FTTH Business Guide

Edition 3

Business Committee

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Fibre to the Home Council Europe

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Contents

Foreword

Welcome to the third version of the FTTH Business Guide. As in previous years, the content of the Business Guide was presented at several workshops which were held in various countries throughout the year and as always, audience participation in the discussions was very lively.

This document is available in printed form, electronically via http://www.ftthcouncil.eu/EN/home/form-business-guide or as a wiki at http://wiki.ftthcouncil.eu/index.php/Main_Page . It is also available through the Business Guide app for easy use during travelling.

The interest and popularity of this Guide is still high and even on the increase which must mean that more people, companies and countries are discovering the importance of a sound Next Generation Access Network.

As in the last century, infrastructure in the form of streets, motorways and railways formed the basis of growth and prosperity in Europe; FTTH is having the same impact on the information age within the globalized world. Europe can no longer be seen to fall behind other countries in the development and deployment of fibre and its related services.

The move towards FTTH is not only driven by countries; cities and regions are also acutely aware of the need to progress to the next infrastructural level. There is a wide variety of FTTH players throughout Europe: in some regions electricity power providers or municipalities are initiating the move to FTTH and at other places the local telecom incumbent.

One of the most significant and fast developing services is cloud computing. Having real-time access is crucial for many, with key factors involving not only speed but also symmetry in down and upload speed. FTTH is now making real and perceivable differences in accessing cloud services.

Existing copper based networks, which served us well in the past, could become a hindrance to the further development of our information and knowledge-based economies. Having reached the limits of this medium, there is a real risk that the introduction of the new infrastructure process may be missed.

The aim of the FTTH Council Europe is to encourage the development of FTTH. This is achieved through providing accurate and relevant information, conducting marketing and communication activities and compiling business and technical guides and handbooks. In addition, the Council organizes an annual FTTH

Conference, which is the largest in the world. The Council also provides authorities with industrial knowledge. As the location of the FTTH Conference 2012 is Munich, the Business Guide will also be available in German.

The Business Committee of the FTTH Council Europe decided to put focus in 2012 on financing an FTTH network, therefore an entire chapter in the Guide has been dedicated to this important area.

Paolo Sebben, Chair of the Business Committee

FTTH Council Europe

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Second edition

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First and Second editions were edited by **Pauline Rigby**, freelance editor.

Third edition was revised and edited by **Eileen Connolly Bull**, Connolly Communication AB.

Who should read this guide?

The Business Guide discusses the business case for fibre-to-the-home and the major influences on the business plan and should be read by those thinking of planning, constructing or investing in a fibre access network, or have already started this process and want to find out more.

This guide is for:

- municipalities or local governments
- utility companies
- alternative telecoms operators
- real-estate developers
- residential associations
- community project teams
- bankers
- venture capital investors
- anyone interested in the business case for FTTH

This Guide targets a wide audience, and therefore does not assume any prior knowledge of technical or commercial issues relating to FTTH networks. For more information on FTTH technology and deployment we recommend the FTTH Handbook, available via the links given below:

http://www.ftthcouncil.eu

http://wiki.ftthcouncil.eu

Chapter 1: Why Fibre?

Broadband technologies compared

FTTH has obvious advantages for the consumer, both today as well as in the foreseeable future, as it offers improved performance over broadband services that are delivered primarily over copper networks. FTTH offers the highest possible speeds of internet access downstream (from the network to the end user) as well as upstream (from the user to the network).

The following table shows typical download and upload times for image and video transfer using various types of consumer internet connection:

	Time taken for:	1 GB photo album	4.7 GB standard video	25 GB HD video
FTTH	1 Gbps download 1 Gbps upload	9 sec	39 sec	3 min 28 sec
FTTH	100 Mbps download 100 Mbps upload	1 min 23 sec	6 min 31 sec	34 min 40 sec
CATV	50 Mbps download	2 min 46 sec	13 min 2 sec	1 hr 9 min
	10 Mbps upload	13 min 52 sec	1 hr 5 min	5 hr 47 min
DSL	8 Mbps download	19 min 0 sec	1 hr 29 min	7 hr 55 min
	1 Mbps upload	2 hr 32 min	11 hr 54 min	-

Notes:
1. All include +4% overhead for IP/Ethernet framing and DSL +10% for ATM encapsulation
2. 1 GB photo memory card, 4.7 GB DVD-R SL capacity, 25 GB Blu-Ray single layer capacity
3. FTTH examples: 1Gbps or 100 Mbps Ethernet point-to-point or GPON/XG-PON system
4. CATV example: DOCSIS 2.0 system with a single active user (i.e. no capacity contention)
5. DSL example: ADSL system with an ideal “up to 8 Mbps” service
6. Other system technologies, e.g. DOCSIS 3.0, ADSL2+M, VDLS2+, would result in different times

An interactive Fibre Speed comparison tool is available from the FTTH Council website: http://www.ftthcouncil.eu/about-us/about-ftth/fibre-speed-tool

Several access network technologies such as VDSL2 and DOCSIS 3.0 are often claimed to be the "next-generation access", with the promise of increased speeds. However, even though headline speeds are remarkable, it is important to consider other factors that impact on the end-user service.

FTTH speed is non-dependent on the distance from end-user to the telephone exchange, unlike the DSL family of technologies, whose speed reduces with distance. Headline rates of 24Mbps (ADSL2+) or 100Mbps (VDSL2) are theoretical maximums and can only be achieved if the end-user is located adjacent to the exchange or cabinet where the active equipment is installed.

DSL performance is also subject to random noise, other interference and crosstalk during operation which will impact on the overall throughput. The headline speed often includes protocol overheads; approximately 10% of bits are not available to transport data.

Marketing claims which state "up to 8Mbps" or "up to 40Mbps" services may, technically be correct, however end-users are becoming increasingly dissatisfied with the reduced performance that they actually receive, which in some case can be less than half of what was advertised.

The performance of DSL technologies is close to the theoretical limit given by the Shannon theorem. (This is a formula that determines the maximum achievable bit rate over a transmission medium as a function of the frequency-specific signal-to-noise ratio (SNR) values. The SNR decreases with increasing attenuation and increasing noise from crosstalk.)

New techniques such as vectoring, which reduces the occurrence of crosstalk; and bonding, which treats multiple copper pairs as a single transmission line; will prolong the lifespan of DSL technologies. Indeed, 900Mbps transmission over four copper pairs has been demonstrated in the laboratory covering distances of several hundred meters. But it is not possible to sidestep the fundamental physics as described by the Shannon theorem.

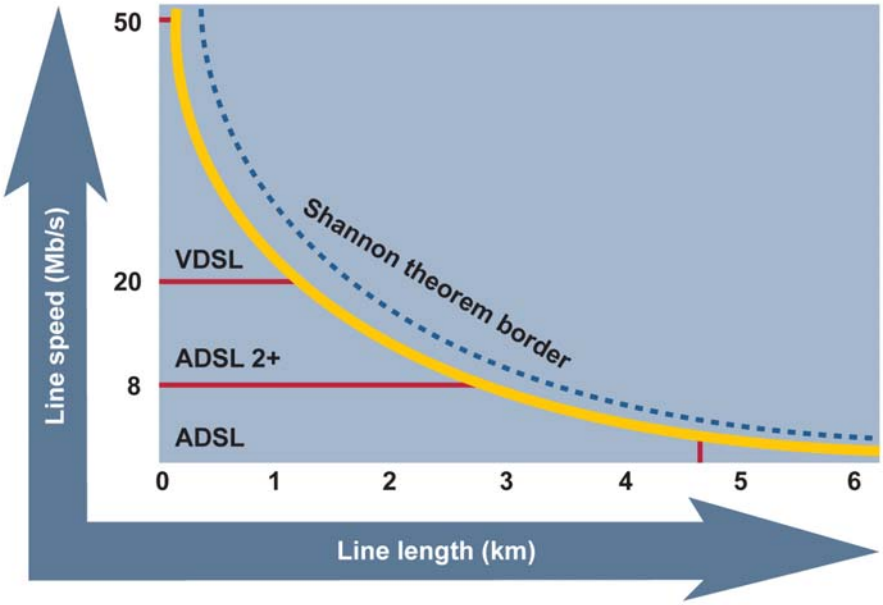


Figure 1: Shannon limit

Cable TV systems encounter a number of problems. DOCSIS 3.0 technology which is used by cable TV operators to deliver headline speeds of 100Mbps (or even 200Mbps in trials) is capable of achieving these higher speeds by "channel bonding". This is a system which connects several channels from a fixed spectrum to increase capacity (these are frequency channels on the coaxial cable spectrum rather than physical channels).

As subscribers share these combined channels they increase their individual peak capacity (peak headline speed) however, they are subject to increased contention and a reduction in throughput at peak times. Furthermore, the design of cable TV systems optimises downstream usage, therefore upstream capacity is not only low, but is also extremely contended. These quality issues are familiar to many cable users.

Advertised speeds for wireless and mobile technologies based on 3G, LTE, can also offer comparable headline speeds to fixed-line broadband. However, these technologies have a number of drawbacks:

- In the case of DSL, wireless transmission technologies only deliver maximum throughput when the user is located adjacent to the base station. Wireless systems have been heavily optimised to make efficient use of spectrum (airwaves) and are also operating close to the Shannon limit.
- Wireless communication is based on a shared medium, called the air interface. Available capacity is shared by all subscribers in a given cell (the area addressed by one base station). As more subscribers use the system, the average bit rate per subscriber will be reduced.

In most circumstances, wireless and mobile technologies should be viewed as complementary rather than a substitute for fixed-line broadband as they allow nomadic use of broadband services.

Bandwidth requirements

Over the past twenty years, connection speeds to access the internet have steadily increased due to a combination of increased computer processing power and software complexity, higher-resolution displays, and the trend of displaying pictures instead of text, audio and video.

Nielsen's Law of internet bandwidth is an empirical observation and states that a high-end user's connection speed grows by 50% per year, or doubles every 21 months. This law has been observed from 1984 to the present day. Nielsen's data point for 2010 gives a connection speed of 31Mbps; which is a speed that is already familiar to many, but by no means the highest available to consumers.

In the future, increased popularity of existing services combined with the introduction of new services will continue to push bandwidth requirements higher. As more and more information becomes available digitally, data will need to be accessed more quickly. Thus the development of new applications will take advantage of the improved capabilities of the network. Applications are already envisaged that require more than 200Mbps.

Broadband marketing has typically focused on downstream bandwidth, however upstream bandwidth will become increasingly important as applications requiring two-way video sharing become more commonplace, and cloud-based services, such as Apple's iCloud, proliferate. FTTH not only offers the highest upstream data rates, it also opens the way to symmetrical bandwidth.

Some examples of current and future applications and their bandwidth requirements are shown in figure 3.

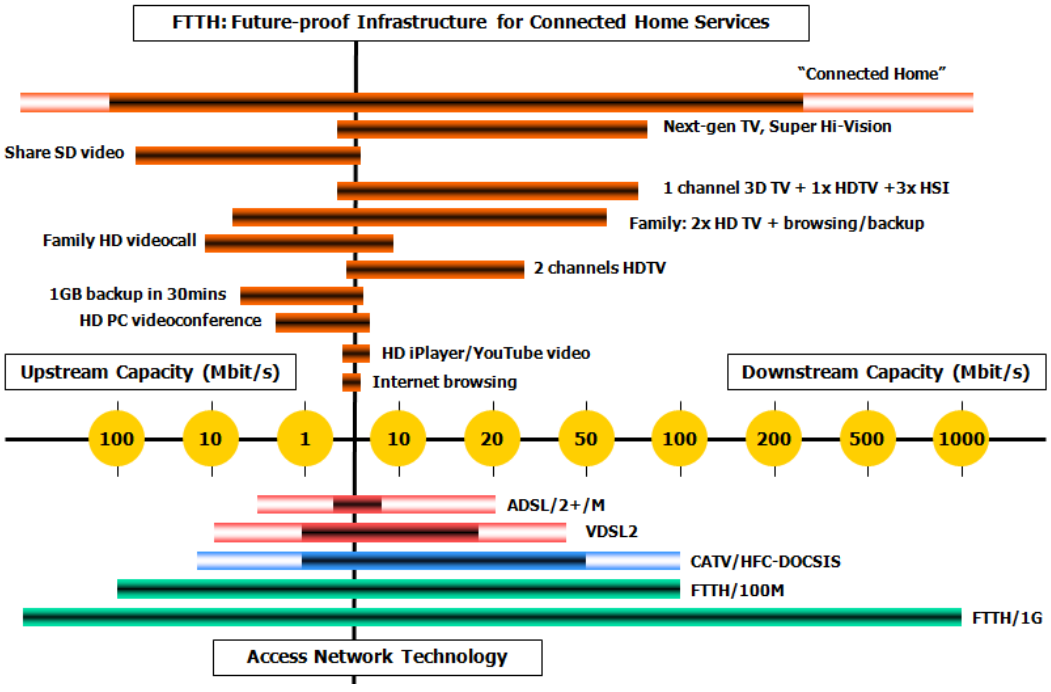


Figure 2: Access network capacity by application and technology

Video is expected to contribute significantly to the growth in global internet traffic; in 2010, internet video overtook peer to peer traffic as the largest component of internet traffic. Numerous internet applications already depend on video:

- C**atch-up TV services** are becoming increasingly popular. The BBC's iPlayer service in the UK, for example, requires a consistent 800 kbps of throughput; bandwidth requirements increase to 3.5bps for the HD version.
- **DVD rental** firms, such as Amazon, are now offering film downloads; consumers may wish to download and watch a film on the same night, this requires an internet connection that is fast enough to download the film in minutes rather than hours.
- In January 2010 Skype launched **HD video calling.** The company recommends a sustained 1Mbps of throughput both upstream and down.
- **Connected TV devices** such as Apple TV, Boxee and Roku, as well as some games consoles and internet-enabled televisions from a variety of firms, such as Sony, can stream internet video content from providers such as YouTube, Amazon, iTunes, Netflix and more (sources vary by country). Video quality is often automatically adjusted to suit the speed of the consumer's broadband connection. Higher quality HD video requires approximately 4 Mbps or more throughput.
- In October 2010, Cisco launched űmi **home telepresence.** This is a consumer video conferencing system that works in combination with the HDTV in the consumers' home and a broadband connection. The HD experience requires a minimum 3.5 Mbps of throughput both upstream and down, although 5 Mbps is recommended.

These applications have been designed with the capabilities of the average broadband connection in mind; service providers need an addressable market for their product. However, the various techniques used to reduce the bit rate of HD video (a reduction in the number of frames per second, or compression techniques) do not come without loss of fidelity. HD video is likely to move towards higher quality as and when consumer broadband connections allow. For comparison, broadcast quality HDTV delivered by terrestrial, cable or satellite requires much higher bitrates in the region of 16—20 Mbps.

Future developments in video can be expected to push bandwidth requirements even higher. On the horizon is the 3D TV, or more accurately, the first generation stereoscopic TV. The first 3D-enabled TVs became available in the stores in mid-2010 and as Hollywood, film and TV studios prepare for 3D production, broadcasters are ready to join them. BBC broadcast the world's first live 3D HD programme in 2008 and in 2010 the UK satellite TV provider Sky launched the UK's first 3D channel on their HD platform.

Beyond HD is "Super Hi-Vision". This has already been demonstrated in a live broadcast in 2008 by the BBC in collaboration with NHK of Japan and is envisaged as a 33 million pixel system (7680 x 4320), offering 32 times the information density of HDTV. This system is currently undergoing standardisation and could enter the broadcast arena as early as 2020 with a target to-the-home bit-rate of 65Mbps. Spectrum, whether satellite, cable or broadcast, is a finite resource and at this point multi-gigabit-per-second FTTH delivery will truly come into its own.

Several trends are also expected to multiply the bandwidth requirements per household:

- **Multitasking**: performing multiple, simultaneous activities online. For example, a subscriber may browse a web page while listening to an online music or video service.
- **Passive networking**, whereby a number of online applications work passively in the background. These could include software updates, online backups, internet personal video recorders (PVR) as well as ambient video, such as nanny-cams and security-cams. Cisco estimates that the number of applications generating traffic per PC increased from 11 to 18 in 2009.
- **Multiple users** sharing a broadband connection in a typical household. For example, one person could be doing online shopping, another accessing their work email over the VPN, a third doing homework through the school website and a fourth watching catch-up TV.

Service provider benefits

The advantages for the consumer translate into benefits for the service provider as they help the service provider to attract and retain customers. However, the potential upside to the service provider extends beyond these parameters and can include:

- new revenue opportunities, such as IPTV
- lower running costs
- improved network reliability (optical fibre is immune to electromagnetic interference, for example)
- the possibility to consolidate central offices
- a future-proof network infrastructure guaranteeing ease of future upgrades

To be able to offer new services is essential for service providers if they are to stay ahead in a highly competitive environment.

- **The entertainment services segment** is extremely dynamic and has been the driving force behind consumer adoption of new technology. For example, the number of IPTV service subscribers increased to around 21 million worldwide during 2008; the prognosis is a growth rate of, at least, 28% per year for the next 5 years. With associated revenues amounting to approximately $6 billion (€4 billion), this is an important and growing revenue source for both established and new entrant service providers.
- **The terrestrial analogue TV transmission** switch-off deadline of 2012 which is recommended by the European Commission is looming on the horizon for many European countries. The transition to digital terrestrial transmission has already proven to be a major market disruption that can be successfully leveraged by IPTV providers, and will result in increased subscription rates.
- **HDTV service** is a fertile area for new business strategies as it provides a differentiator for service providers. Even in developed markets such as the US, which has 61% of the global total of HDTV households; 43% of all households either do not have or do not watch HD content. This represents a considerable market opportunity. With 150-inch displays already available on the market, it is

perhaps only a matter of time before films are premiered directly to the home on IPTV, instead of through cinematic release.

A 2008 study of NGA service portfolios, commissioned by the FTTH Council Europe, also showed that FTTH operators received on average 30% higher revenues per user. This is not due to expensive product services rather more services being purchased by subscribers.

One argument often raised by operators unwilling or uninterested in investing in fibre is they “do not see the demand”. Of course, consumers are unable to demonstrate demand for services that are not available to them. However, the NGA service portfolio study found that FTTH subscribers consume three to five times more bandwidth (aggregate uploads and downloads) than ADSL users.

The same study showed that FTTH subscribers are net contributors to the internet, uploading more material than they download. In other words, once subscribers get access to more bandwidth, they spend longer making use of existing services, as well as becoming proficient in using new ones.

An additional motivator for service providers is that FTTH networks have lower operating costs (OPEX) than existing copper or coaxial cable networks.

- FTTH networks consume less electricity with some reports putting the figure at 20 times less than HFC or VDSL.
- Network operation and maintenance is simplified using full automation and software control, requiring fewer staff.
- Maintenance costs are also reduced as there is no active equipment in the field to maintain, and optical components are extremely reliable.
- Optical fibre is not affected by electromagnetic interference, which is a source of downtime in copper networks.

Verizon in the US has reported that its FiOS FTTH network showed a decline of 80% in network fault report rates, with subscribers being more satisfied with their services which are now more stable and downtime is considerably less. Higher customer satisfaction leads to improved subscriber loyalty and lower churn, which also impacts positively on OPEX. The cost of servicing an existing subscriber is less than recruiting new

FTTH is often described as being “future-proof” but what does this really mean?

