Public Private Interplay for Next Generation Access Networks: Lessons and Warnings from Japan's Broadband Success

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Abstract: This paper contributes to the discussion of how Public Private Interplay (PPI) can be used to foster Next Generation Access (NGA) buildouts in Europe by introducing the experience of Japan. Japan, which succeeded in both promoting nationwide network buildouts and fostering competitive dynamics that led to the world's fastest and cheapest broadband services and deploying them nationwide. The process entailed deregulation, which unleashed new entrepreneurial private actors, and re-regulation that protected them from incumbent carriers. The resulting market dynamics lowered Digital Subscriber Line (DSL) prices, influencing the market price for Fiber-To-The-Home (FTTH), for which the government had heavily subsidized carriers. Central government initiatives, combined with local incentives, led to an almost 100% broadband accessibility within a few years. However, Japan quickly discovered that taking advantage of the broadband environment to produce innovation, productivity growth, and economic dynamism, was far more difficult than facilitating its creation. It discovered regulatory barriers for the use of Information and Communications Technology (ICT) in various areas of the economy. Like Europe, Japan was not home to the ICT lead-user enterprises and industries that drove the ICT revolution, producing innovation and productivity gains. Moreover, the advent of US-centered cloud computing services potentially decreases the minimum bandwidth requirement to access global-scale computing power. The development of wireless technologies far cheaper than Japan's nationwide FTTH also merits serious consideration for European policy discussions.

Key words: broadband, PPI, industry analysis, political economy, Japan.

Public Private Interplay (PPI) is recently gaining attention, particularly in Europe, as a means to foster the deployment of Next Generation Access (NGA) networks. The ultimate goal is to benefit from a wide base of the population's access to high speed broadband, with access to economic opportunities and potential for innovation that this can

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bring. With operators constrained in their ability to finance heavy infrastructure investments, but governments unwilling or incapable of building networks entirely themselves, a set of policy schemes to foster public private interplay are being investigated (FALCH & HENTEN, 2010; NUCCIARELLI *et al*., 2010). The European Commission's ambitious goal to increase Internet penetration and increase access speeds to give all EU citizens access at 30 Megabits per second (Mbps) by 2020, with 50% of households having access at 100 Mbps or more, is accelerating this interest.

This paper introduces an important case outside the EU - that of Japan, which succeeded in building out and introducing the world's fastest and cheapest broadband services and deploying them nationwide, through PPI. The difficulties and challenges that Japan experienced despite these successes, however, reveal a number of fundamental dilemmas in the broader context of Information and Communications Technology (ICT) innovation, providing valuable lessons for the future of Europe.

Cloud computing is arguably the primary benefit of widespread, low-cost broadband access. Cloud computing has emerged as the new platform for ICT. Cloud is at once an innovation ecosystem, production environment, and global marketplace, transforming how information is used, processed, and stored. Cloud computing is not simply "everything online," but is rather the delivery of computing services "to the users at the time, to the location, and in the quantity they wish to consume, with costs based only on the resources used." (KUSHIDA *et al*., 2012) cloud computing is delivered by a handful of large firms with massive datacenters. With an increasing amount of activity on the Internet conducted through cloud computing datacenters, constructed by Cloud-based tools, and with electronic commerce flowing through Cloud-enabled services, the creation of broadband infrastructure is very much about accessing the potential for innovation, efficiency gains, and transformation of activities enabled by cloud computing services.

Critically, the provision of broadband does not ensure that the benefits of cloud computing are captured. One of the lessons from Japan for Europe is that successfully promoting the deployment of broadband networks and services may actually be far easier than fostering an environment in which they are most effectively used. And since much of the gains of broadband are in their use towards innovative and productive ends, this latter challenge of usage is as important as that of promoting the network services.

The Japanese case clearly reveals this dilemma. It is worth restating the overall problem that becomes clear. First, how do nations and regions

promote the construction or deployment of broadband? Second, how do they create markets for broadband services that effectively lower costs and promote diffusion? These two are often at odds with each other, which is why PPI is being focused upon in Europe, and why Japan's success at both promoting costly broadband network buildouts and competitive market dynamics to lower prices is noteworthy. Third, how do countries generate innovative use of the broadband environment, in particular cloud computing? This is where Japan's lack of success reveals important lessons for Europe.

This paper comprises of three main parts: a detailed examination of the PPI dynamics that led to Japan's broadband success; its discoveries of how difficult it was to utilize the ubiquitous broadband environment for innovation and economic dynamism; and suggestions on how large corporate "lead users" have historically driven the ICT revolution. It concludes by noting some additional considerations in the focus on broadband, namely those of alternative wireless technologies, and future broadband speed requirements given the continued rise of computing power.

Japan's broadband success was due to its telecommunication deregulation, combined with aggressive new regulations - re-regulation. Put simply, deregulation unleashed new entrepreneurial private actors, and re-regulation protected them from incumbent carriers. This enabled successful market dynamics that allowed new entrants to drastically lower prices and increased access speeds for DSL (Digital Subscriber Line) broadband. The low priced DSL market then radically lowered prices for the high speed, 100+ Mbps FTTH (Fiber-To-The-Home) broadband services, which were offered by incumbents in response to new entrants' DSL - with many incumbents enjoying public financial backing to build-out networks. As a result, Japan had the fastest and cheapest broadband in the world by 2003, available to the vast majority of its population, despite having trailed behind many other advanced industrial countries in 1999. Central government incentives, matched by local initiatives and support for regional deployment, then facilitated nationwide high speed broadband access, mostly through FTTH.

