International Comparison and Analysis of Broadband Deployment: From the Viewpoints of Policy and Competition

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Abstract

The deployment of broadband for all people becomes major policy objectives in many counties such as Japan and the U.S.A. The U.S.A. announced recently the National Broadband Plan which aims for 100 million households to access to 100Mbps broadband services by 2020. The purpose of this paper is to analyze the factor of broadband service diffusion as for CATV (BB), DSL and FTTx, respectively. Firstly this paper classifies the major countries into "CATV (BB) diffusion type," "DSL dependent type" and "FTTx diffusion type," considering the ratios by technologies. Then focusing on the government policy and business strategies of operators, this paper analyzes factors in deployment of broadband services. The results we obtain are 1) the degree of broadband diffusion in the early stage of broadband, such as CATV (BB) and DSL, could affect the development of FTTx, the late stage of broadband, 2) business strategies of dominant operators effect FTTx diffusion. This analysis will provide an important base for national broadband policy for each county.

1. Introduction

Promoting the rapid deployment of nation-wide broadband services has become an important agenda among many countries including Japan and the US. Japan, for example, implemented a scheme intending to provide broadband connections to every household by 2015, meanwhile the US is pressing forward with its National Broadband Plan, which aims to provide 100 Mbps broadband services to 100 million households. Furthermore, the smooth and effective diffusion of broadband adoption can be vital for

the nation's economic revitalization and other issues.

Therefore, in this paper, we will discuss the possible factors that influence the diffusion of broadband, by analyzing several fixed broadband technologies, in particular, FTTx which has distinctive characteristics such as high-speed capabilities. More specifically, we first look into the diffusion factors of DSL in Japan. We then compare the diffusion process of broadband among major countries, and analyze the diffusion factors of FTTx, etc.

The views in this paper represents the personal opinions of the authors and do not necessarily represent the views of KDDI Group.

2. Previous Studies and the Features of this Paper

With respect to studies on the broadband diffusion factors, there have been various opinions and discussions on the government policies (or deregulations) for broadband diffusion and competition, business strategies of operators, and attributes of each country, in the scope of one single country or region, or multiple countries.

For studies on broadband in a single country, one example can be found in the analysis on broadband markets conducted by the US Federal Communications Commission (FCC) (FCC [2010]), which focuses on the level of education, income, and other attributes found in multiple areas throughout the US. Similarly, one of the previous studies on DSL in Japan, as shown by Tsuji [2003], [2004], [2005] and [2006], and Akematsu [2007], [2008a] and [2008b] made a positive analysis of the DSL diffusion factors, suggesting that the driving force of DSL diffusion throughout Japan is the open-access policy for metal subscriber lines. Later, we will refer to this research in our discussion of the ADSL diffusion factors in Japan.

For studies on broadband, within a region as shown by FCC [2010] and Commission of the European Communities [2009], or among several countries, as shown by Kushida [2006] and [2009], Fiona [2009], and Scott [2009], one of the most prominent works is the research conducted by the Berkman Center for Internet and Society, Harvard University (Berkman Center [2010]). The research analyzes a wide range of broadband diffusion factors, including competition-related issues such as diffusion rates, access speeds, costs, etc. as well as government policies for broadband diffusion and competition, operators' investments, attributes of the country and other factors. The Center examines a broadband diffusion policy including state aid in each

country, while studying broadband competition policies and suggesting a correlation between countries with the open-access policy (unbundling, etc.) for subscriber lines that are irreproducible and high broadband diffusion rates.

In contrast, in this paper, we focus on an analysis of FTTx, a broadband technology that boasts high-speed capabilities. FTTx is not "stand-alone" technology. Rather, it draws heavily on the development of its predecessors, CATV (BB)[1)] and DSL. If CATV (BB) and DSL are considered to represent the early stage of broadband, FTTx can be defined as the late stage. Therefore, we have determined that it is insufficient to analyze diffusion factors by focusing on FTTx only, thus included CATV (BB) and DSL as well, the early stage of network architectures. We first examined the development of broadband in Japan, the global leader of FTTx, starting from the dawning of the broadband age around the year 2000, to the ages of CATV (BB), DSL, and FTTx.

Next, we have selected eleven OECD member countries for our research, based on the FTTx diffusion rate, etc. Then, according to market shares by broadband technologies and other factors, we have classified these countries into three categories; i.e., the CATV (BB) diffusion type, DSL dependent type, and FTTx diffusion type. Like the above study on broadband in Japan, we have conducted analysis on the diffusion process of three broadband technologies of CATV (BB), DSL, and FTTx, by tracing back to the dawning of the broadband age around the year 2000, and further examined diffusion factors by comparing major countries of the above three categories from our unique perspectives. The study, as shown by Fiona [2009], also includes time-line transitions for three broadband technologies (CATV (BB), DSL, and FTTx) since 2006, but does not address transitions since around the year 2000 (the dawning of broadband) or a factor analysis by technologies.

There have been other studies that already discussed the trends in market shares by broadband technologies and other features in Japan and South Korea, as shown by Kushida [2006] and [2009], which fall into the FTTx diffusion type. In this paper, however, we further conducted analysis on diffusion factors by examining 1) trends in operators' share in each of the three broadband technologies, and 2) business strategies of operators on the transition to FTTx and the possibility of removing metal subscriber lines.

The structure of this paper is as follows: First, in the next chapter we analyze the factor of DSL diffusion, giving the example of Japan, one of the leading countries of broadband field. Next in chapter 4, we classify the status of broadband in major

countries into following three categories: (1) the CATV (BB) diffusion type; (2) DSL dependent type; and (3) FTTx diffusion type, according to market shares by broadband technologies, and analyze diffusion factors in countries of these categories by using the comparison analysis.

3. Factors Promoting Japanese DSL

In this chapter, reviewing previous researches as for factors of DSL diffusion in Japan, we make clear the factors which affect diffusion of broadband services. Figure 1 shows that the transition of Japanese market share of DSL by operators. In Japan, ADSL services launched at September, 2001, and deployed widespread quickly.

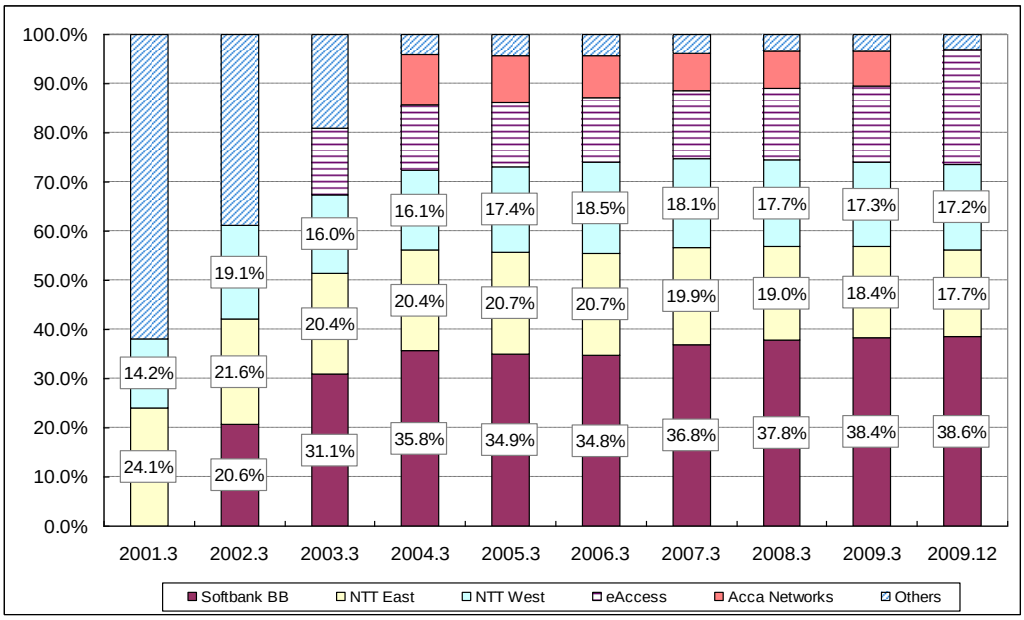

Figure 1: DSL share by operators in Japan

Note: In June, 2009, eAccess consolidates Acca Networks and its share at the end of March, 2009 was 7.1%.

Source: Ministry of Internal Affairs and Communications (MIC)

Tsuji and Tomizuka [2006] and Akematsu [2008b] using the data of several years since 2000 captures core factors which played essential roles in the diffusion of the Japanese DSL. According to these, this paper summarizes factors of DSL diffusion in Japan as the following three: (i) deregulation; (ii) competition; and (iii) technology, and in what follows, this paper examines factors which promote broadband services based

on these standpoints.