- The lifespan of the fibre optic cable is in the region of 30 years.
- The composition of the cable is plastic and glass, which is robust and has an extremely slow degrade rate.
- The fibre in the ground has virtually unlimited capacity with bandwidth upgrades requiring only changes to the equipment on the ends of the link. Although the active equipment on the ends of the link have a shorter lifespan, often five to seven years, this is true of all broadband technology.

Incumbent operators while historically committed to their approach, are nevertheless aware of the inevitability and are thus planning FTTH deployments in the next few years. Telecom operators and cable TV providers will eventually drive fibre all the way to the home, or go out of business: all recognise fibre as the "end game". Some operators have already covered the intermediate steps: Swisscom, for example, has previously invested in ADSL and then VDSL access technology, but now decided to adopt FTTH.

Although VDSL technology continues to improve, it must be seen as a technology with a limited operating life and hence a challenging payback case. It is unlikely that operators will be able to invest in upgrades in the shorter perspective; therefore they need to learn the lessons from early adopters and invest in the most future-proof solution from day one.

Socio-economic benefits

FTTH will also be an enabler, providing considerable social, environmental and economic benefits. Many countries that adopted FTTH within the past decade, are already experiencing tangible benefits, these include Sweden. For governments, local authorities and also communities, these benefits may represent compelling arguments for fibre in their own right and commercially-driven organisations could also recognise the financial benefits from these so-called network externalities, for example, by acquiring public funding, or signing up a healthcare provider as a core subscriber.

Communities connected to FTTH can experience genuine advantages through the availability of a wider range of internet services. Examples of potential benefits that FTTH networks can generate include:

- boosting economic growth and increasing the competitiveness of the community's business base;
- enhancing a community's ability to attract and retain new businesses;
- increased efficiency in the delivery of public services, including education and healthcare;
- enhancing the overall quality of life of the community's citizens by increasing the opportunities for communication; and
- reducing traffic congestion and pollution.

Quantifying these benefits in isolation is challenging. A study by Ovum on behalf of the FTTH Council Europe looked at the socio-economic benefits of FTTH across different communities in Sweden. Ovum's conclusions were that FTTH has a positive influence on health, education and other public services. For example, in Hudiksvall, a town on the eastern coast of the Baltic Sea with around 15,000 inhabitants, a clear link between the installation of fibre optic communications and the ability to attract new businesses to the area was visible. The study suggests the impact will be greatest in rural areas where local resources are limited and end-users face significant travel requirements.

A number of studies have noted a statistical connection between higher broadband adoption and increased economic prosperity on both local as well as national levels. Evidence-based studies on FTTH have not yet been conducted as the technology is still relatively new, therefore a real-world analysis on the economic

impact of FTTH will be carried out in due course. However, several reports have attempted to make realistic predictions regarding the impact FTTH networks have on job creation and the GDP. For example:

- The Columbia Institute for Tele-Information (CITI) conducted a quantitative analysis of the macroeconomic impact of investment in broadband infrastructure in Germany. To meet Germany's national target of providing 50% of households with at least 100 Mbps and an additional 30% with 50 Mbps by 2020 would require investment of €36 billion, they claimed. This would create an additional 541,000 new jobs in the construction and electronic industries, while job creation triggered by enhanced innovation with new services, would create a further 427,000 jobs. The impact on the GDP in Germany is estimated to be €171 billion between 2010 and 2020 which amounts to 0.6% of the annual GDP.

It has also been calculated that usage of FTTH-services can have a positive impact on the environment. The FTTH Council Europe commissioned life-cycle assessment experts PriceWaterhouseCoopers/Ecobilan to study the environmental impact the deployment of a typical FTTH network would have on the environment.

The study found that the environmental impact through the deployment of a typical FTTH network will be positive in less than 15 years compared to the scenario where no FTTH network existed. The energy and raw material used to produce the equipment, transport it and deploy the network is easily compensated by FTTH-enabled services such as teleworking, fewer miles travelled for business, and a reduction in long distance transportation of patients.

Intelligent deployment using existing ducts, and sewers, where available, can further improve the positive environmental impact of FTTH. The FTTH Council North America asked Ecobilan to calculate results tailored to the circumstances of the USA. Results showed that the environmental pay back would be 12 years mainly due to the existence of aerial cable.

It may be difficult for service providers to experience immediate financial benefits from these externalities in the form of service fees, however, other parties involved in the network deployment may include them in their decision-making process. For instance, the potential social and economic benefits for the community could gain local support for the project, thus paving the way for a smooth local deployment process resulting in increased numbers of subscribers. The business case should address all alternative motivators and methods for funding the network rollout.

Chapter 2: Business models

Network layers

An FTTH network can comprise of a number of different layers: the passive infrastructure involving ducts, fibre, enclosures and other outside plants; the active network using electrical equipment; retail services, which provide internet connectivity and managed services, such as IPTV; and not least, the end users. An additional layer can also be included: the content layer, located above the retail services layer and the end users. This can be exploited commercially by so-called “over the top” content providers.

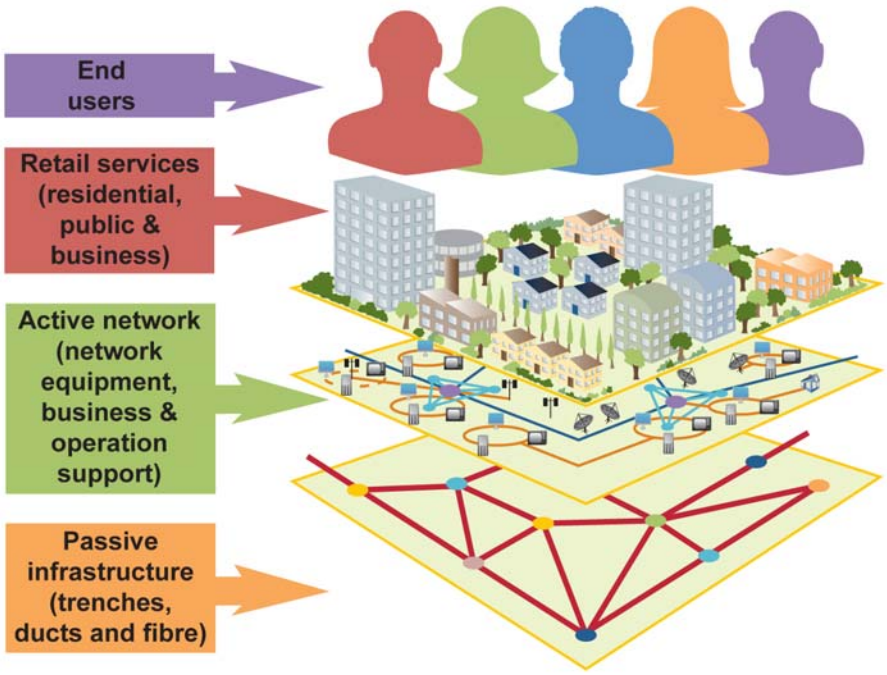


Figure 3: FTTH network layers

This technological structure has implications in the way an FTTH network is organised and operated. For example:

- **Passive infrastructure** involving physical elements needed to build the fibre network. This includes the optical fibre, trenches, ducts and poles on which it is deployed, fibre enclosures, optical distribution frames, patch panels, splicing shelves and so on. The organisation responsible for this layer would also normally be responsible for network route planning, right-of-way negotiations, and civil works used to install the fibre.
- **Active network** refers to the electronic network equipment needed to bring the passive infrastructure alive, as well as the operational support systems required to commercialize the fibre

connectivity. The party in charge of this layer will design, build and operate the active equipment part of the network.

- **Retail services** become involved once the passive and active layers are in place. This layer is where basic internet connectivity and other managed services, such as IPTV, are packaged and presented to consumers and businesses. Besides providing technical support, the company responsible for this layer is also in charge of customer acquisition, go-to-market strategies, and customer service.

Each network layer has a corresponding function. The network owner is in charge of the first layer, although they may outsource its construction to a third party. The network operator owns the active equipment, while the retail services are provided by the internet service provider (ISP).

These three functions may exist as departments within the same company, or under the control of different organisations. Indeed, the same organisation could have different business models in a number of geographical areas, depending on the local market and the availability of potential business partners.

The traditional telecom model is based on “vertical integration”, in which one entity controls all three layers of the network. This is often the case for incumbent operators, for example, Orange in France, Telefonica in Spain and Verizon in the United States.

At the other end of the spectrum is the fully separated ownership of the different layers, as is the case in some parts of Netherlands where Reggefiber controls the passive infrastructure, BBNed runs and operates the active network and provides wholesale access, and various retail service providers package the broadband access with the services they offer and sell directly to the end-users.

Possible FTTH business models include:

- **Vertically integrated** means one operator controls all three layers of the network, and consequently, if a second operator is interested in offering broadband and telephony services in the same area, he would have to build his own infrastructure, operate and market it directly to the end-user. This is a clear form of infrastructure competition.
- **Passive sharing** leverages a single passive infrastructure, which is built and maintained by one infrastructure owner. Active and services layers are owned by different organisations. A second service provider may share the same passive infrastructure with the first service provider, but would be required to invest in active network equipment and operations as well as the services and subscriber-facing activities.
- **Active sharing** is a single organisation owns the passive and active infrastructure and operates the active network. This vertical infrastructure owner wholesales broadband access to various retail service providers who then compete with each other for customers.
- **Full separation**, as mentioned above, ownership layers is partitioned. Each layer is owned by a different party with the infrastructure owner generating income by providing passive infrastructure access to one or more network operators, who in turn wholesale broadband access to retail service providers.

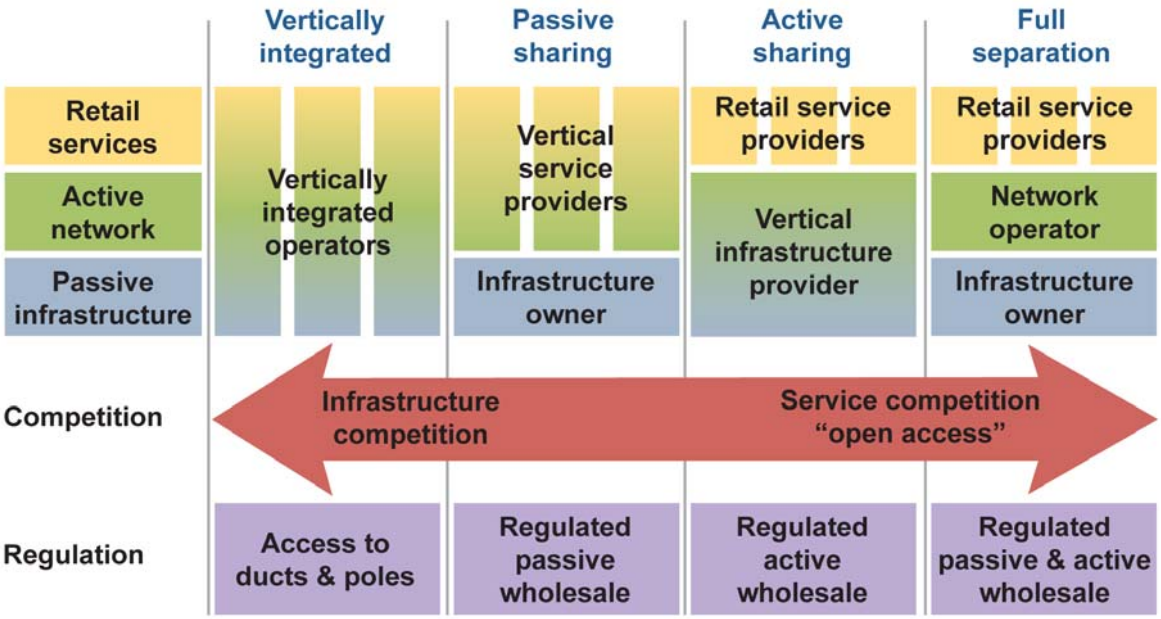


Figure 4: FTTH Business models

The interest of an FTTH network owner could be contained in any one of the three levels in the value chain. Each type of business model has its own opportunities and challenges, which are summarized in the following table:

	Pros	**Cons**
Vertically integrated	Control total value chain and cash flow profile.	Complex operation and high execution risk.
Wholesale operator	Capture extra margin for modest incremental investment.	Must be technically credible yet flexible. Small operators may struggle due to lack of commercial and operational standards for wholesale.
Passive network owner only	Simple operations. About 50% of the revenue potential.	Lack of direct control over the revenue stream and marketing to the end-user.

Deciding which operational model to choose is fundamental as it determines the business model of the activities as well as the financial model and is also very much dependent on local regulations, competitive environment, and the core business activities and competencies of the organisation.

The existence of differentiated business models has opened up the FTTH market to organisations other than traditional telecoms operators, including electricity power providers, housing associations and local authorities.

Case Study #1: HanseNet (Germany)

Summary: HanseNet Telekommunikation, an established broadband ISP in Germany, has constructed a pilot FTTB network covering 700 buildings in the Eimsbüttel area in Hamburg. Thomas Hartmann, network capacity planning manager, explains the firm's business model.

HanseNet provides subscribers in MDU's with 100Mbps via a GPON optical network unit (ONU) placed in the basement of the building and VDSL2 to send data around the building. The operator offers triple-play services (voice, broadband, TV), and video-on-demand, which it markets under the Alice brand. This name will be phased out due to the sale of the company to Telefonica in February 2010.

HanseNet has chosen to use the "vertically integrated" model involving three layers: passive, active and retail services which are all under its control. The layers have been planned, built and commissioned by HanseNet using either its own resources or implemented under the company's project leadership. As one of the largest ISPs on the German market, HanseNet has the professionalism and expertise to plan and implement the entire project.

Planning guidelines for the passive and active network were written by HanseNet and are used to regulate future construction of the network regardless of builder. HanseNet could choose to assign one or more network layers to another company to build and operate, however, all partners will be strictly bound to the guidelines that the operator has laid down by HanseNet. Conversely, it is also possible for HanseNet to establish partnerships with other FTTx-providers, whether they are building up a passive or active network or whether they are a vertically integrated operator.

The main HanseNet chose a vertically integrated model was to own technical and financial proof of concept. Using the experiences gained from the Hamburg pilot, HanseNet is in the position to determine the value of potential partners. An important consideration as a single provider is unlikely to have the ability to build up FTTx networks all over Germany; thus there will be a number of partnerships for a German-wide rollout of FTTx networks.

HanseNet chose the solo partnership model due to a lack of possible partners able to implement a passive network rollout in Hamburg or able to build up an active network. Owing to its market share of nearly 40%, HanseNet was the only service provider willing to make such an investment in Hamburg.

Case study written December 2009; updated January 2011.

Open Access Networks

The term “open access” implies a resource that is made available to clients, other than the owner, on fair and non-discriminatory terms; in other words, the price for access is the same for all clients.

In the context of telecommunications networks, “open access” typically means the access granted to multiple service providers to wholesale services in the local access network enabling them to reach the subscriber without the need to deploy a new fibre access network. The wholesale pricing structure is transparent and the same for all service providers. Wholesale products could be accessed via the fibre itself or through bitstream (data) products as both fall under the heading of open access when offered to all subscribers on equal terms.

The most obvious business model for an Open Access network is full separation, but other models are also possible. **Functional separation** separates the ownership of the network from service provision. The incumbent operator must establish a separate business unit responsible for sale of wholesale products, and create a Chinese wall between the new business unit and other parts of the company.

There is strong political interest in Open Access networks as this mechanism encourages competition between service providers. It is a useful instrument in the regulatory toolbox, particularly in rural areas where FTTH provision is likely to create a monopoly at the infrastructure layer.

Chapter 3: Project Planning

The complexity of starting up an FTTH project does not often get highlighted as much as it should. A small but dedicated team will be needed to establish the viability of the project.

Distinction should be established between building an FTTH network and operating the network. Different skills are required and therefore it is likely that people with different competencies will be employed for construction and at the operation stage of the network.

Project timeline

The following diagram provides a visual timeline of the key stages leading up to the activation of the FTTH network, and highlights the most important events during the deployment phase.

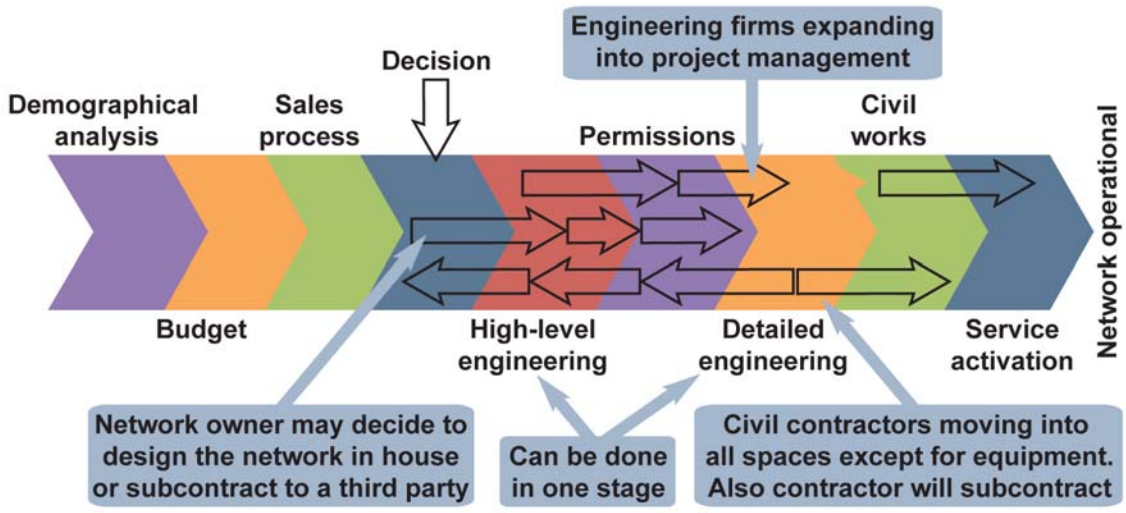


Figure 5: FTTH project timeline

Included in this timeline are the following stages:

1. **Establishment**: formation of a steering group, securing initial funding, carrying out a demographic analysis, developing key relationships, and building awareness of the project.
2. **Business plan**: drawing up a detailed financial budget for presentation to potential investors, including analysis of expected revenues and planned expenditure.
3. **Financing and procurement**: securing the major funding required and completing procurement process with network construction companies.
4. **Deployment**: securing planning and building permissions, installing the fibre and other infrastructure.
5. **Service activation**: lighting the fibre and connecting the users.

Understanding the market

It is important to understand the market: the potential subscriber base, the service provider competition, as well as the geography and existing infrastructure in the proposed deployment area. This information enables the network project leader to make an initial assessment of the situation and complete business plan.