Up to a certain speed, broadband was indeed becoming a baseline for connectivity. Beyond this basic speed of a few Mbps, however, Japan quickly discovered that fostering the deployment of costly fiber networks to the home, along with the market dynamics that enabled low pricing, was far easier than facilitating the innovation that took advantage of this broadband environment. The locus of innovation for Information Technology (IT) services, such as Google, Amazon, Salesforce.com, Paypal, and others, as

well as hardware companies that take advantage of online services, such as Apple, remained in the US, and particularly Silicon Valley - an environment with significantly slower household broadband than Japan. In fact, Japan's fast broadband provided Silicon Valley firms with a fertile ground for experimentation, with the value captured by the experimenters. Moreover, Japanese innovation that took advantage of the extremely high speed broadband - which required the existence of such connection speeds - were actually trapped in the domestic market. The lesson from Japan is that the business ecosystem and institutional configurations that precipitate innovation and entrepreneurship are different from those that foster broadband deployments.

How, then, can countries best benefit from broadband? Historically, the IT revolution has been driven by sophisticated "lead users," under intense competitive pressure, applying IT in new and innovative ways (COHEN *et al*., 2000). While latecomers may not necessarily follow the exact steps of leaders, enhancing competition among potential lead users should be part of the overall strategy to develop broadband networks.

Governments can also play a role in disseminating information about potential uses of what they can do with new ICT technologies, even if governments are not directly involved in deploying such uses, since it is also crucial for users to understand what they can do with the technologies—the possibilities from Cloud and broadband application, for example. This is another component that the European debates should engage in from early on.

■ Japan's spectacular broadband development: speed and price

Japan's broadband growth was spectacular, driven by a particular set of PPI dynamics. In early 1999, Japan had no broadband market and expensive landline Internet access. As a result, Japan's Internet diffusion lagged behind the US and many other advanced industrial countries. [1]

[1] In 1999, by population percentage, Internet subscriptions were: 8% for Japan, 18% for the US, 13% in the UK, 10% Germany, and 5% France. The Organization for Economic Co-operation and Development (OECD) average was 9%. Other high diffusion countries included Denmark and Sweden (21%), Netherlands (19%), Norway and Switzerland (14%), and Australia (13%) (OECD). This does not include mobile Internet services.

In the early 2000s, however, Japan's broadband services grew abruptly. Japanese consumers suddenly found themselves enjoying not only the fastest, but also the cheapest broadband services worldwide. Digital Subscriber Line (DSL) subscriptions exploded from 211 at the end of 1999 to almost 14 million by March 2003 (ITU 2004). The rapid deployment of high speed (100 Mpbs) Fiber-To-The-Home (FTTH) services followed on the heels of DSL growth, starting in 2001. As a result, by 2003, 4 of the world's 10 fastest broadband providers were Japanese (see figure 1). Competition among DSL providers, and between DSL and FTTH, led Japan to have the lowest broadband prices worldwide (see figure 2). Low DSL prices is often thought to dampen demand for FTTH, but in Japan's case, while this did occur to a degree, DSL was offered initially by new entrants, with incumbents responding by offering FTTH to regain consumers from new entrants' DSL services. In 2003, Japan had the lowest broadband prices, as well as the best price-performance (price per unit of data transmission) (ITU 2003).

As the low-priced, high speed FTTH caught on, particularly by offering value-added services such as telephone-substitute Voice-over-IP (VoIP) [2] with lower charges than conventional telephones, FTTH subscriber levels surged past that of DSL, overtaking it in 2008 (see figure 3).

Figure 1 - Fastest broadband service providers worldwide, 2003

Country	*Company*	*Access Type*	*Download Speed (Mbps)*	*Monthly charge*	
				USD	*PPP*
Japan	**NTT East**	**FTTH**	**100**	**52.45**	**42.46**
Japan	**Usen**	**FTTH**	**100**	**35.38**	**28.84**
Japan	**eAccess**	**ADSL**	**40**	**38.46**	**31.35**
Japan	**Yahoo!BB**	**ADSL**	**26**	**25.19**	**20.54**
Sweden	Bostream	vDSL	26	48.04	41.33
Korea	Hanaro	DSL	20	41.25	66.38
Korea	KT	DSL	13	42.01	67.61
Canada	Gulf Islands	Fixed wireless	11	23.00	27.06
Korea	Thrunet	DSL	10	31.74	51.08
Sweden	Bredbands Bolaget	Ethernet LAN	10	38.63	33.23

