., The Effect of Access Regulation on Broadband Deployment. Review of Industrial Organization (forthcoming).
104 Foros, Øystein, Hans Jarle Kind, and Jan Yngve Sand. 2009. Entry may increase networks providers' profit. Telecommunications Policy. 33(9), 486-494.

both the effects of the increasing size of the market brought about by network effects and service innovations by entrants, and the benefits of investment that differentiate the platform owner from entrants.

Access, unbundling, and investment: Industry sponsored

The Cambini and Jiang (2009) literature review lists several papers that are industry supported, without noting their provenance. It begins with six papers that are part of an exchange between, on the one hand, the Phoenix Center, apparently funded by AT&T when AT&T was an entrant and sought access to unbundled loops,[105] and Criterion Economics, whose clients include the major telecommunications incumbents, and whose principal authors at that period are now part of Empiris, whose declaration on behalf of the industry associations introduced this literature review into the comments. While it is important to read these pieces and understand their arguments and methods, in general it is also important to approach them cautiously, and treat these papers and others like them as a different species of paper than refereed, academic papers, or government agency or international body papers. These are papers prepared for and paid by competitors in a market, about the costs and benefits of regulatory changes then being considered by the FCC, whose outcome would affect their relative viability in the market. Their conclusions are all aligned with the interests of the commissioning party. Given, however, the complexity of the problems, the subtlety with which every minor assumption or choice in model specification can affect the results, such provenance counsels great caution on the part of the reader. (As we shall see, these six are not the only papers generated with funding from the interested parties that are collected in the literature review.) It is not insignificant that AT&T was absorbed by SBC almost immediately after this regulatory battle was settled in favor of the incumbents. The fossil record of their lobbying efforts can still be seen in the literature. MCI, the other major entrant at that time, was absorbed by Verizon after the regulatory debate for which these papers were prepared was resolved in favor of the incumbents. For purposes of understanding the literature, it is also significant that the creation of the new AT&T seemed to have marked the end of U.S.-based papers of this kind. All industry-supported, U.S.-based papers that support unbundling appear to have been funded by AT&T when it was an entrant seeking access to local loops. The elimination of effective competition by entrants appears to have also eliminated industry-sponsored papers in favor of unbundling. The same is obviously not true for the winning side in that debate, in support of the opposite conclusion.

The first of the papers in this group of six, (Crandall and Singer 2003)[106] is a consultancy report by Criterion Economics, issued in response to an entrant-funded study that purported to show that unbundling under the U.S. 1996 Telecommunications Act added 92,000 jobs.[107] The paper aims several well-taken criticisms at the weak paper it was attacking, but then launches into some questionable claims of its own. First, the paper assumes that jobs in resale and marketing are not "jobs," but are socially wasteful. The paper explains its rationale with a metaphor:

105 See Drew Clark, *Broadband*, Technology Daily July 26, 2006 ("Spiwak said the Phoenix Center is funded by "the old AT&T, the new AT&T, wireless companies, software providers" and other Bell competitors. Unlike other telecommunications think tanks, he said the Phoenix Center does not participate in lobbying coalitions or in FCC proceedings"); Drew Clark, *Telecom*, Technology Daily November 10, 2005 ("Everyone has to make a living in this town," Phoenix Center Executive Director Lawrence Spiwak said in reference to contributions from AT&T and the Bells. "The point is, go and look at the work" of the Phoenix Center, he said, describing it as "dispassionate" and scholarly.").

106 Crandall, R. & Singer, H. (2003). An accurate scorecard of the Telecommunications Act of 1996: rejoinder to the Phoenix Center Study No. 7. Report by Criterion Economics, Washington, DC.

107 The underlying report to which this was a response was "The Positive Effects of Competition on Employment in the Telecommunications Industry, Phoenix Center Policy Bulletin No. 7, Oct. 15, 2003 ."

> If a principal of a high school can manage a student body of 250 efficiently by herself, society is not better off when the school hires an additional administrator. Likewise, if a Bell Operating Company requires a sales force of one employee for every 500 lines, then society is not better off when a CLEC hires one or more additional telemarketers to resell the same 500 lines. Domestic product is not increased by either new job. Presumably, the additional administrator and telemarketers could be put to better uses that would increase domestic product.

By this rationale, marketing jobs created by market actors who think they can make money by offering better deals on, say, the same cars, are not adding to the GDP. By this rationale, lower prices and more marketing do not increase the quantity sold. Indeed, the authors conclude: "The purported savings to consumers who have switched to a CLEC do not constitute an increase in economic welfare—these dollars are merely a transfer of income from the ILEC to the customers." (at p. 22). In other words, supply and demand are fixed; the only thing happening when competitors enter is transfer of rents from producer surplus to consumer surplus. We note that, in comparing LLU for voice and LLU for broadband in a paper commissioned by France Telecom, apparently in its capacity as a cross-border broadband entrant through Wanadoo, Crandall and Waverman (2006) write: "Since broadband offers consumers the prospect of genuinely new and distinctive services, marketed and bundled for them in genuinely new and distinctive ways, the consumer welfare gains from services-based broadband competition might be significant, thus sustaining entry."[108] The Crandall and Singer paper follows the questionable assumption about fixed supply and demand with an effort to establish that unbundling causes reduced capital expenditure, but rather than doing so using actual numbers of reduced investments, properly controlling for the fact that the relevant period was also a period of boom and bust in the industry, the document employs a variety of numeric examples and hypothetical losses in investment based on projected reduced cash flow from unbundled lines relative to ILEC-sold lines.

The next paper, Ingraham and Sidak (2003),[109] is an econometrics paper published in a student-edited law journal. The authors are a founder of Criterion (although in the paper he describes himself as a fellow emeritus of the American Enterprise Institute, and does not disclose the Criterion affiliation) and a Criterion Vice President, the same consultancy that produced two of the other papers over this period that purported to show negative effects of unbundling. It calculates that the volatility of Verizon and BellSouth stock was higher than that of the S&P 500 and the DJIA after the tech-bubble burst than it was during the expansion that preceded the 2001 recession, while the volatility of SBC and Qwest stock was not statistically-significantly higher than that of these two indexes over the same period. For some reason, although Qwest was part of the study, the tables simply did not report the negative results for Qwest. These were, instead, reported only in footnotes. (Ingraham and Sidak 2003: at note 29: "The coefficient on RM*Dr was not significant, either economically or statistically, in the Qwest regressions"; note 31: "For the Qwest regressions, the coefficient on RM*Dr is insignificant in both statistical and economic respects. In particular, we cannot reject the null hypothesis that β r = 0 for Qwest. Also, the estimates of βr that we obtained for Qwest (-0.01 when using either the S&P 500 Index or the DJIA) are very close to zero. Therefore, we find no evidence that Qwest's beta changed during the recession."). The paper argues that this "finding" (higher volatility for two of four players, not so for the other two) substantiates the hypothesis that mandatory unbundling will increase volatility of ILEC stocks in a recession.

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108 Crandall, Robert W. and Leonard Waverman. The Failure of Competitive Entry Into Fixed-Line Telecommunications: Who is At Fault. Journal of Competition Law and Economics. 2(1) 113-148. At page 140.

109 Ingraham, A., & Sidak, G. (2003). Mandatory unbundling, UNE-P, and the cost of equity: Does TELRIC pricing increase risk for incumbent local exchange carriers?. Yale Journal on Regulation, 20, 389–406.

The next two papers in the literature review are Phoenix Center Policy Bulletins. These are self-published, non-refereed documents. Policy Bulletin No. 6[110] is an effort to respond to methodological criticisms (from Criterion and other consultants) of Policy Bulletin No. 5.[111] Both attempt to show that unbundling, and in particular UNE-P, increase investment by the then-remaining Bell Companies.

The next round in this debate is Crandall, Ingraham, and Singer (2003).[112] It is a paper published in a refereed journal; its origin is in a Criterion Economics paper.[113] It is primarily a theoretical model arguing that lower unbundling rates will lead entrants to use unbundled loops to provide service, rather than invest in their own facilities. To the limited extent that data is used in this paper, it reflects data provided by the Bell Companies to the researchers, analyzing a total of 56 observations from 2000 and 2001, excluding somewhere between 15 and 20 states. From these data the authors claim that higher rates for unbundled loops are correlated with higher levels of facilities-based CLEC lines. The authors then use the theoretical model to argue that the mechanism is by displacement of incentives to invest away from unbundling, and towards facilities-based competition. Neither the model nor the data can establish the extent to which the high cost results in displacement to facilities-based competition, as opposed to exiting the market. While the former is likely desirable (assuming that social cost of the redundant investment does not outweigh the welfare gain from competition that does not depend on regulation), the latter clearly is not.

The parting shot in this series is again a policy paper from the Phoenix Center, seeking to establish that unbundling increases broadband availability (as measured by zip codes in which at least one provider is available and zip codes in which four or more providers are available.) (Ford and Spiwak 2004.)[114] Although it is placed in a literature review on investment, it is not a paper on investment, but on penetration. The argument for effects on investment is by derivation—if performance is high, therefore investment likely happened. However, given that entry here can be over existing lines, it is feasible in principle to get higher penetration, and greater competition, without greater investment. The results, in any event, even as specified, show only weak statistical significance, at the 10% level.

The Cambini and Jiang paper goes on to cover several other papers that either explicitly or by clear implication, are industry-sponsored. Hazlett and Bazelon (2005)[115] is an unpublished conference paper. Bazelon is a consultant with Analysis Group, where Hazlett, who holds an academic appointment at George Mason, also consulted at the time.[116] Analysis Group was, it appears, employed by Verizon during this period to produce work on unbundling.[117] As a consequence, it would be appropriate to treat

110 Phoenix Center Policy Bulletin No. 6 (2003): *UNE-P Drives Bell Investment - A Synthesis Model* Available at http://www.phoenix-center.org/PolicyBulletin/PolicyBulletin6Final.pdf

111 Phoenix Center Policy Bulletin No. 5 (2003): *Competition and Bell Company Investment in Telecommunications Plant: The Effects of UNE-P*. Available at: http://www.phoenix-center.org/PolicyBulletin/PolicyBulletin5.pdf

112 Crandall, R., Ingraham, A., & Singer, H. (2004). Do unbundling policies discourage CLEC facilities-based investment. Topics in Economic Analysis & Policy, 4(1), 1136.

113 Footnote 24 of Crandall and Singer (2003) identifies what later became Crandall, Ingraham, and Singer 2004 as a Criterion Economics paper. As with Ingraham and Sidak 2003, one author, identifies himself by his think-tank affiliation, in the case of this paper, Crandall with Brookings, rather than Sidak with AEI, and not by the consultancy that he chairs and that the other author/authors work for.

114 Ford, G., & Spiwak, L. (2004). The positive effects of unbundling on broadband deployment. Phoenix Center Policy Paper No.19. The Phoenix Center. Available at: /http://www.phoenix-center.org/pcpp/PCPP19Final.pdf.

115 Hazlett, T., & Bazelon, C. (2005). Regulated unbundling of telecommunications networks: a stepping stone to facilities-based competition?. George Mason University. Available at: /http://mason.gmu.edu/~thazlett/pubs/Stepping%20Stone%20TPRC.10.04.05%20.pdf

116 Hazlett CV, 2006. http://www.law.gmu.edu/assets/files/faculty/cv/hazlett.pdf.

117 Robert Pyndick uses Analysis for his consulting, and in Pyndick 2007 properly discloses that the analysis there was commissioned by Verizon. He then thanks Hazlett and Bazelon for their help. His CV, again, with admirable candor, discloses that he was a consultant to Verizon at the relevant period (2003-2005). Similarly, the Hazlett and Bazelon

the results of this paper with the caution properly associated with industry-sponsored papers, although no sponsorship is formally disclosed in the paper itself. The first conclusion of the paper—that unbundling harms investment—is based on the observation that investment in telecommunications dropped massively after the tech-bubble burst in 2001. The authors' sole effort to tie this fact, which was true in many countries, including Switzerland, which did not have unbundling during this period at all, is a graph that shows investment declining from 2001 and number of UNE-P lines increasing over the same period. No effort is made to control for overall changes in the market. Much of the causal explanation simply refers to financial analysts' beliefs that the regulatory structure is anti-investment. The second conclusion of the paper does actually rely on a regression, and claims to show that use of unbundling in earlier periods does not predict facilities-based investment by CLECs in later periods. However, it seemed to show a negative relationship initially, and a positive relationship over time, describing only the total effect over three periods as statistically insignificant. The authors' final assertion is that the rate of DSL subscription increased by better-than-trend after the FCC's formal abandonment of line sharing, based on subscription data from Legg Mason. This is simply an early version of the erroneous analysis discussed in the context of Hazlett and Caliskan (2008) above.

Zarakas et al (2005)[118] is a consultancy-produced paper that relies on an agent-based simulation. The paper used strategic action modeling to claim that unbundling at TELRIC rates increased innovation.[119] The assumptions in this model are nothing short of heroic. It assumes three facilities-based competitors and one unbundling competitor, and it assumes that each of the three facilities-based competitors immediately achieves full capacity whenever it deploys lines, does not need to build market share over time, and "there is no unused capacity." (p. 16). For this assumption to be true, it would have to be the case that three separate wires would be going into each home, each capable of serving all of that household's needs, and the household would nonetheless subscribe to all three wires. Using these assumptions and various rounded-up and rounded-down data from actual markets, the paper hypothesizes the effects of different levels of prices for unbundled network elements. It predicts based on these simulations that decreases in the prices of unbundled elements would lead to increases in investments in facilities (by these firms whose every new line is immediately taken up by a new customer, even though that customer already had access to two other wires and was subscribing to both of them).

Willig (2006)[120] is a self-published paper by an academic at Princeton. The paper originated in an analysis done for a declaration on behalf of AT&T, in an FCC filing, while AT&T was an entrant.[121] It begins with an informal conceptual description of what it calls the Investment Deterrence Hypothesis and the Competitive Stimulus Hypothesis. The two names are self-explanatory. It primarily emphasizes that investment deterrence must necessarily rely on the idea that TELRIC price regulation does not in fact do what it is designed to do—mimic efficient investment costs for an entrant. It also emphasizes that competitive stimulus relies on the observation that entry into markets with such high fixed and sunk costs are high, and that competition, where feasible, performs better than monopoly. Lower prices will

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paper itself, in footnote 19, cites to a declaration filed by Hazlett and Bazelon and one collaborator on behalf of Verizon, covering some of the materials discussed in the paper.

118 Zarakas, W., Woroch, G., Wood, L., McFadden, D., Ilias, N., & Liu, P. (2005). Structural simulation of facility sharing: unbundling policies and investment strategy in local exchange markets. Report by The Brattle Group, Washington, DC. Available at: /http://www.brattle.com/_documents/UploadLibrary/ ArticleReport2347.pdf .

119 Clarke, R. N., Hassett, K., Ivanova, Z. and Kotlikoff, L., Assessing the Economic Gains from Telecom Competition. NBER Working Paper No. W10482 (2004).

120 Willig, R. (2006). Investment is appropriately stimulated by TELRIC. Princeton University. Available at: /http://psc.ky.gov/pscecf/2003-00379/5200700_efs/ 04132004/MCI_ST_MTB_EX_14_04%2013%2004.pdf

121 Willig (2006) at notes 10, 24.

drive demand, and higher demand will drive new investment. It then reports on results of a different submission to the FCC, on several papers by the Phoenix Center, and on a dated OECD policy report.

The next paper, Waverman and Dasgupta (2006),[122] is a consultancy document prepared by LECG for France Telecom. It is a conceptual paper. It lays out the case that too much regulation will undermine incentives; it asserts that the basic high-fixed-cost structure of the telecommunications markets has largely been superseded; it specifically states that econometrics cannot capture the full complexity and multi-dimensionality of the regulatory process; and it states merely that if the purpose of regulation is to increase investment in a second infrastructure, then over-regulation is more of a risk than under-regulation.

Pyndick (2007)[123] is a refereed article[124] by an academic, whose headnote properly discloses that the study was commissioned by Verizon. It is a theoretical article. It provides an option-value approach to confirming the Hausman (1998) critique of TSLRIC pricing.

We include here the counterpart to Waverman et al 2007 produced for the entrants' side, Cadman (2007).[125] Cadman 2007 is a consultancy paper created for ECTA, the entrant's organization that is the counterpart to the incumbents' ETNO. Its provenance therefore requires as much caution as appropriate for the Waverman et al 2007 paper. Cadman 2007 provides an econometric analysis of the relationship between regulatory effectiveness and investment per capita. It uses ECTA's own regulatory effectiveness index. This raises the possibility that the index is biased, although at a minimum it likely reflects the degree to which entrants view a given country's regulatory environment as conducive to their entry. It also uses the OECD's regulatory reform index for the telecoms sectors. Running regressions controlling for GDP, population, area, and interest rate, it finds significant correlation to good performance on the regulatory efficacy indexes. It is important to emphasize that regulatory efficacy is not a direct measure of open access, and this analysis does not address itself to the effectiveness specifically of access-related regulations, but to the effectiveness of the telecommunications regulatory system more generally.

Friederiszick, H., Grajek, M., & Roller, L. (2008)[126] is an academic working paper, supported by Deutsche Telekom. It uses a sophisticated model, focuses on data at the operator level rather than the country level, and uses external indexes to identify not only formal, but also effective regulation and political environment. The paper finds that access regulation that forces incumbents to open access to their networks has a negative effect on fixed-lines entrants' investment, but no negative effects on fixed-line incumbents' investments, and no negative effects on either incumbents or entrants in mobile. While the framing of the paper strongly emphasizes its results on fixed-line entrants, its findings on incumbent and mobile investment support the proposition that open access regulation does not undermine investment overall, or socially efficient investment. The authors emphasize the displacement of entrant investment, projecting from their findings that entrants invest in a given five year period about half of what they would have invested without access regulation. As long as a strict investment ladder approach

122 Waverman, L., & Dasgupta, K. (2006). Investment in telecommunication networks: a 21st century perspective. Report by LECG Consulting, London, UK.

123 Pyndick, R. (2007). Mandatory unbundling and irreversible investment in telecom networks. Review of Network Economics, 6(3), 274–298.

124 The paper is published, like several others, in the Review of Network Economics. That journal states that publication requires a single referee to provide a positive evaluation. It is not clear whether this requires the absence of negative reports.

125 Cadman, R. 2007. Regulation and Investment in European Telecoms Markets. SPC Network.

126 Friederiszick, H., Grajek, M., & Roller, L. (2008). Analyzing the relationship between regulation and investment in the telecom sector. ESMI White Paper No. WP-108-01.

is taken, this is clearly evidence against open access. However, given that redundant investment is a regulatory hedge with ambiguous long term welfare effects, the implications of avoidance of such investment become more ambiguous.

Friederiszick et al (2008) find that open access rules do not cause incumbents to invest less in upgrading their networks. They hypothesize that “One possible explanation of this is that entrants are able to boost end customer demand due to increased variety and innovativeness of their information and communication services offered on incumbents’ networks. In this case the lost profit margins of incumbents could be offset by the increase in total demand. ” (Friederiszick et al 2008 p. 33). This finding is consistent with the empirical findings in Chang, Koski, and Majumdar (2003) and with some of the theoretical models discussed in Guthrie (2006). Friederiszick et al warn, however, that their findings do not necessarily carry over to investment in next generation networks, although nothing in their data either supports or refutes that extension.

Access, unbundling, and investment: Conclusion

We review here 23 papers on unbundling and investment. These include all the papers in Cambini and Jiang, except for those more appropriately reviewed in the sections on performance or the qualitative case studies. We add three academic, one governmental, and one industry-sponsored report, and treat one double citation in that report as a single paper. Of the 23 papers, over half, 13, are industry sponsored. Of these thirteen, only two or three are published, only one refereed. All but one take the position that would support the position of the paper’s sponsor. The majority of the papers exhibit weakness; several are not empirical. Of the remaining ten papers, two are government sponsored, unpublished papers. One shows that higher regulatory effectiveness increases investment, but its descriptive portions are more powerful than its econometrics. The second is methodologically powerful, hypothesizes weaker investments by entrants as a result of unbundling, but does not in fact find lower investments by entrants. The remaining eight papers are academic and think tank. They are all published. Four are theoretical, two showing positive effects on investment, one negative, and one emphasizes the current state of uncertainty about the effects of unbundling on investment. Of the remaining four, two find that investment increases and two find that investment declines or is delayed. Of these latter two, one has severe methodological problems. The second supports the finding of delayed investment. However, the paper suggests that delayed investment is likely a reflection of strategic jockeying for a more favorable regulatory environment, rather than a real incentive effect, and that the welfare lost may not be very large.

4.4.5 Qualitative case studies of open access

Given the relative ambiguity of the sum of the quantitative data, it is appropriate to rely primarily on the qualitative literature. For these same reasons, our own study draws heavily on qualitative work. In this section, we review the most relevant qualitative work. In comparison to the quantitative work, more of this literature is produced by academics and published in refereed journals. The studies in this segment of the literature are not as frequently sponsored by industry and largely provide more support for the proposition that open access policies have had a positive impact on the diffusion and performance of broadband.

Table 4.4. Qualitative case studies of open access

Citation	Pub=1 Self-pub=0	Sponsor	Countries covered	Open access played role? + / - / 0	Main observations
Academic/ Think tank					
Lee & Chan-Olmsted (2004)	1		South Korea; U.S.	0	Detailed study of broadband policy in South Korea; attributes South Korean success to wide range of geographic and demographic factors; emphasizes urban density; emphasizes government demand-side programs. Confirms that South Korean early entry was by leased access over cable Confirms that a contemporaneous view of the U.S. regulatory shift was that early 2002 to early 2003 was when cable and telco broadband providers were clearly deregulated from access provisions pertaining to broadband
Frieden 2005	1		U.S., Canada, Japan, South Korea	0/+	Emphasizes the different responses of the various incumbents to the regulatory and policy efforts in their countries. Emphasizes that U.S. incumbents fought to obtain an unregulated duopoly market structure. "Stakeholders appeared more intent on competing in the courtroom than in the marketplace."
Ida 2006	1		Japan	+	Highly detailed study of Japanese market, demand and supply elements. Strong emphasis on role of Softbank Yahoo!BB in driving DSL and demand. Strong emphasis on K-Opticom in fiber. Anticipates expansion of KDDI and Softbank to fiber.
Chung 2006	1		South Korea	0	Emphasis on geography and demand policies. Claims "hands off" approach of South Korean government played large role. Confirms that Hanaro entered over leased lines as an important way to enter at low cost.
Bauer (2006)	1		U.S.		Detailed study of the U.S. market, determinants of supply and demand, players, both incumbents and entrants, and political economy. "American broadband policy evolves in a piecemeal fashion, driven by political agendas, corporate strategies, and legal and regulatory battles." Detailed description of the regulatory battles, promises, and the retreat in early 2002 to early 2003 from unbundling for broadband.

Citation	Pub=1 Self-pub=0	Sponsor	Countries covered	Open access played role? + / - / 0	Main observations
Krafft (2006)	1		France	~+	Highly detailed study of the French market and regulatory environment. Author explains the failure to thrive of cable as in part caused by regulatory fragmentation, in part by France Telecom early control over facilities. Krafft emphasizes entry of Free/Iliad as important, but laments small market shares of Neuf, Cegetel, and Alice as too small to thrive (all are now part of SFR or Iliad). Regulatory shift in late 2002-2003; attributes to combination of change of leadership in ART/ARCEP, learning from Japan, and cooperation with the EU Framework Directive.
Bullingen (2006)	1		Germany	~	Detailed study of German market; emphasizes dominance of DT and weakness of regulatory agency; hypothesizes that the importance of DT to German industrial and labor policy immunizes it from effective regulation; confirms the regional boundaries of entrants in Germany.
Antonelli and Patrucco (2006)	1		Italy	0/~	Emphasizes highly regional nature of Italian market; the wealthy parts: 3% of landmass, 25% of population have high competition, including fiber from Fastweb; other areas lag. Emphasizes geographic concentration and facilities-based competition; sees unbundling as useful for the underserved areas of Italy.
Lindmark and Bjorstedt (2006)	1		Sweden	+	Detailed description of Swedish market. Emphasis on early entry by dial-up companies; early entry by facilities-based competitor Bredbandsbolaget; complementarities between facilities-based and LLU-based entry; concerned with too fragmented a market for the LLU portions of the market (pre-consolidation by Telenor).
Fransman (2006)	1		Synthesis of other studies of Japan, South Korea, U.S., France, Germany, Italy, Sweden, informal observations about UK	+	Emphasizes role of disruptive entrants, like Softbank or Free/Iliad. Emphasizes the less innovative nature of incumbents when they are the sole competitors. Confirms then-contemporaneous view, just before functional separation in UK, of strategic obstruction by BT. Emphasizes then-clear difference between France and Germany expressed in prices and speeds.

Citation	Pub=1 Self-pub=0	Sponsor	Countries covered	Open access played role? + / - / 0	Main observations
Picot & Wernick (2007)	1		U.S., South Korea, EU countries	+	"LLU and access obligations play important roles throughout Europe and have contributed to high deployment rates in countries lacking alternative infrastructure as well as in countries with competing platforms." Germany, however, continues to debate regulatory holidays "From a competition-related perspective, the leading position of South Korea has been furthered by platform competition between DSL and cable modem. While LLU played a negligible role, open access obligations for cable owners were important for new entries to compete on a level playing field." "Thus, the U.S. is moving in an entirely different direction than Europe, and also in comparison to U.S. regulatory policy prior to about 2002 ".
Kushida and Oh (2007)	1		Japan, South Korea	+	Detailed political economy of regulation in both countries; emphasizes effective regulator and policy programs; emphasizes unbundling in Japan, through Softbank; notes role of open access over cable in Hanaro entry in South Korea
de Bijl and Peitz (2008)	1		Netherlands	-/+	More a conceptual piece than an empirical piece; seeks to persuade the Dutch regulator to phase out unbundling over time. Acknowledges that unbundling played an important role in competition and investment, but raises concerns over long term investment incentives and emphasizes the benefits of high cable penetration in the Netherlands.
Whallen and Curren (2008)	1		UK	0	Functional separation in BT was difficult; policing boundaries between the parts of the firm hard; no rush to adopt in other EU countries
Eskelinen et al (2008)	1	N/A	Finland, Sweden	+	Emphasis on comparing the level of government planning and funding; by implication, suggests that Finland's emphasis on competition, in part through early unbundling, coupled with competition among its former incumbents, was largely as effective as Sweden's more encompassing approach, although took longer to mature.
Sadowski et al (2009)	1	N/A	Netherlands	+/-	Analyzes municipal fiber initiative; argues access is important component; actual observations seem to support the opposite conclusion for a small municipality like the one studied.

Citation	Pub=1 Self-pub=0	Sponsor	Countries covered	Open access played role? + / - / 0	Main observations
Industry supported					
Hausman and Sidak (2005)	1	Vodafone	U.S., UK, NZ, Canada, Germany	-	Qualitative case studies; five countries: U.S., UK, NZ, Canada and Germany; all countries in the study had weak and contested implementations of LLU.
Crandall and Waverman (2006)	1	France Telecom	U.S., Canada, UK, rest of Europe in less detail; Japan	+ Likely positive effects for broadband competition, but not for voice	Extensive review of the covered markets; emphasis on the possibilities of unbundling to be a productive avenue for broadband, even if it is not for voice-only competition; strong emphasis on unbundling as entry strategy for incumbents in one country entering the turf of others; endorsement of Free/Iliad as a model for Europe; strong emphasis of Softbank role in Japan adoption, and more measured predictions on its future role in Japan
Crandall et al. (2009)	1	Verizon	UK, NZ, Italy, Australia, Sweden	-	Argues that functional separation harmed growth of penetration rates and investment in the countries that adopted it; emphasis on UK.

Qualitative case studies of access regulation: Academics

Lee & Chan-Olmsted (2004)[127] is a peer reviewed article by an academic and a researcher at Samsung. It provides a detailed case study of South Korea and the United States. The study seeks to provide insights into what each country can learn from the relative success of the other. The U.S. is seen as performing particularly well higher-up in the stack, in e-commerce and online content, while South Korea is seen as performing better at the infrastructure layer. At that level, the one more pertinent to our study here, the paper describes the range of investments, strategic programs, and interventions of the South Korean government, as well as the access regime. Consistent with Picot and Wernick's (2007) characterization of South Korea's cable infrastructure regulatory regime prior to 2002 as "open access," Lee and Chan-Olmstead emphasize that, "It is also important to note that most South Korean cable ISPs are not cable system operators but lease space from the operators. " (661). In their review of broadband regulation in the United States, these authors had no difficulty concluding, based on the February and March 2002 NPRM and Declaratory ruling,[128] that "Thus, the phone companies' and cable companies' broadband services appear to be freed from many of the regulations in the United States."[129] The

127 Lee, C., & Chan-Olmsted, S. M. (2004). Competitive advantage of broadband Internet: A Comparative study between South Korea and the United States. *Telecommunications Policy, 28*(9-10), 649-677.

128 Federal Communications Commission (FCC). (2002, February 15). Notice of Proposed Rule making: In the matter of appropriate framework for the broadband access to the Internet over wireline facilities; universal service obligation of broadband providers; computer III future remand proceedings: Bell operating company provisions of enhanced services (FCC 02-42). Washington, DC: FCC. Federal Communications Commission (FCC). (2002, March 15). Declaratory ruling and notice of proposed rule making: In the matter of inquiring concerning high-speed access to the Internet over cable and other facilities; Internet over cable declaratory ruling; appropriate regulatory treatment for the broadband access to the Internet over cable facilities (FCC 02-77). Washington, DC: FCC.

129 This contemporaneous assessment of the interpretation of the FCC decisions is consistent with our interpretation of the U.S. timeline, which has been disputed in comments to our report.

authors observe that actual competition—that is to say, at the local level where choice actually exists—is likely higher in South Korea than in the U.S.: among three, as opposed to two, providers per market. The paper then goes, in detail, into comparisons of the two countries in terms of potential determinants of Internet adoption: education, age, income, online activities, self-reported reasons for not connecting, and e-commerce. The study ultimately concludes that housing patterns played a large role in broadband deployment, a conclusion that will surprise no one. But it also attributes a real role to the basket of regulatory and investment policies of the South Korean government.

Frieden (2005)[130] is a peer-reviewed, academic paper with no industry sponsorship. Frieden's review of the U.S. experience juxtaposes the enormous success and innovation in the high-technology, Silicon Valley sectors of the U.S. information technology sector to the lackluster performance of U.S. telecommunications and broadband provisioning sector. He describes the history of the response to the 1996 Telecommunications Act in the United States, concluding that: "The combination of market downturn, legislative failure and lack of consensus on operating standards has removed many of the incentives for risk taking and investment, even as the need for network upgrades proved essential for the evolution of high-speed broadband ICT services. Stakeholders appeared more intent on competing in the courtroom than in the marketplace. The incumbent Bell Operating Companies made infrastructure investment contingent on securing massive regulatory liberalization which, if implemented, might result in the establishment of a shared monopoly among telephone and cable television companies without significant government oversight." (602). In other words, Frieden's interpretation of the U.S. case is that postponement of investment was more strategic, as part of the regulatory negotiation process, than straight incentives-based. Frieden then goes on to observe the government investment and strategic planning, as well as demand side interventions in Canada, Japan, and South Korea, as higher performers, as well as at their competitive strategies. The study does not dig deep into the precise dynamics of firms and their investments, but emphasizes the differences between the heavy resistance and litigation tactics of the U.S. firms, relative to the more compliant and cooperative approach taken by firms in the three other countries he observes.

Ida (2006)[131] is an academic book chapter, with no industry sponsorship. It offers a detailed description of the regulatory choices and history in the breakup of NTT, and the introduction of access regulation. The paper analyzes the different market players, provides information about market shares, then-measured elasticities of demand for the various forms of broadband, and analyzes the interactions between the market segments. Ida focuses very heavily on the role of Softbank as an entrant over unbundled DSL as a driver of the market, as well as the entry by K-Opticom as a driver of fiber competition. The paper observes the KDDI entry over leased fiber, and, in 2006, anticipates that Softbank will expand their service to offer FTTH using the facilities of others.

Chung (2006)[132] is an academic book chapter. It offers market data on the role of the major players in initial broadband adoption in South Korea. Unlike the other case studies of South Korea, it describes Hanaro and Thrunet as having made major facilities-based investments of their own. On the other hand, when describing Hanaro's entry strategy in detail, the chapter specifically notes the company's emphasis on using already-installed fiber (which it did not install or own) to businesses and large apartment complexes. The chapter in several places describes the South Korean government's approach as a

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130 Frieden, R. (2005). Lessons from broadband development in Canada, Japan, Korea and the United States. *Telecommunications Policy, 29*, 595-613.

131 Ida, T. (2006). "Broadband, Information Society, and National System in Japan," M. Fransman (ed.), Global Broadband Battles, Stanford University Press: 65-86 .

132 Chung, I. (2006). "Broadband, Information Society, and National System: The Korean Case," M. Fransman (ed.), Global Broadband Battles, Stanford University Press: 87-108 .

“hands off” policy, which seems at odds with all other descriptions of the South Korean experience, but likely refers to the late introduction of unbundling of the copper plant. In all, the author attributes South Korea's success to “market, geographic, and demographic factors, to some extent. It is important, however, to note that facilities-based competition combined with the non-interventionist policy and various incentive programs greatly contributed to the earlier establishment of the market compared with other countries.”[133]

Bauer (2006)[134] is an academic book chapter that offers a detailed qualitative analysis of the state of the U.S. broadband market up to and following the decision to abandon open access policies. The chapter describes the anatomy of the U.S. broadband market after the 1996 Telecommunications Act, household and business demand, and the nature of the companies providing broadband in the market. It describes the relative dominance of the RBOCs and cable companies, while mentioning the early entry of other entrants. In particular, the chapter notes Covad's entry, based on unbundling, and what the author described as that company's uncertain future as a market participant, given the FCC's retreat from open access under Chairman Powell. The chapter describes the litigation and regulatory negotiations; and notes the promises by several of the incumbents that they would scale up investment in fiber after they received regulatory assurance that they would not need to unbundle those newer facilities. The chapter describes Verizon's investment in fiber-to-the-home, but the choice by SBC and Bell South to scale back from their fiber-to-the-home promises, and to deploy instead DSL services over fiber-to-the-node systems. (p. 144). The chapter speculates that this is a transitional approach, although looking back from late 2009, it is clear that the new AT&T continues the xDSL approach that SBC began in 2004, as described in Bauer (2006).

The paper begins its review of the regulatory history by stating “American broadband policy evolves in a piecemeal fashion, driven by political agendas, corporate strategies, and legal and regulatory battles.” It goes on to detail the early implementation of unbundling, and early efforts to extend open access to cable networks, at the franchising authority level; and then the shift, under the new FCC, beginning in the March 2002 decision to declare cable broadband an information service and concluding with the February 2003 Triennial Review order phasing out line-sharing, the decision that unbundling did not apply to new fiber-to-the-home deployments, and the later clarification that that exemption also applied to fiber-to-the-curb projects, which put xDSL networks outside of the unbundling regime and enabled Bell South and SBC to pursue their trajectory. The chapter, published in 2006, expresses a hope that the changes, if indeed they will have the positive investment effects they are intended to have, will result in the U.S. closing the then-small performance gap between the U.S. and the slightly better performing Nordic countries and the Netherlands. As of 2009, however, that gap has widened, and more European countries, mostly with improved open access regimes, have surpassed the U.S.

Krafft (2006)[135] is an academic book chapter providing a detailed qualitative analysis of the French market and regulatory environment. Krafft provides a highly detailed and careful analysis of the French market, its development, and in particular the regulatory developments in 2002-2003 that drove effective implementation of unbundling and France's broadband performance takeoff. Krafft attributes the failure of cable broadband in France in part to the regulatory fragmentation of markets, and in part from France Telecom's large ownership of essential cable facilities, which stifled its competitors on that platform. The author sees a major shift in French regulatory policies toward unbundling in late 2002 early 2003.

133 Id., at 107.
134 Bauer, J. (2006). Broadband in the United States. M. Fransman (ed.), Global Broadband Battles, Stanford University Press: 132-163.
135 Krafft, J. (2006). Emergence and Growth of Broadband in the French Infocommunications system of Innovation. M. Fransman (ed.), Global Broadband Battles, Stanford University Press: 172-194.

She attributes these in part to insights internal to the ART, later ARCEP, and its observations of the successes of Japan and South Korea, in part to a change in leadership in January of 2003, and in part in response to, and with the support of, the new European Framework Directive. At the time, Krafft describes Free/Iliad as the primary entrant, based on unbundling, and laments the relatively fragmented state of the remainder of the market, with Neuf, Cegetel, and Alice holding very small market shares. From today's perspective, however, we know that through consolidation these too-small entrants formed the basis of today's likely more sustainable competitive structure of the French market. The paper offers an excellent snapshot of the observations of an academic in the mid-2000s of the French performance, at a time when the change in policies had begun to bear fruit, but had not played out its full effect as can be observed with three or four more years of data available to us today.

Bullingen (2006)[136] is an academic book chapter that provides a detailed case study of Germany. Bullingen starts by noting the unusually high market share of Deutsche Telekom in the early 2000s (falling from 97% in 2001 to 88% in 2004, still unusually high), and the odd fact that although Germany had very high cable television penetration, it had almost no cable broadband competition at the time. He describes DSL as dominant, and Deutsche Telekom as dominant in DSL. While unbundling was enacted early, and there is a substantial amount of unbundling, Bullingen discusses the relatively high prices for line sharing at the time and the lack of clarity on bitstream access and entry with complementary assets by entrants. As for cable, the paper attributes much of the late start of cable to outdated infrastructure and repeated mistakes by German regulators—both competition authorities that prevented various investments and consolidations, and what appear to be the equivalent of franchising rules that resulted in a highly fragmented cable market. The paper also surveys several other efforts at other sources of entry, but largely sees them as making no real inroads. It concludes with an effort to understand the relative inefficacy of German regulation, and hypothesizes that DT forms an important part of German industrial policy and labor policy, and that weakening DT through a more competitive market was simply inconsistent with the broader industrial and labor policies of the German government.

Antonelli and Patrucco (2006)[137] is an academic book chapter that offers a detailed case study of the Italian broadband market. The authors provide a detailed description of the broadband market, demand and application, major firms, and regulatory structure. The most important insight offered by this paper is the highly segmented nature of the Italian market, and the somewhat surprising relationship between the relatively low prices in the Italian market, on the one hand, and the low penetration rates, on the other. The paper covers the large differences in wealth, density, and deployment between Lombardy, Liguria, Emiliga-Romanga, and to a lesser extent the Piedmont, which are wealthy, with high urban density, covering 25% of the population in 3% of the territory, and the lower density area of the third Italy, and the remainder of the country, mostly in the south and in some of the mountainous areas. The largest success story of competition in the northwest was Fastweb. The company was started by the Milan power utility, AEM, which in December 2004 merged with e.Biscom. Its strategy relied on using the utility's own ducts to lay fiber to the home, bypassing Telecom Italia's infrastructure, in the most densely settled municipalities—Milan, initially, and then in the other major Italian urban centers: Rome, Turin, Genoa, Naples and Bologna. Only later did Fastweb begin to combine its own fiber with unbundled loop to extend it service beyond the core high-density, higher wealth areas. The paper classifies Italy, therefore, as primarily a story about facilities-based entry, with a high geographic and demographic bias. In most of the country, however, competition is weak.

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136 Bullingen, F. (2006). Development of the Broadband Market in Germany. M. Fransman (ed.), Global Broadband Battles, Stanford University Press: 195-218.

137 Antonelli, C. and Patrucco, P.P. (2006) Broadband in Italy. M. Fransman (ed.), Global Broadband Battles, Stanford University Press: 219-239.

Lindmark and Bjorstedt (2006)[138] is an academic book chapter that provides a detailed case study of the Swedish broadband market. It begins with the history of the early and vigorous dial-up market, tracks the privatization of Telia, the divestment of its cable holdings in ComHem, the emergence of broadband through, in particular, early entry by Bredbandsbolaget into the fiber to the home business and significant early price competition that it introduced in the major urban centers, public investment in a national backbone, alongside public-private deals, most prominently mentioned was Tele2 and the Swedish Railway Administration. The chapter also describes the public investments through the municipalities. Particularly interesting is the description of the competitive dynamics in 2004, as Telia and Bredbandsbolaget competed by lowering installation charges; in response, Glocalnet, a ULL entrant, lowered installation charges to zero, while unbundling-base Bostream began to offer higher data rates. At the time of that writing, Telenor had not yet moved to consolidate these smaller broadband entrants.

Fransman (2006) is an edited volume that includes the prior book chapters and several synthesis segments. Fransman provides the synthesis of the specific and detailed case studies discussed above as book chapters. He argues that effective regulation clearly played an important role in the successful performance of the high performing countries, in particular Japan and South Korea. He attributes the success to the combination of effective access regulation and disruptive entrants, more entrepreneurial than the large incumbents that typify the U.S. market, even where they do compete. His classic example is Softbank in Japan. He seems more skeptical that Iliad in France is indeed of the same type, although he does suggest that Iliad was inspired by, and self-consciously followed the model of, Softbank. Published as a book in 2006, and likely written therefore in 2005, the synthesis is clearly consistent with our own observations nearly five years later about the role of agile, entrepreneurial competitors entering over access to incumbent networks. The synthesis also coheres with our own observations regarding the difference between the reluctance of the German regulator to impose access regulation, the relatively concentrated market structure in Germany, and the relative switch in the performance of France and Germany, particularly along dimensions of price and speed, rather than penetration, following the French regulatory changes in the face of German reluctance to adopt open access. Fransman adds insights into the UK market, because his description is written contemporaneously with the consideration of the imposition of functional separation on BT. He emphasizes that unbundling in particular was weakly implemented in the UK, and while wholesale competition existed, more disruptive entry of the Softbank style was impossible without unbundling. Fransman then quotes from an interview with the Director General of Oftel that "had 'he realised earlier that BT was playing a long game' he would have 'handled local loop unbundling differently,'" and would have been "more directive" (Fransman 2006, p. 189). This description is consistent with the observations of Ofcom, as well as the observation of the history since introduction of functional separation in the UK.

Picot & Wernick (2007)[139] is a peer reviewed, academic article with no visible industry sponsorship. It offers qualitative case studies of EU countries, South Korea, and the United States. It does not seek to draw normative conclusions about which of the various approaches is, overall, better. Its findings are largely consistent with our own. The authors concluded that "LLU and access obligations play important roles throughout Europe and have contributed to high deployment rates in countries lacking alternative infrastructure as well as in countries with competing platforms." (672). They do, however, note the continuing debates over whether open access obligations undermine investment incentives, pointing in particular to the debates over regulatory holidays in Germany. (672). With regard to South Korea, the authors offer an interpretation similar to ours of the history of South Korean deployment.

138 Lindmark, S. and Bjorstedt, P. (2006). The Swedish Broadband Market. M. Fransman (ed.), Global Broadband Battles, Stanford University Press: 240-265.

139 Picot, A., & Wernick, C. (2007). The role of government in broadband access. *Telecommunications Policy, 31*(10-11), 660-674.

That is, most of the work in South Korea was done by the various government intervention programs, but the competition policy component should be seen as a piece of, as opposed to entirely distinct from, the open access debate. Looking at the early use by Hanaro and Thrunet of leased access lines over cable: "From a competition-related perspective, the leading position of South Korea has been furthered by platform competition between DSL and cable modem. While LLU played a negligible role, open access obligations for cable owners were important for new entries to compete on a level playing field." (671). Finally, with regard to the U.S., the authors conclude in 2007: "Thus, the U.S. is moving in an entirely different direction than Europe, and also in comparison to U.S. regulatory policy prior to about 2002." (671).

Kushida and Oh (2007)[140] is an academic peer reviewed article. It describes the political regulatory history of Japanese and South Korean broadband development, surveying the relationships between the regulators and the incumbents and describing the market dynamics between the major firms. The paper suggests that the balance of power and professionalism between the regulator and the incumbent played a large role in the takeoff in broadband in both countries, and that access regulation played a significant role in Japan. Kushida and Oh, like Lee and Chan Olmstead (2007) and like Picot and Wernick (2007), observe the open access nature of cable infrastructure entry in South Korea: "In April 1999 Hanaro commenced broadband services, utilizing both DSL and cable, using its own DSL network and leasing cable capacity from Powercomm, a subsidiary of KEPCO and KT " (495).

De Bijl and Peitz (2008)[141] is a peer reviewed journal written by an academic and a researcher at an independent government research center. It is addressed to Dutch policy makers, but is largely a conceptual piece, not a qualitative or quantitative analysis piece. It seeks to persuade the Dutch regulator to focus on an approach for phasing out unbundling and open access over time. While the study acknowledges that unbundling played a role in spurring competition and investment in the Netherlands as a practical matter, it raises concerns about longer term investment incentives. In particular, it emphasizes the fact that the Netherlands has a high degree of cable competition to DSL to argue that open access policy is unlikely, in the long term, to be better for the Netherlands.

Whallen and Curren (2008)[142] is a paper by two academics with no visible corporate sponsorship. It is published in Communications and Strategies, the IDATE journal. It is a relatively simple descriptive paper. It primarily tells the story of BT's functional separation as a difficult one. The emphasis is on the difficulty of practical implementation and the necessity of extensive, continuous monitoring and adjustment by the regulator to define the boundaries between the wholesale and retail divisions, and the content of what needs to be offered by Openreach. The paper also briefly reviews the experience of other countries and suggests that the Italian case was primarily driven by an effort to prevent AT&T's entry into the market in order to keep Telecom Italia under Italian control; it further suggests that elsewhere in Europe regulators were not jumping on the functional separation bandwagon.

Eskelinen et al (2008)[143] is an academic paper in a refereed journal with no industry support. It very broadly compares the Swedish early broadband plan and government funding model to the somewhat later Finnish national plan, which did not depend on government funding but rather on entry by former incumbents into each other's markets. It concludes that the Swedish approach resulted in earlier growth

140 Kenji Kushida and Seung-Youn Oh, The Political Economies of Broadband Development in Korea and Japan, Asian Survey, Vol. XLVII, 2007. 49 0-504.

141 de Bijl, P., & Peitz, M. (2008). Innovation, convergence and the role of regulation in the Netherlands and beyond. *Telecommunications Policy, 32*(11), 744-754.

142 "Is Functional Separation BT-Style the Answer?" Communications and Strategies. (71), 3rd quarter 2008, p. 145-165.

143 Heikki Eskelinen, Lauri Frank, and Timo Hirvonen. 2008. Does strategy matter? A comparison of broadband rollout policies in Finland and Sweden . Telecommunications Policy, 32:412-421.

of penetration and lower prices earlier; but that the Finnish approach ultimately caught up. The authors conclude that the choice of approaches—government investment driven or competition driven—did not result in substantially different results. While the paper does to some extent note the historical difference between the incumbency structures in the two countries, it focuses primarily on the difference in funding policies, and does not seek to explore the different ways in which competition was introduced into the markets; the relative roles of cable and utilities in each of the markets, or the role and take-up of unbundling and access regulation in creating the competitive environment. Because of these omissions, the paper leaves much of what appears to be relevant and contested in the policy analysis under-explored. Nonetheless, its implication is that Finland's access-based competition, among incumbents entering each other's traditional regions using, in part, unbundling, is that competition in the presence of open access performed as well in the medium term as the more state-sponsored approach pursued by Sweden.

Sadowski et al (2009)[144] is an academic paper with no corporate sponsorship, published in a refereed journal. It provides a detailed case study of one municipal fiber-to-the-home network, and an overview of several others in the Netherlands. The paper outlines several approaches, ranging from public utility-like models to a joint-venture like model. It concludes that there is significant room for municipalities to play a role in constructing fiber networks, although its description suggests that implementation is far from simple. Moreover, the paper concludes that municipalities should mandate open access obligations on new networks. The case study itself, however, suggests that vertical integration turned out to be important in that case to recover the costs of deployment; that the studied system itself ended up being taken over by Reggefiber and operated, as a practical matter, as a vertically-integrated operation; that competitive service providers did not enter, and that open access was available for passive, Layer 1 elements, not for active components higher up in the stack.

Qualitative case studies of access regulation: Industry sponsored

Hausman and Sidak (2005)[145] is a peer-reviewed article. The headnote properly discloses that the research was commissioned by Vodafone.[146] The paper uses case studies to argue that none of the rationales of unbundling is borne out by the evidence from five countries' experience: the United States, the United Kingdom, New Zealand, Canada, and Germany. We note that all five countries are those that we, and other case studies described here, diagnosed as, at least at the time, having weak, ineffective, or strategically contested unbundling regimes. The study is from a period when the United States was passed the peak of its unbundling policy; the UK and New Zealand were both on the verge of reaching a decision that their approach had failed, and were about to shift to functional separation; Canada and Germany, in turn, were two of the countries that had adopted unbundling formally, but were among the most reticent in implementation. There are various places where Hausman and Sidak interpret their evidence more favorably to their position than we would have, but these are not fatal to the analysis. Given the countries they chose, however, the analysis primarily comports with the observation that half-

144 Sadowski, Bert. M, Alberto Nucciarelli, and Marc de Rooij. 2009. Providing incentives for private investment in municipal broadband networks: Evidence from the Netherlands. Telecommunications Policy. 33:582-595

145 Hausman, J., & Sidak, G. (2005). Did mandatory unbundling achieve its purpose? Empirical evidence from five countries. Journal of Competition Law and Economics, 1(1), 173–245.

146 This does not necessarily connote a conflict. Vodafone at the time owned Arcor, in Germany, which is a facilities-based based CLEC, not an unbundling-based CLEC. It also owns shares in SFR, which at the time had not yet bought Neuf-Cegetel, and so was in mobile, not home-broadband. It certainly is not an incumbent-supported paper. To the extent that there is a conflict we have not detected, it would suggest bias in favor of entrants, rather than incumbents. The paper, however, supports the incumbents' case. The authors had written in opposition to unbundling several times in the prior years.

hearted implementations of unbundling do not work very well. The study does not include a single country that was at the time effectively implementing unbundling.

Crandall and Waverman (2006) is a refereed paper sponsored by France Telecom. Its abstract and some of the discussion suggest that this analysis was focused on "the emerging broadband strategy in Europe of large ISPs owned by incumbent telecommunication companies in other countries (for example, France Telecom's Wanadoo)": in other words, cross-border market entry by incumbents in one country to compete in their neighbors' erstwhile backyards. In our own case studies this was most visible in the entry of the Nordic incumbents into each other's markets. As such, it is an interesting paper by authors who normally write from the incumbents' perspective, who are asked to write from the perspective of an incumbent in one jurisdiction as it seeks to enter another.

