

Ultrabroadband Investment Models

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Abstract: This paper explores why investment models might help explain different fiber deployment patterns, thereby conditioning the path to telecommunications-based ultrabroadband. The delivery of ultrabroadband to the residential market requires additional infrastructure investments beyond Fiber to the Home (FTTH). However, since FTTH is the path to delivering telecommunications-based ultrabroadband, fiber deployment could indicate which geographies would benefit from the new service in the long run.

Key words: fiber optics, investment, market structure, revenues, subsidies

Three different paces of fiber access deployment can be identified around the world: 1) Japan and South Korea (approx. 20% of broadband accesses), 2) United States (7% of broadband accesses) and 3) Europe (2% of broadband connections¹). Explanations of different deployment patterns have focused so far on assessing the impact of regulatory variables (KITTL *et al*, 2006; CRANDALL, 2007; KATZ, 2008; FTTH Council, 2006). This paper will attempt to explain these differential deployment patterns by building an investment model and applying it to two distinct industry environments, Japan and the United States². Our purpose is to answer three questions:

- How important are uncertain financial returns in explaining limited deployment?
- Do strategic imperatives of operators (e.g. defend the franchise) override their concerns for low profitability?

(*) The author wishes to acknowledge the support on the Japanese case provided by Toshiya Jitsuzumi, a Visiting Scholar at CITI, and the useful feedback of Prof. Eli Noam.

¹ All numbers for 1Q2008.

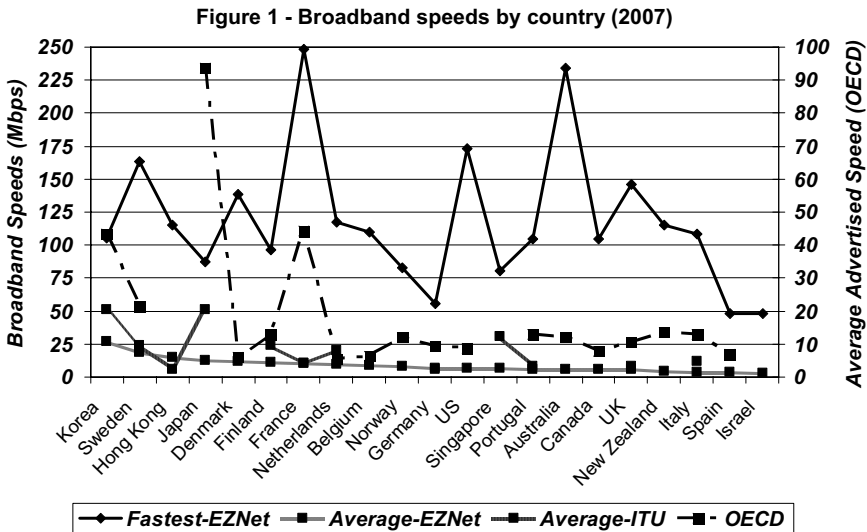
² The other explanation that needs to be focused on is industry structure (e.g. a structure comprised of 2.5 players could drive faster speed of deployment than a more concentrated market of, say, 1.5 players). See ATKINSON, 2008.

- How do regulatory and public policy interventions lessen the concerns about low profits?

■ Different fiber deployment and ultrabroadband

Ultrabroadband ³ has not been deployed yet in any country around the world. In fact, none of the national broadband networks constructed so far can handle throughput speeds in excess of an average of 50 Mbps ⁴. Figure 1 presents data on four measurements of broadband speed by country:

- average national speed according to the ITU corresponding to the year 2007,
- average national advertised speed according to the OECD for 2007,
- fastest speed according to an Australian site which compiles end user measurements (33,000 end-user observations gathered in 2008),
- average speed from the same site.



Source: ITU; OECD Broadband Portal; EZNet

³ For the purposes of this paper, ultrabroadband is defined as the infrastructure that enables access to the internet at throughput speeds of 1 Gbps.

⁴ However, some community-based networks are already operating well beyond this level (e.g. Columbia University's network has been offering 100 Mbps speeds for the past three years).

As the figure shows, while only Korea and Japan exhibit average speeds of 50 Mbps (not surprisingly given the level of fiber deployment in both countries), maximum speeds in excess of 200 Mbps have been registered in most industrialized countries with the exception of Belgium, Singapore, Spain and Israel.

While deploying FTTH is a pre-condition to delivering 1Gbps, delivering ultrabroadband download speeds can only be possible once the access portion of the telecommunications networks is upgraded⁵. As a result, even if a carrier has deployed fiber to the premise (FTTP), the link has to be upgraded to FTTH: GPON (Gigabit Passive Optical Network), which would require changing the Optical Network Unit, removing any splitters (most carriers currently use 16:1 or 32:1), adding more fiber in the access to the premise (from the splitters to the Optical Network Termination - ONT), adding more ONT ports, as well as increasing fiber capacity in the aggregation network⁶.