A check list of actions:

- Identify all key stakeholders in the targeted deployment area, including potential suppliers, collaborators and end-users.
- From government sources (e.g. the Census Bureau or Office of National Statistics), basic information about the market, including population by town/region and number of households. In some cases this information may be so detailed as to provide a breakdown of the population into those living in SFU's (Single Family Units) and those in MDU (Multi Dwelling Units). This information is extremely useful when estimating figure capital expenditure.
- Collate information relating to existing broadband provision in the region, especially relating to availability, speeds and prices of existing services. Service provider websites are an obvious first point of call. Where possible, determine if existing service providers have plans to enhance their product offerings. This information may be available through news sources or by approaching the service provider directly.
- The national regulator's website is also an excellent reference as data relating to current take up rates of broadband services is normally available. The regulator may also record more detailed information such as the penetration of different types of services, such as IPTV. A list of telecom regulators is available in Appendix A.
- Prepare a map of the proposed deployment area to identify gaps in service provision and opportunities to exploit other infrastructure, such as roads, electricity pylons, sewers, disused mine workings, and so on. Google Earth offers maps and satellite images that provide more detailed geographical information about the terrain and features of the landscape.
- At this point a survey of potential customers is advisable to find out:
    - what services they are interested in receiving
    - the level of service provided by their existing communications provider
    - services they might be interested in purchasing and at what price, and
    - how their needs might develop in the future
- Conduct appropriate research, gather information regarding events surrounding similar contexts in other regions, lessons learned from elsewhere can either be fully adopted or adapted to individual situations.

Some key factors to consider in a demographic analysis:

- population density
- type of building, SFU's or MDU's
- household income
- average age in households and number of children living at home
- adoption of existing broadband services
- density of small and medium businesses
- presence of existing complementary or competing networks

The analysis will give an indication which areas should be first on the rollout list.

If market research shows a strong demand for better broadband services, this information may encourage an existing operator into taking action. Indeed, this could be the desired result of a demand campaign. It should be noted that the response of other operators could impact negatively on a project as incumbent service providers will work hard to retain their existing customers, through the use of price reductions, improved services or even more devious tactics.

Some FTTH projects have experienced legal challenges from other operators, which can cause substantial delays in launching proposed services. Such delays can also extend the time needed to achieve positive cash flow, have a detrimental effect on borrowing costs, as well as the addition of legal expenses. To the extent these challenges can be avoided or dealt with expeditiously, the road to positive cash flow is likely to be achieved faster.

A thorough and detailed demographic analysis (together with sales activities based on the analysis) will help boost subscriber penetration of the network. The analysis and sales activities should be the basis of the design of the network rather than the other way around.

Initial budget

Draw up an initial budget for the project. The areas that are most attractive should be identified in the demographic analysis. Some important variables are:

- chosen business model – from network owner to fully integrated operator
- choice of topology – point-to-point or point-to-multipoint
- choice of technology – Ethernet or PON
- size and locations of the POPs
- cable route – pavements, asphalt or soft dig
- cabling strategy – buried cables, aerial cables, or a combination
- commissioning strategy – fibre outlet in the household, in the street outside, duct ready installed or drop box within a given distance
- cost of the equipment to light the fibre
- both capital expenditure and operating costs must be taken into account
- sales costs

Go decision

The initial budget, together with possible revenues indicated by the demographic analysis, will indicate realistic procedure to the next stage. Assuming an overall “go” decision, a business plan and secure funding for the project must be in place.

A minimum percentage of signed up subscribers in a given area ahead of construction is strongly recommended. Registering subscriptions in advance of network rollout is a common strategy among FTTH operators. The Dutch operator Reggefiber, sets a “trigger” level for network deployment – digging only starts when at least 40% of households in the connection area have pre-registered for services.

An awareness-raising campaign outlining the advantages of FTTH to potential subscribers can help to stimulate demand and increase sign-ups. This strategy can be important as potential subscribers are largely unaware of the benefits of FTTH, or even of the type of broadband connection they are currently using. This is partly due to service providers who often sell broadband products using a brand name, such as Verizon’s FiOS. Further confusion arises as some broadband products based on cable or VDSL technologies are branded as “fibre optic”, even though fibre does not extend from the neighbourhood into the home.

A number of key sales considerations:

- business model for revenue sharing should be complete before starting sales process
- price used to attract early adopters; however, limit extent of any possible connection fee offers
- do not underestimate the installation time
- sales results should steer installation schedule
- set demand registration targets: one for starting the design and the second for entering into right-of-way agreements
- services must be ready at the same time as connectivity as without has limited value to the end user;
- streamline installation activities to limit time from sale to connection as short as possible

High-level engineering

Decide on a construction strategy. All possible existing duct systems should be considered and long-term perspective of the infrastructure has to be considered.

Some key considerations include:

- construction strategy: in-house versus third party turn-key solution
- fibre or duct only
- redundancy – the existence of multiple paths in the network in case of failure
- demarcation points between the customer and end-user
- rights-of-way
- quality of documentation from contractors
- flexibility in design should be compared with initial costs

Permissions

The right-of-way process should be considered early on in the project as should the involvement of the local inhabitants in the actual area of deployment. This action is also a support to the sales process and minimizes the number of objections. In addition the support and official backing of the project by the community and political leaders is vital.

This process not only includes negotiating rights-of-way and network maintenance, it also includes finding spaces for POPs and cross-connection points.

Some important issues are:

- contracts should correlate with the expected lifespan of the network
- avoid gatekeepers – organisations or individual that can hold the project to ransom by threatening to cut off the network from the outside world
- do not be afraid to rethink the design

Detailed engineering

Network design may be carried out either by the network owner or the contractor, depending on the strategy chosen for the purchase of construction.

The question of where to terminate the connection has to be settled; the upfront cost has to be compared with the cost of extra truck rolls to activate a new subscriber. Networks where, the termination point is positioned too far from the subscriber in an attempt to keep the costs of the initial investment down, could end up in a negative spiral where connecting difficulties hinders attracting new customers.

Some key considerations are:

- draw up a tailor-made network design without the aid of vendors
- the detailed design should be clearly documented
- historically there is a tendency to install too few fibres
- the network will reach 80—90% penetration during its lifetime; plan accordingly
- depending on active technology, consider the port loss problem
- use public areas for distribution

Civil works

Even though fibre infrastructure can be considered high tech, most of the costs are related to digging. Investigate methods and material to minimize digging and work on site to bring down total cost.

A major issue is actual access to homes, particularly MDU's (Multi Dwelling Units). Installation often requires co-ordination where several individuals have to provide access to their homes to support a sequence. This together with the handling of keys often disrupts the installation process, and causes unexpected costs.

Some key issues are:

- ascertain scope of the work if going for lump sum offers
- if working with open books, partner with the contractor early and maintain good cost control
- secure quality of contract documentation
- indoor and outdoor activities might require different engineer competencies
- use the construction phase as a marketing opportunity, taking advantage of the occasion and correlate sales activities to the roll out

Service activation

The activation phases can not start until a complete link is created from the end user to external networks. Depending on the business model, this activity could be handled by the network owner, a communication operator or a telecom operator. It is important that documentation is correct and that sales activities have been consolidated in a system that also supports commissioning.

The network is of no value to the end user and will not generate any income for the service provider until it is activated and filled with services that can be used. Services should be available at the same time as the connectivity. A network with pre-installed outlets makes remote commissioning possible and decreases the costs of connecting subscribers.

Customer Support has to be in place as soon as there are paying subscribers on the network.

Some key issues are:

- physical installation takes time
- active equipment at the user end is needed but will create support costs
- clear demarcation points between different parties (network owner, operator and service provider), should be in place for the benefit of the subscriber
- the party with subscriber contact should handle front line support
- in a multi-service network, a single source of front line support may be separate from the services

Chapter 4: Services

What services will be offered over the network? This is a key question for all types of FTTH organisations; whether they involve network owner, wholesale operator, or retail service provider. If the organisation does not plan to operate in the retail services layer; it will need to set up relationships with the companies that will.

Retail services can be divided according to market segments:

- residential
- business
- carrier
- public sector

Residential

Typical residential services include:

- basic telephony (using VOIP)
- internet access
- IPTV

A retail package that includes all three elements is termed “triple play”.

Retail ISPs may also choose to offer other services to subscribers, such as web space, online backup, technical advice and so on. These services may be bundled together in the basic package.

Internet access itself is the “killer app”. An increasing number of subscribers are demanding reliable, high-speed broadband connectivity to access an expanding range of internet activities, including online shopping, online banking, school homework, access to online public services, catch-up TV services such as BBC iPlayer or Hulu, online gaming, and much more

Catch-up TV is an example of over-the-top (OTT) internet application, because it is available to anyone with internet access. This is distinct from broadcast IPTV services, which are provided by the retail service provider exclusively to its subscribers.

Many internet applications also require good upstream data rates. Examples are back-up to an online data vault or online video calling.

The network owner may also wish to offer specialised services, for example:

- A housing association-owned network might offer a central system for booking landlord visits and building maintenance.
- A municipal network might offer local TV broadcasts or views from CCTV cameras.
- A power provider might team up with the network owner to offer an integrated system to implement smart grid and/or home automation technologies.

The high capacity available from FTTH provides a good platform for delivering new services, but should not be exaggerated. The basics have to be right: fast, reliable broadband is a good way to secure subscriber loyalty. Broadband on its own is a profitable product; in fact it is the most profitable product for many service providers, according to a study conducted by Yankee Group (2009) on next-generation access service portfolios.

Business

Many large enterprises are already involved in fibre optic networks due to the high bandwidth, high reliability and high security requirements which far exceed those available to the residential sector. As a result of special requirements, these large businesses are not usually linked directly to the same infrastructure as residential subscribers.

However, research has found that there is considerable market opportunity in addressing the under-served lower end of the business market. Small and medium-size businesses (SMEs) can easily be served from a typical FTTH network, even if the network is subscriber-focused, a discussion with any businesses located within the coverage area may be advantageous.

The technical network requirements for businesses may not be substantially different from those for subscribers. Business users may be interested in tailored service packages involving extra features such as uptime guarantees, lower contention, higher security and business-grade customer service. A discussion with local businesses to assess their needs is advised.

Cloud services, and application outsourcing, are becoming popular with businesses. It is generally understood that these services work with high speed symmetric fibre connections only.

Further service provision opportunities may exist that require features only deliverable through fibre, for example:

- video conferencing and telepresence are complementary to business services
- high-frequency trading where participants need lowest latency connections to stock exchanges
- virtual orchestra where musicians need low latency connections to colleagues residing in remote place. A possible model for the professional music recording business

Carrier

Studies suggest that “open access” policies, which allow third parties to offer their services on the network, can enhance the business case, particularly involving new parties in the retail market place. Attracting established, respected, internet service providers to offer products and services over the network can be an effective means of increasing overall market penetration. Even if the business model is vertically integrated, it is worth considering expanding the network to include wholesale subscribers.

A good example of an Open Access approach is Mälarenergi Stadsnät in Sweden (see next page). This company is of the opinion that the number of revenue opportunities could be increased substantially through this approach. Today there are more than 35 service providers operating over the network.

Case study #2: Mälarenergi Stadsnät

Summary: The municipality of Västerås was the first in Sweden, and probably in Europe, to build an open access FTTH network. This concept has been documented and sold to other cities in Sweden.

In 1999 the Swedish city of Västerås decided to build its own municipal fibre optic network. The motivation was simple: the local authorities wanted to develop a communications infrastructure for their own use, and to attract new businesses to the city. In those days it was cheaper to dig than to rent dark fibre capacity from existing operators.

Thus, in July 2000 Mälarenergi Stadsnät was created, 40% of which was owned by the industrial firm ABB and 60% by energy provider Mälarenergi, which in turn is owned by the Municipality of Västerås. (Today the company is a wholly-owned subsidiary of Mälarenergi having purchased ABB's share in the business three years after the partnership was formed).

The concept of Open Access was new, but made good sense, according to Per Norrthon, CEO of Mälarenergi Stadsnät. "The investment was substantial and the only way to finance this was to sign up many users and offer many services," he explained. "We decided to merge the needs from the business community with the private sector and create an active infrastructure offering very high performance, available to all and meeting every need; data communication, TV distribution, telephony as well as future services, whatever they might be."

Mälarenergi understood early on that good marketing was vital to success. The first marketing campaigns targeted commercial properties by focusing on a single area and getting as many businesses as possible to sign up. As well as promoting the benefits of fibre, the campaign specified the higher cost of connecting to the network at a later stage. The strategy was highly successful, over 95% of businesses registered for connections and all agreed to pay their connection fee in advance, which kept the company cash flow positive in the first year.

In 2003, new campaigns were launched to target residential properties. The first connected subscriber was the municipally-owned housing organisation, Mimer; the second was the municipal administration itself. These major agreements made it possible to expand the network throughout different areas of the city, and from that position sell connections to SFU's (Single Family Units).

"A lot of effort was put into promoting our offer to the market," said Norrthon. "We created different groups of customers; business users, property owners, subscribers, and so on. We invited them to seminars and meetings to explain the advantages of our product using ambassadors: people in the potential subscriber arenas who understood the advantages of our solution and would recommend it to colleagues and neighbours."

Mälarenergi realised that it could not recover the investment within a reasonable time frame from wholesale fees alone, unless these were set at an unrealistically high level. Instead it chose a business model whereby the property owner pays the city network for the physical installation of the fibre, and when the subscriber buys a service from any of the service providers on the network, the city network also gets a part of the fee paid by the subscriber to the service provider. Historically, a SFU-owner paid SEK 30,000 (about €3,200) to be connected to the city network. Mälarenergi Stadsnät has arrangements with several banks to offer loans using the house as security. "Our colleagues in other countries think it is remarkable that we can sell these connections, but we do," commented Norrthon. Despite the relatively high upfront cost, subscribers are attracted by the additional value to their property and gaining lifetime access to a wide range of services at lower prices than those available on other networks.

Today there are more than 35 service providers on the network, including major operators, including Telia and Tele2, as well as more than 185 different services to choose from. The menu of services goes far beyond basic telephony and internet and now includes IPTV, alarms and monitoring services, local booking systems for laundry or parking spaces, and community services such as healthcare and communication for the elderly. Plans to launch a broadband TV service are also well advanced which will provide end-users with up to 250 channels without the need for a new set-top box.

More than €40 million has been invested in the city network over the past 10 years, but due to its novel business model, Mälarenergi Stadsnät has had several profitable years since 2004. "It should be possible to get a return on investment in 10 years, but of course expanding the network also costs," said Norrthon. In 2008 Mälarenergi Stadsnät took over the operation of the network in the neighbouring town of Hallstahammar, and in 2009 it reached an agreement to extend the fibre network to include the nearby city of Eskilstuna. Further investment is also being made in Västerås: as part of an upgrade programme subscribers are now being asked to register their interest in receiving 1 Gbps connections.

Written Sept 2010.

The roll out of optical fibre into the access network on a greater scale has further advantages for other networks such as mobile. Mobile broadband currently offers download speeds of 10Mbps to users through such technology as HSPA. The next generation of mobile broadband based on LTE or WiMAX is currently being rolled out, and has the potential to offer 100Mbps or more. With multiple users the base station connectivity requirements are likely to exceed the capability of current microwave backhaul systems. Further, the increased bit rates will require higher densities of antenna, which may also need to be interconnected with fibre. Incorporating mobile backhaul into the access network could provide scalable and cost-effective mobile network architecture, especially since mobile base stations are often located on top of MFU's and commercial buildings. An additional return on investment may be possible for the network builder who takes this added dimension into consideration.

Public sector

The public sector should not be neglected when drawing up FTTH network plans. Schools, libraries, hospitals, clinics and local government buildings all require connectivity and have expanding requirements. With the growth of ICT in school curriculums, libraries becoming digital access points, doctors sharing patient records electronically and governments offering an increasing number of public services online, these organisations can become anchor tenants on the network.

Pricing strategies

ARPU (average revenue per user) is the correct term for the average monthly revenues paid by a subscriber. The higher the ARPU in the target market, the more attractive that market will be. Broadband pricing is influenced by a range of factors, including geography, demographics, competition and possible regulation. The business community and the public sector will generally support different pricing levels than retail consumers.

Many incumbents have conducted pre-launch market studies that have tended to suggest that residential potential subscribers would be willing to pay a 10-15% premium for a triple-play subscription over fibre. In areas where there is a strong satellite TV offering this figure may be lower. However, it must be stressed that this is market-dependent: Verizon in the US has reported an ARPU exceeding $140 in Q409 for its FiOS service which is growing head-to-head with entrenched cable TV competition.

Use the information collected during the market research phase to assess the needs of the market and the level which potential subscribers would be willing to pay, these are not necessarily the same thing, This information must be kept up to date and relevant throughout the business planning phase.

A study into NGA product portfolios commissioned by the FTTH Council Europe identified several different retail strategies. Yankee Group analysed the service portfolios of 20 NGA operators around the world in order to identify the kind of services currently offered; the attractiveness, relative profitability and technical requirements of these services; as well as the directions in which service providers are developing or proposing to develop new services in the future.

The study identified three different strategies at play on the market:

- The **broadband-utility** strategy focuses on customer acquisition, aimed at providing affordable internet access to as many users as possible. This is a typical strategy for municipal networks and alternative operators.
- The **expand-and-cash-in** strategy consists of a wide network deployment with few added-value services offered until a critical mass of subscribers has been achieved.
- The **keep-it-premium** strategy involves providing attractive new services at premium prices, aimed at a smaller, niche subscriber base without cannibalising existing revenues. This kind of behaviour is often found in incumbent operators.

Research has shown that the business case for FTTH is highly sensitive to subscriber take-up services. The choice of service package and the ability to provide these and future services has been one of the main criteria for success or failure of many of the independent FTTH networks.

In a separate study, Yankee Group showed that penetration rather than ARPU has the strongest effect on the FTTH business case. For the set of assumptions in their model, it was difficult to create a business plan with a payback in five years or less, unless penetration reached at least 30%.

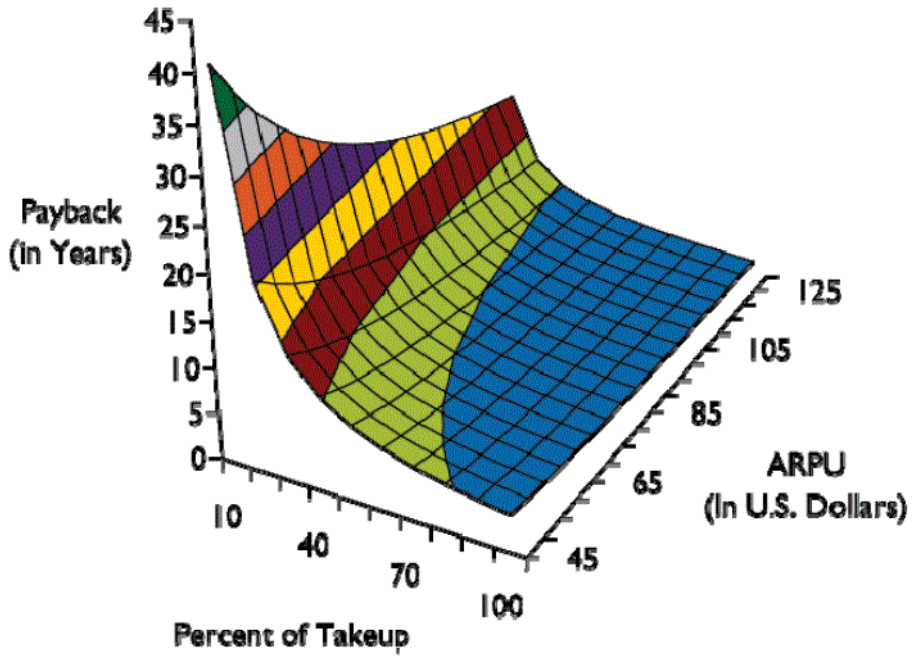


Figure 6: Undiscounted payback period with $1000 per home connected and 45% gross margin. Source: Yankee Group, 2009, webinar "Making that business model work"

How much market share is it reasonable to expect? Experience indicates that first year penetration rates in areas with no fibre, cable or fast DSL competition can be as high as 50%, but 20—30% is perhaps more realistic. The final penetration in the same area might be as high as 70%, but again estimating the realistic penetration will also depend on the ability and willingness to pay.