About the U.S., discussing primarily voice, rather than broadband, unbundling, Crandall and Waverman write:

> AT&T and MCI largely abandoned mass-market local services because of the recent court decision that overturned the FCC's liberal unbundling rules and have since been acquired by SBC and Verizon, the two largest incumbents." (at 119.) "The continued growth of local competition in the United States through June 2004 was due almost entirely to the growth of the unbundled network platform, which had been leased by incumbents at rates 40 – 60 percent of the incumbents' average revenues per line. … This form of competition was nothing more than regulatory arbitrage, but it may have been profitable until the incumbents responded with their own bundled service packages. This conjecture is now largely irrelevant because the courts have forced the FCC to change its network unbundling rules. As a result, AT&T and subsequently MCI largely abandoned the mass market for local and long-distance services and merged into the two largest Bell companies.

Regarding the UK, they write:

> In the United Kingdom, unlike the United States, there was little CLEC entry aimed at residential markets. This may have been due to the fact that LLU began five years later than in the United States (2001 versus 1996), as well as capital market constraints that surely existed a year after LLU began in the EU. (p. 130)

> In the United States, some commentators blame regulation, that is, the implementation of the 1996 Telecommunications Act, which resulted in very large wholesale discounts for entrants, for providing incentives for inefficient entry. Yet similar excessive entry occurred in the United Kingdom, where mandated resale and LLU did not exist. This suggests that capital markets as well as regulatory incentives played crucial roles in stimulating uneconomic entry into telecommunications generally. (132).

Reviewing the experience of Europe, the authors write:

> However, there is one large and significant difference between narrowband and broadband services competition. In narrowband markets such (LLU based) competition merely replaces an incumbent's services with identical services from an entrant. The welfare gains—and thus the overall prospects for revenue growth and sustainable entry—are likely to be limited. Broadband, however, is a relatively new service with a rapidly increasing number of residential subscribers in Europe. Since broadband offers consumers the prospect of genuinely new and distinctive services, marketed and bundled for them in genuinely new and distinctive ways, the consumer welfare gains from services-based broadband competition might be significant, thus sustaining entry.

> Some analysts suggest an inverse relationship between the use of LLU and the rollout of broadband, because LLU diminishes the incentives for the incumbent to upgrade its network for broadband. In Europe, however, we see no simple inverse relationship between the number of lines unbundled and the percentage of homes with broadband, but there is a compounding issue. In Germany and France the incumbent telco is the major ISP, unlike the United Kingdom where BT until recently has been a minor ISP provider. It may be that the incumbent's desire to maintain its position as an ISP offsets the adverse incentives created by LLU in Europe. (141).
>
> As broadband providers however, Wanadoo, AOL, and other ISPs control the broadband portion of the local loop. Moreover, if they do not use LLU but rather bitstream access, they have incentives to use VoIP, competing directly with the incumbent telco. Note the number of large multi-country ISPs in Table 11: Tiscali (an independent and the second largest ISP in Europe), Wanadoo, Tele-2, Chello Broadband (controlled by the Dutch cable company UPC), Easynet (controlled by the founders of Easyjet, the successful low cost airline), AOL, and NTL. These represent a potentially large, diversified set of competitors for telcos offering ADSL.
>
> The experience of Iliad/Free in France also suggests that broadband ISPs with differentiated and innovative offerings can be viable. Free is the only nationwide "triple play" operator offering "ADSL 2+" technology over unbundled loops. By 2005, Free accounted for 43 percent of all unbundled lines in France. Further, Free reported 130,000 paying subscribers to Freebox TV services, and 1,135,000 telephone users. Iliad, Free's parent company, reported a 52 percent increase in revenue between the first quarter of 2004 and the first quarter of 2005, largely thanks to an 83 percent jump in Internet revenues. Free's stated goal is to reach 1.5 million ADSL customers for the year 2005. As of 30 June 2005, the firm had achieved an ADSL subscriber base of 1,316,000.73 Michel Boukobza, Managing Director of Iliad recently declared, "Our business model is simple, we have a E29.9 monthly rental [from our retail customers] and we pay France Telecom E10.5 per month per subscriber. The difference allows us to amortise our network as well as R&D costs." This would suggest that there is plenty of scope for entrants to use low LLU rates to operate profitably. However, other entrants have not replicated Free's successes, and French LLU rates are not significantly different from the European average. There is nothing obviously different about France (relative to the rest of Western Europe)—such as vastly lower input costs for entrants—that would explain how and why Free has been successful. On the other hand, Free has been offering innovative products such as TV over DSL, and it is this product differentiation and innovation that might explain its rapid increase in subscribership. Indeed, France's relatively low cable penetration might create an opportunity for ISPs that offer bundles of broadband along with Digital TV.

On Japan Crandall and Waverman write:

> In December 2000, the Ministry of Public Management, Home Affairs, Posts, and Telecommunications introduced a network unbundling requirement in Japan, allowing new entrants to offer DSL services over shared NTT lines. At that time, there were less than one million broadband subscribers in Japan, and most of them were subscribing to cable modem service. DSL has since grown rapidly, attracting 12.8 million subscribers by September 2004, while cable modems have grown more slowly to just 2.68 million lines and fiber to the home has increased to 2.0 million lines. The new entrants had accounted for nearly 62.5 percent of Japanese DSL subscriber lines by March 2004, thanks largely to aggressive price competition from Yahoo!Broadband ("Yahoo!BB"), which is offering DSL for as little as 2280 Yen (about $20) per month, not including the cost of the modem. In its first year, Yahoo!BB had more than 1 million lines, and by March 2004 it had increased its subscribers to 4.9 million using lines shared with NTT. Yahoo!BB is a subsidiary of Softbank, which provides the financing

> and infrastructure for Yahoo!BB's operations. Although Yahoo!BB has reported substantial profits from its operations, Softbank has continued to report very large losses in its "Broadband Infrastructure Division." Softbank's objective is to build a very large customer base to which it can sell a variety of entertainment and information services, as well as VoIP. It has been extremely successful in selling VoIP to its subscribers, with 4.7 million of its 4.9 DSL subscribers accepting the service. Whether its strategy of building market share and eventually selling enough content to offset its huge start-up losses can succeed no one can know at this time.

Crandall et al. (2009)[147] is a forthcoming publication funded by Verizon; its authors are identified both by their affiliation as Empiris consultants and by other institutional affiliation, most prominently the Brookings Institute. The article is a qualitative analysis of the effects of functional separation in the UK, New Zealand, Italy, Sweden and Australia. The paper begins with a background conceptual framing of the costs of functional separation in terms of lost efficiencies of vertical integration. It then reviews the experience of the UK, in particular, and to a lesser extent the remaining four countries that adopted separation. The paper argues that the UK's efforts support the proposition that vertical separation has no positive effect on penetration and will undermine investment. In particular, the paper discusses the slower levels of growth in penetration in the UK by comparison to its own growth rate during the period of September 2002 to September 2005, and to the growth rate of the EU 15.

This claim is difficult to interpret because of the relatively low base from which the UK grew in the earlier period, relative to the later period. It is common for growth rates from a higher base to be lower than growth rates from a lower base, earlier in the diffusion process. From Q4 2002 to Q4 2003, the UK broadband penetration rate grew from 2.3% to 5.4%, and then the following year from 5.4% to 10.4%. The following year penetration grew from 10.3% to 16.3%. After separation, the yearly increases continued from 16.3% to 21.4%, then 25.8%, and 28.5% by 2008. By comparison, in the U.S over the same period, without functional separation and after the elimination of all access rules, penetration also started from an identical level to that of the UK in Q4 2005, 16.3%, but then grew more slowly than in the UK, to 20.3%, 23.4%, and 25.8% over the same periods. It is possible that the diffusion curves of each country are different, but that would make the comparison to the EU 15 at least as problematic. The Crandall et al paper does not address the dramatic increase in unbundled lines, from under 200,000 to five million, which suggests substantial complementary investment from entrants, or the substantial annual drop in prices emphasized by Ofcom in its own review of the separation.

Crandall et al then move to focus on investment. The authors acknowledge that BT's investment levels are among the highest in the EU, but attribute it to "the dreadful condition of BT's network at the end of the 20th century." No attempt is made to explain why the dreadfulness of the condition of the network has any bearing on whether or not an incumbent has incentives to invest. They do emphasize that BT's capital expenditures have grown more slowly since the recovery from the burst bubble than the average growth of 12 of the EU 15, but again, do so without identifying the base from which that growth has occurred. The paper recognizes that BT's base levels of investment were relatively higher than those in the other countries. Proceeding to compare BT's rate of growth in investment from the higher base is less revealing when compared to an average of 12 countries if those countries grew from lower baseline levels of investment. Finally, the paper underscores the difficulties of transposing open access to fiber, the relatively low levels of investments in fiber in the UK, and the increasing interest of the UK government to find government sources of funding for fiber deployment to much of the country. This description raises valid concerns with the application of separation to fiber, in particular the extent to

147 Crandall, Robert, Jeffrey Eisenach, and Robert Litan. 2009. Vertical Separation in Telecommunications Networks: Evidence from Five Countries. *Forthcoming* Federal Communications Law Journal.

which functional separation indeed can be contained to passive elements only, as opposed to be extended to standardized active elements. On the other hand, the comparisons in the paper between BT's (absence of) investments in fiber to the home relative to Virgin Media's investments in DOCSIS 3.0 rollout are difficult to justify, since the cost structures of the two investment pathways are different—this is the great short-term advantage cable has over fiber—the near-term rough equivalence of performance coupled with an order-of-magnitude cheaper upgrade path. Furthermore, the comparison to U.S. investment in fiber is also complicated by the fact that U.S. fiber to the home reflects only Verizon's investments; it does not explain the absence of similar investments by AT&T or Qwest.

In discussing the other four countries, the Crandall et al paper also discusses penetration and investment. For penetration, because it focuses on growth, the paper uses a log-scale to show broadband penetration per 100. The authors write "In fact, if one plots the growth of broadband across most of the major OECD countries, one observes a convergence in both *the level* and the rate of growth of broadband penetration, as shown in Figure 4." (emphasis added). With regard to the level of penetration, however, the log scale is inappropriate and distorts the penetration data preventing a real comparison. It treats Italy's level of penetration in Q2 2008, of 18.2%, as "converged" with Denmark's rate of 36.7%. On a log scale, this looks no greater than the difference between 2% and 4%, and as drawn in Crandall et al 2009, Figure 4, that near 20% difference is drawn as no greater than the difference between 0.2% penetration and 0.4% penetration earlier in the decade.[148] Furthermore, even on this scale, in Figure 3 of the paper, it is clear that New Zealand at the time of adoption of functional separation was well below the OECD average penetration, and well below Italy. After separation, New Zealand's penetration level reached that of the OECD average, and passed that of Italy, which had not yet, during this period, adopted functional separation (the paper itself pegs the approval of separation in Italy at December 2008, two quarters after the end of the evidence presented in the paper to show the effects of separation on penetration). The paper's analysis of fiber implementation by the companies that "succumbed to functional separation," as the paper puts it (p. 28), suffers from the fact that it is looking at outcomes of fiber investment, investments with a multi-decade horizon, as responses to regulatory interventions that are, in the case of Italy, less than a year old, and in the case of Sweden, about 18 months old. Moreover, in Sweden, the market for fiber-to-the-home is influenced by the presence of municipal networks. The paper states, for example, "While Telia-Sonera began to roll out fiber to the home in 15 major cities in Finland in 2007, it has not launched a similar program in Sweden."[149] In Sweden, however, much of the fiber to the home market begins with municipalities, and TeliaSonera does offer triple play bundles over the municipal fiber networks, and is itself a contractor for some of the municipal networks. The Swedish regulator's report on dark fiber states that "TeliaSonera accounts for 53 per cent of the total supply of optical fibre in Sweden and approximately 47 per cent of the coverage of all optical fibre;"[150] and also that "Municipal authorities and municipal companies represent the highest rate of growth, but, of the other stakeholders, TeliaSonera is by far the largest stakeholder rolling out fibre."[151] While these statements refer to fiber generally, not to fiber to the home, they do suggest that it is difficult to discuss Sweden as a case of failure in fiber-to-the-home deployment, much less that such a "failure" was occasioned by the recent adoption of functional separation.

148 If one were for a moment to take seriously the World Bank's recent calculation that a 10 point increase in penetration rate translates into 1.21% higher GDP growth, the paper is in effect treating as "convergence" a difference in penetration between countries that would translate into about 2.3% growth rate per year: more than the average growth rate of a developed economy in the period between 1980 and 2006.

149 Crandall et al 2009, p. 28.

150 Dark Fibre: Market and State of Competition. PTS-ER-2008:9. p. 22.

151 Id. at 19.

Qualitative case studies of access regulation: Conclusion

Of nineteen qualitative papers (several are discrete country chapters in a single 2006 edited volume), only two present clearly negative conclusions about unbundling. Both were industry funded. The observations of the older of the two papers are purely based on countries that at the time had not implemented unbundling effectively. The observations of the newer paper emphasize growth rates without regard to relative maturity of the market, and treat convergence on a log scale as convergence for practical policy purposes, characterizing vast differences such as between 20% and a 40% level of penetration as "converged." Of the remaining papers, nine view access regulations, where implemented, as having played a positive role in penetration, consumer use, and/or investment. One of these nine was industry-sponsored. The remaining papers focus on the political economy, on the political and practical difficulties of effective implementation, or, in the case of South Korea, on the importance of other factors. The case studies, in the main, comport with our own observations in our case studies. They present a very clear picture of the extent to which in the U.S. unbundling and open access were litigated and blocked by the incumbents at every step. They suggest that in Germany too this was the case. They suggest that, while South Korea likely exhibits other factors as more important, early entry indeed was based on open access to cable plant, rather than on unbundling. They emphasize the role of entrepreneurial entrants, like Softbank Yahoo! BB in Japan, or Free/Iliad in France. In all, these qualitative case studies provide substantial support for our own independent review of evidence, which brings the history that these earlier papers discuss up to date.

The existing empirical literature, then, does not support the present dismissal of open access as a serious potential tool in the regulatory toolbox. The econometrics literature is systematically weak, and heavily influenced by interested parties. The qualitative work is more appropriate for the kinds of complex, nuanced phenomena involved in broadband policy, and is less polluted by interested research. It also tends more strongly to support the beneficial effects of open access policy.

The remainder of this part is dedicated to our own contribution to the existing work with new and updated studies of open access policies in fourteen other OECD countries. We precede the fourteen case studies with the case of the U.S. as a baseline for comparison.

4.5 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."[152] 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.

152 142 CONG. REC. HI 145, 1146 (Feb. 1, 1996).

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.[153] 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.[154] 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. The approach was initially proposed in the Triennial Review NPRM from December of 2001, which introduced the theory of intermodal competition as a reason to abandon access regulations,[155] and was immediately followed up and expanded as a broad basis for national broadband policy in the February 2002 NPRM on Appropriate Framework for Wireline[156] and the March 2002 Declaratory Ruling and NOI on cable broadband.[157] For those potential entrants who were slow and did not read the writing on the wall during the first quarter of 2002, the FCC's press release announcing the declaration of cable broadband as an information service specifically tied all these documents together, stating:

> Today's decision follows five other related proceedings - the Cable Modem NOI, the National Performance Measures NPRM, the Incumbent LEC Broadband Notice, the Triennial UNE Review Notice and, most recently, the Wireline Broadband NPRM. These proceedings, together with today's actions, are intended to build the foundation for a comprehensive and consistent national broadband policy.[158]

At the time, this was not an unreasonable idea. Cable operators were leading the way in the broadband transition in the United States, while 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

153 United States Telecom Association v. FCC, 290 F.3d 415 (D.C. Cir. 2002).
154 AT&T v. City of Portland, 216 F.3d 871 (9th Cir. 2000).
155 Triennial Review NPRM, FCC 01-361, Docket No. 01-338, December 12, 2001, paras. 27-30.
156 NPRM: In the Matter of Appropriate Framework for Broadband Access to the Internet over Wireline Facilities FCC 02-42, February 14, 2002.
157 Declaratory Ruling and Notice of Proposed Rulemaking (FCC 02-77), March 14, 2002.
158 Cable NOI news release, http://www.fcc.gov/Bureaus/Cable/News_Releases/2002/nrcb0201.html.

model of inter-modal competition (competition between firms, each of which uses a different technological mode to provide its service) seemed to work well. The battle continued until its final conclusion in 2005, after which the largest unbundling-based entrant, AT&T, was bought by SBC, MCI by Verizon, and other, smaller entrants shifted focus away from the residential market or disappeared.

Perhaps the most contested (at least legally) aspect of this series of decisions was that the shift was achieved 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.[159] 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, at least 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.

4.6 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.

4.6.1 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

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

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.[160] 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.[161] NTT was forced to abandon its ISDN-to-Fiber gradual move, and shift to DSL and fiber to the home investments. NTT had already built much of the heart of the fiber infrastructure in the 1990s.

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 4.3.[162] 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 retail fiber access over NTT's Flet's Hikari fiber-to-the-home service and has become a major player in fixed mobile 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-

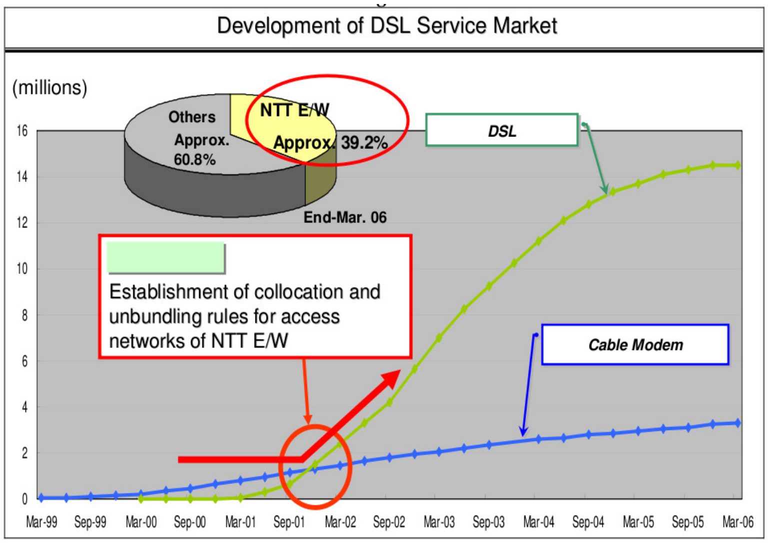
160 Kenji Kushida and Seung-Youn Oh, The Political Economies of Broadband Development in Japan, Asian Survey, 48(3) May/June 2007, 480-504.

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

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

extraction devices, like NTT's ISDN policy. That entrant continues to be a major force in the market almost a decade later.

Figure 4.3. Development of DSL Service Market, MIC, Yasu Taniwaki



The story of fiber development, on the other hand, makes the Japanese case 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 fiber and open-access-based DSL elements into its business model, as well as Softbank's entry into fiber services through reselling NTT’s Flet’s 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 some 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.[163] 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.

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163 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 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.

4.6.2 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.[164] 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

164 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.[165] 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 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,

165 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.

4.7 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 relatively low population density and urbanicity; the Netherlands occupies the second position. By our own rankings, which include price and speed, Norway and Iceland slip because of higher prices, while Sweden, Denmark, Finland, and the Netherlands occupy four of the top seven spots, together with Japan, South Korea, and Switzerland. High per capita GDP and median income, high education, low inequality all likely contribute to this performance, as does government investment in Sweden and possibly 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 and a single long-distance monopoly, 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.

4.7.1 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 example of incumbents invading each other's territories using unbundling as an element in the entry strategy. Finland's fixed-line competition developed from the former regional and national telephone monopolists entering the more densely populated parts of their rival's territories, combining unbundled access 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.

4.7.2 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 purchasing the 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.[166] 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. The consolidation of entrants we observe here, as well as in Sweden, in which Telenor plays a productive role, is precisely what a Schumpeterian model of competition would seek and predict—more competition than a monopoly or duopoly, but less than perfectly free entry resulting in competitors that are too small to sustainably threaten the incumbent.

4.7.3 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, which now covers 90% of Swedish homes through unbundled DSL, purchased Glocalnet 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 acquired, 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-

166 Sources: Broadband Prices in Nordic Countries; Market research using TeleGeography's *GlobalComms Database* and various news reports.

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 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.[167] 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.[168]

4.7.4 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 because of its higher prices. 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

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

168 TeleGeography, *GlobalComms Database,* Sweden Country profile.

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 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 bitstream access price regulation may contribute to the fact that Norway's prices are substantially higher than they are in the other Nordic countries. Indeed, for the very high speeds our pricing study shows that the prices in Norway are the highest in our entire dataset: mostly the offerings of Telenor and Canal Digital, but also of the southern power company Lyse. Only NextGenTel's 40Mbps offer is priced at rates that are mid-tier and consistent with Danish prices, though still much higher than prices in Sweden or Finland for next generation speed offerings. 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.

4.7.5 Finland

Finland became the first Nordic country to introduce unbundling in 1996. 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 holds 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. While interviews and published materials about Finland do not mention unbundling as an important component of entry strategy, the sheer numbers of unbundled loops used in Finland suggest that much of this entry indeed occurs over unbundled loops. According to the ECTA scorecard for the first quarter of 2009,[169] Finland had 347,400 fully unbundled loops used for broadband, and an additional 26,800 shared access loops for broadband. Given a total number of 433,000 retailed broadband connections provided by DSL entrants reported in the same report for Finland, the data strongly suggest that almost all broadband connections sold by a competitive xDSL provider in Finland are sold over unbundled loops. In the discussion of the Canadian market below, we see that a similar structure, where former incumbents can enter each other's markets using unbundling, has not in fact resulted in significant competition. In Finland, on the other hand, 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 Figure 4.4), Elisa and TeliaSonera Finland have practically

169 ECTA Broadband Scorecard; March 2009.

identical offerings at the very high speed tiers that are comparable to the affordably priced highest-speed offers of the entrants in South Korea (but not KT) and France Telecom, and at prices only somewhat higher than those in Japan, France (entrants only), and Sweden. 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.

4.7.6 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).

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 plans described by KPN suggest that a pattern of investment aimed at developing a shared core set of facilities will continue, aiming for an open access next generation network, and rolled out on a regional basis, lowest-cost areas first.[170]

OPTA, the Dutch regulator, is the first regulator in Europe to have implemented a requirement for fiber unbundling on regulated terms.[171] OPTA uses a price-cap approach, subject to three-year review, with

170 Update on KPN's fiber roll-out: Next phase in consumer strategy. KPN 15 December 2009. https://www.kpn.com/v2/upload/4140a0cd-d7b7-4104-b7b1-76ba7c3419fc_Presentation_Fiber_update.pdf.

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

levels backed out of the business case of KPN and Reggefiber (discussed 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 (now T-Mobile) 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 begun to invest in fiber-to-the-home as a real-estate-like investment, Reggefiber, to deploy the fiber infrastructure in a number of towns. KPN will 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. KPN will then provide service over that platform alongside, and on equal terms with, its competitors. Reggefiber has, as part of this effort, sought to increase its share of a public private partnership that was rolling out fiber in Amsterdam, Glasvezelnet Amsterdam (GNA) to 70%, while leaving the city and housing corporations that are part of the project some important veto rights (see below, part 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. This model is of sufficient discrete interest that we offer a more extensive analysis of the business case for Reggefiber and the KPN Reggefiber JV as an annex to this chapter.

4.7.7 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 the translation of the lessons of the past decade to the next generation transition has taken the form of imposing functional separation on the incumbent as it moves to deploy the next generation network. In the Netherlands, KPN's new joint venture with Reggefiber and its regulatory treatment result in the effective equivalent of functional separation for open access fiber. In both countries that approach was complemented by municipal efforts, as we will discuss in the part on municipal investments.

4.8 The larger European economies: Diverse responses to recalcitrant incumbents

Compared to the Nordic countries, France, Germany, the UK and Italy are much larger countries and economies with 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, where there is high regional divergence, and where mobile broadband seems to have taken off and to a great extent substituted for fixed broadband.

4.8.1 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 somewhat different trajectories. In 2002-2003, France revamped its regulatory scheme to emphasize the needs of innovative entrants over those of incumbent France Telecom. Germany postponed action, and only extended access practically after much of the debate shifted to next generation infrastructure, where it continues to struggle to implement an access model. France Telecom's two major competitors both have their roots in access-based entrants. They have a larger market share than do Deutsche Telekom's competitors, 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.[172] In speed, France today is part of the small group of first-tier countries with substantial offerings of 100 Mbps service. At least three 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 are among the lowest in the world for all but the very low speeds. 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 ranks 8th rank by our measures; Germany is 12th.

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.[173]

172 France is clearly ahead in penetration per 100. The recent Eurostat household survey suggests that in 2008 France was ahead in per household penetration as well. The 2009 numbers suggest that France had zero growth, in household terms, in penetration, and is now slightly behind Germany. This is difficult to square with France’s growth trend as well as that of every other country in the survey, and its continuing growth in per inhabitant penetration.

173 OECD, G7 historical penetration rates. http://www.oecd.org/dataoecd/22/14/39574797.xls.

Its broadband penetration rate per 100 inhabitants was 15th in the world, compared to the U.S. position of 4th.[174] 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 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."[175] 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.

The degree to which change in France came as a result of the regulator's own internal motivation, or as a result of European Union action, is somewhat murky. 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,[176] 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. The OECD's regulatory review suggested at the time that 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.[177] Between February 2003 and January 2004, the number of unbundled loops in France grew from practically none to over 250,000.[178] 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.[179] ARCEP's characterization of its own history places a substantially lower emphasis on the EU intervention, and points to a range of actions the ART took that were effectively implementing unbundling before the EU directive passed. Krafft (2006) seems to suggest there is some truth to both claims, emphasizing both alignment with Europe and a change in leadership in early 2003

174 OECD Measuring the Information Economy 2002, p. 39.

175 OECD Regulatory Reform in France: Regulatory Reform in the Telecommunications Sector (2003). In its comments to our draft report, the French current regulator, ARCEP, noted that the litigation did not have the power to delay implementation. ARCEP Comment, FCC Docket 09-47. 11/02/2009. While we do not presume to challenge the understanding of the French regulator of its own law, we note that "delay" in this case means not legal formal delay, but level of uncertainty for entrant investment. Our assessment here relies on the contemporaneous OECD regulatory reform review, as well as on the fact that pre-2003 France performed poorly on the ECTA regulatory reform card, whereas after 2003 France's position as a well-regulated environment, at least from the perspective of entrants, improved dramatically. That observation is indeed consistent with the OECD's version of events, more so than the French regulator's assessment of the degree to which the litigation indeed did deter entrants from entering the market as long as as the regulatory decisions were under litigation clouds.

176 2002/12/EC.

177 OECD Regulatory Reform in France, Table 3.

178 OECD Regulatory Reform in France, Figure 2.

179 ARCEP timeline, http://www.arcep.fr/index.php?id=13&L=1#11131.

and influence from Japan and South Korea as causes for the increased emphasis of the French regulatory system on effective implementation of unbundlng. As a practical matter, from the perspective of lessons for the US, how much of the change was driven internally and how much was externally imposed is less important. The fact is that on ECTA's regulatory scorecard, which suggests at least the degree to which the regulatory framework is seen as effective from an entrant's perspective, France rose from 8th to 3rd position between 2003 and 2005.

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 EUR30 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 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[180] 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."[181] 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 EUR49 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."[182]

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. Germany's regulatory reform occurred several years after France's, and has never clearly realigned the relative power of the regulator and the incumbent. 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.

180 http://www.upperside.fr/tvodsl2005/tvodsl2005intro.htm
181 http://www.lightreading.com/document.asp?doc_id=66872.
182 TeleGeography, *GlobalComms Database,* Company Overview (emphasis added).

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 be 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.[183] Again, it took more than another year before DT addressed this imbalance—by raising its retail rates.

In 2005, the German regulatory framework was reorganized, and the new Federal Network Agency, BnetzA, was formed.[184] At that point unbundled and shared access loops accounted for slightly over 13% of all DSL lines, when, for that same period, unbundled and shared access lines accounted for over 23% of broadband connections in France. Since then the number of unbundled lines has grown up to 35%, by comparison to France's 38%. BnetzA also moved Germany towards implementing bitstream access, the cheapest method of allowing competitors into the market, in September 2006. By that point, the debate had largely shifted to next generation networks, and the question of whether DT would be required to open access to its VDSL facilities 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."[185] The European Commission sued the German government in the European Court of Justice after the bill became law in February of 2007. The European Court of Justice ultimately invalidated the German regulatory holiday in December, 2009. BnetzA's new access rules, announced after the decision, require DT to offer access to ducts for competitors to run their own fiber; access to some dark fiber, and requires DT to install DSLAMs in its VDSL network points. As of this writing, it is too soon to tell how effective these new rules will be.

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 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."[186]

183 OECD Regulatory Review, p. 29.
184 Communications Outlook 2007.
185 TeleGeography, *GlobalComms Database*, DT Company Overview.
186 Francesco Caio, The Next Phase of Broadband UK: Action now for long term competitiveness (September 2008)

On the facilities-based competition side Germany has only recently begun to take advantage of its large installed cable plant, passing over two-thirds of homes. A number of factors slowed the entry of cable into German broadband markets. 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. Nonetheless, cable subscriptions have risen over the past couple of years in Germany and now comprise almost 10% of broadband connections. This is expected to rise, as 30% of new broadband subscriptions are cable.

A review of DT's primary competitors suggests that the need to build a facilities-based alternative from the ground appears to have 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, and is now owned by Telecom Italia. Arcor launched its own network for voice competition in 1998, and was bought by UK-based mobile carrier Vodafone in 2000. Its strategy had 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 Vodafone/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. Vodafone/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 Deutschland 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. Perhaps as part of its new strategy to share and spread risks of next generation deployment, perhaps in anticipation of the ECJ's invalidation of the regulatory holiday, DT had entered into access agreements to its VDSL network with Vodafone/Arcor and United.

DT's final major competitor, United is 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 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, while unbundling-based offers took off, 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 markedly different stories on the role of regulatory engagement and open access obligations, although recent changes in Germany suggest that they may be converging for first-generation broadband technologies, but diverging on next generation connectivity. 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 (although there is good reason to believe that this was also internally driven in the French case). 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. 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. France is among the countries in the first tier of speed availability, with 100Mbps service available from four firms. Germany is in the second tier, with offerings of 50Mbps characterizing the top range available to residential subscribers. More generally, advertised and actual speeds, as measured from the end-user side (though not using Akamai’s measurements), are higher in France. Average advertised prices in Germany are substantially higher across every category of service, from very low speeds to very high speeds. While the countries’ regulatory framework began to converge for first-generation broadband technologies, it remains quite distinct for next-generation connectivity. On the other hand, Germany appears poised to take advantage, after long delay, of its much larger deployed base of cable penetration in a way that France is not. Whether Germany’s current stance on open access for next generation facilities will survive EU challenge, and if so, which of the two effects will dominate—the access approach in France, where cable plays a very small role but access is being transposed to the next generation, or the facilities-based approach that Germany appears to be favoring for the next generation transition—remains to be determined and merits observation over the coming years.

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. Looking at the first generation transition, however, France presents a more attractive profile of competitive entry than does Germany, which it outperforms in every category of interest, and considering next generation transition, the two countries continue to serve as an important point of observation.

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.

4.8.2 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. On the negative side, while BT is planning investments in new, next generation fiber infrastructure, currently the UK does not have significant fiber to the home or very high speed DSL service. 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, related to the terms under which BT would offer 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.[187] 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.[188] 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.[189] 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, Sweden, and Italy, has been functionally implemented in the Netherlands, and more recently was 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 should have less incentive and latitude to favor 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. 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 which 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

187 All this from the 2002 OECD paper on regulator reform in telecomms in UK.

188 The Office of Communications Act of 2002 created Ofcom, and the Communications Act of 2003 defined its powers.

189 Indeed, the former director of Oftel was quoted at the time has having said that "had 'he realised earlier that BT was playing a long game' he would have 'handled local loop unbundling differently,'" and would have been "more directive" (Fransman 2006, p. 189).

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. Moreover, the initial expansion of competition, followed by consolidation to a smaller number of more sustainable entrants, follows precisely the pattern that the Schumpeterian model of competition in this kind of a market would identify as desirable. 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.[190] At the most basic level, the price of a basket of residential broadband services decreased by 16% per year between 2005 and 2007. Local loop unbundling became much more 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 example provides an interesting contrast to the experiences of 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. It is unclear to what extent Virgin Media is emphasizing services over Cable and Wireless facilities in those parts of the country in which it did not own cable plant, relative to upgrading its own infrastructure for higher speeds, although it appears to be doing some of both.

The UK experience raises various questions. It is fairly clear that aggressive investment to build capacity to use unbundled loops followed the introduction of functional separation in the third quarter of 2005. 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 the application of a similar open access regime to the cable infrastructure would have encouraged cable

190 Ofcom. Impact of the Strategic Review of Telecommunications. May 2009.

to expand earlier, or whether it would have deterred investments, remains a matter of speculation. It is also a matter for 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 are 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 with even higher-capacity offerings. What is clear is that, while BT opposed unbundling and functional separation until it was forced to separate, the company has become a convert—supporting the benefits of functional separation as an affirmative business case, allowing it to be more flexible and free of utility-like lumbering as far as the more dynamic, services portion of its business goes, while freeing the utility portion from the pressures of the more competitive parts of the business at the same time.[191]

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

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

Italy has been relatively slow in achieving wide broadband adoption. 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. The difference may reflect the highly regionalized development of Internet service in Italy, with the highly urbanized, wealthy centers of the Northwest and Rome having higher levels of penetration and competition, and the majority of the country having poorer access.[192] 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 that were much higher than Italy's.

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

191 Cecilia Kang, *British Telecom Chairman Says Open Access ey to Broadband Growth* (2009), http://voices.washingtonpost.com/posttech/2009/05/british_telecom_chairman_rake.html.
192 Antonelli and Patrucco (2006).

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. Although Wind currently provides no fiber-to-the-home services, it has announced plans to invest in fiber-to-the-home service. It is less clear what the precise mix of own- and unbundled facilities is for Tiscali. 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 subscriber base is served by using Telecom Italia's infrastructure. Its core model relied on cherry-picking the highest density areas, and doing so with fiber to the home in particular.

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.[193] It was not until the end of 2008 that Agcom approved the details of the proposed separate division, Open Access.[194] 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.

Italy, then, presents an interesting case study with mixed results. 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 the cherry-picking strategy of FastWeb, which focuses on serving businesses and high-density urban areas. 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 part. A major puzzle remains why Italy's levels of penetration are so low despite its low prices. Clearly, low prices are not enough and other demand side factors are important. One likely possibility is that the national numbers mask highly differentiated outcomes in a country with regions with very different levels of economic development and urban concentration. 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.

4.9 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 has been 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

193 http://www.globalinsight.com/SDA/SDADetail11538.htm.
194 TeleGeography, *GlobalComms Database,* country profile: Italy.

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. 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, in some measure it seems in response to new municipal fiber efforts in several municipalities and cantons, and in some measure in response to investments by some of the smaller cable companies that seem to be transitioning to fiber, rather than to DOCSIS 3.0. 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 with regulated rates that favored the incumbents. In 2008, the same policy was extended to fiber, but again, with a limited time horizon. During the first generation transition and to this day, Canada has had 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.

4.9.1 Switzerland

Switzerland has the fourth highest level of penetration per 100 inhabitants; its position in per household penetration is lower, at 8th for 2007, the last year for which there are full numbers. It has relatively low prices for medium and high speed, but higher prices for low speed offerings and a middling price for its very high-speed offering. Switzerland ranks in the second quintile of OECD countries for median measured speeds. In mobile cellular broadband, 3G penetration is in the third quintile. 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 ranks 5th.

Broadband was launched in Switzerland by Cablecom, which currently occupies 19% of the market. (Other local smaller cable companies constitute 1% of the market.) Cable's entry into broadband forced Swisscom to introduce DSL technology in 2001. Cable continues to be the main source of competition to the incumbent in broadband markets. The only other significant competitor, with just under 10% of the market, is Sunrise Communications, which is a reseller of Swisscom DSL. Sunrise is the 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 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 are two wrinkles in this story of success without unbundling. First, Swisscom is majority-owned by the Swiss Federal government. While the government does not intervene in management decisions, it is very hard to separate out what role the discipline of the market played, and what role the discipline of potential policy decisions play for a company in which the government holds a majority stake.[195] Second, 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, and DT's touting of its current VDSL network voluntary agreements with Vodafone/Arcor and United as part of the German debate over open access to next generation networks. Despite these potential confounders, in particular the unusually large stake the Swiss government continues to hold, Switzerland does represent the one significant example of high performance under inter-modal competition not complemented by open access during the first broadband transition.

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, fiber investments by some of the smaller cable companies, and early decisions by municipalities to raise funds publicly and build FTTH networks in Zurich over the state-owned utility, ewz network (March 2007), in St Gallen (February 2008 pilot, February 2009 final approval), and in several smaller localities, which are designed to offer Internet service providers an open access FTTH infrastructure. This version of the story of next generation investment in Switzerland lends qualified support to the theory that intermodal competition is sufficient to spur investment, insofar as it relates to the DOCSIS 3.0 and cable investments in fiber, but adds the nuance that competition from public investment also has a potential role to play. 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 preempt further municipal investment; it may be 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 and negotiated 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 or two fibers and provide access to the others in one of four ways. First, owners of ducts, like cable companies and the municipal 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

195 For example, when Swisscom was moving towards acquisition of Eircom Group in 2005, the Swiss Federal Council instructed its representative on the Board of Directors to vote against this acquisition, and it was abandoned; Swisscom may not issue shares that would dilute the government's share to below 50%; and as part of its strategic goals, Swisscom is required to create specifically long-term shareholder value. All these mean that, at a minimum, Swisscom operates with much more "patient" money than do fully private companies responsive to pressures for shorter-term shareholder returns. Particularly in the context of long-term investments like Fiber-to-the-Home, this makes Swisscom's position quite different from that of other telecommunications firms that are historically private, or were more completely privatized in the recent past.

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 without their own ducts and construction capacity would have the option of sharing 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., Because the Swiss case presents particularly interesting possibilities for transposition to the US context, as with the Dutch model, we offer a more detailed and complete case study of the Swisscom four-fiber model at the end of this chapter, as part of the section on transposing access to next generation connectivity.

4.9.2 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.[196] 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. 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 that it would withdraw from its plans to invest beyond its existing service areas. (One might assume that the 2005 announcement was itself intended to add political pressure to change the

196 E.g., Bell, Tom and Solveig Singleton, eds. Regulators Revenge: The Future of Telecommunications Regulation (Cato Institute 1998).

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 along with the improvement in New Zealand's penetration ranking 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 22nd 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.[197] 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.[198] 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.[199]

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

We close our access-related case studies with Canada, a country that appears to have made a half-hearted commitment to unbundling. 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.[200] As of December of 2003, Canada had the second highest level of Internet penetration both per 100 inhabitants and per household in the OECD, second only to South Korea. At that time, there were 1.3 cable broadband subscribers for every DSL subscriber.

Upon declaring that it is imposing unbundling in 1997, the CRTC announced that it would phase out unbundling by 2002. The theory was that the pending 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 was to avoid investment disincentives to the incumbents. By 2001, however, unbundling was not being adopted. The CRTC then

197 http://www.reuters.com/article/pressRelease/idUS153081+18-Jun-2009+BW20090618.
198 OECD Communications Outlook 2009, Figure 7.12.
199 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.
200 CRTC Communications Monitoring Report August 2009). pages 213-226.

extended unbundling indefinitely. In 2002, it cut back the markup on pricing to 15%, keeping the same price setting 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 was intended to be phased out, just as the original implementation had been.[201] In December 2009, the Federal Cabinet sided in favor of the incumbents on two appeals from prior CRTR decisions. The Cabinet confirmed one CRTR decision and overturned another, taking decisions that appear to effectively exempt next-generation networks from unbundling requirements.[202]

The Canadian market is largely typified by facilities-based competition, not by unbundled access. The major players are the former telephone incumbents: Bell Canada (22.4% of the market) and Telus (12.1%), and the major cable companies: Rogers (17.7%) and Shaw (17.8%) in different parts of the English speaking provinces, and Videotron (11.5%) in Quebec. In recent years both the residential and business markets for Internet access seem to have undergone consolidation, with incumbent telecommunication service providers and large cable companies picking up market share at the expense of both new entrants and early efforts reportedly made by incumbents to operate outside of their traditional geographic regions.[203] In August 2009 the CRTC reported that revenue shares for all Internet access captured by all entrants (including residential and business; dial-up and broadband; and non-incumbents and out-of-territory incumbent TSPs) declined from 23% in 2003 to 12% in 2008.[204] While out-of-territory incumbent TSPs have never had a presence in the residential market for high-speed Internet access and only a small presence in the market for residential dial-up access,[205] their revenue share in the business market for Internet access declined from 13% in 2004 to 10% in 2008.[206] During this same time period, the revenue share of non-incumbent TSPs in the business market also declined, from 31% to 24%.[207] The share of residential Internet access subscribers, both dial-up and high speed, captured by all entrants, both non-incumbents and out-of-territory incumbents TSPs, has also declined, from 16% in 2004 to 8% in 2008.[208] The entrants' share of high-speed access (at or above 128kbps) in 2008 was even smaller at 5.5%, though had risen slightly from 4% in 2004.[209] These numbers seem to suggest that as dial-up access phases out, some subscribers of entrants are remaining with non-incumbent broadband, but some are shifting to incumbent telecommunications and cable companies, resulting in greater overall market and subscriber shares in the residential market relative to new entrants, and incumbent providers operating out-of-territory. This consolidation in the residential market

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201 CRTC 2008 decision.

202 CBC News, December 11, 2009. "Open Access Rules Take Hits" http://www.cbc.ca/technology/story/2009/12/11/clement-internet-access-bell-telus-mts.html

203 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

204 CRTC Communications Monitoring Report 2009, p. 214 (http://www.crtc.gc.ca/eng/publications/reports/policymonitoring/2009/2009MonitoringReportFinalEn.pdf)

205 *See* CRTC Telecommunications Monitoring Report 2006, p. 59, Table 4.4.7 (http://www.crtc.gc.ca/eng/publications/reports/policymonitoring/2006/tmr2006.pdf); CRTC Communications Monitoring Report 2009, p. 218, Fig. 5.3.1 (http://www.crtc.gc.ca/eng/publications/reports/policymonitoring/2009/2009MonitoringReportFinalEn.pdf)

206 CRTC Telecommunications Monitoring Report 2006, p. 58, Table 4.4.6 (http://www.crtc.gc.ca/eng/publications/reports/policymonitoring/2006/tmr2006.pdf); CRTC Communications Monitoring Report 2009, p. 218, Fig. 5.3.1 (http://www.crtc.gc.ca/eng/publications/reports/policymonitoring/2009/2009MonitoringReportFinalEn.pdf)

207 *See* CRTC Communications Monitoring Report 2009, p. 217, Table 5.3.1 (http://www.crtc.gc.ca/eng/publications/reports/policymonitoring/2009/2009MonitoringReportFinalEn.pdf)

208 CRTC Communications Monitoring Report 2009, p. 215 (http://www.crtc.gc.ca/eng/publications/reports/policymonitoring/2009/2009MonitoringReportFinalEn.pdf)

209 CRTC Communications Monitoring Report 2009, p. 219, Table 5.3.2 (http://www.crtc.gc.ca/eng/publications/reports/policymonitoring/2009/2009MonitoringReportFinalEn.pdf)

has its parallel in the business market, as incumbent telecommunications providers, who had ventured out of their traditional areas at least for business connections, seem to be retrenching in their own historical territories, while other entrants have lost market share, largely to cable companies.[210]

It is not entirely clear why Canada, despite its implementation of local loop unbundling, has seen so little competitive entry by comparison to other countries that we studied. 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 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 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 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 OECD 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 own, broader pricing study with some more recent updates, shows that both Videotron and Rogers do now offer next-generation level speeds, at 50Mbps speeds, and that Rogers's offer is similar to the high US prices, while Videotron's is more in line with the mid-range prices of the Netherlands and Denmark.[211] Our company-level pricing study for the highest-speed offers in the countries we observe here locates all of the Canadian companies but one 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 19th 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).

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210 *Compare* CRTC Report to the Governor in Council: Status of Competition in Canadian Telecommunications Markets 2005, p. 62, Figure 4.4.1 (http://www.crtc.gc.ca/eng/publications/reports/policymonitoring/2005/gic2005.pdf), *with* CRTC Communications Monitoring Report 2009, p. 218, Figure 5.3.1 (http://www.crtc.gc.ca/eng/publications/reports/policymonitoring/2009/2009MonitoringReportFinalEn.pdf)

211 The Videotron offer appears in our firm-level study of next generation oriented offerings at the end of this Part, but is not part of the benchmarking exercise because Videotron is not a top-4 provider in the Canadian market.

4.9.4 Lessons from Switzerland, New Zealand, and Canada

- Switzerland's experience suggests that, under the right conditions, a country can do well without enforcing open access regulations. This conclusion is somewhat muddied by the fact that Swisscom is majority owned by the Swiss government, and to some extent by the fact that it operated throughout much of this period under the threat of regulation.

- 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 adopt 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 third and fourth quintile performer in speed 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.

4.10 Firm-level price and speed data for next generation offerings

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 78 firms in the OECD, primarily in the 15 countries whose experience we described in detail in this part.

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* maintained by TeleGeography and the Point Topic dataset, as we did in Section 3.6. (For a more complete methodological description see the pricing annex to this Part). We analyze these data sets at a firm-level resolution. In our benchmarking measurement we took the best prices for the highest-speed offerings in each country, restricting our observations to the four largest providers by market share. This allowed 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. Here we expand our observations to 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. We did this because the datasets included a relatively sparse set of US-based offerings, and these were very high priced, and given our particular focus on the US lessons we wanted to make sure that we were comparing other prices to real US prices. This biases the results somewhat in favor of the U.S. providers, because we were able to include offers from more US companies, and to find better offers, than those that were available purely from looking at our datasets. 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, which has cheaper moderately-high speed offers, Videotron, which has a moderately priced 50Mbps offering, and Cablevision, which has a high-priced 101Mbps offering. AT&T, Verizon, Qwest, Comcast, Charter, Time Warner, and Cox, from the U.S., and Bell Canada, Shaw, and Rogers, from Canada are joined by the Norwegian companies (except NextGenTel), KPN, the Dutch incumbent,[212] and M-Tel, the Hungarian incumbent, in the lower left triangle that marks high prices and low speeds. 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.

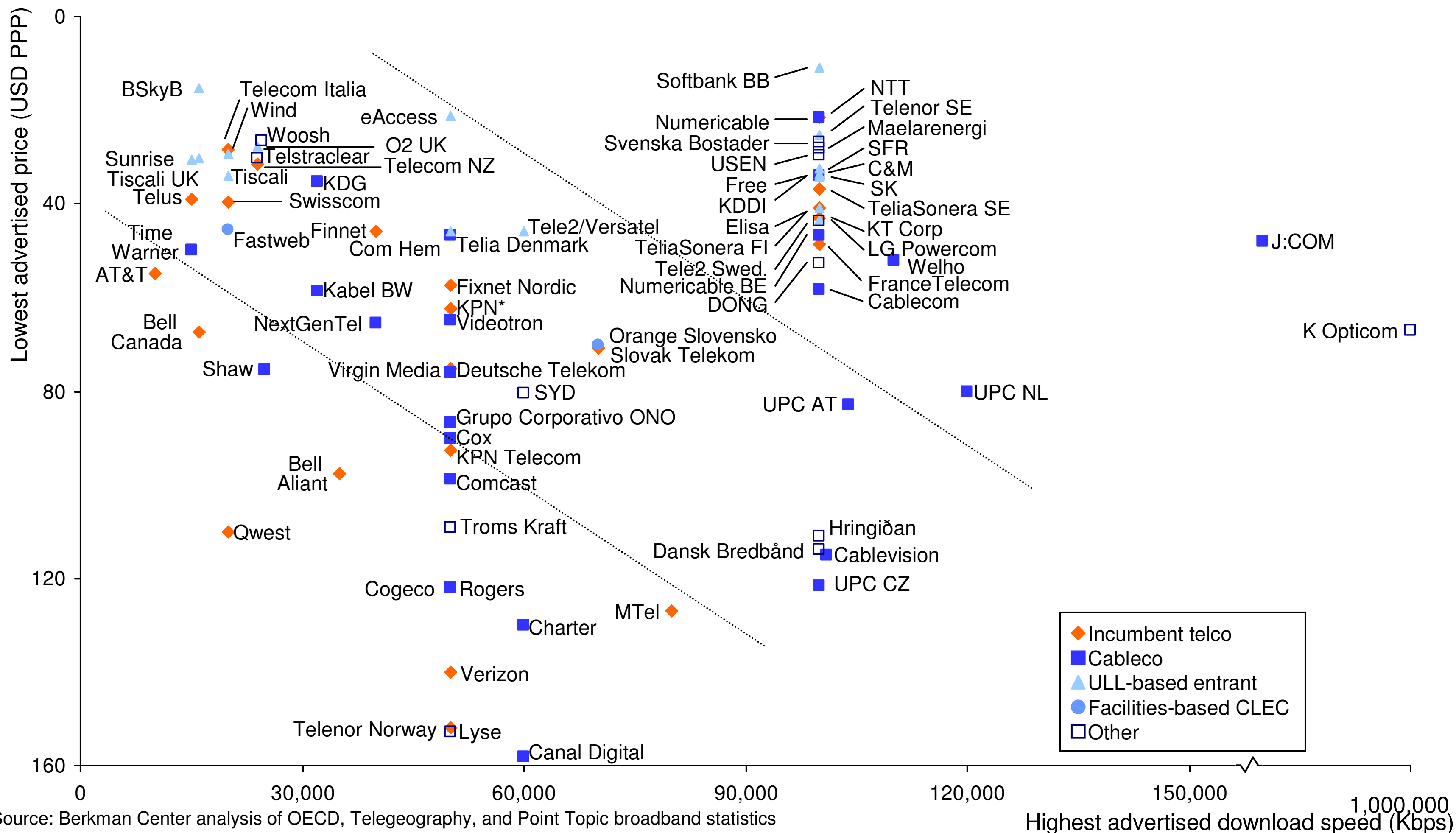
At the other end, we see a natural separation between a middle swath of performers and the cluster of firms that offer high-speed, low-priced offerings. The latter group, in the upper right hand corner, includes several countries that have most of their major players in that corner: Japan, France, Finland,

212 This is a clear instance where our methodology biases the result in favor of US companies. Looking at KPN’s current offerings over Reggefiber, as we did for US companies, would have resulted in KPN’s shifting locations to roughly where Cablevision is on Figure 4.4, outside the bottom left triangle.