To reiterate, the deployment of FTTH is a step on the road to ultrabroadband. As a consequence, the assessment of the pace at which FTTH is being deployed would allow us to estimate when carriers will be able to deliver ultrabroadband services. Having said that, the state of fiber deployment around the world is still, with few exceptions (Korea, Japan and few European countries), proceeding at a slow pace⁷. We have compiled information for 2007 both on broadband diffusion and fiber deployment as a percent of all broadband accesses (including cable modem) for most industrialized countries (see figure 2).

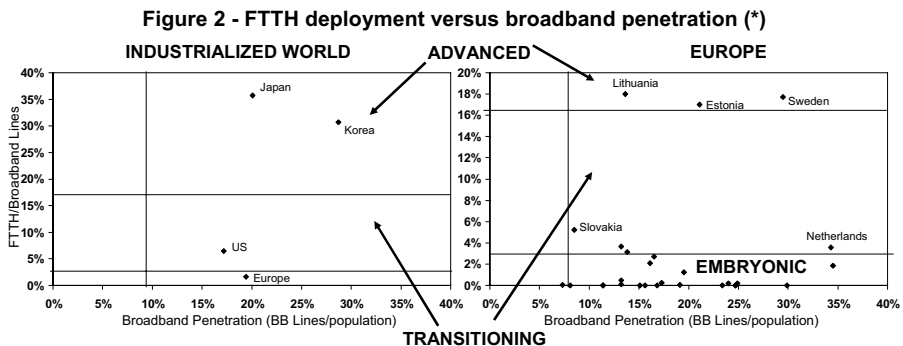
Three deployment stages of fiber can be identified around the industrialized world. The **advanced** countries (Japan, South Korea, Sweden, Lithuania, and Estonia) have clearly made industrial policy choices characterized by a dominance of fiber as the future primary access to the internet. They exhibit a level of broadband penetration ranging between 15% and 30%, and fiber accesses in excess of 15% of total broadband lines.

⁵ The long haul portion of the network handles between 40 and 100 Gbps, while metropolitan distribution networks handle around 10Gbps. Obviously, one should mention that cable systems can deliver 100 Mbps by bonding three channels (DOCSIS 3.0) and 160 Mbps by adding a fourth channel.

⁶ Even if a carrier has already deployed FTTH:GPON, it needs to remove GPON splitters and do one of two things: add more fiber and ONT ports, or place an Ethernet switch that can handle 1 Gbps to the home and 10 Gbps to the Central Office.

⁷ Although in the last two years we have witnessed considerable acceleration in other countries such as the US.

Even within this group, Japan and South Korea are way ahead of the European countries. The second group of countries, labelled as **transitioning** (comprising the United States, Netherlands, Slovakia, Latvia and Czech Republic) exhibit broadband penetration levels ranging from 9% to 35%, and fiber accesses between 3% and 7% of total broadband lines (which include DSL, cable modem and fiber). Their higher level of broadband penetration, combined with a lower stage in fiber deployment indicate that these countries are engaged in a process of constructing new infrastructure, although they have begun that process later than the advanced countries. The third group countries, characterized as **embryonic** include most European countries which exhibit a relatively high level of broadband adoption, averaging 20%, but fiber deployment of under 3% of total access lines.



(*) Broadband penetration includes DSL, cable modem and fiber access)

Sources: ECTA (2007); OECD Broadband Portal; analysis by the author

Why are the deployment patterns so different across the industrialized world? Explanations so far tend to focus on regulatory variables. In particular, the lack of Next Generation Access Network investment protection in Europe has been raised to explain the delay in fiber deployment of most of the European Union countries. Conversely, infrastructure-based competition in the US and the Netherlands represents a driver of the acceleration of deployment in these countries since 2005. Finally, industrial policy explains, to some degree, the advanced deployment in Japan and Korea. While we agree that the regulatory framework constitutes a critical variable in explaining telecommunications investment, we consider this to be an intermediate factor influencing business cases and investment models. As are expected, carriers considering the deployment of fiber construct business cases to evaluate the profitability of such a move. It is within those

models that regulation will play a role directly affecting some variables, such as wholesale pricing (and therefore revenues), or indirectly influencing competitive dynamics having an impact on market share and competitive differentiation. Accordingly, unless we understand the investment models guiding the deployment decision making process, it will be difficult to gauge the importance of regulatory variables. For this purpose, we have built an investment model that evaluates the business case for fiber deployment. We have then applied the model to two markets exhibiting different economic and regulatory conditions: Japan and the United States. In this context, we have tried to answer questions such as the following:

- Is the Japanese deployment of FTTH yielding a positive return? If not, how is the government supporting the carrier to stimulate deployment?
- Is the investment model under infrastructure-based competition in the US yielding a positive return on the investment? If not, what is the deploying carrier doing to improve the investment returns?
- Or are strategic imperatives (i.e., defend the franchise) leading carriers to invest despite unclear financial returns ⁸?

