FTTH Business Guide

Helping you to develop the business case for fibre-to-the-home

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Foreword

The FTTH Council Europe is an industry organisation with a mission to accelerate the adoption of fibre to homes and businesses throughout Europe. The Council promotes fibre for delivery of high-speed broadband because we believe it contributes to a better environment, increases economic competitiveness, and enables many new applications that can enhance the quality of life.

Feedback from the Council's members, and our ongoing dialogue with fibre network operators, consultants and investors, suggested that there was scope to provide additional guidance on the business case for FTTH.

When we tested the idea of a Business Guide in a workshop at the FTTx Summit in Munich last June, nearly a third of all the event delegates came to hear about it and there was an extremely lively and positive debate.

Following more than six months of hard work by the Business Committee, we are pleased to present what we believe is the first ever comprehensive guide to FTTH business planning. This document is a perfect match with the Council's mission, and complements our existing resources in the public domain.

In these pages, industry experts share their knowledge and experience on topics relevant to the crucial early stages of planning FTTH networks, from demographic analysis to deployment strategies and types of funding. We hope that their collective wisdom will encourage all new entrants in the FTTH space, and help them to build profitable businesses based on fibre.

Karel Helsen, President, FTTH Council Europe

Who should read this guide?

This document is about the business case for fibre-to-the-home. You should read this document if you are thinking of planning, constructing or investing in a last-mile fibre 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 else interested in the business case for FTTH

This book targets a wide audience, and therefore we do not assume any prior knowledge of technical, financial, or business issues relating to FTTH networks.

Introduction

After more than a decade of deployment around the world, fibre-to-the-home (FTTH) is no longer a telecom research project advanced by starry-eyed scientists. On the contrary, FTTH is shaping up to be the foundation of our new digital society, bringing economic prosperity and a multitude of business, social and entertainment opportunities to its users.

We all have personal experience of society's increasing digital appetite – whether consumed as internet browsing, photos or movies – and our growing dependency on digital resources such as storage and bandwidth. As legacy, copper-based access networks continue their inevitable journey towards retirement, organisations large and small are securing their digital future by investing in fibre.

Over the past few years, next-generation access services have continued to be adopted by more end-users, as service providers of all types continue or begin their rollouts. Globally FTTH subscribers grew by 29 percent during 2008 to reach 33.6 million at year-end, and a further 5.5 million subscribers joined them in the first half of 2009 alone. The growth in subscriber numbers shows little sign of slowing down, despite the worldwide economic downturn of 2009.

Today FTTH is being deployed by many diverse organisations, including incumbent and alternate operators, governments and local authorities, real estate developers and residential associations, utility companies and municipalities. These companies may be gaining new revenue streams from IPTV entertainment services, lowering their network total-cost-of-ownership or winning subscribers from their competitors. Others may be leasing infrastructure assets, providing application content or earning wholesale revenue. There are many ways to capitalise on the FTTH value chain.

The FTTH business model is straightforward – first you must build the fibre infrastructure at a sensible cost, then rent fibre to service providers or take on some complexity and create your own services. But although the concept is simple, the detail and execution required can be formidable. Since many organisations now planning or building FTTH networks are not from traditional telecommunications backgrounds, they may face a steep learning curve.

Therefore, the FTTH Council Europe decided to develop this Business Guide to provide a framework for new entrants in the FTTH space, in order to broaden their knowledge, and help them move forward with FTTH deployment projects with confidence and a quicker step. FTTH investments have already been made with success, and there are many more business opportunities to be developed and exploited – this is a long-running world-wide program.

It is certainly possible to build a strong business case for FTTH. Like any other kind of business opportunity, however, there are potholes that can trip you up along the way. How can you make money? How do you avoid costly mistakes? The purpose of this document is to alert people to the areas where they should be paying attention when developing realistic plans for FTTH businesses.

Putting together an FTTH project requires many different inputs. Each individual project is unique, depending on geography, the history of the market, national regulation, and a multitude of other factors. Many of the variables involved are interconnected; improve one thing and you must compromise on another. This document cannot describe all possible situations, but outlines key considerations and provides examples from real-world instances.

The Business Guide deals with the crucial early phase of an FTTH network, from project conception to the development of a business plan. We start by providing background information on the advantages of FTTH and the possible operator business models. Then we consider the major influences on revenues (chapter 4) and expenditure (chapter 5) – careful projection of these figures will be needed when developing the business case. Regulation is discussed in chapter 6. The business plan itself is the subject of chapter 7, which looks at methods of funding FTTH projects and the financial metrics used for business case assessment.

In the final chapter, we present various case studies from across Europe, and discuss the factors that have contributed to their success. While our case studies illustrate how positive business cases have been achieved, they also highlight the importance of careful planning and execution from start to finish.

We hope that this Business Guide will become a valuable resource for potential FTTH network owners and builders. The FTTH Council Europe plans to update it on a regular basis to keep up with current industry trends and best practise. We would be pleased to receive any reader comments on how we can improve it.

Albert Grooten, Chair of the Business Committee,
FTTH Council Europe

Chapter 1: Why Fibre?

Why do you want to build an FTTH network? Since you are reading this guide, you will already have some ideas about the answer to this question. Understanding the advantages of FTTH, and being able to articulate them clearly will put you in a better position to write a strong business plan.

FTTH has clear advantages for the end-user because it can provide higher bandwidth, and better reliability than broadband services that have ADSL or cable as the underlying technology – both now and in the foreseeable future.

The advantages for the end-user translate into benefits for the service provider, because they help the service provider to attract and retain customers. However, the potential upside to the service provider extends further, and also includes new revenue opportunities, lower operating costs, central office consolidation, and a future-proof network infrastructure guaranteeing ease of upgrade in the future.

FTTH will also be an enabler for considerable social, environmental and economic benefits – and these benefits are already tangible in countries that have adopted fibre over the past decade, such as Sweden. For government, local authorities or communities, these benefits may represent compelling arguments for fibre in their own right. Commercially driven organisations may also be able to capture a financial benefit from these so-called network externalities, for example, by winning public funding, or signing up a healthcare provider as a core customer.

The information in this section is intended to provide both a summary of the main advantages of FTTH, and a starting point for developing your own arguments about why fibre is the best foundation for your future business. For background information on the technical aspects of FTTH, we recommend that you read the *FTTH Handbook*, which is available via the FTTH Council Europe website.

Consumer benefits

The main selling point of FTTH is bandwidth – the amount of data that can be carried over the connection in a given amount of time. FTTH offers the highest available bandwidth of any technology, in both downstream (from the internet to the end-user) and upstream (from the user to the internet) directions.

Today users with a 100Mbps FTTH connection can download content over 10 times faster than users with a typical 8Mbps ADSL connection. The following table shows typical download and upload times for image and video transfer over different types of broadband connection:

Time taken for:		1 GB photo album	4.7 GB standard video	25 GB HD video
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 example: 100 Mbps Ethernet point-to-point system
4. CATV example: DOCSIS 2.0 system with a single active user (ie. no capacity contention)
5. DSL example: ADSL system with an ideal "up to 8 Mbps" service
6. Other system technologies, e.g. GPON/10GPON, EPON/10G-EPON, DOCSIS 3.0, ADSL2+M, VDLS2+, would result in different times
7. An interactive *FibreSpeed* comparison tool is available from the FTTH Council website: http://ftthcouncil.eu/home/fibrespeed_tool/?cid=259.

Several other access network technologies such as ADSL2+, VDSL2 and DOCSIS 3.0 are often touted as "next-generation broadband", and promise increased speeds, but FTTH demonstrates both long-term and short-term advantages. Although headline speeds are eye-catching, it's important to understand some of the other factors that impact end-user service, beyond the headline speed.

First, FTTH speed is independent of the distance from end-user to the telephone exchange – unlike the DSL family of technologies, whose speed reduces with distance. DSL performance is also subject to random noise, interference and crosstalk during operation, which reduces the throughput.

Headline rates of 24Mbps (ADSL2+) or 100Mbps (VDSL2) are theoretical maximums, don't include framing and encapsulation overheads, and can only be achieved if the end-user is adjacent to the exchange or cabinet where the active equipment is installed. Marketing such as "up to 8Mbps" or "up to 40Mbps" services may be technically correct, but end-users are increasingly dissatisfied at the inevitably lower performance that they actually receive – often less than half of what was advertised.

Cable TV systems suffer from a different problem. DOCSIS 3.0 technology, used by cable TV operators to deliver headline speeds of 100Mbps (or even 200Mbps in trials), achieves these higher speeds by "channel bonding" – combining several channels out of a fixed spectrum to increase capacity. The downside here is that more subscribers need to share the combined channel, so whilst headline speeds go up, end-users suffer from increased contention and their throughput suffers at peak times. Further, cable TV systems are optimised for downstream usage by design, and upstream capacity is not only low, but is also extremely contended. These quality issues are familiar to many cable users.

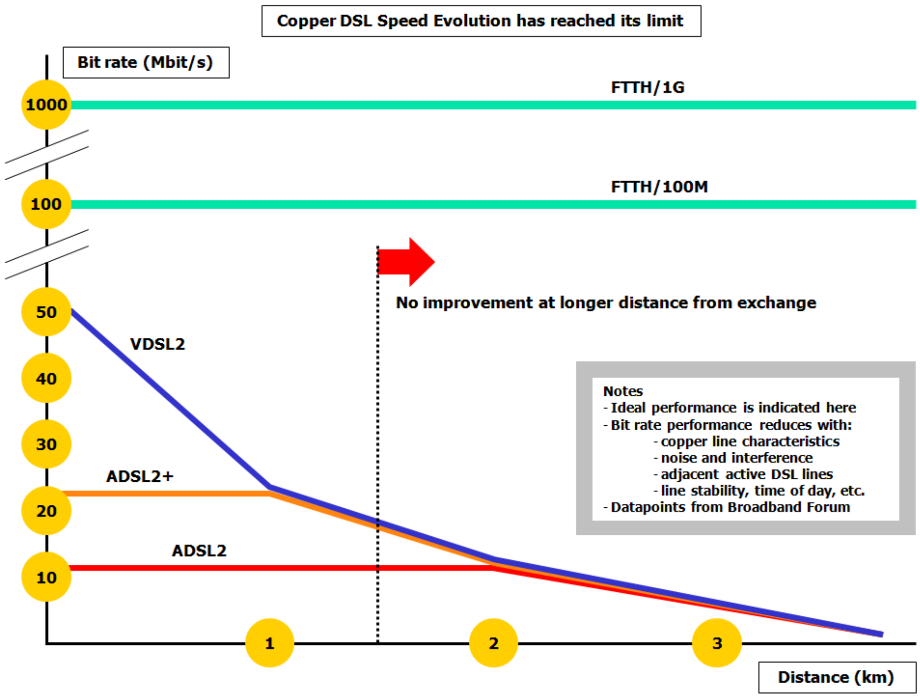


Figure 1: How broadband speed changes with distance from the telephone exchange.

A key question is how much bandwidth is enough? Nielsen's Law of internet bandwidth is an empirical law that states that a high-end user's connection speed grows by 50 percent per year, and this law has held true for the past 25 years. Nielsen's data point for 2010 is a connection speed of 31Mbps, a speed that is already familiar to many, but by no means the highest available to consumers.

Looking forward, a combination of increasing uptake of existing services and new services entering the market will continue to push bandwidth requirements higher. Applications are already envisaged that will consume more than 200Mbps of access capacity. A selection of existing and future services and their bandwidth requirements are presented in Figure 2.

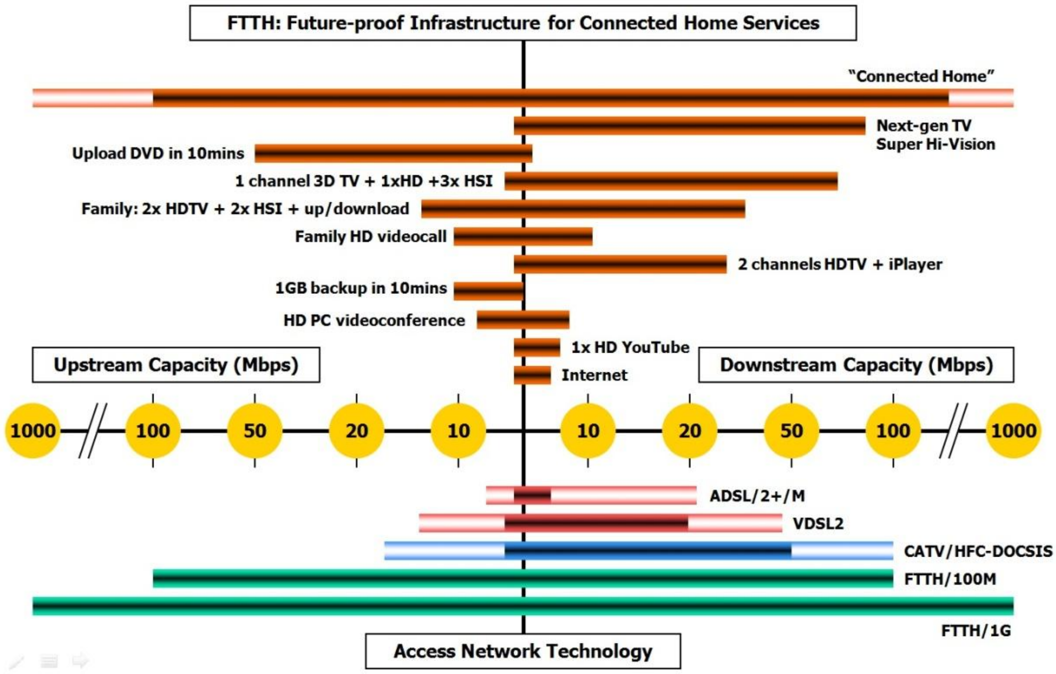


Figure 2: FTTH versus other fixed-line technologies.   Note that downstream and upstream scales are logarithmic. Two-tone bars represent typical and best-case scenarios. DSL speeds reduce with distance from the telephone exchange, as described in Figure 1.

Two trends are expected to generate higher bandwidth needs for individual users. The first trend is multitasking: performing multiple, simultaneous activities online. For example, a user may be browsing a web page, while listening to the audio from an online music or video service.

The second trend is passive networking, whereby a number of online applications work passively in the background, such as software updates, online backups, internet PVR (personal video recorder) and ambient video, such as nanny-cams and security-cams. Cisco estimates that the number of applications generating traffic per PC has increased from 11 to 18 over the last year.

And of course, in a typical household there are likely to be multiple users sharing a single broadband connection.