Sweden, and South Korea, as well as countries that have one representative company each in that quadrant: the Swiss, Dutch, and Belgian cable broadband companies, and a Danish power company. For France, we see unbundling-based providers Free and SFR alongside their incumbent provider France Telecom and cable competitor Numericable. For Japan, we see 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, 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, and although in our dataset TeliaSonera Sweden does not join them, 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. 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. The majority of 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, alongside most of the Norwegian companies. 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, Sweden, and Finland—or in South Korea, which enforces open access but where the companies making the offerings do not rely on it. There is also a single offer from each of Switzerland, the Netherlands, Denmark, and Belgium, but although these countries all have an open access regime, none of the offers are from open access-based providers, and they are the most expensive within this set of high performing companies (e.g., the Dutch cable broadband offering from UPC, the fastest among these, is almost twice the price of the faster Japanese cable broadband offering from J:COM; the 100Mbps offering from Numericable Belgium is twice as expensive as Numericable's French offering of the same speed, and it is the lowest-priced cable broadband offering among the Belgian, Dutch, and Swiss cable companies each of which is the sole representatives of its country in this part of the graph,). 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 4.4. Best price for highest speed offering



Source: Berkman Center analysis of OECD, Telegeography, and Point Topic broadband statistics
Note: Includes highest speed offerings from US players with minimum 2M subscribers

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. We include and emphasize in this description two voluntary models for sharing risks and costs of deployment of Fiber-to-the-Home, those of Swisscom and KPN-Reggefiber in the Netherlands. We do so because we think that from a US perspective, models that rely on voluntary infrastructure sharing offer a particularly attractive model, at least for initial exploration.

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. The shift to next-generation networks, in particular fiber-to-the-home, underscores that the high fixed cost characteristics of physical communications networks have not been repealed. The temporary relaxation of that assumption caused by the relatively low cost upgrade paths of copper and cable networks is no longer descriptive of FTTH networks.

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. For example, as we see below, Reggefiber's actual cost of deployment is relatively cheaper than in other countries, because of the low cost of digging in Dutch soil, and nonetheless requires a 45% penetration to return the investment over a period of 8 or more years. Such a cost structure is inconsistent with having both a competitive market and a market occupied solely by players who can afford the price of building their own facilities. Even where 45% penetration, rather than, say, 60%, is necessary to justify the investment, markets will not support more than two players. 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 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 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 may change as Reggefiber takes over from Amsterdam CityNet, because Reggefiber has been deploying point-to-point networks connecting about 3000 homes per pop.) 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). An October 2009 study conducted by Analysis Mason for Ofcom identifies seven different models of making GPON architectures amenable to unbundling, and finds several of these either immediately feasible or feasible within three to five years, given expectations about developing standards.[213] 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.[214] Experience with the Amsterdam CityNet network suggests that 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.

As we describe below, Reggefiber is built on a commercial real-estate model, whose revenue is optimized by making it easily accessible to as many "tenants" as possible. It is therefore deploying a point-to-point topology. Both Reggefiber's own experience and that of Amsterdam CityNet confirm the British Broadband Stakeholders Group report explanation 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 chosen to deploy a GPON topology. Iliad/Free, on the

213 Analysis Mason. GPON Market Review: Competitive Models in GPON, Initial Phase. 26 October 2009 Report for Ofcom.

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

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.

- It appears that, in the short to medium term, PON, like point-to-point, will be technically amenable to unbundling, so while the choice is significant, it does not appear to be irreversible.

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.[215] 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 approached in part 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%.[216])

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, is on track to become more private than public when Reggefiber will buy new shares in the project that will bring its share in the project to 70%.

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-

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

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. Reggefiber apparently is pursuing similar strategies in the smaller Dutch markets.

Private joint ventures on an open access model.

Two primary models are being explored in Europe for joint private investment. We provide more detailed case studies of each of these in the Annex to this chapter. 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 relies on independent players (at the moment, primarily Swisscom and publicly-owned municipal electric utilities) overbuilding complementary parts of the network and then sharing their overbuilt, four-fiber networks between them and with other entrants.

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, the public municipal electric utilities, like those in Zurich and St. Gallen, that have already decided to deploy FTTH networks, and the cable companies that have begun to invest in fiber). 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. The October 2009 Analysis Mason study for Ofcom discusses in some detail the costs and benefits of multi-fiber to the home strategies versus single-fiber to the home strategies, with switchover in a local exchange point rather than at the home. These involve upfront capital costs (slightly higher for multifiber in the home) relative to somewhat higher continuing labor costs and potential for human error with single fiber and switchover at exchange points). Deutsche Telekom too has announced several cooperative ventures with regional competitors along similar lines, although without any claim of making the infrastructure available on an open access model, but strictly sharing it among the original companies deploying the infrastructure. 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.[217] Moreover, France decided to support the move to fiber in its urban areas, Paris in particular, by opening up its sewer system to providers 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.[218] “Passive” elements are inert pieces of equipment that just carry electronic or optical signals 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 or optical 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.[219] 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 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

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

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.[220]

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, and is most conducive to the commercial real estate development model led by Reggefiber's majority shareholder, which is indeed a real estate company. 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.[221] 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.[222] 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 States 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.[223] 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 separate open access division. And we have seen that the Dutch incumbent, KPN, has entered into a

220 ERG (17) 2009 at pp 19-20.
221 ERG(17)2009 p. 23-24.
222 ERG (17) 2009 p. 59.
223 ERG (07) 44.

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 also 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.[224] 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 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.

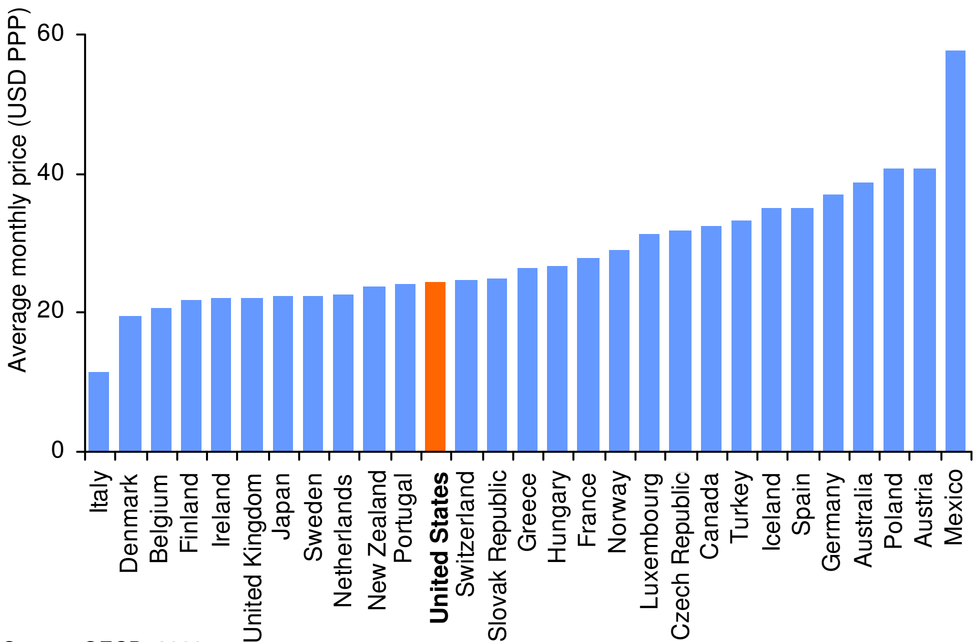
4.12.1 OECD pricing data set

The OECD pricing data set includes 631 consumer broadband offerings surveyed in September 2008 from broadband providers in OECD countries.[225] 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 make than the composite totals do.

Graphs of the average price from the OECD pricing data set are shown in Figures 4.5 through 4.8. These results are computed using a simple average of all the offerings in the data set for that country in that tier.

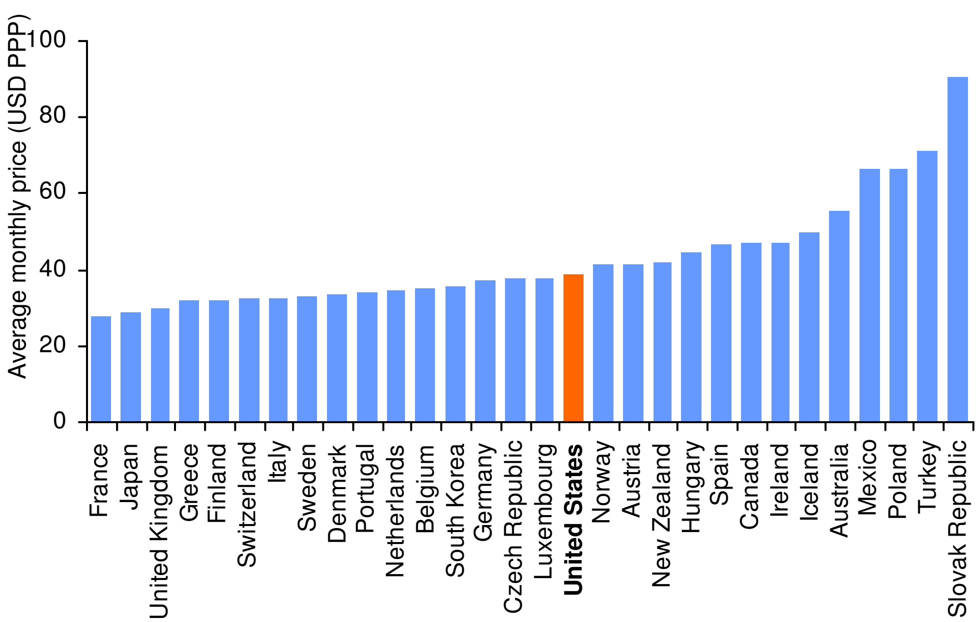
224 TeleGeography *GlobalComms Database*, Point Topic Standalone Tariffs
225 OECD *Communications Outlook 2009*. Table 7.4, p 302-309.

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



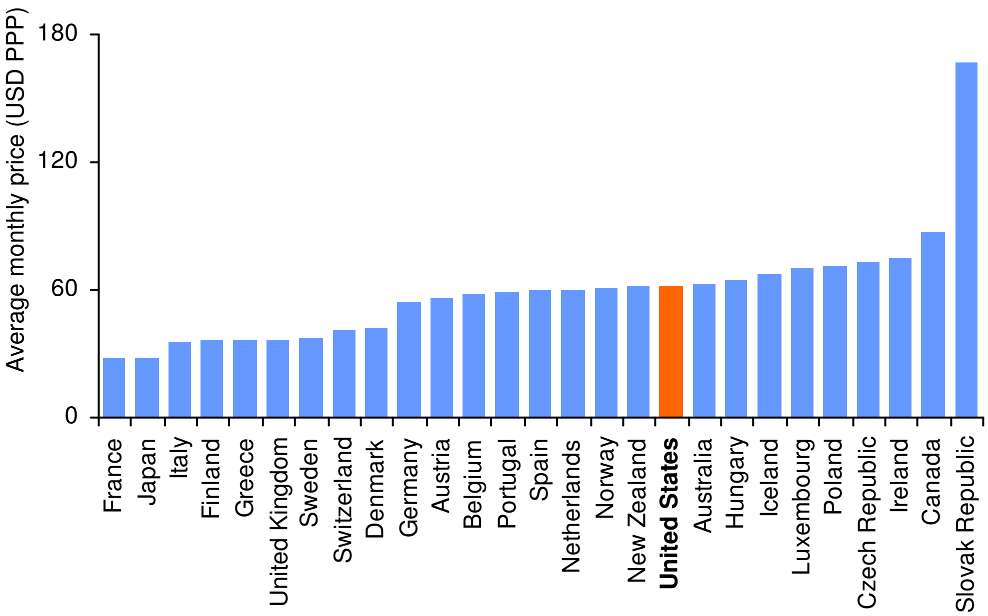
Source: OECD, 2008

Figure 4.6. Average monthly price for medium speed tier, OECD



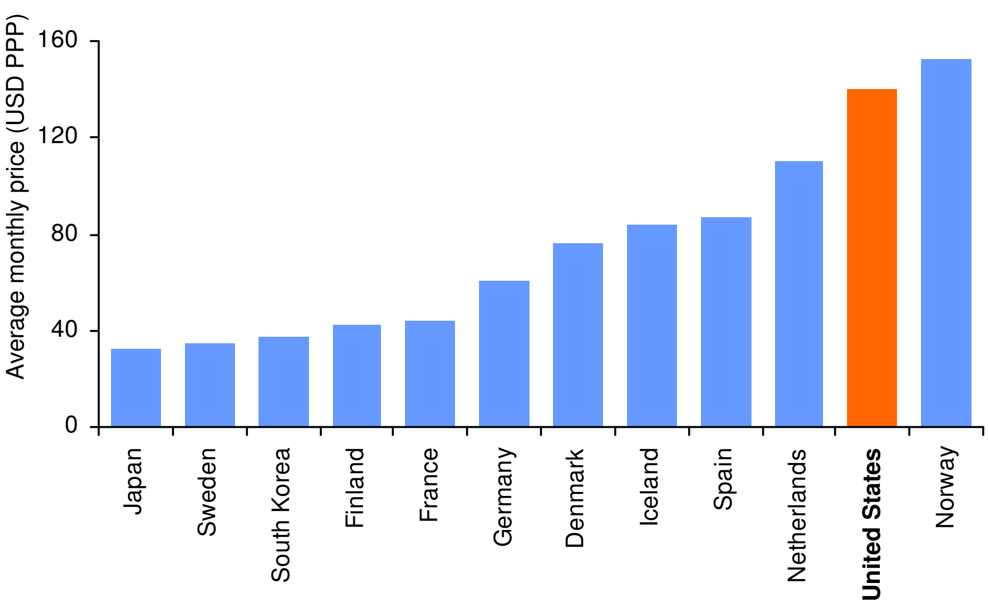
Source: OECD, 2008

Figure 4.7. Average monthly price for high speed tier, OECD



Source: OECD, 2008

Figure 4.8. Average monthly price for very high speed tier, OECD



Source: OECD, 2008

4.12.2 Berkman study using the TeleGeography 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.[226] 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.[227] 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 TeleGeography *GlobalComms Database*. This database is a regularly updated set 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 TeleGeography database contained 529 offerings from February 2008 to 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.

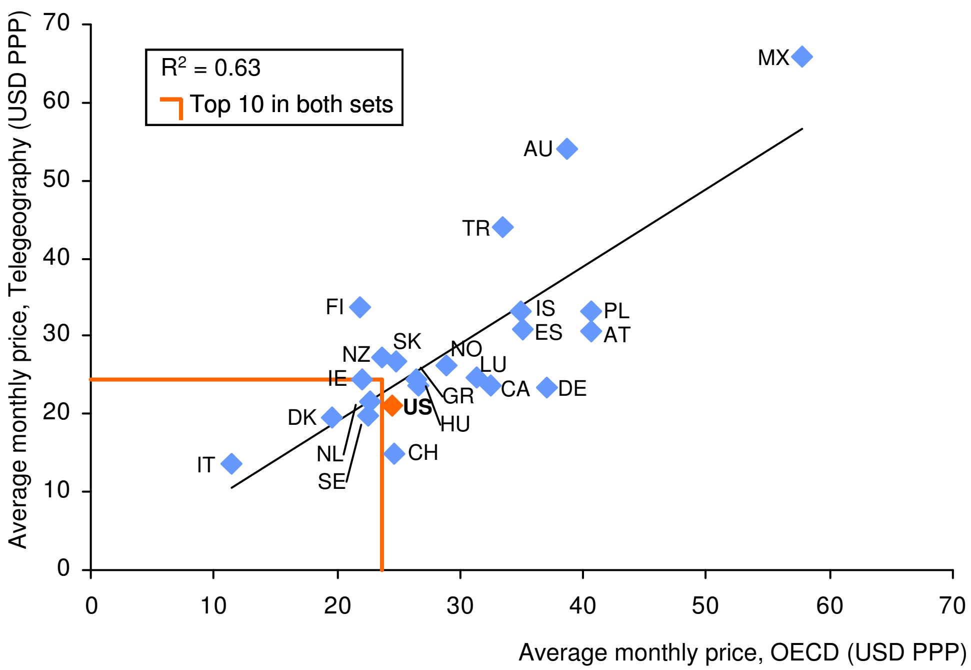
Results

We graphed the two data sets to see how similar or different the resulting averages are, and the results are shown in Figures 4.9 through 4.12.

226 If we include all the U.S. providers in our dataset, we do get to roughly 80%. Doing so increases the prices for the cheapest and medium tiers by $11 in each case; and increases the price by $8 for the high speed tier. It does, however, decrease the price for next generation speeds by $8. The price decrease does not affect the U.S. standing in the next generation speed tier, as even the lower price is still higher than the next worst country in this tier, Canada. Moreover, if we apply the same methodology to Canada, then prices for Canada also improve, leaving the U.S. trailing further behind in terms of prices for next generation speeds.

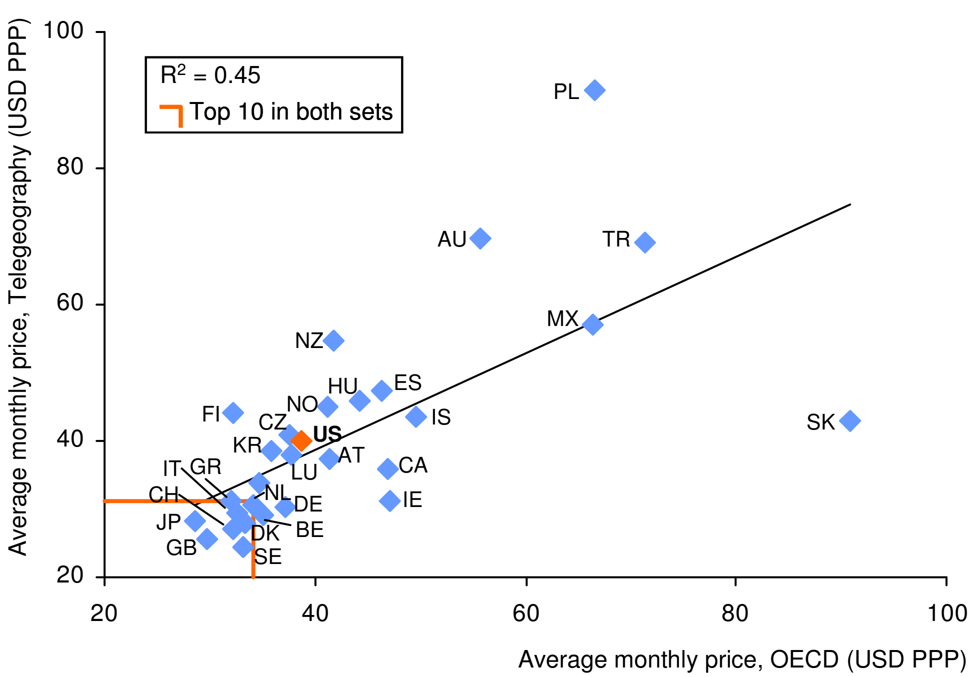
227 http://www.comcast.net/terms/network/amendment/ (last visited Sept 4, 2009)

Figure 4.9. OECD versus TeleGeography pricing in low speed tier



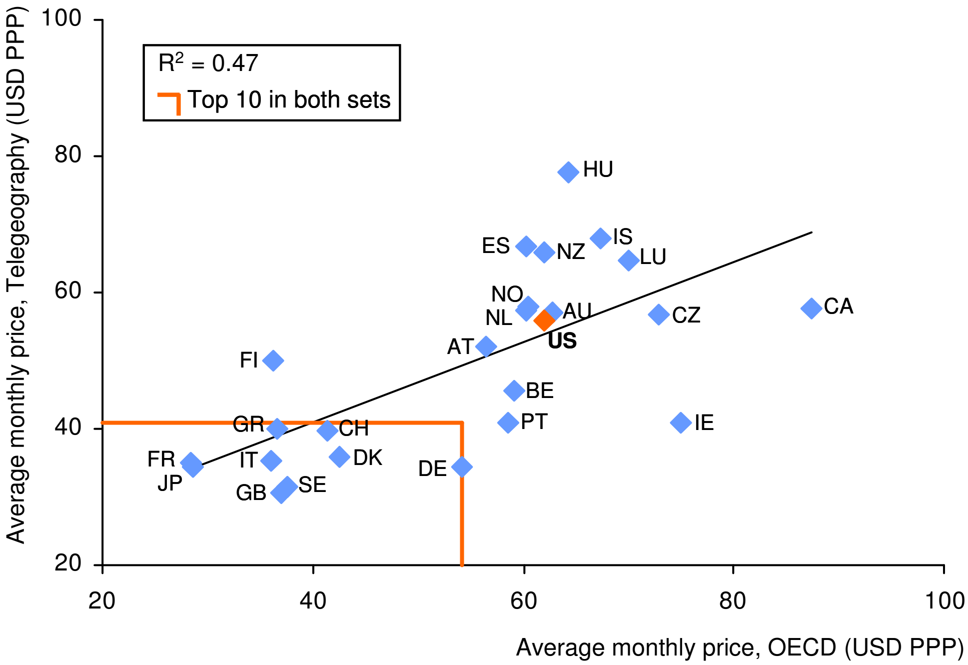
Source: Berkman Center analysis of OECD and TeleGeography broadband statistics
Note: Belgium, UK, Japan, Portugal are top 10 players in OECD dataset but are not displayed because they lack data in TeleGeography

Figure 4.10. OECD versus TeleGeography pricing in medium speed tier



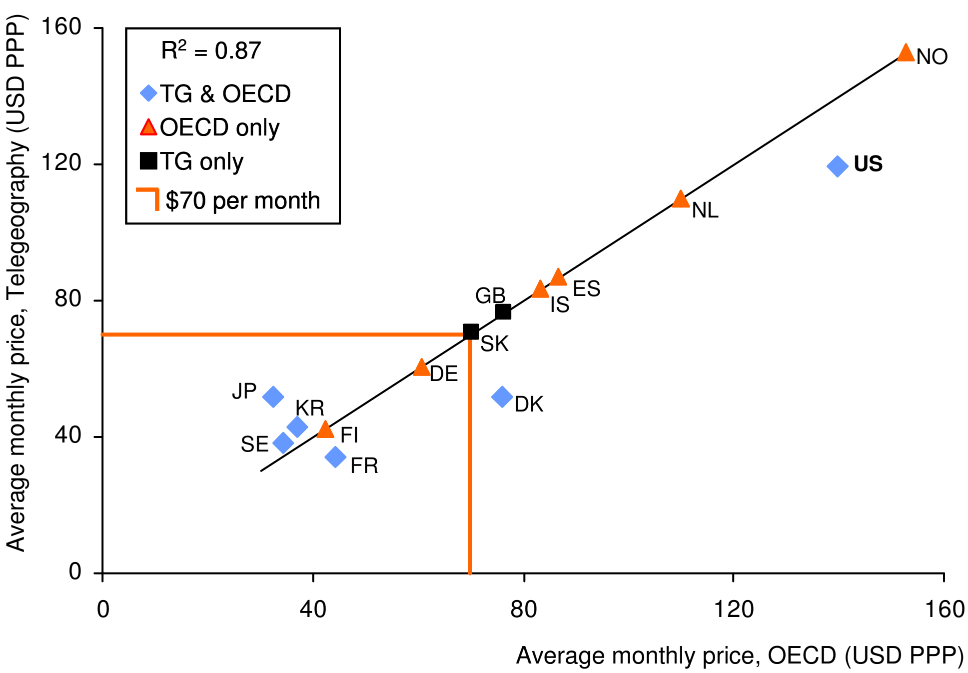
Source: Berkman Center analysis of OECD and TeleGeography broadband statistics
Note: France is the best ranked player in the OECD dataset but is not displayed here because it lacks data in the TeleGeography dataset

Figure 4.11. OECD versus TeleGeography pricing in high speed tier



Source: Berkman Center analysis of OECD and TeleGeography broadband statistics
Note: Slovak Republic and Poland excluded as outliers

Figure 4.12. OECD versus TeleGeography pricing in very high speed tier



Source: Berkman Center analysis of OECD and TeleGeography 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

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

Key take-aways

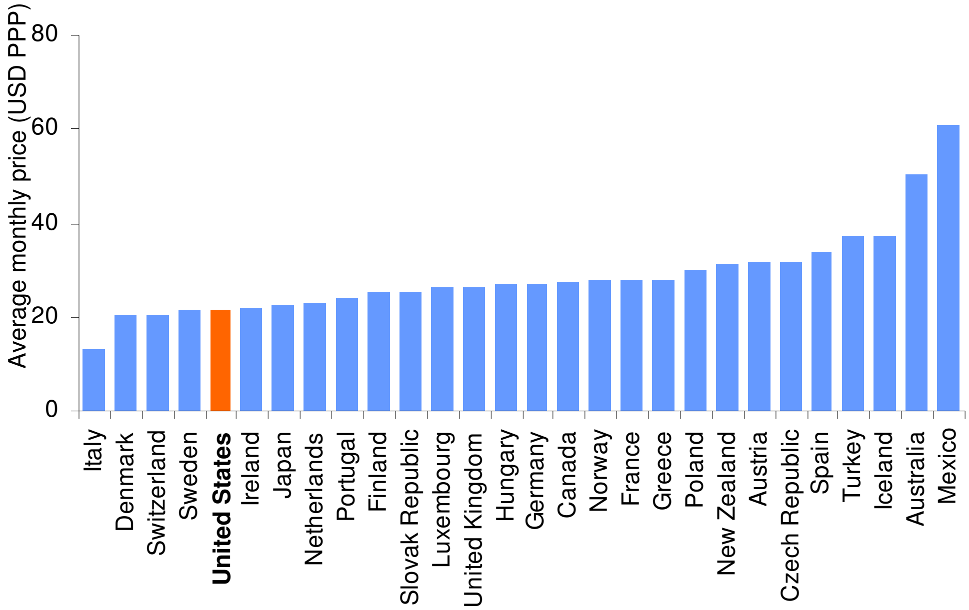
There are two key findings from this analysis. First, a country that has been identified in the top ten in both data sets (those that fall within the orange box), can confidently be labeled as a high performer in that speed tier. Denmark, Ireland, Italy, the Netherlands, and Sweden all reside in the 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 TeleGeography 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

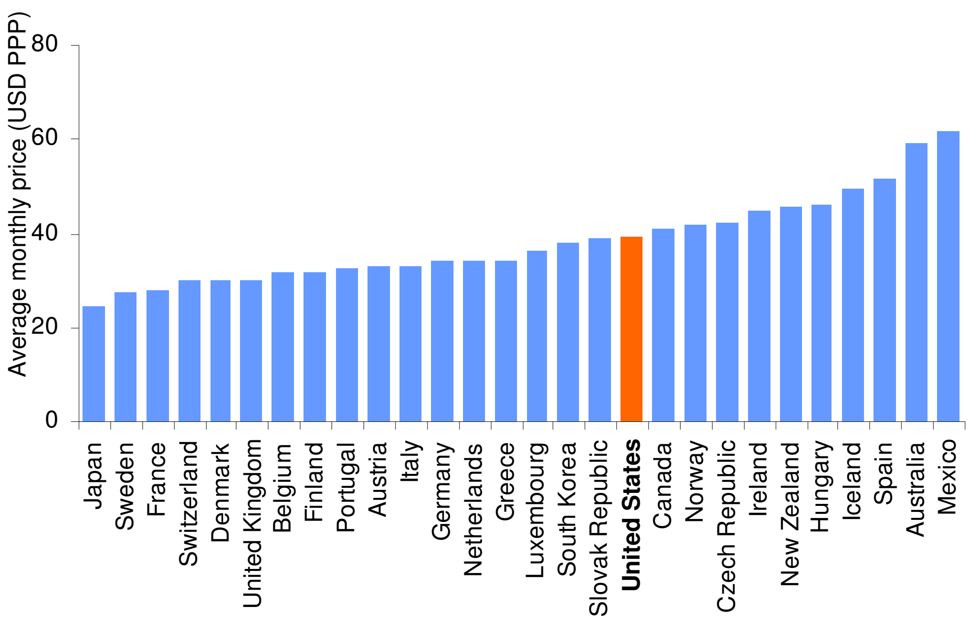
The combination of the OECD and the TeleGeography data sets revealed nearly 150 duplicate offerings which were manually tagged and removed from the combined set. Where there was duplication, we kept the OECD offering. The resulting set had nearly 1000 entries. Of those, 277 were excluded in our methodology 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 4.13 through 4.16.

Figure 4.13. Combined pricing set in low speed tier



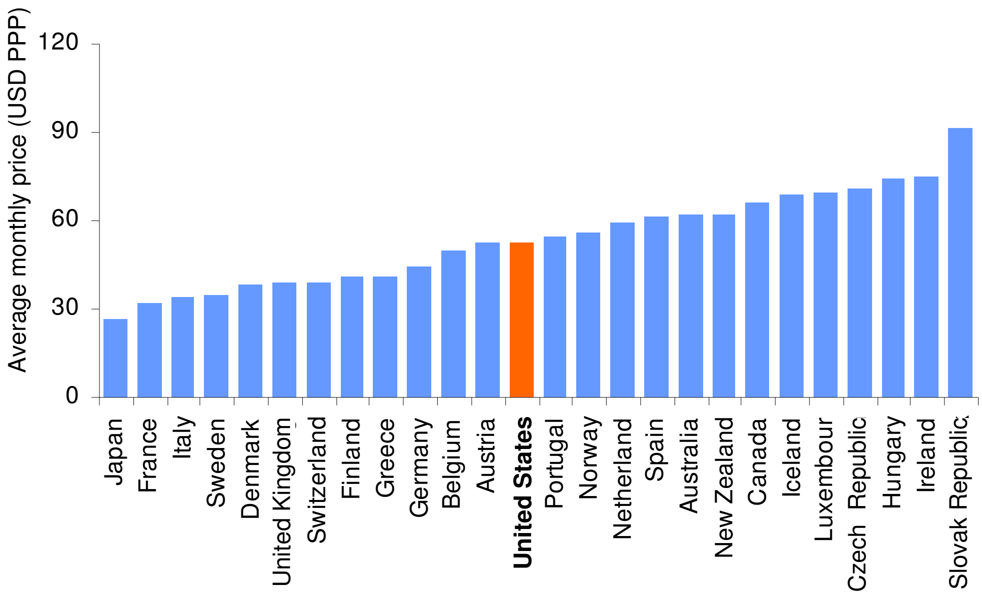
Source: Berkman Center analysis of OECD and TeleGeography broadband statistics

Figure 4.14. Combined pricing set in medium speed tier



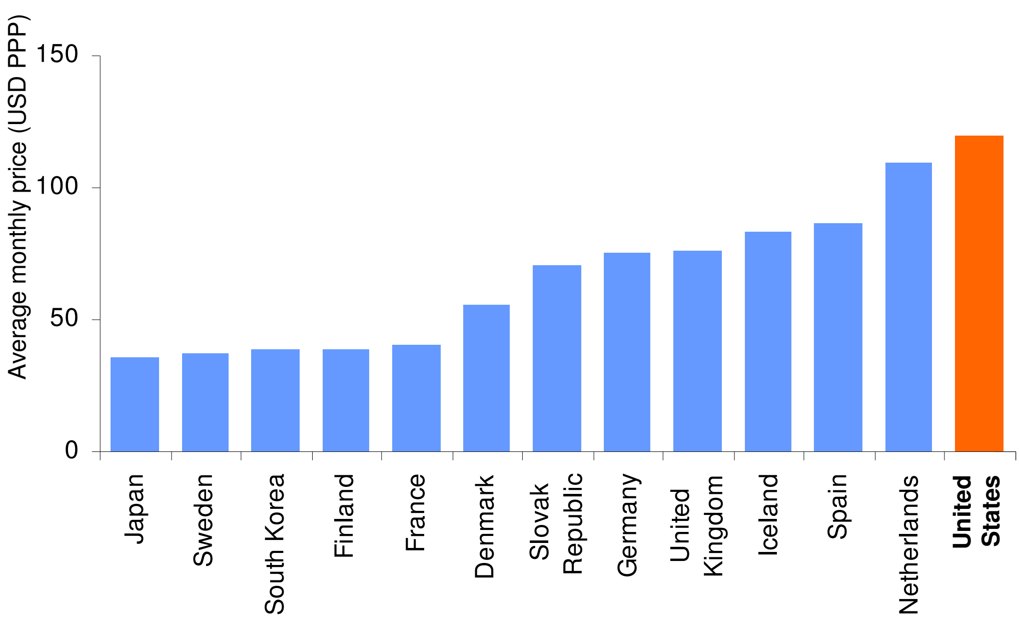
Source: Berkman Center analysis of OECD and TeleGeography broadband statistics

Figure 4.15. Combined pricing set in high speed tier



Source: Berkman Center analysis of OECD and TeleGeography broadband statistics
Note: Poland not displayed

Figure 4.16. Combined pricing set on very high speed tier



Source: Berkman Center analysis of OECD and TeleGeography 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 TeleGeography 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 TeleGeography 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 17^{th} to 18^{th}. 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 7^{th} 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 TeleGeography 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 Even more independent data sets

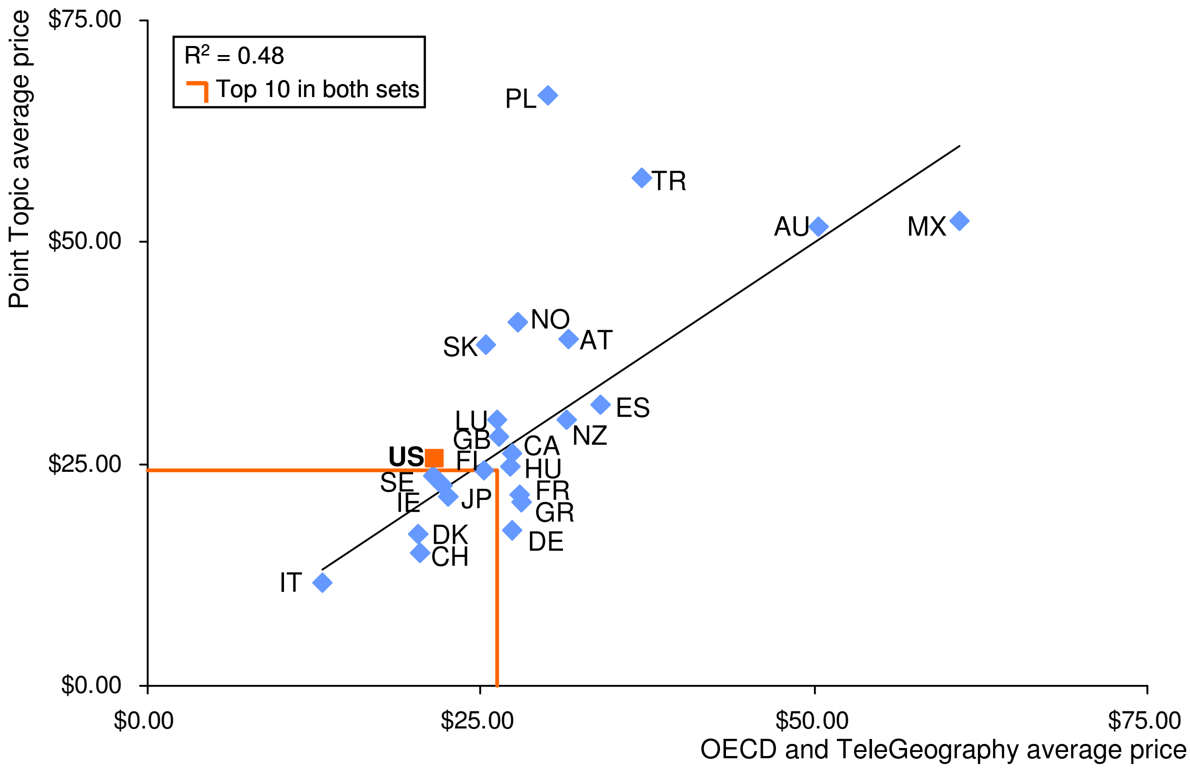
After the release of the first draft of the Next Generation Connectivity report, we sought to further refine and improve our pricing data set. We believe that each of the data sets we have used presents a separate draw from a noisy data set; thus, the larger the aggregated set, the better view we have. To this end, we have analyzed and included the standalone tariff set from Point Topic.

Point Topic

We downloaded the standalone tariff data from Point Topic in November 2009, so this set included prices collected during Q2 and Q3 2009, both overlapping and extending the coverage from the TeleGeography data set. We also collected a select set of bundled offers where key players were missing coverage (e.g., Free in France who only offers bundled service).

The resulting Point Topic data set included 825 offerings, covering 29 countries (Iceland was not covered). Of these 757 included all the necessary data (e.g., pricing and speed). These offerings were coded with the rank of each of the providers and evaluated based on their bit cap. Once only the top four providers with offers of more than a 2GB cap were considered, there were 438 offerings to evaluate. We then ran similar bivariate analyses of the Point Topic data set against the combined OECD and TeleGeography data set.

Figure 4.17: Point Topic versus combined pricing data set, low speed tier



Note: removal of outliers (i.e., Poland, Turkey) results in an R^2 of 0.70

Figure 4.18 Point Topic versus combined pricing data set, medium speed tier

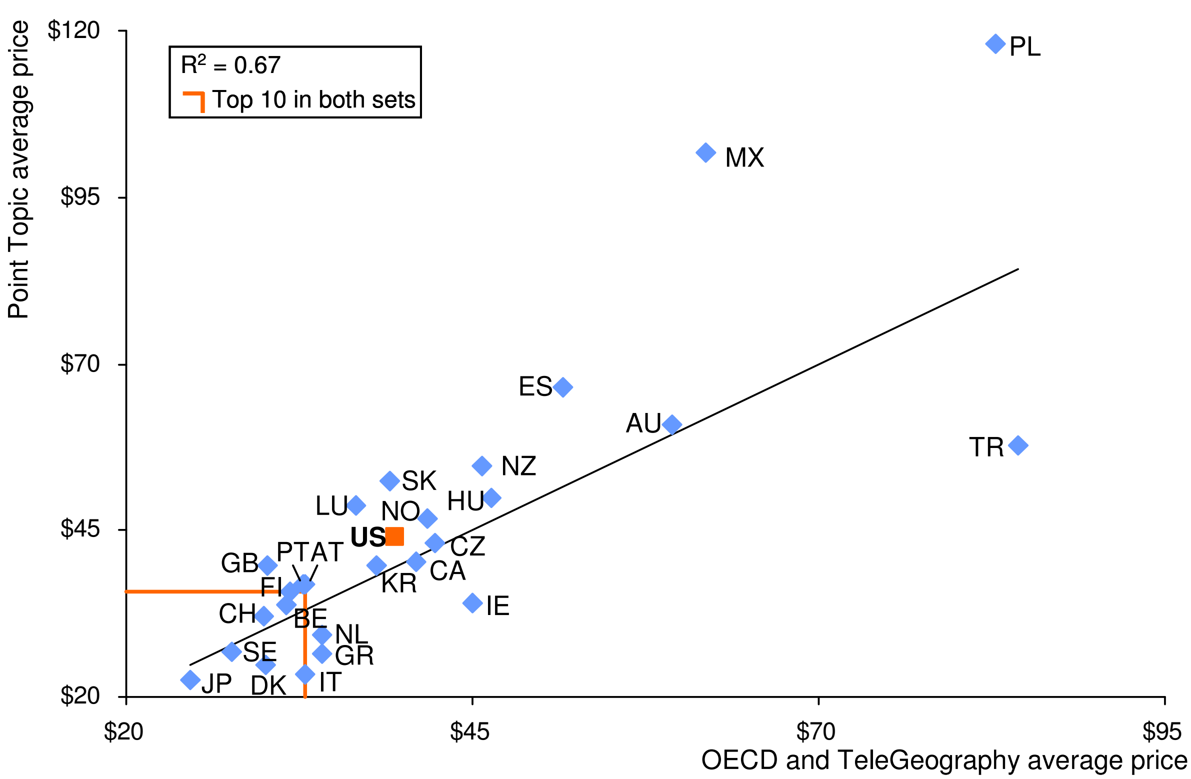
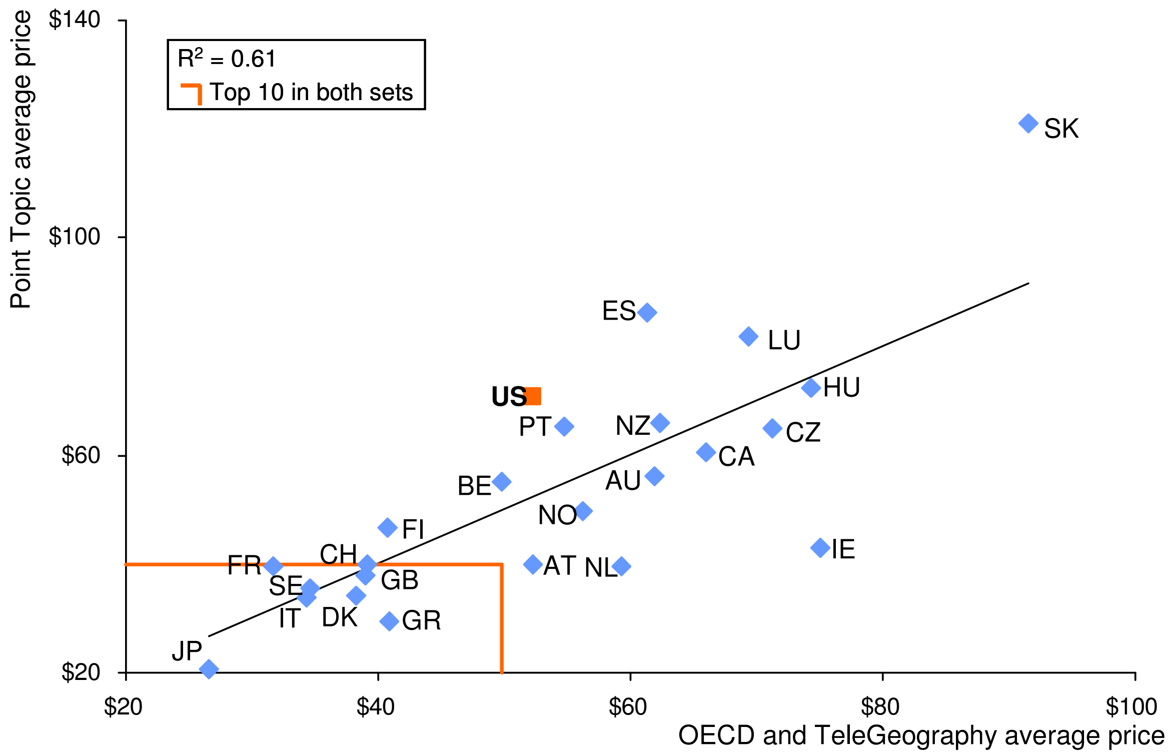
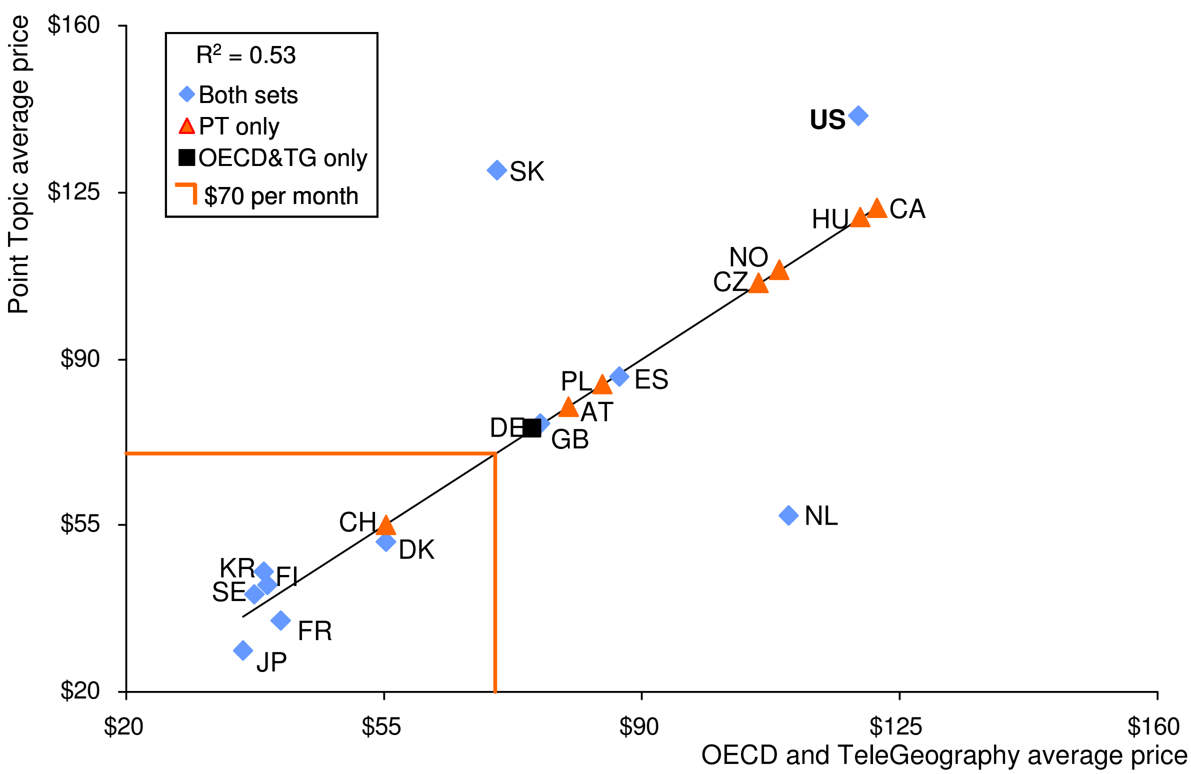


Figure 4.19: Point Topic versus combined pricing data set, high speed tier



Note: Poland not displayed at an OECD average of $210, PT average of $122

Figure 4.20 Point Topic versus combined pricing data set, very high speed tier



In each of these we found that there was significant correlation between the two sets, but that there was also additional data in the Point Topic data set not found in the combined set of OECD and TeleGeography. Consistently, Poland was an outlier amongst each tier. Although we could not determine the cause of this, we decided to exclude the Point Topic data on Poland in the combined set.

We then aggregated the Point Topic data into the combined data set, removing duplicate offers and regenerating our rankings based on this set. This combined data set now includes 950 offerings that meet the criteria of our study.