Source: Adapted from FRANSMAN, 2006: 11, 12

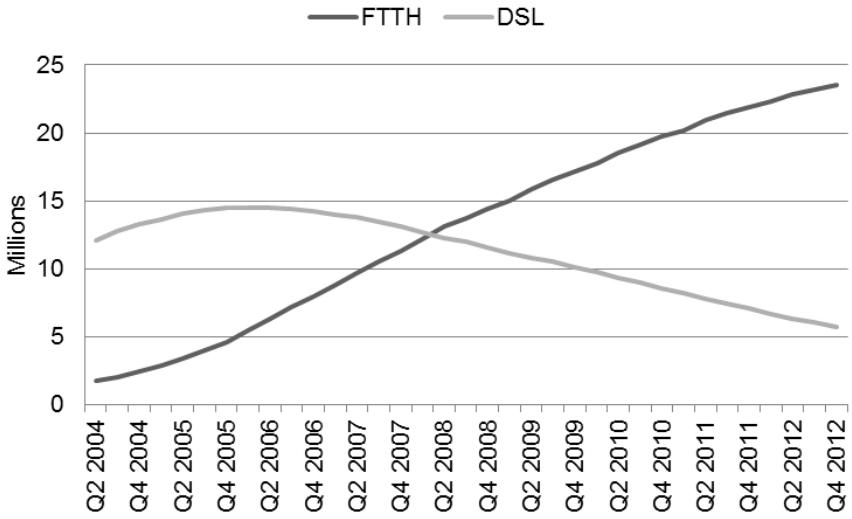
[2] VoIP entails voice data travelling over the Internet as packets of data, bypassing traditional circuit switched telephone networks.

Figure 2 - Average monthly prices of broadband subscriptions (USD)
G8 countries minus Russia, plus Australia, South Korea, and Singapore, 2003

Country	*Price*
Australia	91.8
Italy	73.6
Singapore	53.0
Canada	51.6
South Korea	49.2
UK	44.6
Hong Kong	38.2
US	33.2
Japan	**24.2**

Source: ITU Asia-Pacific Telecommunications Indicators (2004)

Figure 3 – Japan's FTTH and DSL subscribers, 2004-2012



Source: MIC

Japan also succeeded in deploying broadband regionally. By mid-2012, it had virtually 100% of households covered by broadband, defined as FTTH, DSL, Cable Internet, fixed wireless access, satellite, and 3.5G wireless. More notably, over 97% of households had access to broadband services with 30Mbps minimum downlink speeds, mostly through FTTH (see figure 4). As early as in 2009, approximately 90% of Japan's households had access to at? least 100Mbps downlink FTTH.

Figure 4 - Japan's prefectural household broadband accessibility, March 2012

Prefecture	*Broadband accessible households (%)* (*)	*Ultra high-speed broadband accessible households (%)*	*Prefecture*	*Broadband accessible households (%)*	*Ultra high-speed broadband accessible households (%)* (*)
Aichi	100	100	Miyazaki	100	89.8
Akita	100	92.5	Nagano	100	97.4
Aomori	100	90	Nagasaki	100	84.8
Chiba	100	99.1	Nara	100	99.7
Ehime	100	94.9	Niigata	100	97
Fukui	100	95.5	Oita	100	97.4
Fukuoka	100	98.1	Okayama	100	91.9
Fukushima	100	97.7	Okinawa	100	92.6
Gifu	100	97.4	Osaka	100	100
Gunma	100	99.9	Saga	100	99.5
Hiroshima	100	93.6	Saitama	100	99.9
Hokkaido	100	94.9	Shiga	100	99.9
Hyogo	100	98.6	Shimane	100	93.3
Ibaraki	100	96.5	Shizuoka	100	94.6
Ishikawa	100	99.2	Tochigi	100	99.7
Iwate	99.9	89.4	Tokushima	100	98.7
Kagawa	100	92.8	Tokyo	100	100
Kagoshima	100	83.1	Tottori	100	93.4
Kanagawa	100	100	Toyama	100	96.1
Kochi	100	84.5	Wakayama	100	98.8
Kumamoto	100	87.7	Yamagata	100	95.8
Kyoto	100	99.7	Yamaguchi	100	94.4
Mie	100	100	Yamanashi	100	97
Miyagi	100	98.5	**National**	**100** (**)	**97.3**

(*) Broadband includes: FTTH, DSL, Cable Internet, Satellite, Broadband wireless access, 3.5G wireless. Ultra broadband includes FTTH, and any other broadband exceeding 30Mbps downlink.

(**) Rounded to nearest thousandth

Source: MIC

■ The PPI policy drivers of Japan's broadband infrastructure

Japan's extensive broadband deployment occurred as a result of market dynamics that were put into play by a particular set of PPI. The policy drivers

were part of a 'regulatory regime shift' in Japan's telecommunications policy, which provided both opportunities and protection for new entrepreneurial entrants (KUSHIDA, 2012), combined with government support for infrastructure deployment. The shift occurred in two phases: sweeping deregulation creating opportunities, and new regulations, responding to new entrants' efforts, protecting them from incumbents.

Fostering competition in DSL:
deregulation and re-regulation from the 'Regulatory Regime Shift'

The proximate driver for initial broadband diffusion, in the form of DSL, was intense entrepreneurial market competition. New entrants of the 1990s rather than the first wave of telecommunications competitors (known as New Common Carriers, NCCs) from the 1980s, were the leaders in fast low-cost broadband. These new entrants were independent from the major industrial groups as well as the NCCs.