3-1. Deregulation factors

There were several important deregulations implemented including "Admission of line sharing and dry copper connection charges (December 2000)," "Revision and enforcement of the Telecommunications Business Law (April 2001)," and "Enactment of notification (June 2001)," those are categorized as the deregulation factors. Except for "Admission of line sharing and dry copper connection charges (December 2000)". All deregulation factors are proved to have significantly positive effect to DSL diffusion. And "Revision and enforcement of the Telecommunications Business Law" is the most positive in comparison with all other factors. Akematsu [2008b] asserted, therefore, that deregulation actually promoted ADSL diffusion by increasing the number of subscribers.

3-2. Competition factors

Three operators, NTT East and West, e-Access, and ACCA, but not Yahoo!BB, provide network services to ISPs, such as @nifty, Biglobe, and So-net. These ISPs, not the operators, then compete with each other to obtain subscribers. Business strategies for increasing subscriber numbers are related to ISPs, not to the three operators. In this sense, it is not desirable for the estimation to include factors concerning the marketing strategies of each ISP. Only Yahoo!BB, on the other hand, owns ISP services. For this reason, the marketing strategies of Yahoo!BB are included among the other factors. Except for factors concerning the launching of new services by operators, all factors related to the three operators are positive effects to DSL diffusion.

The competition factors extracted by the estimation are as follows: "A new service launch by NTT East and West," "A new service launch by Yahoo!BB," and "Two-month free trial campaign by Yahoo!BB". Generally speaking, a new service launched by one operator has negative effects on subscribers to other operators. The estimation result, however, shows that the sign for factor, that is new service launched by Yahoo!BB, is significantly positive. This can be interpreted as follows: the elasticity of charges is low in the ADSL market, and this implies that users rarely change operators. The entrance of Yahoo!BB into the market expanded and vitalized the whole market, and this lead to other operators obtaining new subscribers. "Two-month free trial campaign by Yahoo!BB" is also effective, and it can be said that the campaign was

successful. In spite of the fact that this factor is attached only to Yahoo!BB, the estimated coefficient is rather large, and this shows the strong power of Yahoo!BB at that time.

3-3. Technology factors

ADSL technological development occurred continuously, especially that related to connection speed. According to the result, the 12Mbps service has the largest factor. The 24Mbps service is also effective, following 12Mbps. The 40Mbps service is ineffective. The results related to different connection speeds are interesting. Generally speaking, the higher the speed of connection service launched, the greater will be the increase in the number of subscribers for this particular speed. The result we obtained, however, was the converse of this. One possible interpretation is that since most data can be transmitted smoothly at around 1Mbps users are not particularly concerned about very high speed connections.

We can summarize as follows as the results of this chapter: (i) there were factors which affected DSL diffusion in Japan, including deregulation, competition and technology; and (ii) deregulation affected most.

In the next chapter, we categorize major countries into "CATV (BB) diffusion type," "DSL dependent type" and "FTTx diffusion type," considering the ratios by technologies to make clear the factors of diffusion of broadband services in those countries.

4. Comparison and Classification of Broadband Overseas

In the first decade of the 21st century, broadband has developed at a staggering rate, and now boasts three different technological types: CATV (BB), DSL, and FTTx. DSL uses pre-laid metal subscriber lines and, on the other hand, FTTx uses fiber-optic lines currently being laid. Therefore, it is difficult to identify general diffusion factors such as government policies, business strategies of operators, competitive conditions, and attributes of the country by examining only one country.

Thus, we have selected eleven OECD countries for an analysis of FTTx diffusion rates. Market shares by broadband technologies in these eleven countries are given in Figure 2 (as of June 2009).

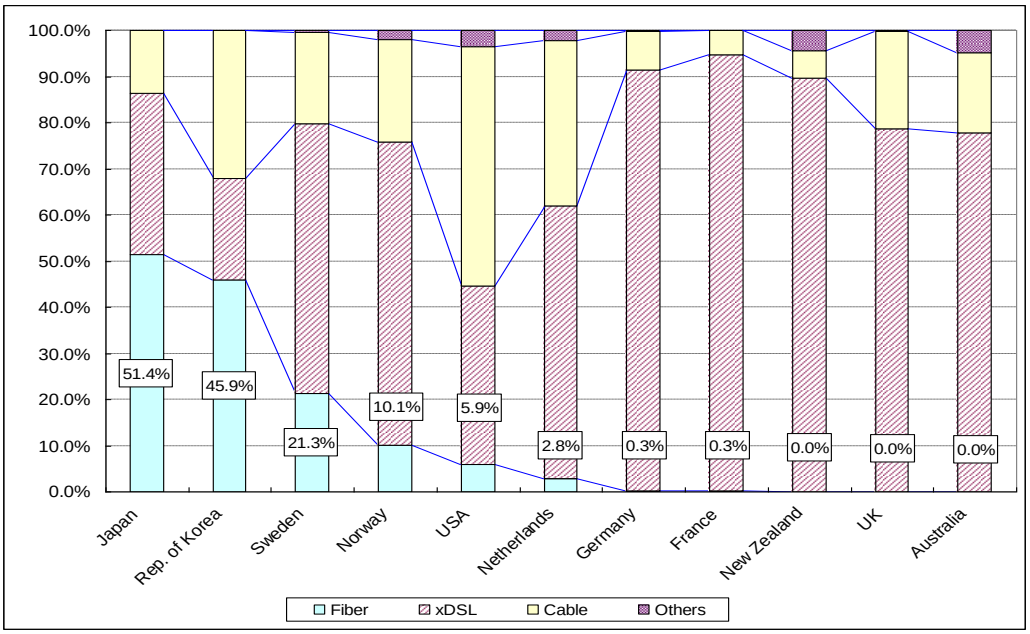

Figure 2: Broadband ratios by technologies in various countries (as of June 2009)

Source: OECD

Countries with relatively high proportions (around 50%) of CATV (BB) diffusion, such as the US and the Netherlands are categorized as "CATV (BB) diffusion type," while France, Germany, the UK and other countries where DSL is the primary format are categorized as "DSL dependent type". Countries where FTTx is the dominant broadband technology, such as South Korea and Japan, are categorized as "FTTx diffusion type."

Classification of these eleven countries for analysis into the three categories was determined at the time of gathering data for Figure 2 (as of June 2009), however, each country continues to shift between these categories over time. And, the CATV (BB) market also saw a shift from the predominant coaxial cable format to a higher-speed fiber-optic cable format. In this paper, however, we do not discuss the particulars of these formats; instead group them together as CATV (BB).

In the following chapters, we will analyze the characteristics of the aforementioned types and their diffusion factors.

5. CATV (BB) Diffusion Type

Generally speaking, in most countries, except the US and a few others,

telecommunications services originated in a state monopoly that permitted competition years later. This meant that a dominant operator controls the requisite subscriber lines and attains a large market share in terms of services.

In this kind of oligopolistic environment, we could see one characteristic of the CATV (BB) diffusion type; i.e. the provision of broadband services by using subscriber lines of CATV (broadcast), a system completely separated from telecommunications carriers. From the market standpoint, this system is significant in generating competitions and certain market shares by operators other than dominant operators, and for users, it offers another choice of broadband services.

In this chapter, we discuss about the US and Netherlands those countries are categorized as CATV(BB) diffusion type, and before that, we suggest the following three factors that may contribute to the spread of CATV (BB).

(1) in terms of customer share, at the dawning of the broadband age around the year 2000, CATV (broadcast) had a high household diffusion rate.

(2) in terms of infrastructures, there was a high diffusion rate of CATV homes passed.

(3) consolidation and business expansion occurred among CATV providers to increase investment possibilities for CATV infrastructures.

Therefore, we propose a hypothesis that the above three factors are essential as conditions to promote CATV (BB) diffusion, and in the following Chapters, we verify this hypothesis by comparing the development of broadband diffusion in several countries.

5-1. Process of CATV (BB) diffusion

The US and the Netherlands both belong to the CATV (BB) diffusion type category, but the process of diffusion in the two countries took different routes.

In the US, with its massive territory, terrestrial broadcasting cannot cover the entire country by itself. Therefore, in the 1970s, CATV (broadcast) spread throughout the country, being combined with satellite broadcasting, as a way to improve reception, eventually securing an established position with the start of CATV-only channels devoted to news and other topics. Now, when a construction company builds a house, CATV wiring is routinely drawn into the plans.