Figure 4.21: All three data sources, low speed tier

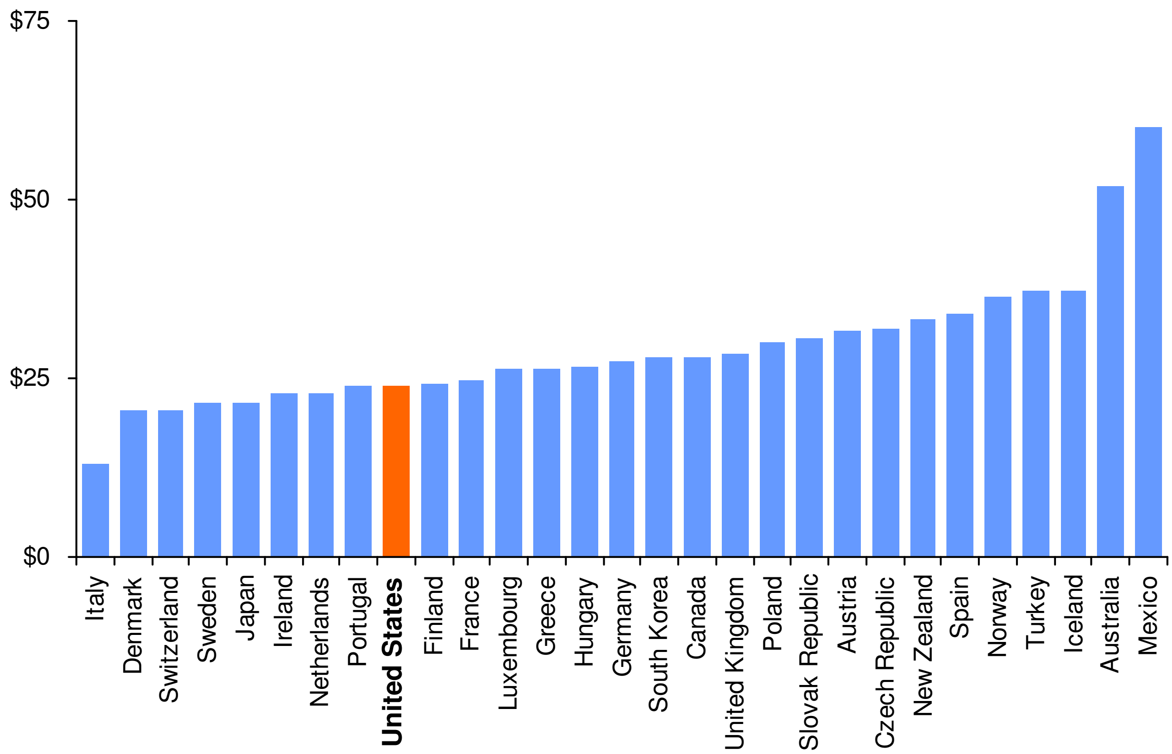


Figure 4.22: All three data sources, medium speed tier

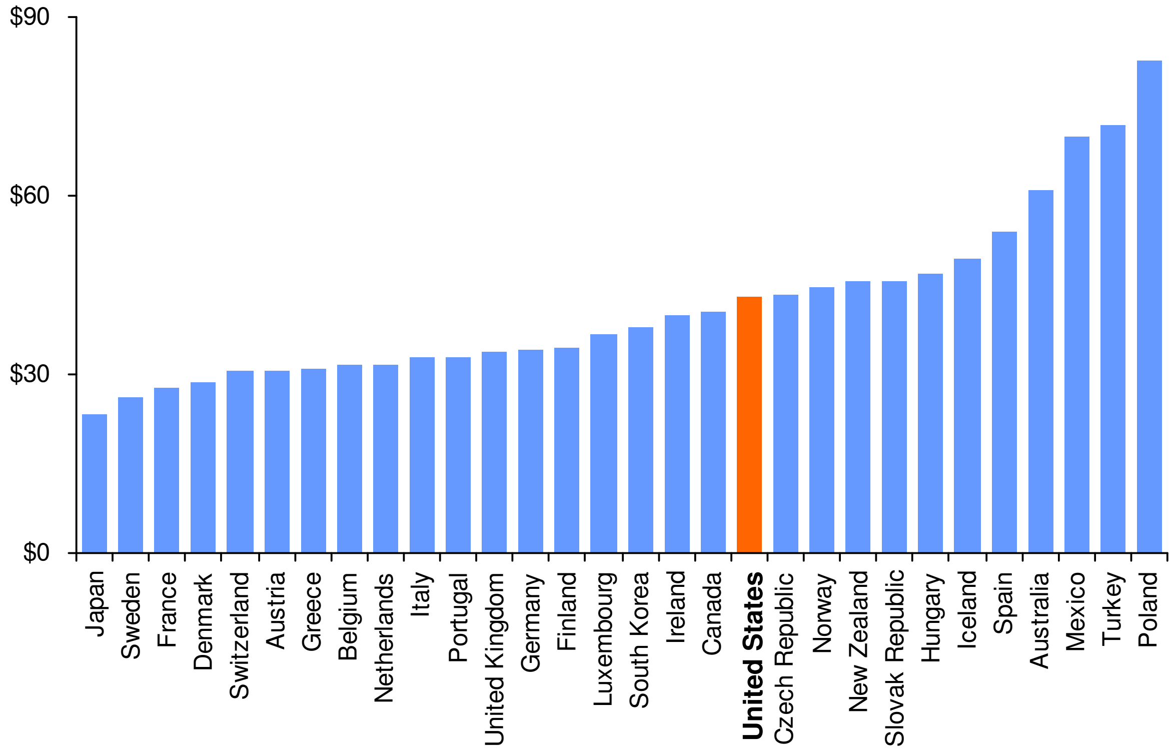
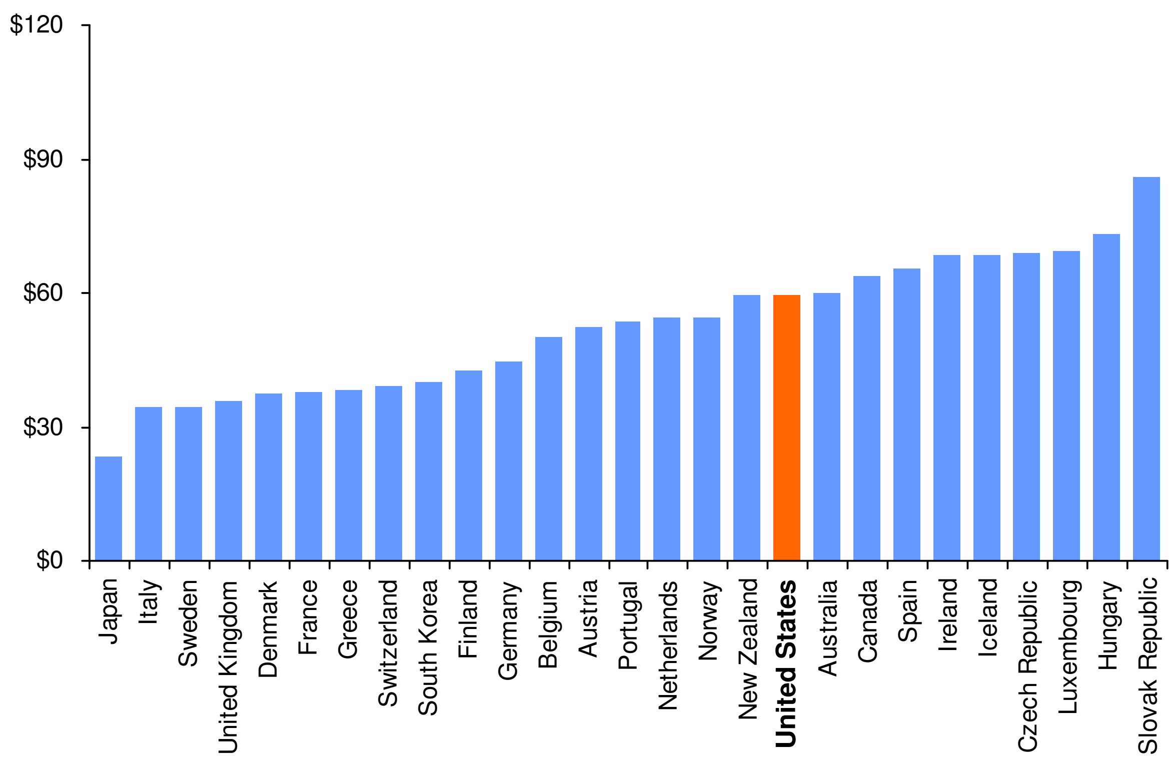
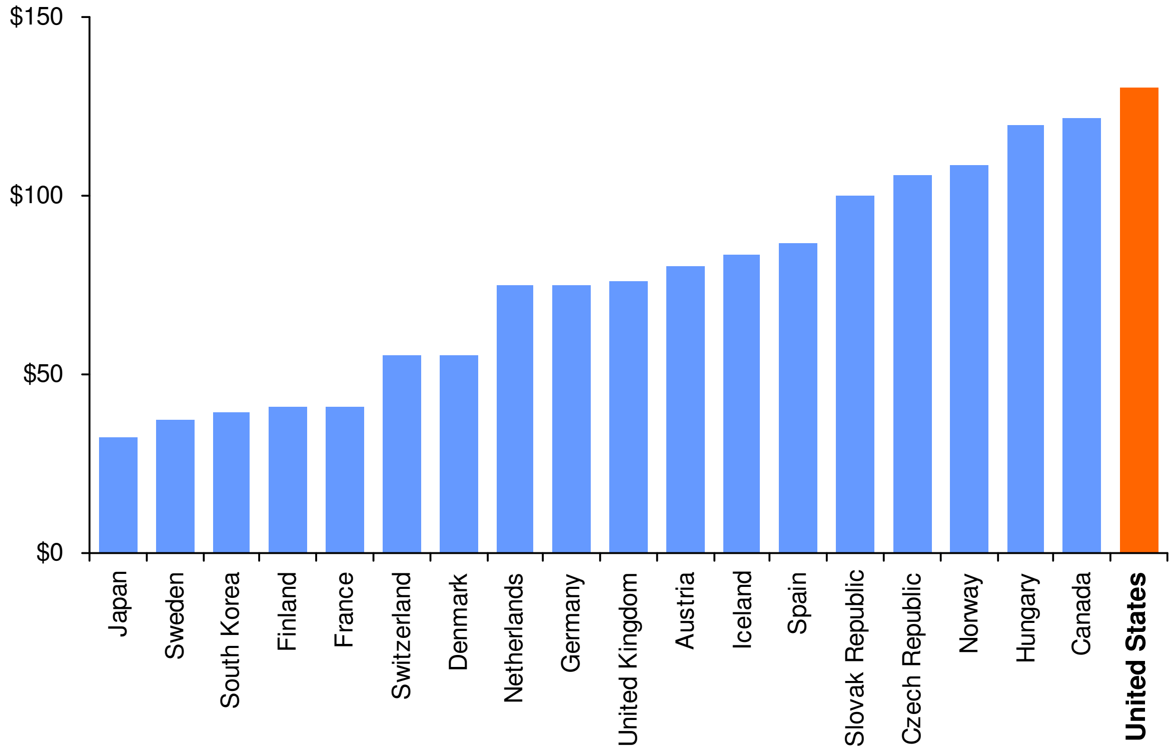


Figure 4.23: All three data sources, high speed tier



Note: Poland not displayed

Figure 4.24: All three data sources, very high speed tier



In the low speed tier, the US drops from 5th to 9th with the addition of the Point Topic data set, returning it to a similar position as with the OECD set alone. The Point Topic data set includes low speed tier offers from Comcast which are not present in the other two data sets. The increase in the average price from $21 per month to $24 per month leads to other countries surpassing the US.

In the medium speed tier the US ranks 19th when all data sources are combined, dropping one place. Additional offers from Comcast, AT&T, Time Warner and Verizon at different upload speeds account for the increase in average price from $39 to $43 per month.

In the high speed tier, the US fairs slightly worse with all data sources than just with the OECD and TeleGeography. The increase in the average US price from $52 to $59 is attributable to new offerings from providers at higher speeds such as Comcast's 22Mbps offer and Verizon's 25Mbps offer.

In the very high speed tier, the US remains at the back of the pack. No other country in any of the data sets has prices as high as the US at next generation speeds.

The FCC's data set

We also investigated the data set that the FCC has collected on pricing. This data set includes 726 offerings from 35 countries. This includes several countries absent from the OECD data set: Bulgaria, Cyprus, Estonia, Hong Kong, Latvia, Lithuania, Malta, Romania, Singapore, and Slovenia. It also lacks several players: the United States, Canada, Mexico, New Zealand, Switzerland, and Turkey. Reviewing this data for the countries in common between the two sets revealed that there was significant correlation (~50%) with the OECD data set, and some correlation with the TeleGeography and Point Topic data sets. Looking at several key countries (Sweden, Finland, Japan, South Korea, and France), the averages are reasonably close. We have opted to not roll this data set into our aggregated set due to the mismatch in coverage.

4.12.5 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 the OECD, TeleGeography and Point Topic. 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.[228] 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 TeleGeography data set as having over 2 million subscribers. For these we included the lowest-priced, highest-speed offering we could find 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.

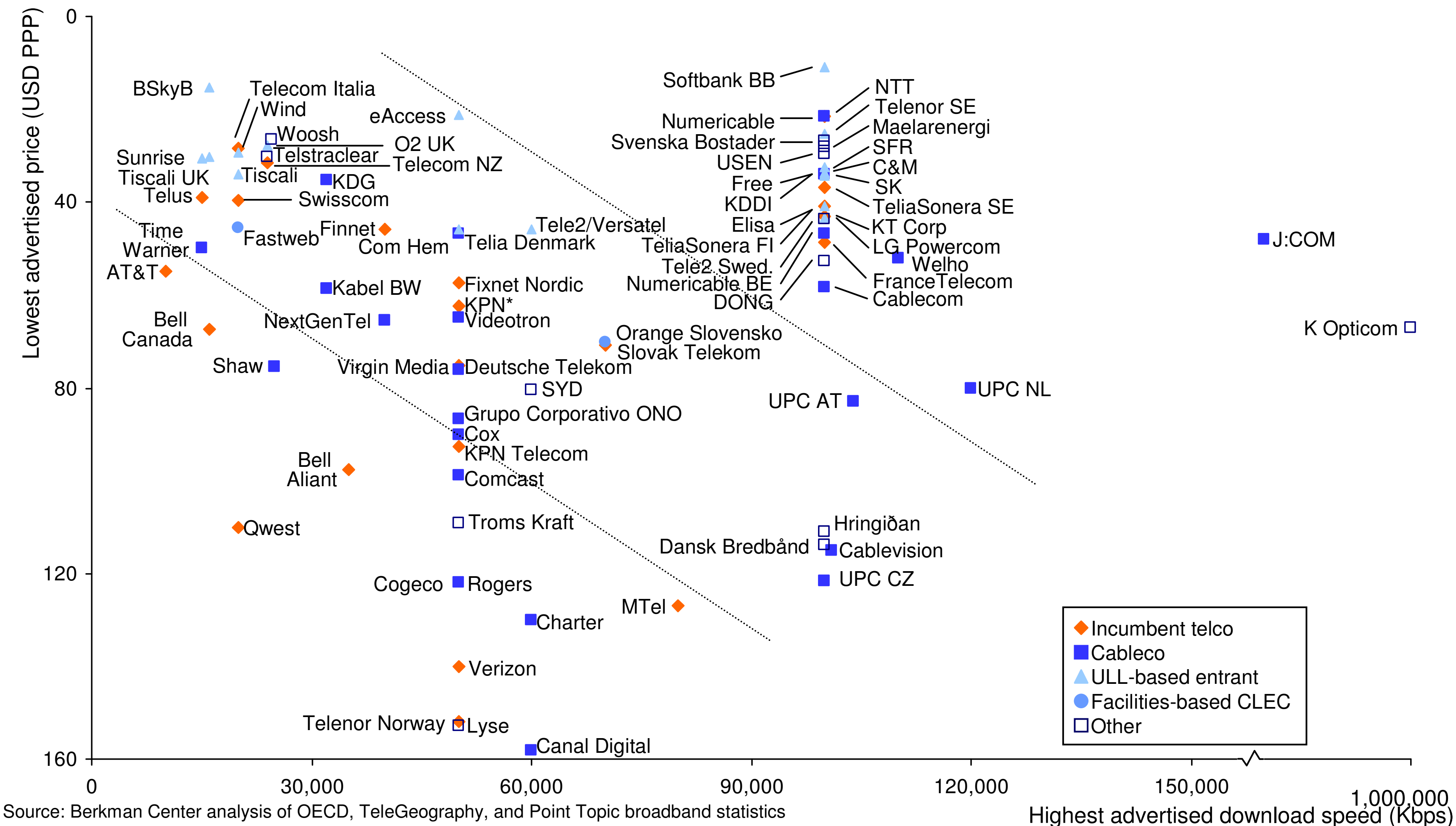
Our methodology resulted in 78 observed offerings. We then used the company profiles and our own research to characterize each firm in our data set as an incumbent telephone company, a cable company, an unbundling-based entrant, a facilities-based telecommunications provider, that is, a provider that 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.

228 Some comments to our initial draft release seemed to have missed this methodological difference between this part of the study and the general pricing benchmark. For Canada in particular, Videotron, which does have a very high speed offer, is not a top 4 provider on a national basis.

Conclusion

Our complete findings are described in the main text. In brief, we found the very highest prices in Norway, and the highest prices to lowest speed combinations occur in North America. These findings are notable in that 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. All Norwegian offers but one at the very high speeds are provided by facilities-based competitors, not the access-based competitors that occupy high-speed tiers and lower: Lyse, a power company in Southern Norway, Telenor Norway, the incumbent, and Canal Digital, the Telenor-owned cable broadband provider. The sole offer offered by an entrant using unbundled access, NextGenTel, has a 40Mbps offer at $65US PPP. 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 4.25. Best price for highest speed offering



Source: Berkman Center analysis of OECD, TeleGeography, and Point Topic broadband statistics
Note: Includes highest speed offerings from US players with minimum 2M subscribers

4.13 Annex: Voluntary Access Models: The Dutch and Swiss Cases

4.13.1 Reggefiber FTTH: Business Case Brief

Reggefiber FTTH is the primary provider of Fiber to the Home (FTTH) infrastructure in the Netherlands. It was founded as a subsidiary of Reggeborgh, an investment vehicle of one of the wealthiest real-estate business families in the Netherlands, the Wessels (who have the second largest real-estate holdings in the Netherlands). As such, it was conceived from the start on a commercial real estate model: long-term returns, maximizing the number and diversity of tenants. In communications infrastructure terms, this translated into a passive network that was, from the start, built to be open access so as to maximize the number of potential rent-paying tenants offering services over the network. In 2008, after Reggefiber had already connected 200,000 homes in southern and eastern Netherlands, KPN, the incumbent fixed, mobile and broadband operator, acquired a 41% minority stake in a joint venture. The remaining 59% was retained by Reggeborgh. KPN retains an option to increase its holding to 60% upon reaching certain volumes, but has indicated that it is unlikely to do so before 2012.[229] Reggefiber's immediate aim is to reach 1.3m homes with FTTH by the end of 2012, starting with 5 selected pilot regions[230] and expanding to other densely populated urban areas. In the medium term, Reggefiber aims to reach 30-60% of households in the Netherlands, selecting regions for expansion based on regional business cases. The estimated capital expenditures (capex) requirement for Reggefiber of this roll-out assuming coverage of more than 60% of Dutch homes is €6-7 million.[231] Reggefiber's network was always conceived as open access, on the commercial real estate model. This joint-venture (JV) business model was implemented as an agreement with the NMa (Dutch competition authority) and OPTA (Dutch telecom regulator). KPN's competitors are able to provide services over the fiber with a wholesale price ceiling of between €14.50 and €17.50 per line (two dark fibers to each customer) per month depending on the capex requirement of the corresponding geographical area, with discounts of up to 20% depending on total lines in a particular area.[232] The implementation of the business model in the regulatory framework is seen to provide assurances to customers (the entrant providers) and investors that the rates will remain stable and predictable over the payout period.[233]

The FTTH deployment plans and JV with Reggefiber should be seen in the context of a broader KPN strategy for Next Generation Access (NGA). KPN is in the process of migration away from a copper network to a NGN on the basis that FTTH "is the superior long term technology,"[234] but operates with a portfolio approach of "regional differentiation [of high speed network technologies] based on business case by region." Specifically, KPN also has a parallel Fiber to the Curb (FTTC) roll-out which has reached 450,000 households in 5 cities,[235] but has been temporarily suspended due to operational scalability issues. Independent from the fiber initiatives, KPN will have upgraded its existing copper offering to VDSL by mid-2010.[236] Within this portfolio, the FTTH strategy is aimed at users seeking higher bandwidths, higher quality TV, and TV as part of a triple-play package.[237] In effect, copper-based

229 Harm Luttikhede, "KPN: Full consolidation of Reggefiber unlikely before 2012", WSJ Online, 15 December 2009

230 Almere-Haven, Son en Breugel, Uden, Elburg, Haaksbergen are the FTTH pilot areas under KPN's 2x5 strategy for fiber roll-out

231 Analysys Mason, "Europe Looks on as KPN and Reggefiber plan nationwide FTTH services, Analysys Mason comments", 21 November 2008

232 Jaap Doeleman, "Digging for gold? Incentivising NGAs in the Netherlands", International Bar Association Legal Practice Division Communications Law Committee Newsletter, May 2009, p11

233 Personal communication, Jan van Rooijen, CFO Reggefiber, January 19, 2010.

234 KPN, "Update on KPN's fiber roll-out: Next phase in consumer strategy", Investor Presentation, 15 December 2009, p4

235 KPN, "Update on KPN's fiber roll-out: Next phase in consumer strategy", Investor Presentation, 15 December 2009, p14

236 KPN, "Update on KPN's fiber roll-out: Next phase in consumer strategy", Investor Presentation, 15 December 2009, p7

237 KPN, "Update on KPN's fiber roll-out: Next phase in consumer strategy", Investor Presentation, 15 December 2009, p32

infrastructure cannot compete in the long term with cable, and KPN likely sees FTTH as the only long-term approach to avoid being squeezed out of the fixed line Internet access markets over the course of the coming decade.

KPN currently offers 3 high-speed packages over Reggefiber's network, starting with Bronze (30Mb/s downstream, 3Mb/s upstream) for €65/month (inc. VAT), and rising to Silver (50Mb/s downstream, 5Mb/s upstream) for €80/month and Gold (100Mb/s downstream, 6Mb/s upstream) for €110/month, with the aim of all packages becoming downstream/upstream symmetric in 2010.[238] These packages are more expensive than KPN's own FTTC offerings or competing DOCSIS 3.0 cable offerings.[239]

By September 2009, Reggefiber had passed 462,000 homes in the Netherlands, connected 339,000 of those homes, and had 160,000 of those households as active FTTH subscribers.[240] In addition to its aim to pass 1.3m homes by 2012, Reggefiber also aims to lift its current 20-30% subscription rate in FTTH areas to a subscription rate of 60%. Its basic business case break-even point is 45%.

Viability of the FTTH business model in the Netherlands

In 2008, OPTA (Dutch telecom regulator) commissioned Analysis Mason (a leading telecom consultancy) to study the theoretical business case for KPN to construct a FTTH network in the Netherlands.[241] Analysis Mason (AM) concluded that the business case for construction was just positive if KPN passed 60% of households and achieved penetration in 60% of households passed, duct costs were €30/meter, and revenue per subscription increased by €13.40/month for users of the FTTH network.[242] This study provides the baseline against which to evaluate the actual performance of Reggefiber during the first year since the joint venture was consummated.

In developing this estimate, AM assumed that the capex to deploy FTTH to 60% of Dutch households was €6.3bn, amounting to €1566 per home passed or €2088 per subscriber.[243] KPN would pass 60% of Dutch homes, connect 80% of those (48% of total households), activate 60% of those (36% of total households), with 45% served by KPN retail and 15% served by the wholesale market.[244] The cost to KPN to provide fiber unbundling would be €17.99 per line per month.[245] The free cash flow from this roll-out was then modeled over a 10-year time horizon and discounted at KPN's regulated weighted average cost of capital (WACC) of 9.2%.[246] The free cash flow model suggests, as expected[247], that the NPV and payback period of constructing a FTTH network is most sensitive to penetration and cost per

238 KPN, "Update on KPN's fiber roll-out: Next phase in consumer strategy", Investor Presentation, 15 December 2009, p31
239 Rudolf Van Der Berg, "UPC Fiber Power triumphant over KPN FTTH", Internet Thought Blog, 10 April 2009, http://internetthought.blogspot.com/2009/04/upc-fiber-power-triumphant-over-kpn.html
240 KPN, "Update on KPN's fiber roll-out: Next phase in consumer strategy", Investor Presentation, 15 December 2009, p20
241 Analysys Mason, "The business case for fibre-based access in the Netherlands", Final Report for OPTA – Public Version, 24 July 2008
242 Analysys Mason, "The business case for fibre-based access in the Netherlands", Final Report for OPTA – Public Version, 24 July 2008, p4
243 Analysys Mason, "The business case for fibre-based access in the Netherlands", Final Report for OPTA – Public Version, 24 July 2008, p28
244 Analysys Mason, "The business case for fibre-based access in the Netherlands", Final Report for OPTA – Public Version, 24 July 2008, p26
245 Analysys Mason, "The business case for fibre-based access in the Netherlands", Final Report for OPTA – Public Version, 24 July 2008, p2
246 Analysys Mason, "The business case for fibre-based access in the Netherlands", Final Report for OPTA – Public Version, 24 July 2008, p16
247 Yankee Group FTTH Model, In: Yankee Group, "Fiber to the Home: Making that Business Model Work", Webinar Presentation, 30 June 2009, p7

home,[248] and that if only households in densely populated urban areas are passed, the required increase in per user revenue falls.

Evaluating the Reggefiber JV business case after 12 months

The evidence from the first year of Reggefiber's operation since the JV suggests that its actual business case is overall positive, but KPN sees it as remaining relatively risky. KPN estimates an 8-year payback period for the average area of 1,000 homes passed (based on an initial average subscriber revenue of €60 / month and including a monthly fee to the JV for use of passive fiber, initial investments in the JV, and investments in customer activation by KPN).[249] FTTH still requires more capex (€1000 vs. €350), more risk, and a longer payback period (8 years vs. 4-5 years) than KPN's parallel FTTC deployment,[250] but the capex is off KPN's books and shared with a long-term investor and bank financing.

Reggefiber's actual capex of €1000 per home passed (€800 dark fiber + €200 fiber termination unit)[251] is much lower than AM's estimate of €1566 per home passed, reducing the costs which need to be recouped in higher subscriber revenue. It appears that AM overstated the costs of digging in part because digging in Dutch soil is easier and cheaper than in other places, and in part because Reggefiber, as a real-estate company, has seen reduced costs with scale through long-term commitments to construction companies.[252] Reggefiber has already achieved 20-30% penetration in its 5 pilot cities,[253] despite a poor initial offering which is uncompetitive in price compared to cable,[254] and so could reasonably believed to be on track to reach AM's assumed 60% penetration. Further, both the lower capex and the plan to expand to densely populated areas (aiming for only 30-60% medium-term coverage) offset this lower penetration of subscribers in FTTH areas. KPN has observed an increase in blended monthly subscriber revenue of €8 in FTTH areas,[255] and the subscriber revenue gap between dual play (copper €40) and triple play (fiber €60) customers is €20, suggesting potential for an increase in average user fees in excess of AM's €13.40.

There are however, significant risks in KPN's FTTH business model which have not yet been eliminated in the 2x5 pilot (KPN has separate FTTC and FTTH pilot programs in five cities each). Penetration in FTTH areas may not follow KPN's projected adoption curve and instead remain in the 20-30% region currently observed. KPN's target is 60% penetration, at least one independent analyst believes that FTTH only becomes viable for the JV at a penetration of above 45% in FTTH passed areas,[256] and an early study of the economics of Sweden's FTTH network suggests a critical market share of 45%.[257] Penetration may remain low if KPN's offering continues to be uncompetitive with cable offerings, as the required increase of subscriber revenue in excess of €8 means that increasing penetration rates with lower prices is not a viable strategy. KPN's speed of operations may also impact upon the ability of Reggefiber to raise external financing. The 1.3m FTTH homes passed by 2012 implies an average increase in coverage of under 250,000 homes per year, limited by KPN's ability to activate new customers. It is unclear what impact this slower than planned expansion has on the JV's business

248 If duct costs fell to €20/meter, the business case becomes positive at an incremental monthly ARPU of €9.
249 KPN, "Update on KPN's fiber roll-out: Next phase in consumer strategy", Investor Presentation, 15 December 2009, p24
250 "Update on KPN's fiber roll-out: Next phase in consumer strategy", Investor Presentation, 15 December 2009, p30
251 KPN Presentation
252 Personal communication, Jan van Rooijen, CFO Reggefiber, January 19, 2010.
253 KPN, "Update on KPN's fiber roll-out: Next phase in consumer strategy", Investor Presentation, 15 December 2009, p20
254 Rudolf Van Der Berg, "UPC Fiber Power triumphant over KPN FTTH", Internet Thought Blog, 10 April 2009, http://internetthought.blogspot.com/2009/04/upc-fiber-power-triumphant-over-kpn.html
255 KPN, "Update on KPN's fiber roll-out: Next phase in consumer strategy", Investor Presentation, 15 December 2009, p22
256 Paul Budde, "KPN's focus on FTTC misses the broader picture", CircleID – Internet Infrastructure, 16 December 2009
257 WIK Consult, "The Economics of Next Generation Access: Results of a study for ECTA", 25 June 2008, p19

model.[258] Finally, retail competition may reduce subscription rates for KPN. Despite open access, there are not yet any other operators in the Netherlands buying dark fiber access from KPN and offering a service direct to customers, although Reggefiber is in pilot stages with broadband entrants, and entry would both generate additional earnings for KPN through the JV, and more importantly would likely increase marketing and reduce prices, thereby increasing levels of penetration. The driving force, and major concern, is competition from cable companies in a market where the most recent data (Q3 2009) suggests that new subscribers are choosing between cable and fiber, and KPN is at risk of losing customers migrating from DSL to higher speed offerings. In anticipation of this speed competition, Reggefiber's new deployments are intended to provide 200Mbps service and are installing gigabit capable equipment in anticipation of future scaling.

Explaining the Reggefiber JV: Beyond the business case

Three factors beyond the business case and net present value analysis explain why the Reggefiber JV provided a strong opportunity for KPN despite the significant risks involved in constructing a FTTH network.

First, the JV structure keeps most of the capex required for FTTH network construction off KPN's financial statements. KPN has only a minority (41%) interest in Reggefiber, below the 61% holding which triggers NMa takeover approval and the threshold which triggers consolidated accounting under Dutch law.[259] This allows KPN to effectively outsource FTTH capex and use free cash flow for share buybacks to satisfy investors.[260] KPN only committed €174m in cash and €16m in assets to the JV initially,[261] and estimates that only €75m-150m per year in capex (related to customer activation) will appear on KPN's financials.[262] As a result, KPN is able to work within its 'Back to Growth' strategy which limits capex to €2bn and targets €2.4bn of free cash flow in 2010.[263] Further, the majority partner in the JV is Reggeborgh, a family-owned construction firm with long-term investment horizons and no external shareholders, facilitating an investment project with >8 year payback periods.[264] These conclusions about the JV structure are supported by the fact that KPN is not aiming to increase its stake in Reggefiber until after 2012 at the earliest,[265] and that Reggefiber aims to raise external financing in the first half of 2010.[266]

Second, investment in FTTH through Reggefiber should be seen as a competitive strategy against Dutch cable providers. The threat of losing customers to cable companies, particularly in areas where high-speed DOCSIS 3.0 services are offered, typically means that telecom operators can account in their business case for revenues from customers who would have been lost, rather than just the incremental revenues of existing customers migrated from dual to triple play.[267] This threat is accentuated in the Netherlands because of a strong cable presence, with >95% cable coverage and more than 80% of the country's 7.3m households subscribing to at least cable TV.[268] UPC, the second cable operator with 2.3m

258 Tim Poulus, "Guidance, IT, hold back KPN's FTTH Ambitions", TelecomPaper, 16 December 2009
259 Harm Luttikhede, "KPN: Full consolidation of Reggefiber unlikely before 2012", WSJ Online, 15 December 2009
260 KPN, "Company Presentation: Investor Relations", May 2008, p10
261 KPN, "Update on KPN's fiber roll-out: Next phase in consumer strategy", Investor Presentation, 15 December 2009, p29
262 KPN, "Update on KPN's fiber roll-out: Next phase in consumer strategy", Investor Presentation, 15 December 2009, p32
263 Tim Poulus, "Guidance, IT, hold back KPN's FTTH Ambitions", TelecomPaper, 16 December 2009
264 Analysys Mason, "The business case for suburban fibre will be tough", 3 December 2009
265 Harm Luttikhede, "KPN: Full consolidation of Reggefiber unlikely before 2012", WSJ Online, 15 December 2009
266 KPN, "Update on KPN's fiber roll-out: Next phase in consumer strategy", Investor Presentation, 15 December 2009, p29
267 Analysys Mason, "The business case for suburban fibre will be tough", 3 December 2009
268 Jaap Doeleman, "Digging for gold? Incentivising NGAs in the Netherlands", International Bar Association Legal Practice Division Communications Law Committee Newsletter, May 2009, p11

customers, has recently launched its very high-speed Fiber Power offering which offers comparable service[269] at a lower price.[270] 2009 Q3 data on subscriptions seem to support KPN's fear of losing subscribers to high-speed cable if they cannot offer FTTH. Q3 2009 total subscriptions grew by 38,300 net, but cable added 32,500 subscriptions compared to fiber which only added 17,000. Most importantly, DSL lost 12,700 subscriptions,[271] suggesting that new subscriptions are essentially all cable and fiber and that DSL users face a choice between cable and fiber.[272]

Third, Reggefiber enjoys a relatively attractive regulatory environment in the Netherlands. KPN and Reggefiber had already committed to provide open access through fiber unbundling before OPTA formally proposed the inclusion of FTTH in its Significant Market Power (SMP) designation in market 4 (wholesale physical network access at a fixed location)[273] with the resulting remedy of fiber unbundling and wholesale price ceilings. KPN seems to favor open access because of what it perceives as mistakes made in negotiations over copper unbundling from 1996 and because according to their CEO, "if you allow all of your competitors on your network, all services will run on your network, and that results in the lowest cost possible per service. This in turn attracts more customers for those services, so your network grows much faster."[274]

KPN's acquisition was proposed in May 2008 and cleared on 19 December 2008 by the Nma (Dutch competition authority), subject to wholesale price ceilings.[275] This operator acceptance of the principle of wholesale access shifted the regulatory discussion to setting wholesale pricing to account for higher construction and regulatory risk than in copper networks.[276] Here, OPTA relied on Reggefiber's business model and internal rate of return (IRR), rather than a separately commissioned cost model.[277] This initial ex ante testing of pricing based on an operator's business plan is likely to favor Reggefiber, but is in line with European Commission guidelines.[278] Ultimately OPTA chose initially to set wholesale price ceilings in the range of €14.50 - €17.50 per subscriber per month, depending on the capex required for each geographical area, reflecting a reasonable IRR of 7-10%.[279] The rates will increase with inflation and a discount of up to 20% is available depending on the total (not just wholesale) number of lines in a particular area. In the future, the price ceilings will be reviewed every 3 years by comparing Reggefiber's IRR to an 'all risk WACC.'[280] This includes a risk premium to compensate for the extra risk of fiber (variable and decreasing over time) and a 3.5% premium to compensate for asymmetric regulatory risk.[281]

269 At least until Reggefiber offers symmetric download and upload speeds
270 Rudolf Van Der Berg, "UPC Fiber Power triumphant over KPN FTTH", Internet Thought Blog, 10 April 2009, http://internetthought.blogspot.com/2009/04/upc-fiber-power-triumphant-over-kpn.html
271 TelecomPaper, "Dutch broadband grows 0.8% in Q3, despite drop in DSL users", 4 December 2009
272 Rudolf Van Der Berg, "Dutch cable grows faster than DSL and KPN is in trouble", Internet Thought Blog, 7 December 2009, http://internetthought.blogspot.com/2009/12/dutch-cable-grows-faster-than-dsl-and.html
273 T-Regs, "Netherlands: OPTA consultation on fees for unbundled fiber access", 16 January 2009
274 Ad Scheepbouwer (CEO, KPN), Cited In: Benoit Felten, "A World of Fiber", Yankee Group Presentation, 2007
275 Nma, "NMa conditionally approves joint venture of KPN and Reggefiber", 19 December 2008
276 KPN, "Fiber to the home in the Netherlands", WIK Conference FTTB/H in Europe, 23 March 2009, p14
277 OPTA, "Draft policy rules: Tariff regulation for unbundled fibre access", Public Version – Translated, 24 November 2008
278 Jaap Doeleman, "Digging for gold? Incentivising NGAs in the Netherlands", International Bar Association Legal Practice Division Communications Law Committee Newsletter, May 2009, p11
279 Jaap Doeleman, "Digging for gold? Incentivising NGAs in the Netherlands", International Bar Association Legal Practice Division Communications Law Committee Newsletter, May 2009, p11
280 Jaap Doeleman, "Digging for gold? Incentivising NGAs in the Netherlands", International Bar Association Legal Practice Division Communications Law Committee Newsletter, May 2009, p11
281 Rudolf Van Der Berg, "KPN/Reggefiber offer fiber for 12 Euro/month", Internet Thought Blog, 24 November 2008, http://internetthought.blogspot.com/2008/11/kpnreggefiber-offer-fiber-for-12.html

The combination of the extra risk premiums to compensate investors, and the fact that Reggefiber can to some degree control the wholesale price ceilings by choosing to invest FTTH construction in less profitable regions to lower their IRR[282] makes the resulting regulatory compromise attractive. More skeptical but well-respected commentators point to the regulatory arrangement as being more political than economic. Under this scenario, OPTA assigns SMP to Reggefiber FTTH to assert its role in regulating fiber, KPN accepts this to receive Nma approval for the JV and have influence on the wholesale price ceilings through use of its cost model, and in embracing open access KPN gains both a FTTH network to rival Dutch cable companies and a stronger position in lobbying for open access to cable networks.[283] While possible, there is however no public evidence to support this as a separate thesis.

4.13.2 Swisscom Fibre Suisse

In the late 1990s Swisscom[284] started to provide fiber-optic networks to large companies in Switzerland. By the end of 2008, it connected 12,500 business premises via optical fibers. However, it was not before October 2008 that Swisscom started expanding its fiber network to small and medium sized enterprises (SME) as well as residential customers in Zurich, Basel, and Geneva, with the original goal of connecting 100,000 households with fiber-optic cables by the end of 2009.[285]

The earliest fiber-to-the-home (FTTH) pilot projects in Switzerland date back to 2003, when state-owned local utility company Services Industriels de Genève (SIG) launched its "Voisin, voisine" initiative with a triple-play offering to test the end-user market in the Charmilles district.[286] A radically more aggressive approach was taken by the city of Zurich, where a 200 million Swiss Francs credit was approved in a March 2007 public vote in order to build and maintain a fiber optics network based on the infrastructure of ewz Zurich, the state-owned local power utility company. Nineteen months later, companies such as Orange, GGA Maur, Init Seven, Translumina and Green are offering telecommunication services over the ewz network to their customers.[287]

Roughly at the time of the Zurich vote – and before Swisscom expanded its fiber network to residential customers – smaller local cable service providers started to offer fiber-to-the home (FTTH) services. One of the first significant FTTH-installations in Switzerland was reported in March 2007, when local CATV Satellitentechnik AG connected a 190-unit housing cooperative to the fiber network in the city of Basel.[288] Synchronously, the local cable network of Télévision Sierre SA started developing a FTTH

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282 Remko Bos, "Access pricing, a key element in effective NGN Access Regulation", OPTA Presentation, WIK Conference, 23-24 March 2009, p12

283 Tim Poulus, "Possible ingredients of a Possible KPN/OPTA Deal", Seeking Alpha Blog, 4 December 2008, http://seekingalpha.com/article/109116-ingredients-of-a-possible-kpn-opta-deal

284 Swisscom is Switzerland's leading telecoms provider, with ~5,5 million mobile customers and ~1.8 million broadband connections. In the first three quarters of 2009, the company's 19,704 employees generated 8,9 billion Swiss Francs in revenue. According to the latest press release issued by the Federal Department of Finance, the Swiss Confederation has a majority holding in the company in terms of capital and votes, amounting to 56.94% (up from 52%) of Swisscom's share capital. See http://www.swisscom.ch/GHQ/content/Investor_Relations/Aktionaersinformationen/Besitzstruktur/Besitzstruktur.htm?WBCMODE=presentationunpublished%3flang

285 http://www.swisscom.com/GHQ/content/Media/Medienmitteilungen/2008/20081209_01_Mit_fibre_suisse_in_die_Glasfaserzukunft.htm?lang=en

286 http://wapedia.mobi/en/Geneva?t=4.

287 http://www.portel.de/nc/nachricht/artikel/20715-openaxs-schweizer-staedte-bekaempfen-glasfaser-monopol-der-swisscom/

288 http://www.catv.ag/content.cfm?nav=16&content=50

network to provide advanced IPTV services to its customers in early 2007;[289] in December 2009, TV Sierre reported that all households in the town of Sierre are connected to the fiber-optics network.[290] Another pioneer in the field is Stadtantennen AG Baar (STAG), which started to connect private households to its fiber network in summer 2007. There are similar examples from other areas of Switzerland as well, including the offerings by Télédistal, a small cable operator based in the French part of Switzerland near Lausanne.[291]

The next milestone in the FTTH history of Switzerland was a February 2008 decision by the parliament of the city of St. Gallen to support a FTTH pilot project proposed by the city-owned St. Galler Stadtwerke, a public utilities provider that outlined the vision of a next generation Internet infrastructure available to all St. Gallen citizens. The pilot project ran from July to October 2008, included 100 homes and 30 SMEs and a budget of 550,000 Swiss Francs. In December 2008, Swisscom for the first time announced interest in building a fiber-optic network in the city of St. Gallen and approached selected households with a free-trial offer as part of a marketing campaign.[292] In February 2009, residents of the city of St. Gallen voted by a clear majority of 82% in favor of a 78 million Swiss Francs investment in order to create a low-cost FTTH network based on the local public utilities network, which would serve 90% of all households within 10 years. In the context of the referendum, the city committed to competition and non-discriminatory access to its fiber network.

A few months later, in April 2008, AMB (Aziende Municipalizzate Bellinzona), EBL (Elektra Baselland), EKT AG (Elektrizitätswerk des Kantons Thurgau), Groupe E (serving Fribourg and Neuchatel), IWB (Industrielle Werke Basel), St. Galler Stadtwerke (SGSW) and Stadtwerk Winterthur launched an association called Openaxs, an initiative committed to the concept of open access and with the goal to promote fiber-optic networks in general and FTTH in particular based on the principles of fair competition and consumer choice.[293] Openaxs currently includes 11 full members and 6 associated members (including, for instance, Swisscom-competitor Sunrise).[294] It focuses on awareness raising and knowledge exchange and actively promotes open standards of fiber-optic networks and fiber-based service layers.

In July 2008, Swisscom invited "potential cooperation partners from the telecommunications, cable and utilities industries to work with it building fibre-optic networks, with the aim of implementing the network more quickly and cost-effectively in conjunction with several partners."[295] In December 2008, Swisscom announced the launch of the "Fibre Suisse" initiative in a much-regarded press release and outlined what it has named a "cooperation model on the construction and operation of the fibre-optic network." In order to "enable potential cooperation partners to expand their own fibre-optic infrastructure after the construction work has started," Swisscom publicly announced that it "will be laying several fibres per household in all areas. One fibre will be used by Swisscom, while the others will be made available to the cooperation partners." Swisscom's press release (perhaps surprisingly) made the point that such an approach "will prevent the creation of a new network monopoly in

289 http://express-press-release.net/35/Sierre%20Energie%20deploys%20Anevia%20Flamingo%20gateways%20to%20retransmit%20TV%20Channels%20as%20part%20of%20its%20IPTV%20Service.php

290 Presentation available via http://www.fibre-suisse.ch/?p=769.

291 www.emc-web.com/emc/c/filepdf/anga2005-e-page02.pdf

292 http://www.tagblatt.ch/lokales/stgallen/tb-ag/Swisscom-startet-Werbetour-und-eroeffnet-Glasfaser-Konkurrenzkampf;art197,1243979.

293 http://www.openaxs.ch/files/pdf/statuten-openaxs.pdf

294 http://www.openaxs.ch/home/verbandsmitglieder/

295 http://www.swisscom.com/GHQ/content/Media/Medienmitteilungen/2008/20081209_01_Mit_fibre_suisse_in_die_Glasfaserzukunft.htm?lang=en

Switzerland and also meet competitors requirements for full access to the local loop (copper pairs) as stipulated by the Telecommunications Act."[296] The press release sketched the following cooperation models aimed at "preventing duplication, saving costs and accelerating the introduction of broadband networks in Switzerland":[297]

- "Construction partnership: This cooperation model is aimed in particular at partners with their own ducts, such as electrical utilities or cable network providers. One of the partners takes on responsibility for building the fibre-optic network in a defined region - for example a specific district or an entire city. Several fibres are laid, and when the network is completed each of the other cooperation partners is assigned one fibre. If all of the partners network regions which are the same size and are to be shared, no compensatory payment is required.

- Investment partnership: This form of cooperation is of interest to partners without their own cable ducts. Network expansion is jointly financed by all the partners. One partner builds the entire network and grants the investor usage rights to the fibres laid.

- Rental of individual fibres: Individual fibres are rented by partners who do not wish to invest in network expansion but want to decide themselves on the preferred technical level for controlling the fibre-optic network.

- Leasing of transmission services: As with DSL broadband technology, which has long been established on the market, Swisscom also provides reseller offerings for Internet service providers who do not wish to invest in their own infrastructure. These providers can use Swisscom's optical fibres and higher-level network technology."

The December 2008 Swisscom press release also included the following:

- Swisscom stated that the FTTH deployment started in Zurich, Basel and Geneva and mentioned "the plan … to further extend the network in the course of [2009] to include residential premises in the cities of St. Gallen, Berne, Fribourg and Lausanne."

- Swisscom announced its intention to invest 8 billion Swiss Francs over the next six years in Swiss telecommunications and IT infrastructure, "with 35% of this sum earmarked for fibre-optic expansion."

- Swisscom announced the launch of reseller offerings in March 2009 for Zurich, Basel and Geneva as a "pilot phase", stating that the partners will check the technical implementation and market acceptance of the individual offerings and are free to design their own end customer and reseller offerings.

Since the launch of this cooperation model in December 2008, Swisscom has entered a series of collaborations across Switzerland and is in negotiations with additional parties, including the city of Basel. The successfully negotiated agreement concluded in December 2009 between Swisscom and the ewz proved to be particularly challenging due to technical complexities and in the light of the economic importance of the Zurich market. The following agreements based on Swisscom's "Fibre Suisse" framework have been concluded:

296 Id.
297 The following excerpt is a direct quote from the press release; id.

Bern: Swisscom reached an agreement with Energie Wasser Bern (EWB) in April 2009 (signed in December 2009),[298] which defines all key elements of the cooperation and paves the way "to set up a comprehensive high-speed data network infrastructure in Berne within five years" (as opposed to the 10-year plan originally presented by EWB.)[299] According to the agreement, Berne will connect 70% of the households to the fiber-optic network, Swisscom 30%. Swisscom will receive exclusive access to up to two fiber-cables. Depending on sources, the total investment appears to be somewhere between 140 and 200 million Swiss Francs. According to Swisscom's press release, compensation has been defined base on Swisscom's shares of the broadband market;[300] other sources indicate that Swisscom bears slightly more than half of the costs of investment.[301]

St. Gallen: In August 2009, in the aftermath of the public vote and after six months of negotiations, the St. Galler Stadtwerke and Swisscom reached an agreement to collaborate on the building of a local fiber-optic network. More precisely, "Swisscom and the St. Gallen Public Utilities have agreed that the utilities will be responsible for the laying and maintenance of the fibre-optic network."[302] While the details of the agreement remain confidential, Swisscom announced that it will "contribute substantially to the necessary investments" in return for "exclusive long-term access to up to two fibre-optic cables per household and business customer."[303]

Pfyn: In August 2009, the municipality of Pfyn and Swisscom entered into a cooperation agreement for the construction of a fiber-optic network. Pfyn is a small municipality in a rural area of the canton Thurgau. The focus of the cooperation is on a village called Dettighofen, which is currently an underserved area with regard to both TV and Internet services. The Dettighofen fiber-network will be built by the Elektrizitätswerk Pfyn and includes four fibers per household, two of which will be allocated to Swisscom. According to the press release, consumers will receive one connection box per household, enabling them to simply switch the connector cable to change to another provider.[304]

Lausanne: In September 2009, Industrial Services Lausanne (which provides, inter alia, cable TV to its citizens) and Swisscom entered a collaboration aimed at constructing a pilot fibre-optic network in the areas of Chailly and Praz Séchaud.[305] According to the letter of intent, Lausanne Industrial Services will build the fiber network in Chailly and Swisscom the fiber network in Praz Séchaud. In contrast to other models, only 500 buildings – and not the 3,000 individual households in the pilot area – will be connected to the four fibers, of which each partner will control two. Both partners committed to the standards of the Federal Office of Communications (OFCOM) regarding household connections. While the details of the deal remain confidential, Swisscom seems to bear a large portion of the financial investment.[306] Based on this pilot project, the city of Lausanne and Swisscom will later decide whether to extend the partnership across the entire municipality.

Fribourg: The canton of Fribourg, the electricity company Groupe E, and Swisscom launched a fiber network pilot project for the district of Torry in Fribourg and for parts of the village of Neyruz. According to the November 2009 press release, the district of Torry fiber-optic network will connect

298 http://www.ewb.ch/de/ueber-uns/medien/medienmitteilungen/2009/eckpunkte-vereinbart.html
299 http://www.swisscom.ch/GHQ/content/Media/Medienmitteilungen/2009/20091218_MM_Glasfaser_Bern.htm?lang=en
300 Id.
301 "Glasfasern in der halben Zeit." Berner Zeitung, 19.12.2009, p. 23.
302 http://www.swisscom.com/GHQ/content/Media/Medienmitteilungen/2009/20090901_MM_Glasfasernetz_St.Gallen.htm?lang=en
303 Id.
304 http://www.1888pressrelease.com/municipality-of-pfyn-tg-and-swisscom-to-cooperate-in-the-c-pr-141396.html
305 http://www.swisscom.com/GHQ/content/Media/Medienmitteilungen/2009/20090909_MM_SIL.htm?lang=en
306 http://www.fibre-suisse.ch/?p=773

2,600 households and 150 companies, while the Neyruz network starts with 300 households. Every household or company will be connected to a cable with four fibers; Swisscom will offer services to all of its residential, corporate, and wholesales customers, while Groupe E plans to offer "an information transport service to all interested service providers, which will allow them to distribute their services without having to invest in the infrastructure,"[307] in addition to using the fiber infrastructure for intelligent energy management services. The canton of Fribourg acts as an investor. If the pilot is successful, the model is expected to expand gradually until the entire canton of Fribourg is fully fiber-connected by 2025.

Zurich: After extensive negotiations (the announcement of an agreement has been delayed twice), [308] the ewz (Elektrizitätswerk der Stadt Zürich) and Swisscom announced an agreement to work together on a single city-wide FTTH infrastructure that will connect practically every building to the high-speed network slated for completion in 2017. Swisscom will continue its efforts in the districts of Albisrieden, Enge, Hirslanden and Limmat, while ewz will be responsible for construction in the other districts. According to the press release, existing conduit infrastructures of both partners will be used, allowing construction activities to be coordinated. They plan to jointly invest around CHF 430 million in the construction of the city's fiber network. As in other cities, the two parties will grant one another a long-term irrevocable right of use to one fiber per connection and provide competitors non-discriminatory access to the network. The framework includes a one-time payment between ewz and Swisscom in an amount that has not been made public. They will share operating and maintenance costs. The agreement between ewz and Swisscom will avoid the construction of two parallel networks in Switzerland's economically most important city, but changes the mandate from the March 2007 public vote (see above) and has therefore been criticized by some observers. It needs to be approved by the City Council, which has to modify ewz's business mandate and approve a new credit line. The electorate of the city of Zurich will have the final word.

Geneva: Another important milestone in the Fibre Suisse strategy is the recently announced agreement between Geneva Industrial Services and Swisscom, who will work hand-in-hand on the construction of a fiber-optic network that connects households and businesses in the city of Geneva, the suburbs and in surrounding areas.[309] To facilitate coordination of the construction work, taking into account technical reasons and population density, the canton of Geneva has been divided up into three zones. Swisscom will be responsible for construction in the city of Geneva, while Geneva Industrial Services will connect larger adjacent communities. A separate agreement will outline the cooperation for the rural communities surrounding Geneva. The majority of households and businesses in the canton of Geneva shall be connected within four years. The Geneva model follows by and large the conceptual approach taken in other cities and supports the standards of the Federal Office of Communications (OFCOM) relating to household connections.

In order to define a framework for cooperation in terms of network construction and the standardization of network access, the Swiss Federal Communications Commission (ComCom) launched a FTTH Roundtable Initiative in the summer of 2008, which facilitated some of the collaborations mentioned in the previous paragraphs. Since then, key decision-makers from both the private and public sector

307 www.swisscom.com/NR/.../20091130_MM_Pilotprojekt_Torry_en.pdf
308 "Nach wie vor keine Einigung zwischen ewz und Swisscom. Verhandlungen ueber Kooperation beim Glasfasernetz-Bau dauern an." Neue Zuercher Zeitung, 19.12.2009, p. 19. http://www.swisscom.com/GHQ/content/Media/Medienmitteilungen/2010/20100128_MM_ewz_Swisscom.htm
309 http://www.swisscom.com/GHQ/content/Media/Medienmitteilungen/2010/20100204_MM_Glasfasernetz_Genf.htm

involved in the construction of fiber-optic networks across Switzerland have met four times. These stakeholders have reached consensus regarding the following FTTH core principles:[310]

Creation of one single fiber-optic network: The stakeholders agreed to work together in a coordinated manner in order to avoid the parallel construction of new fiber networks. (Within this framework, however, some public utilities companies insisted on a parallel connection from the manhole to the respective operating centers of both the utilities and Swisscom.)