However, there is a sound argument that more bandwidth is needed *today*. For example, DVD rental firms like Amazon have started offering movie downloads. Catch-up TV services are becoming increasingly popular; the BBC's iPlayer HD service requires a minimum 3.5Mbps of download capability. On demand TV, where content is streamed on request, is also becoming increasingly common. Individually, these services can be supported on existing broadband connections, but with many homes containing more than one computer or television, the multiplier takes the bandwidth requirements out of range for the majority of households.

There is also evidence that existing products and services are being limited by lack of speed. For example, the time to upload home video or digital photographs at full resolution in order to share them with family is typically measured in tens of minutes or even hours – an unacceptably long time for most people. By the same token, online backup services are constrained by the lack of upload capacity. A 100 GB hard drive is considered small by today's standards; uploading just half that amount of data could take over 200 hours with a high-end ADSL connection.

In January 2010 Skype launched HD video calling, which requires at least 800 kbps of bandwidth in both directions – putting it out of reach of users with a standard ADSL+ connection with its maximum upstream data rate of 448 kbps. Indeed, providing decent quality, low-resolution video conferencing with accurate lip-synch is still a challenge over many residential broadband connections.

Broadband marketing has typically focused on downstream bandwidth, but upstream bandwidth will become increasingly important as applications that require two-way video sharing become commonplace, and cloud-based services proliferate. Not only does FTTH offer the highest upstream data rates, it also opens the way to symmetrical bandwidth.

Service provider benefits

FTTH is often quoted as being a "future-proof technology" but what does this really mean? FTTH requires installation of a fibre connection to each home or building, in order to deliver communications services currently provided over copper cable. The life-time of the fibre cable is expected to be 30 years or more – the cable itself is just plastic and glass, which is robust and degrades extremely slowly. The fibre in the ground has virtually unlimited capacity, so bandwidth upgrades only require changes to the equipment on the ends of the link.

The active equipment on the ends of the link has a shorter lifespan – typically seven years – but this is true of any broadband technology. FTTH equipment is available today that supports 100Mbps or even 1Gbps to end-users, and further technology generations are possible. In contrast, alternative technologies like VDSL and DOCSIS 3.0 are already pushing the limits as far as copper cabling is concerned – copper that is, in the majority of cases, far older than 30 years.

Incumbent operators, while historically committed to their approach, nevertheless can see the writing on the wall, and many are planning FTTH deployments in coming years. Both traditional telecoms 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 moved through the intermediate steps: Swisscom, for example, has previously invested in ADSL and then VDSL access technology, but has now decided to adopt FTTH.

Although VDSL technology continues to improve, VDSL 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 re-invest to upgrade over a very short timeframe, and therefore the emphasis should be to learn the lessons from early adopters and put in the most future-proof solution from day one.

Another motivator for service providers is that FTTH networks have significantly lower operational costs (OPEX) than existing copper or coaxial cable networks. FTTH networks consume less electricity – some reports put the figure at 20 times less than HFC or VDSL. Network operation and maintenance can be simplified by full automation and software control, so fewer staff can be employed. In addition, maintenance costs are typically reduced because there is no active equipment in the field to maintain, and optical components have better reliability.

Verizon in the US has reported that its FiOS FTTH network showed a decline of 80 percent in network trouble report rates, and that customers are more satisfied with their service because it is more stable and suffers from less downtime.

Higher customer satisfaction tends to lead to improved customer retention and lower churn, which also helps to reduce OPEX – it's cheaper to hang onto an existing customer than to recruit a new one.

A 2008 study on NGA service portfolios commissioned by the FTTH Council Europe also showed that FTTH operators collected 30 percent higher average revenues per user – not because their offerings were intrinsically more expensive, but because customers subscribed to more services.

The ability to offer new services is a key attraction for service providers, who want to stay ahead in a highly competitive environment. The entertainment services segment is extremely dynamic and has been driving consumer adoption of new technology. For example, IPTV service subscribers increased to around 21 million worldwide during 2008 and a growth rate of 28 percent is forecast to continue for at least the next 5 years. With associated revenues of around $6 billion (€4 billion), this is an important and growing revenue stream for established and new entrant service providers alike.

The terrestrial analogue TV switch-off deadline of 2012 – recommended by the European Commission – is looming in many European countries. The transition to digital terrestrial transmission has already proven to be a major market discontinuity 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 because it provides a differentiator for service providers. Even in developed markets like the US, which has 61 percent of the global total of HDTV households, 43 percent of households either don't have or don't watch HD content and this represents a considerable market opportunity. With 150-inch displays already on the market, it is perhaps only a matter of time before films are premiered directly to the home on IPTV, instead of a cinematic release.

Already on the horizon is 3D TV – or more accurately, a first generation of stereoscopic TV. The first 3D-enabled TVs, from big names like Sony and Panasonic, are expected to hit the stores as soon as mid-2010. As Hollywood, film and TV studios gear up for 3D production, broadcasters are ready to join them. The BBC broadcast the world's first live 3D HD programme in 2008, and UK satellite TV provider Sky has announced its intention to launch the UK's first 3D channel on their HD platform this year. Even though standards and technology require further development, it seems likely that 3D will drive consumer investment, and video service providers hope it will enable them to secure premium service fees.

Beyond HD is "Super Hi-Vision". Already demonstrated in a live broadcast in 2008 jointly by the BBC in collaboration with NHK of Japan, this is envisaged as a 33 million pixel system (7680 x 4320), with 32 times the information density of HDTV. This is currently being standardised, 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.

One argument often raised by operators that don't want to invest in fibre is that they "don't 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. Further, 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 more time using existing services, as well as gaining the ability to use new services.

Community benefits

Communities with FTTH can obtain genuine advantages because they will be able to access a wider range of internet services. Examples of potential benefits that FTTH networks can generate include:

- boosting economic growth and increasing the global 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 number of studies have observed a statistical connection between higher broadband adoption and an increase in economic prosperity at both local and national level. Evidence-based studies on FTTH have not yet been carried out because the technology has not been mainstream for long enough; it is anticipated that real-world analysis on the economic impact of FTTH will be carried out in due course. However, several reports have attempted to make sensible predictions on the impact of FTTH networks on job creation and GDP.

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

A recent study by Ovum for the FTTH Council Europe looked at the socio-economic benefits of FTTH across different communities in Sweden, and found evidence that FTTH has a positive influence on health, education and other public services. For example, in Hudiksvall, a town on the Baltic Sea coast with around 15,000 inhabitants, there was a clear link between rollout of fibre to the community, and the ability to attract new businesses to the area. The study suggests the impact will be greatest in rural areas where there are limited local resources and end-users face significant travel requirements.

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 of the deployment of a typical FTTH network. The results showed that the energy and raw material used to produce the equipment, transport it and deploy the network is easily compensated by FTTH-enabled services like teleworking, fewer miles travelled for business, and reduced long-distance transport of patients.

The study found that the environmental impact of the deployment of a typical FTTH network will be positive in less than 15 years compared to if the network had not been built. 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, which showed environmental pay back in just 12 years – mostly due to the ready availability of aerial cable.

It may be difficult for service providers to capture the financial value of these externalities directly in the form of service fees. However, other parties involved in the network deployment may take these benefits into consideration when making decisions. For instance, the potential social and economic benefits for the community could help you to gain local support for the project, which could help to smooth the deployment process locally, and result in more customers signing up to receive services. The business case should address all alternative drivers and methods for funding the network rollout.

Chapter 2: FTTH Operator Models

Network layers

An FTTH network can be considered to have four layers: the passive infrastructure comprising the fibre, duct, enclosures and other outside plant; the active network comprising the electrical equipment; retail services, which provides connectivity to the internet; and of course the end-users. Some people also visualize an additional layer, the content layer, lying above the retail services layer, which may also be exploited commercially.

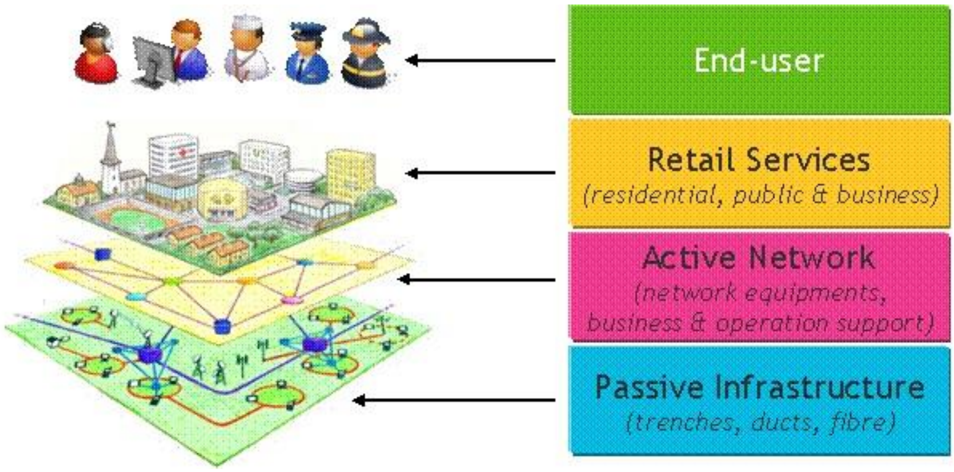


Figure 3: Network layers.

This technological structure has implications for the way that a FTTH network is organised and operated.   Let's look at these in more detail:

Passive infrastructure

The passive infrastructure layer comprises all the physical elements needed to build the fibre network. This includes physical objects such as the optical fibre, the trenches, ducts and poles on which it is deployed, fibre enclosures, optical distribution frames, patch panels, splicing shelves and so on. The organisation in charge of this layer will normally be responsible for network route planning, right-of-way negotiations, and the civil works to install the fibre. This is the layer where the network topology is implemented, whether point-to-multipoint (also known as "tree" or "star") or point-to-point (also known as "home run").

Active network

The active network layer 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

Once the passive and active layers are in place, retail services come into play. This is the layer where the internet connectivity is packaged as a service for consumers and businesses. Besides enabling those services technically, the company responsible for this layer is also in charge of customer acquisition, go-to-market strategies, and customer service. The retail service provider may also decide to offer premium services from the content layer, such as IPTV (more in Chapter 4).

Types of FTTH organisation

Each network layer has a corresponding function. The network owner is in charge of the first layer, although they will probably outsource its construction to a third party. The wholesale provider owns the active equipment, while the retail services are provided by the internet service provider (ISP). These three functions may be found as departments within the same company, or they may be under the control of different organisations.

In the case of a vertically integrated model, a single player will own all three layers of the network. This is often the case for incumbent operators, like for example Orange in France, Telefonica in Spain and Verizon in the United States. On the other end of the spectrum, we see the fully separated ownership of the different layers, as is the case in some parts of the 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 their services and sell directly to the end-users.

Here are some typical FTTH operator models:

Vertically integrated

As mentioned above, the vertically integrated model means that one operator controls all three layers of the network, and consequently, if a second operator wishes to also offer broadband and telephony services in the same area, he will have to build his own infrastructure, operate it and market it directly to the end-users. This is a clear form of infrastructural competition.

Passive sharing

While this model can be considered a form of infrastructural competition, it leverages a single passive infrastructure, which is built and maintained by one owner. The active and services layers are owned by a different organisation. A second service provider may share the same passive infrastructure with the first service provider, but will still have to invest in active network equipment and operations as well as the services and go-to-market activities. Typically, this model goes hand in hand with regulatory requirements for passive wholesaling.

Active sharing

In the active sharing model a single organisation owns the passive infrastructure and operates the active network. This vertical infrastructure owner wholesales broadband access to the various retail service providers who will then compete against each other for customers. The regulatory framework associated with this operator model regulates active wholesale specifically, and seeks to encourage service competition.

Full separation

Full separation, as was already mentioned above, partitions the ownership of the different layers. Each layer is owned by a different player, with the infrastructure owner generating income by providing passive infrastructure access to the network operator, who in turn wholesales broadband access to retail service providers. This model stimulates competition at the services level and goes hand in hand with regulatory requirements for passive and active wholesaling.

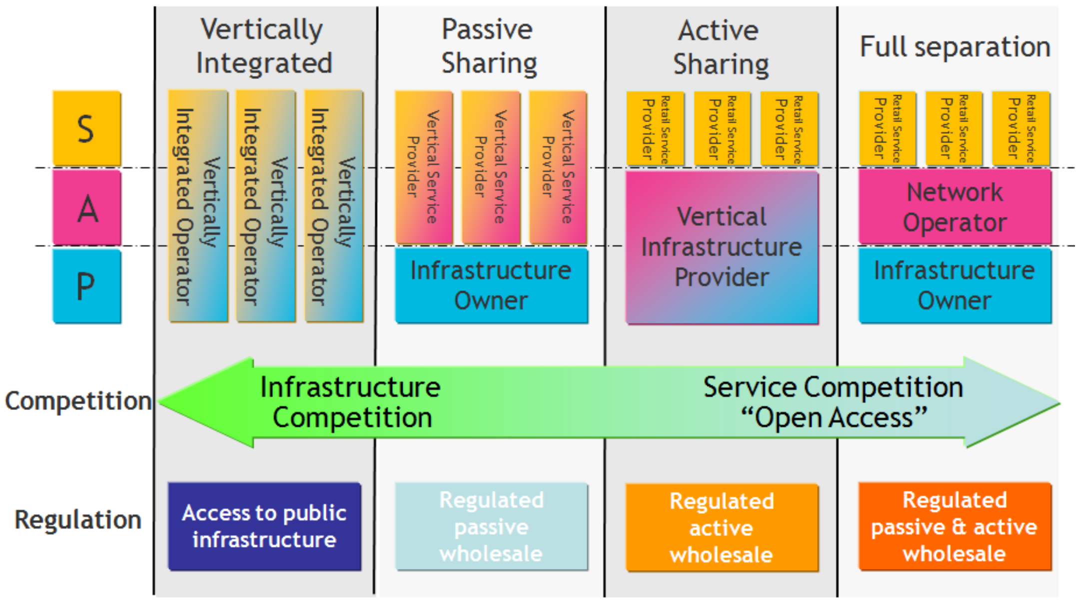


Figure 4: FTTH operator models and regulation

As an FTTH network owner, your interest could stop at any of the three levels in the value chain. Indeed, the same organisation could have different interests in different geographical areas, depending on the local market and the availability of potential business partners.