The 1990s' new entrants forced the reluctant incumbent, NTT, to offer high-speed broadband access earlier than it intended, at lower prices than it wanted, using technology it initially resisted. Tokyo Metallic Communications (TMC) pioneered commercial DSL services in late 1999, joined shortly by eAccess and several other start-ups. NTT responded in spring 2001 with its own DSL service. Softbank, founded in the early 1980s, entered the DSL market by delivering a price shock in 2001 by halving DSL prices. Usen also entered in 2001, offering high-speed FTTH services to a limited area, at prices comparable to pre-Softbank-shock DSL. As other NCCs also began FTTH, NTT was again forced to offer FTTH at similarly low rates.

The 'regulatory regime shift' that provided the impetus for entrepreneurship in broadband was driven by politics and a normative shift within the Ministry of Posts and Telecommunications (MPT). Political debates, spanning decades, over market liberalization and the breakup of NTT led to compromises that shaped the sector. A generational shift among MPT officials transformed their regulatory preferences from managing competition *ex ante* toward governing markets *ex post*.

The telecommunications regulatory structure of the mid-1980s was characterized by MPT micromanagement of competition. MPT attempted to break apart NTT to increase competition, while simultaneously keeping the number of new entrants in check and discouraging price wars. This strategy of gradual entry and price control led to a series of "lock-step" price

reductions as NCCs and NTT undercut one another. This 'controlled competition' regime from the 1980s through the mid-1990s left little room for entrepreneurship in terms of new entrants introducing radical new technologies, disruptive business models, or aggressive pricing strategies. However, it also ensured that prices were sufficiently high for future entrants to be able to cause major disruption through low-priced technologies and services.

The 'regulatory regime shift' began with MPT's deregulation, facilitated by the political leadership's broader reform agenda. The Cabinet's 'Three Year Plan for Deregulation', from 1995 encompassed several industries including telecommunications, strengthening MPT's ability to amend the Telecommunications Business Law without parliamentary debates. MPT fully supported these measures, and at times even fought for additional deregulation. By 2003, little remained of MPT's policy tools for *ex ante* competition management.

This wave of deregulation provided opportunities for the DSL start-ups of the late 1990s, and ushered in a host of new entrants. The first of these firms was TMC, which negotiated an agreement with MPT and NTT to access NTT's facilities to install its own DSL equipment in 1999 (TOJO, 2010). TMC's founder had planned to drastically undercut NTT in the ISP market in the early 1990s, but NTT's monopoly pricing for line leases made this impossible. [3] TMC was soon followed by eAccess, which began service in 2000. In contrast to TMC, whose business model was vertically integrated to provide both DSL and ISP services directly to consumers, eAccess chose to become a wholesaler to other ISPs. ISPs competed against each other on price and bore the cost of reaching consumers, while eAccess could focus on providing the underlying DSL access to ISPs.

However, deregulation alone was not sufficient to dramatically restructure the sector. New entrants still required access to NTT infrastructure to install DSL services, and DSL threatened NTT's business model of charging by the minute for Internet access. Despite the recent deregulations, NTT still fought to hinder access to its infrastructure (KUSHIDA, 2012). By December 2000, NTT had launched its own DSL service, further disincentivising it to allow easy access to DSL startups. Many government regulations also continued

[3] NTT charged ¥53,000/month to lease NTT's private line for 64 K, ¥286,000 for a 1 M line, and double that for a 3 M line. TTNet wanted to offer its ISP services at ¥100,000 for 64 K, but NTT's interconnection fees made this extremely challenging.

to exist that frustrated DSL startups' infrastructure access. [4] It was not until a process of re-regulation began in early 2000s that Japan saw a series of unprecedented price and service wars. After the introduction of NTTs proprietary DSL service, policy makers and regulators began to support DSL startups. The Cabinet Office spearheaded broadband promotion policies, establishing an 'IT Strategy Headquarters', which produced a report, the 'e-Japan strategy', highlighting Japan's lagging IT development. Soon after, the Cabinet Office passed the "IT Basic Law," which gave the Ministry of Internal Affairs and Communications (MIC) - the successor to MPT – the authority to implement policy measures conducive to the promotion of IT without amending laws.

The MIC used its newly inherited powers to provide a friendlier network environment to startups. In December 2000, MIC required NTT to lease out its unused fiber infrastructure, mandating that fees be based on NTT's operational cost rather than the far higher cost of NTT's historical infrastructure investments (FUKE, 2003). The Japan Fair Trade Commission (JFTC), a new policy actor in telecommunications, then bolstered DSL start-ups' position against NTT in December 2000. Citing antitrust concerns, it issued the first-ever warning to NTT. This signaled the JFTC's tough stance on NTT - good news for competitors. The MIC's newly established Dispute Resolution Commission (DRC) then ruled against NTT after filings by Tokyo Metallic and eAccess. The DRC was in principle a neutral third-party organization, but represented the ministry's commitment to govern competition on an *ex post* basis, addressing conflict after the fact rather than orchestrating competition *ex ante* to minimize potential conflict. MIC further clamped down on NTT, warning NTT in the spring of 2001 about its marketing practices. eAccess and others had complained that when potential subscribers contacted NTT about switching their ISDN lines back to copper, NTT directed them to its own DSL service.

Thus, by the spring of 2001, the new regulatory framework had substantially altered the opportunities facing DSL providers. Many early entrants' challenges were no longer major issues. While de-regulation provided the opportunity to enter, re-regulation provided the protection to sustain commercially viable businesses.