In 1984, AT&T, once the behemoth of American telecommunications, separated into “new” AT&T for long-distance communications and seven “Baby Bells" for

regional communications. AT&T prepared to enter the CATV (BB) market in its formative stages, acquiring TCI (March 1999) and Media One (May 1999), which held the second and third largest shares of the CATV (broadcast) market, to jump into the second place behind AOL Time Warner in the CATV industry. In December 2001, the CATV business, previously acquired by AT&T, was merged with fourth-place Comcast as a result of AT&T's spin-off. This made Comcast the largest CATV company in the US, with 22 million CATV (broadcast) subscribers, 2.2 million CATV (BB) subscribers, and 1 million CATV (telephone) subscribers.

In subsequent years, Comcast actively worked to become a true triple player, building on its broadband base by offering almost all of its customers IP telephone services by the end of 2005. As a result, the company was able to win a 19.3% share of the entire broadband market, just behind the 19.5% share held by the new at&t[2)], the largest broadband-providing telecommunications firm. In terms of CATV (BB) sector, it acquired the largest share of the broadband market (51.3%, including 11.3% share of Time Warner Cable, the second biggest provider), followed by 41.6% share of DSL. (Each share data here is as of December, 2008, based on OECD Broadband Statistics and other statistics.)

In the Netherlands, however, local governments controlled CATV (broadcast), and by the end of the 1980s, 85% of households of this country became subscribers. After liberalization policies established in the 1990s, CATV (broadcast) was privatized, and in 2000, three companies (UPC, Essent, and Casema) formed an oligopoly that controlled 86% of the total CATV market. Essent and Casema were later reorganized, eventually becoming Zesko Holding (Ziggo) in June 2008 and securing a 22.4% CATV (BB) share of the overall broadband market. With UPC at an 11.3% share and other companies accounting for smaller shares, 37.4% of the broadband market is controlled by CATV (BB), trailing only KPN (43.8%), the country's largest telecommunications company. (Each share data in this paragraph is as of March, 2009 by Telecom Markets)

As for broadband diffusion trends after the dawning of the broadband age around the year 2000, Figure 3 shows that at nearly 100%, the US and the Netherlands have much higher CATV homes passed diffusion rates than any other countries. Likewise, Figure 4 shows that the US (approximately 60%) and the Netherlands (approximately 90%) have also extremely high CATV (broadcast) household diffusion rates.

Given the backdrop described above, the two countries of the CATV (BB) diffusion type experienced a steady increase in CATV (BB) household diffusion rates

from around 2000, the dawning of the broadband age, and eventually reached roughly 30% in 2007 in Figure 5 and around 50% in June of 2009 in Figure 2.

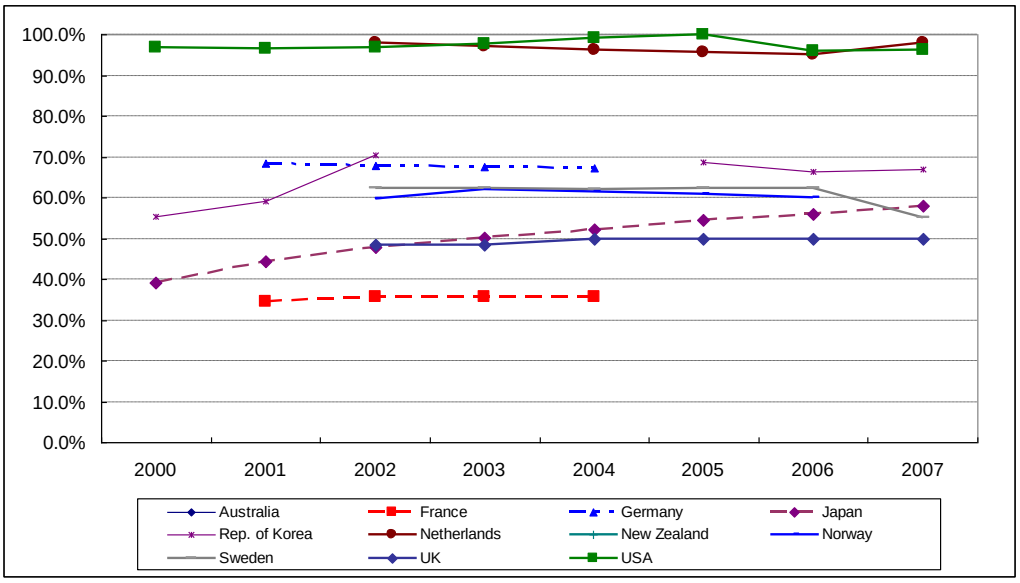

Figure 3: CATV home pass household diffusion rates

(number of home pass/number of households)

Source: OECD

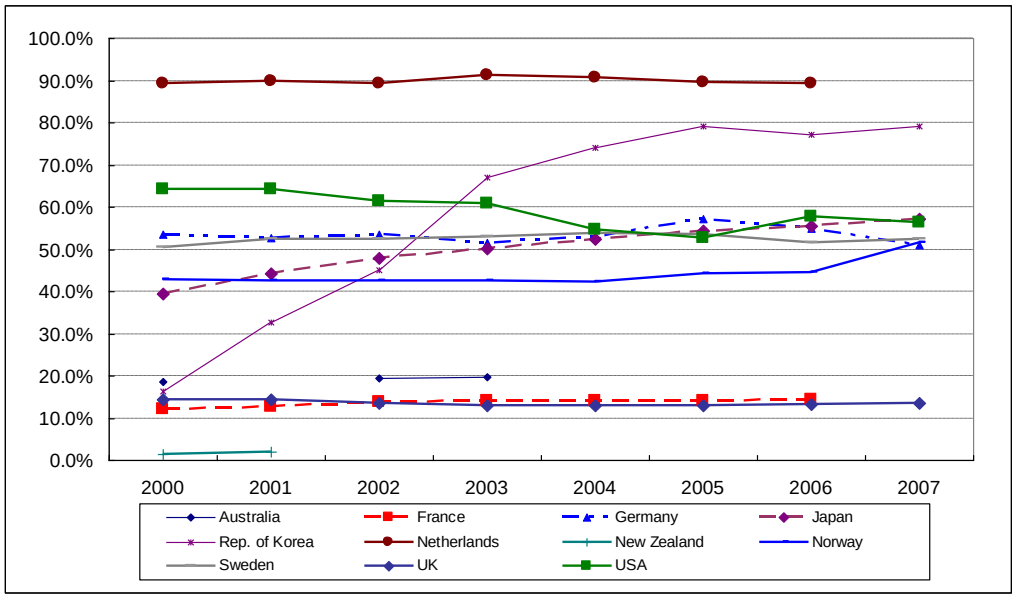

Figure 4: CATV (broadcast) household diffusion rates

(number of contracts/number of households)

Source: OECD

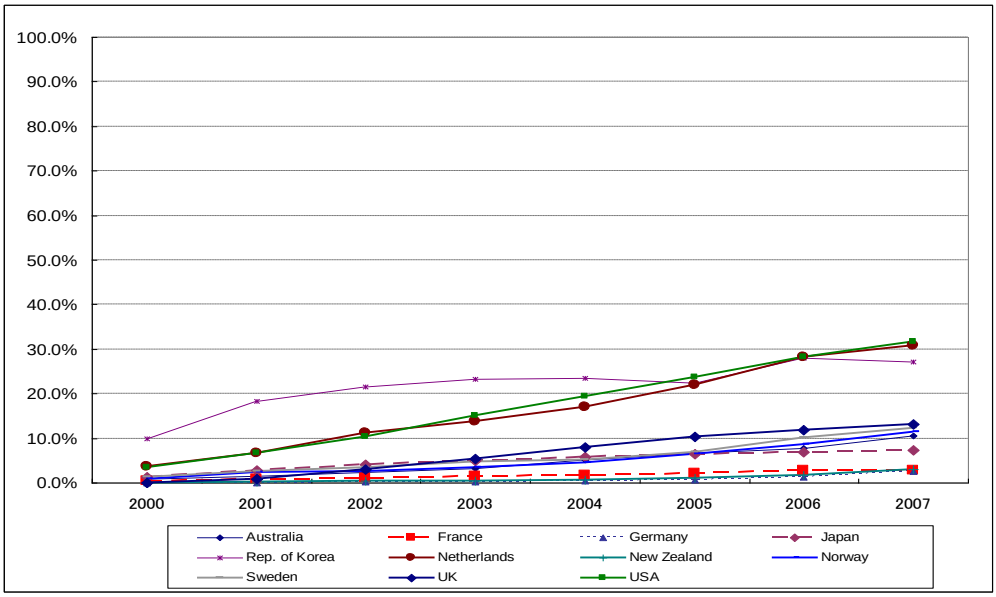

Figure 5: CATV (BB) household diffusion rates (number of contracts/number of households)

Source：OECD

5-3. Business strategies of telecommunications carriers – from metal to optical

AT&T and Verizon are currently working on to build an FTTx network in the US. In October 2004, AT&T announced its "Project Light Speed," a three-year plan to lay optical lines enough to serve 18 million homes. Verizon also announced its "FiOS" in the same month, pledging to lay lines for 18 million homes by 2010. However, as evidenced by Verizon's 1.5Mbps FTTx speed, in the US, even FTTx cannot always provide the 100Mbps services that far exceed the capabilities of ADSL. Currently, however, Verizon provides the broadband service its downstream is up to 50Mbps (FiOS Internet), and AT&T also provides the service up to 24Mpbs (U-verse High Speed Internet).