■ Ultrabroadband investment model structure and sensitivities

We have constructed an investment model that captures all commercial and financial variables needed to assess the financial viability of an FTTH business case (see figure 3).

Aimed at calculating the Net Present Value of free cash flows generated by such an investment, the model is driven by a target deployment plan of homes passed and a set of assumptions regarding percentage of homes connected, a mix of wholesale/retail accesses (assuming that the carrier is subject to access obligations), a wholesale access tariff, a retail ARPU to be generated by each household connected, and a set of capital expenditures and operating expenses (see appendix A for assumptions and rationale).

The baseline case of our model estimates costs and revenues for a moderate deployment plan contemplating 5,600,000 homes passed, 25% of

⁸ We consider this to be a broader definition of return on the investment.

which are connected and a capital investment of 1,300,000,000 Euros. The model output for our base case indicates a positive Net Present Value, although most of it resides in its terminal value (see figure 4)

Figure 3 - FTTH investment model

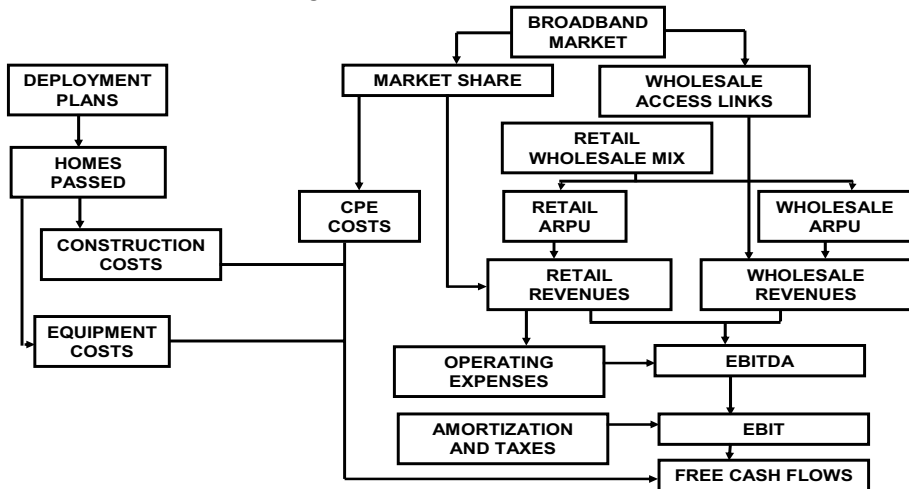


Figure 4 - FTTH investment financials (baseline case)

	Year 1	Year 2	Year 3	Year 4	Year 5
REVENUES	115	335	563	799	1,022
OPEX	31.4	56.9	84.4	113.6	131.4
EBITDA	83.7	277.9	478.4	685.8	879.4
EBIT	55.1	214.5	374.2	582.5	776.9
FCF	(170.6)	(83.3)	17.24	208.7	349.6

NET PRESENT VALUE (W/O terminal value)	€ 105 MM
NET PRESENT VALUE (W/terminal value)	€ 3,373 MM

The business case turns cash positive in year three and has a sizable value in the long run, indicating the strategic opportunity for a carrier to build a fiber access network. However, as expected, the model is highly sensitive

to the percentage of homes passed that are connected. At 20% of homes passed, the Net Present Value is only positive when considering the terminal value. The value diminishes quite dramatically if homes connected drops below 20% (see figure 5).

Figure 5 - Sensitivity to homes connected as percentage of homes passed

	HOMES CONNECTED/HOMES PASSED	NET PRESENT VALUE (W/O terminal value)	NET PRESENT VALUE (W/terminal value)
	(average over five years)		
BASE CASE	10 %	€(207) MM	€ 597 MM
	15 %	€(103) MM	€ 1,522 MM
	20 %	€ 1 MM	€ 2,448 MM
	25 %	€ 105 MM	€ 3,373 MM
	30 %	€ 209 MM	€ 4,298 MM
	35 %	€ 313 MM	€ 5,223 MM
	40 %	€ 417 MM	€ 6,148 MM
	45 %	€ 521 MM	€ 7,072 MM
	50 %	€ 625 MM	€ 7,996 MM

Similarly, the business case is very sensitive to retail ARPU (Average Revenues per User, or household). For this, we tested four scenarios:

- Fiber prices align themselves with pre-existing DSL (in other words, while users value faster speeds they are not willing to pay more than what they were paying for legacy services).
- Broadband prices decline uniformly at 6% per annum, but preserving the differential between DSL and fiber.
- Same as above, but broadband prices decline is at 8% per annum.
- DSL prices drop 8.6% per annum ⁹ while fiber access drops 6%.