Each type of operational model has its own opportunities and challenges, which are summarized in the following table:

	Pros	**Cons**
Vertically integrated	You 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 chose is fundamental, as it will determine the business model of your activities and your financial model. This decision, however, is also dependent on the regulations within the territory you are planning to operate, the competitive environment, and your core business activities and competencies.

Example: HanseNet

HanseNet (Alice Germany) is deploying an FTTB network in the Eimsbüttel area in Hamburg. Based on the GPON standard, the network will connect every customer with 100Mbps via VDSL2 with an optical network unit (ONU) placed in the basement of the building. HanseNet provides triple-play services (voice, broadband, TV), and video-on-demand.

HanseNet has decided to use the "vertically integrated" model. This means that all three layers – passive, active and retail services – are under its control. The layers have been planned, built and commissioned by HanseNet with its own resources or implemented under its project leadership. As one of the biggest ISPs on the German telecommunications market, HanseNet has the professionals and expertise to plan and implement the whole network.

Planning guidelines for the passive and active network were written by HanseNet. These guidelines regulate how the network must be built in future, no matter who builds it. HanseNet could choose to give one or more network layers to another company to build and operate, but the partners would be strictly bound to the guidelines laid down by HanseNet.

Conversely, it is also possible for HanseNet to establish partnerships with other FTTx-providers, whether they are just building up a passive or active network or whether they are a vertically integrated operator. Until now HanseNet has been using service platforms from other carriers in Germany to distribute the Alice portfolio all over Germany. Therefore HanseNet will also be able to integrate new FTTx wholesale customers into the existing IT-platform.

The main reason for choosing a vertically integrated model was because HanseNet wanted to have a technical and financial proof of concept. Using the experiences gained from the Hamburg trial, HanseNet will be able to determine the value of potential partners. This is important because it is unlikely that a single provider will be able to build up FTTx networks all over Germany; instead there will be a lot of partnerships for a German-wide rollout of FTTx networks.

Another reason HanseNet did everything itself was because there were no possible partners available to do a passive network rollout in Hamburg, and there were no possible partners able to build up an active network. Owing to its market share of nearly 40 percent, HanseNet was the only service provider willing to make such an investment in Hamburg.

Chapter 3: First Steps

The complexity of starting up an FTTH project often does not get as much attention as needed. A small but dedicated team will be needed to establish the viability of the project. The team may need a variety of skills: accountant, lawyer, technical, marketing and communications, and market research. The projects that have the greatest chance of success are those with a champion, someone who is absolutely passionate about the project, and has been there from the beginning.

A distinction should be made between building an FTTH network and operating the network – different skills are required, and therefore it is likely that you will employ different people for the construction and operation stages of the network.

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:

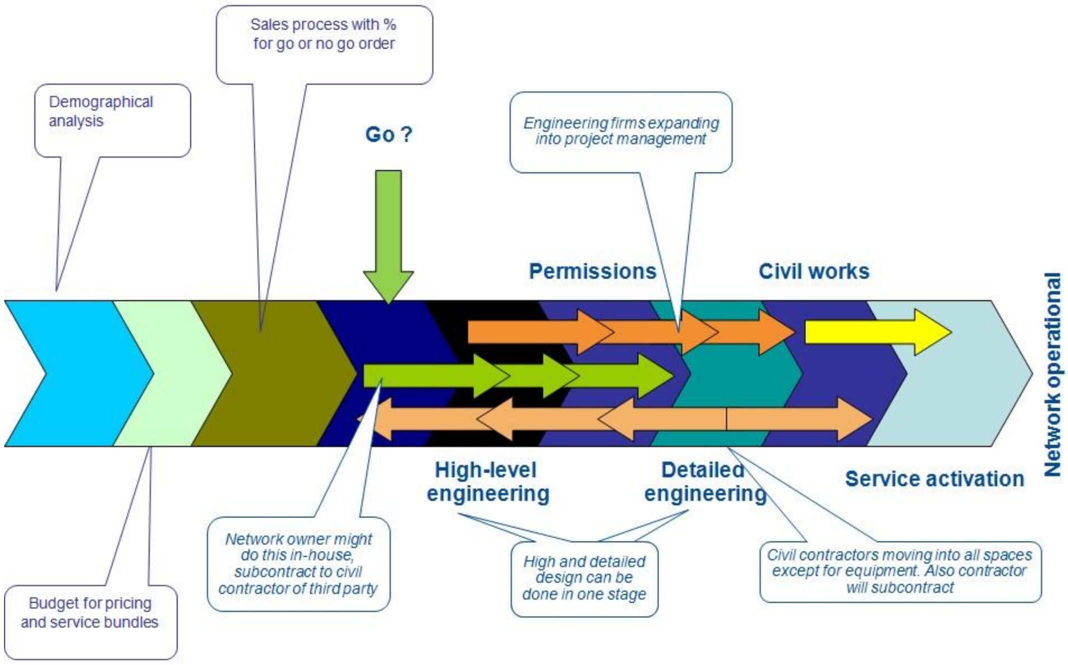


Figure 5: Timeline of an FTTH deployment.

Included in this timeline are the following stages:

1. Establishment: putting together a steering group, securing initial funding, carrying out a demographical analysis, developing key relationships, and building awareness of the project.

2. Business plan: putting together a detailed financial budget that you can take to the bank, including analysis of the expected revenues, and planned expenditure.

3. Financing and procurement: securing the major funding required and establishing contracts with companies that will build the network.

4. Deployment: securing planning permissions, installing the fibre and other infrastructure.

5. Service activation: lighting the fibre, and connecting the users.

In the rest of this chapter we will look at the establishment phase in more detail.

Market research

It is important to understand the market in which you hope to operate, in terms of the potential customer base, the service provider competition, and the geography and existing infrastructure in the proposed deployment area. Using this information you can proceed to an initial assessment, and later to a complete business plan.

First, identify all the key players in the targeted deployment area, both suppliers and end-users – actual and potential.

From government sources (e.g. the Census Bureau or Office of National Statistics), you should be able to ascertain some basic information about the market including the population by town/region and the number of households. If you are lucky the information may also break down the population into those living in ordinary houses/villas and those in multi-dwelling units. This information is extremely useful when estimating the capital expenditure later on.

Collect information about existing broadband provision in the territory, especially information relating to availability, speeds and prices of existing services. Service provider websites are an obvious first point of call. Where possible, find out what plans existing service providers have to enhance their product offerings in the area – you may need to consult news sources or ask the service provider directly.

Your national regulator's website will also be an excellent reference as they normally have data on the current take up of broadband services. The regulator may also record more detailed information such as the penetration of different types of service, like IPTV. See *Chapter 6* for a list of telecoms regulators.

Prepare a map of the proposed deployment territory to identify gaps in service provision and opportunities to exploit other infrastructure, like 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 stage, we recommend "doing your homework": especially finding out what has happened in similar contexts in other regions and countries, and what lessons from elsewhere can be usefully adapted to your particular situation.

Customer engagement

Carry out an awareness-raising campaign to explain the advantages of FTTH to your potential customers, and to stimulate demand for services. This is an important step because consumers are largely unaware of the benefits of FTTH.

Many consumers may not be aware of the type of broadband connection they are using. Service providers don't necessarily tell customers that their service is FTTH, instead referring to it by brand name, like Verizon's FiOS. There is also a certain degree of confusion in the marketplace because some broadband products based on cable or VDSL technologies are branded as "fibre-optic", even though fibre only reaches the neighbourhood, not the home.

At this point you may also wish to carry out a survey of potential customers to find out what services they are interested in receiving, how well they feel they are being served by existing communications providers, and how their needs might develop in the future.

Registering demand in advance of network rollout is a common strategy among FTTH operators. Dutch operator Reggefiber, for instance, sets a "trigger" level for network deployment – digging only starts when at least 40 percent of households in the connection area have pre-registered for services.

The competitive response

If your market research shows that there is considerable pent-up demand for better broadband, this information alone may be enough to coax an existing operator into action. Indeed, this could be the desired end-result of a demand aggregation strategy.

However, if this is not your intention, then the response of other operators could impact your plan negatively. Incumbent service providers will work hard to keep customers, with price reductions, improved services or even more devious tactics.

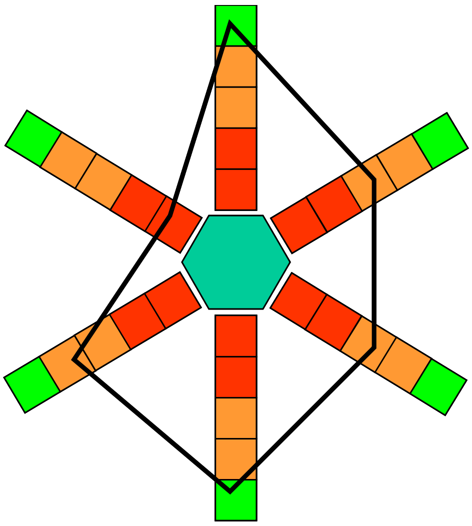
Some FTTH projects have experienced legal challenges from other telecoms providers, which habe caused substantial delay to the project. Because these delays tend to extend the time needed to reach positive cash flow, they will increase the cost of borrowing, as well as adding direct legal costs. To the extent that these challenges can be avoided or dealt with in a speedy and efficient manner, the ramp to positive cash flow is likely to occur more quickly.

Project feasibility

If you believe that you have spotted an FTTH opportunity, then first carry out a high-level assessment. Only if enough of the fundamentals are right is it worth spending more time, effort and possibly money on a more detailed assessment, which would typically involve a financial model and business plan.

The FTTH Council suggests the following simple framework for assessment, which is designed to provide help potential entrants identify areas that are likely to require attention. The criteria for assessment are presented in the form of spider diagrams – one for revenue potential and the other operations – which are shown on the following pages along with suggested specific criteria. These criteria will be discussed in more detail in later chapters.

The result of the process will be a qualitative assessment expressed as a picture such as the one on the right.



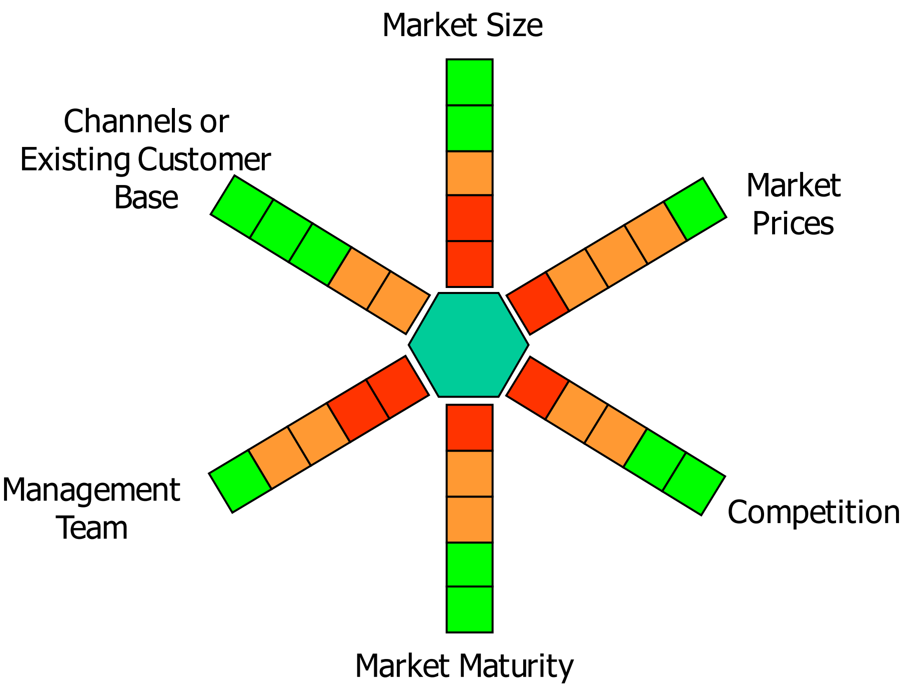
There are no hard and fast rules, but if a project has either zero greens or two or more reds on either diagram then caution is advised.

These diagrams are not a set of definitive requirements, but merely a guide to assessment, which can be used to stimulate thinking and internal discussion.

Every FTTH opportunity is different, and some factors may not be relevant for a particular project, whereas factors not shown could be of vital importance. In such cases, the framework should be modified to suit. In light of the increased government emphasis on universal broadband, the availability of public funds may have a significant impact on some of the red areas, particularly those associated with high infrastructure costs.

Figures on pages 28, 29 and 31 are reproduced courtesy of Ventura Team LLP.

Revenue assessment



Critical Issues
Significant risk and `red flag' for the project

Concerns
Manageable but of concern

Okay
Good or encouraging position

Suggested criteria for assessment are as follows:

Market Size	<2000 homes to pass	2000 - 5000 homes to pass	5000 - 20000 homes to pass	20000 - 50000 homes to pass	>50000 homes to pass
Price (in low/high salary market)	Broadband price per month in Low cost: < €10 High cost: < €17	Broadband price per month in Low cost: < €15 High cost: < €25	Broadband price per month in Low cost: < €20 High cost: < €33	Broadband price per month in Low cost: <€25 High cost: < €42	Broadband price per month in Low cost: > €30 High cost: > €50
Competition	Established FTTH or upgraded & effective cable TV. Dominant sat TV provider	Well financed and agile cable/VDSL/FTTH competitor(s)	cable TV not upgraded, unbundlers, moderately strong sat TV	High growth in broadband. Untapped potential in TV	Little broadband. Major problems with supply
Market Maturity	Saturated with existing FTTH true broadband	Slow sales of existing 20 Mbit/s or HDTV offers	Rapid evolution of products and fierce price competition	Early growth in mass market phase	High prices for slow speeds
Management team	No team and poor proposition to potential recruits	No team or weak team. Major uncertainties re recruitment proposition	Team(s) identified & good proposition to them tested and viable	Leader in place with ability to manage build/run transition	Team proven in similar project & highly commmitted to this project
Channels or Existing Customer Base	No presence	Channels or partnerships - eg with housing associations	Relevant and good relationship with target market	Providing telecom services to target market already	Already loved as a telecom provider

Market size: Any business will have some fixed costs. In the case of an FTTH organisation there will be a substantial fixed element relating to central systems for provisioning new customers, billing, customer care centres and so on. Where the potential number of customers is low, the disproportionately high level of fixed costs can make it difficult to make a sensible business case. On the other hand, as one of the case studies shows, it is possible to build a successful FTTH network to single apartment block.

Market Prices: Broadband is the foundation service on a fibre network, although it may be bundled with additional services, such as voice telephony, TV, or even a mobile phone contract. However, for the purposes of the initial assessment, it is useful to consider the current pricing of the broadband element alone because this provides an important indicator of the financial feasibility of the project. Chapter 4 contains a more detailed discussion on services and pricing.