[4] For example, only NTT-approved technicians were allowed into NTT's facilities, forcing start-ups to contract an NTT group company to install their equipment. More problematic was the requirement that government-certified technicians (therefore, another NTT group company) install the DSL modems in subscribers' homes. The modems themselves were also restricted to rentals, just as telephones and cellular phones had been historically.

In the summer of 2001, Softbank took the opportunities offered by the new regulatory environment to their extreme when he announced Softbank's entry into DSL. Softbank not only halved the prevailing DSL market rate but also offered speeds of up to 8 Mbps compared to NTT's 1.5 Mbps.

Softbank's pricing strategy astonished government officials and industry participants but was enthusiastically embraced by consumers. Many government officials feared that Softbank's 'reckless' price war threatened carriers' future infrastructure investment capabilities, and the strategy almost certainly would not have been permitted under MPT's previous 'controlled competition' regime. [5] Other DSL providers had little choice but to follow Softbank with lower prices and faster DSL speeds (see figure 5). Softbank later drove prices even lower by bundling free VoIP subscriptions with its DSL.

Figure 5 - Softbank's price shock and NTT's response

	March 2001	September 2001	September 2002	September 2003
NTT East (1.5M)	54 (43)	52 (41)	43 (34)	41 (32)
NTT East (8M)			44 (35)	41 (32)
NTT East (12M)				42 (33)
NTT East (24M)				42 (33)
Softbank BB (8M)		21 (17)	21 (17)	21 (17)
Softbank BB (12M)			24 (19)	24 (19)
Softbank BB (26M)				25 (20)

Source: (IDA, 2006)

Fostering FTTH: public support of core infrastructure, dynamics of competition from DSL

Japan developed a world-leading FTTH market simultaneously with DSL. While FTTH providers were different firms than the DSL providers, the low DSL prices set FTTH price levels as well. For FTTH, the government directly supported fiber network build-outs with various industrial policy tools from the 'controlled competition' regulatory regime of the 1990s. First, the Development Bank of Japan (DBJ) provided low-interest loans to NCCs to buildout fiber networks, with no interest charged for public corporations. To finance the interest for DBJ loans, the Telecommunications Advancement

[5] Interviews, various current and former MIC officials, Tokyo 2005-2010.

Organization (TAO), controlled and funded by MIC, provided need-basis low interest financing. The government also implemented a variety of tax incentives, such as special corporate tax redemptions of 6-18% for broadband access network operators, and a decrease in the tax standard for fixed assets. Moreover, TAO guaranteed the debt liabilities of broadband operators, making it easier for them to secure external bank financing (TANIWAKI, 2003). By 1999, over 75 billion yen worth of loans had been allocated from the DBJ (KUSHIDA, 2011). Aided by this financing, both NTT and NCCs aggressively built out fiber infrastructure. By April 2003, 97% of metropolitan areas and 72% of the nation was covered by fiber optic infrastructure (MIC). The actual FTTH services market price, however, was strongly shaped by a new entrant, Usen. Commencing services in 2001, Usen's transmission speed, 100 Mbp, was substantially faster than DSL (16 Mbp at the time). Yet it charged only about 5000 yen - the pre-price shock DSL level.

In March 2001, with support from MIC officials interested in fostering competition against NTT, Usen became the first firm to offer residential FTTH. It initially served a limited part of Tokyo at half the price of NTT's FTTH trial services. However, only a few months later, Softbank delivered its price shock in DSL. For most consumers, slower DSL service for 2500 yen sufficed (in the early 2000s, before the advent of video streaming). Usen retained its price level but significantly slowed expansion plans (WADA, 2006). Other NCCs, who had deployed fiber networks with government support, were forced to match Usen's FTTH prices.

Thus, Japan's PPI that diffused broadband, both DSL and FTTH, at low prices took the form of market competition by start-up firms and new entrants forcing incumbents to adjust. The policy drivers were deregulation, which enabled new entrants to experiment with new services, new technologies, and new business models, and re-regulation, entailing a variety of new rules, new organizations, and new regulatory actors to protect the new entrants. This deregulation and re-regulation stemmed from Japan's telecommunications regulatory 'regime shift.'

Regional deployment support

The provision of broadband service to remote regions often requires policy encouragement. Japan's "Plan to Eliminate Broadband Zero Areas" adopted in 2006 authorized the government to subsidize broadband

infrastructure to make it available to 100% of the nation. Just like the support during the late 1990s for fiber infrastructure, the plan offered low interest loans, tax breaks, and debt guarantees, as well as aid to local authorities for the deployment of broadband schemes (see figure 6)(MIC 2008).

Figure 6 - Japan's promotion schemes for nationwide broadband deployment, mid-2000s

Central government measures for local governments building broadband facilities	*Measures for operators building broadband facilities*
Grants/subsidies - ICT Grant of 1/3 project cost for private use broadband development - ICT Grant of 1/3 of project cost for public facilities broadband development	**Interest aid** - National Institute of Information and Communications Technology (NICT) provides maximum 2% interest loans to operators
Local government financial measures - Special allocation tax for broadband development - Local government may issue Depopulated Area Development Bonds for broadband development	**Debt guarantee** - NICT guarantees 80% of operator loans **Tax breaks** - Accelerated tax depreciation for operators - Partial reduction of tax base for fixed asset taxes

Source: MIC

A second, indirect broadband facilitation program entailed subsidies to cable companies, equal to half of the cost of construction, to update analog signals to digital broadcasts, with the costs shared between the national and local governments. Digital broadcast infrastructure enabled broadband, and with local cable operators originally having developed to re-broadcast terrestrial signals to remote regions, this spread the availability of rural broadband services (ARAI & NAGANUMA, 2010).