All four scenarios are likely to occur. For example, price compression between fiber and DSL is a potential outcome for consumers accustomed to benefit from successive increases in computing power and memory being marketed at fairly stable prices. As to the price decline trends, competitive dynamics in the broadband market have driven pricing down at a rate of 5% in the past few years.

⁹ We assumed a faster price decline for copper access resulting from compounding historical broadband price reductions with substitution pressure coming from fiber.

These four scenarios result in substantial value erosion as soon as prices begin to decline (see figure 6).

Figure 6 - Sensitivity to price trends

Pricing scenarios	RETAIL ARPU (average over five years)	NET PRESENT VALUE (W/O terminal value)	NET PRESENT VALUE (W/terminal value)
Broadband prices fall at ~8% p.a.	€ 47.1	€ (166) MM	€ 1,696 MM
Copper broadband drops 8.6% and fiber 6%	€ 48.8	€ (141) MM	€ 1,851 MM
Broadband prices decline uniformly 6% p.a.	€ 51.5	€ (99) MM	€ 2,109 MM
Fiber prices align with copper	€ 54.0	€ (83) MM	€ 2,212 MM
BASE CASE Baseline case (price tiering)	€ 63.0	€ 105 MM	€ 3,373 MM

All scenarios lead to negative Net Present Value (without considering the terminal value). The implications of this finding are quite dramatic. If carriers need to offer discounts to promote fiber adoption or if they are obliged to drop prices as a result of competitive pressures (all quite likely situations) (RAPPOPPORT *et al.*, 2008), the fiber investment will be negatively affected in a considerable way. Why are the scenarios not improved by price elasticity or technology substitution? First, given the overall levels of overall broadband penetration (and emerging signs of saturation) in advanced countries, we cannot expect price elasticity to improve the revenue forecast¹⁰. Second, fiber-copper substitution has already been factored in our model at a 75% rate.

We have finally stress-tested the financial model by simultaneously reducing the proportion of homes connected of homes passed, decreasing prices and increasing capital expenditures (this last effect being a consequence of a potential over-optimistic engineering estimate). As expected, the result of these three effects is quite negative. For example, a reduction in homes connected to 15% of homes passed, combined with the alignment of fiber prices with DSL and their decline at 6% per annum, and an increase in capex of 20% with respect to the original estimations would yield a Net Present Value (w/o terminal value) of -374 MM Euros.

To sum up, the deployment of FTTH only under very restrictive conditions yields positive NPVs:

- homes connected/homes passed: 25%

¹⁰ Our model assumes a price elasticity coefficient of 0.83.

- retail ARPU: 63 Euros
- wholesale ARPU: 28 Euros
- retail/Wholesale mix: 85/15

However, the investment model for fiber deployment is highly sensitive to two variables: homes connected/passed (a proxy for share in overbuilt environments) and Retail ARPU. On the positive side, deployment of fiber in new developments or MDUs (Multiple Dwelling Units) with no competing infrastructure is highly profitable. In this case, market share equals homes connected/homes passed, which under broadband installation assumptions can reach 50%. On the other hand, deployment of fiber in areas where copper DSL is already offered requires an increase in fiber retail pricing to compensate for cannibalization; this must be approximately 15%. In this situation, carriers, have three options:

- Raise prices: in this case, consumers might balk mirroring their behavior with regards to upgrades in the laptop market (more memory, more speed but always pay the same price).
- Still, price increases can be partially achieved by price tiering (different tariffs by speed).
- Add new services that can be enabled by new infrastructure: this will put pressure on innovation but benefits consumers; however, one should remember factoring in product development costs in financial returns.

All in all, this is a very tenuous scenario, where returns on the investment can turn negative very easily ¹¹. These results can be further impacted by the additional capital required to deliver ultrabroadband speeds. For example, if connecting a home with FTTH G-PON requires approximately 790 Euros, the incremental capex required to deliver ultrabroadband is roughly 130 Euros (or an additional 16%). This increases the pressure to keep retail ARPU high and capture a high market share.