The competitive environment will be the major influence expected achievable market share. The maturity of broadband and triple-play local markets varies greatly across Europe. Greece, on the one hand, only had affordable, broad penetration cable television and ADSL since 2008. Whilst Sweden has a large number of areas where FTTH and cable compete and ADSL has been more or less squeezed out of the market.

In general, it is easier to gain traction in a growing market, although it is also entirely possible to convert a local market from lower broadband speeds to high-speed broadband. Places not currently served by broadband clearly offer the best prospects; however, broadband "notspots", which are locations too far from

the telephone exchange to receive DSL services, tend to be geographically diverse, and therefore more expensive to connect with fibre.

The most risky proposition is a market that already has good FTTH coverage. All other factors being equal, the presence of an existing FTTH operator immediately reduces the addressable market by 50% – why should a new provider expect to get more than a fair share of the market? In reality a new provider is most likely to be competing for the unaddressed portion of the market and consequently also a much harder sell. If they didn't want fibre from the first service provider, why would they want it from a second?

See Appendix D, White Paper, for more detailed information. This document has been created by the Content and Applications Committee.

Chapter 5: Deployment

This chapter looks into the all-important issue of cost. How much investment is required to build the network, and how much will be required to keep it going? What are the main influences on those costs? Possible strategies for network deployment and their impact on the business case will also be discussed.

Expenditure falls into three main categories:

- capital expenditure (CAPEX): major posts paid at the start of the project, during upgrades and extensions;
- operating expenditure (OPEX): the cost of keeping everything running;
- cost of goods sold (COGS): costs incurred when a sale is made.

Capital expenditure

It is helpful to understand the relative contribution of each of the different items of capital expenditure, and thus the relative cost-saving potential. The chart below shows a simplified CAPEX distribution for typical Greenfield FTTH deployments, where no existing infrastructure can be reused. Civil works – digging trenches to bury duct or cable and then filling them in again – is the most expensive post and therefore offer the greatest potential for cost reduction and also the largest variance between different situations.

The other main items are:

- CO actives – the active equipment in the central office
- subscriber actives – equipment installed on the subscriber premises
- material – fibre optic cable, enclosures and other passive hardware.

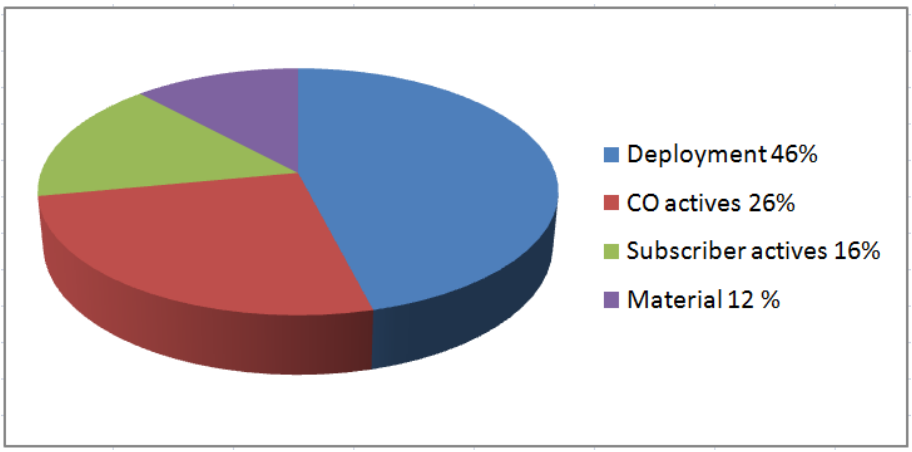
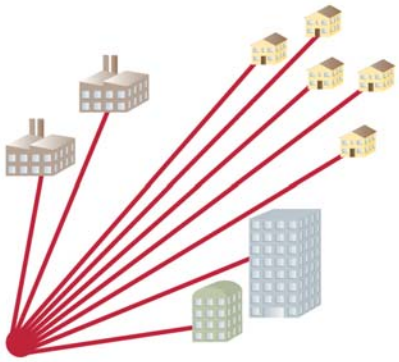


Figure 7: Cost breakdown of a FTTH project

Network architecture

In terms of the cable plant, there are two main options: point-to-point or point-to-multipoint topologies.

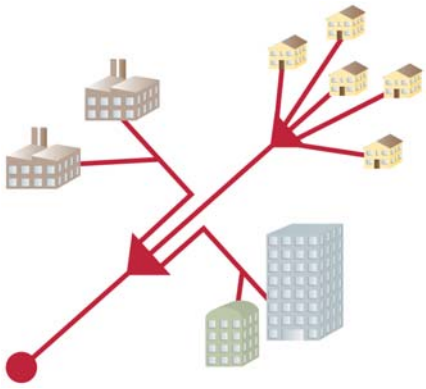
In a **point-to-point** topology each end-user is served by a single fibre that runs from the central office to the subscribers' premises. The route will probably comprise of several sections of fibre joined with splices or connectors providing a continuous, uninterrupted optical path from the central office to the home. This is sometimes called a "home run" network.



Active Ethernet network

In a **point-to-multipoint** topology all traffic is carried on a single, shared fibre from the central office to a branching point, and from there the traffic is routed onto individual, dedicated fibres, one per customer. A passive optical network technology such as GPON uses passive optical splitters at the branching point(s) to broadcast light across multiple fibres; data is encoded so that users only receive data intended for them.

Another option is to route traffic electronically using Ethernet routers, an architecture called Active Ethernet. Although the cable plant has a point-to-multipoint topology, each subscriber has a logical point-to-point connection. The end-user sends and receives only the data intended for them.



Passive optical network

The subscribers' premises may be a SFU (Single Family Unit) or a multiple dwelling unit (MDU) in which case active equipment may be installed in the building in order to aggregate traffic from all subscribers in the building onto the single fibre.

Variations of the basic network architectures are possible depending on the number of fibres, positions of splitters and aggregation points. For example, some networks use two fibres from the central office to the subscriber. The first fibre delivers broadband, telephone and video-on-demand, while the second is used for broadcast TV using PON equipment located in the central office – allowing the network operator to take advantage of the broadcast capabilities of PON.

Installation inside an MDU

Choosing the right network architecture often generates considerable debate. There is no clear winner; in today's market, different architectures suit different operator

requirements, business and technical priorities.

A simple classification of the different options is shown in the following table:

		Technology	
		Ethernet	TDM-PON (GPON, EPON, DPON, XG-PON, 10GEPON)
Topology	P2P	Ethernet P2P	PON P2P
	P2MP	Active Ethernet	PON P2MP

Dedicated medium

Shared medium

Figure 8: Topology and technology combinations

Whatever the network architecture, it is important to consider how the design of the cable plant may affect the evolution of the network in the future. An FTTH network is a long-term investment. The anticipated lifespan of the cable in the ground is at least 25 years (this is the manufacturer's guaranteed minimum lifespan) however the working lifespan is likely to be much longer. The active equipment will need to be upgraded several times in this timeframe, but the infrastructure should be re-usable. Decisions relating to the cable plant made at the start of a project will have long term consequences.

A common mistake in network design is to save on initial costs by installing fibre that corresponds with actual requirements. Historically, the demand for fibre has grown over the years and is likely to continue to do so. Installing a minimum of fibre often leads to the need for more advanced and expensive communication equipment. Single fibre solutions could create technical or commercial bottlenecks in the future.

At the start of the project it is worth considering whether to put extra ducts in the trenches. Duct systems that can be reused by pulling or blowing in new or additional fibre will enhance the life of the network. If non-reusable ducts, direct buried cables, water cable, aerial cable or façade cables are considered, the lifespan of the network would depend on the anticipated lifespan of the chosen fibre cables.

Active equipment

The central office is usually a small building or room where all fibre connections are terminated and connected to the electronic transmission equipment – the FTTH equivalent of a telephone exchange. Inside optical distribution frames (ODFs) are usually located along with patch panels for managing the fibre connections and fibre test equipment as well as the transmission equipment.

The price of equipment in the POPs will depend on the chosen technology and vendor. As mentioned before, there is no simple answer to the question: which technology is best? The best solution depends on a number of factors, such as access to duct space, local cost of labour, the organisation's competencies, and so on. The network operator must carefully evaluate the specific network circumstances. See Appendix E.

In general, modelling shows that point-to-point deployment costs are likely to grow in proportion with homes connected after the homes have been passed: equipment does not need to be deployed, powered, managed or maintained until there is a paying subscriber ready to take revenue-generating service.

In contrast, PON deployment costs per subscriber may initially be higher but decreases with subscriber density: as more are connected, the common exchange costs are shared accordingly.

Some other variables to consider include:

1. **Space** – point-to-point networks require more floor space in the central office since each incoming fibre must be patched through and terminated individually on an active module, whereas a single PON active module is connected to many subscribers with just one fibre.
2. **Security** – There are many business subscribers using PON networks. However, since PON is a shared medium, some organisations with highly sensitive data, such as hospitals, may not accept this type of connection, preferring a dedicated fibre. Whilst downstream data is encrypted in the current PON standards, it is visible at all end-points, upstream data is not encrypted.
3. **Power consumption** – is highly variable depending on subscriber penetration, the geographic distribution of subscribers on the network, and the equipment configuration at the central office. PON technologies are power efficient for high penetration rates. However, PON high-speed transmitters must be powered even when there are only a few active subscribers on the branch can result in higher power consumption per subscriber at lower penetration rates.
4. **Ease of troubleshooting** – since there are no optical elements in the link between the central office and the subscriber, P2P networks can be tested from the central office saving time and money. The splitter in a PON makes this more difficult, although not impossible.
5. **Impact of a cable cut** – In the event of a complete cable cut in the feeder part of the network, architectures with fewer fibres will take less time to repair. Independent of the architecture, the time to repair could also be reduced by using more cables (i.e. fewer fibres per cable) in the network design, allowing repair teams to work in parallel.
6. **Unbundling** – is there, or is there likely to be in the future, a regulatory or business need to allow other operators to install their own equipment in the exchange? Unbundling is easier with point-to-point architectures.

Feeder fibres

The horizontal portion of the outside plant (OSP) brings the fibre down the street, passing all buildings. In most cases the OSP has the largest impact on cost, especially if cables need to be buried.

Although a fibre always exists between the central hub and the customers, the way that this is routed will have a major impact on construction cost. The possibility to reuse existing ducts and conduits should always be considered as the presence of ducts for part of the route allows fibre to be blown through and could substantially reduce the deployment cost over that length.

The lowest cost solution where a building does not exist is an aerial route. Power or similar poles are used to support the fibre. This clearly is advantageous to all power providers interested in the fibre based business.

A similar approach that may be used is stapling. Here the fibre is literally passed around the outside of the building and stapled in place.

Where the above is not possible, the fibre will need to be dug. This is achieved by digging a shallow approach called micro-trenching (the metre cost is twice that of aerial installation) or a deeper, full trench method (the cost would now be approximately double that of micro-trenching.

The state of existing pavements will have an impact on digging costs. Where ornate paving is in place the cost to make good the pavement will be greatly increased. Even the particular nature of the subsoil has an impact on costs: soft ground may permit fast construction using dedicated mole equipment: detailed local knowledge is invaluable.

The cost for right–of–way permission should also be taken in to consideration when choosing the route of the network. These costs consist of annual fees as well as initial permission charges.

Whatever the method of building fibre around a town or city, the average length of fibre per home passed will have a serious impact on the financing. Individual homes will clearly be the highest cost to connect whilst MDU's being the cheapest.

Of course, demographics cannot be changed, but should be taken into consideration when deciding where to roll out the network and which areas to target first.

Potential improvements:

- duct renting if available
- aerial fibre involves attaching fibre to poles
- façade fibre staples the fibre to the front of buildings, where allowed
- low cost, fast techniques such as micro trenching
- reducing digging costs by training local contractors to carry out the work
- optimisation of network topology

Final drop

In addition to the connections along the street, SFU's also needed to be connected from the street. The cost per subscriber will be dependent on the type of residence, whether it is an SFU or an MDU. Although MDU's are cheaper on a per subscriber basis, they also present specific challenges.

The cost of in-building cabling in MDU's can vary substantially depending on the availability of technical shafts (or otherwise), the ease of access to the basement, and ease of access inside the apartments; this can have a big impact on final costs.

The cost of handling keys and difficulty in gaining access to apartments is often underestimated, particularly in cases where access to multiple apartments is required on the same day. When writing contracts, it is important to address the issue of access. It must be clear who has the responsibility if access is denied.

The cost also varies according to the strategy. It is not usually desirable to connect every property with fibre on day one, unless it is a new build area. However, it may be more cost-effective to use micro duct to every apartment in an MDU, allowing fibre to be blown through as and when required.

The cost for negotiating with individual subscribers contracts must also be included. The worst case is where terms must be agreed with individual residents with subsequent problems where the need to gather all tenants together at the same time or if this is not possible then conduct several meetings to gain agreement.

The opposite extreme occurs where there is potential to negotiate with either a tenant's association or landlord who is authorised to make decisions on behalf of tens or hundreds of occupants. The scope of these negotiations may be greater than for one home but overall, the effort per home connected is significantly reduced and hence the associated costs are reduced.

Potential improvements:

- involving preparative work with potential subscribers
- pre-ordering/mass connection initiative for initial rollout
- reusing existing copper cabling inside buildings

In some cases, connections will be paid for by landlords or tenant associations. Landlords are becoming increasingly aware that the provision of triple-play services in their properties enables them to charge higher rents or sale prices.

There have already been cases where home owners are willing to pay €1000 for a fibre connection as they see the additional value to their home outweighs installation costs. However, such schemes only work where a reasonable number of homes to be served will commit to the scheme in advance.

A number of innovative methods have been developed to reduce the cost of the final connection and these should be investigated to establish the most appropriate method and therefore the associated cost model.

Subscriber equipment

As well as the cost of terminating the fibre in the home or apartment, there is a cost associated with activating the connection and installing the necessary active equipment in the home: whether residential gateway, router or set-top box. Unlike legacy DSL, the subscriber equipment is usually not available from retail suppliers, and must be supplied by the operator providing the FTTH connection.

When entering a private home, ideally the installation process should be planned as a single visit. This means the installation team should be prepared to do all in-home activities including installing the fibre and subscriber equipment.

It is important that the installation teams update all documentation when installing and splicing fibre. If a fibre outlet is left in the apartment the risk of exposing a laser beam should be considered.

Potential improvements:

- mass connection initiative during rollout
- let the end-user pay for the equipment by renting or buying it

Deployment Strategies

Aiming to pass as many homes as quickly as possible is not necessarily the most economical way of rolling out a network. The business case would normally show that it is better to achieve good penetration in a limited area than to have lower penetration over a bigger area. A higher return on investment (ROI) is generally achieved with a cherry-picking approach where FTTH is deployed in specially selected, limited areas offering a higher potential for FTTH take-up for the lowest possible cost per home passed.

This approach often requires analysing a number of areas, ranking them in order of the least attractive and then selecting for deployment the areas that appear most attractive. These would normally be areas that promise the highest take-up (subscribers vs. Homes passed) for the lowest cost per home passed.

Various criteria may be used for analysing and ranking potential deployment areas. Generally, these can be divided into two groups: those related to take-up rates and those related to deployment cost per household. It is important to note that there is no single set of criteria that works best in all possible deployment situations. Bearing this in mind, the following criteria may be useful:

Take-up criteria:

- **Broadband penetration**: areas with higher broadband Internet penetration (whether DSL, cable or other technologies) among the existing population generally yield higher FTTH take-up than areas with lower broadband penetration;
- **Average revenue per user** (ARPU): areas with higher ARPU from telecommunications and TV services generally yield higher FTTH take-up than areas with lower ARPU.

Cost criteria:

- **housing density**: areas comprising of MDU's generally have a lower deployment cost per household than areas with mainly SFU's
- **urban versus rural** – urban areas with a larger potential subscriber base generally incur a lower deployment cost per household than sparsely populated areas in rural areas;

The effects of these criteria on ROI are summarized in the following table:

Lower ROI	Higher ROI	
Lower broadband penetration	Vs. Higher broadband penetration	Take up drivers
Lower ARPU	Vs. Higher ARPU	
Lower housing density (SFU's)	Vs. Higher housing density (MDU'S)	Cost drivers
Rural areas	Vs. Urban areas	

The ideal deployment situation would be an area with the highest potential take-up rate and the lowest deployment cost. However, in reality the situation is rarely this straightforward. A densely populated urban area comprising of MDU's may have a lower deployment cost per household, but also a lower take-up rate. Likewise, a more sparsely populated rural or semi-rural area with SFU's may have a higher deployment cost per household, but also a higher take-up rate.

The attractiveness of rural areas for FTTH deployment usually improves substantially when some form of government subsidy is available. For example, European funds are available for this purpose and since the announcement of the European Digital Agenda (see Chapter 6) will be more widely sought.

Operating costs

Typical operational expenditure posts will include:

- communications license fees, where applicable
- administration (office rental, vehicles etc)
- personnel (recruitment, training, salaries, etc)
- right–of–way costs (ROW)
- running cost for POPs (rent, electricity, etc)
- backhaul connection
- subscriber acquisition and marketing
- network maintenance and troubleshooting

All businesses have some fixed costs. The FTTH service provider will be subject to substantial fixed elements covering central systems which relate to the acquisition of new subscribers, billing, customer support, etc. Therefore, where the potential number of subscribers is low, the disproportionately high level of fixed costs will make it difficult to draw up a realistic business case. Conversely, as the number of potential subscribers increases, the fixed central costs become less of an issue.

For a small operator the biggest post may not involve central system costs but employees. Network organisations with fewer than five employees are rare but not unheard of.

Nevertheless, as our case study of the Red Apple building shows, it is possible to build a successful FTTH network dedicated to a single MDU.

If the network is to be rented to one or more established service provider their areas of responsibility could also involve marketing, billing and subscriber care, therefore a suitable margin covering these posts must be included in all calculations. Established service providers are not generally interested in small-scale, special cases as cost-affectivity lies in the mass market.

Case Study #3: The Red Apple building (Netherlands)

In 2009, the Red Apple building in Rotterdam became the first MDU owner association to be equipped with an FTTH network with in excess of 90% of the residents becoming subscribers.

Rotterdam, with a population of 607.000, is the second-largest populated city in the Netherlands. The city centre comprises of a number of modern, luxury MDU's which have been built to attract young people; the Red Apple is one such building.

The owner association of this 40 floor building offered a contract for the roll out of fibre throughout the building, OONO (Onafhankelijke Open Network Operator) was contracted to install and operate a GPON network with the Municipality providing a fibre backhaul connection to the building. The CEO and founder of OONO Oscar Kuiper explained his decision to go with GPON rather than Ethernet point-to-point: the physical structure of the building made it impossible to roll out a second fibre dedicated to analogue TV.