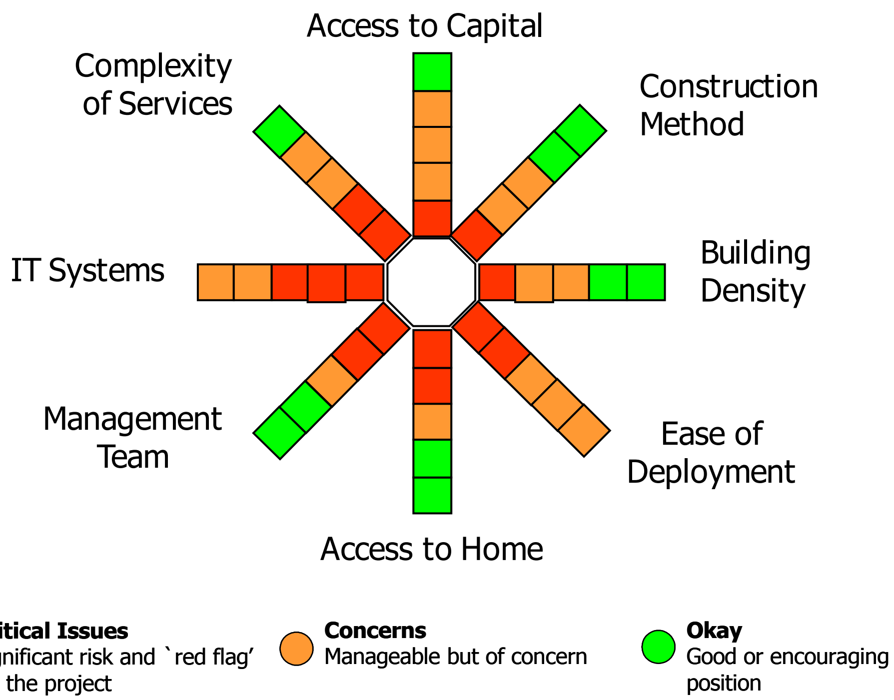
Competition: The competitive environment will determine the market share that you can expect to achieve. Places that are not served by broadband clearly offer the best prospects; however, broadband black spots – locations too far from the telephone exchange to receive DSL services – tend to be geographically diverse, and therefore more expensive to connect with fibre.

Market maturity: The maturity of broadband and triple-play local markets varies greatly across Europe. On the one hand, in Greece there is no cable television and ADSL only became widely available and affordable in 2008. On the other hand in Sweden there are many 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.

Management team: As in any business, there will be a great difference between the achievements of a good team compared to a weak team. A classic problem is that the team focuses on technology or construction, and initial marketing is poor, which then takes a long time and considerable effort to overcome.

Existing channels: A company that has an existing customer base has a two-fold advantage over a completely new brand in that they have a reputation already, and can use existing channels to publicise the fibre services. These advantages can result in lower costs to inform potential new customers, higher take-up rates and improved margins.

Operations assessment



Suggested criteria for assessment are as follows:

Access to Capital	Insufficient finance. >14% WACC.	~12% WACC Confident of revenues and build to budget	~10% WACC Can finance viable scale	~8% WACC	WACC <8%. Grants. Shareholder guarantees.
Construction Methodology	100% Dug - high quality pavements	Mainly Dug - average quality pavements	Some ducts available	Extensive duct network owned or leaseable	Aerial cable rights secured
Building Density	Individual houses in low density developments	Few or no blocks but dense homes with grass verge or other low cost	Mixed high density houses / apartment blocks	Mainly apartment blocks - >16 homes per block	New build apartments or high density homes
Ease of Deployment	No right to build and hostile authorities	Rights slow to obtain. Shortage of skilled contractors	Reasonable rights to build. Moderate difficulties	No material obstacles to deployment	Contractors bear construction risk
Access to the Home	Costs 12 or more months revenue. Agreement by individual home	Costs 9 or months revenue	Costs <6 months revenue. Agreement at apartment block level	Access to existing ducts/fibres with existing right of access	Customers keen to pay access costs
Management Team	Technology driven. Incomplete or poor skills	Lacking clear leadership	Good generalists	Experienced in 3 play. Can manage build-operate transition	Strong experience in all functions & good commerically focussed leader
IT Systems	Paying 3rd party for bespoke build	Build from scratch	Ready made over web	Adapting existing system	Established and proven system
Complexity of Competitive Offerings	Techy culture. >25% added to fixed costs	No wholesale. Fixed costs add >15% to fixed costs	Multiple product variants & prcing across multiple services	Wholesale available for all main services	Broadband only viable in the market

Access to capital: There will be a high level of capital expenditure in the early years. Assuming the money can be obtained, it is the cost of money that counts, specifically the weighted average cost of capital (WACC). This will depend on the nature of the project and the source of funds – more information in Chapter 7.

Construction methodology: Connecting a central office to individual homes and businesses is a major part of the capital expenditure in an FTTH network. The way that the fibre is routed, as well as the construction method – shallow or deep digging, existing duct or large conduit, or aerial cable – will have a major impact on construction cost. The influences on construction cost are discussed in Chapter 5.

Housing density: 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 large apartment blocks will be the cheapest.

Ease of deployment: We do not believe that construction often runs to time and budget so there is no green segment on this scale. This may be unnecessarily pessimistic so feel free to add a green option in your own assessment, particularly if you have access to utility or other infrastructure that takes your fibre directly to where it is needed.

Access to homes: This is about trying to connect up homes for the lowest possible cost per home. There are costs associated with marketing to the customer, drawing up contracts, and gaining access to the building to carry out the installation. Please see Chapter 5 for more information.

Management team: An experienced management team will make better choices and save money compared to complete newcomers. The better the management team understands the mechanics of fibre industries, the better they are likely to perform. As in any company, a commercial and customer focus is vital.

IT systems: IT is another area in which we are pessimistic. We have seen many larger operators spend millions on IT systems and still not be able to operate in the way they wish. For smaller FTTH projects it is less of an issue but with multiple partners or your own services to develop, there is potential for an awful lot of complexity which generally means large fees to IT consultants.

Complexity of Services: In addition to direct IT costs, there is a hidden cost of complexity faced by multi-service operators. As more services and more variations are added, customer support and billing become more complex, and the overall potential for errors goes up. For these reasons, the simpler the competitive environment you are entering, the easier it will be for your project.

Chapter 4: Services and Pricing

What services do you plan to offer over the network, and how much will you charge? These are key questions for all types of FTTH organisations, whether network owner, wholesale operator, retail service provider or some combination of these three. Even if your organisation does not plan to operate in the retail services layer, you will need to set up relationships with the companies that will.

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

Retail services can be divided up according to market segment:

- residential
- business
- carrier
- public sector

Residential

An increasing number of consumers are demanding reliable, high-speed broadband connectivity in order to access an expanding range of internet activities, including online shopping, online banking, school homework, catch-up TV services such as BBC iPlayer or Hulu, and many more.

Catch-up TV is an example of over-the-top (OTT) internet video services, because it is available to anyone with a broadband internet connection at no extra charge. This is distinct from broadcast IPTV services, which are provided by the retail service provider exclusively to its customers.

Typical residential services include:

- Basic telephony (using VOIP)
- High-speed broadband
- IPTV

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

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

In the context of a community network, the network owner may also wish to offer local services. For example, a housing association-owned network may offer a central system for booking landlord visits and building maintenance. A municipal network could offer free access to public services, or local TV broadcasting.

Business

Many large corporations are already hooked into fibre-optic networks because they have high bandwidth, high reliability and high security requirements that far exceed those of the residential sector. As a result of their special requirements, these large businesses are not usually linked directly to the same infrastructure as residential customers.

However, research has found that there is a considerable market opportunity to address the underserved lower end of the business market. Small and medium size businesses can easily be served from a typical FTTH network. Even if your network is consumer focused, it is worth considering whether to connect any businesses that happen to be within your coverage area.

The technical network requirements for businesses may not be substantially different for those for consumers, but you could consider offering service packages tailored to the business user, with extra features such as uptime guarantees, lower contention, and business-grade customer service. Speak to local businesses to assess their needs.

Carrier

Studies suggest that "open access" policies, which allow third parties to offer their services on the network, can enhance the business case, particularly if you are a new player in the retail market place. Getting established, respected internet service providers to offer their products over your network can be an effective means of increasing your overall market penetration. Therefore, if you plan to adopt the vertically integrated model, consider also opening up your network to wholesale customers.

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 a scalable and cost-effective mobile network architecture, especially since mobile base stations are often located on top of apartment and business buildings. Therefore, a further return on investment may be possible for the network builder who takes this added dimension into account.

Public sector

Don't neglect the public sector when drawing up your FTTH network plan. Schools, libraries, hospitals, doctors surgeries and local government buildings all require connectivity and have expanding requirements as more ICT is brought into the school curriculum, libraries become digital access points, doctors share patient records electronically, and governments put more public services online.

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.

As with many things, it is clear that one approach does not suit all situations. Broadband pricing is influenced by geography, demographics, competition and possibly regulation. Businesses and the public sector will generally support different pricing levels than retail consumers.

Many incumbents have run pre-launch market studies that tended to suggest that residential customers were only willing to pay a 10-15 percent 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 you collected during the market research phase to assess what the market wants and would be willing to pay for – these are not necessarily the same thing. Keep this information 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 what kind of services are currently offered; the attractiveness, relative profitability and technical requirements of these services; and the directions in which service providers are developing or envisage developing new services in the future.

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

- The *broadband-utility* strategy focuses on customer acquisition, with the aim of 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 customers is attained.
- The *keep-it-premium* strategy is about providing sexy new services at premium prices, to address a smaller customer base without cannibalising existing revenues. This kind of behaviour is often found at incumbent operators.

Market share

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 percent.

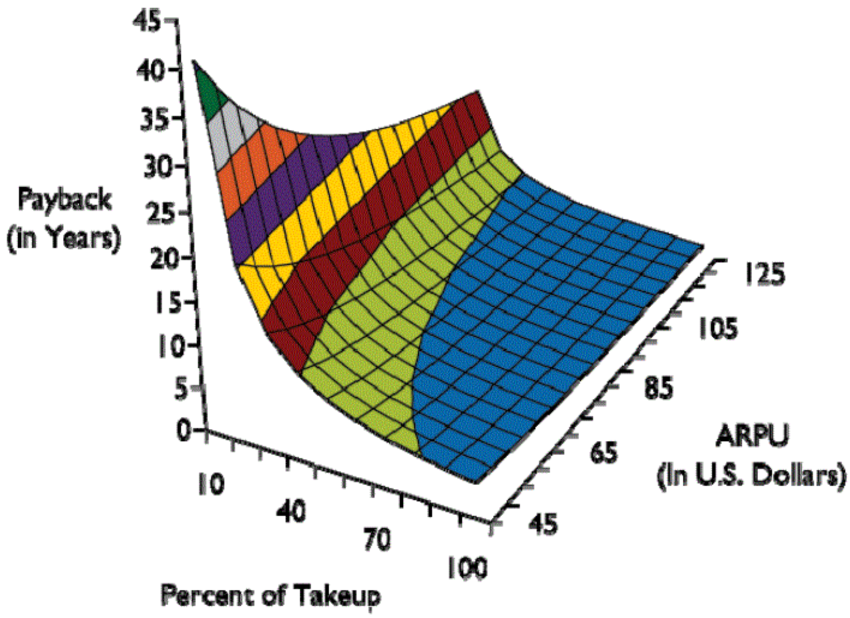


Figure 6: Undiscounted payback period with $1000 per home connected and 45 percent gross margin. Source: Yankee Group, 2009, webinar “Making that business model work”.

So how much market share is it reasonable to expect? Experience of FTTH operators indicates that first year penetration rates in areas with no fibre, cable or fast DSL competition can be as high as 50 percent, but conservatively 20-30 percent is perhaps more realistic. The final penetration in the same area might be as high as 70 percent, but again you have to estimate the realistic penetration and this will also depend on the ability and willingness to pay.

The competitive environment will be the major influence on the market share that you can expect to achieve. The maturity of broadband and triple-play local markets varies greatly across Europe. On the one hand, in Greece there is no cable television and ADSL only became widely available and affordable in 2008. On the other hand in Sweden there are many 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 that are not served by broadband clearly offer the best prospects; however, broadband "notspots" – 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 your addressable market by 50 percent – why should you expect to get more than your fair share of the market? In practise, you are likely to be competing for the unaddressed portion of the market, which is likely to be a harder sell – if they didn't want fibre from the first service provider, why would they want it from a second?

Back to basics

FTTH technology has inherently advantages when it comes to providing a range of new services, but don't get carried away. Getting the basics right – fast, reliable broadband – is a good way to secure customer loyalty. Broadband on its own is a profitable product – in fact it is the most profitable product for carriers, according to research.

One way to avoid mistakes that could alienate future customers is to run a trial. Limit your commercial launch to a beta test group that fully understands that you will be testing your services, and is prepared to expect the teething problems. Do not expand beyond your beta group until the system is up and running properly and has been thoroughly tested.

Chapter 5: Deployment

In this chapter we ask the all-important question, how much will the network cost? How much investment will be required to build the network, and how much will be required to keep it going? Expenditure falls into three main categories:

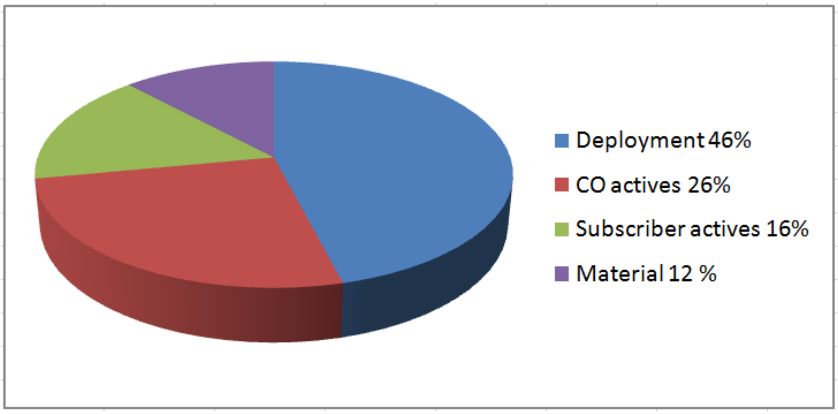
- capital expenditure (CAPEX) – big ticket items paid for at the start of the project, and during upgrades and extensions;
- operating expenditure (OPEX) – the cost of keeping the network running;
- cost of goods sold (COGS) – costs incurred when a sale is made.