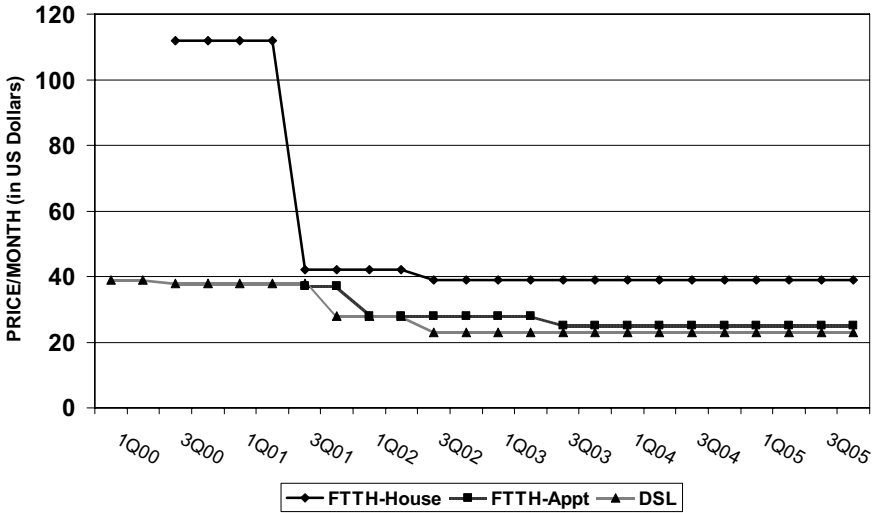
¹¹ Our results are consistent with other estimates. For example, Credit Suisse (2006) stated that without favorable regulation, fiber deployments can be NPV negative. In their assessment, the biggest sensitivities are installation costs and retail ARPU. Similarly, Alliance Bernstein (2005) estimated that the FTTH business case yields IRR of 19%, but it is highly sensitive to operating savings (63% of opex per line of \$186). Finally, Corning Fiber Systems considered that the fiber access is profitable with either high monthly revenue per user (which means new services) or high penetration rate (approximately 35%).

■ Geographic specific investment parameters

We will now apply the investment model to the specific cases of NTT (Japan) and Verizon (United States) in an attempt to understand the carriers' situation vis-à-vis the respective FTTH deployments.

NTT, the incumbent carrier, has been actively deploying FTTH within a context of service-based competition. As of the end of 2007, fiber in Japan represented 36% of all broadband connections. Service is available to 84% of the population and projected to reach 90% by 2010. NTT, who controls 79% of all FTTH accesses, started deploying fiber in the year 2000. When analyzing the Japanese situation, two features become critical variables in constraining the investment model: first, under service-based competition, NTT is obliged to provide access to its fiber platform to other operators; second, forced by severe price competition in broadband and loss of market share in ADSL, the carrier drastically reduced FTTH pricing. This occurred while the carrier could not introduce additional services which would have been instrumental in keeping retail ARPU high ¹² (see figure 7).

Figure 7 - Broadband pricing in Japan



Source: NTT

¹² The only exceptions were IP telephony and video.

A drop in retail ARPU of this magnitude in year 2 of deployment should severely affect the financial return on a fiber investment. According to our investment model, a drop in retail ARPU from 63 Euros (baseline case) to 33.70 Euros in year 2 yields a negative NPV of -700 MM Euros (without terminal value) and -1,288 MM Euros (with terminal value). All in all, a dismal value proposition ¹³. This conclusion can be validated with NTT's public information.

Although NTT is not disclosing the segmented profit/loss figure of FTTH and FTTN, the item "Designated Telecommunications Services" in the NTT-East annual report comprises four services: FTTH, FTTN, ISDN and "Off-Talk". This segment was reported to incur a loss of 103,099 million yen (\$ 1 billion) in 2007. Considering the number of users of each service is 3,339,000 for fiber service and only 258,000 are for ISDN and 60,000 for "off-talk", it is safe to conclude that the majority of the loss comes from FTTH and FTTN.

Furthermore, the President of NTT-East has made two statements confirming that the fiber service is losing money:

"In order to stop the deteriorating overall financial situation, it is important for us to increase FTTH&FTTN revenue through offering new services, such as video and, on top of this, to decrease its cost per subscribers by increasing sales." (Aug. 2, 2007).