The network is Open Access; the network owner, operator and service providers have strictly separate organisations. The network is owned by the MDU's owners' association, OONO is the active operator and various companies are contracted to provide services.

Internet, telephony and TV are available either separately or bundled. Prices for triple-play are from €42.50 to €69.95 per month [data from *Telecompaper*, retrieved 7 Sept 2009]. The cheapest subscription is for symmetric internet at 20Mbps with the most expensive package including 60Mbps, unlimited calling to fixed numbers in the Netherlands and 110 digital TV channels. A 100Mbps subscription is also available.

Initial connection costs are €400 per household and the owners association expects to get a return on its investment in just three years. Rotterdam Municipality is looking to encouraging other stakeholders (architects, construction companies, and developers) to adopt a similar approach.

Meanwhile, OONO has embarked upon an additional three small-scale FTTH projects in the municipalities of Tilburg, Waalwijk and Vught. The model will be the same in all the projects: OONO is the network operator, and the subscribers own the network, which is open to any service provider.

Written November 2009

Right-of-way

Network operators do not always own all the land over which the FTTH network passes. Therefore it is necessary to seek permission and pay the landowner for the right to install fibre cables. If this right-of-way is acquired through the payment of a lump sum, this will be categorized as a capital expenditure; alternatively, if invoiced as a periodic rent (monthly, quarterly or annually) it will be classified as an operational expense. In other words, right–of -way costs can be treated as CAPEX or OPEX; the majority are treated as operational expenses.

Careful planning can have a positive effect on right-of-way costs, for example, if rent is paid for the deployment of fibre in third-party ducts, choosing an architecture which uses fewer fibres or cables may reduce costs.

Marketing

One activity often overlooked in a business case is the cost of attracting subscribers to the network.

Where contracts can be agreed with MDU landlords and/or tenant associations, costs are spread across 50, 100 or even more potential subscribers. When selling to SFU's it may be necessary to use low-cost approaches (e.g. leaflets) as the cost of mass media advertising may not be justifiable for the limited number of potential subscribers.

Opening a temporary shop/information outlet in a roll-out area could be a good option to generate awareness and provide information relating to installation progress, product portfolios and service providers. However, the viability of this does depend on the size of the business and the potential subscriber base.

One way to avoid mistakes that could alienate potential subscribers is to run a trial. Limit the commercial launch to a beta test group that is fully acquainted with the services that are being tested and the possible teething problems that may occur. Expanding introduction of the system should be delayed until the system is up and running properly and has been thoroughly tested.

Where wholesale fibre access is the main product, developing partnerships with potential customers, who are operators and service providers, ahead of the build is preferable. This is especially so as their input in defining interfaces and processes is highly beneficial. A number of municipal fibre projects have failed due to overly complex or inappropriate systems with the result that they were unable to secure contracts with service providers.

Backhaul

Planning and budgeting for backhaul is a necessity as the FTTH network needs to be connected to the internet. The cost of this will depend on whether the network owner leases dark fibre from another operator, purchases a bitstream product or is the owner of the backhaul. As backhaul costs will be an operational expense purchasing the minimum capacity necessary for the network is to be recommended

Bitstream costs for a fibre operator can be substantial, depending on availability, local pricing, and the degree of competition. The challenge then is to estimate and cost the correct usage per user, decide how

much backhaul oversubscription (if any) is permissible and whether to place a cap on usage. This is not an uncommon practise in regions with high IP transit costs.

A single access for IP transit is not recommended in the event of failure. A second access point should be able to cope with 80% of the maximum traffic, even if this facility is not normally used.

Case Study #4: SkåNet (Sweden)

Summary: SkåNet is a regional network providing fibre connections to more than 250 small towns and rural communities in Sweden. The majority of access network connections are provided over wireless or ADSL; the aim is to upgrade those last mile connections to 100 Mbps FTTH.

Bredband för alla i Skåne (BAS – Broadband for all in Skåne) is a project aimed at providing broadband services to all in the Skåne region which is the southernmost county in Sweden. With a population of approximately 1.2 million, Skåne County covers 3% of Sweden's total geographical area. The objective was to make the predominantly rural county of Skåne more attractive for businesses, investors, workers and general population and to help bridge the digital divide between urban and rural areas in Sweden.

To achieve this, the regional council (Region Skåne) and the Association of Municipalities in Skåne (Kommunförbundet Skåne) set up SkåNet in 2003 as a public-private partnership. SkåNet's main task was to coordinate the planning, procurement and monitoring of an Open Access fibre network across the county. The idea was to create an operator that could offer fibre connections to smaller towns and rural areas throughout the region. By investing substantial resources in infrastructure to all locations with more than 200 inhabitants, resources would be freed for other market players to invest in the local access network.

Alternative operator Tele2 was contracted to build, own and operate the BAS network in an agreement covering a period of eight years, until 2011. Under the conditions of the agreement, the network must be open to all communications providers on equal terms.

The expansion of the network took place in three stages, and was officially complete in 2008. The BAS network now consists of 2,000 km of fibre optic cable, accessing a total of 253 locations in Skåne and available to a total of over one million inhabitants.

An additional role of SkåNet was to co-ordinate government subsidies for broadband. Skåne had been allocated in excess of SEK 250 million to cover network expansion; SkåNet coordinated the municipalities' grant applications for the project. This was highly successful. Due to the high degree of coordination, the municipalities' share of the financing is lower in Skåne than in any other part of Sweden.

Additional funding for the network expansion came from Region Skåne's purchase of services in the healthcare network as well as the municipalities' acquisition of communications services. There was, however, no obligation for the Region to do so.

Last mile connections are typically provided by municipalities or telecoms operators using ADSL or WiMAX technologies. Of the 34 municipalities involved, 15 have their own municipal networks. With bandwidth requirements steadily increasing since the project first started in 2003, SkåNet's attention turned to FTTH:

would it be possible to provide everyone in Skåne with fibre all the way to their homes? As a result, SkåNet has been encouraging “DIY fibre” – offering specialist advice to communities that are willing to dig to install their own fibre between their homes and a telehouse facility on the BAS network. SkåNet provides advice on all aspects of the process, from choice of the correct ducts and cables, to contract templates for the drawing up of operation and maintenance agreements.

At the end of 2008, about 15% of the Skåne population was connected with fibre; this had increased to 27% by the end of 2010. SkåNet is developing a strategy to bring 100Mbps FTTH connections to all homes in the region by 2020, which is in line with the Swedish National Broadband Strategy announced in autumn 2009.

Case study written December 2009; updated January 2011.

Chapter 6: Regulation

Understanding laws and regulations on both country and European level, is vital as business decisions made during FTTH project planning will be affected by these . Of course, regulations apply to many diverse areas of business; this Chapter will consider a topic of specific relevance to FTTH deployment: electronic communications sector regulation.

Principles of regulation

The purpose of regulations is to address market failure and can manifest itself in many ways. A classic example is the monopoly telephone provider offering a limited service at an extortionately high price. In fact, until the 1980s, the telecommunications sector in Europe was dominated by State-owned operators, and prices for voice communications were high by today's standards, especially for long-distance calls.

In 1988 the European Commission began the process of liberalising the electronic communications market, using competition legislation and regulations to remove policy measures introduced by Member States that granted exclusive or special rights to operators. Major milestones were passed in July 1990 when services, other than voice telephony, were liberalised and in January 1998, when voice telephony was also liberalised. This has allowed new operators to access the market, creating competition which has dramatically reduced the cost of long-distance telephone calls and paved the way for the proliferation of mobile phones.

In an FTTH context, lack of high-speed broadband services in rural areas is a clear case of market failure. Another would be the inability to consider all the costs and benefits when making a business decision. The provision of improved health care services or increased teleworking have, for example, brought great benefits to society, areas which normally network operators have difficulty in substantiating in their business plans.

There are two main mechanisms for market regulation:

- **Competition legislation** – penalising businesses for anti-competitive behaviour (referred to as ex-post regulation).
- **Sector specific regulations** – where it is judged that a company has significant market power (SMP), the market can be regulated in advance of any anti-competitive behaviour (referred to as the ex-ante approach).

The national regulatory authorities (NRAs) of European member states must comply with appropriate European legislation when setting regulatory policy. A new legislative framework for regulating the electronic communications sector was agreed in September 2009, known as the "Telecoms package" and includes five Directives:

- Directive to establish a harmonised framework for the regulation of electronic communications networks and services (the "Framework Directive")

- Directive on the authorisation of electronic communications networks and services (the "Authorisation Directive")
- Directive on access to, and interconnection of, electronic communications networks and associated facilities (the "Access Directive")
- Directive on universal service (the "Universal Service Directive")
- Directive on the processing of personal data (the "Privacy and Electronic Communications Directive").

The Telecoms Package was further amended in December 2009 with the addition of the "Better Regulation Directive" and the "Citizen's Rights Directive".

The main changes brought in by the Telecoms Package gives NRAs a greater say on when and where regulation is needed and provides the Commission with additional influence in NRAs decisions regarding intervention. In general, there is now a greater emphasis on encouraging investment. There are also specific provisions relating to NGA deployment, which includes FTTH. The overall aim is to promote competition, while encouraging more consistent regulation across Europe.

The **Body of European Regulators for Electronic Communications (BEREC)**, comprises of the heads of 27 NRAs and was established as a result of the Telecoms Package. BEREC's function is to advise the Commission and develop and disseminate regulatory best practice, such as common approaches, methodologies or guidelines on the implementation of the EU regulatory framework. Next-generation access (NGA) forms one of BEREC's more active workgroup areas.

The Commission has defined seven product and service markets within the electronic communications sector where ex-ante regulation may be warranted (see Recommendation 2007/879/EC). Two markets which are directly relevant to FTTH networks are:

- Market 4 – wholesale local access (access to physical network infrastructure)
- Market 5 – wholesale broadband access.

NRAs must follow a three-step process for regulating these markets:

Step 1: Market Definition	Step 2: Market Analysis	Step 3: Market Remedies
Market 4: Wholesale (physical) network infrastructure access at a fixed location (including shared or fully unbundled access)	Market 4: Always dominated by the former incumbent operator in a copper context. Cable is excluded from the market. In an FTTH context, different results are possible, e.g. no-SMP finding in Romania based on multiple FTTB networks.	Market 4: Grant access to the physical path of the network. If not technically or economically feasible other remedies are permitted.
Market 5: Wholesale broadband access	Market 5: Can still be competitive even if SMP on market 4 (dependent on product definition and geography).	Market 5: A range of possible remedies include different levels of bitstream access, different pricing mechanisms, etc.

NRAs look at the entire value chain from the passive infrastructure to the retail services. It is obvious that the choice of where and how to award access in the value chain will impact on operators' opportunities to enter the market and determine the nature and range of services delivered to retail consumers. In extremis, even if wholesale products are available but few, if any, alternative operators enter the market to supply at the retail level, NRAs may regulate the retail product directly via price caps in an effort to protect end-users. An overwhelming preference is to allow as many to operate as are interested by making appropriate wholesale products available and allowing competitive processes to work as freely as possible.

Where dominance exists NRAs must introduce at least one remedy which should be introduced as high as possible in the value chain (further from the end-user) as wholesale regulation leaves more room for competitive entry into the market. Retail regulation is viewed as a last resort.

Proposed remedies:

- **price control**, including cost orientation – limiting wholesale pricing to the cost of maintaining the access network
- **transparency** – the basis of wholesale pricing must be made public
- accounting separation
- **non-discrimination** – wholesale prices not dependent on purchase volume
- mandatory access to specific facilities – typically access to the central office
- mandatory provision of specific facilities – e.g. power in the central office.
- **functional separation** whereby the network and service divisions are operated independently of each other.

Under the Framework Directive a series of symmetric remedies are also available which are applicable to all operators in the electronic communications market, regardless of size. While many of these remedies relate to consumer contracts and consumer rights, some important obligations regarding infrastructure sharing also exist under this heading.

The Digital Agenda

In March 2010 the European Commission launched the "Europe 2020" strategy to prepare the EU economy for the next decade. The Commission has identified three key motors which are to be implemented through concrete actions at European and national levels:

- smart growth (fostering knowledge, innovation, education and the digital society)
- sustainable growth (making production more resource efficient while boosting competitiveness)
- inclusive growth (raising participation in the labour market, the acquisition of skills and the fight against poverty)

The Digital Agenda is one of seven initiatives in the Europe 2020 strategy. The complete Digital Agenda element, published in May 2011, sets targets to speed up the roll-out of high-speed internet and reap the benefits of a digital single market for consumers and businesses.

The Commission has identified the need to increase European access to high-speed internet connections. The Digital Agenda restates the objective endorsed by the European Council to bring basic broadband to all Europeans by 2013 and adds a more ambitious target: by 2020 all Europeans should have access to internet speeds of 30 Mbps or above, with 50% or more of households subscribing to connections of 100Mbps.

The Commission has promised to investigate measures to attract investment in broadband through better and more consistent regulation, and through practical measures such as credit enhancement mechanisms and guidance on to apply the state aid rules. The vehicles to achieve these aims are the NGA Recommendation and the Broadband Communication, respectively.

NGA Recommendation

In September 2010, the European Commission published a **Recommendation on regulated access to NGA networks**, which seeks to guide NRAs as to the appropriate market remedies for NGA Networks. This is a non-binding text based on Article 19 of the Better Regulation Directive; however, NRAs must "take utmost account" of these guidelines when selecting remedies as part of their analysis of Markets 4 and 5.

It is clear in the Recommendation that preservation of competition is paramount and that access in the form of fibre unbundling and/or active access will continue as in the past. Such access conditions will include risk premiums to attract investment.

The Recommendation gives priority to remedies aimed at reducing deployment costs, such as granting access to passive infrastructures. Specifically on this point, the Recommendation suggests a combination of Article 12 of Directive 2002/21/EC (Framework Directive) and Article 5 of Directive 2002/19/EC (Access Directive) as a legal basis to justify mandating access to passive infrastructures.

There are further provisions which require NRAs to work with other authorities to establish a database containing information on geographical location, available capacity and other physical characteristics of all civil engineering infrastructure which could be used for the deployment of optical fibre networks in a given market or market segment. The resulting data-base should be accessible to all operators.

NRAs are also guided to mandate access to the terminating segment of the access network of any operator with SMP. This includes access to wiring inside buildings. In this context NRAs are obliged to provide the SMP operator with detailed information on its access network architecture and, following consultation with potential access seekers on viable access points, determine where the distribution point of the terminating segment of the access network should be for the purpose of mandating access.

The Recommendation further advises that NRAs should take into account the fact that any distribution point will need to host a sufficient number of end-user connections to be commercially viable for the access seeker. NRAs are also asked, where possible under national law, to oblige the operator with SMP to deploy multiple fibre lines in the terminating segment.

Where the SMP operator deploys FTTH, NRAs should in principle also impose fibre unbundling, regardless of the network architecture, with an access point at the metropolitan point of presence. The Commission suggests that technological development will address unbundling difficulties in time (e.g. through wavelength

unbundling) and that in the meantime alternative options such as “virtual unbundling” (e.g. VULA as in the UK) could be offered as a substitute for a transitional period. However, NRAs are recommended to “mandate physical unbundling as soon as technically and commercially feasible”.

NRAs are required to ensure that there is sufficient information on network plans available to the market to facilitate the transition from copper- to fibre-based networks. In practice these plans are important for an NRA’s role as a co-ordinator of co-investment schemes.

The Recommendation points to specific circumstances where regulation may not be necessary. NRAs have the option of defining sub-national markets if substantially different competitive conditions, which are stable over time, can be identified, or they can define broader geographic markets but limit the geographic scope of remedies applied. NRAs can waive the requirement for unbundled access in geographic areas where there are several alternative infrastructures, such as FTTH networks and/or cable, in combination with access offers.

There is also the option to remove regulation completely if operators co-invest on the basis of multi-fibre lines and the conditions attaching to the co-investment project assure equality of access for all participants. In practice the various opt-outs from regulation are suggestions that, under certain circumstances, there may be no SMP finding.

Even if a finding of SMP is made, under certain circumstances investors may also enjoy greater discretion when setting access prices, for instance with co-investment schemes which seek to foster market-driven investment outside densely populated areas. Where physical access remedies are working well in a market, greater pricing discretion in relation to bitstream access can also be allowed.

This guidance, if fully implemented, could have a significant impact on deployment models. Even with the guidance in the NGA Recommendation, NRA’s enjoy considerable discretion concerning the details of the remedies to be applied at national level. Readers are advised to consult locally with their local NRA to ensure appropriate knowledge of local policies. A list of NRAs is contained in Appendix A.

Case Study #5: ARCEP (National regulator in France)

For the purposes of FTTH regulation, ARCEP has divided France into three zones according to housing density, and has proposed a different regulatory regime for each zone.

- **Zone 1**: large cities, where operators can reasonably expect to make a profit
- **Zone 2**: less dense towns and cities, where infrastructure competition is unlikely to emerge
- **Zone 3**: rural areas where the business case for fibre is challenging and public funding will be needed.

Zone 1 includes areas with a concentrated population where it is economically possible for several operators to deploy their own infrastructure, in this case optical fibre networks, in the vicinity of subscriber premises. According to ARCEP, 148 municipalities fall inside Zone 1, representing 5.16 million households.

For such areas, the regulator is generally in favour of a multi-fibre solution between the subscriber and a local access point. To prevent repetitive installations in the same building, the first operator in the building must install fibre to all apartments in the building, and the in-building network must be opened to other operators upon request. The building operator should install four fibres if there is more than one service provider in the building, otherwise one fibre will suffice.

As a rule of thumb, the local connection point should be located outside the limit of individual private properties. However, ARCEP also defines the cases where the local connection point for access to in-building fibre wiring can be located on private property. The local access point could be placed inside if the number of subscribers per building is at least 12, or the building is served by the accessible galleries of a public network, such as the sewers of Paris, regardless of the number of subscribers per building.

The French Competition Commission approved ARCEP's draft decision and recommendation in November 2009. ARCEP then submitted its draft decision and recommendation to the European Commission, where it was approved, before its publication and adoption by the end of 2010.

Discussions regarding regulations for Zones 2 and 3 are ongoing. Topics still to be decided include whether or not it would be best to build a single, open network infrastructure, public funding, the position of the vertical sharing point, and much more.

Written January 2010

Chapter 7: Finance FTTH

Fibre to the Home represents the New Generation Access Network. There are two choices, either install a new green field network in those areas where new constructions are taking place or replace the old copper network with the new fibre network. Often the migration of subscribers from the old networks to the new has more to do with evolution rather than revolution.

In modern countries a copper and in some cases also a coaxial network are already in place. However, if a fibre network is added and the existing legacy networks still continue in operation, the result will be, over time, the slow migration of subscribers to the new, fibre network. The speed at which subscribers migrate and new subscriber take-up rates grow has much to do with the quality of the existing copper network versus price levels and service available from the new optical network provider. In general, service providers deploy 'traditional' triple play services on the copper as well as the fibre networks. Therefore, it seems to make little sense for the average subscriber to move over to services provided on the FTTH Network. Delivering only yesterday's services on the Next Generation Network is not exploiting the true potential of the FTTH Network. However it should be mentioned that not all New Generation services are, as yet, available today. Services will be introduced continuously. The first phase of the introduction is called the "FTTH Push Phase" which describes the process with which the Network is being "pushed" onto the market once various activities have been achieved (see figure 10 below).