■ Broadband success followed by the harder challenge: taking advantage of the broadband for innovation and productivity growth

Despite becoming a world broadband leader in terms of speed, price, and accessibility for almost a decade, Japan has not become a leader in value-added IT services. Policymakers quickly discovered an array of impediments to facilitate the use of high speed broadband, and enterprise investment into ICT was limited. By contrast, US firms have moved from strength to strength, with new waves of innovative online services, such as Google, Amazon, Youtube, Salesforce.com, and more, despite relatively poor consumer

broadband access. Clearly, a different set of ingredients is required to take advantage of widespread high-speed broadband diffusion than to create it. This is a point highly relevant to Europe, which has been concerned about the productivity gap between the US, particularly in IT intensive service industries (van ARK *et al.,* 2003; van ARK *et al*., 2008).

Japan's strategies to promote broadband-based innovation: policy coordination challenges

Japan's lack of dramatic success in taking advantage of its broadband infrastructure was not for lack of trying. In 2003, Japan launched the "e-Japan Strategy II," aimed at using the new network environment to foster high value-added economic activity.

However, the implementation of this second strategy required policy coordination with a myriad of legislative actors, each with their own jurisdiction over some of the targeted areas, many of whom had their own institutional prerogatives and concerns over jurisdictional turf. For example, developing new health-care services and applications utilizing the Internet as a platform fell under the policy domains of the Ministry of Health and Welfare (MHW); the Ministry of Economy, Trade, and Industry (METI); and the MIC. The MHW's almost exclusive focus on domestic health-related issues, even at the expense of the international competitiveness of industry, was difficult to reconcile with METI's focus on international competitiveness. Moreover, METI and MIC were bureaucratic rivals to some degree, each trying to assert jurisdiction over IT network-enabled services. They set up somewhat parallel organizations and strategies, with METI focused on raising the productivity of various service-related industries, and MIC's "u-Japan" strategy aimed at fostering the use of Japan's "ubiquitous networks." Compared to building the networks, which fell under the jurisdiction of MIC, policy coordination toward strategic ends in services such as health care was clearly more difficult (KUSHIDA & ZYSMAN, 2009).

Unexpected regulatory roadblocks also appeared. In 2006, the Japanese government launched a project to create a new, national search engine. However, these plans were blindsided by a conflict with Japan's copyright laws. Under national copyright laws, the act of copying web sites with

copyrighted material on them to "cache" them was illegal (MEXT, 2007). [6] The government soon found itself in the embarrassing position of funding and promoting the development of a national search engine, then finding that such a service was illegal. The obvious solution of revising the copyright laws was not as easy as one might expect. Copyright laws fell under the jurisdiction of the Agency for Cultural Affairs within the Ministry of Education, Science and Technology (MEXT). MEXT was not known to be focused on Japan's international industrial competitiveness, and was less inclined to listen to the wishes of business and industry associations compared to METI - the Ministry promoting the development of a Japanese national search engine. It was not until January 2010 that the Copyright Act was amended to legalize storing of search engine cache results.

These examples of unexpected roadblocks illustrate the potentially complex nature of national strategies facing services. Issues can cut across previous policy jurisdictions that were historically relatively separate, bringing together different sets of regulatory actors and policy-making dynamics. The creation of successful IT services therefore, appears to be less a product of national strategic coordination, and more a product of the broader national or regional dynamics of innovation and entrepreneurship.

A playground for experimentation by others?

A potential irony of successfully building advanced domestic IT networks, but lacking the skills or business environment to take advantage of them, may be that the domestic environment becomes a playground for experimentation by others - others who may extract the high value-added elements and sell them elsewhere, including back to the host country. In Japan, this became the case as US-based Salesforce.com negotiated a contract with Japan Post, the largest financial institution in the world in terms of deposits, to operate its customer service database. Similarly, Google and Microsoft began to manage university email systems, giving them access to data flows from young Japanese users.

Moreover, Japan's highly developed broadband environment actually accelerated the diffusion of "killer applications" from elsewhere. Yahoo and Google dominate search in Japan, and Apple's iTunes store quickly became

[6] "Fair use" interpretations of the *Digital Millennium Act* made these actions legal in the United States.