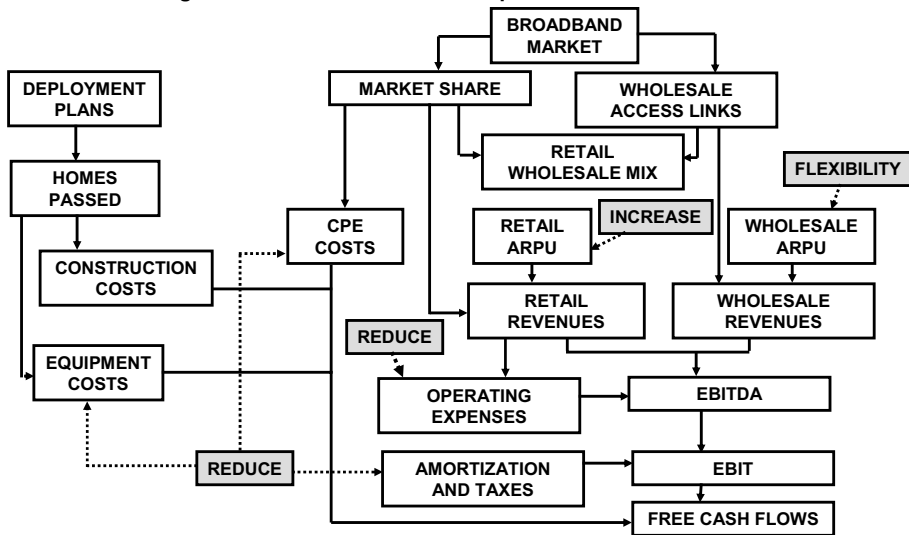
"I think it is a great problem if we still continue generating significant loss in our FTTH business in 2010 when FTTH/FTTN is estimated to have 20 million users. I think that an increase in subscribers allows us to capture economies of scale and that sales expense will also become relatively cheap in the future. Also, I can see the operating cost will also come down. I hope additional revenue which comes from several value-added services, such as video distribution, will contribute to its bottom-line and make it a healthy business." (Nov. 9, 2007).

What can be done to additionally reduce the financial burden for the carrier? The government has intervened by reducing the negative impact of some of the investment variables. For example, loans with interest rates lower than market rate are made available to any carrier with a fiber deployment plan, while carriers deploying fiber can also benefit from fiscal incentives (TANIWAKI, 2007). Furthermore, the government has shown

¹³ Even a reduction in capital expenditures to account for Japan's predominant aerial deployment (less expensive than digging trenches) and its characteristic urban density does not help rendering the NPV positive.

flexibility in setting up wholesale rates by agreeing to review the methodology for calculating wholesale charges (KATAGIRI, 2005). To sum up, the Japanese investment model indicates that so far, due to the drastic price reduction, NTT, the dominant fiber builder, has negative returns (see figure 8).

Figure 8 - Variables affected in Japanese investment model



To improve the business case, the government has introduced some financial and fiscal stimuli. However, the key avenues for restoring profitability are launching new services, which would allow NTT to raise the retail ARPU and reduce overall operating expenses by virtue of achieving critical mass of fiber in the access network ¹⁴.

Let us now turn to Verizon, which is the only major US carrier deploying FTTH, under the FiOS brand. As of July 2008, the carrier had passed 12.3 million households, and was projecting to reach 18 million by 2010. In this context, it had connected 21% of homes passed and was projecting to reach 25% in two years ¹⁵. It had also contracted 1,000,000 triple play subscribers (11%) ¹⁶ with an ARPU for triple play of \$94.99/month (declining at 3% per

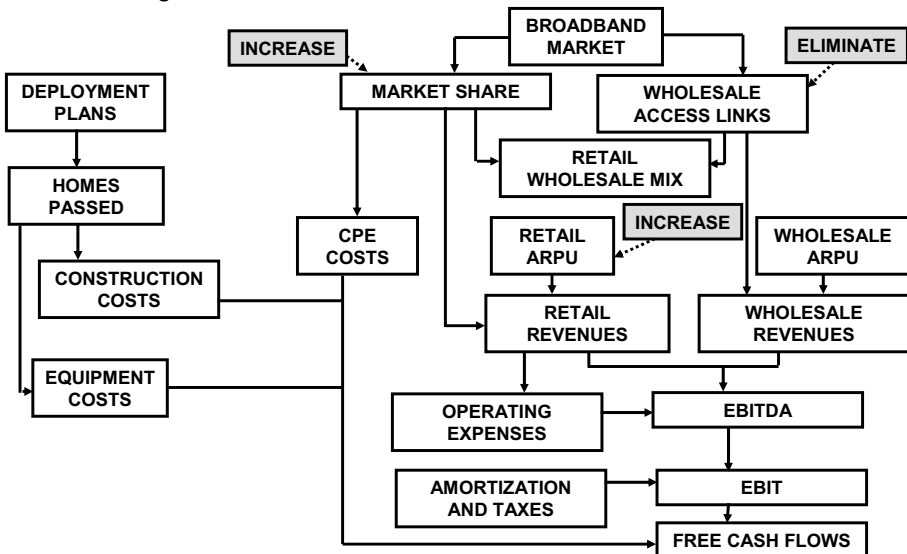
¹⁴ FTTH is less opex intensive than copper since most active equipment is managed at the Central Office, and a fiber sub-loop costs less to maintain than copper.