In the Netherlands, Reggefiber (formed in 2005) launched a new business relating to wholesale dark fiber optic cables, jointly with KPN in April 2008. With its efforts, the company has already laid fiber-optic lines to 510,000 of the Netherlands' 7.2 million households, with 140,000 of the households already linked to FTTx services. For its wholesale optic fiber business in the capital city of Amsterdam, Reggefiber acquired a 70% stake in Glasvezel Net Amsterdam (GNA), a fiber optic enterprise, while the city of Amsterdam and a public housing corporation invested 15% each. GNA has launched a CityNet project, which is currently providing FTTx services to 40,000 households,

and planned to increase the number to 45,000 in the coming years.

5-4. Diffusion factors for the CATV(BB) diffusion type

As discussed above, the development of CATV (BB) diffusion in the US and the Netherlands, a CATV (BB) diffusion type, can be summarized as follows: First, in the early stage of broadband (CATV (BB) and DSL), although diffusion policies in the two countries differed, with the US forced to deal with territorial size issues and the Netherlands able to make use of local governments, both countries satisfy the diffusion conditions and saw the rapid diffusion of CATV (BB). Second, broadband competition policies, which implemented open access to metal subscriber lines, promoted DSL diffusion. In the late stage of broadband (FTTx), heated market share competition between CATV (BB) and DSL provided by telecommunications operators has prompted the controlling telecommunications operators to make capital investments for optical subscriber lines, shifting their operations to FTTx.

In the next chapter, we will analyze the diffusion factors of countries classified as "DSL Dependent Type," including France, Germany and UK.

6. DSL Dependent Type

The decision to call the second category the "DSL dependent type" category is intended to suggest that DSL is "not permanent." DSL, which uses pre-existing telephone metal subscriber lines for a broadband connection, is a significant part of broadband as a whole. However, there are issues with the metal subscriber lines required for DSL service provision. First, as the lines have been used for several decades (this duration depends on the country), they will eventually reach the limit of their physical capabilities. Second, dominant operators that own the metal lines want to concentrate their efforts on optical subscriber lines and avoid having to maintain both metal subscriber lines and optical subscriber lines. Third, DSL has limitations in terms of broadband speed. Fourth, it has also technical distance restrictions, preventing it from covering an entire country. For these reasons, several countries are looking into the removal of DSL[3)]. In broadband leaders Japan and South Korea, metal subscriber line-based DSL once represented a considerable portion of the market share by broadband technologies, but the market has begun to shift toward fiber-optic FTTx.

6-1. France and Germany

France and Germany, the countries that make up the DSL dependent type, are characterized by the facts that: both have low CATV (BB) diffusion rates, but for different reasons; DSL holds at least a 90% of market share by broadband technologies; and the FTTx transition process in the two countries differs due to differences in telecommunications network structures.

6-1-1. Low CATV (BB) diffusion rates and different factors in France and Germany

In France, the nationwide CATV (broadcast) cable television network was created by France Telecom based on cable television network structure plans developed in 1982, and public utility companies used CATV lines of France Telecom to provide CATV (broadcast) services. However, diffusion was limited by the high costs of CATV lines and the fact that pay-television was available only on terrestrial television. In 1986, companies other than France Telecom were permitted to construct cable television networks, and the number of cable television stations is estimated to have reached 14 in 2004, and thereafter, reduced to two operators (Noos and Numericable) in 2005 due to consolidations.

At the dawning of the broadband age around the year 2000, the CATV (broadcast) household diffusion rate, representing what would be the customer base, was low at around a mid-10% in Figure 4. The infrastructure situation was murky, as well, with the CATV home pass diffusion rate in the 30% range in Figure 3 - the lowest among the countries chosen for analysis besides New Zealand and Australia, for which no statistical data exists. Thus, the CATV (BB) share of the total broadband market is stagnant at around 5% (as of June 2009), the lowest among the eleven countries chosen for analysis in Figure 5.

Germany, on the other hand, is a CATV colossus, with CATV (broadcast) boasting around 50% household diffusion rate and CATV home pass diffusion rate of around 70% at the turn of the century in Figures 3 and 4, respectively. The CATV (BB) household diffusion rate, on the other hand, remained under 10%, comparatively lower than the levels in other countries in Figure 5. This is partly due to a unique structure of the German CATV industry, in which there are two kinds of providers: those who own CATV networks and those who directly provide CATV (broadcast) services to customers, and the latter is small-sized and majority. In Germany, the federal postal service (the forerunner to Deutsche Telekom) began work on the CATV network in

around 1982 under the leadership of the federal government, but considerable frictions arose between CATV and the community antenna television companies that had provided services to housing complexes and other subscribers at the private level. The government responded by splitting CATV providers into two groups[4)]: companies to serve subscriber residences and companies to serve the public sphere. This division made the postal service responsible for the CATV network provider side and allowed community antenna providers to continue to maintain the customer base. The transformation, it is said, led to the establishment of thousands of customer-side providers, some serving less than one hundred households and others serving tens of thousands. The presence of myriad companies that enter into contracts with customers and vary greatly in both size and structure are part of the reason that CATV (BB) did not penetrate well throughout the German market.

In addition, in 1999, the European Commission issued a directive that banned the ownership of CATV networks by dominant telecommunication operators. Thus, Deutsche Telekom sold its CATV business by dividing it into nine regional operations. However, Callahan Associates, the purchaser of two of these regional operations, was unable to win the cooperation of the many customer-side providers and went bankrupt, while Liberty Media, which acquired six regional operations, received an order from the Federal Cartel Office in 2002 to suspend buying. Thus, the German CATV industry at the dawning of the broadband age around the year 2000 was unable to afford to promote CATV (BB) diffusion.

As shown above, German CATV at the dawning of the broadband age had, in terms of customer base, high CATV (broadcast) household diffusion rates, and, in terms of infrastructures, high CATV home pass diffusion rates. However, it also had a unique industry structure in which the major CATV network-side company and multiple small-scale customer-side providers were separated; this structure prevented CATV providers from consolidations and business expansions.

6-1-2. DSL and FTTx in France

France Telecom was forced to unbundle DSL metal subscriber lines in April 2001. Dry copper became available for competitors in June of the following year, helping the DSL household diffusion rate gather steady upward momentum in Figure 6. In recent years, France Telecom has devoted the majority of its around 46% share of the market to DSL, while Free allots the entirety of its around 23% share to DSL (each data is as of

March, 2009 by Telecom Markets).

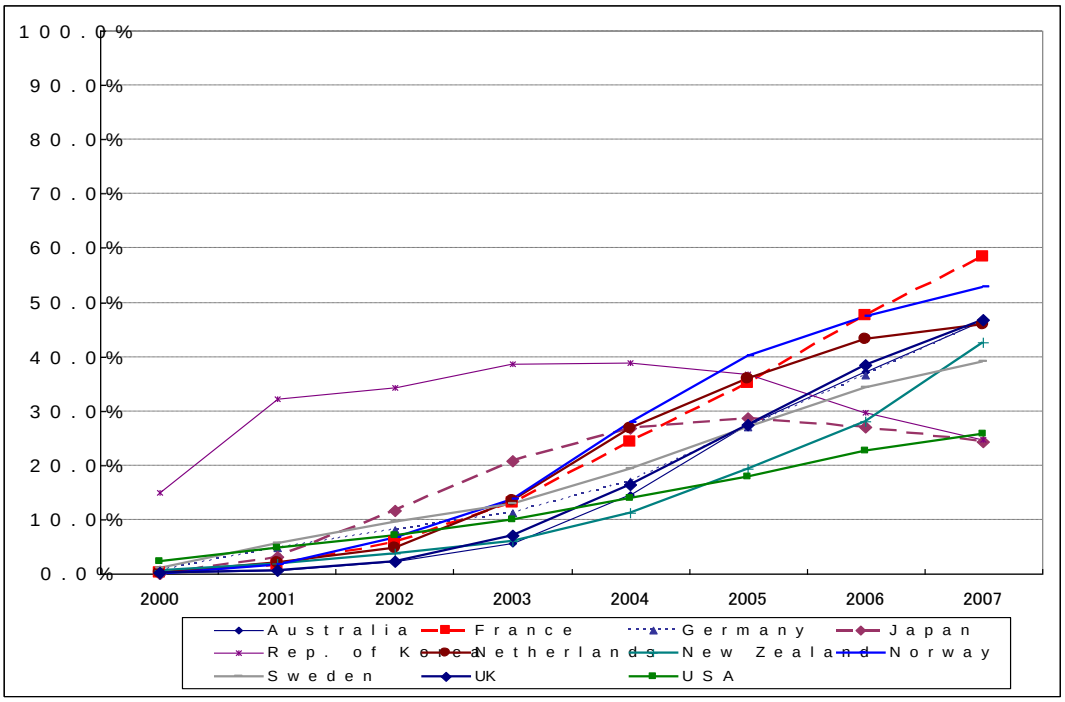

Figure 6: DSL household diffusion rates (number of contracts/number of households