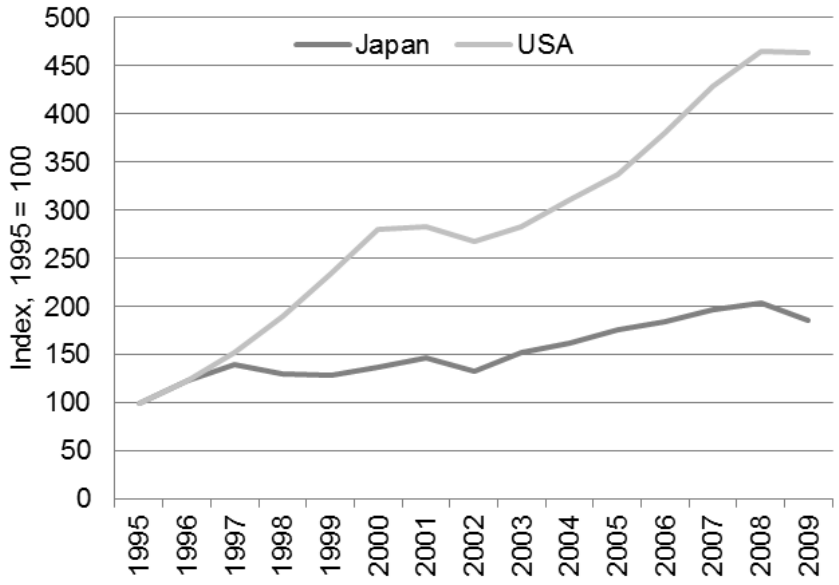
the dominant online music vendor. The fast broadband speeds fostered rapid penetration and use of YouTube, spawning popular domestic competitors, but without fundamentally new business models. Success in building advanced domestic infrastructure can also trap innovations in services, applications, and business models in the domestic market if they depend on particular characteristics of infrastructure, or platforms only available in the domestic market. Finally, attempts to directly regulate particular services to facilitate their adoption can entail a tradeoff between limiting the scope of a particular service by closely defining it, versus keeping open the possibility for innovation by leaving it unregulated, but risking slow deployment (KUSHIDA & OGATA, 2007).

The logic of IT-intensive innovation: lead users, services, skills

To address the question of how to best use the broadband networks once they are in place, it is useful to understand the logic of IT-intensive innovation. The US spearheaded the IT revolution through a process of adoption, experimentation, and innovation (COHEN *et al*., 2000). Lead users of IT tools were large corporations, facing intense competition, who first implemented computers to solve particular problems. They then discovered new uses for this computing power, transforming computers from calculators into "what-if" machines; for example, airlines that implemented computer systems in the 1980s for record-keeping discovered they could utilize the data to completely reorganize their supply-demand management of routes and prices. Likewise, banks discovered that IT tools implemented into their back-end operations enabled the business processes themselves to be unbundled and moved all over the world, as well as many portions automated. The key was that lead users of IT tools faced newly deregulated environments, pressuring them into intense competition (COHEN *et al*., 2000).

From the perspective of potential lead users as large enterprises facing competition, an examination of the ICT investments by enterprises in Japan compared to the US is revealing. The widening gap between the US and Japan is stark (see figure 7). It suggests that despite being advanced in nationwide consumer broadband, Japanese firms are not investing in ICT, implying a lower economic gain and forgoing potential innovations and productivity increases.

Figure 7 - Enterprise investments in ICT



Source: MIC

The ICT services transformation

In the current digital, global era, ICT tools have been revolutionizing service activities, which are transforming into drivers of innovation, economic dynamism, and productivity - what some have called a "services transformation." (ZYSMAN *et al*., 2013) The "productivity paradox" of the 1990s, in which ICT investment did not yield visibly higher productivity growth, is no longer, with productivity growth clearly observed in industries with heavy ICT investments (ZYSMAN *et al*., 2013).

Much of the innovation has stemmed from the US Silicon Valley region, with a distinct set of institutions, skills, and business ecosystems that have produced several generations of leading IT firms - from Intel and Apple to Sun Microsystems, Cisco, Yahoo, Google, and countless others. [7] For the rest of the world, simply attempting to copy some elements from Silicon

[7] For overviews of the Silicon Valley ecosystem, see SAXENIAN, 1994; KENNEY, 2000; LEE *et al*., 2000.

Valley is rarely a recipe for success; countries around the world have attempted but mostly failed to implement a Silicon Valley-style legal and business environment. Yet, certain competencies and skills in a population can matter more than others, and as a policy matter, doing nothing may not be an option (BREZNITZ & ZYSMAN, 2013). For example, Japan is experiencing a shortage of system engineers and software programmers, threatening the ability of firms attempting to offer high-end IT systems and business services.

The cloud computing disruption

The United States has also led in the adoption and creation of cloud computing platforms. As a production platform, innovation ecosystem, and a marketplace, cloud computing is transforming the uses and provision of processing power, storage, and provision of information (KUSHIDA *et al*., 2012). With fully one third of websites visited by typical users built on top of Amazon's virtual servers and increasing reach of services such as Google, and business services such as Salesforce.com, Cloud is becoming ever more ubiquitous as a computing infrastructure.

With cloud computing, scaling up or down is cheaper and faster than ever for new startups, making possible the rapid growth of services such as storage service Dropbox, video streaming company Netflix, and others. Large enterprises benefit from the lowering operating costs offered by increased allocation efficiency and the ability to experiment with bursts of processing power. As the emerging cloud computing industry is consolidating to major global players, each with an array of billion dollar datacenters, the logic of computing is changing towards a more centralized model, where much of the intensive processing is done in the seemingly limitless processing capacity of the major Cloud providers. Cloud providers are themselves actively purchasing extensive fiber networks for their backbone infrastructure to save on costs of delivery and exercise greater control over the innovation process (KUSHIDA *et al*., 2011).