¹⁵ It actually reached 21% in June 2008.

¹⁶ The target is 35 % for broadband and 25% for content distribution, an overly ambitious objective given industry trends and cable's competitive response.

annum). With these inputs, our investment model yields a negative Net Present Value (without terminal value) of -569 MM Euros, and a marginally positive Net Present Value (with terminal value) of 826 MM Euros. So what can Verizon do to render the fiber investment case more attractive? It is pertinent to mention here that due to the model prevalent in the US of infrastructure-based competition, Verizon does not have any access obligations at the wholesale level. Therefore, all initiatives aimed at improving the business case have to be made within the strategic and commercial realms. First, the carrier introduced tiered pricing of its broadband service to lessen the impact of cannibalization. As many have already noted (RAPPOPORT *et al.*, 2008), a large portion of Verizon's fiber subscriber adds pertain to ADSL customers replacing its legacy service with FiOS. By differentiating price by speed, Verizon attempts to improve overall revenues by hoping existing customers will replace their ADSL service with fiber at higher speeds, thereby increasing ARPU. Second, the carrier approaches fiber construction following the principle of "success-based" deployment. According to this, Verizon will try to deploy fiber to the premises only after getting a prior commitment from the customer. This reduces temporary capex commitments and naturally increases the percent connected of homes passed. Finally, the carrier actively tests markets in terms of their potential for share gain before deploying. As figure 9 shows, Verizon is trying to emphasize working on two commercial variables to improve the investment case profile.

Figure 9 - Variables affected in United States investment model



The remaining variable which could enhance financial returns is the reduction of operating expenses, although the magnitude of impact is dependent on scale of deployment.

■ Conclusion

Is a stand-alone investment model for fiber yielding positive returns? We believe that according to our models, so far, no. Three factors are affecting the overall case:

- the CAPEX problem: fiber builds tend to reduce FCF by 20-30%,
- demand for new services remains speculative so far,
- consumers balk at seeing prices for enhancing throughput rise.

What should carriers do under this situation? Beyond the commercial and strategic moves attempted by carriers like Verizon, it would appear that there is some benefit to look at fiber networks as two-sided markets with the consequent ability to monetize the investment through advertising and other platform-based strategies¹⁷. This is currently being implemented by KT in South Korea. In addition, the regulatory and industrial policy variable is the only one that can provide some flexibility. This would require in Europe to review wholesale access obligations for fiber. Alternatively, governments should consider fiber to be a new highway system and therefore subject it to massive government investment.

If governments are unwilling to provide any of these, the incumbents are confronted with the following options:

- Invest in FTTH and take 20-30% of FCF forecasts with consequent impact on the stock.
- Do not invest in FTTH and allocate CAPEX to other areas of the portfolio (purchasing spectrum, investing in overseas subsidiaries if incumbent is global).
- Short term, this option is more attractive but the incumbent might lose innovation initiative to domestic cable.

¹⁷ If ultrabroadband access becomes the chosen platform to deliver and upload content from the customer premise, it could be positioned as a facilitator of all sorts of transactions (advertising, financial, supporting the distribution of user generated content) with the ability to generate access revenues, advertising fees, financial commissions and the like.

The problem is that carriers might not have a choice. They need to respond to the cable threat of introduction of 100 Mbps service by means of upgrading their networks to DOCSIS 3.0 (US, Japan, Korea, Belgium, Switzerland, Portugal, Austria). This should be the moment when the "strategic imperative" is being raised as an investment rationale:

- The transformational argument: fiber deployment will allow to reduce network operations and maintenance expenses by virtue of reaching critical mass.
- The defensive retaliation argument: "we will not make money but we have to respond to the cable threat".
- The arms race argument: "let us raise the stakes and see whether the cable industry can follow us".
- The unprofitable growth argument: "We buy market share".

But, if the cable threat is low **and** there is low willingness from the government to change access rules (like in the case of the European Union where rules exist), FTTH might not materialize. This will be even more acute if the incumbent carrier has a large overseas portfolio and therefore can allocate capital in other regions/businesses. This could be the case of some European carriers. Alternatively, if the cable threat is high **and** there is willingness by the regulator to reduce access obligations **and** the incumbent has a concentrated domestic business, it will most likely invest in fiber. This is the case of Verizon. Finally, if the competitive threat is high **and** the government provides investment incentives **and** the carrier has limited overseas portfolio, it will tend to invest domestically in FTTH. This is the case of NTT.