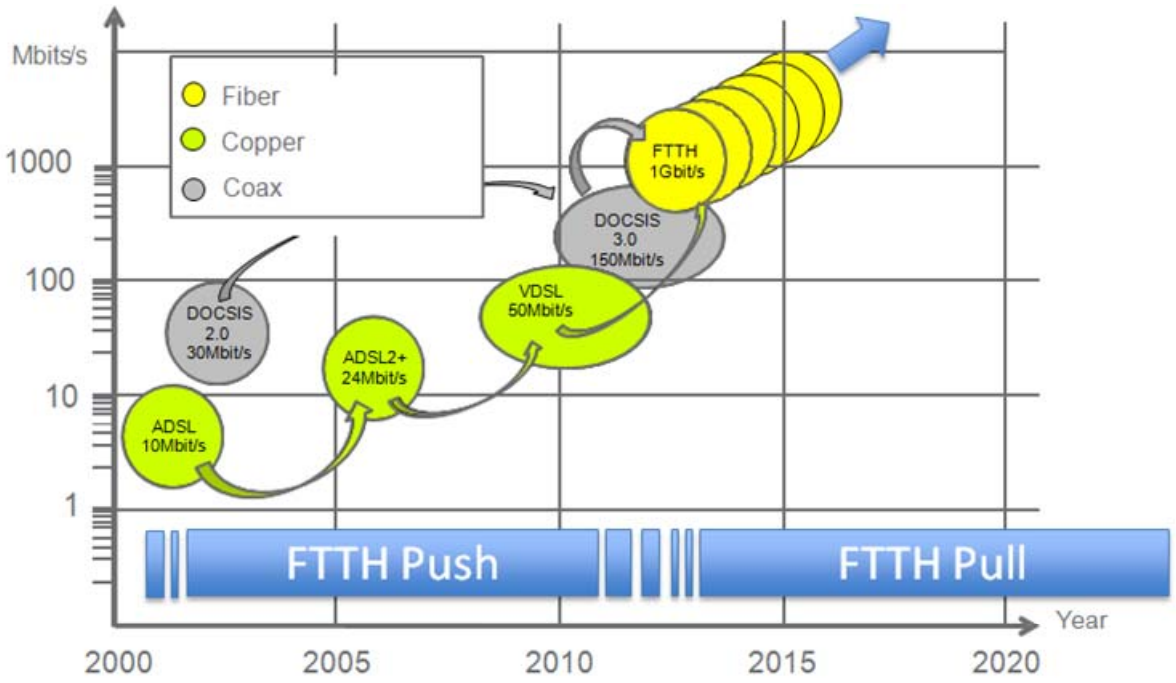


Figure 9

Without supporting actions, FTTH often turns into a typical Infrastructure project with the result that investors should be prepared to take a long term view. The so-called “dead man´s valley” period when the cash burns before income is realised (cumulated free cash flow) has to be minimized. This is achieved by seeing that potential subscribers commit to the new services ahead of introduction and through intelligent network design incorporating the existing infrastructures.

FTTH Push: Maximising early take up rates

As previously mentioned, the period during the transitional phase, when the potential subscriber is looking into the options available from various networks, is known as the FTTH Push Phase. The subscriber has to be motivated to make a decision. Studies have shown that a high take up rate is essential to the success of the project, thus time and energy has to be spent on this area during the planning phase.

Supporting actions could involve strong marketing campaigns as well a convincing service offer to the market.

The strengths of the FTTH Network versus the legacy networks should also be exploited without compromise. The opportunity of informing the public of a high performance internet access service, new broadband services, or the availability of services which are exclusive to the fibre network should not be neglected.

Subscribers may be attracted to the network at an early stage if an approach is made to the community to invest in the venture. Such an approach could be in the form of a cooperative. This binds a large number of potential subscribers to the project early in the planning phase.

FTTH Pull: New applications bring obsolescence to existing networks

With the event of the FTTH Pull era, old networks will become obsolete as applications and the use of the net will overload the capacities of the existing technology.

Cloud Computing, Machine to Machine Communication, Over the Top Services, Smart Grid and even Quantum Computing are just some of the reasons why fibre is essential for a modern society. All the above applications as well as many more are not benefiting from the fibre optic networks even though the symmetric behaviour (the up and down load speeds) is almost the same.

For the FTTH business the difficulty lies in finding the optimal solution to managing the FTTH Push time: reducing the time dedicated to the dead man’s valley period.

The investment case strongly dependent on local situations

Which investors could, potentially, be interested in the FTTH business is dependent on a number of factors including proposed business model, competition on a local level, demography and density.

The existing local situation relating to investment opportunities and competition can vary considerably from place to place. In the city with a high density of homes, it is more cost-efficient to connect the subscribers than in less densely populated areas.

In the areas where it is difficult to finance an FTTH Business case, the involvement of the public sector to ensure the funding may be a realistic option. The argument being that FTTH is not only of interest to traditional investors but is essential to the development of a region.

An FTTH Business case requires at least two types of return on investment. One is the return the FTTH investor receives and the other is towards the community and the businesses operating within that local area. Both benefit from the Next Generation Network.

On occasion, benefits gained by the community exceed the costs of realizing FTTH. According to the OECD, health care, electrical power supply and transportation in particular all benefit from FTTH.

Putting financial resources into FTTH is a good investment, both from the investor's perspective as well as the community´s. The financial investor can expect a good return over the lifetime of the network and the community will benefit from better connectivity as well as the new services enabled by the FTTH networks.

According to Heise Netze 25.02.2010 (www.heise.de/netze/56elding/FTTH-Konferenz),the OECD, which always promotes the policy that governments should not interfere with the private sector, are of the opinion that in the case of FTTH they will make an exception. The OECD favours an active and supportive role by the public sector to develop FTTH Networks.

FTTH Operators

New FTTH operations could involve a number of stakeholders.

The parties' active in an FTTH business could include municipalities, electricity providers, alternative operators or incumbents.

Figure 10

Electricity providers:

These organizations often do not have an existing customer base in telecommunications. They enter this business for a variety of reasons and, through the nature of their core business, most probably have one or several duct systems which are suitable for the deployment of FTTH.

An additional and common motivator for them is to increase the functions of the energy network: SMART grid. It is obvious that as far as the electricity providers are concerned, this will become of strategic importance to their business in the future. Information Technology will be a key factor to realising success, optimising production and consumption and structuring supply and purchasing in the energy world.

The majority of electricity providers choose the Open Access business model. However, some of them start to build up cooperation's to commonly run own services on their particular infrastructure in order to cover the whole value chain and increase revenues.

Alternative Operator:

It is often the case that the alternative operator does not own a physical network infrastructure. In the majority of cases he seeks cooperation with electricity providers, which enables him to install the fibres in their network. Alternative operators are also typical customers/partners in Open Access networks. Their motivation is to gain competitive advantages over others especially incumbent operators. The alternative operator is often small-scale, flexible and fast, choosing to rent network access from the electricity providers as they are light on capital.

Incumbent:

The incumbent, however, is interested in protecting the investment of the legacy network, whilst at the same time, seeking the optimal time frame to build the next generation network in order to migrate existing subscribers to the new platform. Once this is in place, he is more than happy to abandon the operations of the old copper network, as the original network is superfluous to his needs. Typically the incumbents' asset is a solid subscriber stock, and if he succeeds in migrating the existing subscribers to FTTH, he can, from the offset, exploit economies of scale. The capital structure of the incumbent is heavy as he owns the network.

A number of incumbents are installing several fibres to the homes; anything from between one to four. Those fibres which are superfluous to the incumbents needs are sometimes leased to other regional operators.

FTTH Investors

Institutional Investors:

Institutional investors look for major investment situations with relatively low risk. Today, more and more insurance companies and pension fund investors are becoming increasingly interested in FTTH. The reason

is that this business offers long term investment opportunities in a stable market, such as property, roads and infrastructure. (see Figure 11)

Other, more specialised institutional investors may be more interested in short term, perhaps more aggressive, returns. Institutional investors are also useful if an established company, which quite often is listed on the stock exchange, is looking for growth investment.

Banks

Only a few banks have the knowledge to understand the mechanisms of the FTTH business and, like most institutional investors, do not take high risks. It is more probable that they join forces with another investor rather than go it alone relying on their partner´s expert knowledge of the FTTH business. Also banks choose to support incumbents directly. Banks are also playing an important role in bringing the OPEX financing to a project.

Business Angels and Venture Capital

In most cases these are interested in helping start-up businesses. Their intention is to help the business grow to a size where it can be sold on or floated on the stock exchange. Most businesses receiving business angel support are medium sized with new approaches and innovations within existing businesses attracting their attention.

Private Equity

Typical private equity investors are looking for established businesses in need of reorganization and which can be sold on within a few years. Private equity collaborates with the banks to create the necessary leverage and to finalise the transactions. Private equity investments range from tens of millions to billions of Euros.

Governments

In areas which are less financially attractive to mainstream investors, governments and local authorities play an important role in funding FTTH networks. Governmental subsidies for rural areas are necessary whilst more attractive areas such as cities, are left to private investors.

European Investment Bank EIB

This is a skilled FTTH partner. An objective of this organization is to finance basic infrastructures such as FTTH. However one drawback is the funding process is usually time consuming and difficult.

Institutional Investors	Banks	Risk Capital & Business Angels	EIB
• High volume • Stock exchange listed companies only (with some exceptions) • Require a „professional" business case • Some understanding of FTTH	• Low volume • Risk avers (Basel III) • Lack of understanding of FTTH	• Medium volume • Need to be addressed directly • Need for a good „business story" • Short term investments • Lack of understanding of FTTH	• High volume • Official „role" to finance FTTH • Good understanding of FTTH • „slow" • Trigger private share

Figure 11

Type of Investments

Two fundamental elements of an investment situation involve strategy and the business model. Depending on the business constellation, certain types of investors are more or less suitable. Open Access business models with blanket coverage are typically appreciated by governments and inhabitants and, if used correctly, should increase competitiveness of available services. The term . Blanket Coverage involves connecting up every building, regardless of cost and suitability.

Particularly in rural areas where housing density is low, the investment per connected household exceeds the cost of installation in urban areas. On the other hand, infrastructural competition tends to be less and can, therefore, be a contributing factor to low long term investment risk and why public funding or governmental subsidies are often the best vehicle for FTTH projects in rural areas.

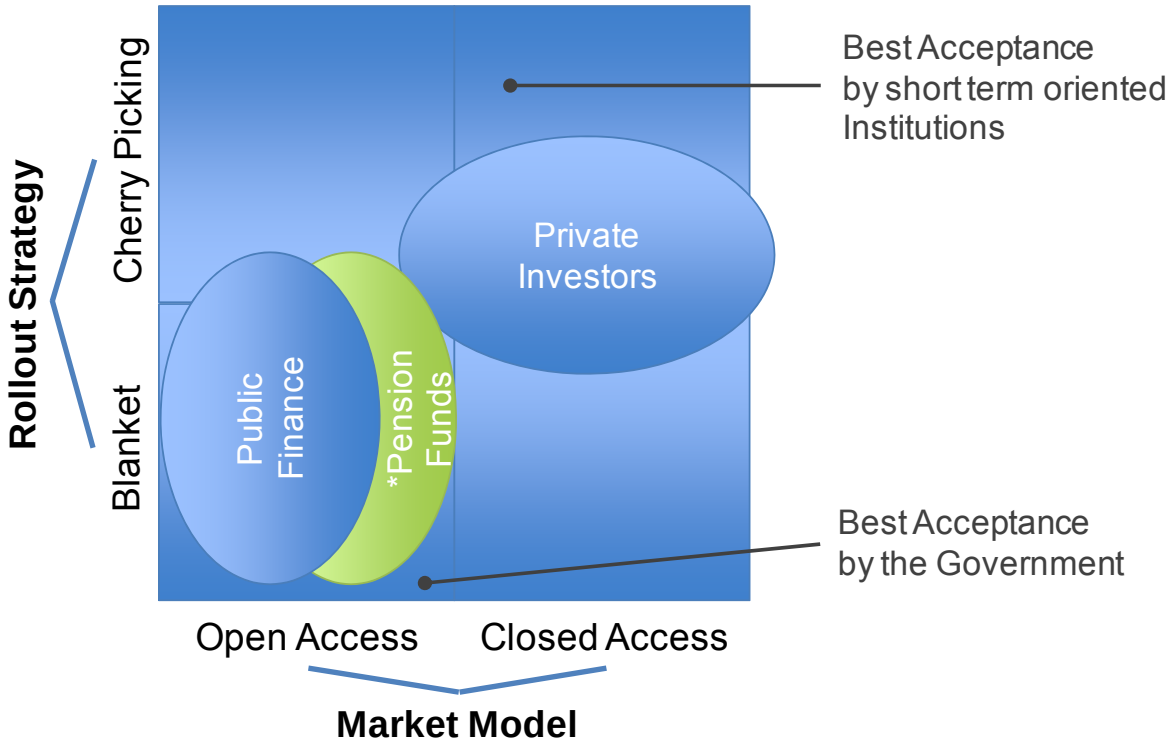


Figure 12

Private investors prefer convenience and, as a result, some buildings and areas are excluded. This is commonly known as “cherry picking”. This term is also used to describe buildings where the number of subscribers who have signed a contract is high, thus minimizing the risks.

Instead of Open Access, some private investors seek vertically integrated models, or models involving no more than two partners. This is because in the vertically integrated models, the FTTH provider is personally responsible for marketing, maintenance services and sales activities. Success does not depend on third parties.

Alternative Models

Cooperatives

Over the last one hundred years or so, many electricity distribution networks in a number of countries, have been financed by cooperatives. These cooperatives often involve the entire population of a village.

In some regions, especially Finland, cooperatives have also been used to finance FTTH infrastructures. This type of financing is very effective as most of the village inhabitants are involved, will subscribe to the network and contribute towards financing.

Cooperations

Reduction of Capex through cooperation involves two partners - the incumbent and the local electricity provider – who both invest in FTTH.

An example of this is Switzerland where Swisscom cooperates with several electricity providers. A precondition for this cooperation is the installation of a multi fibre as well as a Point to Point architecture which will allow for fibre exchange and long term use of fibre to all partners.

Cooperations can also arise between the electricity providers. This can, for example, take the form of each electricity provider maintaining its own passive cable network with the creation of services, active network component maintenance and management of call centres being provided centrally. This achieves reduction of CAPEX as well as OPEX and increase revenues.

Examples

City of Basel (Public Private combined with cooperation)

The FTTH Project in the City of Basel requires investments amounting to SFR 175 M.,

Swisscom has invested SFR 105 M (60%) and the local electricity provider (IWB) contributing about SFR 70 M, which amounts to 40% of the investment.

The latter investment comes from both own as well as credit capital. The City of Basel has borrowed SFR 22 M.to invest in the project. This loan is long term covering a period of 30 years.

Basel's local government has declared that it would prefer no parallel digs within the City and has suggested that Swisscom and the electricity providers join forces to build the network thus reducing noise levels, minimising traffic problems or dust in the city centre.

The Netherlands

KPN and the investment firm Reggeborgh established a joint venture called Reggefiber, which has rolled-out an FTTH network to 300,000 households in the Netherlands. KPN is the minority shareholder, but has a call option to purchase additional shares in 2012.

Italy

Telecom Italia entered into a Public Private Partnership (PPP) project with the municipality of Trento located in the northeast part of Italy, co-investing EUR 100 M to roll-out FTTH networks.

France

France Telecom announced plans to invest EUR 2 B into FTTB/H network roll-outs by 2015, focusing on urban areas, such as Paris and Marseille. In smaller cities and rural areas, France Telecom has entered into a partnership with its competitor, SFR, which is the second largest mobile operator in the country.

Germany

Deutsche Telekom is operating a pilot project with EWE Tel; an alternative network operator in Northern Germany. Each partner is rolling-out FTTH in regions of the federal state of Lower Saxony and is granting FTTH bit-stream access to its partner.

Case Study #6: Amsterdam Citynet

Summary: The FTTH network in the Dutch capital has been under intense scrutiny from regulators, which has delayed construction. On the positive side, this has resulted in a clear regulatory policy providing municipalities interested in building a FTTH network in Europe with proper guidelines.

Already the cultural and financial capital of the Netherlands, Amsterdam is set to become the fibre capital as well. Glasvezelnet Amsterdam (GNA), which is a consortium of private and public investors, has finished rolling out an FTTH network to 43,000 homes in Amsterdam and is planning to connect the rest of the city.

It has been a long journey for Citynet. Back in 2001 the municipality recognised the importance of high-speed connectivity to the economic well-being of the city, and launched a formal investigation into the best way to proceed. City officials reasoned that the network would need to be operational within the 2010—2015 timeframe, but could, in fact, take seven to nine years to build, so construction needed to begin immediately.

The first step was to ascertain whether the incumbent operator KPN or the cable TV companies had any intention of deploying fibre in Amsterdam. This seemed like a possibility in 2003, when KPN published the "Delta Plan Fibre" outlining a vision for bringing fibre to the whole of the Netherlands in collaboration with the cable companies. But the cable operators weren't interested (cable was fast enough, they claimed), and the plan was dropped.

Following advice from Dutch and European regulators in 2004, the Amsterdam municipality decided to create a public-private partnership (PPP) to invest in the passive fibre infrastructure only. This corporate structure was chosen as ait would not contravene state aid rules, designed to prevent governments from making investments that distort markets and competition.

In late 2005 contracts were awarded for the construction and operation of the network. The physical network was to be constructed by a consortium of local Dutch companies. Operator BBned won the contract to operate the electronic equipment in the exchanges and offer wholesale services. The project finally became a reality in 2006 when GNA was incorporated, with three groups of investors — the municipality, the housing associations (which own 50% of homes in Amsterdam) and the private sector— each investing €6m in return for a one third stake in the company. Another €12m in funding was provided as debt financing, bringing the total investment to €30m.

According to Herman Wagter, Chief Technologist at GNA, the biggest challenges the network has faced were not in construction, but in bringing together the right partners under the right conditions for investment, taking a total of five years from the initial idea to laying the first cable. Citynet was also challenged in court

twice by cable operator UPC, and it took three years to get regulatory approval from the European Commission.

That final decision came in December 2007; the Commission ruled that the investment was not state aid because it met the terms of the Market Economy Investor Principle. In other words, the city of Amsterdam was permitted to invest in the network because substantial private investment was made at the same time and on the same terms.

In terms of commercial success, Citynet discovered that customers preferred competitive services in a multi-operator market. Owing to limited funding by parent company Telecom Italia, this was something wholesale operator BBned could not support on its own. Therefore, GNA struck a deal with KPN, resulting in KPN becoming a wholesale operator on the network in 2010.

In parallel, the Reggefiber Group, which is a shareholder of GNA, was thinking of joining forces with KPN to deploy fibre across the whole of the Netherlands. The Dutch competition authority NMa and telecoms regulator OPTA joined the negotiations because they wanted to create a framework that would guarantee equal access to service providers and infrastructure competition without holding back investment. The desire to include the public-private partnership of GNA in this framework prolonged the discussions with the regulators until the end of 2009, at which point Reggefiber was able to increase its share in GNA to 70% and let GNA enjoy the economies of scale that Reggefiber can achieve.