Multiple Fiber Model: All roundtable participants have committed to build a network with multiple fibers leading into every building. They agreed that at least four fibers are required to ensure access under non-discriminatory and reasonable conditions.

Non-discriminatory access: The stakeholder agreed that all providers must have access to the fiber-optic network under the same conditions. Access based on non-discriminatory terms will be granted to both the cable infrastructure layer (Layer 1) and the service layer for products and applications (Layer 3). In addition, Swisscom committed to make an offer for layer 2 if the market demands it and if the costs of platform modification can be split.

The conversations have been structured along four thematic tracks, which have been explored by dedicated working groups. Led by the Swiss Federal Office of Communications (OFCOM), the working groups have drafted recommendations for better coordination of household connection to fiber networks.[311] The first working group ("L1") deals with the specification of internal domestic cabling. The second group ("L2") focuses on the standardization of network access at the transport level of the network. A third working group ("L1B") dealt with the definition of the transfer points where the operators' and alternative providers' networks are connected up. The fourth group ("AG3") has drafted recommendations regarding the design of contracts between house owners and fiber-optic network operators. After the last round of negotiations, the following agreement has been reached regarding technical standards:[312]

Uniform home installation: In order to make it easier for customers to switch providers, the roundtable participants have drafted a series of technical recommendations regarding home installation.[313] In essence, the multi-fiber connection must ensure that various network and service providers have access to customers. In addition, the operators agreed on a single plug connector type for sockets in homes so that customers do not have to search for the correct adapter cable when they switch providers. On a separate, but related note, Swisscom recently announced that it reached an agreement with the Swiss Homeowners' Association (HEV) and the Zurich Real Estate Association (VZI) about the costs of in-house cable installation. According to the agreement, Swisscom will finance cabling inside buildings in order to foster its FTTH initiative and provide easy access for its customers. In the past, Swisscom has covered the costs of laying fiber-optic cables only up to building, but not inside the home. Swisscom, HEV and VZI agreed to draft a sample contract and have reached consensus on all of the main issues regarding in-house cabling. Most notably, homeowners who have already paid these costs for in-house FTTH cabling will be reimbursed.

Access to the fiber-optic network for service providers: Other recommendations are dealing with standardized network access for service providers. An open interface ensures that service providers will

310 See FTTH-Roundtable vom 5. Oktober 2009 (unpublished).
311 http://www.comcom.admin.ch/themen/00769/index.html?lang=en
312 The following summary is based on http://www.comcom.admin.ch/aktuell/00429/00457/00560/index.html?lang=en&msg-id=29395
313 http://www.swisscom.com/GHQ/content/Media/Medienmitteilungen/2010/20100203_MM_HEV_Schweiz.htm

enjoy network access to customers at all times. This, for instance, will enable customers to opt for a different service provider on the same network without any technical complications. The companies involved in the discussion are committed to a uniform platform for ordering and operating optical fibers.

Contracts between house owners and fiber-optic network operators: The participants identified the need for guiding principles for contracts between house owners and fiber network operators. In order to make it easier for customers to switch providers, the group advocated for harmonized terms of service regarding notice and cancellation in consumer contracts. The working group seeks to adopt a joint recommendation in the near future and will further explore this set of issues in the months to come.

Moving forward, the FTTH Roundtable Initiative continues to operate in a slightly modified configuration with two different working groups aimed at clarifying open questions. ComCom also announced that it will be examining the need for new regulatory instruments in order to address any future shortcomings in the FTTH market; it is expected that the Swiss Federal Council will express its views on this matter to the parliament by mid-2010 at the latest.[314]

314 http://www.comcom.admin.ch/aktuell/00429/00457/00560/index.html?lang=en&msg-id=29395

4.14 Annex: Econometrics Literature Review

4.14.1 Follow-up Note on Estimating the Impact of Unbundling on Internet Penetration Rates

We include in this section a review and follow-up on several of the econometric attempts, including our own, to estimate quantitatively the impact of unbundling on penetration rates. As described earlier, after an extensive review of the literature, we are confident that the available evidence strongly supports our decision to rely on detailed qualitative analysis for conducting international comparisons. Nevertheless, cross-country quantitative analysis may indeed provide a heuristic aid to inform and guide qualitative analyses. We do not believe that cross-country empirical work, given the several data and model specification issues, can reliably inform questions of policy efficacy.

In the draft version of this report released in October 2009, we included a reanalysis of a paper commissioned by the OECD (De Ridder 2007) and critiqued by Boyle, Howell and Zhang (2008). We took those papers on their own methods, and explored the particular effects of influential points, in that case Switzerland, and the sensitivity to assumptions about the formal adoption of rules versus the actual effectiveness of implementation.[315] That analysis drew several responses, in particular in comments from one of the authors of Boyle, Howell, and Zhang, as well as in the response filed to the FCC by the consulting firm Empiris[316] on behalf of the National Cable & Telecommunications Association and United States Telecom Association.[317] The Empiris declaration in particular took the challenge head on, cleared up some of the quirks in the approaches of the two earlier papers, and added new data. We follow up on their analysis here, with all prior caveats about this approach in full force.

The Empiris declaration replicates the analysis with more observations by virtue of dropping the price variable. The Empiris declaration agrees with our sense that including price as an explanatory variable would be inappropriate and it is preferable to drop it as an explanatory variable. The authors remove Greece and The Slovak Republic, and add several other potential explanatory variables.[318] In addition to the standard issues with cross-country analyses, estimating the impact of particular policies on the broadband penetration rates is complicated by two particularly knotty issues. These issues carry through from De Ridder (2007), through Boyle, Howell, and Zhang (2008), the work included in our draft report, the Empiris declaration, and comments submitted to the FCC by Howell, along with many other related papers included in the literature review.

The first issue is that technology diffuses over time, and most observers agree that it diffuses in some form of an S curve—slowly at first, then at higher rates, and then slowly again as markets approach saturation. The second thing is that regulatory regimes are not binary. The existence of a policy masks

315 Several comments to our draft report misunderstood the intention and logic of searching for influential points in the data. We 'dropped' Switzerland, along with every other country in turn, to estimate the impact of individual countries on the analysis, not, as several comments suggested, because we were unhappy with the impact its inclusion had on the results.

316 Declaration of Robert W. Crandall, Everett M. Ehrlich, and Jefferey A. Eisenbach Regarding the Berkman Center Study (NBP Public Notice 13), November 16, 2009.

317 One other document, by the Phoenix Center, was more a vehement denunciation than a critique. We note only that both Empiris and Howell managed to analyze and criticize our analysis without mischaracterizing our technique or findings as downward sloping supply curves. We also note that the Empiris declaration, footnote 19, explains that the data do not provide sufficient price data to perform the two-stage least squares method that the Phoenix Center protested to be the only way to analyze these data, and which it then used to "find" the "errors" in our study.

318 We don't understand the logic of including population as an explanatory variable. We found no explanation for including this variable.

tremendous variation across countries in the scope, depth and implementation of the policy.[319] Moreover, the date of formal passage of a rule is rarely the day on which it is effectively implemented and creates results. Regulators learn; entrants learn; incumbents learn. They all adjust their behavior over time, so that it is reasonable to assume that a regulatory system will function more effectively three or five years after initial implementation than immediately on the first year.[320] De Ridder sought to account for this effect with a variable GUyrs (Government-unbundling-years). Efforts to account for the second fact, however, encounter the problem that they might be simply capturing the natural S-curve diffusion. This was the nub of the Boyle, Howell, and Zhang critique, which is well taken. This is indeed a genuinely hard problem to solve. The authors of Empiris declaration tried to control for by using a variable describing the number of years since DSL was introduced into a country, and a separate dummy variable, for every year on which a country did, or did not, have unbundling in place, following Boyle, Howell and Zhang.

When they introduce DSL years, Empiris finds that the significant effect of unbundling over time, GUyrs, is rendered insignificant, supporting the work of Boyle, Howell, Zhang. However, when they replace GUyrs with their simple dummy variable for unbundling, they find that "Unbundling is negative and statistically significant," suggesting that with more data over more time one can show that "unbundling has slowed the pace of broadband adoption in the sample countries." (Empiris declaration, para. 27.) Empiris admirably provided their data in Table D.2. of the declaration allowing us to replicate the analysis using their data.

As a reality check, it is first important to recognize the value for the 'unbundling' variable is 1 for almost all countries in the dataset. Only Turkey, Mexico, the Czech Republic, Hungary, New Zealand, and Switzerland have a value of 0 for any appreciable amount of time in this dataset. The conclusions of the analysis, in other words, are that the rest of the countries have been doing something wrong, and this particular set of countries have done better by not adopting unbundling. The analysis suggests that the results of one country in the top quintile, plus four countries from the bottom quintile and one from the fourth quintile, should lead us to follow those countries' strategy of rejecting unbundling.

Two things are problematic with the Empiris analysis that we believe lead to this odd conclusion. The first is that, while GUyrs and DSLyears do have a simple correlation coefficient of 0.58, a multicollinearity test reveals that including both GUyrs and DSLyears in the model does not bias the results. This means that including only unbundling, and losing the data on how long an unbundling regime has been functioning, unnecessarily omits useful data. The second is that according to numerous sources, the correct method to employ with this type of data is not the Parks Method (FGLS) employed by Empiris. The Parks method is only efficient when the number of time periods is substantially greater than the number of units.[321] In this data set, the number of units is twice as large as the number of time

319 In our draft report, we constructed an alternative measure of the unbundling policy variable in an attempt to capture more accurately the point at which each country implemented unbundling in a serious way, which is not captured by the existing unbundling variable. This new variable was constructed using our own best judgment after a review of the experiences of each country. We were fairly criticized in several of the comments for injecting too much subjectivity into the analysis and thereby leaving open the possibility that our own biases would influence the results.

320 In comments submitted to the FCC, Howell makes the case for using a dummy variable to measure unbundling, implying that the full impact of the policy change will be felt in the first year. We are not convinced.

321 The Parks method can underestimate standard errors. (Hurwicz, L. 1950. "Least-Squares Bias in Time Series." In Statistical Inference in Dynamic Economic Models, ed. T. Koopmans. New York: Wiley.) Although the Parks method performs well in large samples (Cramer, J. 1986. Econometric Applications of Maximum Likelihood Methods. New York: Cambridge University Press.), the Parks method should not be used unless T is at least as big as N (Beck, Nathaniel, Jonathan N. Katz, R. Michael Alvarez, Geoffrey Garret, and Peter Lange. 1993. "Government Partisanship, Labor Organization, and Macroeconomic Performance: A Corrigendum." American Political Science Review 87: 945-

points, and therefore leads to an underestimation of standard errors by at least 20%. One way to correct for this is apply a method of panel corrected standard errors (Beck and Katz, 1995). The following table was calculated using panel corrected standard errors for heteroskedastic error terms and autocorrelation. When employing this method, the dummy variable for unbundling is negative, but no longer statistically significant. Replacing unbundling with the GUyrs variable, we can see a positive and statistically significant relationship. In other words, on these new data that Empiris introduces, when we use the proper test and account for the increasing effectiveness of a regulatory regime over time, unbundling has a positive effect on penetration.

We do not argue here that by this analysis alone one can prove the efficacy of unbundling. The data are not capable of delivering that kind of certainty. Separating out the effects of diffusion over time, and the effects of improved regulatory effectiveness over time is genuinely hard. Deriving determinate causal claims from a simple cross-country regression is highly uncertain. This is true even when we ignore that many of the actions may be strategically driven, or the regional variation within countries, or any one of many complexities. Some have taken the argument in another direction to suggest that the inability of this approach to produce more reliable results suggests that unbundling has had no appreciable impact on broadband deployment. This is not correct. The inherent short-comings of this approach is why it is so important to use case studies and qualitative analysis, or narrow and well designed econometric studies using micro-data and exogenous instruments and natural experiments.

Panel Corrected Standard Error Model

VARIABLES	(1) GUyrs	(2) Unbundled
guyrs	0.887**	
	(0.300)	
dslyears	2.299***	3.014***
	(0.278)	(0.172)
pop_density	0.011@	0.011@
	(0.006)	(0.006)
pops_mils	-0.025***	-0.014*
	(0.007)	(0.007)
gdp	0.000*	0.000***
	(0.000)	(0.000)
unbundled		-1.328
		(0.814)
Constant	-8.407***	-10.207***
	(1.990)	(2.124)
Observations	168	168
R-squared	0.492	0.460
Number of countries	28	28

Standard errors in parentheses
*** p<0.001, ** p<0.01, * p<0.05, @ p<0.1

48). Even if T 4 times greater than N, the Parks method still underestimates standard errors by 20% (Beck, Nathaniel, Jonathan N. Katz, 1995. "Nuisance vs. Substance: Specifying and Estimating Time-Series-Cross-Section Models" Political Analysis, 6:1.

4.14.2 Complete Country Influence Testing Results for Wallsten Hausladen

Table 1: Without Austria

VARIABLES	(1) Entrant Fiber per Cap	(2) Incumbent Fiber per Cap	(3) Entrant Fiber per Cap	(4) Incumbent Fiber per Cap
Unbundled Lines per Cap	-0.098@	-0.040		
	(0.055)	(0.044)		
GDP per Cap	-0.050	0.034	-0.106	0.020
	(0.172)	(0.066)	(0.263)	(0.093)
Bitstream Lines per Cap			-0.219	-0.064
			(0.133)	(0.055)
Constant	0.008	0.001	0.009	0.001
	(0.005)	(0.002)	(0.007)	(0.003)
Observations	233	233	222	222
Number of Countries	26	26	25	25
Adjusted R-squared	0.19	0.04	0.23	0.05

Robust standard errors in parentheses
*** p<0.001, ** p<0.01, * p<0.05, @ p<0.1

Table 2: Without Belgium

VARIABLES	(1) Entrant Fiber per Cap	(2) Incumbent Fiber per Cap	(3) Entrant Fiber per Cap	(4) Incumbent Fiber per Cap
Unbundled Lines per Cap	-0.119@	-0.045		
	(0.059)	(0.049)		
GDP per Cap	-0.064	0.029	-0.100	0.021
	(0.170)	(0.066)	(0.256)	(0.090)
Bitstream Lines per Cap			-0.219	-0.065
			(0.139)	(0.057)
Constant	0.008	0.001	0.009	0.001
	(0.005)	(0.002)	(0.007)	(0.003)
Observations	233	233	222	222
Number of Countries	26	26	25	25
Adjusted R-squared	0.21	0.05	0.23	0.05

Robust standard errors in parentheses
*** p<0.001, ** p<0.01, * p<0.05, @ p<0.1

Table 3: Without Bulgaria

VARIABLES	(1) Entrant Fiber per Cap	(2) Incumbent Fiber per Cap	(3) Entrant Fiber per Cap	(4) Incumbent Fiber per Cap
Unbundled Lines per Cap	-0.103@	-0.041		
	(0.056)	(0.045)		
GDP per Cap	-0.048	0.034	-0.100	0.021
	(0.167)	(0.065)	(0.255)	(0.090)
Bitstream Lines per Cap			-0.219	-0.064
			(0.133)	(0.055)
Constant	0.007	0.001	0.009	0.001
	(0.005)	(0.002)	(0.007)	(0.003)
Observations	242	242	231	231
Number of Countries	26	26	25	25
Adjusted R-squared	0.19	0.04	0.23	0.05

Robust standard errors in parentheses
*** p<0.001, ** p<0.01, * p<0.05, @ p<0.1

Table 4: Without Cyprus

VARIABLES	(1) Entrant Fiber per Cap	(2) Incumbent Fiber per Cap	(3) Entrant Fiber per Cap	(4) Incumbent Fiber per Cap
Unbundled Lines per Cap	-0.107@	-0.042		
	(0.057)	(0.046)		
GDP per Cap	-0.065	0.028	-0.125	0.014
	(0.163)	(0.063)	(0.257)	(0.090)
Bitstream Lines per Cap			-0.231	-0.068
			(0.138)	(0.058)
Constant	0.008	0.001	0.010	0.001
	(0.005)	(0.002)	(0.008)	(0.003)
Observations	236	236	225	225
Number of Countries	26	26	25	25
Adjusted R-squared	0.19	0.04	0.24	0.05

Robust standard errors in parentheses
*** p<0.001, ** p<0.01, * p<0.05, @ p<0.1

Table 5: Without Czech Republic

VARIABLES	(1) Entrant Fiber per Cap	(2) Incumbent Fiber per Cap	(3) Entrant Fiber per Cap	(4) Incumbent Fiber per Cap
Unbundled Lines per Cap	-0.104@	-0.042		
	(0.057)	(0.045)		
GDP per Cap	-0.048	0.033	-0.101	0.021
	(0.168)	(0.065)	(0.257)	(0.091)
Bitstream Lines per Cap			-0.222	-0.065
			(0.135)	(0.056)
Constant	0.007	0.001	0.009	0.001
	(0.005)	(0.002)	(0.008)	(0.003)
Observations	238	238	227	227
Number of Countries	26	26	25	25
Adjusted R-squared	0.19	0.04	0.23	0.05

Robust standard errors in parentheses
*** p<0.001, ** p<0.01, * p<0.05, @ p<0.1

Table 6: Without Denmark

VARIABLES	(1) Entrant Fiber per Cap	(2) Incumbent Fiber per Cap	(3) Entrant Fiber per Cap	(4) Incumbent Fiber per Cap
Unbundled Lines per Cap	-0.105@	-0.041		
	(0.056)	(0.044)		
GDP per Cap	-0.056	0.040	-0.121	0.025
	(0.161)	(0.074)	(0.239)	(0.097)
Bitstream Lines per Cap			-0.226	-0.064
			(0.134)	(0.055)
Constant	0.008	0.001	0.010	0.001
	(0.005)	(0.002)	(0.007)	(0.003)
Observations	233	233	222	222
Number of Countries	26	26	25	25
Adjusted R-squared	0.17	0.04	0.22	0.05

Robust standard errors in parentheses
*** p<0.001, ** p<0.01, * p<0.05, @ p<0.1

Table 7: Without Finland

VARIABLES	(1) Entrant Fiber per Cap	(2) Incumbent Fiber per Cap	(3) Entrant Fiber per Cap	(4) Incumbent Fiber per Cap
Unbundled Lines per Cap	-0.097	-0.042		
	(0.058)	(0.047)		
GDP per Cap	-0.042	0.035	-0.093	0.024
	(0.176)	(0.067)	(0.266)	(0.095)
Bitstream Lines per Cap			-0.218	-0.065
			(0.134)	(0.056)
Constant	0.007	0.001	0.009	0.001
	(0.005)	(0.002)	(0.008)	(0.003)
Observations	233	233	222	222
Number of Countries	26	26	25	25
Adjusted R-squared	0.19	0.04	0.23	0.05

Robust standard errors in parentheses
*** p<0.001, ** p<0.01, * p<0.05, @ p<0.1

Table 8: Without France

VARIABLES	(1) Entrant Fiber per Cap	(2) Incumbent Fiber per Cap	(3) Entrant Fiber per Cap	(4) Incumbent Fiber per Cap
Unbundled Lines per Cap	-0.101	-0.043		
	(0.062)	(0.049)		
GDP per Cap	-0.054	0.034	-0.102	0.021
	(0.165)	(0.065)	(0.273)	(0.097)
Bitstream Lines per Cap			-0.268	-0.084
			(0.165)	(0.070)
Constant	0.008	0.001	0.010	0.001
	(0.005)	(0.002)	(0.008)	(0.003)
Observations	233	233	222	222
Number of Countries	26	26	25	25
Adjusted R-squared	0.19	0.04	0.24	0.05

Robust standard errors in parentheses
*** p<0.001, ** p<0.01, * p<0.05, @ p<0.1

Table 9: Without Germany

VARIABLES	(1) Entrant Fiber per Cap	(2) Incumbent Fiber per Cap	(3) Entrant Fiber per Cap	(4) Incumbent Fiber per Cap
Unbundled Lines per Cap	-0.108	-0.052		
	(0.075)	(0.059)		
GDP per Cap	-0.048	0.041	-0.183	0.021
	(0.164)	(0.070)	(0.246)	(0.092)
Bitstream Lines per Cap			-0.261@	-0.065
			(0.147)	(0.055)
Constant	0.007	0.001	0.012	0.001
	(0.005)	(0.002)	(0.008)	(0.003)
Observations	233	233	222	222
Number of Countries	26	26	25	25
Adjusted R-squared	0.19	0.04	0.26	0.05

Robust standard errors in parentheses
*** p<0.001, ** p<0.01, * p<0.05, @ p<0.1

Table 10: Without Greece

VARIABLES	(1) Entrant Fiber per Cap	(2) Incumbent Fiber per Cap	(3) Entrant Fiber per Cap	(4) Incumbent Fiber per Cap
Unbundled Lines per Cap	-0.116@	-0.045		
	(0.059)	(0.048)		
GDP per Cap	-0.054	0.031	-0.103	0.021
	(0.176)	(0.067)	(0.266)	(0.092)
Bitstream Lines per Cap			-0.226	-0.065
			(0.141)	(0.055)
Constant	0.008	0.001	0.009	0.001
	(0.005)	(0.002)	(0.008)	(0.003)
Observations	233	233	222	222
Number of Countries	26	26	25	25
Adjusted R-squared	0.20	0.04	0.23	0.05

Robust standard errors in parentheses
*** p<0.001, ** p<0.01, * p<0.05, @ p<0.1

Table 11: Without Ireland

VARIABLES	(1) Entrant Fiber per Cap	(2) Incumbent Fiber per Cap	(3) Entrant Fiber per Cap	(4) Incumbent Fiber per Cap
Unbundled Lines per Cap	-0.106@	-0.042		
	(0.057)	(0.045)		
GDP per Cap	-0.023	0.040	-0.091	0.023
	(0.195)	(0.075)	(0.273)	(0.096)
Bitstream Lines per Cap			-0.221	-0.064
			(0.134)	(0.055)
Constant	0.007	0.001	0.009	0.001
	(0.006)	(0.002)	(0.008)	(0.003)
Observations	235	235	224	224
Number of Countries	26	26	25	25
Adjusted R-squared	0.19	0.04	0.23	0.05

Robust standard errors in parentheses
*** p<0.001, ** p<0.01, * p<0.05, @ p<0.1

Table 12: Without Italy

VARIABLES	(1) Entrant Fiber per Cap	(2) Incumbent Fiber per Cap	(3) Entrant Fiber per Cap	(4) Incumbent Fiber per Cap
Unbundled Lines per Cap	-0.103@	-0.040		
	(0.055)	(0.044)		
GDP per Cap	-0.049	0.028	-0.094	0.017
	(0.171)	(0.063)	(0.267)	(0.090)
Bitstream Lines per Cap			-0.220	-0.063
			(0.133)	(0.054)
Constant	0.007	0.001	0.009	0.001
	(0.005)	(0.002)	(0.008)	(0.003)
Observations	233	233	222	222
Number of Countries	26	26	25	25
Adjusted R-squared	0.18	0.04	0.22	0.05

Robust standard errors in parentheses
*** p<0.001, ** p<0.01, * p<0.05, @ p<0.1

Table 13: Without Latvia

VARIABLES	(1) Entrant Fiber per Cap	(2) Incumbent Fiber per Cap	(3) Entrant Fiber per Cap	(4) Incumbent Fiber per Cap
Unbundled Lines per Cap	-0.107@	-0.044		
	(0.059)	(0.048)		
GDP per Cap	-0.049	0.033	-0.102	0.021
	(0.169)	(0.067)	(0.258)	(0.093)
Bitstream Lines per Cap			-0.222	-0.066
			(0.136)	(0.057)
Constant	0.008	0.001	0.010	0.001
	(0.005)	(0.002)	(0.008)	(0.003)
Observations	237	237	226	226
Number of Countries	26	26	25	25
Adjusted R-squared	0.19	0.04	0.23	0.05

Robust standard errors in parentheses
*** p<0.001, ** p<0.01, * p<0.05, @ p<0.1

Table 14: Without Luxembourg

VARIABLES	(1) Entrant Fiber per Cap	(2) Incumbent Fiber per Cap	(3) Entrant Fiber per Cap	(4) Incumbent Fiber per Cap
Unbundled Lines per Cap	-0.091	-0.036		
	(0.057)	(0.041)		
GDP per Cap	0.723	0.345	1.063	0.476
	(0.633)	(0.325)	(0.720)	(0.419)
Bitstream Lines per Cap			-0.259@	-0.079
			(0.144)	(0.067)
Constant	-0.011	-0.007	-0.017	-0.009
	(0.015)	(0.007)	(0.016)	(0.009)
Observations	234	234	223	223
Number of Countries	26	26	25	25
Adjusted R-squared	0.21	0.06	0.29	0.09

Robust standard errors in parentheses
*** p<0.001, ** p<0.01, * p<0.05, @ p<0.1

Table 15: Without Malta

VARIABLES	(1) Entrant Fiber per Cap	(2) Incumbent Fiber per Cap	(3) Entrant Fiber per Cap	(4) Incumbent Fiber per Cap
Unbundled Lines per Cap	-0.113@	-0.044		
	(0.059)	(0.048)		
GDP per Cap	-0.072	0.026	-0.124	0.014
	(0.160)	(0.061)	(0.254)	(0.089)
Bitstream Lines per Cap			-0.227	-0.067
			(0.137)	(0.057)
Constant	0.008	0.001	0.010	0.001
	(0.005)	(0.002)	(0.008)	(0.003)
Observations	237	237	226	226
Number of Countries	26	26	25	25
Adjusted R-squared	0.20	0.04	0.24	0.05

Robust standard errors in parentheses
*** p<0.001, ** p<0.01, * p<0.05, @ p<0.1

Table 16: Without Netherlands

VARIABLES	(1) Entrant Fiber per Cap	(2) Incumbent Fiber per Cap	(3) Entrant Fiber per Cap	(4) Incumbent Fiber per Cap
Unbundled Lines per Cap	-0.108@	-0.040		
	(0.055)	(0.044)		
GDP per Cap	-0.051	0.033	-0.100	0.021
	(0.163)	(0.067)	(0.255)	(0.090)
Bitstream Lines per Cap			-0.219	-0.064
			(0.133)	(0.055)
Constant	0.008	0.001	0.009	0.001
	(0.005)	(0.002)	(0.007)	(0.003)
Observations	233	233	233	233
Number of Countries	26	26	26	26
Adjusted R-squared	0.18	0.04	0.23	0.05

Robust standard errors in parentheses
*** p<0.001, ** p<0.01, * p<0.05, @ p<0.1

Table 17: Without Poland

VARIABLES	(1) Entrant Fiber per Cap	(2) Incumbent Fiber per Cap	(3) Entrant Fiber per Cap	(4) Incumbent Fiber per Cap
Unbundled Lines per Cap	-0.114@	-0.045		
	(0.059)	(0.048)		
GDP per Cap	-0.070	0.026	-0.122	0.014
	(0.162)	(0.062)	(0.258)	(0.090)
Bitstream Lines per Cap			-0.229	-0.067
			(0.138)	(0.058)
Constant	0.008	0.001	0.010	0.001
	(0.005)	(0.002)	(0.008)	(0.003)
Observations	236	236	225	225
Number of Countries	26	26	25	25
Adjusted R-squared	0.20	0.04	0.24	0.05

Robust standard errors in parentheses
*** p<0.001, ** p<0.01, * p<0.05, @ p<0.1

Table 18: Without Portugal

VARIABLES	(1) Entrant Fiber per Cap	(2) Incumbent Fiber per Cap	(3) Entrant Fiber per Cap	(4) Incumbent Fiber per Cap
Unbundled Lines per Cap	-0.100@	-0.040		
	(0.056)	(0.044)		
GDP per Cap	-0.092	0.027	-0.193	0.000
	(0.146)	(0.063)	(0.230)	(0.086)
Bitstream Lines per Cap			-0.246@	-0.070
			(0.143)	(0.060)
Constant	0.009@	0.001	0.012	0.002
	(0.005)	(0.002)	(0.007)	(0.003)
Observations	233	233	222	222
Number of Countries	26	26	25	25
Adjusted R-squared	0.19	0.04	0.25	0.05

Robust standard errors in parentheses
*** p<0.001, ** p<0.01, * p<0.05, @ p<0.1

Table 19: Without Romania

VARIABLES	(1) Entrant Fiber per Cap	(2) Incumbent Fiber per Cap	(3) Entrant Fiber per Cap	(4) Incumbent Fiber per Cap
Unbundled Lines per Cap	-0.103@	-0.041		
	(0.056)	(0.045)		
GDP per Cap	-0.048	0.034	-0.100	0.021
	(0.167)	(0.065)	(0.255)	(0.090)
Bitstream Lines per Cap			-0.219	-0.064
			(0.133)	(0.055)
Constant	0.007	0.001	0.009	0.001
	(0.005)	(0.002)	(0.007)	(0.003)
Observations	242	242	231	231
Number of Countries	26	26	25	25
Adjusted R-squared	0.19	0.04	0.23	0.05

Robust standard errors in parentheses
*** p<0.001, ** p<0.01, * p<0.05, @ p<0.1

Table 20: Without The Slovak Republic

VARIABLES	(1) Entrant Fiber per Cap	(2) Incumbent Fiber per Cap	(3) Entrant Fiber per Cap	(4) Incumbent Fiber per Cap
Unbundled Lines per Cap	-0.096	-0.045		
	(0.060)	(0.048)		
GDP per Cap	-0.048	0.032	-0.103	0.019
	(0.164)	(0.067)	(0.250)	(0.094)
Bitstream Lines per Cap			-0.216	-0.068
			(0.138)	(0.058)
Constant	0.007	0.001	0.009	0.001
	(0.005)	(0.002)	(0.007)	(0.003)
Observations	236	236	225	225
Number of Countries	26	26	25	25
Adjusted R-squared	0.17	0.05	0.21	0.05

Robust standard errors in parentheses
*** p<0.001, ** p<0.01, * p<0.05, @ p<0.1

Table 21: Without Slovenia

VARIABLES	(1) Entrant Fiber per Cap	(2) Incumbent Fiber per Cap	(3) Entrant Fiber per Cap	(4) Incumbent Fiber per Cap
Unbundled Lines per Cap	-0.104@	-0.041		
	(0.056)	(0.045)		
GDP per Cap	-0.053	0.032	-0.105	0.020
	(0.168)	(0.065)	(0.257)	(0.091)
Bitstream Lines per Cap			-0.221	-0.064
			(0.134)	(0.055)
Constant	0.008	0.001	0.009	0.001
	(0.005)	(0.002)	(0.008)	(0.003)
Observations	236	236	225	225
Number of Countries	26	26	25	25
Adjusted R-squared	0.19	0.04	0.23	0.05

Robust standard errors in parentheses
*** p<0.001, ** p<0.01, * p<0.05, @ p<0.1

Table 22: Without Spain

VARIABLES	(1) Entrant Fiber per Cap	(2) Incumbent Fiber per Cap	(3) Entrant Fiber per Cap	(4) Incumbent Fiber per Cap
Unbundled Lines per Cap	-0.108@	-0.042		
	(0.057)	(0.046)		
GDP per Cap	-0.053	0.032	-0.118	0.015
	(0.174)	(0.067)	(0.276)	(0.096)
Bitstream Lines per Cap			-0.247@	-0.073
			(0.144)	(0.063)
Constant	0.008	0.001	0.010	0.001
	(0.005)	(0.002)	(0.008)	(0.003)
Observations	233	233	222	222
Number of Countries	26	26	25	25
Adjusted R-squared	0.20	0.04	0.25	0.06

Robust standard errors in parentheses
*** p<0.001, ** p<0.01, * p<0.05, @ p<0.1

Table 23: Without Sweden

VARIABLES	(1) Entrant Fiber per Cap	(2) Incumbent Fiber per Cap	(3) Entrant Fiber per Cap	(4) Incumbent Fiber per Cap
Unbundled Lines per Cap	-0.098@	-0.041		
	(0.056)	(0.045)		
GDP per Cap	-0.080	0.027	-0.090	0.018
	(0.101)	(0.053)	(0.156)	(0.080)
Bitstream Lines per Cap			-0.115	-0.058
			(0.084)	(0.062)
Constant	0.007	0.001	0.006	0.001
	(0.004)	(0.002)	(0.005)	(0.002)
Observations	233	233	222	222
Number of Countries	26	26	25	25
Adjusted R-squared	0.19	0.02	0.16	0.02

Robust standard errors in parentheses
*** p<0.001, ** p<0.01, * p<0.05, @ p<0.1

Table 24: Without United Kingdom

VARIABLES	(1) Entrant Fiber per Cap	(2) Incumbent Fiber per Cap	(3) Entrant Fiber per Cap	(4) Incumbent Fiber per Cap
Unbundled Lines per Cap	-0.111@	-0.043		
	(0.058)	(0.047)		
GDP per Cap	-0.049	0.034	-0.100	0.023
	(0.178)	(0.070)	(0.261)	(0.093)
Bitstream Lines per Cap			-0.216	-0.063
			(0.134)	(0.054)
Constant	0.008	0.001	0.009	0.001
	(0.005)	(0.002)	(0.007)	(0.003)
Observations	233	233	222	222
Number of Countries	26	26	25	25
Adjusted R-squared	0.20	0.04	0.23	0.05

Robust standard errors in parentheses
*** p<0.001, ** p<0.01, * p<0.05, @ p<0.

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."[322] 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

322 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 Wi-Fi 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 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.[323] 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

323 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[324] 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.[325] 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.[326] 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.[327] 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.[328]

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

325 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)

326 OECD Communications Outlook 2009 Table 4.17.

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

328 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[329]
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

329 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.[330] 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

330 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 outside of Sweden has been Amsterdam's CityNet.[331] 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. At an operation level, the project has only been partially successful. While 43,000 homes have been passed, only a small proportion of the houses passed signing up for service. Nonetheless, it has been sufficiently successful to draw the investments from the KPN Reggefiber joint venture. The project has also been successful in the sense that 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, on the market-investor principal; and because its success was one of the factors that apparently 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 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 EUR 18 million equity investment of the EUR30 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 Telecom 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. BBned itself had retail affiliates that would sell such services.

331 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;

In the European Union case, Dutch, Spanish, and Swedish cable operators UPC, ONO, and Com Hem, as well as France Telecom, 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 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. One strand of investment permitted is where the state invests 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 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 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 made it easier for the Dutch government to pursue a course to reverse that decision, and to initiate a process to support municipal efforts built on the Amsterdam model.

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.[332] 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."[333] 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 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

332 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.

333 *Id*. Section 2.1.

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. [334]

334 EU Guidelines, English version, page 23-24.

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.[335] The program consisted of a week-long, 20 hour course, subsidized through over a thousand training institutions so that courses cost about USD30.[336] 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

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

335 Kushida and Oh.
336 Atkinson et al, 2008, p. 38.

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. Australia

Introduction

After starting slowly, broadband take-up and average advertised speeds are now above the OECD average though well behind the leaders. Prices are comparatively high; caps on usage are universal and plans for fiber access networks have stalled since 2005. 3G wireless penetration far outstrips fixed-line access in Australia. Under a plan announced in April 2009, the federal government is establishing a public-private partnership to build and operate a national, wholesale-only, fiber-to-the-premises (FTTP) network. Many have welcomed this as a visionary response to slow, expensive broadband and the continuing power of the once state-owned incumbent, Telstra. But the plan has also been strongly criticized by those unconvinced of the universal demand for these fixed access speeds, and skeptical about the likely commercial return on the huge investment, especially given the rapid growth of mobile broadband.

Market highlights

Overall, 52.0% of households in Australia have broadband access.[337]

	Fiber / LAN	Cable	DSL	Other	Overall[338]
Subscriptions per 100 people [339]	0.0	4.3	19.9	1.2	25.4

Penetration Metrics	Rank amongst OECD 30 countries	Speed metrics	Rank amongst OECD 30 countries	Price metrics	Rank amongst OECD 30 countries
Penetration per 100, OECD	16	Maximum advertised speed, OECD	14	Price low speeds, combined	28
Household penetration, OECD	13	Average advertised speed, OECD	7	Price med speeds, combined	27
3G penetration, Telegeography	3	Average speed, Akamai	24	Price high speeds, combined	19
Wi-Fi hotspots per 100000, Jiwire	17	Median download, speedtest.net	22	Price very high speeds, combined	N/A
		Median upload, speedtest.net	24		
		Median latency, speedtest.net	17		
		90% Download, speedtest.net	18		
		90% Upload, speedtest.net	24		

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

Note: Details in Part 3
Source: OECD, TeleGeography, Jiwire, Speedtest.net, Akamai, Point Topic Berkman Center analysis

337 Australian Bureau of Statistics, Household Use of Information Technology, 2007/08, 8146.0, as of 2007/08.
338 Does not include 3G Wireless. Since subscriptions are shared within a household, this number will never be 100.
339 OECD Broadband Portal, Table 1d, data supplied by the Australian Government, as of 2008.

Broadband development to date

Broadband in Australia started slowly. Cable TV penetration was low; cable modem services launched by Telstra and Optus in the late-1990s were expensive by North American standards, and untimed local calls made dial-up internet cheap. Telstra launched the first DSL services in 2000. Two years later, there were 1.3 broadband subscribers per 100 inhabitants, about a third of the OECD average and well behind market leaders Korea (20.3) and Canada (10.3). In 2004, the figure had increased to 5.2, closer to the OECD average (8.5) but still leaving Australia 20th in the OECD.

Take-up was boosted by Telstra's sharp price reductions early in 2004, just as Optus was planning to launch a resale DSL product. Australia moved ahead of the OECD average (13.6 to 13.0) in December 2005. At 25.4 subscribers per 100 inhabitants in December 2008, overall penetration is still above the OECD average (22.4) though well behind the market leaders.

Dial-up subscriptions peaked in 2004, the same year DSL overtook cable modem as the main form of broadband connection. By June 2009, 87% of all internet subscribers had broadband connections (at least 256 kbps).[340] Of the 7.3 million broadband subscribers, 57% were DSL and just 13% were cable. The very few fiber access lines are mainly in new housing estates and central business districts. Stalled plans for wider-scale private deployment of fiber access networks have been at the center of the government plans for public investment in FTTx networks.

The fastest-growing broadband access technology is wireless. In the 18 months before June 2009, Australia added 1.7 million new wireless subscribers and 500,000 DSL subscribers. Twenty-seven percent of all broadband subscribers are now wireless.[341] This figure reflects aggressive competition from 3G operators. Telstra NextG reaches 99% of the population, Optus 96%, and Vodafone, which recently merged its 3G operations with Hutchison, 94%, though these networks reach far smaller percentages of Australia's land-mass.

Fixed broadband became more competitive as providers installed equipment in Telstra's exchanges, taking advantage of local loop unbundling (LLU) and line sharing services. The level of competition varies greatly across the country. By September 2008, 245 of Telstra's roughly 5000 exchanges had five or more facilities-based competitors, but 2315 had no competitor and 2221 had only one. Most Australians live in places served by Telstra and at least two competing, unbundling-based, DSLAM-type DSL providers. Higher speed ADSL2+ services were available in 1403 exchanges by September 2008, including most metropolitan exchanges. According to the competition regulator, nearly half the population at that time lived within 1.5 km of an ADSL2+ enabled exchange, making download speeds of 12-24 Mbps possible.

According to the OECD's September-October 2008 data, Australia's broadband speeds were in the second quintile of OECD countries (7th), though well behind Japan, Korea, and France, measured by the average advertised speed of surveyed plans. Actual speed measurements from both Akamai and Speedtest were substantially lower, however. Prices were in the most expensive two quintiles of countries, except for the high-speed tier. Australia is one of just four OECD countries where all advertised plans were capped. Further, the average cap among the surveyed offers was around half that of Canada. Once the cap was reached, the average price per additional Mbps was the highest in the OECD.

340 Australian Bureau of Statistics, Internet Activity in Australia, June 2009, 8153.0.
341 Australian Bureau of Statistics, Internet Activity in Australia, June 2009, 8153.0.

Market share and key players

Telstra has the biggest share of all three main retail market segments. Its competitors have been more successful in winning market share in mobile than in broadband. In 2008/09, for the first time, Telstra earned more revenue from mobile than traditional PSTN (local access and fixed voice) services. Of its mobile revenues, 44% came from data.[342] Telstra's main competitor in both fixed and wireless broadband is Optus, which stopped reselling DSL broadband over Telstra's network in 2007. Optus has its own wireline LLU network and may stop investing in this network if Telstra wins the contract for the National Broadband Network.[343]

Four companies compete in the Australian wireless broadband market: Telstra, Optus Mobile, Vodafone Australia, and Hutchison 3G Australia. The latter no longer operates a 2G network. Telstra controls approximately 42% of the market; Optus controls approximately 33%; Vodafone has 13%; and Hutchison 11%. In addition, dozens of mobile virtual network operators (MVNOs) resell services over these companies' wireless networks.[344]

Regulatory framework

A specialist regulator, the Australian Communications and Media Authority (ACMA), was formed in 2005 by merging the broadcasting and telecommunications regulators. It licenses carriers and broadcasters, allocates spectrum, and administers content regulation. Competition regulation is handled by the Australian Competition and Consumer Commission (ACCC). It has responsibility for these issues across the whole economy under the Trade Practices Act, but that legislation contains telecoms-specific provisions governing access to networks and anti-competitive conduct.

The overall communications regulatory framework emphasizes competition to ensure high quality services at affordable prices, but regulatory measures also support this goal. Since 1991, a universal service scheme has required a designated provider or providers to offer basic services (voice telephone, payphones, and low speed digital data capability) to anyone requesting them within certain time frames. The net cost of delivering the uneconomic services is recovered through an industry levy. In practice, the scheme has been controversial. Telstra has remained the universal service carrier and its dominance of total industry revenue means it continues to meet most of the cost. Changes are now proposed, although the scheme has been eclipsed by the proposed broadband network as the primary policy tool and source of funds for delivering universal access to basic and advanced services. A Customer Service Guarantee sets standards for service connections, fault repairs and attending appointments with customers. Compensation must be paid to customers where these standards are not met. The scheme covers standard voice telephone services but not internet access or mobile services.

Political economy

Australia is a parliamentary democracy with a market economy. Legislative power is shared between federal and state parliaments and local councils. Telecommunications, spectrum, broadcasting, and intellectual property laws are made by the federal parliament. A mix of federal, state and local government laws regulates the building of communications infrastructure, classification, and censorship of content and consumer protection. The wide social and economic impact of broadband has given all levels of government an interest in the quality and price of services. The federal government's legislative powers and financial capacity mean it is best placed to act.

342 Telstra Corporation, Full Year 2009 Financial Results Analyst Briefing, 13 August 2009
343 TeleGeography, GlobalComms Database, Country profile,, Australia, pp. 5-6.
344 Ibid, pp. 9-10.

A state-owned monopoly controlled domestic telecoms for most of the 20th century. International links were provided by private and mixed public-private operators until soon after World War II, when they were merged and nationalized. A state-owned domestic satellite system was established in the 1980s. The Labor Government elected in 1983 reversed many long-standing economic policy positions, liberalized financial markets, cut tariffs, and privatized state-owned enterprises. Telecoms markets were progressively opened to competition from the late 1980s. The state-owned domestic and international telecoms companies were merged to form Telstra. The Liberal/National (Conservative) Coalition Government, elected in 1996, privatized it in three stages between 1997 and 2006. A 2003 poll found that 57% of Australians preferred Telstra to be fully publicly owned and 31% preferred mixed public/private ownership. Less than 10% wanted full privatization.[345]

Debates over broadband policy in the 2000s were shaped by the major political parties' long-held positions on privatization. The Coalition was unwilling to contemplate major structural changes to a company it was determined to sell; Labor defended public ownership of a vital national asset.

Broadband strategy

The centerpiece of the Government's strategy is the National Broadband Network (NBN) announced in April 2009. Costing up to AUD 43 billion (USD 36.5 billion), around USD 1800 per head of population, the plan will deliver download speeds of 100 Mbps to 90% of homes and workplaces within eight years. It will wholly replicate most of Australia's 11 million copper exchange lines with optical fiber-to-the-premises (FTTP). The 10% of the population not served will get speeds of at least 12 Mbps by other means, such as terrestrial wireless or satellite. In addition to the access network, extra fiber backhaul links will be constructed in non-metropolitan areas.

A company has been established to build and operate the NBN. Substantial private sector participation is intended, but the government will remain the majority shareholder. The Government now says AUD 43 billion figure has "got a pretty sizeable chunk of contingency built into it." Its contribution will be around AUD 11 billion. This assumes 50/50 debt/equity for the whole project with half of the equity held by government. Of the AUD 11 billion, AUD 4.7 billion will be direct public subsidy and AUD 6.3 billion will come from Infrastructure Bonds offered to institutional and retail investors on terms yet to be settled. The network will be privatized five years after construction ends. The company will have no retail customers, but will offer wholesale access to all on fair and non-discriminatory terms. Much of the detail of its structure and operation, including any non-government shareholdings and the terms and conditions of access to its facilities, has not been settled.

The NBN supplants the broadband policy the Labor Opposition took to the 2007 election. It would have provided AUD A4.7 billion to bring speeds of 12 Mbps to 98% of Australians via an upgrade of the fixed line network to fiber-to-the-node, FTTN. This first plan for revived public investment provided a policy bridge away from Labor's historic opposition to privatizing Telstra. It capitalized on the "broadband backwater" implied by the OECD's data, the technical opportunity offered by next generation fixed line access networks, widespread criticism of Telstra's continuing power, and its refusal to invest in a fiber access network without regulatory change and large budget surpluses.

345 Pusey, M. and Turnbull, N. 2005, 'Have Australians embraced economic reform', in Wilson, S. et al (eds), Australian Social Attitudes: The First Report, UNSW Press, Sydney, pp. 161-81 at 165-6

The global financial and economic crisis helped spread these policy impulses across the whole economy. By diminishing the private sector's capacity to invest, increasing the demands for governments to spend, and undermining faith in the efficacy of free markets, the crisis provided a rationale for "nation-building" initiatives. Among them, broadband, "the most important economic infrastructure of the 21st century" in the Australian Prime Minister's words, was as persuasive as any. Interpreting FTTN as only an interim solution, FTTP became a leap-frog straight to what the finance minister has called "the end game."

This large public investment in telecommunications infrastructure is a big shift from the trends that dominated Australian policy for more than a decade. Early thinking about broadband in the mid-1990s coincided with the liberalization of telecommunications markets and the long-delayed launch of pay television services. Successive governments agreed that this burgeoning competition was the key to new, higher-bandwidth services, along with telcoms-specific laws about third-party access to essential facilities and anti-competitive conduct and safety net regulation for consumers.

One way the Liberal/National Government secured parliamentary support for privatization was by committing large sums from the proceeds towards improvements in telecommunications infrastructure and services, especially in rural areas. A lack of focus and performance evaluation in the initial Networking the Nation program was criticized, and subsequent schemes addressed more specific needs, funding either particular groups (local government, regional and remote communities) or particular solutions (extended mobile phone coverage, extra rural networks).

Two inquiries into the state of communications in non-metropolitan Australia in 2000 and 2002 made detailed recommendations to improve services. A National Broadband Strategy, coordinated between federal and state governments, was announced in 2004. Funding was provided to build on broadband infrastructure developments in public sector areas such as health and education, and to aggregate broadband demand in local areas to attract additional infrastructure investment. The Strategy also established the first of a series of programs providing per-customer subsidies to ISPs offering broadband services in regional, rural, and remote areas at metro-comparable prices. Around AUD 250 million has been committed to the latest version of this program, the Australian Broadband Guarantee, over four years to 2012. Metro-comparable broadband service means any service offering at least 512 kbps download and 128 kbps upload and 3GB per month data usage.

Policy interventions and outcomes

Government investment in infrastructure

Even before the change of government in 2007, policy had shifted back towards higher public investment in telecoms infrastructure. An AUD 2 billion Communications Fund was established by the Liberal/National Government to generate an annual revenue stream to fund new technologies in rural areas. That government also nearly agreed to a subsidy for Telstra to upgrade its fixed line network to FTTN. In response to the Labor Opposition's 2007 broadband plan, the Government announced its own plan, to provide WiMAX and ADSL2+ local access and fiber backhaul in non-metropolitan areas.

Unlike the current NBN, this plan targeted areas where advanced services were least likely to be commercial and did not involve government directly in the new enterprise. It envisaged more use of wireless and cost considerably less. A tender was run and won, but the incoming government terminated the contract. It proceeded to implement, and later greatly expand, its own national plan, then supplemented it with changes to regulation and Telstra's structure.

Skill building, education, and demand programs

The federal government is spending AUD 2.2 billion over six years on what it calls a "Digital Education Revolution."[346] Most of the funds are being spent to increase computers in schools to one per student in years 9-12 by the end of 2011. In early 2008, almost a third of secondary schools had a computer-to-student ratio of 1 to 8 or worse. Schools will receive FTTP broadband connections under the NBN. Federal and state governments are also supporting IT training for teachers, further work on the professional development required to integrate IT into pedagogical practice, online curriculum tools and resources, and improved online opportunities for parents to participate in their children's education. A "Digital Regions Initiative" is co-funding partnerships to improve health, education and emergency services in non-metropolitan communities.[347]

Competition policy

Extensive criticism of the existing regime comes from quite different perspectives. Some argue it has been too weak to prevent the vertically and horizontally integrated incumbent Telstra from dominating local telecommunications markets, particularly for fixed line services.[348] Others suggest that the telecommunications industry-specific laws governing third-party access to networks give the regulator too much discretion, which it has exercised capriciously. By regulating too much of Telstra's network and setting access prices (including for LLU) too low, the ACCC has "severely distorted" price signals and discouraged investment by Telstra and its competitors alike.[349]

The ACCC first ordered Telstra to open its copper local loop to DSL competition very early, in mid-1999. The following several years saw continuous conflicts over LLU pricing, with the ACCC imposing a set of price controls in April of 2002, which did not allay complaints by entrants, in particular Primus and AAPT, the then-primary users of Telstra unbundled loops. By March 2004 the ACCC issued a notice against Telstra for anti-competitive conduct, but it was another year before Telstra's prices were lowered and its commitments brought sufficiently into alignment with the ACCC's requirements that the competition notice was revoked. Throughout 2005 and until August 2006 there was an extended back and forth between the ACCC and Telstra over the proper pricing of LLU services. The OECD 2007 Communications Outlook described Australia as having, by late 2006, no effective regulated rate, and having higher per-month charges in the lowest-cost, Metropolitan areas that were higher than all other OECD countries other than Norway, Poland, and the Slovak republic, while unbundling rates for access to regional networks were almost twice that high.[350] By 2008 LLU prices extracted from the dispute resolution process administered by the ACCC were in line with prices elsewhere.[351] The relationship between the regulator and the incumbent appears to a reader of reports of the history of regulation in this area to be a fairly contentious one.