Source：OECD

In France, metal subscriber lines are laid from end offices to subscriber residences via street cabinets located all over the country. Unlike the case in Germany (explained below), in France, with its long-distance metal subscriber lines (sub-loop), a nationwide VSDL-based FTTC system on a pre-laid sub-loop would encounter several problems, including reduced speeds. Thus, though France realizes that the next logical choice after DSL with fixed speed limits would be FTTH, such a system requires substantial investment in fiber-optic lines to reach customer residences.

After the enactment of a law in 2004 that allowed local authorities to become telecommunications operators, local authorities in nearly 50 communities have made significant contributions to broadband service provision, and fiber-optic resources in 65 regional development bases have been opened up for use. Other telecommunications carriers often use these freed resources to provide services to subscribers.

In terms of infrastructures, roughly 800,000 households live in buildings with fiber-optic access, 70,000 of which are FTTH users. An additional 3.5 million households have access to FTT-LA (last amplifier, a system in which the terminal

leading wire is a CATV coaxial line), which combines fiber-optic technology with a terminal's CATV and is used by approximately 220,000 households.

6-1-3. Recent government policies in France

In 2001, the French government demanded that the Caisse des Depots et Consignations (CDC), a French public-sector financial institution, contribute to broadband diffusion. CDC made an investment of 230 million Euros and has worked together with local authorities to discuss and invest in broadband projects. In most cases, public agencies in various regions select private sector companies as their partners, make a certain contribution and lay communications lines and establish other infrastructures. These infrastructures are then opened for the use by broadband service providers to serve their customers.

In April 2009, aiming to promote competition for FTTx on an infrastructure base, the Autorité de Régulation des Communications Électroniques et des Postes (ARCEP), an independent French agency in charge of regulating telecommunications, required France Telecom and all other operators to open up building wiring to owners of the buildings.

6-1-4. DSL and FTTx in Germany

In Germany, as in France, metal subscriber lines are laid from end offices to subscriber residences via street cabinets located all over the country. In Germany where the number of street cabinets is large and the distance of metal subscriber lines (sub-loops) is short, these street cabinets are used for ADSL and VDSL. Basically, with ADSL equipment (DSLAM) installed in street cabinets, subscribers have access to ADSL services. Recent figures in market shares show that broadband services are provided by three major companies: i.e. Deutsche Telekom (43.7%), United Internet (13.9%), and the Vodafone group (13%), and all of them provide DSL services (each data is as of September, 2009 by Telecom Markets).

In addition, when street cabinets are outfitted with even faster VDSL equipment, users can access FTTx (FTTC) services as well. This requires new optical lines to be laid from the street cabinet to the corresponding end office. However, once the optical lines are split by VDSL equipment installed within street cabinets, the multiple sub-loops that stretch to subscriber residences can make use of pre-laid metal subscriber lines. This not only keeps capital investment to a minimum, but also provides

FTTC-based 50Mbps broadband services to users virtually nationwide.

6-1-5. Recent government and business strategies in Germany

Thus, with FTTC a viable option in Germany, the federal government developed broadband stimulation policies in 2009 that pledge to provide 1) 1Mbps or faster broadband services to every household by the end of 2010; 2) 50Mbps or faster broadband to 75% of all households by the end of 2014; and 3) thereafter to provide 50Mbps or faster broadband to every household forthwith.

In addition to investing 30 billion Euros in the DSL development since 1990, Deutsche Telekom has invested another 30 billion Euros in VDSL-based FTTx (FTTC) in 50 urban areas. Some cities have also secured FTTB/H services, with NetCologne and M-Net building operations in Kern and Munich, respectively.

6-1-6. Diffusion factors for both countries

In sum, the development of broadband diffusion in France and Germany can be summarized as follows: First, in the early stage of broadband (CATV (BB) and DSL), although conditions were different in the two countries, CATV (BB), which fails to meet the aforementioned diffusion conditions, spread minimally, while DSL diffusion became comparable with other countries due to broadband competition policies on metal subscriber lines (open-access policies). In terms of the late stage broadband (FTTx), differences in network structure have set the countries on different paths, as France is forced to convert to FTTH while Germany was able to provide 50Mbps services nationwide by making use of portions (sub-loops) of the pre-laid metal subscriber line network.

6-2. UK

6-2-1. Low CATV (BB) household diffusion rates

As it currently stands, broadband in the UK is provided almost exclusively in the CATV (BB) and DSL technologies in Figure 2, and diffusion rates put the country in the middle of the eleven nations being examined in Figures 5 and 6.

British CATV (broadcast) originated in 1951, later evolving into a format that could be used for telephony (1991) and broadband services. At the dawning of the broadband age around the year 2000, however, the CATV (broadcast) household diffusion rate of 13% and CATV home pass diffusion rate of approximately 50% (2002

statistics) were below those in almost all of the countries for analysis in Figures 3 and 4. Although the market share by broadband technologies claimed by CATV (BB) reached the 40% range in 2004, DSL diffusion brought the share back down to around 20% by June 2009.

6-2-2. DSL and "wholesale"

In order to analyze DSL diffusion factors in the UK, we first need to discuss the "wholesale[5)]" method that dominated British DSL until the mid-2000s. Therefore, we will examine this method by making comparison with the "unbundling" of metal subscriber lines below.

"Unbundling" is when competitors use metal subscriber lines owned by British Telecom (BT) as raw materials (copper wires); that is, a competitor chooses "only the equipment necessary for DSL services" and purchases it from BT. Then, in order to provide DSL services, the competitor sets and creates its own specifications for all equipment at both ends of the metal subscriber lines - more specifically, the end office equipment is DSLAM, and the customer-end equipment is a DSL modem. Because DSLAM equipment is installed in hundreds of end offices, initial investment costs are substantial, but the equipment helps reduce the costs required in eventual expansion. The other crucial element of unbundling is that it affords the competitor a high degree of management and administration freedom: a provider can increase service speeds by simply modifying equipment specifications on both ends of the metal subscriber lines.

On the other hand, "wholesale" refers to not only using metal subscriber lines owned by BT, but also BT infrastructures at both ends of lines with BT specifications. Essentially, this means that a competitor purchases "semi-product DSL services" from BT and sells the services to customers. For competitors, wholesaling minimizes initial investment costs but generally offers little benefit in upscaling. Another important contrast between wholesale and unbundling is that wholesaling limits the amount of administration freedom a competitor has: the competitor cannot arbitrarily change the infrastructures connected to both ends of the metal subscriber lines, and, as a result, DSL service speeds are restricted.

As explained above, for dominant operators, DSL diffusion and increased service speeds inhibit the revenues produced by existing services. Thus, the wholesale method, which gives dominant operators some control over DSL speed, etc. is beneficial for dominant operators.

The UK also opted in 2000 to unbundle metal subscriber lines by imposing BT licensing conditions. However, unlike Japan where DSL experienced a sudden surge due to the 2001 unbundling implementation, the UK saw a weaker upswing in the household diffusion rate. This is because of the fact that the wholesale for DSL services was the popular method in the country at that time in Figure 6. As a result, CATV (BB) held on to roughly half of the broadband market until around 2003 in Figures 5 and 6. Then, in December 2004, the Office of Communications (OFCOM), an independent regulator and competition authority for the UK communications industries, conducted a market review that resulted in not only the reduction in metal subscriber line unbundling fees by 70%, but also the establishment of collocation and other rules for unbundling. After this critical juncture, the number of unbundled metal subscriber lines grew from 21,000 lines (September 2004) to 1.3 million lines (at the end of 2006) and later to 6.36 million lines (at the end of 2009), with the DSL household diffusion rate rising accordingly in Figure 6.