In the following sections we consider the major influences on these items, and offer some general advice on how to reduce costs during network deployment.

For technical information on FTTH equipment and deployment please refer to the *FTTH Handbook*, which is available via the FTTH Council Europe website.

CAPEX

It is helpful to understand the relative contribution of each 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 are the most expensive item, and therefore offer the greatest potential for cost reduction – and also the largest variance between different situations.



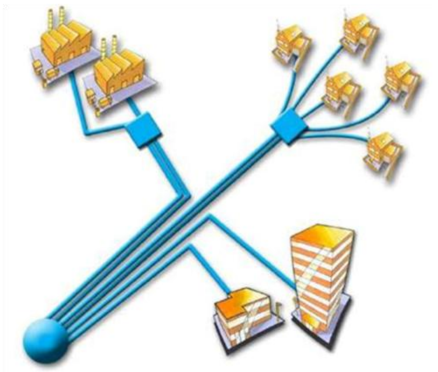
The other items are:

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

Network design

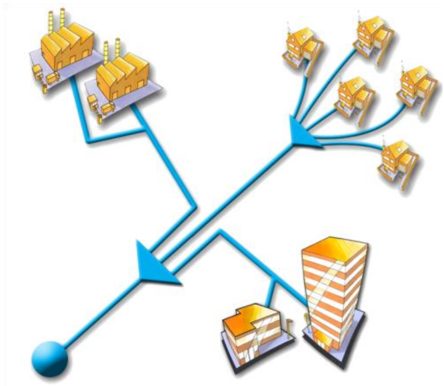
An FTTH network is a long-term investment. The anticipated lifetime of the cable in the ground is at least 25 years – that's the manufacturer's guaranteed minimum lifetime; the working lifetime is likely to be much longer. The active equipment will be upgraded in this timeframe, but it should be possible to reuse the infrastructure. With this in mind, it is worth considering a design for the cable plant that is capable of supporting different network architectures.

In terms of the cable plant, there are two main options for the topology of the access network: point-to-point and point-to-multipoint.



Point-to-point network

In a point-to-point (P2P) topology each end-user is served by a single fibre that runs all the way from the central office to the customer's home or office. This will probably consist of several sections of fibre joined with splices or connectors, but there is a single, uninterrupted optical path from the central office to the customer premises. This is sometimes referred to as a "home run" network.



Point-to-multipoint 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. In a passive optical network (PON) routing is accomplished optically using passive optical splitters. Splitters can be centralized or cascaded (not usually more than two).

Installation inside an MDU

The customer premises in either case may be a single residence, or a multiple dwelling unit (MDU) in which case active equipment may be installed in the building in order to aggregate traffic from all customers in the building on onto the single fibre.

Routing in a point-to-multipoint network can also be achieved electronically with Ethernet routers, in which case the architecture, rather confusingly, is called Ethernet point-to-point. Although the cable plant has a point-to-multipoint topology, each customer has a logical point-to-point connection. The end-user sends and receives only the data intended for them – there is no broadcast or time-sharing of customer traffic.

Several variations of the basic network architectures are possible. For example, some home-run networks have been deployed using two fibres from the central office to the subscriber. The first fibre delivers broadband, telephone, and customer-specific video services like IPTV and video-on-demand, while the second can be used for broadcast TV. This allows the network operator to take advantage of the inherent broadcast capabilities of PON equipment. If the second fibre is also deployed in a home-run topology, the PON splitter can be located in the central office.

Choosing the right network architecture often generates considerable debate. There is no clear winner; in today's market, different architectures suit different operator requirements, and it's important to be clear about your own requirements, business and technical priorities, and to ensure that you make a fully informed, balanced choice.

When designing a fibre network a common mistake is to save on initial costs by putting in fibre that corresponds with current requirements. Historically the need 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 bottlenecks in the future, either technical or commercial.

At the start of the project consider 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 lifetime of the network. If non-reusable ducts, direct buried cables, water cable, aerial cable or façade cables are considered, the lifetime of the network would decrease to the anticipated lifetime of the chosen fibre cables.

Active equipment

The POP is the FTTH equivalent of the telephone exchange, typically a small building or room where all fibre connections are terminated and connected to the active equipment. Inside the POP, you will find the optical distribution frames (ODFs), patch panels, the active equipment and the fibre test equipment.

The price of equipment in the POPs will depend on the chosen technology and vendor. As mentioned earlier, there is no simple answer to the question: which is best: point-to-point or PON? The best solution depends on a number of factors, including the price of equipment, planned services, projected customer take-up, and access to duct space, to name just a few. You must make careful evaluation of your specific network circumstances.

In general, modelling shows that point-to-point deployment costs are likely to grow in proportion with homes connected: equipment does not need to be deployed, powered, managed or maintained until there is a paying customer ready to take revenue-generating service. In contrast, the cost per subscriber in PON deployments decreases with subscriber density: as more customers are connected, the common exchange costs are increasingly shared.

Some other variables to consider include:

1. Space – P2P 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 customers using PON networks. However, since PON is a shared medium, businesses and other organisations with highly sensitive data such as hospitals may still 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 – and 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, the fact that the PON's high-speed transmitter must be powered even when there are only a few active customers on that branch of the network 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 customer, P2P networks can be tested from the central office, which saves 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.

Outside plant

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

Although there is always a fibre 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. If ducts are already in place for part of the route, then blowing fibre through them could substantially reduce the deployment cost over that length.

The lowest cost solution where there is no existing build is an aerial route, where power (or similar) poles are used to string the fibre between. This clearly plays into the hands of any utility companies that want to be part of a 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 can be done using a shallow digging approach called micro-trenching (at about twice the price per metre of aerial) or a deeper, full trench method (roughly doubling the price again at least).

The state of the existing pavements will impact these costs for digging. Where ornate paving is in place then 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 rights-of-way should also be taken in to consideration when choosing the route of the network. These costs consist of annual fees and costs to get permissions.

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 large apartment blocks will be the cheapest.

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

Aiming to pass as many homes as possible as quickly as possible is an uneconomical way of rolling out a network. Your business case would normally show that it is better to achieve good penetration in a limited area then to have lower penetration over a bigger area.

Housing density is so significant an element of cost that low density rural areas are unlikely to be viable candidates for fibre networks unless some form of government subsidy is available.

Potential improvements:

- duct renting if available
- aerial fibre – attaching fibre to poles
- façade fibre – stapling the fibre to the front of buildings, where allowed
- reducing the digging costs – train local contractors to do the work
- optimisation of network topology

Final drop

In addition to connecting along the streets, connections need to be made from the street to individual homes. The cost per customer will be dependent on the type of residences – whether stand-alone houses or MDU. Although MDUs are cheaper on a per customer basis, they also present specific challenges.

The costs of in-building cabling in MDUs 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 approach. You probably do not want to connect up every property with fibre on day one, unless it is a new build area. However, it may be more cost-effective to put micro-duct to every apartment in an MDU, allowing fibre to be blown in later as and when required.

There is also a cost for negotiating customer contracts. The worst case is where you have to agree terms with individual residents. This creates problems of getting everyone together at once or having to carry out several visits to gain agreement. This would be the case in some apartment blocks with particular types of joint care agreements in place.

The opposite extreme occurs where there is potential to negotiate with either a tenant's association or landlord who can 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.

Some costs are only incurred when new subscribers connect to the network, so these costs are proportional to the take rate of the services.

Potential improvements:

- involving customers in preparative work
- pre-ordering/mass connection initiative for initial rollout
- reusing copper cabling inside MDUs, for example, by terminating the FTTB network with a VDSL-DSLAM

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, because it boosts the value of their homes by significantly more. However, such schemes only work where a reasonable proportion of the 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 customer equipment is typically not available from retail suppliers, and so 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

FTTH planning software

Several suppliers now offer software packages that cover all aspects of building an FTTH network, which can help to save costs, and speed up the planning, construction and maintenance phases of an FTTH network.

The software combines computer aided design (CAD) with geographical information systems (GIS) to create a single integrated software package that covers the design and construction of the central office, outside plant and in-building wiring.

You should consider software that features the following three modules built around a common database:

- network design tool
- project and material management tool
- network registration and maintenance tool

This kind of software can be used to:

- estimate costs accurately before starting work
- plan and schedule every step so it follows on seamlessly
- scale manpower needs accurately and deploy people more efficiently
- reduce overall man hours dramatically and do more with fewer people
- reduce total engineering costs
- optimise costs at every stage in the network design, implementation and registration chain

The single, central database allows the entire project group, including contractors and local authorities, to work from the same, always up-to-date information.

OPEX

Typical items of operational expenditure include:

- communications license fees, if applicable (e.g. universal service)
- administration (office rental, vehicles etc)
- personnel (recruitment, training, salaries, etc)
- cost for rights-of-way
- running cost for POPs (rent, electricity, etc)
- backhaul connection
- customer acquisition and marketing
- network maintenance and troubleshooting

Rights-of-way

If you do not own all the land over which the FTTH network passes, then you will have to pay the land owner for the right to put your fibre cables into the owner's ground or into the owner's ducts. If you acquire the right by paying a lump sum, it will be categorized as a capital expenditure; alternatively, in the case where you pay a periodic rent (monthly, annual) it will be classified as an operational expense. In other words, rights of way can be treated as CAPEX or OPEX, but experience has shown that in most deployments it will be an operational expense.

Careful planning can have a positive effect on the costs associated with rights-of-way. For example, if you are paying rent to deploy fibre in third party ducts, you may be able to reduce your expense by opting for an architecture that uses fewer fibres or cables.

Backhaul

Don't forget to plan and budget for backhaul – your FTTH network needs to be connected to the rest of the world. The cost of this will depend on whether you own your own backhaul, lease fibre from another operator, or purchase a bitstream product – in other words buy only the capacity that your network uses. Unless you own your own fibre, backhaul costs will be an operational expense.

Bitstream costs for a fibre operator can be significant, depending on availability, local pricing, and the degree of competition. The challenge then is to estimate and cost the right usage per user, decide how much backhaul oversubscription (if any) you will allow, and decide whether you want to use a cap on usage – this is not an uncommon practise in regions with high IP transit costs.

It is not a good idea to have a single source of access for IP transit, in case of failure. Your second access point should be able to cope with 80 percent of your maximum traffic, even if this facility is not normally used.

Marketing

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

Where contracts can be agreed with landlords and/or tenant associations, the cost of sale is spread across 50, 100, 500 or more potential customers. If you have to try to sell to each individual tenant/home owner then you may need to use low-cost approaches (e.g. leaflets) as advertising may not be justifiable for the limited number of clients.

A shop in a roll-out area can be a good idea, depending on the size of your business and your potential customer base. Customers need to be made aware of the network roll-out, and it is useful to have a place where they can get information. The shop could provide information about the progress of the roll-out, as well as on the product-portfolio of the service providers that will be active in this area.

When wholesale fibre access is the main product, it is a good idea to develop some partnerships with operators and service providers ahead of the build if possible, because they will be your eventual "customers". The potential partners should also be used to guide the definition of interfaces and processes – some municipal fibre projects have failed because they built overly complex or inappropriate systems and failed to do business with service providers as a result.

Other fixed costs

Any business will have some fixed costs. In the case of an FTTH organisation there will be a substantial fixed element relating to central systems for provisioning new customers, billing, customer care and so on. This means that, where the potential number of customers is low, the disproportionately high level of fixed costs will make it difficult to make a sensible business case. Conversely, as the number of potential customers increases, the fixed central costs become less of an issue.

For a small operator the greatest impact may not be the cost of central systems but the cost of employees. Network organisations with fewer than five people are rare, although it is possible to operate in such a way. For most organisations the salary costs of staff imply a minimum viable network size.

If you are going to rent out the network to one or more established service providers that will do marketing, billing and customer care for you, then you must allow a suitable margin for them to cover these costs. However, established service providers are not generally interested in small special cases because it is more cost effective for them to go after the mass market. This is a real world disadvantage of small scale.

Chapter 6: Regulation

Make sure you understand the laws and regulations that apply in your country and at European level, because these will influence business decisions during FTTH project planning. Of course, laws and regulation apply to many diverse areas of business; here we will consider two topics of particular relevance to FTTH deployment: telecommunications sector regulation, and state aid.

Principles of telecoms regulation

The purpose of regulation is to address market failure, and introduce mechanisms to foster competition and innovation for the benefit of the consumer. Market failure can take many forms. A classic example would be a monopoly telephony provider offering a limited service at too high a price.

Until the 1980s, the telecommunications sector in Europe was exempt from competition law, with individual member states controlling their local market as they saw fit. Starting in 1988, however, the telecommunications markets were progressively liberalized, with the Commission removing policy measures taken by member states that granted exclusive or special rights to operators. Major steps were taken in July 1990, when services other than voice telephony were liberalized, and in January 1998, when voice telephony and infrastructure provision for voice telephony were also liberalized.

There are two main mechanisms for market regulation:

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

In contrast to the past, regulation in Europe is becoming more coordinated at European level. The National Regulatory Authorities (NRAs) of the member states must comply with relevant European directives and guidelines, including the Access Directive (2002/19/EC), the Universal Service Directive (2002/22/EC), and Guidelines on Significant Market Power (2002/C165/03).

Furthermore, an NRA is not able to decide by itself which market remedies are appropriate; instead its proposals must be submitted to the Commission for approval using an Article 7 procedure. This process is designed to avoid market fragmentation across Europe.

A further step towards more consistent regulation was taken on 25 November 2009, when the Body of European Regulators for Electronic Communications (BEREC) was established. This body, introduced as part of the new Telecoms Package, comprises the heads of 27 NRAs. BEREC's function is to develop and disseminate regulatory best practice, such as common approaches, methodologies or guidelines on the implementation of the EU regulatory framework.