In summary, financial models indicate that investment in FTTH could be at serious risk. While government intervention to lessen the financial impact might be one part of the answer, it is pertinent to raise the question of what might happen if carriers cannot identify commercial and/or strategic initiatives capable of improving the returns. That might put the ultrabroadband future into question.

Appendix A - Financial model assumptions

TYPES	ITEM	ASSUMPTION	RATIONALE
CAPITAL	EQUIPMENT COSTS	<ul style="list-style-type: none"> • FTTB-G-PON: 289.5 € • FTTH-G-PON: 393.4 € 	<ul style="list-style-type: none"> •Sanford Bernstein estimates 950 € for home connected, split as 650 € for home passed and 300 € incremental for connected
	CONSTRUCTION COSTS (OSP and CO labor)	•29.5 €	<ul style="list-style-type: none"> •Verizon mentions that at 5 million homes passed, homes passed are 382 € and 213 € incremental for connected
	CPE COSTS (ONT, OLT and equipment)	• 320 €	
REVENUES	RETAIL ARPU (average over five years)	•€ 63	<ul style="list-style-type: none"> •Starting point is the ARPU of a digital household (around 62 Euros) •Assumed to increase by adding other value-added services aimed at capturing a portion of the consumer surplus (raising to 73 Euros) •Prices would start diminishing at 2% per annum
	CUSTOMER CHURN	•1.4%/Month	<ul style="list-style-type: none"> •Consistent with international triple play experience (e.g. Cox)
	WHOLESALE ARPU	• 28 €	<ul style="list-style-type: none"> •Driven by approximately 40% wholesale/retail ratio
	WHOLESALE/RETAIL MIX	• 89% to 85 %	<ul style="list-style-type: none"> • Assumes that 90% of fiber is deployed in areas of competition, triggering ULL provisioning

ITEM	ASSUMPTION	RATIONALE
OPEX	• 54 Euros/line/month	<ul style="list-style-type: none"> •Operating expenses comprise four categories: customer acquisition costs, provisioning costs (installation and activation of service), maintenance and customer assistance costs, and general costs •These costs are known to be lower than those of the legacy network (approximately 70%) reaching 54 Euros/ line/month
WACC	• 8.26	<ul style="list-style-type: none"> •Driven by Beta=1.36 (averaging internet and data transport firms)
g	• 2%	<ul style="list-style-type: none"> •Average of analysts assessment for Iliad and CSFB for Fastweb

Bibliography

ALLIANCE BERNSTEIN (2005): *The couch potato war*, New York: May.

ATKINSON, R. (2008): "Market structure for Ultrabroadband", *COMMUNICATIONS & STRATEGIES*, 4th Quarter.

CRANDALL, R. (2007): "What matters: Broadband penetration or capital investment?", presentation at the Conference on State of Telecom, Columbia Institute for Tele-Information on October 16, 2007 in New York, United States.

Credit Suisse (2006): *Fiber in the streets*, Report prepared by Integrated Telecommunications Services, July 4.

ECTA (2007): *Broadband Scorecard*, Antwerp, Belgium.

FTTH Council (2006): *Regulatory barriers for fiber deployment*, Paris, France.

GENTZOGALNIS, A. (2007): "Forecasting (Ultra) Broadband and other Information technologies", presentation at the Conference on Ultrabroadband, Columbia Institute for Tele-Information on June 14, 2007 in New York, United States.

KATAGIRI, Y. (2005): *Interconnection system in Japan (itemized discussion)*, Japan: Ministry of Internal Affairs and Communication, August 2005.

KATZ, R. (2008): *Impacto de la regulación de las telecomunicaciones en España*, Madrid: Enter.

KITTL, J., LUNDBORG, M. & RUHLE, E-O. (2006): "Infrastructure-based versus service-based competition in telecommunications", *COMMUNICATIONS & STRATEGIES*, No. 64, 4th Quarter, pp. 67-87.

RAPPOPORT, P., ALLEMAN, J. & TAYLOR, L. (2008): "The demand for video services: when fiber becomes an alternative", paper presented at the Biennial Conference of the International Telecommunications Society on June 25, 2008 in Montreal, Canada.

TANIWAKI, YASU (2007): "Broadband competition policy in Japan", Keynote Speech prepared for Seminar on Managing Competition in a Next Generation Networks Environment hosted by BRTI, infoDev and the World Bank on September 25, 2007 in Jakarta, Indonesia.

VERIZON. FiOS Fact sheet.

WAVERMAN, L. (2007): "Benefiting from convergence, access, mobility and ubiquity", a discussion paper prepared for the Canada Roundtable on the Future of the Internet Economy, Ottawa, October 2, 2007.