In January 2006, upon consultations with OFCOM, BT announced that it would create a separate organization (a functional separation) for its access line section, which maintained a high market share, in order to ensure fairness. This move was mostly due to the stagnation in DSL diffusion caused by "wholesaling."

6-2-3. Recent government and business strategies

Having started work on the promotion of broadband diffusion, the UK government created a "Digital Britain" program in June 2006 to accelerate broadband diffusion by eliminating obstacles to duct access and so on, to provide universal access to 2Mbps broadband services by 2012, and to establish a support fund for ultra high-speed broadband. The project includes a provision by which users of fixed metal lines and cable telephone lines would contribute 50 pence (about 70 yen) per month to create an overall investment of one billion pounds over the next five years. Prior to the development of Digital Britain, BT announced a plan in July 2008 to invest 1.5 billion pounds through 2012 to reach 10 million households (40% of the total population) with a fiber-optic network.

Hence, the development of broadband diffusion in the UK can be summarized as follows: in the early stage of broadband (CATV (BB) and DSL), CATV (BB) did not satisfy diffusion conditions and thus did not spread well, while DSL diffusion was also slowed by insufficient broadband competition policies (open-access policies) that made

"wholesale" the primary method of dealing with metal subscriber lines. The subsequent involvement of regulatory agencies helped propel metal subscriber line deregulation; DSL diffusion, which had fallen behind diffusion trends in other countries, is now regaining stream. Delayed by the slow progress of the early stage of broadband, the late stage of broadband (FTTx) is still at the starting line.

In the next chapter, we will analyze the diffusion factors of countries classified as "FTTx Diffusion Type," including Japan and South Korea.

7. FTTx Diffusion Type

The FTTx diffusion type is characterized by a high FTTx share of the broadband market - the FTTx shares in Japan and South Korea account for about half of the respective markets at 51.4% and 45.9% in Figure 2 - and DSL peak-out in Figures 7 and 9. As the diffusion status of CATV (BB) in the two countries differs, this section will examine past backgrounds starting with CATV (BB).

7-1. Japan

Figure 7 shows the transition of subscribers in Japanese broadband market.

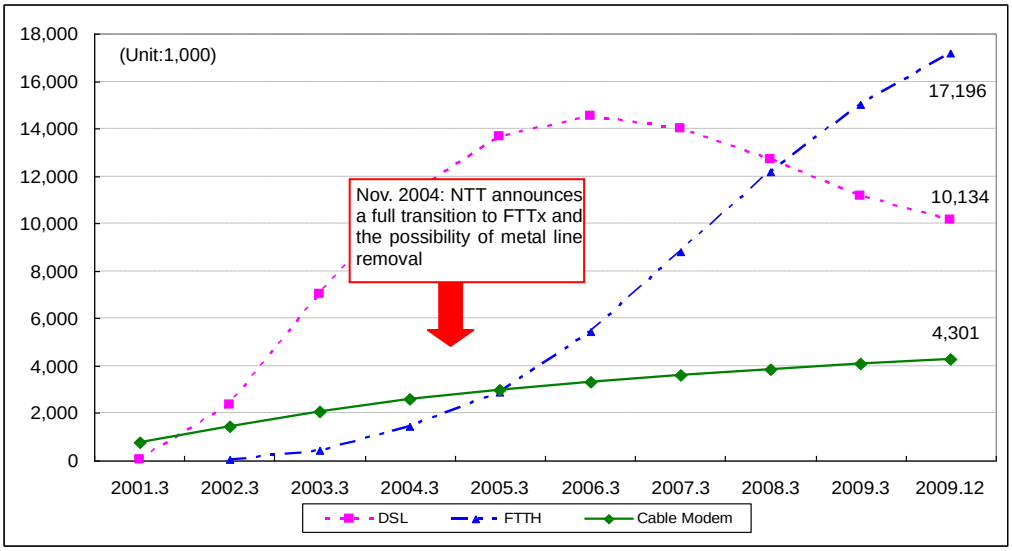

Figure 7: The number of broadband subscribers in Japan

Source: Ministry of Internal Affairs and Communications, and various company publications

7-1-1 FTTx diffusion and DSL peak out

The spread of FTTx started to accelerate around 2005, with FTTx eventually securing a larger share than DSL in June 2008 and assuming the lead in the broadband market in Figure 7. Due to the widespread diffusion of FTTx, DSL experienced a peak out in March 2006 in Figure 7.

7-1-2 Government policies and market conditions on FTTx

Unlike other broadband services that use pre-laid metal subscriber lines, FTTx requires fiber-optic subscriber lines. The Japanese government has started to work on a series of FTTx diffusion policies, but considering the state of telecommunications in Japan, diffusion is bound to depend heavily on capital investment by NTT East, NTT West and other operators.

NTT East and NTT West, the dominant operators, are obligated to open fiber-optic subscriber lines, just as it was with DSL service metal subscriber lines. This requirement, like the DSL requirement, is intended to establish unbundling, collocation, and connection fees so that other operators are able to offer services that can compete with NTT East and NTT West's FTTx services. However, as the technical attributes of fiber-optic technology limit unbundling to a certain level[6)], competitors that make use of NTT East's and NTT West's fiber-optic infrastructures cannot actually offer services that are completely competitive with those of NTT East and NTT West.

As it currently stands in Japan, then, a competing third party that wants to provide full-scale FTTx services must lay its own fiber-optic lines, thus making the Japanese FTTx market a de facto facility/equipment competitive environment.

7-1-3 FTTx competition

In Japan, FTTx services are provided by NTT East, NTT West, other competitors (including telecommunication subsidiaries of electricity companies that serve regional communities) and KDDI, which has acquired several telecommunication subsidiaries of electricity companies in certain areas. Although individual electric companies are competitive with NTT services in some areas, NTT East and NTT West's overall national FTTx market share is consistently on the rise and has now passed the 70% mark, while competitors' total share has stalled at around 20% in Figure 8 as of December 2009.

NTT East's and NTT West's total broadband market share is also on an upward

trend, increasing from 25.2% in March 2002 to 51.6% as of December 2009.

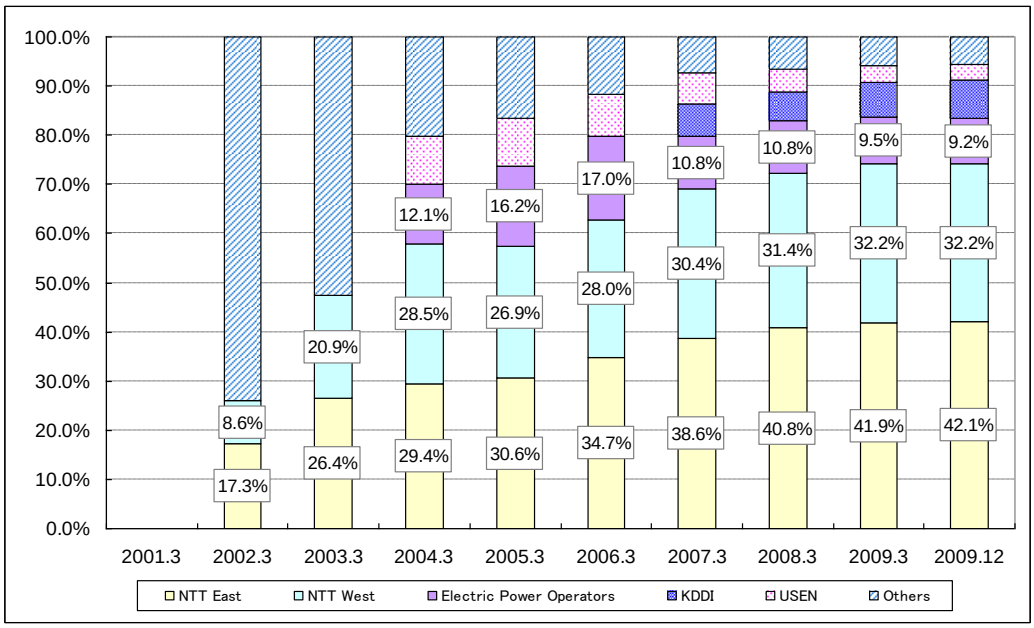

Figure 8: FTTx share by operators in Japan

Note: In January 2007, KDDI consolidates POWEREDCOM (Tokyo Electric Power's group company)

Source: Ministry of Internal Affairs and Communications, and various company publications

7-1-4 Business conditions and policies of operators

The growing diffusion of FTTx and the phasing out of ADSL have become prominent after NTT East and NTT West, the owner of the metal lines, announced in November 2004 its intentions to make a complete transition to the optical network and the possibility of removing metal subscriber lines[7)] in Figure 7.