Table 7.1 Overview of the obligations on NRAs

	SMP	No SMP	Universal Service Provider
Regulatory Framework Directive (Article 95)		• Facility sharing • Accounting separation • Possibility to impose compulsory standards	
Access Directive (2002/19/EC)	Menu of possible obligations to be chosen by NRAs: • Access at non-discriminatory conditions • Access at cost-based conditions • Transparency • Accounting separation Other conditions with prior agreement of the Commission.	Interconnection and interoperability of content, application and services, and associated facilities	
Universal Service Directive (2002/22/EC)	• Control on retail services • Carrier pre-selection • Leased lines	• Contract-transparency quality • Interoperability of TV equipment • Directories emergency numbers • Number portability • Must carry	Universal service obligation

The EU has defined seven product and service markets in which *ex ante* regulation may be warranted. Markets 4 and 5 are relevant to FTTH networks because they concern broadband (for a complete list of markets see Recommendation 2007/879/EC). Market 4 is wholesale infrastructure access, and market 5 is 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 (including shared or fully unbundled access) at a fixed location.	Market 4: Typically dominated by the former incumbent operator.	Market 4: Grant access to the physical path of the network.
Market 5: Wholesale broadband access.	Market 5: Not always 100% incumbent dominant (dependent on product definition and geography).	Market 5: A range of possible remedies include different levels of bitstream access, different pricing mechanisms, etc.

Where dominance is found, NRAs must apply at least one remedy. Remedies must be applied as high as possible in the value chain (further from the end-user) because wholesale regulation leaves more room for competitive entry into the market. Retail regulation is viewed as a last resort.

Remedies can include:

- 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.

It is possible for NRAs to deviate from the above list, for example, by imposing functional separation.

NGA regulation

In July 2009, the EU proposed a draft document *Commission Recommendation on regulated access to NGA networks*. The recommendations provide NRAs with a set of guidelines on how to regulate fibre deployment, including market analysis, whether operators have significant market power, and how to apply remedies. The second consultation period on the draft recommendations has now closed; the final Recommendation is due to be published in April 2010. This is a non-binding text, not a directive; however NRAs will be expected to apply the guidelines in their analysis of Markets 4 and 5.

Example: NGA Regulation in France

In November 2009, the French Competition Commission approved regulator ARCEP's draft decision and recommendation on the general terms and conditions for access to fibre-optic electronic communication lines.

For the purposes of FTTH regulation, ARCEP divided France into three zones, according to housing density:

- 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, and some public funding of FTTH may be needed;
- Zone 3: rural areas where the business case for fibre is challenging and a large amount of public funding is 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 customer 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 operator 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.

ARCEP also defines the cases where the local connection point for access to in-building fibre wiring can be located on private property. As a rule of thumb, the local connection point should be located outside the limit of individual private properties. Nevertheless, 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.

In the near future, ARCEP will be submitting its draft decision and recommendation to the European Commission and to the other authorities, before its publication and entry into force by the end of 2010.

Discussions about how to regulate 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, etc.

List of telecommunications regulators by country

Be aware that NGA regulation continues to evolve. Please consult your national regulator for up to date information about your country; a list of NRAs follows:

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
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

Country	Name of Regulator	Abbreviation
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

State aid

The European Commission has put broadband at the heart of public policy initiatives with the consequent benefits in terms of job creation and economic prosperity. This creates an opportunity for private sector partners to work with local and regional authorities to create fibre networks, but also means that those authorities must be diligent about working in harmony with the EU rules on state aid – the penalty can be a refund of all aid granted, plus interest.

The objective of state-aid control is to ensure that government interventions do not distort competition and intra-community trade. State aid is defined as an advantage in any form whatsoever conferred on a selective basis to undertakings by national public authorities. The EC Treaty pronounces the general prohibition of state aid. However, there are exemptions for a number of policy objectives, for which state aid can be considered acceptable.

Viviane Reding, Commissioner for Information Society and Media (2004-2010), has said: "Deployment of broadband may be hampered by market failures in rural and remote areas. In such cases, well-targeted state aid may therefore be appropriate...”. Projects that have benefited from EU support include the clearance for the Welsh Development Agency’s FibreSpeed project in Wales in early 2006, and the “Broadband for Kärnten” project in Austria.

In September 2009, the European Commission formally adopted guidelines on the application of EC Treaty state aid rules to the public funding of broadband networks. The guidelines set out the basis for past practice and how the rules will be applied in the future. The aim is to boost investments in NGA networks, while allowing public support for deployments in areas with market failure.

One of the key ideas introduced in this document is that of geographically differentiated regulation. The guidelines define white (unserved), grey (private monopoly served) and black (multiple private infrastructures) areas for NGA networks. As a rule of thumb, state aid is acceptable for white areas, possibly acceptable in grey areas, and not allowed in black areas.

The document also refers to the principle that public investment in a private venture under market conditions is not considered to be state aid – this is known as the Market Economy Investor Principle (MEIP). This rule was applied when the Commission approved the Citynet project in the Dutch city of Amsterdam.

From the point of view of an FTTH network project, early consideration should be given to the following factors:

- Is there a market failure? The key test at a basic level is that of duplication: would the FTTH project duplicate equivalent assets already provided by the private sector?
- Procurement – private sector partners should be selected through rigorous advertising and procurement procedures with clearly defined criteria.
- Profit share – public/private venture should share profits in the same percentage as funds are provided by the partners.

Chapter 7: Finance

Fibre projects are by their nature capital intensive infrastructure projects and so payback periods are rarely less than five years – often much longer. This means that financing is of central importance to any fibre project. Finance is a large subject, however, there are some very clear aspects of finance that are vital to creation of a business case for FTTH-based businesses.

The development of a business case for a new operator, business unit or product/service has clear, if complex, inputs. To set the business up, you will need to invest money in capital expenditure (CAPEX) to build the infrastructure, and connect up the network, and use working capital to pay for operating expenditures (OPEX) such as wages, office costs, and so on. In return, you expect to generate revenues and ultimately, after covering operating costs, to generate profits and a return on capital.

Other chapters in this book cover estimation of the different elements of CAPEX, OPEX and revenues. However, in this chapter we will briefly discuss the types of finance typically used in FTTH projects, and then in more detail explain how to use your estimates and projections to provide the important answers that shareholders, boards and bankers need. They want to know if the projected business case will be profitable and whether it is worth investing in. That's a simple question – answering it can be a little more challenging.

Types of finance

To those unfamiliar with banking terms the array of financing solutions can at first seem bewildering and details can vary greatly between countries. In this section we discuss the basic concepts and solutions to provide a roadmap for general managers or other non-financial executives considering an FTTH project.

At its simplest, capital invested (as opposed to being granted by government) in a project will be equity or debt, or may be a hybrid of the two, called mezzanine.

Equity represents ownership in the company. Investors buying shares in the company put their money at risk – if the business fails they generally get nothing back. Start-up projects are generally funded in this way, and shareholders expect a higher rate of return than lenders because of the extra risk they take. Financing a project entirely with equity would therefore be extremely expensive.

Shares can have different classes so that some shareholders have more voting rights (control) than their raw financial contribution would suggest.

Venture capitalists will claim to provide equity but in reality they provide debt which they convert to shares if a company is a success. They do this in order to have first claim on the assets of the company if it fails; their investment is repaid first before other ordinary shareholders get a return on their money.

As its name suggests, mezzanine capital lies in between debt and equity. In practical terms this is achieved contractually by a combination of a loan and some equity or claim on equity in the future (like a warrant or similar technique).

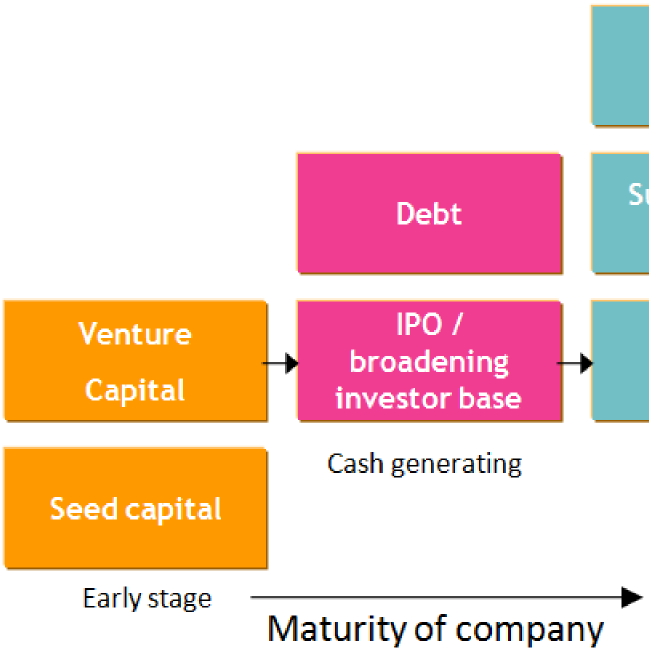


Figure 7: The availability of different types of finance will change over time.

If mezzanine risks were taken purely with a loan, the interest payments would probably be prohibitively high and ultimately impossible for the company to make. Often therefore the interest is paid in kind (PIK loan) by means of issuing new equity (shares, warrants or some equivalent means) or may be rolled up in the loan balance or by a combination of these two approaches. Smaller companies or riskier projects tend to use mezzanine funding; nevertheless it is a potentially useful method of meeting part of the capital cost of an FTTH project particularly in the risky early stages before there are significant revenues.

Debt is money loaned to the business with a reasonable expectation that it will be returned with interest in the future. In order to have that reasonable expectation either the business must be already established and generating cash, or be close to proving that it will generate cash with which to repay the loan or a parent company. Alternatively, another party with adequate assets or stable cash flow must guarantee the loan.

As less risk is taken, debt is cheaper than equity. This does not mean a project should be funded with too much debt however. If the business runs into a short-term problem and cannot make a specific repayment lenders can, if nervous, put the company into bankruptcy and take the assets, wiping out any shareholders and probably replacing the managers.

There are different types of debt depending on the level of risk taken and their position in the queue for loan repayments in the event of liquidation. Senior debt has a better position (and therefore costs less) than junior or subordinated debt. High-yield debt (formerly called junk bonds) attract a higher rate of interest than other types of loan because they are issued by companies of lower quality and/or have fewer protections than other forms of debt.

With this in mind, there are several basic types of financial approach for FTTH:

1. An incremental network extension by an established telecom, cable TV operator or energy utility – these are financed internally using general corporate resources and this approach is not discussed here;
2. A major new build (or upgrade from copper) by a smaller operator relying primarily on private finance in a mix of debt and equity;
3. Public-sector owned (typically by an existing State corporation or by a new special purpose vehicle , i.e. a type of government-owned “company”);
4. Public/private partnership (PPP) which is in effect a consortium between the State and private companies and banks in which the government guarantees future revenue or other payments in return for the private sector building and often operating the project;
5. Grant- or soft-loan-aided development project in which a private company or consortium owns and executes the project and is simply given or lent money on very generous terms (possibly unsecured) by the State to encourage them to carry out the project.

The first and last methods of State finance above are self explanatory, although in practical terms obtaining funding will involve many complex hoops through which a management team must jump. The PPP option is discussed in more detail next.

Public-private partnership

Given the considerable potential for economic regeneration or development that fibre offers, public authorities are frequent funders of FTTH projects. There are various schemes – local, regional and European Union funds – and the range of options can mirror the private sector in terms of complexity. In essence, public funding steps in where there is an insufficient economic return.

In the European Union there are explicit rules (the State Aid Rules) which define and seek to limit the circumstances in which public money can support fibre projects. The underlying goal is to restrict public finance to those areas where the private sector will not build or operate unaided. Despite this, public investment in wealthy urban areas is still allowable under the rules but with certain caveats, principally that the public sector investor must earn a commercial rate of return even if the period of time is perhaps longer than a bank or similar private investor would accept for projects of this type.   However, in such a case the rules also require that the State is a minority provider of finance – probably best achieved by using a structure such as a PPP (public private partnership).

PPPs developed as a way for the private sector to fund capital projects in return for a guaranteed future revenue stream from government. In essence public debt is replaced with private debt that will make a more or less guaranteed return over several years. In build and operate PPPs, the contract may be tied to the construction and also possibly operation of a major capital asset. The original idea was that the private sector would be better at building on time and to budget than the public sector and would have a clear profit incentive to do so. Hospitals, bridges and many other such projects have been funded using PPPs.

As the examples suggest there are many different configurations of PPPs and there is no single solution – each deal is structured and negotiated on its merits. However, the basic feature is that the State has to guarantee future revenue. It is that future income stream which enables the private sector to fund the construction, and possibly operation, of the project.

In FTTH projects a common approach is to define an “availability payment”, which is money paid regularly to the project when it has been built and put into service. If revenue from customers grows, the availability payment is reduced using a pre-defined formula. An agreement may even provide a reverse payment or revenue share to the public sector sponsor if the project is more successful than expected.

The advantage for the public sector is that cost of the project is funded out of future budgets rather than current capital budgets. The cost is the premium for risk and the required return that is given to private sector financiers funding the construction. PPPs also tend to be complicated to set-up and administer and this can make them costly.

Key performance indicators

There are a number of measures that are used in finance to look at a set of cash flows (money out and money in). We will begin by describing these relatively simple measures.

Payback is a very simple and commonly used measure. Let's consider a simple example. In year 1 the company will invest €10,000 in the project. From then on the net difference between the money out (expenditure) and money in (revenues) provides a cash flow result in each year as shown below:

	YEAR						
	1	2	3	4	5	6	7
CASH FLOWS	-10,000	2,000	2,500	2,500	3,000	3,000	3,500

Payback tells you how long it is before the initial investment is matched by the cash flow in. To calculate the payback, you simply work out the cumulative cash flow from the start of the project to each particular year as shown:

	YEAR						
	1	2	3	4	5	6	7
CASH FLOWS	-10,000	2,000	2,500	2,500	3,000	3,000	3,500
CUMULATIVE TOTAL	-10,000	-8,000	-5,500	-3,000	0	3,000	6,500

The cumulative total remains negative until year 5 when the total positive cash flows equal the total cash out. The payback period is therefore five years in the example above.

If the cash flow goes negative in some years, the approach does not change. You still look for the year (or month in a more detailed analysis) that the cumulative positive cash flow is greater than the cumulative total of negative cash flows.

Payback is sometimes used as a quick check on a project, but it does have drawbacks. First, this approach essentially ignores all cash flows after the payback period. This may not seem a problem at first but if, in the example above, there was a large cash outflow in year 6, the payback measure would ignore it.

Second, the payback method does not consider the cost of money, such as the interest rate on a loan. For example, if a company invests €100 million in a project and does not receive pay back for 20 years, then that is not as good an investment as if they put the money into a bank and received interest on it.

Discounted cash flow

To get around one of the weaknesses of payback, it is possible to modify the cash flows to reflect the cost of money. First let's explain the idea of a discount rate.

In one year's time, if you invested €100 in a project and it gave you a 10% return, you would have €110. A discounted cash flow works in reverse by calculating the value of a future amount to you today. Therefore, €110 in a year's time at 10% discount rate is the same as €100 today.