One unfortunate side-effect of the discussions with the regulators was that many business decisions had to wait until the regulatory framework had been settled. This stalled further roll out until the beginning of 2010, but deployment has now restarted in earnest, with the target of connecting an additional 100,000 addresses by the end of 2012.

Written Sept 2010.

Appendix A: List of Telecommunications Regulators by Country

Country	Name of Regulator	Abbreviation
Austria	Rundfunk und Telekom Regulierungs www.rtr.at	RTR
Belgium	Institut Belge des services Postaux et de Télécommunications www.bipt.be	BIPT
Bulgaria	Communications Regulation Commission www.crc.bg	CRC
Croatia	Hrvatska agencija za poštu i elektroničke komunikacije www.telekom.hr	HAKOM
Cyprus	Office of the Commissioner of Electronic Communications and Postal Regulation www.ocecpr.org.cy	OCECPR
Czech Republic	Český telekomunikační úřad www.ctu.cz	CTU
Denmark	Telestyrelsen - National Telecom Agency www.itst.dk	NTA
Estonia	KONKURENTSIAMET www.konkurentsiamet.ee	KONKURENTSIAMET
Finland	Viestintävirasto Kommunikationsverket www.ficora.fi	FICORA
France	Autorité de Régulation des Communications Electroniques et des Postes www.arcep.fr	ARCEP
Germany	Bundesnetzagentur für Elektrizität, Gas, Telekommunikation, Post und Eisenbahnen www.bundesnetzagentur.de	BNETZA
Greece	National Telecommunications and Post Commission www.eett.gr	EETT
Hungary	Nemzeti Hírközlési Hatóság www.hif.hu	NHH
Iceland	Póst- og fjarskiptastofnun www.pta.is	PTA
Ireland	Commission for Communications Regulation www.odtr.ie	ComReg
Italy	Autorità per le Garanzie nelle Comunicazioni www.agcom.it	Agcom
Latvia	Sabiedrisko pakalpojumu regulesanas komisija www.sprk.gov.lv	SPRK
Liechtenstein	Amt für Kommunikation www.ak.llv.li	AK
Lithuania	Ryšių reguliavimo tarnyba www.rrt.lt	RRT

Country	Name of Regulator	Abbreviation
Luxembourg	Institut Luxembourgeois de Régulation www.ilr.lu	ILR
Republic of Macedonia	Agency for Electronic Communications www.aec.mk/eng	AEC
Malta	Malta Communications Authority www.mca.org.mt	MCA
Netherlands	Onafhankelijke Post en Telecommunicatie Autoriteit www.opta.nl	OPTA
Norway	Post- og teletilsynet www.npt.no	PT
Poland	Urzędu Komunikacji Elektronicznej www.uke.gov.pl	UKE
Portugal	Autoridade Nacional de Comunicações www.anacom.pt	ANACOM
Romania	Autoritatea Naţională pentru Administrare şi Reglementare în Comunicaţii www.ancom.org.ro	ANCOM
Slovak Republic	Telekomunikacný úrad Slovenskej republiky www.teleoff.gov.sk	TO SR
Slovenia	Agencija za pošto in elektronske komunikacije RS www.apek.si	APEK
Spain	Comisión del Mercado de las Telecomunicaciones www.cmt.es	CMT
Sweden	Post- och Telestyrelsen www.pts.se	PTS
Switzerland	Office fédéral de la Communication www.bakom.ch	OFCOM
Turkey	Bilgi Teknolojileri ve İletişim Kurumu www.tk.gov.tr	BTK
United Kingdom	Office of Communications www.ofcom.org.uk	Ofcom

Appendix B: Suggested Further Reading

1. **FTTH Handbook** by the D&O Committee of the FTTH Council Europe. Available at http://www.ftthcouncil.eu/EN/home/form-handbook.
2. **Opportunities in Fibre to the Home (FTTH) and How to Make a First Assessment** – an independent report by Ventura Team LLP for the FTTH Council Europe. Contact Ventura Team.
3. **Understanding the Market – Assessing the Prospects for a New Fibre Business**, by Ventura Team LLP, available at http://venturateam.com/site/download.html [accessed 5/2/10].
4. Summary of EU Telecommunications legislation in force: http://ec.europa.eu/competition/sectors/telecommunications/legislation.html [accessed 06/01/2010].
5. **Europe's Digital Agenda**: http://ec.europa.eu/information_society/digital-agenda/index_en.htm [accessed 05/01/2011]
6. **2010/572/EU: Commission Recommendation of 20 September 2010 on Regulated Access to Next Generation Access Networks (NGA)** http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32010H0572:EN:NOT [accessed 30/10/2010].
7. **Communication From The Commission To The European Parliament, The Council, The European Economic And Social Committee And The Committee Of The Regions** http://ec.europa.eu/information_society/activities/broadband/docs/bb_communication.pdf [accessed 05/01/2011]
8. **Checklist of Actions for Public Authorities considering Broadband Interventions in Under-Served Territories** – prepared by the European Broadband Portal (EBP). Available at http://www.broadband-europe.eu [accessed 08/12/2009].
9. **ICT Regulation Toolkit** *infoDev* in cooperation with the International Telecommunication Union (ITU) http://www.ictregulationtoolkit.org [accessed 16/01/2011]

Appendix C: Glossary

ADSL	Asymmetric Digital Subscriber Line
ARPU	Average revenue per user
CAPEX	Capital expenditure
CO	Central office
CPE	Customer premises equipment
DOCSIS	Data Over cable System Interface Specification – a cable TV network solution
DSL	Digital Subscriber Line
EBITDA	Earnings before interest, tax, depreciation and amortization
FTTH	Fibre-to-the-home
FTTx	Fibre-to-the-x – any type of fibre access network architecture
GPON	Gigabit Passive Optical Network – shared fibre access network architecture (ITU-T G.984)
HD TV	High-definition television
ISP	Internet service provider
IRR	Internal rate of return
LLU	Local loop unbundling
Mbps	Megabits per second – a measure of data transmission rate
MDU	Multi-dwelling unit – an apartment block
NPV	Net present value
NRA	National regulatory authority
OLT	Optical line terminal – the PON equipment in the central office
ONT	Optical network termination – equipment terminating the fibre in the subscriber's home
ONU	Optical network unit – generic term for equipment terminating the fibre in a subscriber's home or building
OPEX	Operational expenditure
OSS	Operations support system
PON	Passive optical network
POP	Point of presence – the FTTH equivalent of a telephone exchange
ROI	Return on investment
SMP	Significant market power
VDSL	Very-high bit-rate Digital Subscriber Line
VoIP	Voice over Internet Protocol
WACC	Weighted average cost of capital
xDSL	x Digital Subscriber Line (of any type)

Appendix D: White Paper

FTTH: Shaping the Future of a Content-based World

Telecom operators, application and content providers have come a long way in building relationships with each other in recent years.

Yet the next major investment in Europe's broadband networks will demand even more: The future of Europe's broadband infrastructure depends on further collaboration between application and content providers and telecom operators and a deeper understanding of how they interplay to each other's benefit.

The last decade illustrates how a mixture of innovation in broadband communications and IT can rapidly reshape how society communicates, works and entertains. But we are on the brink of much greater change. Ongoing innovation in the fields of nano technology, biotechnology and computing promise to radically alter the way we use, design and distribute goods, health care, education, entertainment and communication services.

After all, few people building power stations in the early 20th century could have imagined the extent to which electricity networks would drive new industries for domestic appliances and revolutionize housework: Fortunately the creators of yesterday's power generators laid an infrastructure that could accommodate a century of growth.

Today's investors in broadband need to take a similar leap and create a sustainable, flexible infrastructure that can accommodate new, unexpected services and ways of doing business.

In this white paper we will look at how very high-speed FTTH access is needed for innovative and diverse services and create the potential for new businesses and mutually beneficial interaction between diverse sectors.

Back to the Future

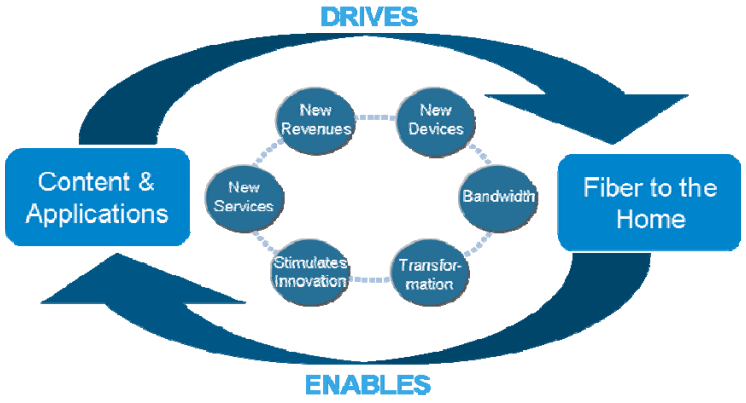
Internet history reveals a strong correlation between how much bandwidth consumers have at their disposal and the development of content, service and device ecosystems. Whole new communication and business models have been made possible by increases in broadband access speeds.

Back in 1996, CEOs from major software companies, including Oracle, put forward the idea of network computing, which is the storing and running of applications on a server in a network. The idea was great, but dial-up Internet speeds were not. The concept of network computing was shelved.

Fast forward over a decade and the accessing and sharing of resources on servers in a network – or cloud computing -- is becoming a reality for users equipped with very high speed broadband.

Striking changes in communications usage have also taken place in the home. Over a decade ago, receiving a phone call when online usually resulted in a dropped connection.

Consumers today would baulk at such levels of service. Instead their requirements are growing in line with the simultaneous use of several residential broadband applications. And there is every sign that consumers' demands will grow, with the next stage in delivering content and interactive video broadband services requiring more capacity than today's legacy networks can provide. If service providers are to avoid their customers cancelling their subscription and going to competition, then they will need to invest in infrastructure that can cope with huge capacity requirements from both fixed and wireless usage.



New services create new revenue streams, encourage adoption of new devices, change end-user behavior and drive the need for increased bandwidth capacity. In return, network upgrades accommodate content and application growth, spur new services and open the door to new business opportunities.

Figure 13: The evolution of services and bandwidth is closely connected

People have also benefited when on the move. Clever marketing and design helped put smartphones where they are today, and a mini mobile computer would be much less practical without the last decade's constant rise in wireless network speeds. But mobile operators cannot squeeze capacity from their networks, indefinitely: continuing growth in mobile data usage places constraints on wireless networks, which need to be alleviated by local fibre access networks. Not only does fibre provide backhaul from base stations, Wifi, 3G and 4G can be integrated with an FTTH installation to provide full wireless coverage throughout the home. In this way consumers can connect several wireless devices running HD or 3D video via Wifi to the FTTH network, allowing mobile operators to lift the strain on their mobile infrastructure and offer a sophisticated array of broadband services. FTTH takes residential users far beyond simple triple-play and opens the door to the concurrent use of multiple high-bandwidth applications.

New Investors in Infrastructure

Today most consumers' upload capacity is a small fraction of their download speeds. A large jump in two-way bandwidth capacity in the form of FTTH promises to unlock a raft of new applications that will benefit consumers, businesses and the suppliers of content, health and education services.

Practically unlimited capacity enables several members of the family to use high definition video applications simultaneously, whether they are watching TV, playing a 3D video game, making a low latency video call to

a friend, consulting with a doctor, or posting film clips to social networks. Residential fibre networks will also open up new uses of cloud computing and enable a more flexible and creative approach to work. Not only will home-workers be able to quickly access shared enterprise applications, high upload speeds will make it practical to send, store and share large files of video, music and photos in the cloud. Meanwhile, small businesses will be able to work collaboratively online with suppliers and customers around the world in ways that are today only possible for larger enterprises equipped with fibre access.

FTTH represents a genuinely new platform for creating a real change in broadband usage, which in turn can spur service innovation that leads to socio-economic benefits. This is the reason why municipalities and utility companies across Europe have been among the first investors in FTTH networks. Municipalities see FTTH as an opportunity to lower the cost of providing key services such as healthcare and education to their citizens, while improving their quality and reach. Municipalities also realize that FTTH attracts companies to set up in their region.

Utilities, meanwhile, see in FTTH an opportunity for additional revenue streams by complementary investment to prime business and become the unique wholesale broadband provider to residential dwellings. Not only are utilities used to making long-term infrastructure investments, they also have experience in providing open access to third parties. In addition, utilities already provide services such as water and electricity to apartment blocks and individual dwellings, making them well placed to negotiate access to buildings with landlords and building managers.

Meanwhile, FTTH benefits property owners, who will be able to improve the rental or sale value of dwellings that are hooked to future-proof fibre networks. They can also use FTTH networks to increase security, by installing the video-based surveillance of communal spaces, such as hallways, car parks and stairwells. Recent investments in FTTH come amid an increasingly competitive broadband environment. Europe's cable operators, for example, are busy equipping their networks with Docsis 3.0, which provides downstream speeds of between 100Mbps and 300 Mbps. Yet even cable and DSL network operators that are making upgrades to prolong the life of existing networks see fibre as the target solution. So it comes as little surprise that a number of European telcos are starting to up the ante on FTTH deployment. Deutsche Telekom, for example, announced in August 2011 the establishment of an FTTH unit, with a budget of €1.5 Billion, approximately 1500 employees and an objective of connecting 160,000 households by the end of 2011.

Investing in Innovation

Players with little or no experience of investing in infrastructure are also showing interest in developing FTTH delivery platforms. Content and application companies, big and small, are fully aware of the business potential) of a two-way very high speed broadband network. In April 2011 Google announced it would build and trial an FTTH network that delivers speeds of up to 1Gbps and involve as many as 500,000 subscribers, starting in Kansas City, Kansas. In July 2011, the first users were already being connected. Like many telecom operators, Internet companies combine a powerful brand with a large user base. They and other forward-thinking companies that see their future in two-way high speed video usage could potentially pursue FTTH investments which disintermediate operators.

Equally they could choose to continue to play to their strengths and instead partner with network operators on delivering new services. Today's telecom operators combine a billing infrastructure with IT expertise, a large, national customer base and a reputation for safe-guarding end-consumer privacy, which make them well placed to work with health authorities, insurance providers, schools, universities and content and application companies alike.

Home Networking

FTTH allows operators to enrich their triple-play offerings today, while laying the foundations for the entertainment and home management network of the future. The ongoing moves to develop e-education, e-health and e-administration services, combined with the increasingly intelligent home devices creates new business opportunities for telecom operators, energy companies, electrical goods and device manufacturers, broadcasters, film distributors and content and application service providers. To date telcos such as Orange in France have collaborated fruitfully with content providers on video-on demand and television services, as digital downloads become an increasingly important channel for film distributors. The market for transactional movies grew by 38% year-on-year in 2010, with digital rental increasingly becoming consumers' favored way of consuming films, according to the film and broadcasting research company, Screen Digest. FTTH will serve to strengthen the relationships between the producers of video content and network operators and provide the bandwidth capacity to investigate new business models. Service providers, for example, will be able to offer 3D video-on-demand and television programming, or semi-immersive online gaming.

In addition, FTTH's large upload capacity opens up the potential to offer new low-latency, high-quality video services, alongside home management and surveillance services, as well as e-health and e-education.

Already a number of major Internet companies are busy providing video-conferencing platforms to consumers.

In June 2011 Facebook and Skype, announced a tie-up to provide a social-networking video application. The companies initially will make a low-quality video calling facility available from within Facebook, which will encourage video communication between Facebook users. The move follows Google's development of an online multi-user video-conferencing application, called 'Hangout', which is part of its social network Google+.

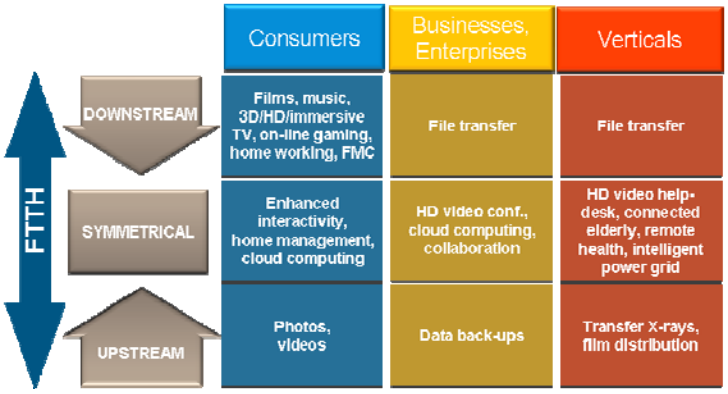


Figure 14: Technical Requirements for Next Gen Services

Bandwidth requirements for all segments of end-users are set to grow rapidly, in line with the availability and adoption of new services. Cloud based applications; video streaming, large file sharing etc. are pushing today's bandwidth boundaries both in upstream and downstream direction. Although available bandwidth is an important network requirement for next gen services - it is not the only one. In cloud computing, where information can be stored anywhere in the world, low latency is one of the critical requirements. Only fibre to the home fulfills these requirements and future-proofs operators against a cycle of network upgrades.

Google and Facebook will not be the last word in consumer video-conferencing, Telcos could look to make the most of their strong brands and reputation for high quality of service to offer high-quality video-conferencing over FTTH, either alone, or in conjunction with third parties. Further possibilities for new business ventures will open as screen prices fall to levels where they can be placed liberally around the home, enabling instant photo downloads to screens, or video-conferencing facilities in multiple rooms.

Telcos' direct relationships with a large client base make them attractive partners for content and application companies, as do telcos' existing billing platforms to charge for premium programming, games and applications. Secure fibre networks can also help protect content from piracy and telcos can make available their retail outlets, as well as their national customer support systems for both sales and resolving enquiries related to third-party services. In return, telcos gain access to premium, differentiated content and services, which allows them to win new customers and grow revenues.

Workplace revolution

Of course the transformational effects of broadband reach far beyond an individual's personal sphere. Today's broadband infrastructure already enables individuals to connect and do business with a global network of companies, from home or the office. The resulting flexibility in working practices benefits employers, employees and contractors alike.
Yet the next step change in how companies and workers collaborate will require FTTH.

Very high-speed fibre broadband, for example, lets companies and individuals use shared cloud computing resources to remotely access heavy-duty enterprise applications. This not only further facilitates home-working, it also opens new ways for knowledge workers around the world to interact with large companies and each other. Cloud computing also creates cost-effective methods of sharing huge computational resources for research and development projects, regardless of where participants are based.

Many application, telecom and service companies have already developed cloud computing applications. However, it is still early days for cloud computing, leaving open opportunities for innovative cross-sector collaboration between software companies, systems integrators and others, in order to better serve customers.

In addition FTTH will give companies of all sizes the means to use secure, private, high quality video-conferencing facilities. As a result employees and contractors will be able to communicate with multiple parties in various locations around the world.

Again, no one company holds all the pieces that will create the new working environment of tomorrow. Telcos, however, have built strong reputations for providing enterprise-strength applications making them well-placed to collaborate on offering the next generation of secure remote enterprise services.

Transforming healthcare

Security and reliability will be key to another important role for FTTH, this time in the distribution of health services.