This move has created three major problems for competitors that had previously focused on DSL services. First, NTT's announcement on the possibility of removing metal subscriber lines made it increasingly difficult to concentrate primarily on DSL and forced the providers to be more cautious about continued investment in management resources. Second, NTT's full transition to FTTx would mean a smaller DSL market and higher speed broadband services in the entire market, thereby putting pressure on competitors, as well, to move from DSL to FTTx. Third, competitors were unable to offer FTTx services which are sufficiently competitive with NTT, thus it was difficult to develop its broadband service operations. In fact, Softbank, which had

secured a share comparable to that of NTT in the DSL market, abandoned its plans to make a full-scale entry into the FTTx market (deciding not to provide FTTx as a Softbank service), and now sells NTT East and NTT West's FTTx services.

On the other hand, NTT East and NTT West, the dominant operators, had the following five major reasons that influenced their move:

(1) Since they are a strictly fixed (not mobile) operator, they intended to concentrate on the enhancement of management resources including capital investments in order to set FTTx as a mainstay business;

(2) They wanted to pool resources toward optical subscriber lines only, and avoid the double burden of having both metal subscriber lines and optical subscriber lines;

(3) They were locked in a battle with Softbank for DSL share supremacy, with both tied at roughly 35% (NTT had provided all domestic telecommunications services prior to the 1985 liberalization);

(4) They have suggested the possibility of removing metal subscriber lines, which are vital to DSL services. They had no intention to reinforce the permanency of DSL; and,

(5) They planned to shift 50% of its customer base to FTTx by 2010.

As described above, we could assume that the fierce competition between operators in the DSL arena, fueled by the provisions of broadband competition policies that opened metal subscriber line infrastructures, prompted NTT East and NTT West to shift to FTTx. Then, having concentrated on management resources for FTTx and made aggressive capital investment moves, NTT has widened its lead over competitors. It seems apparent that the decision of the dominant operator, who owns the metal lines, on the transition of its business entirely toward the optical subscriber network and the possibility of removing metal subscriber lines has caused rapid FTTx diffusion in Japan and DSL peak-out to a certain degree.

Hence, the development of broadband diffusion in Japan can be summarized as follows: First, with respect to the early stage of broadband (CATV (BB) and DSL), CATV (BB) did not spread due to the fact that at the dawning of the broadband age around the year 2000, the conditions for the CATV (broadcast) diffusion in terms of infrastructures, customer base, and provider aggregation were not satisfied. Second, beginning in 2001, broadband competition policies, which opened metal subscriber line infrastructures, helped DSL spread in bursts. In the late stage of broadband (FTTx),

NTT East and NTT West, facing with heated competitor opposition that pulled its share of the DSL market down to a tie for the lead (35%), decided to make capital investments in optical subscriber lines, prompting the shift from DSL to FTTx.

7-2 South Korea

Though South Korea belongs to the FTTx category, it has a relatively high CATV (BB) broadband share by type in Figure 9.

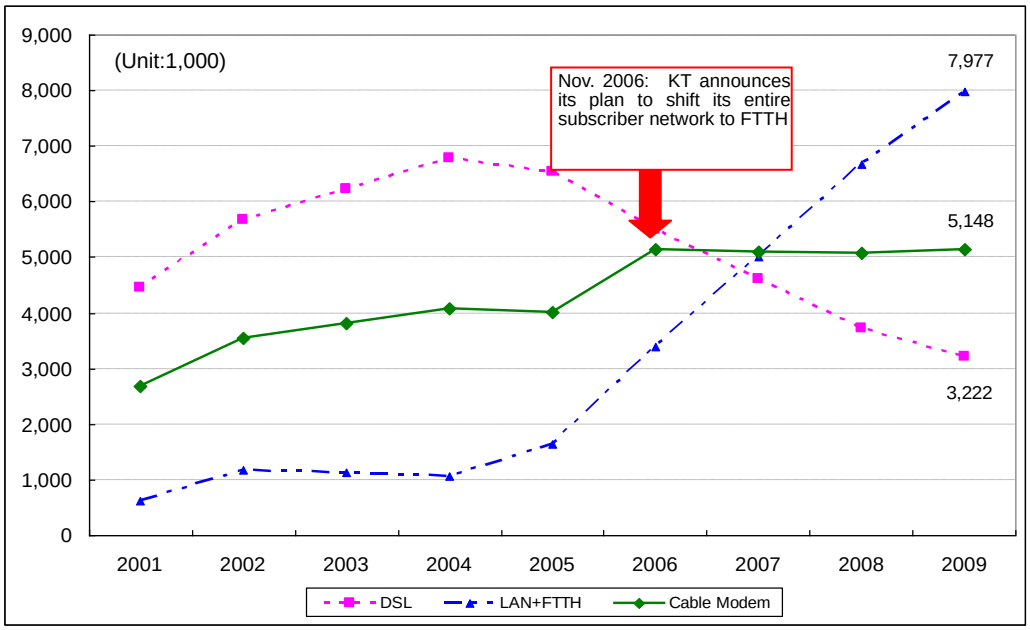

Figure 9: Broadband Internet connection contracts in South Korea

Note: In September, 2005, LG Powercom (electric power group company) enters the retail market

source：KCC

7-2-1 CATV (BB) diffusion

South Korean CATV started around 1960, when relay operators (ROs) launched services to solve problems with poor reception, and spread to 60% of all households by the mid-1990s. Due to the illegal transmission of foreign satellite broadcasting and many other factors, however, new regulations regarding system operators (SOs) were established in 1991 to help ensure transmission legalization. The CATV home pass diffusion rate increased slowly from about 55% to 70% (2000-2007), while the CATV (broadcast) household diffusion rate boomed, rising from about 15% to 80% over the

same span.

The effects of legalization to prevent illegal providers (although we could not reach out into its detailed process), helped South Korea emerge ahead of other countries in CATV (BB) diffusion, even reaching a household diffusion rate of around 20% in 2001 in Figure 5. Since around 2004, however, the market appears to be saturated. Thus, South Korea, which satisfies the three conditions for CATV (BB) diffusion at certain level presented in our hypothesis, has a high CATV (BB) diffusion rate, to a certain extent as well.

7-2-2 Development of DSL and FTTx diffusion

Since 2001 in South Korea, the market share by broadband technologies has fluctuated dramatically in Figure 9 while KT and other competitors have settled into a dead heat in share competition.

The development process of ADSL and FTTx diffusion in South Korea can be described as follows:

(1) After ADSL was launched in April, 1999, Hanaro Telecom, the competitor, used an electric power company's rights of way to bring its own fiber-optic lines to customers neighboring site and began providing services;

(2) Korea Telecom (KT), the dominant operator, kept pace by launching its ADSL services in June of the same year;

(3) The unbundling of KT metal subscriber lines (dry copper) was institutionalized at the end of 2001, however, due to several issues such as connection fees that were determined on a negotiation basis, not authorized by the government, Hanaro avoided making active use of unbundled resources (dry copper) and instead chose to shift from ADSL to FTTx in order to ensure higher speeds in Figure 10;

(4) As a result, KT continued to maintain a massive share of the DSL market, growing to around 75% at the end of 2001 and around 93% by the end of 2009. DSL peaked out in 2003 in Figure 9;

(5) While in the FTTx market – the main battleground – KT's share has leveled out at around 50% since 2002 in the face of stiff competition in Figure 10;

(6) In 2005, LG Powercom entered into the FTTx market by using a power company's lines, creating a three-way struggle between LG Powercom, KT, and SK Broadband (Hanaro affiliated with SK in 2008 and changed its name)

in Figure 10: and,

(7) In 2006, KT announced its plans to create a full-subscriber FTTH network by 2010 in Figure 9.

Hence, a comparison of FTTx diffusion in Japan and South Korea with an eye to DSL company shares reveals a key point. In Japan, where dominant operator did not always succeed in securing a significant DSL share, the dominant operator indicated the possibility of removing the metal subscriber lines required for DSL and devoted its energies toward a transition to FTTx. On the other hand, in South Korea, where dominant operator was successful in winning significant market shares, competitors entered the FTTx market on an infrastructure base, thus prompting the dominant operator to shift to FTTx. Though the conditions in the two countries may be slightly different, FTTx diffusion and DSL peak-out were affected to a certain degree by provider business strategies.