Telstra is already subject to accounting separation. Further structural change is central to the planned NBN. The open access network itself will deliver a degree of structural separation and in mid-September 2009, legislation was introduced requiring Telstra to voluntarily structurally separate its wholesale and retail fixed line operations or have strong functional separation imposed by law.[352] While its fixed line

346 Department of Broadband, Communications and the Digital Economy (DBCDE) 2009, Australia's Digital Economy: Future Directions - Snapshot, Canberra: DBCDE (July) and see http://www.deewr.gov.au/Schooling/DigitalEducationRevolution/Pages/default.aspx

347 http://www.dbcde.gov.au/communications/digital_regions_initiative

348 Fletcher, P. 2009, Wired Brown Land? Telstra's Battle for Broadband, UNSW Press, Sydney.

349 Ergas, H. 2008, Wrong Number: Resolving Australia's Telecommunications Impasse, Allen and Unwin, Sydney.

350 OECD, Communications Outlook 2007. Table 2.10.

351 OECD, Communications Outlook 2009. Table 2.10.

352 Senator Stephen Conroy 2009, 'Historic reforms to telecommunications regulation', 15 September.

activities remain vertically integrated, and it retains an HFC network and 50% stake in pay TV operator Foxtel, it will be unable to acquire additional spectrum for advanced wireless broadband. The government appears determined to ensure the NBN is not thwarted by competition from a still vertically-integrated Telstra.

Network non-discrimination

Network non-discrimination has not been a major issue. The ACCC declined to impose a form of neutrality for backbone networks in 2004. Telstra argues that this results from competitive retail broadband and universal "volumetric pricing" capped plans where usage above the monthly allowance is throttled or charged at a pre-determined rate. This practice is said to reduce any incentive for ISPs to block or throttle content unaffiliated to the ISP or generated by users, while creating an incentive for them to encourage extra use of content from any source and to upgrade facilities.[353] The neutrality issue is playing out in a different way. Rather than negatively discriminating against particular content, some ISPs are positively discriminating by offering unmetered access to some content. The publicly-funded national broadcaster, the ABC, argues that the publicly-funded NBN should carry all its content unmetered.

Spectrum policy

Spectrum can be allocated under flexible spectrum licenses that do not specify uses, or licenses that authorize the operation of particular transmitters. Use of spectrum can also be authorized under rules that allow complying devices to be operated without individual licenses. In 2001, Australia auctioned 3G spectrum licenses, which were won by Telstra, Vodafone, Optus, and Hutchison. In its Spectrum Outlook, ACMA identifies three major projects: the expiry of spectrum licenses for 2G mobile telephony in 2013 and 2015 and 3G in 2017; the "digital dividend" from shutting down analog TV between 2010 and 2013; and a review of government, including defense, spectrum use. Demand is growing for the parts of the spectrum that best suit emerging and evolving services, like mobile broadband. Each of these projects could improve spectrum efficiency and create opportunities for new services, though not without cost to existing users.

Conclusion

Announcing his broadband policy for the 2007 election, the current Prime Minister cited Australia's poor international ranking and the need to do something about worsening productivity, especially to help deliver prosperity beyond the mining boom. His response had two strands, an "education revolution" and improved infrastructure. Broadband figured in both. In government, amid a global recession, he has massively increased the scope and cost of the planned NBN and announced major changes to regulation and the structure of Telstra, placing a big, public wager on the benefits that will flow from faster fixed line broadband and a publicly-controlled, wholesale-only operator.

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353 Kelso, R. 2009, 'Moving the debate from open access to network neutrality: US lessons for Australia', Telecommunications Journal of Australia (TJA), 59(2), 20.1-20.20; Endres, J. 2009, 'Net neutrality: how relevant is it to Australia', TJA, 59(2), 22.1-22.10.

B. Canada

Introduction

Though it was among the first nations in the world to provide widespread, retail broadband service, Canada's recent broadband development has lagged behind other developed nations. Canada's broadband penetration rates are often lauded, but the country is a poor performer on price and speed and a declining performer in penetration. Canada also faces an urban-rural broadband coverage gap. The Canadian broadband industry is relatively consolidated, and both cable and DSL providers have only recently started to deploy wireless and direct-fiber broadband infrastructure. 3G wireless penetration is substantially weaker than fixed line penetration. Recently, Canada's regulatory bodies have pushed for deregulation of the broadband market in the hopes of promoting a more efficient and affordable broadband market.

Market highlights

Overall, 64.0% of households in Canada have broadband access.[354]

	Fiber / LAN	*Cable*	*DSL*	*Other*	*Overall* [355]
Subscriptions per 100 people [356]	0.0	15.6	13.0	0.4	29.0

Penetration Metrics	Rank amongst OECD 30 countries	Speed metrics	Rank amongst OECD 30 countries	Price metrics	Rank amongst OECD 30 countries
Penetration per 100, OECD	10	Maximum advertised speed, OECD	17	Price low speeds, combined	17
Household penetration, OECD	7	Average advertised speed, OECD	25	Price med speeds, combined	18
3G penetration, Telegeography	26	Average speed, Akamai	13	Price high speeds, combined	20
Wi-Fi hotspots per 100000, Jiwire	20	Median download, speedtest.net	15	Price very high speeds, combined	18
		Median upload, speedtest.net	12		
		Median latency, speedtest.net	15		
		90% Download, speedtest.net	22		
		90% Upload, speedtest.net	19		

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

Note: Details in Part 3
Source: OECD, TeleGeography, Jiwire, Speedtest.net, Akamai, Point Topic
Berkman Center analysis

354 OECD Broadband Portal, Table 2a, from "Communications Monitoring Report" published by the Canadian Radio-television and Telecommunications Commission (CRTC).
355 Does not include 3G Wireless. Since subscriptions are shared within a household, this number will never be 100.
356 OECD Broadband Portal, Table 1d, OECD estimation based on company reporting, as of 2008.

Broadband development to date

Cable and DSL services have been available in at least some parts of Canada since 1996. In that year, SaskTel became one of the world's first telecommunications carriers to offer DSL.[357] At around the same time, Rogers Communications Inc. of Toronto premiered the first high-speed cable Internet service in the world.[358] By the end of 2008, broadband services were available to virtually all urban households, with 94% of all households having access to fixed broadband and over 91% having access to mobile broadband.[359] Only 52% of households actually subscribe to broadband services, however, with a further 22% of households accessing the Internet via dial-up or other connections with speeds under 1.5Mbps.[360] Cable's dominance in the broadband market has persisted. By 2008, 55.0% of residential broadband subscribers accessed the Internet via cable, while only 39.5% did so via DSL.[361]

Despite its early broadband leadership, Canada has most recently lagged peer nations in broadband penetration, speed, and price. Though it was in the top OECD quintile in penetration in 2002, it is no longer. Canada has little fiber-to-the-home (FTTH) deployment.[362] Measured by percent of total subscribers of all broadband technologies, Canada's fiber customers represent 0.01% of all broadband subscribers. This is in stark contrast to countries like Korea (39%), Japan (44%), and Sweden (20%).[363] Possible explanations for Canada's weakening performance include lack of competition.[364] Though broadband providers Rogers, Bell Canada, and cable operator Shaw have announced plans to roll out FTTH services, their plans are primarily geared toward multi-dwelling buildings, condominiums, and hotels.[365] In speed, Canada is a weak to mid-pack performer. By advertised speeds and actual measurements of the highest speeds, Canada is in the fourth or fifth quintile. By measured average speeds, according to both Akamai and Speedtest, Canada is in the third quintile of performers. On prices, the OECD shows Canada as a fourth or fifth tier performer, while our own study observed better prices, locating Canada in the third or fourth tier of prices.[366]

Bandwidth caps are mainstays in the services of the largest Canadian broadband providers, such as Rogers Communications and Bell Canada. While pricing structures differ across companies, bandwidth caps can be as low as 2 GB per month to as high as 60175 GB per month, depending on the service plan. Incumbent carriers such as Bell that provide infrastructure for other broadband services can now also impose bandwidth caps on other companies that provide broadband using its local facilities.[367]

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357 Promoting Broadband: The Case of Canada, p. 17 (http://www.itu.int/osg/spu/ni/promotebroadband/casestudies/canada.pdf)

358 Promoting Broadband: The Case of Canada, p. 18 (http://www.itu.int/osg/spu/ni/promotebroadband/casestudies/canada.pdf)

359 CRTC Communications Monitoring Report 2009, p. 171 (http://www.crtc.gc.ca/eng/publications/reports/policymonitoring/2009/2009MonitoringReportFinalEn.pdf)

360 CRTC Communications Monitoring Report 2009, p. 213 (http://www.crtc.gc.ca/eng/publications/reports/policymonitoring/2009/2009MonitoringReportFinalEn.pdf)

361 CRTC Communications Monitoring Report 2009, p. 259 (http://www.crtc.gc.ca/eng/publications/reports/policymonitoring/2009/2009MonitoringReportFinalEn.pdf)

362 CRTC Communications Monitoring Report 2009, p. 259 (http://www.crtc.gc.ca/eng/publications/reports/policymonitoring/2009/2009MonitoringReportFinalEn.pdf)

363 OECD Communications Outlook 2009, Table 4.8 (http://dx.doi.org/10.1787/624773722011)

364 Michael Geist, Testimony to The Standing Senate Committee on Transport and Communications. (http://www.parl.gc.ca/40/2/parlbus/commbus/senate/Com-e/tran-e/47244-e.htm?Language=E&Parl=40&Ses=2&comm_id=19)

365 TeleGeography, GlobalComms Database, Country profile, Canada, p. 25,28 of 30.

366 Next Generation Connectivity, p. 81, Table 3.6

367 Telecom Order CRTC 2009-484 — Bell Aliant Regional Communications, Limited Partnership and Bell Canada – Applications to introduce usage-based billing and other changes to Gateway Access Services. (http://www.crtc.gc.ca/eng/archive/2009/2009-484.htm)

Canada is even weaker in 3G wireless service than in fixed broadband. This report shows that Canada is a fifth quintile performer in 3G penetration and a fourth quintile performer in Wi-Fi hotspots, and although growth in 3G subscriptions is strong internally, when measured by new subscriptions per capita, growth is still among the five slowest in the OECD.[368] Mobile operators have recently been attempting to expand current 3G wireless services. Bell Mobility and Telus Mobility are currently working to attain total coverage of 3G wireless services in Canada's major population centers. Rogers Communications, along with Bell and Telus, have turned their attention to laying the foundation for rolling out 4G LTE technology in the next several years.

Market share and key players

Five companies dominate broadband services, as measured by market share: Bell Canada (22.4%), Shaw Communications (17.8%), Rogers Communications (17.7%), Telus Communications (12.1%), and Vidéotron (11.52%). Together they control roughly 81% of the broadband market. However, their services are focused in particular regional markets. Bell Canada, a DSL provider, concentrates mostly in Ontario and Quebec. Ninety-two percent of its broadband subscriber base resides in those two provinces. In these areas, Bell Canada competes mainly with cable providers Rogers and Vidéotron, each of which is focused mostly on southeastern Ontario and Quebec, respectively. Cable provider Shaw Communications competes with Telus Communications in western Canada, specifically British Columbia, Alberta, Sasketchewan, Manitoba, and northwestern Ontario.[369] Despite the presence of 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, no substantial competitor to the five major incumbents has emerged.

Industry players are expanding in different directions. DSL providers Bell Canada and Telus have started to provide fiber-based broadband in their largest markets. Vidéotron, eager to cut into Bell Canada's business in Quebec, has begun to lay infrastructure for a fiber-based broadband service of its own as of 2009. Rogers has branched out from its predominantly cable-based business to gain a slight toehold in the DSL broadband market as of the end of 2008.[370]

In recent years, both the residential and business markets for Internet access seem to have undergone consolidation, with incumbent telecommunication service providers (TSPs) and large cable companies picking up market share at the expense of new entrants and incumbent TSPs operating outside of their traditional geographic regions. In August 2009 the CRTC reported that revenue shares for all Internet access captured by all entrants (including residential and business; dial-up and broadband; and non-incumbents and out-of-territory incumbent TSPs) declined from 23% in 2003 to 12% in 2008.[371] While out-of-territory incumbent TSPs have never had a presence in the residential market for high-speed Internet access and only a small presence in the market for residential dial-up access,[372] their revenue share in the business market for Internet access declined from 13% in 2004 to 10% in 2008.[373] During

368 Next Generation Connectivity p. 49, Figure 3.11
369 TeleGeography, *GlobalComms Database.* Canada Country Overview, p. 22-27 of 30.
370 TeleGeography, *GlobalComms Database.* Canada Country Overview,p. 26 of 30.
371 CRTC Communications Monitoring Report 2009, p. 214 (http://www.crtc.gc.ca/eng/publications/reports/policymonitoring/2009/2009MonitoringReportFinalEn.pdf)
372 CRTC Telecommunications Monitoring Report 2006, p. 59, Table 4.4.7 (http://www.crtc.gc.ca/eng/publications/reports/policymonitoring/2006/tmr2006.pdf); CRTC Communications Monitoring Report 2009, p. 218, Fig. 5.3.1 (http://www.crtc.gc.ca/eng/publications/reports/policymonitoring/2009/2009MonitoringReportFinalEn.pdf)
373 CRTC Telecommunications Monitoring Report 2006, p. 58, Table 4.4.6 (http://www.crtc.gc.ca/eng/publications/reports/policymonitoring/2006/tmr2006.pdf); CRTC Communications

this same time period, the revenue share of non-incumbent TSPs in the business market also declined, from 31% to 24%.[374] The share of residential Internet access subscribers, both dial-up and high speed, captured by all entrants, both non-incumbents and out-of-territory incumbents TSPs, has also declined, from 16% in 2004 to 8% in 2008.[375] The entrants' share of high-speed access (at or above 128kbps) in 2008 was even smaller at 5.5%, though had risen slightly from 4% in 2004.[376] These numbers suggest that as dial-up access phases out, incumbent TSPs and cable companies are gaining ever greater market and subscriber shares, especially in the residential market, over new entrants and incumbent TSPs operating out-of-territory. This consolidation in the residential market has its parallel in the business market, as incumbent TSPs who had ventured out of their traditional areas seem to be retrenching in their own historical territories, while other entrants have lost market share, largely to cable companies.[377]

In wireless, Rogers Communications (36.8%), Bell Mobility (30.0%), and Telus Communications (28.4%) comprise most (95.1%) of the wireless market, with SaskTel Mobility, MTS Allstream, and Bell Aliant controlling the remaining share.[378] Rogers, however, has outpaced the rest of the market on deployment. After adopting the 1xEV-DO Rev A standard initially, Bell Mobility and Telus Mobility have now banded together to jointly develop 3.5G HSPA (high-speed packet access) networks to better compete against Rogers, which has already completed a national 3.5G rollout using the UMTS/HSDPA standard and leads the wireless market.[379]

In order to spur competition in the wireless market, Industry Canada reserved 40Mhz of spectrum for non-incumbents during the most recent Advanced Wireless Services (AWS) auction for spectrum in the 1710-2200MHz range.[380] A large portion of this reserved spectrum was awarded to companies such as Vidéotron, Globalive, a long-distance reseller, and DAVE Wireless, a startup, suggesting that the market for mobile broadband will become more competitive in the future. The three incumbents also purchased additional spectrum during the AWS auction in preparation for rolling out 4G services, once they become feasible. The Federal Cabinet decided in December 2009 that Globalive met Canadian ownership and control requirements and would be allowed to compete in the Canadian wireless market, overturning an earlier CRTC decision.

Monitoring Report 2009, p. 218, Fig. 5.3.1 (http://www.crtc.gc.ca/eng/publications/reports/policymonitoring/2009/2009MonitoringReportFinalEn.pdf)

374 CRTC Communications Monitoring Report 2009, p. 217, Table 5.3.1 (http://www.crtc.gc.ca/eng/publications/reports/policymonitoring/2009/2009MonitoringReportFinalEn.pdf)

375 CRTC Communications Monitoring Report 2009, p. 215 (http://www.crtc.gc.ca/eng/publications/reports/policymonitoring/2009/2009MonitoringReportFinalEn.pdf)

376 CRTC Communications Monitoring Report 2009, p. 219, Table 5.3.2 (http://www.crtc.gc.ca/eng/publications/reports/policymonitoring/2009/2009MonitoringReportFinalEn.pdf)

377 Compare CRTC Report to the Governor in Council: Status of Competition in Canadian Telecommunications Markets 2005, p. 62, Figure 4.4.1 (http://www.crtc.gc.ca/eng/publications/reports/policymonitoring/2005/gic2005.pdf), with CRTC Communications Monitoring Report 2009, p. 218, Figure 5.3.1 (http://www.crtc.gc.ca/eng/publications/reports/policymonitoring/2009/2009MonitoringReportFinalEn.pdf)

378 TeleGeography, *GlobalComms Database.* Canada Country Overview, p.15 of 30.

379 TeleGeography, *GlobalComms Database.* Canada Country Overview, p. 17 of 30. *See also* CRTC Communications Monitoring Report 2009, p. 261 (http://www.crtc.gc.ca/eng/publications/reports/policymonitoring/2009/2009MonitoringReportFinalEn.pdf)

380 Industry Canada, Policy Framework for the Auction for Spectrum Licences for Advaced Wireless Services and other Spectrum in the 2 GHz Range, p. 5. (http://www.ic.gc.ca/eic/site/smt-gst.nsf/vwapj/awspolicy-e.pdf/$FILE/awspolicy-e.pdf)

Regulatory framework

Wireline broadband access is governed by the Telecommunications Act of 1993 (the Act). The Act includes general directives to create a telecommunications system across Canada, and to make telecommunications services affordable, efficient, and responsive to the needs of Canadian citizens.[381]

The Canadian Radio-television Telecommunications Commission (CRTC) exercises the main regulatory control over telecommunications. Under §47 of the Act, the CRTC must implement the Act's policy objectives, some of which are mentioned above.[382] The CRTC must also forebear from regulation where telecommunications services face sufficient competition. Thus far, CRTC has forborne from regulation of retail Internet services and satellite services,[383] though it continues to regulate wholesale Internet access.[384] Note that in the case of retail internet services, the CRTC explicitly retained the right to regulate under §27(2) of the Act, a section which prohibits unjust discrimination in the provision of telecommunications services.[385] However, despite the CRTC's power to regulate in specific areas, it is nevertheless directed to follow the policy direction set forth by Industry Canada, which is responsible for the Telecommunications Act. The CRTC has begun to reduce regulation in some parts of the industry in response to an interpretive order, codifying a recommendation of Industry Canada's Telecommunications Policy Review Panel in 2006, that requires the CRTC to "rely on market forces to the maximum extent feasible" to achieve policy objectives.[386] For example, many wholesale Internet providers are scheduled to be deregulated by the end of 2012, with additional review of the remaining wholesale services in 2013.[387] This is in line with the order's language, which required the CRTC to "determine the extent to which mandated access to wholesale services that are not essential services should be phased out," suggesting that continued regulation might reduce "incentives for innovation and investment in and construction of competing telecommunications network facilities."[388] On the other hand, the CRTC did decide in 2008 to extend the unbundling rules to fiber infrastructure, as non-essential facilities subject to phase-out by 2013.[389] This decision, however, was later overturned by the Federal Cabinet.[390]

In the wireless area, Industry Canada is responsible for managing the use of wireless spectrum in Canada under the Radiocommunications Act of 1985.[391] This includes the auctioning of spectrum licenses for wireless broadband providers. However, Industry Canada recommended in 2006 that, for the sake of transparency and efficiency, the management of spectrum should be transferred to the CRTC, leaving Industry Canada to focus on broad spectrum policy.[392]

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381 Telecommunications Act of 1993, Section 7. (http://laws.justice.gc.ca/en/showdoc/cs/T-3.4//20090901/en?page=1)
382 Telecommunications Act of 1993, Section 47
383 CRTC Communications Monitoring Report 2009, Appendix 2, p. 1 of 2. (http://www.crtc.gc.ca/eng/publications/reports/policymonitoring/2009/2009MonitoringReportFinalEn.pdf)
384 TeleGeography, GlobalComms Database, Country profile, Canada, p. 19 of 30.
385 CRTC Telecom Decision 99-592
386 Order Issuing a Direction to the CRTC on Implementing the Canadian Telecommunications Policy Objectives SOR/2006-355, (http://www.gazette.gc.ca/archives/p2/2006/2006-12-27/html/sor-dors355-eng.html)
387 TeleGeography, GlobalComms Database, Country profile, Canada, p. 20 of 30.
388 Order Issuing a Direction to the CRTC on Implementing the Canadian Telecommunications Policy Objectives SOR/2006-355, §1(c)(ii), (http://www.gazette.gc.ca/archives/p2/2006/2006-12-27/html/sor-dors355-eng.html)
389 CRTC Telecom Decision 2008-117.
390 CBC News, December 11, 2009. "Open Access Rules Take Hits" http://www.cbc.ca/technology/story/2009/12/11/clement-internet-access-bell-telus-mts.html
391 *Radiocommunications Act*, Section 5(a). (http://laws.justice.gc.ca/en/showdoc/cs/R-2//20090901/en?page=1)
392 Telecommunications Policy Review Panel: Final Report 2006., Chapter 5. (http://www.telecomreview.ca/eic/site/tprp-gecrt.nsf/vwapj/report_e.pdf/$FILE/report_e.pdf)

Political economy

The CRTC's regulatory regime over broadband service providers has varied in breadth and intensity over the last two decades. The political economy of the broadband market over this period can be characterized as a struggle between a government seeking to increase competition and dominant broadband providers seeking a reprieve from such policies, which they argue can stifle innovation and investment. With the enactment of the Telecommunications Act of 1993, the CRTC imposed much regulation on providers, including local loop unbundling on incumbent telecommunications carriers. These unbundling rules, however, contained sunset provisions and a price-determination method unusual among OECD countries that resulted in comparatively high rates for local loop access, discussed below. Over the years, and at the urging of Industry Canada, the CRTC has begun to slowly loosen its grip in certain areas of the broadband market. In April 2007, the CRTC declared that it would forebear from regulating telecommunications markets where at least two carriers provide service to 75 percent of residential customers.[393]

Given the two-company structure of most regional broadband markets in Canada, this seems to be a victory for the Canadian markets' main broadband providers. Although it is still unclear whether broadband markets in Canada will be fully deregulated, the December 2009 Federal Cabinet decisions lean strongly in that direction. Following CRTC decision 2008-17, which established a general regulatory framework for wholesale internet services, the CRTC issued decision 2008-117, which mandated that ILECs such as Bell Canada offer ADSL wholesale services at the same speeds as its retail services.[394] This rule was further extended to ILECs' next generation networks (NGNs) in CRTC decision 2009-111.[395] Subsequently, both Bell Canada and Telus appealed this decision to the Federal Cabinet. Bell is arguing, among other things, that mandating wholesale access to NGNs amounts to "forced subsidization" of their competitors, that the CRTC's decision will hinder NGN capital investments by making the business case for such investments less attractive, and that the CRTC's decision disproportional burdens ILECs to the benefit of their cable company competitors because wholesale providers "largely rely on the ILECs for providing their internet service."[396] The Federal Cabinet sides with the incumbents and overturned CRTC's earlier decision.

Wholesale customers of ILECs also appealed some related CRTC decisions to the Federal Cabinet. Following CRTC decision 2008-17, MTS Allstream Inc (MTS), a purchaser of wholesale internet services from ILECs (and also an ILEC itself in some regions) appealed the CRTC's designation of high speed Ethernet services as "non-essential and subject to phase out."[397] The CRTC's 2008-17 decision means that by 2013, Ethernet services will no longer be subject to mandatory unbundling. In its appeal, MTS claimed that Ethernet services were not "practically or feasibly duplicable on a national scale" and so would meet the test for "essential service." The CRTC, however, disagreed and in decision 2008-118, upheld its relevant findings in 2008-17. In a separate appeal before the CRTC, MTS also requested that the CRTC modify its classification of aggregated ADSL services from "conditional mandated non-essential" to "conditional essential."[398] According to MTS, this would decrease the price of wholesale

393 Explaining Broadband Leadership, p. A2 (http://www.itif.org/files/ExplainingBBLeadership.pdf)
394 CRTC Telecom Order 2008-117
395 CRTC Telecom Order 2009-111
396 Petition for Bell Aliant and Bell Canada; Petitions to the Governor in Council concerning Telecom Decisions CRTC 2008-117 and CRTC 2008-118, Telecom Regulatory Policy CRTC 2009-34, and Telecom Order CRTC 2009-111; (http://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf09316.html)
397 CRTC Telecom Order 2008-118
398 CRTC Telecom Order 2009-34

service from "rates that include mark-ups of upwards of 50%" to rates of "cost plus 15%".[399] In order 2009-34, the CRTC again disagreed, and upheld its original (2008-17) decision.

Following the CRTC's two decisions, MTS also filed an appeal before the Federal Cabinet. MTS is argued, among other things, that government regulation is needed to ensure a competitive marketplace for internet services and that such services are essential for spurring innovation in the economy, that if Ethernet regulation is phased out, companies such as MTS will not have an incentive to invest in additional Ethernet-related capital equipment, and that the CRTC incorrectly applied the duplicability test in its "essential" service determination discussed above.[400] The Federal Cabinet again sided with the incumbents and denied MTS's appeal.

Broadband strategy

In 2001, the National Broadband Task Force was created by the Minister of Industry to establish a policy on Canadian broadband services. Its mandate was "to map out a strategy for achieving the Government of Canada's goal of ensuring that broadband services are available to businesses and residents in every Canadian community by 2004."[401] The task force recommended a strategy that had four main components: (1) linking all communities in Canada to scalable high-speed networks; (2) emphasizing affordable broadband links to remote and rural communities; (3) ensuring that local broadband infrastructure linked together local education, health, and library facilities; (4) extending local broadband within a community to encompass business and residential users.[402]

As first steps to fulfilling these priorities, the Canadian government established the Broadband for Rural and Northern Development Pilot program (BRAND) and the National Satellite Initiative (NSI) in 2002 and 2003 respectively. The CAD 155 million NSI program sought to expand satellite capacity in the Far North and Mid North, where communities did not have access to fixed line broadband infrastructure.[403] In a similar vein, BRAND had as its goal the provision of broadband to 900 rural communities across Canada. The program disbursed CAD 105 million for the creation of these broadband services.[404] The overall emphasis of BRAND was to encourage the private sector ownership of broadband services. However, it was limited in its ability to achieve universal broadband access given that communities had to apply to the government, as well as organize a plan of action for broadband provision. Therefore, by 2004, Canada still had not achieved universal access.

In 2006, the Telecommunications Policy Review Panel—a group established by Industry Canada—recommended that the government take a step further to create the Ubiquitous Canadian Access Network (U-CAN) program. Whereas the other programs were limited and targeted specific areas that lacked broadband access, the U-CAN program was designed to cover communities that BRAND did not. Such communities included areas that did not attain broadband connectivity through BRAND or NSI, and

399 Petition for MTS Allstream; Petitions to the Governor in Council concerning Telecom Decisions CRTC 2008-117 and CRTC 2008-118, Telecom Regulatory Policy CRTC 2009-34, and Telecom Order CRTC 2009-111; (http://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf09316.html)

400 Petition for MTS Allstream

401 Telecommunications Service in Canada: An Industry Overview, Section 6. (http://www.ic.gc.ca/eic/site/smt-gst.nsf/vwapj/rt-0303sect6e.pdf/$FILE/rt-0303sect6e.pdf)

402 The new national dream: Networking the nation for broadband access. (Report of the National Broadband Task Force), p. 77 of 109 (ftp://ftp.cordis.europa.eu/pub/ist/docs/ka4/mb_broadbandcanada.pdf)

403 Government of Canada Launches National Satellite Initiative to Provide Broadband Access to Northern and Remote Communities (Press Release) (http://www.ic.gc.ca/eic/site/ic1.nsf/eng/02469.html)

404 Allan Rock and Andy Mitchell Announce $44 Million to Bring Broadband Internet Service to First Nations, Rural and Remote Communities (Press Release) (http://www.ic.gc.ca/eic/site/ic1.nsf/eng/02463.html)

where it was not economical for private actors to provide service. Under the U-CAN program, the Canadian government would provide subsidies to private and public actors to extend existing broadband infrastructure to unserved areas. The goal of this program is to deliver broadband to every community in Canada by 2010.[405]

Policy interventions and outcomes

Government investment in infrastructure

Government investment in infrastructure has occurred on the local, provincial, and federal levels. On the municipal level, many local groups have organized to establish broadband connectivity in their own community. For example, in 2000, Upper Canada Networks (UCNet) was formed as a non-profit corporation to provide broadband to communities across the counties of Leeds and Grenville in eastern Ontario. It was funded by a partial grant from the Ontario government, as well as contributions from local equipment vendors, school boards, and local businesses.[406]

On the provincial level, most provinces tend to pair with either local communities or private operators to provide broadband connectivity. For example, the CAD 193 million Alberta SuperNet has private and public components. The base network is funded by Bell West, while the extended network infrastructure is funded by the province itself.[407]

The federal government has continued to focus most of its efforts on improving rural connectivity. As part of Canada's stimulus plan to stave off recession, the federal government has pledged significant funds to providing broadband services to rural and remote areas. As part of the Conservative government's "Economic Action Plan," CAD 255 million is being pledged over the next three years to provinces and private operators to improve access to underserved communities. As of September 2009, specific plans to disburse the funds have not been announced.[408]

Skill building, education, and demand programs

The Government of Canada has stressed that improvements in educational outcomes are partly a result of broadband availability. A particularly successful example of this was SchoolNet, a partnership formed between Industry Canada designed to link all Canadian public schools and libraries to the Internet. While the site was eventually taken down as broadband became more mainstream, the educational dimension of broadband has been underscored as a driving force for increasing broadband provision. As recently as March 2009, the Government of Canada has justified provision of broadband connectivity to more remote areas as enhancing, among other things, the availability of distance learning through broadband access.[409] As the need for more complex and bandwidth-intense educational media grows, broadband providers will necessarily face demands for faster Internet beyond current generation technologies.

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405 Telecommunications Policy Review Panel: Final Report 2006., Chapter 8-14. (http://www.telecomreview.ca/eic/site/tprp-gecrt.nsf/vwapj/report_e.pdf/$FILE/report_e.pdf)
406 Promoting Broadband: The Case of Canada, p. 28.
407 Promoting Broadband: The Case of Canada, p. 29.
408 Canada's Economic Action Plan: A First Report to Canadians, p. 94 (http://www.plandaction.gc.ca/grfx/docs/ecoplan_e.pdf)
409 Government of Canada to Provide Broadband for 21 B.C. First Nations Communities (news release) (http://www.fntc.info/files/documents/03-%20FNESS%20news%20release%20v8%20_March%202009_%20_4_.pdf)

Competition policy

Since 1993, Canada has barred corporations that are not Canadian-owned and controlled from functioning as telecommunications carriers. There are signs that this restriction may be substantially relaxed soon. The National Broadband Task Force and the Commissioner of Competition in Canada have both openly recommended that "foreign ownership restrictions in the telecommunications market should be eliminated."[410] In May of 2009, CRTC initiated a notice for comments related to the review of this ownership restriction.[411] The recent decision by the CRTC in the Globalive case has also thrust the issue of ownership restrictions into the spotlight. In brief, Globalive, a wireless company, planned to enter the Canadian marketplace and purchased wireless spectrum for this purpose during the 2008 AWS auction. Following the auction, the incumbent wireless operators took the matter to the CRTC, and alleged Globalive did not comply with the Canadian ownership and control requirements under §16 of the Act. The CRTC agreed because, among other things, Globalive was 66% owned by Orascom, an Egyptian firm, who also provided most of Globalive's debt and technical expertise.[412] The Federal Cabinet decided in favor of Globalive, providing a boost for competition in the wireless sector.

The CRTC has enforced local loop unbundling (LLU) since 1997 on facilities classified as "essential."[413] Initially, the rules were to sunset by 2002, the idea being that the limited regulatory window would incentivize competitors to invest in their own facilities without deterring them from entering the market in the first place. As unbundling failed to flourish, however, the CRTC extended the application of the rules indefinitely, while simultaneously minimizing their scope. More than a third of local loop infrastructure that was deemed as "essential" (infrastructure under monopoly control, functioning as a required input for telecommunication services, and that cannot be duplicated in an economic fashion) is scheduled to be deregulated by 2013.[414] Moreover, the CRTC has allowed incumbent providers to set prices for access where competitors using incumbent local loops provide fixed telephony services through their own infrastructure.[415]

The methodology that CRTC uses to determine pricing for access to local loop infrastructure differs from the approach used by regulators in other countries. Instead of relying on long run incremental cost, the CRTC initially adopted a pricing model based on incremental cost plus a 25% markup to allow the incumbents to make a profit on their unbundled loops and thus avoid disincentives to infrastructure investment. In 2002, the markup on pricing was reduced to 15%. Perhaps as a result of this non-standard pricing scheme, Canada has the highest monthly rates for unbundled local loop access among OECD countries.[416] As of September 2008, for example, the monthly price of an unbundled local loop in Canada, excluding prices for remote areas or the most dense downtown areas, in terms of purchasing power parity, 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. Combined with the presence of strong incumbents and sunset provisions on unbundling, it is possible that the investment environment is too expensive and uncertain to promote market entry by non-incumbents.

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410 Submission To The Competition Policy Review Panel, p. 3 of 26 (http://www.itu.int/ituweblogs/treg/content/binary/commissioner_competition_bureau.pdf)

411 CRTC Reconsiders Process for Reviewing Foreign Investment in Telecommunications Carriers (article). (http://www.mccarthy.ca/article_detail.aspx?id=4525)

412 CRTC Telecom Decision 2009-678

413 CRTC Telecom Decision 97-8.

414 CRTC Telecom Decision 2008-17.

415 Explaining Broadband Leadership, p. A2 (http://www.itif.org/files/ExplainingBBLeadership.pdf)

416 OECD (2009) *Communications Outlook 2009*.

With respect to next generation networks (NGNs) such as fiber-based broadband services, many of the major telecommunications providers such as Bell Canada faced the possibility of continued regulation by the CRTC. Telecommunications providers succeeded in convincing the Canadian Federal Cabinet to reverse earlier CRTC decisions and to lift regulation on these next generation networks on the grounds that they will stifle the provision of these services.

Network non-discrimination

Network neutrality has been, and remains, a controversial issue in Canada. Notably, in 2005, Telus blocked access to Voices for Change, a website that supported the Telecommunications Workers' Union. The union, at the time, was in a labor dispute with Telus. In addition, in 2008, the Canadian Association of Internet Providers (CAIP) filed a complaint with the CRTC over Bell Canada's traffic management practices. Bell had instituted data throttling measures from 4:30 PM to 2:00 AM that targeted traffic from peer-to-peer (P2P) applications. Bell's measures were applied identically to both its retail clients and to the wholesale services sold to companies represented by CAIP. CAIP asserted that Bell's measures violated, among other things, the Act's §27(2) provision against unjust discrimination. The CRTC disagreed, citing Bell's need to control network congestion and the absence of other reasonable methods to accomplish this end, as well as the fact that Bell's retail and wholesale customers were equally impacted by the P2P throttling measures.[417]

In October 2009, the CRTC released its net neutrality framework. The framework outlines the process by which users can lodge complaints with the CRTC about an internet provider's traffic management practices (ITMPs). In brief, once a complaint is made against an internet provider, the burden of proof shifts to the provider to demonstrate that the IMTP does not discriminate, or if it does, that it accomplishes a particular need and nothing else, that it results "in discrimination or preference as little as reasonably possible", that any harm caused by IMTP is, "as little as reasonably possible", and that network investment or other economic approaches would not suffice (where a technical IMTP is employed).[418] The policy also provides for disclosure standards to end-users so that they have the information necessary to evaluate a provider's IMTPs. Notably, the framework also provides for standards when IMTPs are applied to a provider's wholesale services. In brief, if a provider implements IMTPs that are "more restrictive" on its wholesale customers than on its own retail customers, prior approval must be sought from the CRTC, who will analyze the request using its IMTP framework.[419] Finally, the framework also mentions that application-specific IMTPs that "degrade or prefer one application, class of application, or protocol over another" may "warrant investigation under subsection 27(2) of the Act".[420] It is unclear, however, how this statement will be interpreted in light of the CRTC's prior P2P throttling decision. The possibility of legislation to support network non-discrimination principles has also been discussed. Members of some political parties have voiced support for network neutrality principles. As of 2009, Member of Parliament Charlie Angus tabled a bill mandating network neutrality practices.[421]

Spectrum policy

Industry Canada designates certain parts of the spectrum for specific usages, and then licenses that spectrum to a designated user. Spectrum licenses can be granted on the basis of administrative review

417 CRTC Telecom Decision 2008-108
418 CRTC Regulatory Policy 2009-657
419 CRTC Regulatory Policy 2009-657
420 CRTC Regulatory Policy 2009-657
421 Bill C-398 (http://www2.parl.gc.ca/content/hoc/Bills/402/Private/C-398/C-398_1/C-398_1.PDF)

by Industry Canada. Since 1996, Industry Canada has also auctioned spectrum.[422] As of 2009, it has conducted around seven large-scale auctions of various frequency bands.[423] To ensure that the spectrum is not completely dominated by a few bidders, Industry Canada imposes a 100 MHz "aggregation limit" on the amount of spectrum that a single licensee can hold. Some new developments in spectrum management could be on the horizon. Industry Canada stated in a recent policy memorandum that it should rely primarily on "market forces," in spectrum management, which may result in a reduction in the amount of license-exempt spectrum for public or free use.[424] The next spectrum auction will involve the 700 MHz band. Although Industry Minister Jim Prentice suggested in July 2008 that the auction would likely occur within eighteen months,[425] a date has not yet been set.

Deregulatory impulses have been tempered in certain situations to promote competition. Licenses awarded during the latest AWS spectrum auction mandated that incumbents make roaming available at commercial rates outside of licensees' territory for at least the ten-year term of the AWS licenses, and within new entrants' licensed service areas for five years, to allow entrants to build out their networks.[426] Coinciding with the AWS auction, Industry Canada promulgated a notice in the Canada Gazette in February 2008 outlining conditions for mandatory facilities sharing that apply to all radiocommunication carrier licensees. The new conditions require that licensees facilitate sharing of antenna towers and sites, where technically feasible, with any other licensed radiocommunication carrier by offering to enter a Site-Sharing Agreement, which includes access to ancillary equipment and services, at a reasonable commercial rate.[427]

Conclusion

Canada opened the decade as an extremely strong performer on broadband. Over the course of the decade, its penetration rates have grown more slowly than those of other countries, its prices have remained high, and its speeds are still low in comparison to other OECD countries. In the area of competition policy, Canada implemented unbundling rules formally in 1997, but its regulated rates were high relative to the rest of the OECD, and it consistently imposed sunsets on all or some category of regulation. As a practical matter, its market has evolved toward a regional market with relatively low investments in other regions by incumbents prominent in one region. Most competition in any given region is between the telephone and cable company that was locally dominant in the past. Government investment has mostly focused on connecting unconnected areas, and not on increasing capacity at the higher end. Canada continues to see itself as a high performer in broadband, as it was early in the decade, but current benchmarks suggest that this is no longer a realistic picture of its comparative performance on several relevant measures.

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422 e-Policy Resources: Spectrum Management Policy (http://www.ceprc.ca/spec_e.html)

423 See left hand menu under "Spectrum Auctions" (http://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/h_sf01714.html)

424 Spectrum Policy Framework for Canada, p. 9 (http://www.ic.gc.ca/eic/site/smt-gst.nsf/vwapj/spf2007e.pdf/$FILE/spf2007e.pdf)

425 Rolfe Winkler, UPDATE 2 – Canada plans another wireless spectrum auction, Reuters, July 22, 2008. (http://www.reuters.com/article/technology-media-telco-SP/idUKN2228839320080722?pageNumber=1&virtualBrandChannel=0)

426 Industry Canada, Policy Framework for the Auction for Spectrum Licences for Advanced Wireless Services and other Spectrum in the 2 GHz Range, p. 8. (http://www.ic.gc.ca/eic/site/smt-gst.nsf/vwapj/awspolicy-e.pdf/$FILE/awspolicy-e.pdf)

427 Industry Canada Notice No. DGRB-002-08, pp. 6-7. (http://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf08890.html)

C. 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.[428]

	Fiber / LAN	Cable	DSL	Other	Overall [429]
Subscriptions per 100 people [430]	3.6	9.9	22.6	1.1	37.2

Penetration Metrics	Rank amongst OECD 30 countries	Speed metrics	Rank amongst OECD 30 countries	Price metrics	Rank amongst OECD 30 countries
Penetration per 100, OECD	1	Maximum advertised speed, OECD	3	Price low speeds, combined	2
Household penetration, OECD	4	Average advertised speed, OECD	8	Price med speeds, combined	4
3G penetration, Telegeography	18	Average speed, Akamai	8	Price high speeds, combined	5
Wi-Fi hotspots per 100000, Jiwire	10	Median download, speedtest.net	8	Price very high speeds, combined	7
		Median upload, speedtest.net	4		
		Median latency, speedtest.net	8		
		90% Download, speedtest.net	6		
		90% Upload, speedtest.net	3		

Note: Details in Part 3
Source: OECD, TeleGeography, Jiwire, Speedtest.net, Akamai, Point Topic
Berkman Center analysis

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

428 OECD Broadband Portal, Table 2a, from EU Community Survey, from 2007.
429 Does not include 3G Wireless. Since subscriptions are shared within a household, this number will never be 100.
430 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.[431] 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,[432] which was the leading technology at that time, while access via xDSL and cable was still rare.[433] In a recent economic report, IT- og Telestyrelsen estimates that the number of broadband subscriptions was a mere 0.5 per 100 inhabitants for the year 2000.[434]

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.[435] In 2002, when broadband subscriptions had risen to 8.3 per 100 inhabitants,[436] 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[437] and there were 826,181 xDSL subscriptions and 364,803 cable subscriptions with capacities of at least 144kbit/s.[438] From January 2001 to January 2005, the cost of household ADSL service decreased by over 45%.[439]

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.[440] At the same time, with only 16,882 subscribers at the end of 2008, WiMAX was not yet a significant alternative option to DSL or cable broadband.[441] There are currently four 3G licenses in use, which together cover a spectrum from 1900 to 1980 Mhz and from 2110 to 2170 Mhz.[442] 4G licenses in the 2.5 GHz band are expected to be auctioned in March 2010.[443]

Market share and key players

Even though the fixed-line market was completely liberalized in 1996,[444] the successor of Denmark's monopoly fixed-line operator was still the dominant player at the end of 2008.[445] In the broadband

431 OECD, Regulatory Reform in Denmark, Regulatory Reform in the Telecommunications Industry, 2000, p.7.
432 Whether ISDN should be considered broadband is certainly debatable.
433 Eirwen Nichols et al., The Status of Broadband Services For Consumers and SMES, A Report to Telestyrelsen, October 2000, p.5.
434 IT- og Telestyrelsen, Economic Key Figures 2008, June 2009, p.12.
435 Sherille Ismail and Irene Wu, Broadband Internet Access in OECD Countries: A Comparative Analysis, October 2003, p. 14.
436 Ibid, p.4.
437 IT- og Telestyrelsen, Economic Key Figures 2008, June 2009, p.12.
438 IT- og Telestyrelsen, Tele Yearbook - 2005, p.26.
439 The Danish Government, IT and Telecommunications Policy Report 2005, March 2005, p.10.
440 TeleGeography, GlobalComms Database, Country profile Denmark, p.16.
441 TeleGeography, GlobalComms Database, Country profile Denmark, p.16.
442 http://en.itst.dk/copy_of_frequencies/licences/3g-licences/
443 http://en.itst.dk/copy_of_frequencies/licences/Auctions-and-calls-for-tenders/2-5-ghz/expected-time-table
444 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.
445 Fixnet Nordic controls a share of 82.1% of all subscriber lines. See: TeleGeography, GlobalComms Database, Country

market, TDC (now Fixnet Nordic) had accumulated 1.16 million broadband subscribers by the end of March 2009.[446] 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 led by independent Dansk Bredband with 18.8% and Energi Midt with 16.5%. Two other providers follow with just above 10% market share.[447] 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 its intention to deploy WiMAX services nationwide by 2010.[448]

The market for 3G connections is led 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.[449] Mobile Nordic (owned by TDC) follows with 30% of the market. Telenor Denmark has 21.6% of the 3G subscriptions and Telia 12.6%.[450]

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.[451] Neither licenses nor registration are required by the regulatory body, 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 at interconnection and LLU prices in the years after liberalization.

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".

profile Denmark, p.3.
446 TeleGeography, GlobalComms Database, Country profile Denmark, p.16.
447 Ibid.
448 Ibid.
449 TeleGeography, GlobalComms Database, Country profile Denmark, p.9.
450 TeleGeography, GlobalComms Database, Country profile Denmark, p.16.
451 A fact that caused existing telcos to call for a stricter regime, see: TeleGeography, GlobalComms Database, Country profile Denmark, p.15.

Broadband strategy

Denmark's broadband development is based on a plan issued by the Danish Government in 2001.[452] The plan laid out the ambitious aim "that Denmark should be the world's leading IT nation."[453] 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."[454]

Believing in the market's ability to provide the infrastructure for digital leadership,[455] the broadband strategy called for the analysis and monitoring of the market and the behavior of the demand side actors, 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."[456]

The strategy by which Denmark seeks to promote broadband access 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.[457] 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."[458]

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.[459] 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."[460] The strategy also suggests that public-private partnerships should be established for the development of new public IT services for the citizens.[461] A couple of regional and municipal initiatives have reached out to the private sector for a rollout of fiber.[462]

Denmark’s broadband strategy has proven to be successful; Denmark leads the OECD in broadband penetration rates.[463] The price for a monthly broadband subscription can be as low as USD 6[464] and the

452 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
453 http://en.vtu.dk/files/publications/2001/from-hardware-to-content-strategy-for-fast-cheap-and-secure/html/inde0002.htm
454 The Danish Government, IT and Telecommunications Policy Report 2009, March 2009, p.6.
455 if demand is high enough
456 http://en.vtu.dk/files/publications/2001/from-hardware-to-content-strategy-for-fast-cheap-and-secure/html/inde0009.htm
457 IT- og Telestyrelsen, Comments on FCC GN Docket No. 09-47, June 2009, p.1.
458 Inmaculada Cava-Ferreruela and Antonio Alabau-Muñoz, Broadband policy assessment: A cross-national empirical analysis, in: Telecommunications Policy 30 (2006) 445–463, p.447.
459 http://en.vtu.dk/files/publications/2001/from-hardware-to-content-strategy-for-fast-cheap-and-secure/html/inde0009.htm
460 Ibid.
461 http://en.vtu.dk/files/publications/2001/from-hardware-to-content-strategy-for-fast-cheap-and-secure/html/inde0010.htm
462 see section: Government investment in infrastructure
463 OECD, Broadband Growth and Policies in OECD Countries 2008, 2008, p.35.
464 OECD, Broadband Growth and Policies in OECD Countries 2008, 2008, p.42.

fastest download speeds offered by the incumbent provider are lower than those found in many other countries.[465] Prices for fast connections, however, are still relatively high.[466]

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,[467] the government remains committed to its policy of not funding any broadband infrastructure[468] but rather supports demand through the promotion of IT use in the public sector, education and research programs.

However, there have been public-private partnerships for broadband deployment on a regional and municipal level. The most notable of these are Djurslands.net and Aarhus Network. The former was established in 2001 and covers 8 municipalities by purchasing fiber optic capacity and extending 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.[469]

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[470] primary and secondary schools as well as universities to a conference and learning environment and later to the internet.[471] 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.[472]

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."[473] 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.[474]

465 OECD, Broadband Growth and Policies in OECD Countries 2008, 2008, p.44.
466 OECD, Broadband Growth and Policies in OECD Countries 2008, 2008, p.43
467 The Danish Government, IT and Telecommunications Policy Report 2009, March 2009, p.8.
468 IT- og Telestyrelsen, Comments on FCC GN Docket No. 09-47,June 2009, p.1.
469 IT- og Telestyrelsen, Mapping of Broadband Access Services in Denmark- Status by mid-2004, English summary, December 2004, p.10 et sq.
470 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
471 http://en.vtu.dk/files/publications/2001/from-hardware-to-content-strategy-for-fast-cheap-and-secure/html/inde0007.htm
472 Ibid.
473 The Danish Government, IT and Telecommunications Policy Report 2006, March 2006, p.10.
474 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."[475]

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.[476] 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.[477]

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."[478] In 2009, 50% of basic public services for citizens were available online in Denmark and 86% for enterprises."[479]

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.[480]

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."[481] 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.