If the return you could expect on an investment today is x %, then you can calculate the equivalent of a future sum at today's value. €110 in one year's time is the same as €110/(1 + x%) today, where x is the discount rate, which is 10% in this example.

The discount percentage is selected to include two factors:

- A risk-free return element, which reflects the increase in value if the money was placed in the lowest risk place possible – long term government bonds. That rate of return is low because risk is low.
- A risk premium – the return in excess of the risk free element that an investment is expected to yield. Not every project is guaranteed to succeed. Investors will expect a higher rate of return when an investment is considered to carry more risk.

The above example showed an amount in one year's time. If we invested money for two years then the increase in value would be (1 + x%).(1 + x%). So if the potential growth in the value of investing €100 (including a risk premium) is 10% per annum, the €100 is equivalent to receiving €121 in two years.

The generic formula that can be applied for any year (n) is simply:

$$discounted\ cash\ flow = \frac{cash\ flow\ in\ year\ n}{(1 + x\%)^{n-1}}$$

Note: the current year should be year 1 for the formula to work correctly.

This formula can be used to modify the cash flow in any year. So, to create the discounted cash flow, we take the cash flows we had before and apply the formula to the net cash flow (positive or negative) in each year.

Discount Rate	10%						
	YEAR						
	1	2	3	4	5	6	7
CASH FLOWS	-10,000	2,000	2,500	2,500	3,000	3,000	3,500
CALCULATION	-10,000/ $(1+10\%)^0$	2,000/ $(1+10\%)^1$	2,500/ $(1+10\%)^2$	2,500/ $(1+10\%)^3$	3,000/ $(1+10\%)^4$	3,000/ $(1+10\%)^5$	3,500/ $(1+10\%)^6$
DISCOUNTED CASH FLOW	-10,000	1,818	2,066	1,878	2,049	1,863	1,976
CUMULATIVE DCF	-10,000	-8,182	-6,116	-4,237	-2,188	-326	1,650

The discounted cash flow (DCF) line shows the values adjusted with the given discount rate of 10%. As with payback, we can look at the cumulative total of the discounted cash flows. In the table above, the cumulative total only goes positive in year 7 – as opposed to year 5 using straight payback.

This discounted payback is superior to the straight payback method because it reflects the returns that could be obtained "risk free" as well as a risk premium – the extra that makes it worthwhile doing the project in the face of the fact it may fail to deliver the desired results. However, discounted payback still ignores cash flows after the end of the payback period.

Net present value

The discounted cash flows themselves are the basis for another calculation that is very commonly used and is more useful – net present value or NPV. The NPV of a series of cash flows is a single number calculated using a given discount rate on a set of cash flows. It is simply the addition of all the discounted cash flows for a project. In the example above, it is very easy to create the NPV as a final step.

Discount Rate	10%						
	YEAR						
	1	2	3	4	5	6	7
CASH FLOWS	-10,000	2,000	2,500	2,500	3,000	3,000	3,500
CALCULATION	-10,000/ $(1+10\%)^0$	2,000/ $(1+10\%)^1$	2,500/ $(1+10\%)^2$	2,500/ $(1+10\%)^3$	3,000/ $(1+10\%)^4$	3,000/ $(1+10\%)^5$	3,500/ $(1+10\%)^6$
DISCOUNTED CASH FLOW	-10,000	1,818	2,066	1,878	2,049	1,863	1,976
NPV	1,650						

The NPV is 1,650 and is the sum of the DCF figures calculated in the line above. Please note that this example ignores the benefit of any expected cash flows after year 7 which, as fibre lasts many years, could be considerable.

The basic conclusion that can be drawn with this figure is that if it is greater than zero, the project is worth executing. If it is less than zero the project is not.

This approach does assume that money to invest is not in short supply and there are no alternative projects. If other projects are candidates for investment then the NPV of each should be compared and consideration made of which individual or combination of projects would provide the best return.

However, in the context of your single, unique FTTH-based project, the NPV provides a good reference value for different scenarios. Investors and bankers are likely to ask for sensitivity analyses that reflect what may happen in the business, e.g. subscriber take up is 10 percent lower than expected. The NPV of this new scenario compared to the original will then show if this change in prospects for the business is serious or not.

Internal rate of return

The Internal Rate of Return (IRR) is almost the reverse of the NPV process. It represents the discount rate that would be applied to create a net present value of zero. As stated previously, if the NPV is positive then in simple terms, the project is worth considering and, if the NPV is negative, the project should be dropped, or substantially changed. The point where the NPV becomes zero is an important.

In addition, if you can earn a particular return from an investment, then this can be compared to the IRR of a project. A high-risk project with an IRR of only 6% does not seem very attractive compared to putting money into a very safe investment with a return of 5.5%.

The table below shows three different cash flows and their respective IRR:

	YEAR						
	1	**2**	**3**	**4**	**5**	**6**	**7**
CASH FLOWS	-10,000	2,000	2,500	2,500	3,000	3,000	3,500
IRR	**15%**						
CASH FLOWS	-10,000	2,500	2,500	3,000	3,500	3,500	3,500
IRR	**19%**						
CASH FLOWS	-10,000	3,000	3,500	3,500	5,000	5,000	5,000
IRR	**30%**						

Often, the value of the IRR cannot be found analytically. In this case, numerical methods or graphical methods must be used. One thing to be careful of with the IRR is that, if the cash flows start negative, turn positive and then go negative again, there will be two values for the IRR.

EBITDA

Variations in accounting practices in different countries sometimes make it difficult to compare performance between different companies. Earnings before interest, tax, depreciation and amortisation (EBITDA) is useful because it is a simple measure that eliminates most, if not all, of the geographic differences between how companies are treated.

EBITDA is calculated as the revenue that remains after direct costs have been removed, but before interest, tax, depreciation and amortisation (the reduction in value of intangible assets) have been deducted. EBITDA is also referred to as operating cash because it is the money that the business generates.

EBITDA itself is not that interesting a measure for comparing companies directly, because the size of the companies being compared will affect the EBITDA numbers. However, the EBITDA margin (calculated as EBITDA/sales) is frequently used to benchmark companies and also to assess business plans.

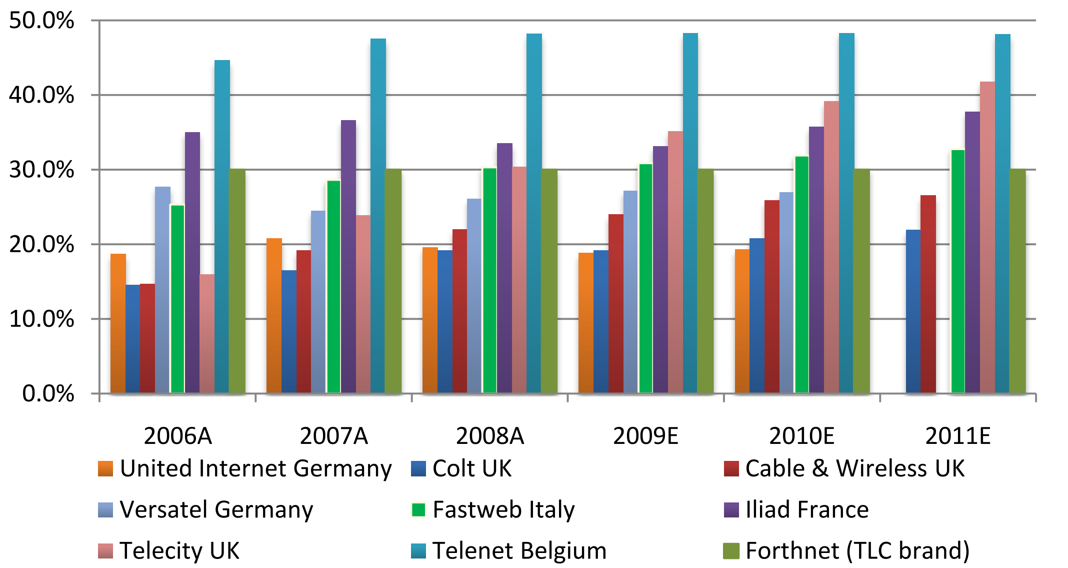


Figure 8: EBITDA for some telecoms firms. Source: Reuters Consensus, oncubed.tv and Ventura Team.

One thing to bear in mind is that you may be creating a new business and this should be able to perform better than some existing operators that have the handicap of legacy networks and business practices to deal with. Do not be afraid to do better than a benchmark but be aware that boards and, in particular, analysts and bankers will want to know very clearly why you are going to do better than a company for whom they have a benchmark.

If you are targeting an EBITDA margin of 90percent for a vertically-integrated FTTH business then, unless you have some incredible advantage, this figure is likely to be too high (see the comparative chart for some real world figures). If your business case suggests only 10 percent then you need to think very hard about whether the venture is worth doing. Even a minor problem for the company could wipe out that 10 percent and leave the company with an operating loss, and that's before other factors like depreciation are taken into account.

Free cash flow

Free cash flow (FCF) represents the cash generated by the business once it has paid for ongoing operations and growth. The following shows how to derive the FCF. Don't worry if you don't understand every step – that's why companies employ finance people. However, it is useful to understand the use of FCF which we will discuss later.

		Year 1	Year 2	Year 3	Year 4	Year 5
EBITDA	A	17.3	206.6	382.0	476.2	477.0
Change in Working Capital	B	59.1	(-5.7)	(-9.6)	(-19.7)	(-38.5)
Taxes Cash Out	C	(-12.8)	(-12.6)	(-37.7)	(-42.5)	(-34.4)
Cash Flow from Operations	**D** = A + B + C	**63.6**	**188.2**	**334.7**	**414.1**	**404.0**
CAPEX	E	(-499.8)	(-598.5)	(-656.0)	(-571.1)	(-262.4)
Intangible Assets	F					
Financial Expenses	G	0.0	(-15.0)	(-42.8)	(-43.1)	(-56.3)
Capex & Financial Expenses	**H** = E + F + G	(-499.8)	(-613.5)	(-698.7)	(-614.2)	(-318.6)
Free Cash Flow	**= D + H**	(-436.2)	(-425.3)	(-364.0)	(-200.1)	85.4

Figure 9: Free cash flow calculation.

Letters in the second column indicate the simple mathematics being used.

Free cash flow (FCF) starts with the EBITDA figure for a given year and then adds the impact of changes in working capital derived from:

- changes in accounts receivables (year on year) plus
- changes in VAT (Value Added Tax) receivables (year on year) less
- changes in current liabilities
- taxes (cash out)

The company needs to build its operations so we need to consider the CAPEX needed to create a network, build a network operation centre (NOC) and so on. To fund this CAPEX, there are likely to be financial expenses to pay.

In the example calculation, the free cash flow figure starts off very negative – reflecting the fact that the business is not generating much cash but is spending heavily on CAPEX. Over the years, the FCF figure becomes less negative (as revenues and hence EBITDA increase) and CAPEX falls significantly in year 5.

Valuing the business

We will confine this discussion to how a fibre business might be valued.   There is a significant difference of course between valuing an established business with customers and cash flows and in valuing a franchise, licence or similar undeveloped opportunity.

For an established operation several approaches are possible:

Approach 1: scrap value	Scrap value can be thought of as the "sum of the parts" value of the components of a project if the individual elements were sold off piecemeal for scrap or re-use elsewhere. This is the worst case scenario of course, so will provide the lowest valuation
Approach 2: Going concern	If a network has been built and is in operation the business it may attract a buyer as a going concern. Going concerns are valued using certain well established methods and we believe the three alternatives below are appropriate for FTTH: • *Comparable transactions*: In any market the best indicator of value is the actual price recently paid for an identical asset. In the market for corporate ownership of course it is rarely the case that two businesses are effectively identical. Nonetheless it is established practice to use the prices paid for similar or analogous companies as benchmarks for the valuation of a going concern. • *Discounted cash flows*: DCF provides the bedrock for any valuation opinion. In valuation theory, the buyer would be willing to pay a sum equivalent to the net present value of future cash flows from the project. • *Capitalisation of income*: This is a simplistic method which simply takes present value of future income to provide a guide to the sale value (using an appropriate discount rate).
Approach 3: historical	In the absence of a sale or other market transaction to set a value, accountants often rely simply on historical cost as the best basis for a valuation. As a potential investor or purchaser of a fibre project you should understand the historical cost and take a view whether it was high or low depending on the efficiency of the original promoters but it is really irrelevant for setting a current value.

Of the above, the preferred method is discounted cash flow (DCF) analysis. When carried out correctly, this gives the best guide because it takes the future potential of a project and discounts that value back to the present using a rate set to reflect the cost of money and the risk of the project.

In reality many FTTH projects are highly dependent on their terminal value and this is itself dependent on a few key assumptions, including the level of continuing annual cash flow – which is a function of projected long term revenues and all the different costs – the growth rate of those cash flows and the discount rate chosen, which is largely a matter of judgement. Valuation is more of an art than a science.

Terminal value

The assets will continue to be capable of generating revenue beyond the period of the business plan. It is pointless to try to project every part of the detailed business case assumptions forward over 25 years (fibre lifetime) or even 40 years (duct lifetime). However, you do need to take account of these revenues when generating a valuation for the business.

Forecasting the cash flows in the next 10 years can involve a certain amount of creativity. The single value that represents the future cash flows (in and out) is called the terminal value. There are several ways to calculate this and we will consider one using a perpetuity calculation. This method adjusts the free cash flow from the final year and multiplies it up to create the perpetuity value. This final figure will be applied in the year after the end of the main plan. In other words, in a 10 year plan, this value will be for year 11.

The adjustment to FCF is that the CAPEX in that extra year is set to be equal to the tangible assets. This is a simple way of removing the impact of depreciation. The table below shows the same derivation of free cash flow as above but also shows the year 11 figures. Years 6 – 10 are hidden.

		Year 1	Year 2	Year 3	Year 4	Year 5	*Year 11*
EBITDA	A	17.3	206.6	382.0	476.2	477.0	*787.2*
Change in Working Capital	B	59.1	(-5.7)	(-9.6)	(-19.7)	(-38.5)	*0.0*
Taxes Cash Out	C	(-12.8)	(-12.6)	(-37.7)	(-42.5)	(-34.4)	*(-87.6)*
Cash Flow from Operations	D = A + B + C	63.6	188.2	334.7	414.1	404.0	*699.5*
CAPEX	E	(-499.8)	(-598.5)	(-656.0)	(-571.1)	(-262.4)	(-223.6)
Intangible Assets	F						
Financial Expenses	G	0.0	(-15.0)	(-42.8)	(-43.1)	(-56.3)	*(-67.5)*
Capex & Financial Expenses	H = E + F + G	(-499.8)	(-613.5)	(-698.7)	(-614.2)	(-318.6)	*(-291.1)*
Free Cash Flow	= D + H	(-436.2)	(-425.3)	(-364.0)	(-200.1)	85.4	*408.5*

Figure 10: Adjusted free cash flow.