Governments faced with ageing populations are looking for cost-effective ways to use IT and telecom networks to provide care and monitoring to the growing numbers of the chronically sick and elderly.

This shift means private companies, including telecom operators, software firms, health equipment suppliers and insurance companies, are working with health authorities to create e-health applications that greatly improve efficiency without dehumanising, or reducing the quality of patient care.

Low latency high quality video-conferencing, for example, allows patients to interact directly with care-givers, doctors and nurses, without having to undertake long journeys.

In Sweden, the nurse Gudrun care channel provides patients with online video consultations over their TV sets, thereby reducing out-patient visits and saving both patients' time and public money. As such e-health applications develop, FTTH will allow HD quality video-conferencing, regardless of whether others in the home are using online applications. A telepresence-like HD video connection not only maintains the caregiver-patient relationship, it offers key visual clues of a patient's state of health. Such services are of particular benefit when patients may be far from specialist care. But video services are also of use to patients who prefer to return home to recover from a medical intervention, yet still need to consult face to face with their doctor.

And as e-health services evolve, FTTH's almost unlimited capacity can allow for an increasingly sophisticated video exchange between a patient at home and multiple health service providers, in addition to an exchange of patient data.

In addition hospitals, which are already equipped with fibre networks,will be able quickly share huge files, such as scans with general practitioners equipped with FTTH, while discussing a patient's diagnosis via a video-conference. E-health applications mean working adults suffering from chronic diseases such as diabetes, can conduct check-ups online, rather than taking precious time off work to wait for consultations in doctors' surgeries, or hospitals.

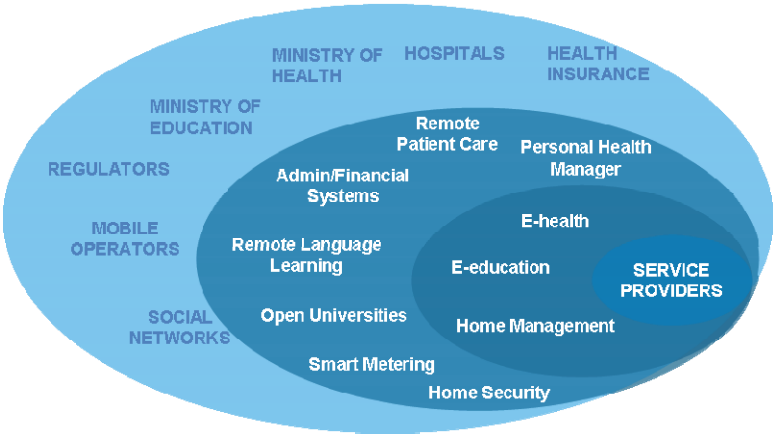


Figure 15: Collaboration between service providers and different stake holders will further drive richness of Next Gen Services

Although e-health is still an emerging service in most markets today, many agree about its benefits: cost efficient, enhanced quality of care, tailored to the individual, educational, extending the geographical boundaries… And this is just the beginning. In order to fully enjoy the benefits of e-health, more collaboration will be needed from different health care players to provide secure internet-based technologies and services that support remote patient care, medical records and decision support tools. Stakeholders will need also to work together to improve computer literacy of e-health consumers and enforce laws to protect the privacy and confidentiality of data. Once hospitals, insurance companies, health and education government institutions join in offering comprehensive e-health service, it will become clear why "eHealth is the single-most important revolution in healthcare since the advent of modern medicine, vaccines, or even public health measures like sanitation and clean water" (Silber, 2003).

Similar changes could be expected in e-education. One vision is that in the future students could follow individual classes from different Universities and lecturers all over the world. This type of educational system is tailored to fit personal and professional individual interests, but would require the involvement of government educational institutions to address questions such as education program recognition and diploma certification.

Other video-based health care applications include physical rehabilitation systems that run over high-speed broadband, which allow patients to practice movements while imaging sensors pick up any mistakes.

Telecom operators equipped with both FTTH and a trusted consumer brand are well placed to partner with health service providers and insurance companies to deliver health services.

Video exchange brings health benefits that are less direct, but important nonetheless: Elderly tech-savvy baby-boomers will be able to use HD or even 3D video conferencing and other communication tools that enable a real time experience when keeping in touch with each other and their families. The independence that a very high speed broadband infrastructure offers means elderly people could stay longer in their own homes, particularly when the benefits of video social networking are bolstered by personal, professional health care.

Home Study

FTTH will power other positive social changes, which in turn will spur new business opportunities. Very high-speed networks, for example, have a clear role to play in providing interactive e-education.

Bill Gates forecast that "*five years from now on the web for free you'll be able to find the best lectures in the world*," when speaking at the 2010 Techonomy conference. "*It will be better than any single university*."

But it won't stop there. E-education can take several forms. Students may simply cherry-pick the best online lectures from top university teachers around the world. Equally, parents may opt for distance-learning when seeking to home-tutor secondary school students.

High-quality interactive video transmission could open new possibilities for teaching the practical elements of science. Or e-education could provide the means to access over-subscribed workshops, lectures and visits run by leading arts schools, or museums. In the meantime, entrepreneurs are already busy setting up companies that combine elements from the fields of education, entertainment and gaming in order to create new forms of engaged, interactive learning. None of this can be done by one company alone. Instead, educational services create fertile ground for several actors to come together to deliver their expertise across very high speed FTTH networks.

Collaborating for the Future

As Google's FTTH investment in Kansas illustrates, in order to fully understand the potential of FTTH, it is necessary to consider what happens once more than 20% of a sizeable population has access to two-way, very-high speed broadband access. Yet revenue pay-offs can come long before network expansion is complete. At the end of 2010 Verizon in the US reported ARPUs increase for its FTTH FIOS service, up 4% from the previous year. The operational benefits of fibre network and richness of services that creates additional revenues resulted in an overall annual rise in FIOS revenues of 26.8% and Verizon confirmed it plans to continue expansion of its FIOS network through 2011[1].

[1] Verizon's Q4 2010 quarterly earnings
http://www22.verizon.com/idc/groups/public/documents/adacct/2010_4th_pre_earnings.pdf

In Europe, larger-scale deployments of FTTH by private operators are only now getting underway.

However, municipalities in Sweden, the Netherlands and France have built FTTH networks, which already offer a glimpse of what can be done once enough subscribers exist to encourage innovation by content and application companies.

The town of Nuenen in the Netherlands, for example, is home to one of the world's highest FTTH densities and has linked its elderly population over high-speed networks to create a video-based platform of community exchange. The social benefits to Nuenen's elderly of reducing solitude by fostering exchange are immeasurable. The platform also gives an inkling of how social video networks could develop once two-way bandwidth is almost unlimited.

Widespread FTTH networks not only offer a wealth of new service opportunities, they also promise to reduce operators' maintenance and operation expenditure. Nevertheless some of Europe's telcos today are approaching FTTH investment cautiously. Although telecom operators recognize fibre to the home as the network of the future, some still question the extent to which they will benefit directly from their investment in tomorrow's very-high speed broadband networks.

Despite concerns over how actors will share both the cost of infrastructure and the benefit of new revenue flows, it remains in everyone's interest that FTTH networks are built. Telcos will be able to offer new, differentiated products and reduce the congestion on their networks that the growing consumer demand for HD video streaming and fixed-mobile convergence brings. Content, Internet and application companies will be able to create truly interactive products and services. And not building FTTH networks puts todays' owners of copper networks at risk of falling behind competing mobile and cable network operators.

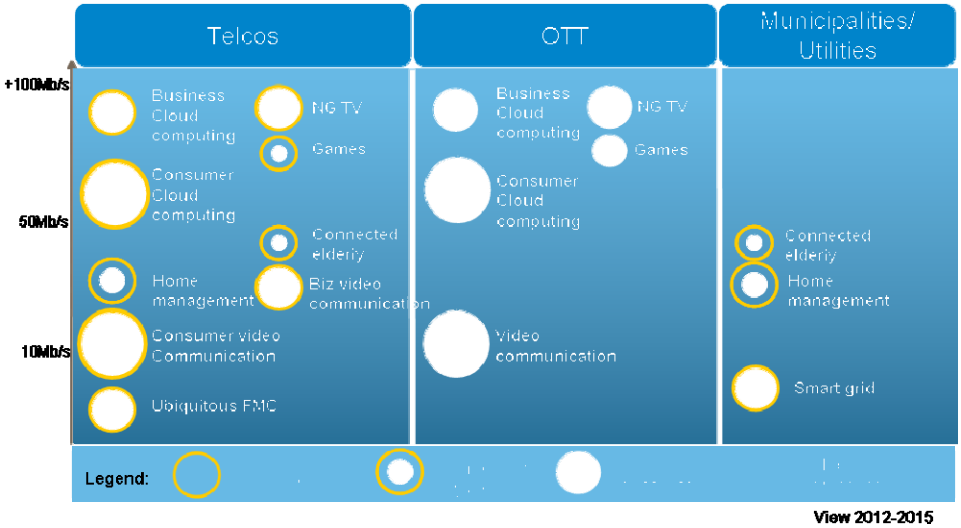


Figure 16: Next Generation Services Value Proposition

A new generation of content and applications opens opportunities for all players to engage on different levels in defining the best business model. The value proposition of different services is based on their market potential, revenue opportunity and end-user requirements such as security, privacy, reliance, cost vs. quality preference etc.

Despite concerns over how actors will share both the cost of infrastructure and new revenue flows, it remains in everyone's interest that FTTH networks are built. Telcos will be able to play on their strong customer relationships and branding to remain prime provider of new, differentiating products and at the same time reduce the operating costs. Content, Internet and application companies will see the opportunity for raising revenues and developing new services. Utilities will be able to get additional revenue streams from investments that complement their prime business. And not building FTTH networks puts todays' owners of copper networks at risk of falling behind competing mobile and cable network operators.

However, if telcos are to invest alongside utility companies and municipalities in building the content and application delivery infrastructure of tomorrow, then all potential actors need to collaborate on building a vibrant, mutually beneficial business model today.

It is Time for Change

Consumers and businesses the world over have been quick to view any new broadband capacity as an essential part of their social and economic fabric. Cloud based services and the internet of things – i.e. the communication between billions of sensors, which enable new and exciting applications – will accelerate broadband adoption. But the broadband adoption is not only fast and massive – it is also addictive: 84% of Germans in their 20s would rather give up their car or partner than their broadband connection [(1)]; 41% of UK internet users would rather keep Internet connection than TV [(2)]. And consumers are not about to become less dependent on broadband. The social network revolution has re-shaped consumer broadband behavior; today's emerging generation of broadband users manage and conduct their social life around online connections. The next big changes will be in the online distribution of health, education and energy services, as well as the development of smart cities.

Today's increasing richness of new applications and its value for our way of living, puts the power to shape future broadband usage in the hands of consumers, rather than telecom operators. Today's networks need to be ready for rapid change. And operators and other stakeholders need to prepare for a future that is not just about providing telecom services, but building an engine for socio-economic development.

[(1)] Bitkom 2011 - http://www.ehow.com/facts_5201693_types-broadband-access.html

[(2)] http://moneyfacts.co.uk/news/broadband/internet-users-willing-to-sacrifice-tv/

Appendix E: FAQs

Deploying Fibre-To-The-Home today…

“The 10 most frequently asked questions”

Demystifying the deployment (and adoption) of Fibre-To-The-Home

Today, telecommunication market players such as traditional operators, municipalities, utility companies or organisations leading individual initiatives, all of them are seeking to offer high speed access to their end-customers, be it in residential or enterprise environment.

This document intends to give more guidance on the main activities one encounters with the deployment of “Fibre-To-The-Home”. Successful FTTH deployment and adoption encompasses a stepwise approach of thinking, analysing, implementing and enabling, starting from the initial business case (justifying the Return on Investment (financially or socially speaking)) and ending by the final adoption of the service by the end-customer.

Issues and solutions are illustrated by means of 10 main questions with respective answers and cover FTTH deployment and clarification of some topics with practical examples. Let this document be a first introduction and sanity check on your ideas for FTTH.

Below are the 5 steps of FTTH deployment:

Prepare and keep detailed documentation of all decisions (go or no go?)

Design the business case, specify the geographic market, concretise your business model, choose a network architecture and check regulatory obligations and requirements.

Deploy your outside plant (put your fibre in)

Perform the dimensioning of your passive infrastructure, select your components, perform cost synergies, implement your fibre termination

Implement your connectivity (light your fibre)

Deploy your active technology, respond your time to market needs, perform interoperability and end to end testing, implement your management solution

Enable your service directly to the end-customer (retail?)

Launch your service bundles, organise your customer support, manage your end-customer’s home environment

Enable service models with third parties (wholesale?)

Expand beyond your traditional 3play services, negotiate quality of service agreements, promote application stores

Step 1: Prepare and keep detailed documentation of all decisions (go or no go?)

Ensure all parameters are specified, for making a sound judgement. Why, when, where and how do we go for it? Only the best plan will lead to the better outcome. Some questions:

Question: Which geographical area(s) do you consider for the FTTH deployment?

Different criteria (socio economics, expected take rate…) can be used to select the geographical areas for the FTTH roll-out. Given a certain investment budget, one can opt, for instance, to maximize revenue generation or to realize maximal coverage.

For that purpose, geo-marketing techniques, based upon socio-economic data within a geographical context, are used for the initial network design and for calculating the related business case.

Question: Do you consider partnerships? Which partners can you engage with?

Partnerships are established to deal with the huge investment costs in fibre infrastructure and/or to meet the challenge of the successful exploitation of an FTTH network.

The big difference in investment budget, life cycle and risks between the active and passive fibre infrastructure, requires long-term partnership agreements on the operational and business aspects. More specific a fair revenue sharing model has to be worked out, to come to a sustainable business model for all involved partners.

Additional questions:

Question: What is a reasonable "pay back period" for FTTH investments?

Question: Can you benefit from an "open network" and how do you concretise?

Question: What basic network design and modelling should you do?

Step 2: Deploying the outside plant (put your fibre in)

The passive infrastructure is the foundation of the FTTH rollout. Consider the best options and anticipate cost-effective implementation. Additional questions:

Question: Are cost synergies possible (imposed or not by regulation) with other infrastructure operators in the public domain?

In general, considerable cost savings can be realized through a better coordination of civil works in the public domain. For that purpose, infrastructure builders are incorporating GIS (Geographical Information Systems) -based network design together with planning and documentation tools. This facilitates the exchange of

public infrastructure information and offers a more synchronized workflow management between the various infrastructure builders. Field practices have shown that the cost per Home Connected/Passed can be further decreased with improved OSP project management.

After the deployment phase, a well documented as-built outside plant leads to less fibre cuts, helpdesk calls and better trouble shooting in case of failure.

Question: What criteria should be used for the selection of passive components such as ODF, cables, enclosures, splices etc…?

As the lifecycle of the passive infrastructure is a multiple of the active technology lifecycle, it is essential to select qualitative passive components which meet future technology requirements (e.g. NG PON). A trade off should be made between the cost, quality and the labour related aspects (intensiveness and skills/tools required) of the components.

Other questions:

Question: What are the hurdles for in-house fibre wiring?

Question: What is the impact of local regulation?

Question: What dimensioning rules should be considered for the passives?

Step 3: Implementing connectivity (light your fibre)

Connecting subscribers involves employing the necessary bandwidths within the FTTH infrastructure. The active network and related technologies will cover that area. Additional questions:

Question: Choosing active technology?

Although fibre technology is subject to rapid evolution, the reality is the market wants the right technology at the right time and at the right price. This should be in line with a realistic view of the services evolution and future bandwidth demands. The need for fibre-to-the-most economical point implies the coexistence and use of different and hybrid fibre technologies.

Independent of the technology choice, technology continuity should be guaranteed to avoid future interoperability issues, the need for truck roll-outs and modifications of the outside plant infrastructure.

Question: How green is FTTH?

Independent studies show that fibre technology, in comparison with legacy systems, significantly reduces the amount of carbon dioxide which is produced by communication activities. Fibre optic systems can transport different types of data over one cable and one network, thus eliminating the need for parallel infrastructures

and power provisions for CATV, fixed telephony and fixed line Internet. Furthermore, fibre optic systems can transport data over much greater systems at lower power utilization rate.

Additional questions:

Question: How can technology continuity be assured?

Question: How can truck roll be minimised?

Question: How can interoperability, standardization and end-to-end testing be embedded?

Step 4: Enable services directly to end-customer (retail?)

If the intention is to become involved in the retail market, then potential subscribers need to be convinced and choose this system. Additional questions:

Question: Why choose FTTH?

What is the best application for FTTH in the residential environment? Video? In what form? What is assured is that any offering, providing faster access and delivering an enriched experience, is certainly a good candidate for sales. FTTH is perfectly aligned to provide this.

FTTH brings unprecedented reliability and guaranteed bandwidth to the home, ensuring a more personalized touch for all.

FTTH brings a richer service offering to the connected home, in a multi-room and multi-screen approach. This will increase the demand for service assurance and remote management solutions for in-home devices and services.

Question: How to move end-users from legacy to enhanced services?

End-users need the visual richness offered by FTTH based access. Adding a visual component to legacy communication services (e.g. video telephony) and to future communication and entertainment services (e.g. immersive communication) is considered one of the key elements for creating an enhanced end-user experience.

Furthermore, policy makers consider FTTH a motor for socio-economic development as well as providing the opportunity to introduce services such as e-health, e-learning, e-government to citizens. Providing services relevant to personal lifestyle and bringing added value to society will further accelerate the mass market acceptance of FTTH.

Additional questions:

Question: How to market the enhanced value offered by FTTH?

Question: What service definitions and assurance procedures should be put in place?

Question: What is the target audience?

Step 5: Enable service models with third parties (wholesale?)

It is not a requirement to implement the entire "vertically integrated' model and enter the retail market alone. Partnerships, agreements, working cooperations etc can all be incorporated to bring about successful FTTH systems. Additional questions:

Question: How to attract Application, Content and Service Providers?

To build a sustainable business model for FTTH, it is necessary to attract innovative third-party application, content and service providers. This requires dedicated service delivery platforms. Essentially, these platforms, based upon open APIs, hide the complexity of the underlying infrastructure and facilitate a more rapid and transparent service delivery.

Exposure of network capacity in a managed, quality-controlled manner is of special interest to trusted parties such as businesses, energy providers and (semi-) public organizations; these groups are willing to pay a premium for this service.

Following on from a guaranteed bandwidth and QoS, the Service Level Agreement (SLA) may cover a wide range of managed common services such as, hosting facilities, app stores, application life cycle management etc. This approach may attract new market entrants, lacking the scale and expertise, but enriching the FTTH ecosystem with innovative applications, services and content.

Question: How to expand beyond traditional triple play offerings?

Moving beyond the traditional commercial triple play offering requires partnerships between Network Service Providers (NSP), Consumer Electronic (CE) manufacturers and Application & Content Providers (ACP). For example, innovative business models are needed for Over-The-Top video delivery to coexist with managed IPTV services.

Additional questions:

Question: How to build a business case for service providers?

Question: How to manage multiple service providers (Quality of Service, Bandwidth, etc)?

Question: What role does advertising have in these business models?

More information relating to the deployment and operation of FTTH is available in the FTTH Handbook.

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