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475 The Ministry of Science, Technology and Innovation, IT for All - IT and Telecommunications Policy and Action Plan 2002.
476 The Danish Government, IT and Telecommunications Policy Report 2008, March 2008, p.13.
477 The Danish Government, IT and Telecommunications Policy Report 2008, March 2008, p.9.
478 The Danish Government, IT and Telecommunications Policy Report 2005, March 2005, p.5.
479 European Commission, Europe's Digital Competitiveness Report, Country Profiles 2009, August 2009, p.18.
480 See: The Ministry of Science, Technology and Innovation, Green IT Guidelines for public authorities, December 2008.
481 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.[482]

Prices for local loop unbundling "are set by Telestyrelsen in cooperation with industry players and are based on long run average incremental costs."[483] 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.[484] 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.[485]

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."[486] 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."[487]

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.[488] 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.[489] The new act will also implement technology neutrality in the use of frequencies and provisions that ban hoarding and anti-competitive behavior.[490]

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482 The Danish Government, IT and Telecommunications Policy Report 2009, March 2009, p.9.
483 TeleGeography, GlobalComms Database, Country profile Denmark, p. 16.
484 The Danish Government, IT and Telecommunications Policy Report 2008, March 2008, p.8.
485 http://europa.eu/rapid/pressReleasesAction.do?reference=IP/09/394&format=HTML&aged=0&language=EN&guiLanguage=nl
486 The Danish Government, IT and Telecommunications Policy Report 2009, March 2009, p.10.
487 The Danish Government, IT and Telecommunications Policy Report 2009, March 2009, p.9.
488 http://en.itst.dk/copy_of_frequencies/frequency-legislation/executive-orders-under-the-frequency-act/the-spectrum-policy-framework-mandate
489 The Danish Government, IT and Telecommunications Policy Report 2009, March 2009, p.10.
490 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.[491]

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

D. 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.[492]

Penetration Metrics	Rank amongst OECD 30 countries	Speed metrics	Rank amongst OECD 30 countries	Price metrics	Rank amongst OECD 30 countries
Penetration per 100, OECD	13	Maximum advertised speed, OECD	3	Price low speeds, combined	11
Household penetration, OECD	18	Average advertised speed, OECD	3	Price med speeds, combined	3
3G penetration, Telegeography	14	Average speed, Akamai	19	Price high speeds, combined	6
Wi-Fi hotspots per 100000, Jiwire	4	Median download, speedtest.net	9	Price very high speeds, combined	5
		Median upload, speedtest.net	6		
		Median latency, speedtest.net	24		
		90% Download, speedtest.net	4		
		90% Upload, speedtest.net	13		

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

Note: Details in Part 3
Source: OECD, TeleGeography, Jiwire, Speedtest.net, Akamai, Point Topic
Berkman Center analysis

492 OECD Broadband Portal, Table 2a, from EU Community Survey, from 2007.

	Fiber / LAN	Cable	DSL	Other	Overall
Subscriptions per 100 people [493]	0.1	1.4	26.6	0.0	28.0[494]

Broadband development to date

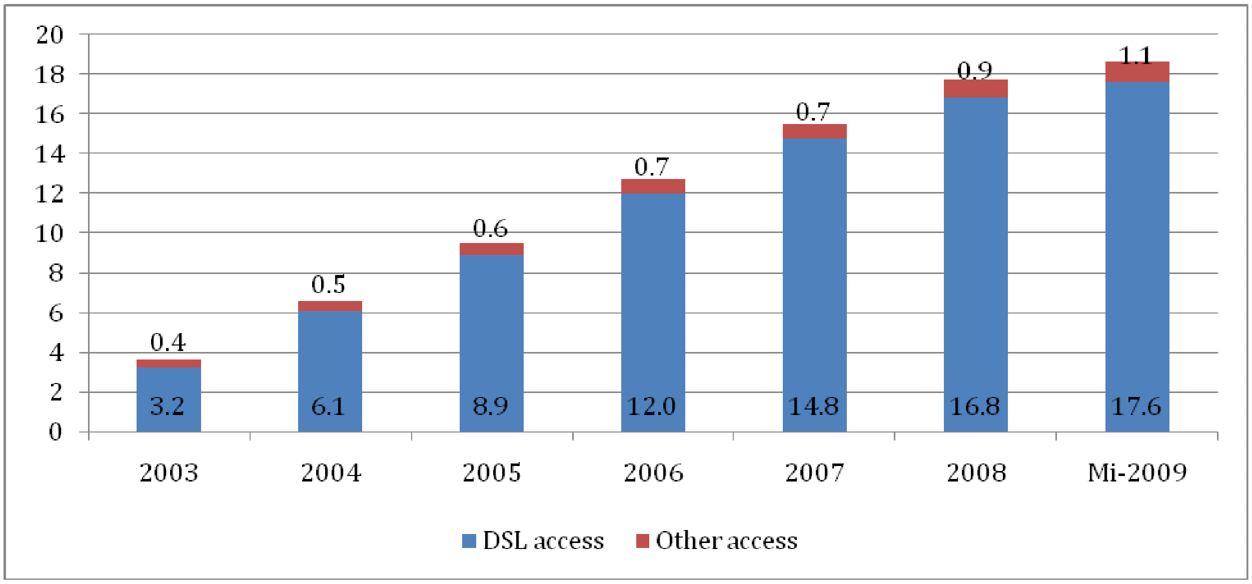
Compared to its European neighbors, France was slow to adopt widespread broadband Internet. In 2001, penetration rates in France stood at about one-third of the overall average for OECD countries.[495] However, following an overhaul of the regulatory regime, broadband penetration rates in France have improved substantially over the past six years. Broadband penetration rates in France are 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. Nomadic broadband is offered as a complementary service by DSL operators and has emerged as a result of the convergence between fixed, nomadic, 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, as well as integrating its nomadic service with its cellular service.

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%).[496]

493 OECD Broadband Portal, Table 1d, supplied by the French government, as of 2008.
494 This number does not include 3G Wireless. Since subscriptions are shared in a household, it will always be below 100.
495 OECD, G7 historical penetration rates. http://www.oecd.org/dataoecd/22/14/39574797.xls.
496 http://europa.eu/rapid/pressReleasesAction.do?reference=IP/09/343&format=HTML&aged=0&language=EN&guiLanguage=en

Figure 1: Broadband subscriptions in France (2003-2009, in millions)



Source: ARCEP

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 by the end of 2012.[497] 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.

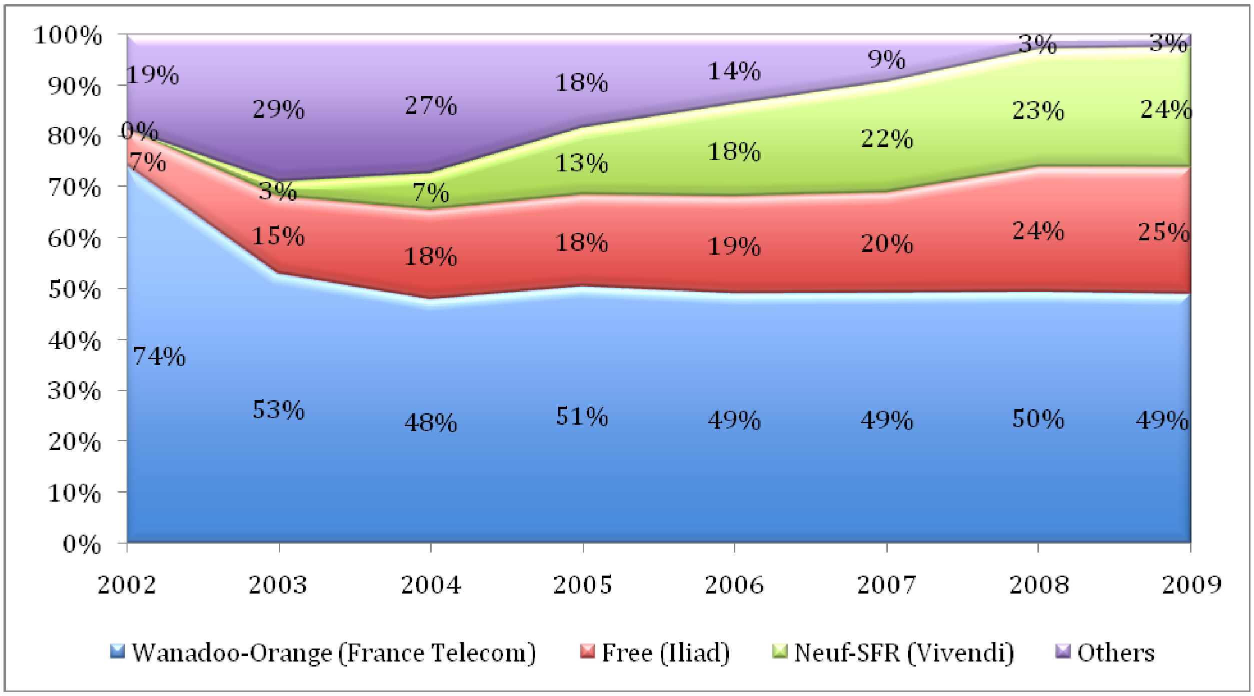
Actual investments in fiber roll-out have been somewhat delayed. In part, this may be due to the public controversy regarding access to the infrastructure of France Telecom. In part, it may be due to demand for high speed services still being fulfilled by the relatively high speeds and low costs of DSL in France. The delayed investment is also consistent with the argument that requiring open access to incumbent facilities delays investment. However these factors interact, fiber-to-the-home has not developed as fast as initially expected in France. By December 2008, only 550,000 households had access to fiber connections in their building,[498] and the number of subscribers remains very low: among 170,000 of all the very high-speed connections, only 40,000 were through fiber.[499]

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 2).

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

Figure 2: Market share of DSL operators in France (2002-2009)



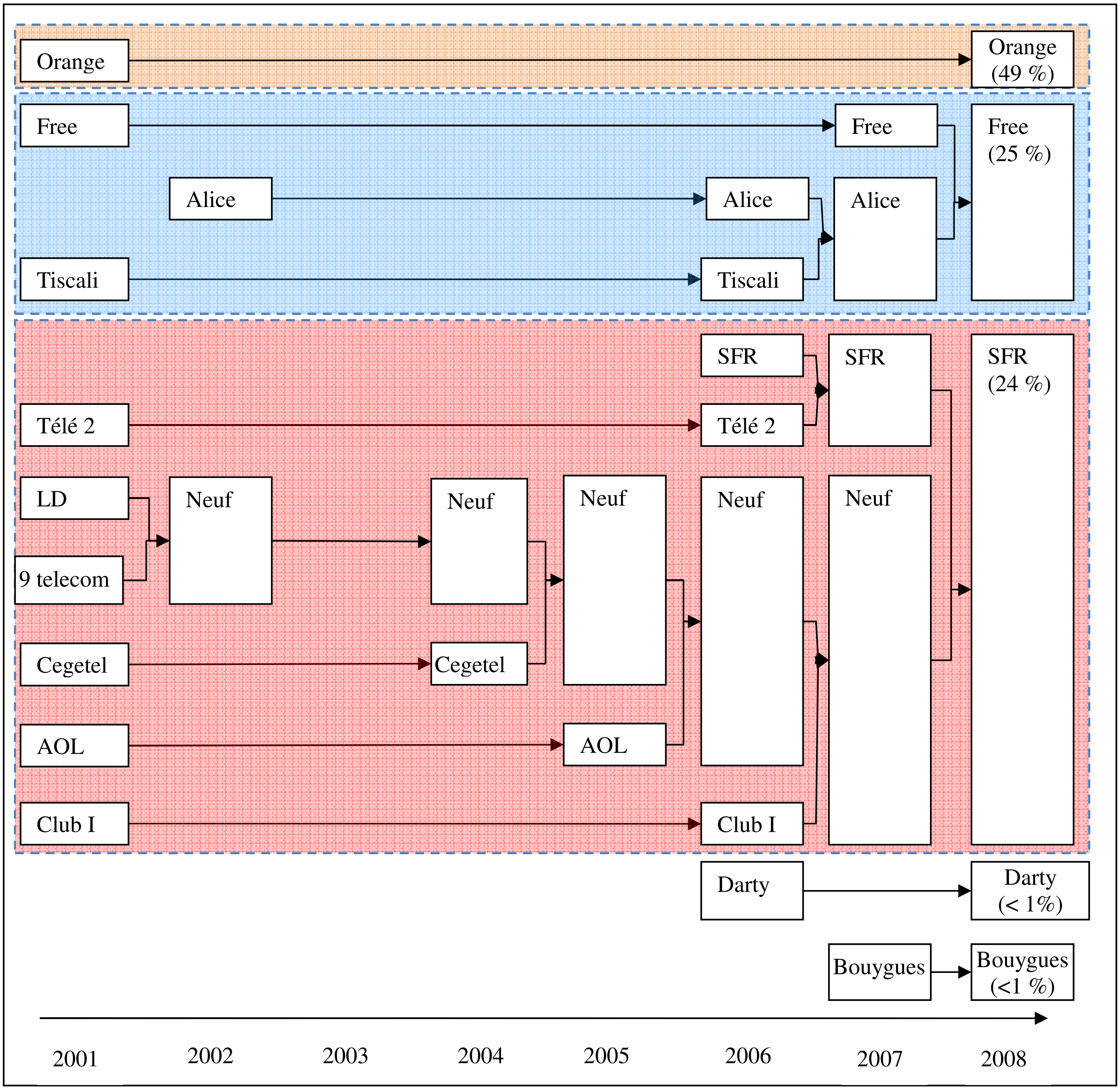
Source: Financial company communication, press releases (collected by Microeconomix)

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 3) 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.

Figure 3: 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.[500] This price has become the reference point for the French broadband market,

500 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.[501]

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.[502] 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.[503] 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 loops and 6th for shared access.[504]

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

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501 Iliad has increasingly relied on 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.

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

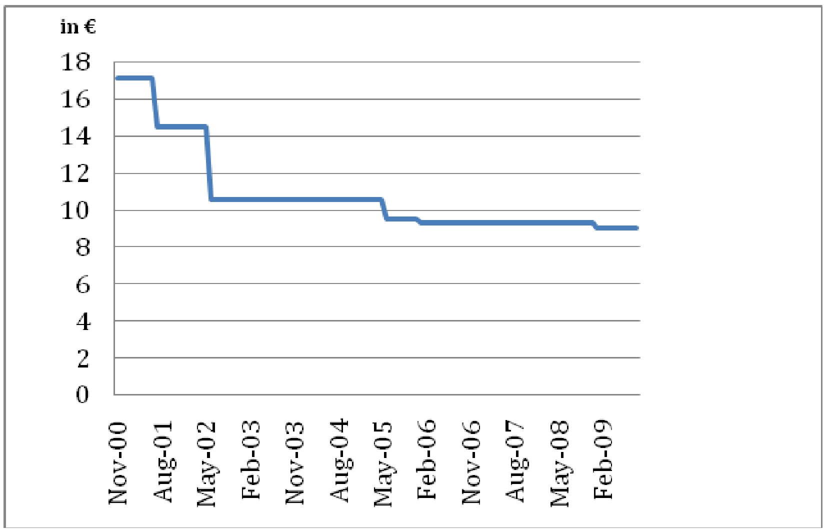
503 European Commission, Press Release nr IP/02/445, March 20, 2002.

504 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.[505] 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.[506]

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.[507] In 2005, ARCEP launched a consultation process for setting tariffs 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.

Figure 4: 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. 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.

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

506 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.

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

Broadband strategy

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.[508]

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 non-urban broadband penetration rates.

Public investments in services must conform to 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.[509] 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 by leasing unbundled local loops and installing DSLAM.[510] Of the 102 projects launched so far, 85 cover more than 60.000 inhabitants.[511]

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

509 This act improves the prevention and enforcement system on the Internet.

510 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.

511 French Government, « Plan de développement de l’économie numérique, France Numérique 2012 », October 2008.

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").[512] 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.[513] 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 in 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 the 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,[514] discriminatory conditions in access to the local loop,[515] and smear campaigns against the alternative operator.[516] 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.

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512 Available online at : http://www.legifrance.gouv.fr/affichCodeArticle.do?cidTexte=LEGITEXT000006070633&idArticle=LEGIARTI000006389450&dateTexte=20080222

513 Les Echos, September 11, 2009.

514 Decision by the EU Commission of 16 July 2003, imposing a €10M fine on FT.

515 Decision 05-D-59 (Conseil de la concurrence 7 November 2005), imposing a €80M fine on FT.

516 Decision 07-D-33 (Conseil de la concurrence 15 October 2007), imposing a €45M fine on FT.

The competitive analysis of mergers has been especially relevant in two recent cases: SFR-Télé 2[517] and SFR-Neuf.[518] 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.[519] Only Bouygues Telecom applied for a license and was awarded a concession in September 2002.[520]

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. Iliad 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.

517 http://ec.europa.eu/competition/mergers/cases/decisions/m4504_20070718_20600_en.pdf
518 http://www.dgccrf.bercy.gouv.fr/boccrf/2008/08_04bis/c2007_181_sfr_9cegetel.pdf
519 OECD Regulatory Reform in France: Regulatory Reform in the Telecommunications Sector (2003).
520 TeleGeography, GlobalComms Database, DT Company Overview (updated March 2009).

E. Germany

Introduction

Germany was an early leader in liberalizing telecommunications markets, and was the first European country to implement local loop unbundling. However, it struggled for years to fully implement these policies. The national regulatory agency has faced pressures from the incumbent Deutsche Telekom (DT), on the one hand, and ongoing pressure from the European Commission to more effectively implement its policies, on the other. Germany's broadband market is dominated by DSL. Cable, while widely deployed, did not develop as a significant competitor until quite recently. DT owned most of Germany's cable television infrastructure at the inception of broadband. Subsequent owners of cable infrastructure have upgraded the networks with the intent to provide VDSL-competitive speeds in 2010, but their small overall share of the market is further fragmented by regulatory prohibition of mergers. Four different wireless operators compete in the 3G market. A much-anticipated auction of the so-called "digital dividend" frequencies, freed up by the digital television transition, is slated for 2010.

Market Highlights

Overall, 49.6% of households in Germany have broadband access.[521]

	Fiber / LAN	Cable	DSL	Other	Overall [522]
Subscriptions per 100 people [523]	0.0	1.9	25.4	0.0	27.4

Penetration Metrics	Rank amongst OECD 30 countries	Speed metrics	Rank amongst OECD 30 countries	Price metrics	Rank amongst OECD 30 countries
Penetration per 100, OECD	14	Maximum advertised speed, OECD	9	Price low speeds, combined	15
Household penetration, OECD	16	Average advertised speed, OECD	6	Price med speeds, combined	13
3G penetration, Telegeography	13	Average speed, Akamai	15	Price high speeds, combined	11
Wi-Fi hotspots per 100000, Jiwire	14	Median download, speedtest.net	6	Price very high speeds, combined	9
		Median upload, speedtest.net	10		
		Median latency, speedtest.net	14		
		90% Download, speedtest.net	7		
		90% Upload, speedtest.net	16		

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

Note: Details in Part 3
Source: OECD, TeleGeography, Jiwire, Speedtest.net, Akamai, Point Topic
Berkman Center analysis

521 OECD Broadband Portal, Table 2a, from EU Community Survey, from 2007.
522 Does not include 3G Wireless. Since subscriptions are shared within a household, this number will never be 100.
523 OECD Broadband Portal, Table 1d, supplied by the German government, as of 2008.

Broadband development to date

Germany is Europe's largest broadband market by raw numbers, but its penetration per household and per 100 inhabitants lags behind most of its neighbors. The state of broadband in the country is best understood in the context of the gradual privatization of DT. After privatization in 1995, DT retained an unusually high market share. In 2001, it still had 97% of the broadband market, and as recently as 2004 DT still served 88% of the market.[524] At that point, the German government still owned 40% of the shares. DT's primary mode of lowering their retail market share between 2004 and 2006 was resale through one selected competitor, United. That arrangement was found to be on anticompetitive terms vis-à-vis other, smaller competitors by the German regulator, BnetzA, which forced DT to offer all its resellers identical (higher priced) terms. While cable is widely deployed in Germany, it was initially owned by DT, which did not use it to serve broadband. After DT divestment from cable, various limitations on coverage and size kept cable market share of broadband low. Cable is now growing rapidly, but still accounts for less than 10% of the German broadband market. Two providers, KabelBW and KDG, are in the process of rolling out DOCSIS 3.0 that will allow download speeds on the order of 100 Mbit/s.[525]

Fiber-to-the-Home (FTTH) has developed slowly in Germany. The two leading regional projects, M-Net and NetCologne, continue to serve a small portion of the market. Their approach of bringing fiber all the way to the home differs from DT's, which is based on fiber-to-the-node. However, DT has recently partnered with M-Net in order to support its VDSL service via a shared fiber network.[526] FTTH in Germany is in very early stages.[527]

3G services emerged in Germany after the country held spectrum auctions in 2000. Although six licenses were initially awarded, only four players (E-Plus, T-Mobile, Telefonica O2, and Vodafone) were ultimately able to achieve viability. Each has rolled out its service using the higher-speed HSDPA standard. They all appear poised to migrate to 4G LTE services and are expected to be active in the upcoming "digital dividend" spectrum auction. WiMax has been deployed in some rural areas where wireline service is less practical but is typically offered at significantly higher monthly subscription fees than comparable wired service.[528]

Market share and key players

Germany is primarily a DSL country. DT owns the last-mile copper infrastructure as a result of its former-monopoly status. The German government still owns a portion of DT. Despite nominal unbundling in 1998, the company managed to maintain the vast majority of retail customers, 97% in 2001 and 88% as late as 2004. Its reduction of market share between 2004 and 2006 was largely through a resale arrangement which was later ruled discriminatory by Germany's reconstituted regulatory authority, BnetzA. In 2006, after the regulatory reorganization, unbundling and wholesale mandates were implemented more effectively. Currently, the same arguments that intially raged around unbundling of copper now extend to unbundling of fiber-to-the-node and VDSL facilities. DT now serves 47% of the broadband market.

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524 Bullingen, F. (2006). Development of the Broadband Market in Germany. M. Fransman (ed.), Global Broadband Battles, Stanford University Press: 195-218.

525 http://www.kabelbw.de/kabelbw/cms/InternetUndTelefon/CleverKabel_100/ http://www.telegeography.com/cu/article.php?article_id=30302

526 http://www.telegeography.com/cu/article.php?article_id=27625

527 http://www.heise.de/tr/artikel/Im-Kriechgang-in-die-Glasfaser-Zukunft-813748.html

528 See, eg: http://www.televersa.com/

DT has sought to define the VDSL market as distinct from the existing DSL market. While it resists regulatory mandates, DT has recently sought out cooperative arrangements with competitors.[529] It remains to be seen whether the regulator will perceive this as genuine cooperation that leads to infrastructure sharing without regulatory mandates, whether the rates are seen as reasonable, and whether such a distinction can be maintained despite EC skepticism.

United Internet is the leading alternative DSL provider in Germany, with a total customer base of 3.5 million after its May 2009 acquisition of Freenet's DSL assets, making up just over 14% of the market.[530] Arcor/Vodafone trails by just a few hundred thousand subscribers, with just under 14% of the market. United's business consists of reselling capacity, not only of DT but also of Arcor/Vodafone. Arcor/Vodafone itself combines its own extensive infrastructure with unbundled copper loops from DT. HanseNet, which is owned by Telecom Italia, maintains about 2.3 million lines. Telefonica of Spain owns the fifth largest provider, O2. A variety of other companies make use of unbundling or wholesale access to offer retail DSL.[531]

Cable subscribership has grown in recent years, but still sits below 10% of the overall wireline market. This is largely a result of the legacy user base of DSL. It is possible that the rollout of DOCSIS 3.0 will help cable to continue to increase market share. The cable market is somewhat fragmented with different operators at different layers of the network. In some cases, competition concerns have prevented merger of cable firms. Various pieces of different firms have been consolidated and broken up in recent years.

T-Mobile Germany (DT) leads the 3G wireless market with 9 million subscribers—37% of the market. Vodafone is a close second with 34% of the wireless broadband market. E-Plus Mobilfunk and Telefonica O2 hold 16% and 13%, respectively.[532]

Regulatory framework and political economy

Germany's national regulatory agency for telecommunications is the Bundesnetzagentur (BnetzA). The communications sector's previous regulator, the Regulatory Authority for Telecommunications and Post (RegTP), was merged with the BnetzA in 2005. Germany's overall broadband market is governed by the Telecommunications Act (Telekommunikationsgesetz, or TKG), which was revised in 2004 to bring it in line with the European Union's legislative framework for telecommunications. Under the Act, the BnetzA can impose obligations on companies with "significant market power" in individual markets regarding the services they offer in those markets.[533]

The German government's history of effectively implementing its regulatory goals has been checkered. For instance, various hiccups and delay tactics in the unbundling process allowed DT to continue to exercise control over potential competitors for many years. In 2004, the OECD observed, "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.,

529 http://www.telegeography.com/cu/article.php?article_id=29206
530 http://www.telecompaper.com/news/article.aspx?cid=673378
531 TeleGeography GlobalComms Database, March 2009.
532 TeleGeography GlobalComms Database, March 2009.
533 Deutsche Telekom Annual Report 2008.
<http://www.annualreport2008.telekom.de/en/konzernlagebericht/wirtschaftliches-umfeld/index.php?page=63>

DTAG has virtually precluded competition and retained or even recently established a dominant position such as in broadband services."[534]

With the reorganization of BnetzA, the regulator appears to be able to enforce its goals more effectively. Unbundling increased significantly after 2006, and pricing for resellers was made nondiscriminatory, after the agency challenged DT special deals with United.

Much of the regulatory action has now shifted to the next generation, which in Germany is still very much focused on VDSL networks. In 2006, just as BnetzA imposed a more effective unbundling regime on DT, the German legislator passed a regulatory holiday for DT with regard to VDSL investments. The European Commission brought action against this law, arguing that it amounted to giving the national monopolist a head start against competitors. In December 2009, the European Court of Justice invalidated the law as restrictive of competition. BnetzA responded with new access rules that apparently require access to ducts for competitors to run their own fiber and access to some dark fiber. It also requires DT to install DSLAMs in its VDSL network points. As of this writing, it is too soon to tell how effective these new rules will be. As the case of regulatory holidays suggests, the European Commission plays an important role in Germany's regulatory framework, as BnetzA and the legislature seem to be susceptible to pressure from DT prompting greater intervention from Brussels than appears to be the case for Ofcom in the UK or ARCEP in France.

Broadband strategy

The German government published a high-level broadband strategy in February of 2009 that sets a goal of nationwide broadband access to every home in the country by the end of 2010. It also aims at transmission rates of at least 50Mbit/s by 2014 for 75% of German households.[535] The plan envisions cooperation with federal states (Länder), local authorities and industry to boost broadband development in Germany.[536] The effort builds on the government's practice of forming commissions to analyze broadband conditions and policy. In 1999, the D21 broadband initiative was launched, aiming to "support and promote the development of the information society by bringing together national governmental bodies and industry to study broadband strategy, conduct workshops, and prepare policy documents."[537] The government had identified broadband as central to fostering the "Information Society," producing reports in 2003 and 2005, and setting a goal of reaching 50% residential adoption by 2010.[538]

The February 2009 broadband plan includes a four-pillar strategy:

1. Capitalize on synergies from infrastructure projects: Public and private infrastructure providers have to become more open to collaboration in the near future. If they were to allow third-party access to their own systems, costs could be reduced significantly and there would be a win-win situation for business as well as for the economy as a whole.

2. Establish supportive spectrum policies: These policies aim in particular on making optimum use of the frequency band of 790 to 862 MHz, made available in the digital television transition. This dividend should be used to close broadband gaps, especially in rural areas.

534 OECD, Regulatory Reform in Telecommunications in Germany, June 7, 2004. <http://www.oecd.org/dataoecd/46/19/32408088.pdf>
535 Federal Ministry of Economics and Technology. (2009) The Federal Government's Broadband Strategy. p. 5.
536 Federal Ministry of Economics and Technology. (2009) The Federal Government's Broadband Strategy. p. 5/6.
537 Atkinson, Robert; Correa, Daniel & Hedlund, Julie (2008). Explaining International Broadband Leadership. p 21.
538 Ibid.

3. Financial aid: There is often poor immediate broadband uptake in rural areas without government support. Therefore, the government will provide incentives in these areas through support programs to enable internet access in households that do not yet have broadband access.

4. Regulation geared to growth and innovation: Regulation is seen as having promoted competition in the telecommunications market and fostering investment and growth. There will be no significant change in the national legal framework in the near future.[539]

The plan goes on to describe 15 actions:

1. Optimize shared use of existing infrastructure and facilities
2. Compile an infrastructure atlas
3. Compile a database of construction sites
4. Needs-based collaboration on installing ducting and joint creation of infrastructure
5. Improve broadband uptake in the home
6. Rapidly reaping the benefits of the digital dividend
7. Improved conditions of funding in the joint tasks
8. Additional finance for the expansion of infrastructure
9. Improved planning certainty for companies
10. Define the main features of regulation geared to growth and innovation
11. Requirements related to incentives and investment stimulus in the EU regulatory framework
12. Active and participatory public relations
13. Set up a broadband center of excellence
14. Set up a Government-Federal States taskforce
15. Draft an annual monitoring report[540]

These actions warrant significantly more definition. The government took the first steps in doing so in a series of "eckpunkte" (or "cornerstones") released in May of 2009.[541] These cornerstones themselves warrant further definition, but generally echo the principles in the initial plan. They include support for infrastructure sharing, a commitment to regulatory certainty, encouragement of universal service, targeted subsidies, an "infrastructure atlas", and more.

539 Federal Ministry of Economics and Technology. The Federal Government's Broadband Strategy. 2009, p. 10 f & www.i-policy.org/2009/02/german-government-introduces-national-broadband-strategy-pledges-to-auction-digital-dividend-.html & www.zukunft-breitband.de/BBA/Navigation/breitbandstrategie.html.

540 Federal Ministry of Economics and Technology. (2009) The Federal Government's Broadband Strategy. p. 10 f.

541 http://www.bundesnetzagentur.de/media/archive/16268.pdf

Policy interventions and outcomes

Government investment in infrastructure

The German government has made a series of investments in infrastructure in recent years.

Date	EC Decision	Budget (in millions)
10/23/07	N 570 / 2007	~ € 6
7/2/08	N 115 / 2008	€ 141
11/5/08	N 150 / 2008	€ 8
11/5/08	N 237 / 2008	€ 16
11/5/08	N 266 / 2008	€ 20
2/23/09	N 238 / 2008	€ 60
8/14/09	N 243 / 2009	€ 80
		Total: € 332

For instance, in 2008 it announced plans for EUR141 million to "support investments necessary to ensure access to broadband services in rural and remote areas of Germany where there are currently no or insufficient broadband services available and where there are no plans for coverage in the near future ("white areas")."[542] At least 40% of the funds will come from municipalities, with the remaining amount coming from state (Länder), federal, or EU funds. The EC approved the plan in 2008.[543] It requires that each municipality carries out a market analysis, noting that, "aid may only be granted if, after such a consultation, there is no sufficient broadband offer provided by the market or expected to be provided in the near future."

Competition policy

All telecommunications companies deemed to have "significant market power" (SMP) are subject to rate regulation.[544] Furthermore, SMP providers are now obliged to offer line access and interconnection agreements if these remedies are essential for a competitive market. Germany's "simultaneity rule" bars SMP providers from offering new services unless their competitors also have the opportunity to offer a similar service.[545]

In 1998, Germany became the first of the European countries to introduce local loop unbundling to foster intramodal competition. But since that time, German regulators have struggled to ensure that DT offers competitive LLU fees such that DT still served close to 90% of the market in 2004. Since 2006, however, unbundling-based access increased significantly, although the following years saw continuous skirmishing. BnetzA cut DT's access charges by 1.3% in 2007; Vodafone and O2 complained of delays in access provisioning in 2007, followed by a BnetzA complaint that was withdrawn after DT cleared the long queues in 2008; and most recently, in April 2009, the regulator rejected DT's proposal to raise LLU fees, and instead cut rates again by 2.9%. Despite, or perhaps through, this process, Germany now appears to have catalyzed extensive unbundling- and wholesale-based competition through the effective enforcement of unbundling and wholesale mandates. The debate now has shifted, in large measure,

542 http://ec.europa.eu/comm/competition/state_aid/register/ii/doc/N115-2008-WLWL-en-02%2007%202008.pdf
543 http://europa.eu/rapid/pressReleasesAction.do?reference=IP/08/1096
544 TeleGeography GlobalComms Database, March 2009, p. 3.
545 Ibid.

from unbundling of copper to unbundling of fiber-to-the-node VDSL facilities. Past experience suggests that the debate will not end with the most recent decision by the European Court of Justice that invalidates the regulatory holiday that the German legilsator provided DT in late 2006 as a way of allowing it to recover its investments in VDSL plant.

Perhaps in anticipation of the European ruling or perhaps in response to announcements by Vodafone of plans to invest in its own bypass VDSL network, DT had reached voluntary agreements with both Vodafone/Arcor and United to provide access to its VDSL network before the recent ECJ decision. Moreover, DT has announced small scale experiments in a cooperative investment strategy for deploying FTTH in which it will invest in its service area and exchange facilities with competitors who invest in FTTH in their respective service regions.

Spectrum policy

In Germany, operators using wireless spectrum need to be assigned frequency by the regulatory authority. The national radio frequency spectrum allocation table (Frequenznutzungsplan, or FreqNP) dictates which frequencies are given to which purposes. In August 2000, the BnetzA auctioned six UMTS licenses to T-Mobile, Vodafone, E-Plus, O2, Group 3G and freenet. The two latter companies later returned the licenses to the regulatory body.[546] In 2005, the Ministry of Defense freed up E-GSM frequencies that were consequently awarded to O2 and E-Plus.[547]

In 2010 Germany plans to auction the largest amount of spectrum since the original UMTS auctions a decade ago. It appears that the terms of the auctions contemplate the emergence of only three winners. This has raised concerns that Germany's upcoming spectrum auction would put the smaller carriers at a disadvantage relative to T-Mobile and Vodafone, the country's largest mobile carriers, which already have significant holdings in the 900MHz channel. The concern raised by the smaller carriers is that if either Telefonica's O2 or KPN's E-Plus does not gain substantial new holdings in the lower frequency bands, that company will be put at a substantial competitive disadvantage in the future mobile market. It is unclear why this threat would not be reflected in higher bids from these two companies, but this remains to be seen in the upcoming auction.

546 TeleGeography GlobalComms Database, March 2009.
547 TeleGeography GlobalComms Database, March 2009.

F. 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. Fiber deployment was driven by competition between NTT and cable and power companies. 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.[548]

Penetration Metrics	Rank amongst OECD 30 countries	Speed metrics	Rank amongst OECD 30 countries	Price metrics	Rank amongst OECD 30 countries
Penetration per 100, OECD	17	Maximum advertised speed, OECD	1	Price low speeds, combined	5
Household penetration, OECD	14	Average advertised speed, OECD	1	Price med speeds, combined	1
3G penetration, Telegeography	1	Average speed, Akamai	2	Price high speeds, combined	1
Wi-Fi hotspots per 100000, Jiwire	29	Median download, speedtest.net	4	Price very high speeds, combined	1
		Median upload, speedtest.net	1		
		Median latency, speedtest.net	17		
		90% Download, speedtest.net	3		
		90% Upload, speedtest.net	1		

Note: Details in Part 3
Source: OECD, TeleGeography, Jiwire, Speedtest.net, Akamai, Point Topic
Berkman Center analysis

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

	Fiber / LAN	Cable	DSL	Other	Overall[549]
Subscriptions per 100 people [550]	11.3	3.2	9.1	0	23.6

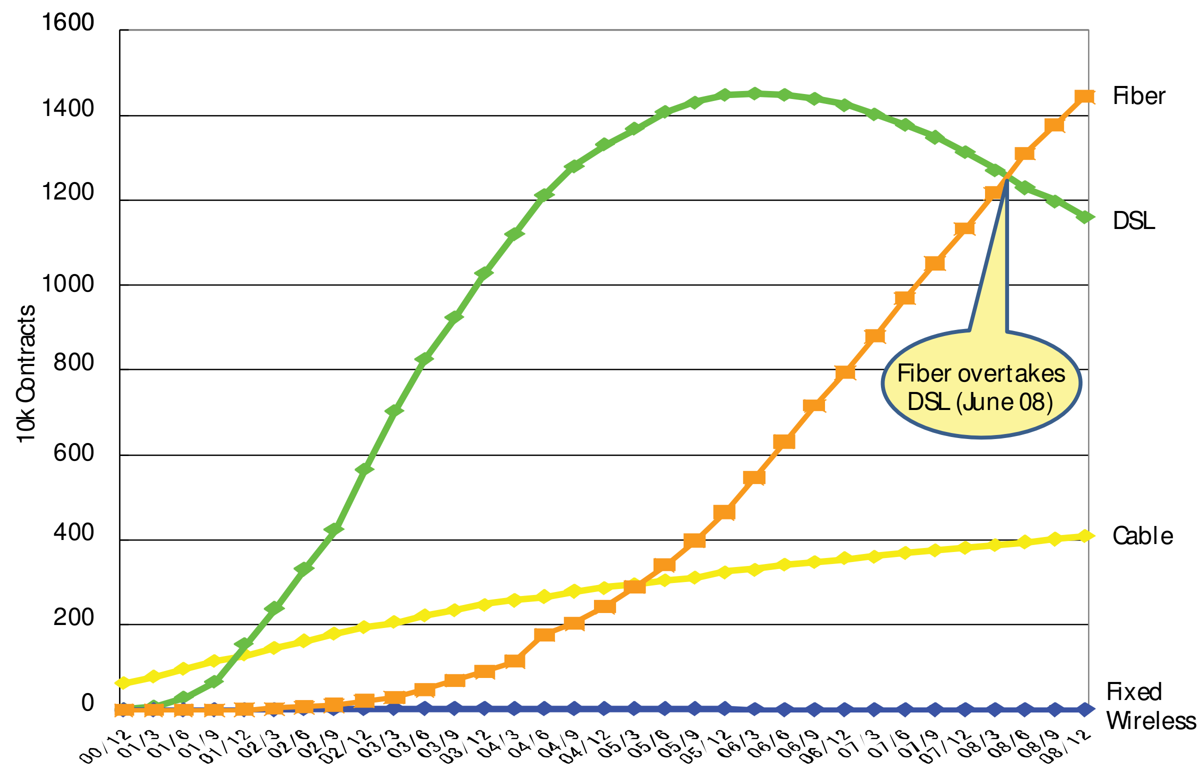
548 OECD Broadband Portal, Table 1e, from EC Community Survey, as of 2007.
549 Does not include 3G Wireless. Since subscriptions are shared within a household, this number will never be 100.
550 OECD Broadband Portal, Table 1d, data supplied by Japanese Government, as of 2008.

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 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 had up to that point 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.[551]

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.[552] 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.

Figure 1: Market Share by Technology



Source: Japan MIC

551 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.
552 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 over NTT's Flet's Hikari service is beginning to grow), followed by eAccess (DSL). The remaining competitors include a variety 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.[553]

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.[554] 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.[555] 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.[556] 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 modify 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.[557] 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.

553 TeleGeography, GlobalComms Database, Country profile, Japan, updated March 2009.
554 TeleGeography, GlobalComms Database, Country profile, Japan, updated March 2009.
555 http://www.emobile.jp/cgi-bin/press.cgi?id=671
556 http://www.rethink-wireless.com/index.asp?article_id=1544
557 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

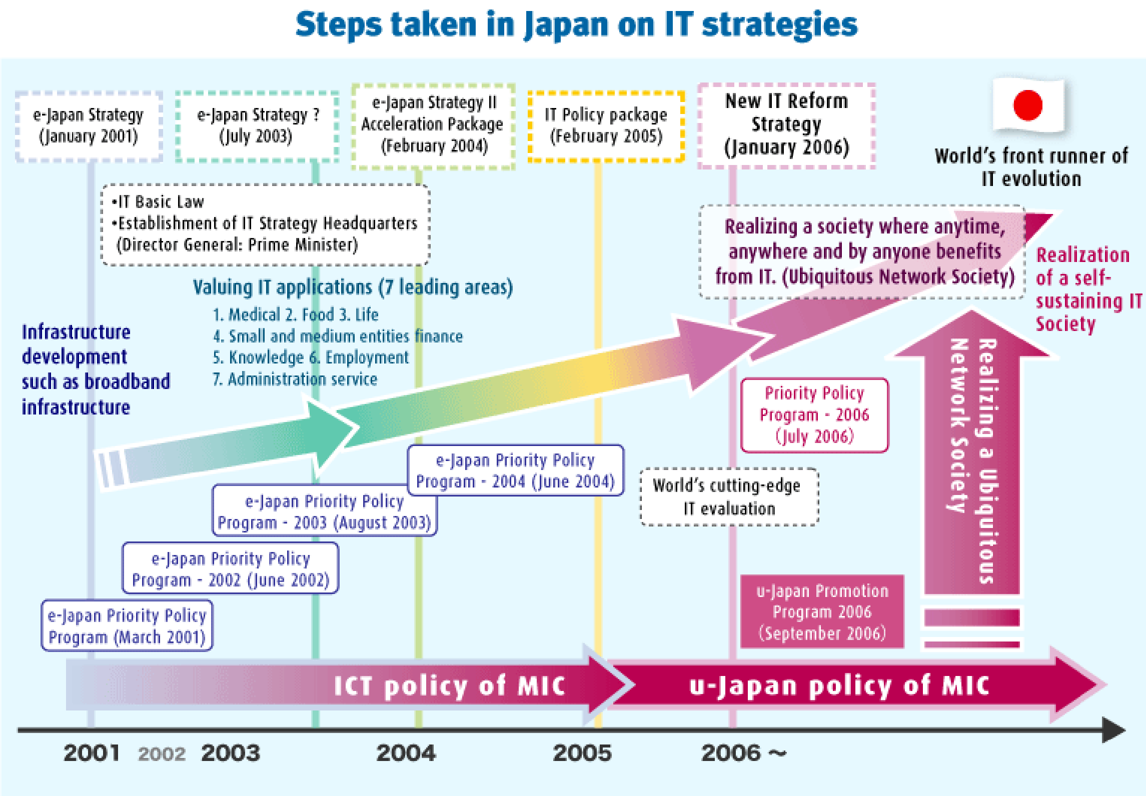
The history of the telecommunications political economy in Japan is defined primarily by the battle between the government and NTT. After NTT was privatized in 1985, the company began to wrestle with its regulator, the Ministry of Posts and Telecommunications (MPT). MPT argued for the breakup of NTT 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.[558]

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.[559] 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,"[560] 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.[561] 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."[562] 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.[563] Each of these initiatives began with high-level targets, backed up by a strong executive and regulatory bureaucracy, and reinforced in a series of more granular policy packages.[564]

558 Kenji E. Kushida and Seung-Youn Oh. The Political Economies of Broadband Development in Korea and Japan. Asian Survey, 47(3): 481-504, 2007.
559 http://www.kantei.go.jp/foreign/it/council/basic_it.html
560 http://www.kantei.go.jp/foreign/it/network/0122full_e.html
561 http://www.kantei.go.jp/foreign/policy/it/0702senryaku_e.pdf
562 http://www.soumu.go.jp/menu_seisaku/ict/u-japan_en/index.html
563 http://www.kantei.go.jp/foreign/policy/it/index_e.html
564 http://www.kantei.go.jp/foreign/it_e.html and http://www.soumu.go.jp/menu_seisaku/ict/u-japan_en/index.html

Figure 2: Strategies in Japan



Source: 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.[565] The government-owned Bank of Japan also began to guarantee loans for network infrastructure, which allowed relevant companies to borrow money at lower rates.[566] NTT itself, however, offers a different interpretation, suggesting that the proportion of investment based on government money was in fact low.[567] 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

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565 "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>
566 Thomas Bleha, "Down to the Wire," Foreign Affairs, May/June 2005 <www.foreignaffairs.org/20050501faessay84311/thomas-bleha/down-to-the-wire.html>
567 NTT comments to Berkman Center Next Generation Connectivity, FCC GN Docket No. 09-47. November 16, 2009.

billion USD) for "…eliminating the digital divide, promoting the development of wireless broadband and fostering digital terrestrial broadcasting."[568]

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.[569] 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.[570]

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 addressed 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."[571]

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.[572]

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568 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>

569 http://www.soumu.go.jp/menu_seisaku/ict/u-japan_en/new_pckg02_menu.html

570 Comments to the FCC by the Government of Japan, FCC Docket 09-51.

571 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

572 TBDSC Secretariat, Overview of Telecommunications Business Dispute Settlement Commission, June 2009, http://www.soumu.go.jp/main_sosiki/hunso/english/pdf/overview.pdf

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;
- Use of networks at an affordable price;
- Free connection with any terminal that meets technical standards.[573]

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."[574] 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.[575] The 4G LTE licenses were nevertheless allocated to four providers, as determined by the government.[576] The new regime has promised to consider auctions, "as appropriate."[577] 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."[578]

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573 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

574 http://www.soumu.go.jp/main_sosiki/joho_tsusin/eng/pdf/070900_1.pdf ("informal" English translation)

575 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

576 http://www.soumu.go.jp/menu_news/s-news/2009/090123_8.html (The Japanese government refers to these as "3.9G" licenses.)

577 http://www.dpj.or.jp/policy/manifesto/seisaku2009/06.html

578 http://www.soumu.go.jp/main_sosiki/joho_tsusin/eng/Releases/Telecommunications/news081107_2.html

G. 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 complemented by infra-platform competition enabled by unbundling. 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. Municipal public-private partnerships to promote investments in FTTH have played an important role in shaping the Netherland's strategy for deploying next generation networks, with an emphasis on cooperative open access models. 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.[579]

Penetration Metrics	Rank amongst OECD 30 countries	Speed metrics	Rank amongst OECD 30 countries	Price metrics	Rank amongst OECD 30 countries
Penetration per 100, OECD	2	Maximum advertised speed, OECD	8	Price low speeds, combined	7
Household penetration, OECD	3	Average advertised speed, OECD	5	Price med speeds, combined	9
3G penetration, Telegeography	25	Average speed, Akamai	5	Price high speeds, combined	15
Wi-Fi hotspots per 100000, Jiwire	13	Median download, speedtest.net	2	Price very high speeds, combined	8
		Median upload, speedtest.net	3		
		Median latency, speedtest.net	1		
		90% Download, speedtest.net	5		
		90% Upload, speedtest.net	9		

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

Note: Details in Part 3
Source: OECD, TeleGeography, Jiwire, Speedtest.net, Akamai, Point Topic
Berkman Center analysis

	Fiber / LAN	Cable	DSL	Other	Overall [580]
Subscriptions per 100 people [581]	0.6	13.4	21.8	0.0	35.8

579 OECD Broadband Portal, Table 2a, from EU Community Survey, from 2007. Some recent estimates near 90%.
580 Does not include 3G Wireless. Since subscriptions are shared within a household, this number will never be 100.

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).[582] 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."[583] 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.[584] 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 expanded 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 gained a majority stake in the Amsterdam CityNet project, which was initially seen as a model case for public investment pushing the commercial viability of FTTH. While this project has fallen short of its anticipated subscription targets, several other municipality-level projects have fared better and have helped to sustain interest in locally funded efforts. 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

581 OECD Broadband Portal, Table 1d, supplied by the Dutch government, as of 2008.

582 Nico van Eijk, "Broadband Services and Local Loop Unbundling in the Netherlands," IEEE Communications Magazine October 1999, p. 2-5.

583 OECD, "Developments in Local Loop Unbundling," DSTI/ICCP/TISP(2002)5/FINAL, September 10, 2003.

584 TeleGeography GlobalComms Database, March 2009.

Belgium and Germany.[585] 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.

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.[586] 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.

FTTH 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.[587] KPN has entered into a 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.[588] 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.[589]

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.[590]

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585 TeleGeography GlobalComms Database, March 2009.

586 TeleGeography GlobalComms Database, March 2009.

587 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

588 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.

589 http://www.telegeography.com/cu/article.php?article_id=27124

590 http://it.tmcnet.com/news/2009/09/21/4380464.htm

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 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.[591] 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.[592] Similarly, NMa worked with OPTA to achieve competitive concessions before approving the KNP/Reggefiber joint venture.[593] OPTA has indicated a willingness to apply a light touch when firms choose an open model that permits competition.[594]

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.[595] 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.[596] This will shape the relative power of national level regulatory agencies and broadband providers across Europe.

591 See, e.g., http://www.opta.nl/nl/actueel/recente-publicaties/publicatie/?id=3015
592 http://www.opta.nl/nl/actueel/alle-publicaties/publicatie/?id=2957
593 NMa Decision 6397.
594 "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.
595 European Commission, Case NL/2009/0868, Letters of February 17, 2009 and May 20, 2009.
596 http://ec.europa.eu/information_society/policy/ecomm/library/public_consult/nga_2/index_en.htm

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 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."[597] 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.[598] 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.[599] 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.[600] The paper also established an "impulse committee" on broadband, which published more detailed guidelines for implementing the Ministry's vision.[601] 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.

597 http://www.expertgroepbreedband.nl/
598 Ministry of Economic Affairs (NL) "The Broadband Paper; A question of pace and better utilisation" (May, 2004)
599 http://www.nederlandbreedbandland.nl/ (The group has the same name as the 2002 panel report, but is distinct)
600 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
601 Bekkers, R., S. Maltha, J. Poort & S. van Geffen, "Naar een nationale strategie voor breedband, Advies van de Impulscommissie Breedband," Utrecht, 2004.

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 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.[602] This included the fairly successful OnsNet project in Nuenen and Eindhoven.

However, government-funded models have been encumbered by measures at both the EU level and the national level that 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,[603] but permitted a public-private joint venture in Amsterdam a year later.[604]

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.[605] There appears to be renewed interest in municipal projects in the Netherlands on the part of both private investors and public stakeholders, based on the experiences of more than a dozen municipal projects. This emerging model for public-private participation in the Netherlands suggests a broader role for service-based competition in next generation networks.[606]

The Commission recently clarified its position, appearing to support a relatively liberal set of scenarios in which government investment will be permitted.[607] 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.[608] 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.

602 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.

603 Decision on the measure C 35/2005 (ex. N 59/2005), October 20, 2005.

604 Decision on the measure C 53/2006 (ex N 262/2005), December 12, 2006.

605 http://fibresystems.org/cws/article/magazine/37080

606 For more detailed context, see: Sadowski, B. M., Nucciarelli, A. and de Rooij, M., "Providing Incentives for Private Investment in Municipal Broadband Networks: Evidence from the Netherlands," Telecommunications Policy, 33: pp. 582-595.

607 http://europa.eu/rapid/pressReleasesAction.do?reference=IP/09/1332

608 http://www.fd.nl/artikel/12868632/ruim-baan-snel-internet-gemeenten

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."[609]

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).[610] However, this has also affected the broadband market, because it has enabled DSL-based providers such as Tele2 to announce plans for more robust triple-play offerings.[611] 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.[612] 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.[613]

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.[614] 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

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609 Dutch Lower House. (September 23, 2009). Kammerstukken 32127, nr. 3.
610 http://europa.eu/rapid/pressReleasesAction.do?reference=IP/09/245 (On October 24, 2006, Dutch Parliament voted in favor of a more expansive cable unbundling proposal, but this never progressed to implementation. Kammerstukken 30800 XIII, nr. 18)
611 http://www.broadbandtvnews.com/2009/02/11/ec-gives-green-light-for-dutch-open-cable/
612 http://yro.slashdot.org/story/09/08/23/1921206/First-European-Provider-To-Break-Net-Neutrality
613 http://www.laquadrature.net/Telecoms_package
614 http://www.telegeography.com/cu/article.php?article_id=28137

returned the spectrum to the government for re-auction in 2010.[615] This outcome was the result of the Dutch government's desire to have all allocated spectrum actively in use.