The implication of the advent of cloud computing for broadband buildouts is that the main requirement for accessing the vast computing resources, and the accompanying production tools, innovation platform, and global markets, is an Internet connection of some sort, but not necessarily the fastest. As end devices become ever more powerful, the data decompression algorithms that can be run locally are rapidly expanding in

possibility. As much of the world is unlikely to get 100, 50, or even 30Mbps connections anytime soon, global markets are likely to optimize for narrower bandwidths or new future wireless technologies. Put simply, the minimum bandwidth threshold for harnessing the vast potential of global-scale cloud computing will probably remain low for at least the medium-term. This is good news for digital divide concerns, but warrants caution for costly fiber infrastructure investments.

■ Conclusion

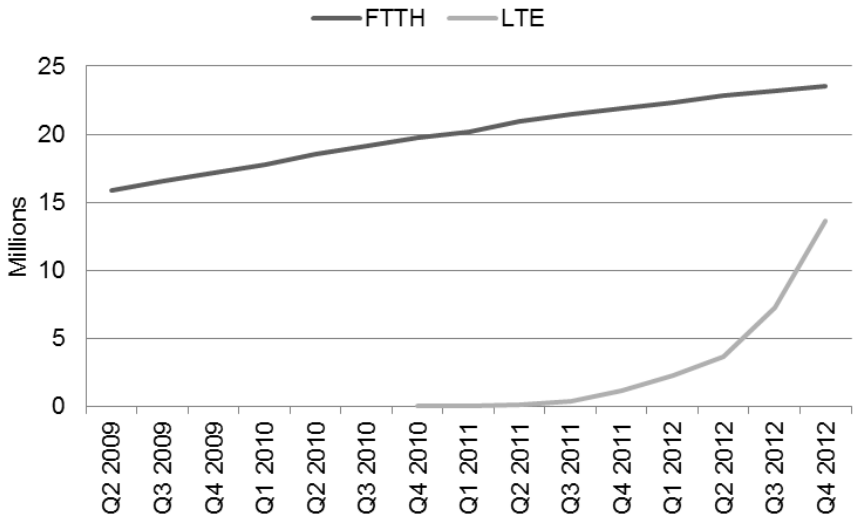
This paper has drawn lessons from Japan, an unambiguous success in deploying nationwide high speed broadband through PPI. For fostering broadband, it emphasizes the importance of harnessing market dynamics attained through both deregulation and re-regulation, to enable new entry and competition, while protecting the new entrants from incumbent competitors. Infrastructure buildouts supported by the government were then subjected to market competition, which led to rapid diffusion. Incentives for regional deployment led to almost full nationwide accessibility in a few years.

The cautionary tale from Japan is that once the broadband network services were in place, taking advantage of them turned out to pose new challenges. Regulatory roadblocks, a lack of institutions to support Silicon Valley-style entrepreneurial dynamics, and the relative lack of large enterprise ICT investments hindered the advent of new lead users aggressively innovating on the basis of the country's extensive high speed broadband environment. In fact, Japan became a useful playground for experimentation by others. Nor did it create the large-scale cloud computing providers to expand globally.

There are two other game-changers that should be taken into account in any serious consideration about PPI for broadband in Europe. First is the advent of high speed, and wireless technologies that will soon reach FTTH-like speeds at far lower infrastructure costs. Near-future iterations of Long Term Evolution (LTE), WiMAX, and the promise of future high speed wireless networks that can potentially exceed current FTTH speeds, require different PPI schemes than conventional FTTH. Moreover, the speed with which new wireless technologies can be adopted is remarkable in urban areas, and vastly cheaper for rural and remote areas vis-à-vis landline infrastructure. The Japanese case strongly suggests that PPI supporting the

deployment of high speed wireless, with a mix of deregulation and re-regulation to foster market dynamics to lower prices, is preferable to a focus on landline fiber infrastructure to the home. Therefore, PPI to foster broadband in Europe should aim for flexibility to incentivize wireless solutions rather than overly concentrate on costly FTTH. Refer to the rapid growth of LTE in Japan, compared to FTTH, as an example, with the understanding that LTE download speeds are expected to soon reach over 100Mbps, as of early 2013 (see figure 9).

Figure 8 - Japan's FTTH and LTE subscribers



The second is the possibility that bandwidth beyond a certain point may yield rapidly diminishing returns as computing power continues to increase. Although cloud computing suggests a greater frequency of data transfers between datacenters and local devices, the amount of data requiring transfer may not grow anywhere as quickly as the amount used and processed. Especially with the overwhelming abundance of computing power on demand that cloud computing provides, processing and data compression at the datacenter will be cheaper and faster than ever. As processing power continues to increase rapidly following Moore's Law, [8] local devices are increasingly able to handle larger data decompression tasks. As these trajectories continue, bandwidth is less likely to become a serious constraint beyond a certain minimum speed, even for high resolution video streaming.

[8] Moore's Law essentially states that processing power doubles every 18 months.

Finally, it is critical for the policy discussion to avoid *ex ante* expectations that fast broadband will somehow unlock innovation and productivity. Instead, stakeholders should engage in substantive discussions about the regulatory and institutions environment for completion among lead user industries. The policy discussions about how to foster broadband should not replace or distract from the critical policy strategies to facilitate competition for lead users, and the possibilities that areas such as cloud computing can open up for user innovation and experimentation.

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