Here we point out some diffusion factors for FTTx by comparing the cases of Japan and Korea, taking into consideration DSL providers' shares. First, in terms of the early stage of broadband (CATV(BB) and DSL), CATV (BB) did not spread in Japan, which does not meet the diffusion conditions, but it did spread to a certain extent in South Korea, which satisfies diffusion conditions to a point. Second, in Japan, which had sufficient broadband competition policies (open-access policies) for metal subscriber lines, DSL spread on service-base competition, whereas in South Korea, which did not have sufficient competition policies in place, DSL spread on infrastructure-base competition. Late stage broadband (FTTx) diffusion is being pushed along by progress in the early stage of broadband competition. In Japan, with its record of fierce DSL share competition, FTTx spread thanks to infrastructure investments made by the dominant operator in hopes of shifting the basis of its operations to FTTx. In Korea, where existing providers succeeded in securing significant shares of the DSL market, competitors entered the FTTx arena on the infrastructure base, thus prompting the dominant operator to shift to FTTx.

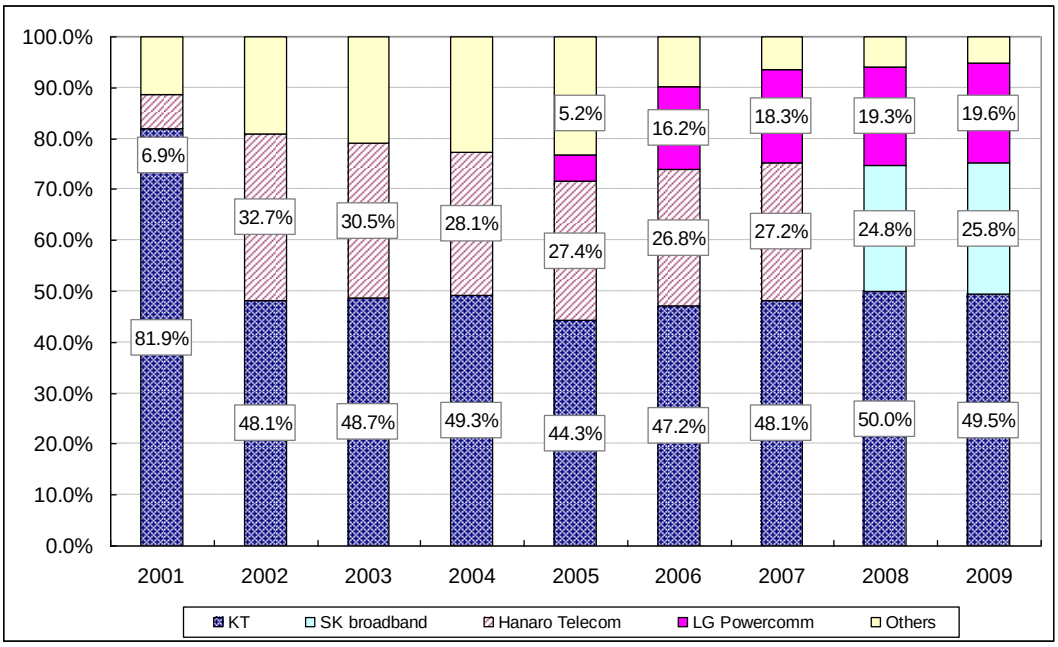

Figure 10: FTTx operators' shares in South Korea

Note 1: In September, 2008, Hanaro Telecom changes its name to SK Broadband (after it became an affiliate of SK in February of the same year).

Note 2: In September, 2005, LG Powercom (electric power group company) enters the retail market

Note 3: In December, 2006, KT announces its FY2007 policies (to make its subscriber network 100% FTTH)

Source: KCC

8. Conclusion

As discussed above, we have conducted an analysis on the broadband diffusion factors in Japan, as well as a comparative analysis of several countries we have selected from OECD.

First, we proposed a hypothesis regarding CATV (BB) and DSL, formats in the early stage of broadband. Our hypothesis is that, in order to attain a high rate of CATV (BB) household diffusion, following three conditions must be satisfied at the dawning of the broadband age around the year 2000: (i) to secure customer bases; (ii) to establish broadband infrastructures; and (iii) to expand business scales by consolidation among broadband service providers. We have provided evidences to verify our hypothesis by applying it to each country. Then, we presented our view on the unbundling method, by comparing cases in Japan and in the UK. The adoption of this method allowed providers a high degree of administrative freedom and a control capacity of higher connection

speeds. This led to the open access to metal subscriber lines and reduced unbundling fees, and as a result, had a substantial influence on DSL diffusion.

Next, we moved on to an investigation of the late stage of broadband (FTTx). We first pointed out that the degree of broadband diffusion in the early stage of broadband could affect the development of FTTx, the late stage of broadband. More specifically, we explained that FTTx has spread to a certain extent in the US and the Netherlands, the category of CATV (BB) diffusion type, and to much greater extent in Japan and South Korea, the category of FTTx diffusion type. These trends were in fact caused by intensified competitions: for the former countries, a heated competition between CATV providers and telecommunications carriers, whereas for the latter countries, a fierce competition between the dominant operators and competitors in the telecommunications industry. In addition, promoting competitions on the infrastructure base could be effective as well for FTTx diffusion, taking into consideration the cases in Japan and South Korea, countries in the category of FTTx diffusion type.

On the other hand, for countries like the UK where the diffusion rate of CATV (BB) and DSL, the early stage of broadband, fell behind other countries, the most realistic broadband technology was the utilization of previously-laid subscriber lines. Hence, there was not much reason for the immediate transition to FTTx. FTTx will allow for much higher speeds, but also requires massive investments in constructing fiber-optic subscriber lines. For these reasons, the progress of FTTx diffusion remained stagnant. Therefore, we concluded that promoting the diffusion of CATV (BB), DSL, and/or other systems in the early stage of broadband is prerequisite for the development of FTTx, the late stage of broadband.

It is also pointed out that an immediate switching of all subscriber lines to fiber-optic technology is not always the optimal way to promote FTTx diffusion. As shown by the German case, street cabinets located nationwide and sub-loops created from pre-laid metal can also be used to formulate a 50Mbps FTTC network for the entire country. In such countries, the most realistic way to form a reliable high-speed network would be first to develop FTTC and achieve nationwide diffusion, and thereafter, find a way to promote faster broadband services by making necessary capital investments according to subscribers needs.

FTTx diffusion requires tremendous capital investments. Therefore, it is essential to seek optimal measures in promoting FTTx diffusion, and implement them at the appropriate time, according to the situations of each country.

Notes

1) In this paper, CATV network-based broadband, often referred to as "cable modem" broadband, is refrred to as “CATV (BB)”.

2) The US is one example. The law: Notice of Network change: Public notice requirement. The Telecommunications Act, CFR title 47, Section 51.325. Example: Public Notice [Jan. 13. 2005], "Wireline Competition Bureau Network Change Notification, Filed by Bellsouth (Report No. NCD-1042)," FCC (refer to chapter 7 for an example in Japan.).

3) SBC, one of the "Baby Bells" created via the AT&T Divesture in 1984, went through several consolidations and acquired AT&T in 2005 (changing its name from SBC to AT&T).

4) To be exact, 4 groups: network level 1, in charge of broadcast centers (NE1); network level 2, in charge of the area between the broadcast center and the local head end (NE2); network level 3, in charge of the area between the local head end and the connection points between public roads (underground) and subscribers' sites (NE3); and network level 4, which connects the underground connection points to subscribers' homes (NE4). The federal postal service (currently Deutsche Telecom) is responsible for NE3 and community antenna providers are responsible for NE4. Here, NE3 is called the CATV network-side provider and NE4 is called the customer-side provider to keep the explanation simple. For more on the CATV situation in Germany, refer to Sugiuchi [2009]. No further information is specified in this paper but the source is used throughout the paper as reference.

5) Refer to Ofcom[2007] (also called Bitstream product, etc. (2.24, 5.8, etc)). Other countries, in which competitors provided DSL services by wholesale instead of unbundling, include France. France, however, reduced wholesale fees and unbundling connection fees before the UK and the DSL diffusion situation was not so dramatically affected compared to the UK in Figure 7.

6) This is a matter of fiber-optic branching. Under the approved interconnection rules, competitors have to use all of 8 branches, even if competitors would really use a part of these branches. So, they request against regulator that they can use and pay each branch of 8. In 2007 and 2008 regulator examined methods 1) sharing the facilities with NTT East and West and all competitors or 2) setting the interconnection tariff for each branch and so on. Finally regulator decided not to impose obligations on NTT East and West because of technical reason including difficulties in providing the quality of its services (March 30, 2007 and March 27, 2008, MIC).

7) "NTT Group Medium-term Management Plan" announced by NTT (November 10, 2004). The Plan states that the majority of users will be shifted to fiber-optic by 2010

and sets that timing and policies for the complete transition from metal subscriber lines to fiber-optic by 2010. Articles of Agreement Concerning Interconnection of NTT East and West indicate that in the case of metal subscriber line removal, operators will be notified at least 4 years in advance, and that NTT will provide "equivalent" replacement infrastructure.

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