615 http://www.telecompaper.com/news/article.aspx?cid=684135

H. 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.[616] 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.[617]

Penetration Metrics	Rank amongst OECD 30 countries	Speed metrics	Rank amongst OECD 30 countries	Price metrics	Rank amongst OECD 30 countries
Penetration per 100, OECD	6	Maximum advertised speed, OECD	3	Price low speeds, combined	16
Household penetration, OECD	1	Average advertised speed, OECD	2	Price med speeds, combined	16
3G penetration, Telegeography	2	Average speed, Akamai	1	Price high speeds, combined	9
Wi-Fi hotspots per 100000, Jiwire	7	Median download, speedtest.net	1	Price very high speeds, combined	3
		Median upload, speedtest.net	9		
		Median latency, speedtest.net	3		
		90% Download, speedtest.net	1		
		90% Upload, speedtest.net	8		

Note: Details in Part 3
Source: OECD, TeleGeography, Jiwire, Speedtest.net, Akamai, Point Topic
Berkman Center analysis

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

616 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.

617 "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.

	Fiber / LAN	Cable	DSL	Other	Overall [618]
Subscriptions per 100 people [619]	13.8	10.5	7.7	0.0	32.00

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.[620] 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.[621] In response, KT abandoned its ISDN plans and invested in DSL. By 2002, 70 out of 100 South Korean households had broadband subscriptions.[622] By that time, KT had gained a majority share in the broadband market[623] due to its geographic reach and competitive pricing.[624] It was only then that the South Korea regulator mandated unbundling of local loop network elements.[625]

Over 80 % of Koreans live in dense, urban housing, an arrangement that has produced significant economies of scale for the expansion of broadband service.[626] 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.[627] 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.[628]

By the end of 2007, fiber connections constituted one-third of all South Korean Internet connections.[629] 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.[630] 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.[631]

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-

618 This table does not include 3G Wireless. Since subscriptions are shared within a household, this number will never be 100.
619 OECD Broadband Portal, Table 1d, supplied by the Korean government, as of 2008
620 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.
621 Kushida and Oh. 495.
622 Ibid. 483.
623 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.
624 Kusida and Oh. 496.
625 Robert D. Atkinson, et al. F3; OECD Directorate for Science, Technology and Industry, "Developments in Local Loop Unbundling", 10 September 2003. 17- 20.
626 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.
627 Robert D. Atkinson, et al. F3.
628 Ibid.
629 Ibid.
630 Ibid.
631 TeleGeography, *GlobalComms Database*, South Korea Country Overview.

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 Rev A network.[632] As of May 2009, KTF offered 5.76 Mbps service in major South Korean cities.[633] In 2008, the Korean Communications Commission announced plans to allocate various blocks of 700MHz, 800MHz, and 900MHz spectrum from SK Telecom to smaller operators.[634] Since then, wireless penetration in South Korea has reached 94 percent.[635] 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.[636] KT Corp launched WiMax service in South Korea, called WiBro (wireless broadband), in 2006.[637] 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.[638] 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% share in the fixed broadband market of 130 ISPs.[639] However, despite the plethora of providers, three companies controlled 85% of the market as of 2006.[640] 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.[641]

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% fixed broadband market share as of 2005.[642] 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% of the market and holds one of three 3G spectrum licenses. Rival KTF Corp holds a 3G license and controls approximately 31% of the market. LG Telecom, the smallest 3G license-holder, controls approximately 18% of the market, and although its relatively late network deployment has put it at a

632 Ibid. 7.
633 Ibid. 7-8.
634 Ibid. 6-7.
635 Ibid. 9.
636 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
637 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
638 Ibid.
639 DTI Global Watch Mission Report. 23.
640 Robert D. Atkinson, et al. F3.
641 Ibid. 25.
642 TeleGeography, *GlobalComms Database*, South Korea Country Overview.

competitive disadvantage vis-à-vis KTF Corp and SK Telecom, its exclusive use of EV-DO 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.[643]

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.[644] 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.[645]

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.[646] 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.[647] The KCC oversees competition, consumer protection, and arbitration of unfair practices in the regulated industries.[648]

South Korea categorizes service providers as facilities-based providers, resale providers, or value-added service (VAS) providers.[649] 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.[650]

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.[651] 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.[652]

Political economy

The first major step in the privatization and deregulation of South Korean telecommunications markets took place between 1987 and 2002 with the privatization of KTA, the state-owned incumbent wireline provider.[653] 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

643 Ibid. 9.
644 Ibid. 8-9.
645 Ibid.
646 Lee, et al. 84.
647 Ibid. 6.
648 TeleGeography, *GlobalComms Database*, South Korea Country Overview.
649 Ibid. 12.
650 Ibid.
651 Lee, et al. 87.
652 TeleGeography, *GlobalComms Database*, South Korea Country Overview.
653 Kenji Kushida and Seung-Youn Oh, "The Political Economies of Broadband Development in Korea and Japan, *Asian Survey*, Vol. XLVII, 2007. 490.

ownership.[654] Mid-1990s legislation gave the MIC strong regulatory authority, and the president appointed IT experts to serve as MIC ministers.[655]

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.[656] 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%.

Broadband strategy

In 1987, South Korea passed the Framework Act on Information Promotion in support of the development of information technology.[657] 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."[658] In 1993, the NIA launched the plan for the Korea Information Infrastructure (KII), which ran from 1995 to 2005.[659] In 1995, South Korea enacted legislation to drive the KII comprehensive plan for a national broadband backbone.[660] 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.[661] In addition, the government has provided tax breaks to businesses that invest in broadband communications systems.[662]

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.[663] Through these programs, the Korean government has provided over $70 billion in loans to service providers.[664] 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.[665]

654 Ibid. 491.
655 Ibid.
656 TeleGeography, *GlobalComms Database*, South Korea Country Overview.
657 Robert D. Atkinson, et al. . F1.
658 Lee, et al. 84.
659 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.
660 Lee, et al. 84.
661 Ibid. 87.
662 Robert D. Atkinson, et al. F2.
663 DTI Global Watch Mission Report. 15.
664 Robert D. Atkinson, et al. F2.
665 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 USD 77 million in preferred loans to facilities-based providers in 1999, an additional USD 77 million in loans for non-urban areas in 2000,[666] USD 70 billion in loans through the IT839 and Broadband Convergence Network programs, (an investment that recipients pledged to match), and USD 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.[667] This program has motivated builders to invest in broadband, as many Koreans apparently want to live in buildings with high-speed broadband capacity.[668]

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.[669] 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.[670] The government has also deployed educational programs targeted at specific demographic groups, such as the One Million Housewife Digital Literacy Education Project,[671] and provided Internet training subsidies targeting 2 million people in 2002.[672] 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.[673] 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.[674] 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.[675]

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.[676] The relatively late unbundling mandate

666 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.
667 Lee, et al. 87-88.
668 Choudrie, et al. 285.
669 Robert D. Atkinson, et al. F3.
670 Lee, et al. 84.
671 Kushida and Oh. 497.
672 Ibid.
673 Arnold Picot and Christian Wernick, "The Role of Government in Broadband Access", Telecommunications Policy 31 (2007). 669.
674 Kushida and Oh, 498.
675 Ibid.
676 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.[677] South Korea has also mandated open access conditions on cable providers[678] and the opening of South Korea's two largest mobile data networks.[679]

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.[680] 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.[681]

Spectrum policy

In 2006, the Korea Radio Promotion Agency (KORPA) was established to manage South Korean radio spectrum.[682] 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.[683] LG Telecom, which failed to win a license at auction, was later awarded the A-band at 1920 MHz-1940 MHz.[684] 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.[685]

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.[686]

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.[687] 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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677 See Kushida and Oh. 494.
678 Ibid.
679 TeleGeography, *GlobalComms Database*, South Korea Country Overview.
680 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
681 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.
682 TeleGeography, *GlobalComms Database*, South Korea Country Overview.
683 Ibid.
684 Ibid.
685 Ibid.
686 Ibid. 8.
687 Ibid. 6.

KTF and LG Telecom may be forced to relinquish their 1.8 GHz licenses in exchange for 800 MHz spectrum concessions.[688]

688 Ibid.

I. 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 in accordance with EU regulation. 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, proposing legislation that would require TeliaSonera to functionally separate its network and retail services divisions. This legislation entered into force on 1 July 2008, but has not been used by the regulator as a result of TeliaSonera's voluntary compliance. 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 Mbps or higher.

In the recent Broadband Strategy for Sweden, the government has put forth a goal that 90% of households should have access to a broadband connection of at least 100 Mbit/s by 2020. This development is intended to be driven by the market rather than public funding.

Market highlights

Overall, 66.6% in Sweden have broadband access.[689]

	Fiber / LAN	Cable	DSL	Other	Overall [690]
Subscriptions per 100 people [691]	6.5	6.2	19.1	0.2	32.0

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

Penetration Metrics	Rank amongst OECD 30 countries	Speed metrics	Rank amongst OECD 30 countries	Price metrics	Rank amongst OECD 30 countries
Penetration per 100, OECD	7	Maximum advertised speed, OECD	3	Price low speeds, combined	4
Household penetration, OECD	6	Average advertised speed, OECD	13	Price med speeds, combined	2
3G penetration, Telegeography	6	Average speed, Akamai	3	Price high speeds, combined	3
Wi-Fi hotspots per 100000, Jiwire	1	Median download, speedtest.net	3	Price very high speeds, combined	2
		Median upload, speedtest.net	2		
		Median latency, speedtest.net	4		
		90% Download, speedtest.net	2		
		90% Upload, speedtest.net	2		

Note: Details in Part 3
Source: OECD, TeleGeography, Jiwire, Speedtest.net, Akamai, Point Topic
Berkman Center analysis

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

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."[692] DSL and cable respectively accounted for 9% and 4% of internet customers.[693] Internet penetration among households with a capacity of 2Mbps or more was at 2.6% in 2001.[694] In 2002, subscriptions for IP telephony in broadband networks were introduced.[695] 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%.[696]

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%.[697] 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."[698] 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.

692 The Swedish Telecommunications Market 2001, p.32 et sq.
693 The Swedish Telecommunications Market 2005, p.78
694 The Swedish Telecommunications Market 2001, p.61.
695 The Swedish Telecommunications Market 2003, p. 19.
696 The Swedish Telecommunications Market 2003, table 33, p.81.
697 The Swedish Telecommunications Market 2005, table 32, p.81.
698 http://www.pts.se/en-gb/Documents/Reports/Internet/2005/Broadband-in-Sweden-2005---PTS-ER-200524/

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 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.[699] 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%.[700] 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%.[701] 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.[702] There were 153 local fiber/LAN broadband networks and more than 98% of the population was covered by a high-speed network.[703] In the wireless market, there were approximately 3.5 million UMTS and CDMA 2000 subscriptions.[704]

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.[705] In 1996, three years after liberalization, the government-owned former monopoly operator, Telia, had a share of 71% of the telecommunications market.[706] At that point, Telia was the only operator in Sweden that offered a public ISDN network.[707]

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.[708]

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

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699 The Swedish Telecommunications Market 2005, p.30.
700 The Swedish Telecommunications Market 2008, table 15, p.93
701 The Swedish Telecommunications Market 2008, table 34, p.98
702 The Swedish Telecommunications Market 2008, table 34 (cont.), p.99
703 TeleGeography, GlobalComms Database, Country profile, Sweden, p.15.
704 The Swedish Telecommunications Market 2008, table 15, p.74.
705 TeleGeography, GlobalComms Database, Country profile, Sweden, p.2.
706 The Swedish Telecommunications Market 1996, p.10.
707 The Swedish Telecommunications Market 1996, p.19.
708 TeleGeography, GlobalComms Database, Country profile, Sweden, p. 15.

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.

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.[709] 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.[710] Municipal networks alone control 20 to 25% of the coverage.[711] Among the more than 150 local fiber/LAN networks in 2008, a majority are owned by municipal authorities or municipally run companies.[712]

The market for wireless broadband, which grew by 229% from mid-2007 to mid-2008,[713] is also dominated by TeliaSonera with 39% of active subscriptions, ahead of Tele2, Hi3G Access and Telenor with 25%, 19% and 15%, respectively.[714] Each of the four major players operates 3.5G networks and is expected to deploy 4G service in 2010. [715] Tele2 has also secured a 2.6GHz license to be used for WiMAX services.[716]

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, represented the transposition of the 2002 EU Regulatory Framework to Swedish law and provided a regulatory framework 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."[717]

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

709 The Swedish Telecommunications Market 2008, table 30, p.93
710 http://www.pts.se/en-gb/Documents/Reports/Internet/2009/Dark-fibre---one-year-later---PTS-ER-200924/
711 Dark Fibre, Market and State of Competition, p.22 et sq.
712 TeleGeography, GlobalComms Database, Country profile, Sweden, p.15.
713 TeleGeography, GlobalComms Database, Country profile, Sweden, p.15
714 TeleGeography, GlobalComms Database, Country profile, Sweden, p.8.
715 TeleGeography, GlobalComms Database, Country profile, Sweden, p.11 et sq.
716 TeleGeography, GlobalComms Database, Country profile, Sweden, p.12.
717 http://www.regeringen.se/content/1/c6/01/84/54/5ae98894.pdf

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.

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: Tele2 used a strategic partnership with the National Swedish Rail Administration to gain access to the railway communication infrastructure.[718] 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. Such initiatives have meant increasing competitive pressure on TeliaSonera.

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.[719] 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."[720] 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.

718 Explaining International Broadband Leadership, Appendix G: Sweden, p.G3.
719 Broadband Stimulation in France, Ireland, and Sweden, p.15.
720 TeleGeography, GlobalComms Database, Country profile, Sweden, 14.

- 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. [721]

The bill refers to public confidence in IT and coordination as two key elements needed to achieve these objectives, with the first condition supported by education and countering threats to security. The plan calls for the state to take responsibility in organizational, logistical, and technical issues in order to meet the coordination objective. [722]

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.[723] 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.[724]

In October 2009, the Swedish government presented its Broadband Strategy for Sweden. The strategy includes a goal that 90% of households should have access to a broadband connection of at least 100 Mbit/s by 2020. This development is intended to driven by the market driven rather than public funding.

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."[725] The roll out was carried out by Svenska Kraftnät, the Swedish National Grid operator.[726] The government allocated an additional EUR 700 million to regional and local broadband projects.[727] Tax breaks were also used as an incentive to promote the spread of broadband.[728] 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.[729]

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.[730] 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

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721 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.

722 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

723 p.22 et sq.

724 Proposal for Swedish broadband strategy, p.54. See also section "Government investment in infrastructure"

725 http://www.bbwo.org.uk/broadband-3045

726 Ibid.

727 TeleGeography, GlobalComms Database, Country profile, Sweden, 14.

728 Explaining International Broadband Leadership, Appendix G: Sweden, p.G2.

729 Ibid.

730 Proposal for Swedish broadband strategy, p.54.

and that the possibility of imposing obligations on a party to provide universal services cannot be viewed as a means of achieving this objective."[731]

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.[732]

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 personal computers, and encouraging the use of broadband for education.[733] As early as 1998, tax breaks were introduced for companies that supplied employees with personal computers.[734] In a later push for digital literacy in education, the government "introduced a USD 25 million project to raise IT literacy among schoolteachers."[735] 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. [736]

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.[737] 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".[738] 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.[739]

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

731 Proposal for Swedish broadband strategy, p.66.
732 http://www.ictregulationtoolkit.org/en/PracticeNote.aspx?id=3244
733 Explaining International Broadband Leadership, Appendix G: Sweden, p.G4.
734 Swedish commitment to broadband both in the cities and in the countryside, p.13
735 Explaining International Broadband Leadership, Appendix G: Sweden, p.G4.
736 see From an IT policy for society to a policy for the information society, Summary of the Swedish Government Bill 2004/05:175
737 TeleGeography, GlobalComms Database, Country profile, Sweden, p.15
738 Proposal for Swedish broadband strategy, p19 et sq.
739 Explaining International Broadband Leadership, Appendix G: Sweden, p.G3.

to promote competition on the route to more sustainable competition."[740] PTS proposed 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."[741] 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 of its passive network. TeliaSonera has committed to a policy of equal treatment of external and internal customers to its wholesale products and has established an Equality of Access Board with external members to monitor and report on equal treatment issues. Although the functional separation legislation entered into force on 1 July 2008, it has not been used by the regulator as a result of TeliaSonera's voluntary compliance.

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.[742] 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."[743]

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.[744]

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."

740 Improved broadband competition through functional separation, p.59.
741 Improved broadband competition through functional separation, p.79.
742 Network neutrality, memorandum, p.7.
743 PTS spectrum policy, p.6.
744 TeleGeography, GlobalComms Database, Country profile, Sweden, p.14.

J. Switzerland

Introduction

Switzerland has experienced strong results in broadband deployment taking a substantially different approach than other countries that have performed well in this space. Until recently, 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 chose not to require local loop unbundling throughout much of the first broadband transition, although it did ultimately adopt this policy in 2007. It is difficult to attribute the Swiss success solely to regulatory abstention, given that Swisscom continues to be majority owned by the Swiss federal government, and that the government continues to exercise control over some of its investment decisions. Furthermore, Swisscom has operated under the threat of continuing efforts by 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: first, the likely effects of local loop unbundling as introduced in 2007; second, 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 third, 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. This strategy appears to be the result of Swisscom's response to competition both from cable company upgrades and from municipal utilities' investments in building fiber-to-the-home networks.

Market highlights

Overall, 52.8% of households in Switzerland have broadband access.[745]

	Fiber / LAN	Cable	DSL	Other	Overall [746]
Subscriptions per 100 people [747]	0.4	9.7	23.2	0.3	33.5

745 OECD Broadband Portal, Table 2a, from EU Community Survey, from 2006.
746 Does not include 3G Wireless. Since subscriptions are shared within a household, this number will never be 100.
747 OECD Broadband Portal, Table 1d, supplied by the Swiss government, as of 2008.

Penetration Metrics	Rank amongst OECD 30 countries	Speed metrics	Rank amongst OECD 30 countries	Price metrics	Rank amongst OECD 30 countries
Penetration per 100, OECD	4	Maximum advertised speed, OECD	17	Price low speeds, combined	3
Household penetration, OECD	8	Average advertised speed, OECD	21	Price med speeds, combined	5
3G penetration, Telegeography	15	Average speed, Akamai	4	Price high speeds, combined	8
Wi-Fi hotspots per 100000, Jiwire	2	Median download, speedtest.net	7	Price very high speeds, combined	6
		Median upload, speedtest.net	11		
		Median latency, speedtest.net	6		
		90% Download, speedtest.net	8		
		90% Upload, speedtest.net	14		

Note: Details in Part 3
Source: OECD, TeleGeography, Jiwire, Speedtest.net, Akamai, Point Topic
Berkman Center analysis

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

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.[748] 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.[749] 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)[750] and advertising campaigns launched by the resellers of the Swisscom wholesale products.[751] 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).[752] 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

748 OFCOM (2009). *The Swiss telecommunications market- an international comparison: Extract from the 14th European Union Implementation report extended to include Switzerland*. p. 106.
749 GlobalComm (2009). *Country overview Swiss section. Broadband Market Commentary*.
750 OECD (2009). *Communications Outlook 2009*. p. 136/205.
751 OFCOM (2009). *The Swiss telecommunications market- an international comparison: Extract from the 14th European Union Implementation report extended to include Switzerland*. p. 106.
752 ComCom (2008). *Annual report* 2007. p. 10.

regional or local cable-providers).[753] Cablecom is currently seeking to catch up by investing in higher performance cable technology (DOCSIS 3.0),[754] which will make it possible to offer consumers download speeds of 100 Mbps or higher.[755]

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."[756] 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.[757] 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.[758]

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.[759]

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,

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753 GlobalComm (2009). *Country overview Swiss section. Broadband Market Commentary*.

754 http://www.cablecom.ch/en/index/kabelanschluss/netupgrade.htm?setlang=4 (last visited 9 September 2009).

755 Neue Zürcher Zeitung (4 July 2009). *Interventionsgelüste im Telekommarkt*. p. 19.

756 Staub, Richard (2009). *Glasfaserkabel für alle Haushalte*. in: Elektrotechnik (May 2009). p. 62-63.

757 City Council of St. Gallen (2008). *Vorlage Stadtparlament: Pilotprojekt für Breitbandnetz auf der Basis "Fibre tot he Home" (FTTH)*. p. 6-7.

758 City Council of St. Gallen (2008). *Vorlage Stadtparlament: Pilotprojekt für Breitbandnetz auf der Basis "Fibre tot he Home" (FTTH)*. p. 1.

759 http://www.comcom.admin.ch/aktuell/00429/00457/00560/index.html?lang=en&msg-id=29395

covering 60% of the country in 2008.[760] Nevertheless, the penetration rate is still low compared to the OECD average (20% in 2007).[761] In 2006, ComCom revoked the 3G license from 3G Mobile AG as the company couldn't meet the conditions stipulated in the license.[762] Swisscom recently announced plans to invest in HSPA+ in the next several years. Handsets supporting this technology are expected to be sold in 2010.[763] 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.[764]

WiMAX still plays a marginal role in the broadband market. In 2007, a license was awarded to Inquam Broadband.[765] The provider is expected to launch a mobile WiMAX service.[766] 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.[767] On a local level, there are a growing number of open wireless city networks, which provide city centers with Internet free of charge.[768]

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,[769] the federal government still holds a 56% stake in the company.[770] Complete privatization had been planned at that time, but the Swiss parliament decided against a full implementation in 2006.[771] 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.[772] However, the consequences of this obligation are quite

760 ComCom (2009). *Annual Report* 2008. p. 21.
761 OECD (2009). *Communications Outlook* 2009. p. 103.
762 ComCom (2007). *Annual Report* 2006. p. 20.
763 http://www.computerworld.ch/aktuell/news/49049/ (last visited 6 September 2009).
764 ComCom (2009). *Annual Report* 2008. p. 21.
765 http://www.news.admin.ch/message/index.html?lang=en&msg-id=12434 (last visited 10 September 2009).
766 GlobalComm (2009). *Country overview Swiss Section: Broadband Market Commentary*.
767 http://www.swisscom.ch/FxRes/Files/PWLAN/online_im_zug.pdf (last visited 11 September 2009).
768 http://www.openwireless.ch/ (last visited 11 September 2009).
769 TeleGeography, GlobalComms Database, Country profile, Switzerland, *Section. Wireline Timeline*.
770 OECD (2009). *Communications Outlook 2009*. p. 46.
771 http://www.parlament.ch/ab/frameset/d/n/4712/221326/d_n_4712_221326_221327.htm (last visited 8 September 2009).
772 ComCom (2006). *Annual Report* 2007. p. 24.

limited due to the fact that the broadband network already reaches 98% of Swiss households.[773] The universal service obligation does not stipulate any specific requirements for access technologies.[774]

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.[775]

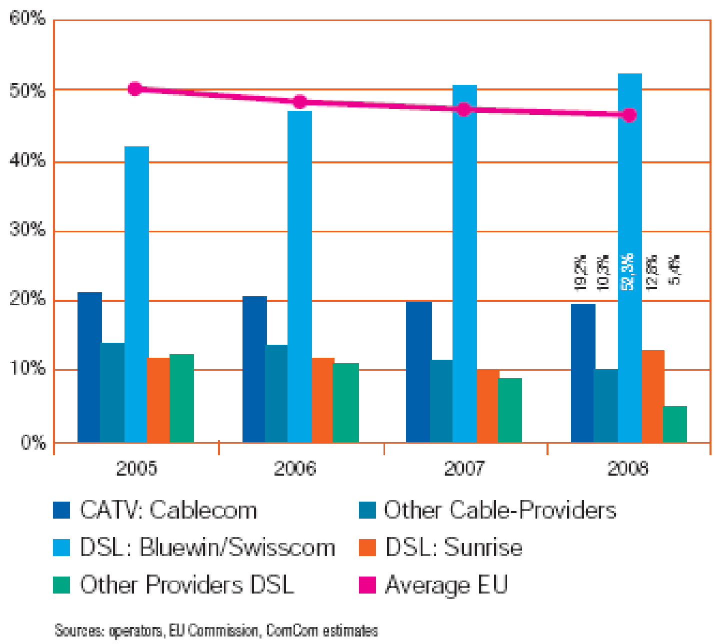

Figure 1: Market shares of broadband connections in Switzerland and in the EU, December 2008[776]

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.[777] The dynamism of Swisscom can partially be explained by strong management with high public and political visibility, coupled with a very solid financial background.[778] 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.[779] Swisscom's high customer satisfaction rates may also contribute to their success and may help explain why better prices alone are often not incentive

773 OFCOM (2007). *Annual Report* 2008. p. 14.
774 ComCom (2009). *Annual Report* 2008. p. 21.
775 ComCom (2009). *Annual Report* 2008. p. 13.
776 ComCom (2009). *Annual Report* 2008. p. 11.
777 ComCom (2009). *Annual Report* 2008. p. 10.
778 http://www.swisscom.ch/GHQ/content/Investor_Relations/Ergebnisse_und_Berichte/Kennzahlen_Finanzergebnis/Wichtiges_in_Kuerze/?lang=en (last visited 17 September 2009).
779 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.[780]

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").[781] 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.[782] Sunrise—Swisscom's strongest competitor—has entered a nation-wide cooperation with the former monopolist, agreeing to buy Swisscom's wholesale fiber products.[783] 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.[784]

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.[785]

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).[786] 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.[787] In light of this regulatory vacuum, ComCom has taken on the role of a facilitator, in addition to the role of a regulator,

780 NZZ am Sonntag (18 November 2007). *"Preisvergleich mit Ausland hinkt"*. Interview with Carsten Schloter, CEO of Swisscom. p. 5.
781 TeleGeography, GlobalComms Database, Country profile, Switzerland, *Section: Broadband Market Commentary*.
782 TeleGeography, GlobalComms Database, Country profile, Switzerland, *Section: Broadband Market Commentary*.
783 Neue Zürcher Zeitung (31 March 2009). *Wenn Stromer ins Telefongeschäft einsteigen*. p. 21.
784 TeleGeography, GlobalComms Database, Country profile, Switzerland, *Section: Broadband Market Commentary*.
785 TeleGeography, GlobalComms Database, Country profile, Switzerland, *Section: Wireless Market Commentary.*
786 TeleGeography, GlobalComms Database, Country profile, Switzerland, *Section: Broadband Regulations.*
787 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.[788]

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.[789]

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.[790] 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.[791] 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

788 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).
789 ComCom (2009). *Annual Report* 2008. p. 5-6.
790 Sonntags Zeitung (31 August 2008). *Aus allen Lobbyisten-Rohren*. p. 65.
791 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.[792]

The Swiss strategy regarding broadband development has four core areas and principles:[793]

- 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.

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.[794]

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.[795] 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 over CHF 200 million to support the local power company in providing fiber-to-the-home to all households. Another example is St. Gallen, where voters approved by a wide majority a CHF 78 million

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792 http://www.bakom.admin.ch/dokumentation/medieninformationen/00471/index.html?lang=en&msg-id=23627 (last visited 17 September 2009).

793 Federal Council (2006). *Strategy of the Federal Council for an Information Society in Switzerland*. p. 2-3.

794 http://www.stadt-zuerich.ch/content/dam/stzh/portal/Deutsch/Abstimmungen%20%26%20Wahlen/070311/Abstimmungszeitung_1_07.pdf (last visited 10 September 2009).

795 http://www.stadt-zuerich.ch/content/dam/stzh/portal/Deutsch/Abstimmungen%20%26%20Wahlen/070311/Abstimmungszeitung_1_07.pdf (last visited 10 September 2009).

investment to create a FTTH network structured as a public utility. Local initiatives such as these have had an impact on national-scale broadband deployment strategies and influenced Swisscom's plans to expand investments through a cooperative approach to FTTH deployment through the Fibre Suisse plan.[796]

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.[797]

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. [798]

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."[799]

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.[800]

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796 Further details of the Fibre Suisse initiative can be found in Section 4.13.2. of Next Generation Connectivity.
797 http://sg.openwireless.ch/finanzierung (last visited 10 September 2009).
798 http://www.bakom.admin.ch/themen/infosociety/01689/index.html?lang=en (last visited 8 September 2009).
799 http://www.bakom.admin.ch/themen/infosociety/01688/index.html?lang=en (last visited 8 September 2009).
800 http://www.bakom.admin.ch/themen/infosociety/02104/index.html?lang=en (last visited 8 September 2009).

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 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.[801]

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.[802] As of January 2009, Swisscom had signed eight contracts with other operators and 31,000 access lines were effectively unbundled.[803] 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.[804]

Competition policy for next generation networks is taking on a notably different form in Switzerland with the cooperative agreements to lay down fiber networks that are emerging. While cable providers will continue to offer competitive broadband services, the over-building strategy under development, based on four fiber lines into each house, offers the prospect of strong competition among internet service providers without mandated line sharing or price controls.

801 Federal Council (2003). *Botschaft zur Änderung des Fernmeldegesetzes (FMG).* p. 7656-7957.
802 OECD (2009). Communications Outlook 2009. p. 55.
803 OFCOM (2009). The Swiss telecommunications market- an international comparison: Extract from the 14th European Union Implementation report extended to include Switzerland. p. 102.
804 OFCOM (2007). Annual Report 2008. p. 6/16.

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.

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.[805] 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.[806]

ComCom is currently preparing for a coordinated reallocation of the most important mobile phone frequencies which become available again in 2013 and 2016.

805 ComCom (2001). Bericht der Eidgenössischen Kommunikationskommission (ComCom) zuhanden des Bundespräsidenten betreffend die Vergabe der IMT-2000/UMTS-Konzessionen in der Schweiz. p. 2-9.

806 TeleGeography, GlobalComms Database, Country profile, Switzerland, section: Broadband Market Commentary.

K. United Kingdom

Introduction

Approximately two-thirds of households in the UK have access to the internet via a broadband connection. DSL is available to nearly the entire country and cable available to slightly over half. Fixed broadband prices are competitive in the UK having fallen by over 16% each year between 2006 and 2008. UK's performance on speed has lagged as measured by both advertised and actual speed. A recent government report noted that 11% of UK homes in fact have these low tier speeds not greater than 2 Mbps. In 2005, the UK became the first OECD country since the global shift to privatization of telecommunications markets to impose functional separation on its incumbent telecommunications provider, British Telecom (BT). The government has since set a goal of providing universal service of 2 Mbps to the entire UK by 2012. Only two carriers, Virgin Media and BT, have plans to deploy "super-fast" fiber networks. The government's plans to support a next generation network include a Next Generation Broadband fund raised from a 50 pence/month levy on all fixed connections. This fund will support deployment to the one-third of the UK that the government predicts the market will not service. Five carriers compete in the 3G wireless market, of which market share is relatively evenly divided.

Market Highlights

Overall, 56.7% of households in United Kingdom have broadband access.[807]

	Fiber / LAN	Cable	DSL	Other	Overall[808]
Subscriptions per 100 people [809]	1.0	13.7	10.3	0.9	25.8

Penetration Metrics	Rank amongst OECD 30 countries	Speed metrics	Rank amongst OECD 30 countries	Price metrics	Rank amongst OECD 30 countries
Penetration per 100, OECD	11	Maximum advertised speed, OECD	21	Price low speeds, combined	18
Household penetration, OECD	11	Average advertised speed, OECD	15	Price med speeds, combined	12
3G penetration, Telegeography	10	Average speed, Akamai	16	Price high speeds, combined	4
Wi-Fi hotspots per 100000, Jiwire	3	Median download, speedtest.net	18	Price very high speeds, combined	10
		Median upload, speedtest.net	21		
		Median latency, speedtest.net	17		
		90% Download, speedtest.net	17		
		90% Upload, speedtest.net	25		

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

Note: Details in Part 3
Source: OECD, TeleGeography, Jiwire, Speedtest.net, Akamai, Point Topic
Berkman Center analysis

807 OECD Broadband Portal, Table 2a, from EC Community Survey, as of 2007.
808 Does not include 3G Wireless. Since subscriptions are shared within a household, this number will never be 100.
809 OECD Broadband Portal, Table 1d, data supplied by UK Government, as of 2008.

Broadband Development to Date

In recent years, increasing access and decreasing price have characterized broadband deployment in the UK. Today, DSL is available to virtually the entire UK, and cable broadband is available to 52% of the country.[810] As of the first quarter of 2009, 65% of UK households had a fixed broadband connection. This figure represents growth of 7% year-over-year. UK fixed broadband subscriptions increased 10.7% in 2008.[811] 92.1% of UK small businesses have broadband service.

The data on connectivity speeds varies depending upon the source. A September 2008, government-solicited study reported average connectivity speeds in the UK to be 5.9 Mbps.[812] By our measures in this study, the UK is at the bottom of the third quintile in the OECD in speeds. The government's June 2009 *Digital Britain* report concluded that 11% of UK homes do not have access to a connection with speeds of greater than 2 Mbps.[813] UK broadband performance is comparatively better in price. In October 2008, OECD rankings showed the UK had the fifth cheapest broadband subscription prices in the world.[814] Our more extended study suggests that the UK was 11th, but had particularly attractive prices for high speed broadband. Broadband prices in the UK fell substantially between 2005 and 2009. British regulator Ofcom recently reported that an 8 Mbps connection in early 2009 cost as little as 20% of what the same connection cost in 2005.[815]

Functional separation of incumbent BT in 2005 and the ensuing expansion of local loop unbundling appear to have played a large role in the price reductions in the fixed-line market and increasing consumer adoption. The UK had originally adopted unbundling in 2001. By late 2005, however, there were still only 200,000 unbundled loops in the entire country. At that point, Britain's regulator, Ofcom, forced BT to functionally separate its retail Internet access services from its network elements business, which were thereafter to be provided by Openreach on an open access basis. A period of intense competition for subscribers over unbundled loops followed including Carphone Warehouse, Tiscali UK, and BskyB. Several service providers led by Carphone Warehouse offered "free" broadband to those who signed up for bundled service in order to attract customers.[816] By the end of 2008, there were 5.5 million unbundled loops in the UK and 80% of UK households were connected to exchange with competitive offerings via unbundling compared to just 40% three years earlier.[817] BT is now moving its entire network to an IP platform, but its plans have been repeatedly delayed and the fixed line market in the UK has shrunk since 2002.[818]

Two UK companies, British Telecom (BT) and Virgin Media, have plans to roll-out "super-fast" fixed broadband networks in the coming years. As of July 2009, Virgin Media has made fiber-based broadband of speeds "up to" 50 Mbps available to 12.5 million homes.[819] This is the only fiber service currently available in the UK. BT plans to deploy its super-fast broadband product of 40 Mbps via fiber-

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810 Ofcom, "The Communications Market 2009," p. 55.
811 Ibid, p. 16.
812 The Next Phase of Broadband UK, p. 9.
813 Digital Britain, Final Report, June 2009, p. 53.
814 OECD, "Broadband Average Subscription Price, October 2008, USD PPP," available at http://www.oecd.org/dataoecd/22/44/39575002.xls; The Next Phase of Broadband UK, p. 9
815 Ofcom, "Impact of the Strategic Review of Telecoms," 29 May 2009, p. 4.
816 TeleGeography, GlobalComms Database, Country Profile, UK.
817 Ofcom, "The Communications Market 2009"
818 TeleGeography, GlobalComms Database, Country Profile, UK. p. 10.
819 Ofcom, "The Communications Market 2009," p. 15 (internal quotation marks omitted).

to-the-home or fiber-to-the-cabinet (node) to 40% of the UK by 2012.[820] Though no other companies have announced such significant investments in next generation networks, some have begun discussions with Openreach, BT's functionally separated, wholesale open access provider, to upgrade access networks to support higher speeds.[821] The June 2009 *Digital Britain* report outlined a subsidy scheme to support the deployment of next generation, super-fast networks to the third of the UK that would not receive such service through the market alone. The report proposed a 50 pence "supplement" to be collected by all fixed-line operators, which would generate from £150m - £175m each year for a "Next Generation Fund" that could make connecting the "final third" commercially viable by 2017.[822] Despite these ambitions, UK regulator Ofcom does not believe that a transition from copper to fiber networks is likely in the near term.[823] Indeed, *Digital Britain* also outlined a universal service plan to ensure a 2 Mbps connection to all Britons using existing networks by 2012.

Five carriers cover the UK mobile broadband market.[824] In order of market share, they are O2 UK (29%); Vodafone UK (23%); T-Mobile UK (21%); Orange UK (20%); and Hutchison 3G UK ("3") (7%).[825] The government originally facilitated competition in the 2G market with the release of 1800 MHz band spectrum. In April 2000, it awarded four 3G licenses in the 2100 MHz band to the four incumbent 2G carriers and one to new entrant Hutchison with the requirement that all carriers achieve coverage of 80% of the UK by the end of 2007.[826] Today, the carriers report 3G coverage varying between 80% (O2) and 95% (Hutchison) of the UK population.[827] All UK 3G networks use W-CDMA technology in various states of evolution. The UK today has 78.5 million wireless subscribers, 24% of which have 3G service.[828] The UK is among Europe's leaders in deployment of Wi-Fi hotspots. Ofcom data show that as of 2007, the UK had 21 Wi-Fi hotspots per 100,000 people.[829] BT has deployed thousands of Wi-Fi hotspots around the UK and Ireland as part of its Openzone program. Customers can buy vouchers from retail outlets for access or pay a monthly subscription fee.

Market share and key players

Although BT provides 65% of wireline connections in the UK, their broadband retail arm now holds just over one quarter of the broadband retail market. The cable provider, Virgin Media, accounts for 23% of the market. Carphone Warehouse serves about one quarter of the UK market after acquiring AOL UK and Tiscali; prior to being purchased by Carphone Warehouse, Tiscali had acquired several competitors. The television company, BskyB, commands 12% of the market and Orange Home 5%. Many smaller ISPs serve the remainder of the market.

Openreach has facilitated a fundamental shift in the market for fixed-line services. The functional separation of BT that began in 2005 has prompted a substantial increase in the number of homes with access to at least one additional operator competing via local loop unbundling. By the end of 2008, these unbundled offerings accounted for approximately one-third of all fixed line connections in the UK.[830] The profusion of new operators in 2005 and intense competition for market share has subsidized

820 Ibid; The Next Phase of Broadband UK, p. 37.
821 The Next Phase of Broadband UK, p. 37.
822 Digital Britain, Final Report, June 2009, p. 65.
823 Ofcom, "Delivering Superfast Broadband in the UK: Promoting Investment and Competition," 3 March 2009, p. 62.
824 TeleGeography, GlobalComms Database, Country Profile, UK, p. 24-25.
825 Ibid. All figures are rounded to the nearest percent.
826 Ibid, p. 18.
827 Ibid, p. 21.
828 Ibid.
829 Ofcom, "The International Communications Market 2008," p. 242.
830 ECTA Broadband Scorecard, available at: http://www.ectaportal.com/en/REPORTS/Overview/

somewhat over the past several years with the consolidation of several of the larger competitors. The connection share of the top five broadband providers, which stood at 73% in 2005, has now risen to over 90%, reflecting the trend towards consolidation in the market.[831]

The wireless market in the UK is poised to consolidate. Orange and Vodafone announced in 2007 that they would share their 2G and 3G infrastructure.[832] Later that year, T-Mobile and Hutchison struck a similar agreement. In early 2009, O2 and Vodafone announced an international network-sharing agreement that includes the UK, Ireland, German, and Spain. MVNOs in the UK largely focus on the pre-paid market.[833]

Regulatory framework

The UK was an early leader in reforming telecommunications markets. The first version of Britain's independent telecommunications regulator, Oftel, was created in 1984 and oversaw the transition to a duopoly market. The duopoly approach was abandoned in 1991 and four years later, Oftel had made significant strides towards promoting service-based competition in UK with an agreement with BT for accounting separation and interconnection based on unbundled components, which had their most immediate effect on international calls competition. Between 1998 and 2000, Oftel issued a series of reports, and managed a series of consultations, that set the terms for wholesale and bitstream access to BT's network. Initially, Oftel and BT were planning to include only wholesale access, but in response to the EU process that later produced the 2002 Directives, Oftel expanded the process to encompass local loop unbundling as well.[834]

The UK overhauled its telecommunications regulatory regime in July 2003 to conform to a new EU framework. The new regulatory structure replaced the licensing system with "General Conditions of Entitlement" across telecommunications markets and "Specific Conditions" applicable to individual companies.[835] The UK Communications Act of 2003 created a new regulatory body, the Office of Communications (Ofcom), an independent "super regulator"[836] with responsibilities including managing spectrum, ensuring high-quality television and radio programming, and regulating broadband service.[837] The Office of the Telecoms Adjudicator (OTA) resolves working-level disputes related to local loop unbundling, wholesale line rental, and Openreach.[838] The creation of the OTA in 2004, along with the imposition of functional separation in 2005 and wholesale access price reductions in 2004 and 2005, are described by Ofcom as the key factors that led to greater retail broadband competition in the UK.[839]

Ofcom concluded a process entitled the Strategic Review of Telecommunications in December of 2005. Its conclusion changed the legal demands on BT, which had long resisted and stifled efforts of competitive carriers to enter the fixed-line market. Although the UK had adopted unbundling in 2001, by late 2005 there were still only 200,000 unbundled loops in the entire country.[840] BT signed a binding Undertaking that imposed functional separation between its wholesale inputs business and its retail operations. The Undertaking created Openreach, whose operations were separate from BT's retail arm,

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831 Ofcom, "The International Communications Market 2008," p. 203.
832 Ibid, p. 21
833 Ibid.
834 Regulatory Reform in UK. OECD. Available at: http://www.oecd.org/dataoecd/46/30/2766201.pdf
835 TeleGeography, GlobalComms Database, Country Profile, UK, pp. 35-36.
836 Ibid.
837 Ofcom, "Ofcom: a short guide to what we do," April 2008, available at http://www.ofcom.org.uk/consumeradvice/guide/
838 Office of the Telecoms Adjudicator, "Objectives," available at http://www.offta.org.uk/vision.htm
839 Ofcom, "The Communications Market 2009," p. 201.
840 Next Generation Connectivity, p. 160.

and which was placed under the obligation to deliver access to inputs, such as network elements, to other parts of BT using the same systems, under the same terms, and with the same timescales as it provides such access to all other non-BT carriers. Functional separation was implemented to enhance competition through neutral access to BT's network. This arrangement also offers greater transparency and is easier to regulate. In May 2009, following a review of the results of functional separation, Ofcom decided to retain the main features of the 2005 Undertaking.[841] It did, however, permit BT to increase its charges for access to unbundled lines.[842] For BT, the separation of its wholesale business and greater retail competition in this new regulatory environment also implies less regulation of its retail operations. Moreover, to promote investment in next generation networks, Ofcom decided in March 2009 to leave prices for wholesale "super-fast" broadband services unregulated.[843]

Political economy

UK telecommunications were highly regulated under the BT monopoly. Today, the regulatory landscape is largely pro-competition. Nonetheless, Ofcom's current administration is viewed as highly aligned with the Labour Party, and UK Conservatives are eager to reduce the regulator's powers. In a recent speech, British Tory leader David Cameron stated, "[w]ith a Conservative Government, Ofcom as we know it will cease to exist. Its remit will be restricted to its narrow technical and enforcement roles." In that speech, Cameron proposed to vest the Department for Culture, Media, and Sport with many of Ofcom's current responsibilities.[844] The European Union would likely welcome a reduction in Ofcom's power. In 2007, the European Commission launched a proposal to subject telecommunications regulatory decisions of member states to a new, Europe-wide authority.[845]

Broadband strategy

In addition to the regulatory measures described above, the UK is now planning to ensure (1) universal broadband service in the UK of at least 2 Mbps and (2) the deployment of next generation, "super-fast" broadband networks. The universal service commitment, outlined in the June 2009 *Digital Britain* report prepared by former Ofcom head Lord Stephen Carter, aims to provide universal availability of broadband at speeds of at least 2 Mbps by 2012 using existing copper and wireless networks. Upgrades to these networks will be supported by £200m of direct government investment from funds leftover from the Digital Switchover, "commercial gain through tender contract and design, in-kind contributions from private partners," and more extensive obligations on mobile carriers, among others. [846]

The deployment of next generation networks will rely primarily on private investment. However, *Digital Britain* concludes that the market alone will lead to the deployment of next generation networks to only one-half to two-thirds of the UK. To reach the "final third," the report proposes a "Next Generation Fund" consisting of a 50 pence "supplement" on all fixed copper connections. This supplement is expected to yield from £150m - £175m per year. The entire scheme is expected to provide super-fast broadband to 90% of the UK by 2017.[847] The report also recognized that other regulatory changes, such

841 Ibid, pp. 86-87.
842 TeleGeography, GlobalComms Database, Country Profile, UK, p. 37.
843 TeleGeography, GlobalComms Database, Country Profile, UK, p. 36.
844 Chris Williams, "Ofcom top of Tory deathlist," The Register, 6 July 2009, available at http://www.theregister.co.uk/2009/07/06/cameron_ofcom/
845 Juliette Garside, "EU moves in on telecoms regulation," Telegraph.co.uk, 11 November 2007, available at http://www.telegraph.co.uk/finance/markets/2819325/EU-moves-in-on-telecoms-regulation.html
846 Digital Britain, Final Report, p. 12, 53-58.
847 Ofcom, "The Communications Market 2009," p. 15.

as providing next generation broadband guidelines to homebuilders and relaxing overhead line installation regulations, may be helpful "in addition" to the Next Generation Fund.[848]

With respect to mobile broadband, *Digital Britain* proposes three objectives: (1) transitioning to high-speed mobile broadband; (2) universal 3G coverage; and (3) maintaining a "highly competitive mobile market."[849] Adopting the May 2009 recommendations of the government-appointed Independent Spectrum Broker, *Digital Britain* recommends clearing the 800 MHz band from the television Digital Switchover and auctioning this with other 3G spectrum in 10 MHz blocks with coverage requirements, imposing spectrum caps, and "liberalisi[ng] existing 2G spectrum in the hands of the existing operators."[850]

Policy interventions and outcomes

Government investment in infrastructure

The UK has relied largely on market forces to deploy broadband service. Consequently, direct government investment in infrastructure is limited. As noted above, the government plans to support its universal service goal in the near term by devoting approximately £200m to upgrading existing copper and wireless networks. Furthermore, the Next Generation Fund, though composed of funds from private customers, will be collected pursuant to government mandate.

Skill building, education, and demand programs

Digital Britain highlighted an urgent need for greater IT skills training to satisfy the needs of British businesses. The report recommended a £30m funding increase[851] for the Technology Strategy Board, a public body established in 2007 that "stimulates technology-enabled innovation" through technology research and development, and commercialization.[852] Since 2006, the Train to Gain program, which provides some government funding for worker training, has helped 127,000 UK businesses train over 1 million workers, albeit primarily in "lower level skills."[853] In February 2009, the government began the Home Access Programme, a pilot project that provided grants for online access to homes with children attending state-run schools. *Digital Britain* reports that the program has been a success and that grants will be unlimited during the rollout of the national program in December 2009.[854] The government also supports a network of 6,000 UK Online Centres, established in 2000. Each day, two million Britons use the centers, which are concentrated in "areas of high deprivation," to access online government services or to take courses in digital learning.[855] The UK is developing a national curriculum to provide digital learning opportunities in schools to ensure that future workers have essential digital skills. Curricular revisions will include "information and communications technology" (ICT) to a new "core competence" parallel to more traditional curriculum subjects.[856]

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848 Digital Britain, Final Report, p. 65.
849 Ibid, p. 14.
850 Ibid.
851 Digital Britain, Final Report, p. 168.
852 Technology Strategy Board, "About us," available at http://www.innovateuk.org/aboutus.ashx
853 Digital Britain, Final Report, p. 182.
854 Ibid, p. 35.
855 Ibid.
856 Ibid, p. 173.

Competition policy

As noted above, local loop unbundling and the functional separation of BT into retail and Openreach wholesale components are central features of recent Ofcom competition policy. In terms of next generation network investment and services, Ofcom's regulatory principles aim to afford carriers regulatory certainty, allow for returns commensurate with the level of investment risk in next generation networks, and provide equal opportunities for wholesale access to promote competition.[857] Ofcom defines two "main options" for competition in the next generation network market: "active" products, those provided by network owners; and "passive" products, those provided using network owners' infrastructure.[858] Though Ofcom's super-fast broadband report recognizes the importance of active products to initial network investment, the regulator believes that significant market power justifies regulations requiring passive access.[859] The report goes so far to state that if "active products on which competition can be based are not delivered in a timely way," then the regulator will consider ways in which passive products can inject competition.[860] Ofcom also suggests that BT design its new networks in ways that will not lead to "foreclosure of future market entry."[861] Note that Ofcom announced in March 2009 that it would not subject wholesale "super-fast" broadband services to price regulation.[862]

Network non-discrimination

In 2007, Ofcom maintained that given the remedies for anti-competitive conduct available through the European framework, net-neutrality non-discrimination regulations in the UK were unnecessary. In May 2009, the European Parliament voted to allow ISPs the discretion to shape traffic over their networks in the Telecoms Rules of 2002, and the issue is unlikely to be debated again at the conciliation procedure in late 2009.

Spectrum policy

In 2000, Oftel – the predecessor of Ofcom – awarded 20-year 3G licenses to the four incumbent 2G wireless carriers and new entrant Hutchison 3G UK. Of the incumbents, T-Mobile, Orange, and O2 received one paired 10 MHz and one unpaired 5 MHz block and Vodafone received one paired 15 MHz block, all in the 2100 MHz band. Hutchison received one paired 15 MHz block, also in the 2100 MHz band.[863] Ofcom began investigating the prospect of rebanding the 900 MHz band for 3G service in 2007 in the face of opposition from incumbent 2G licensees O2 and Vodafone.[864] In 2006, Ofcom announced plans to auction 205 MHz of 2.6 GHz spectrum. In 2008, however, shortly before the auction, O2 and T-Mobile filed suit to delay the auction until the fate of the 900 MHz was resolved.[865] Digital Britain endorsed making 3G spectrum licenses indefinite. It also proposed auctioning the 800 MHz band from the television Digital Switchover with other 3G spectrum (2.6 GHz) in 10 MHz blocks with coverage requirements, imposing spectrum caps, and "liberalisi[ng] existing 2G spectrum in the hands of the

857 Ofcom, "Delivering Superfast Broadband in the UK: Promoting Investment and Competition," 3 March 2009, p. 4.
858 Ibid, p. 5.
859 Ibid, p. 6.
860 Ibid, p. 35.
861 Ibid, p. 45.
862 TeleGeography, GlobalComms Database, Country Profile, UK, p. 39.
863 Ibid, pp. 18, 24.
864 Ibid, p. 18.
865 TeleGeography, GlobalComms Database, Country Profile, UK, p. 36.

existing operators."[866] Consequently, Ofcom delayed the 2.6 GHz auction and now plans to auction this spectrum consistent with the Digital Britain recommendation in 2010.[867]

866 Digital Britain, Final Report, p. 14.
867 TeleGeography, GlobalComms Database, Country Profile, UK, p. 36.