Now there is a value for the free cash flow in the year after the end of the plan. The next step is to convert that value to a figure that represents the value to the business if that same FCF total in year 11 (above) continued year after year. The cash flows will grow slightly over time and so a growth rate is applied.

This is typically only a few percent maximum. It is common practise to apply several different values for the growth rate to show how results might vary. For example, you might use 2%, 2.5% and 3%.

The perpetuity value is calculated as follows:

$$Perpetuity\ value = end\ year\ FCF \times \frac{1 + growth\ rate\ \%}{discount\ rate - growth\ rate}$$

With a growth rate of 2.5% and a discount rate of 12.5%, the perpetuity value would be 10.25 times the adjusted free cash flow for the extra year.

The perpetuity value is a long way into the future (11 years ahead for a ten year plan) and so will be heavily discounted. At a 10% discount rate, it would be reduced to 42% of the full value. At 20% it would be discounted to less than 20%.

However, the numbers above show that the perpetuity value calculation creates a large number and even the impact of discounting does not prevent this value having a significant impact on the NPV of the project.

The terminal value of the project is calculated by calculating the NPV of the free cash flows over the life of the business case along with the perpetuity value (taken as a representation of future free cash flows after the period in the business case). The perpetuity value is discounted from the year after the detailed business case.

Similarly the IRR over the life of the project can be derived from the sum of the free cash flows, including this final perpetuity value.

Improving the business plan

The NPV and IRR numbers have now been created but remember that they represent the numbers for only one view of the business. The results that you find from all the assumptions, including the CAPEX and OPEX calculations, the market estimates, the take up rates and so on, may not be acceptable. This is not necessarily a problem however. Project plans rarely look good when all the elements of the plan are assembled for the first time. You almost certainly need to iterate through different versions of the overall business case until you get something that offers the right blend of investment to return.

If we assume that eventually a viable scenario can be found with the right type of financial results, then it is still vital that your business plan enables you to create iterations. These will include changes to assumptions to demonstrate that the business case is robust. Typical changes might include:

- slower deployment than expected
- lower subscriber penetration than expected
- CAPEX higher than anticipated

A further suggestion is that when the business case is relatively stable, you should note down key metrics with every change that you make. Investors commonly ask for an explanation of why one set of figures has changed. If you carefully note down the impact of every change once the business plan becomes public, then you can talk people through the steps that have created the differences in IRR, NPV, peak funding requirement, and so on.

It is a good idea to pace deployment with available capital. Splitting the project into phases avoids the need to raise all the capital at the start of the build-out. Having identifiable targets at the end of each phase can help to reassure investors that their money is being spent wisely.

Finally, remember that the success of a network – in the eyes of investors and shareholders – will be measured by cash flow generated. To achieve optimum cash flow the design of the network should be commercially not technically driven.

Arcadis NGN model

The FTTH Council Europe considered creating a generic business model for FTTH networks, but discovered that several were already available, including at least one in the public domain. This was put together by Dutch consultants Arcadis at the request of the Ministry of Economic Affairs in the Netherlands.

Arcadis was asked to investigate the costs of connecting and operating the active and passive network layers in an FTTH network. Two generic models were produced, one for the business case and the other for operating costs, which are available on the internet at http://ngn.arcadis.nl/ (in Dutch only). A report describing the input parameters and calculations in the model was published at: http://www.nederlandbreedbandland.nl/uploaded/FILES/rapport_aansluit_netwerkkosten_ez.pdf (also in Dutch).

The user can change any of the input values to the model including, for example, the cost of equipment, the relationship between debt and equity, and how the expected penetration rate will evolve. If certain costs are not known, the user can choose to use a default value in the calculation, but bear in mind that these generic values were worked out in 2005, and costs may have changed. The results are presented in a number of charts delivered as an Excel file.

Chapter 8: Case Studies

The following case studies provide some insight into the business case for fibre. We have selected a variety of FTTH operator models, in order to illustrate how different business strategies and operator models have been applied in the real world. These examples include an incumbent operator starting its first FTTH network deployment in its country, a utility company that has installed fibre alongside its own infrastructure, an owners association bringing fibre to an existing apartment block, and a regional fibre network built through collaboration between local authorities and private companies.

The FTTH Council Europe would like to assemble a library of FTTH case studies. If you are willing to share your story, please contact the FTTH Council Europe.

Case study 1: Makedonski Telekom (Macedonia)

Network owner: Makedonski Telekom
Operator model: vertically integrated
Financial model: corporate resources
Year started: 2009
Network size: 28,000 homes passed and 7,000 subscribers by the end of 2010

Makedonski Telekom, the incumbent operator in Macedonia, is the first company to begin commercial FTTH rollout for residential customers in Macedonia.

The decision to deploy FTTH was prompted by a number of factors, the operator says, including the growing bandwidth requirements of customers, the desire to make the network ready for future needs, an expected reduction in operational expenses, and the possibility of consolidating central offices.

The upgrade to fibre is also a response to competitive pressure: in the capital city of Skopje triple-play packages are on offer from alternative operators using ADSL2+ and from cable TV service providers. Makedonski Telekom wants to be able to offer new services and compete more effectively in the broadband market. The company believes that the first FTTH operator to enter a market or region will have a first-mover advantage and will be able to achieve a higher penetration rate.

The FTTH pilot project began in 2008 when fibre was installed to 120 households and businesses in four buildings in the downtown area of capital city Skopje. The users in the pilot scheme did not have to pay for their connections, in return for providing detailed feedback on their experiences. By the end of 2008, 38 households and businesses were connected to the pilot FTTH network, testing voice-over-IP (VOIP), high-speed internet and IPTV services.

Feedback from test users in the pilot project indicated a greater level of satisfaction from high-speed Internet and IPTV services over FTTH than over other access technologies. The project also allowed Makedonski Telekom to gain valuable experience in the deployment and operation of a FTTH network.

Following the success of the FTTH pilot project, Makedonski Telekom began commercial FTTH rollout based on GPON technology in September 2009. The rollout is currently focused on selected, high population density areas in Skopje. The operator plans to cover around 28,000 households and businesses with FTTH installations by the end of 2010, and around 7,000 are expected to become commercial FTTH subscribers.

Commercial sales of the FTTH-based services began in December 2009, with triple-play (VOIP plus high-speed internet plus IPTV, including HDTV and HD VoD), double play (VOIP and high-speed internet) and high-speed internet services for residential customers, and double play and high-speed internet services for business customers.

The access speed for the FTTH-based internet services is up to 40Mbps symmetrical for residential customers and up to 60Mbps symmetrical for business customers, compared to Makedonski Telecom’s current DSL-based services offering up to 10Mbps/ 768Kbps (download/upload) for residential customers and up to 16Mbps/ 1Mbps (download/upload) for business customers. The incremental monthly fees for the FTTH-based Internet services, above the current DSL-based services, are approximately €5 for residential customers and €10 for business customers, not including 18 percent VAT.

As a subsidiary of Magyar Telekom, which itself is owned by Deutsche Telekom, Makedonski Telekom benefits from a common DT Group procurement policy for FTTH equipment. The DT Group selects FTTH equipment vendors at a group level, and DT business units use the same FTTH equipment from the selected vendors.

Having a common FTTH procurement policy allows the DT Group to obtain volume discounts that no individual business unit would achieve on its own. Using the same FTTH equipment also makes it is easier to spread learning and best practices among DT business units. Apart from Makedonski Telekom in Macedonia, Magyar Telekom in Hungary and Slovak Telekom in Slovakia, both members of the DT Group, have also begun commercial FTTH rollout.

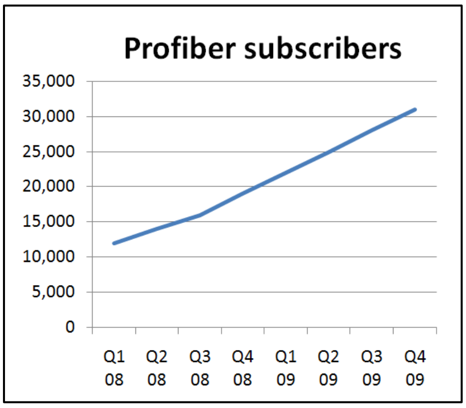
Case Study 2: TRE-FOR (Denmark)

Network owner: TRE-FOR
Operator model: active sharing
Financial model: co-operatively managed utility company
Year started: 2004
Network size: 70,000 homes passed at end 2009

TRE-FOR is a utility company owned by the 125,000 inhabitants of the Southern Danish Triangle Region, a prosperous and economically fast-growing area around the towns of Kolding, Fredericia, Middelfart, Vejle and Vejen. TRE-FOR is the main supplier of electricity and water in the region.

In common with other Danish utility companies, TRE-FOR has been installing fibre networks alongside underground electricity cables. TRE-FOR Broadband was created in 2004 to exploit these existing fibre assets, with the aim of connecting all households in the region with fibre.

TRE-FOR Broadband sells a range of services through a self-service portal under the brand name Profiber. To provide economies of scale, TRE-FOR Broadband has teamed up with two other utility companies with fibre networks, NRGI and Ostjysk Energi, who sell services using the same brand and portal.



The Profiber co-operative has passed 110,000 homes in total, and had around 31,000 subscribers at the end of 2009.

TRE-FOR Broadband's network is the largest of the three partners, passing approximately 70,000 homes. The company has succeeded in achieving penetration rates of 80 percent in certain locations, claims Helle Damm-Henrichsen, Director TRE-FOR Broadband.

The strategic aim is to differentiate on quality, by offering a speed guarantee for high-speed internet, crystal clear TV picture and low-cost telephony. Customers do not pay to rent the connection; all revenues come from service subscriptions.

Today TRE-FOR offers triple-play service packages, for instance: 15/15Mbps internet (download/upload), 30 digital TV channels and flat-rate telephony for 347 DKK/month (€46.6 per month).

However, if TRE-FOR can't beat the cable TV competitor on TV content (cable TV providers typically offer lower prices on TV content) then the company also offers competitively priced double-play comprising 15/15 Mbps internet (download/upload) and flat rate telephony for 247 DKK/month (€33.2 per month).

Damm-Henrichsen says the most important lesson learned in the last few years is that “content is king”. Being able to offer quality content as well as high-speed internet is the key to attracting customers. The other important success factor is customer care – customers demand a fast response from help-desk and customer care services, she says.

In the autumn of 2009 TRE-FOR re-positioned the Profiber brand, and invited other providers to offer their services on the network. It also formed an alliance with Smile Content, a provider of IPTV and video-on-demand services.

The turnover of TRE-FOR Broadband increased from 18 million DKK in 2007 to nearly DKK 40 million in 2008. As a result, TRE-FOR Broadband won an accolade from publisher Computerworld: “growth comet of the year 2009”.

Case study 3: The Red Apple (Netherlands)

Network owner: The Red Apple owners association
Network operator: Onafhankelijke Open Network Operator (OONO)
Operator model: full separation
Year started: 2009
Network size: one apartment block with 154 residents

Rotterdam is the second-largest city by population in the Netherlands, and the sixth-largest metropolitan area in Europe, with a population of 6.7 million. A number of high-rise apartment buildings have been built to attract young people, and there is a trend towards living right in the city centre; as a result there is a growing need for broadband services.

The original ambition of Rotterdam City Council, put forward in 2004, was to connect all households in the city with fibre by 2014, but today FTTH penetration in Rotterdam has only reached about 5 percent. The City Council says it struggled with a number of issues:

- regulation versus open network structure
- high initial cost per connection
- the incumbent had no incentive to invest in fibre
- consequently a lack of broadband services, like digital TV, security, medical
- there was no marketing push to bring this concept to the public

Rotterdam City Council still considers FTTH a must for economic growth and attractiveness to citizens and businesses, and so it developed a new plan with the ambition to have 150,000 homes connected by 2012. At the same time, the City Council has been looking for ways to stimulate FTTH initiatives.

A small but significant success has been achieved at The Red Apple, an apartment building that became the first FTTH network in Europe to be deployed by an owners' association.

Figure 11: View of The Red Apple luxury apartments in Rotterdam (middle of the three tall buildings).

The project was initiated by the residents, who issued a contract for the roll out of fibre throughout the 40-floor apartment building. OONO (Onafhankelijke Open Network Operator) was contracted to build the network, Alcatel-Lucent supplied the GPON equipment, which was configured by OONO, and the City Council provided the fibre connection to the building.

The network is operated as an open access model, with network owner, operator and service providers being strictly separate organisations. The owners' association is the network owner, OONO is the active operator, and various companies have been contracted to provide services.

Residents are free to choose their preferred service providers, and indeed more than 90 percent of the 154 people living in the building have subscribed to the network. Internet, telephony and TV are available separately or bundled.

Prices for the triple-play subscriptions run from €42.50 to €69.95 per month [data from *Telecompaper*, retrieved 7 September 2009]. The cheapest subscription is for symmetrical internet at 20Mbps while the most expensive package offers 60Mbps, unlimited calling to fixed numbers in the Netherlands and 110 digital TV channels. A subscription for 100Mbps is also available.

In an interview with *Telecompaper*, OONO CEO and founder 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 for analogue TV, which would be necessary in a point-to-point architecture.

With an initial connection cost of €400 per household, the owners association expects to get a return on its investment in just three years. Rotterdam City Council now hopes to encourage other stakeholders (architects, construction, and developers) to adopt this business model.

Meanwhile, OONO has embarked upon three more 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 customers own the network, which is open to any service provider.

Case Study 4: SkåNet (Sweden)

Network owner: Tele2 and 16 urban networks
Operator model: active sharing
Year started: 2003
Network size: connects 290 small towns and rural regions with fibre with final access connections provided mostly over wireless or ADSL; the aim is to upgrade those last mile connections to fibre.

Bredband för alla i Skåne (BAS) is a project to bring broadband to everyone in Skåne, the southernmost county in Sweden. With a population of roughly 1.2 million, Skåne County covers around 3 percent of Sweden's total area. The objective was to make the predominantly rural county of Skåne more attractive for companies, investments, labour and people – to help bridge the digital divide between urban and rural areas in Sweden.

To make this happen, 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 plan 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 over 200 inhabitants, resources would be freed up for other market players, which would enable them to invest in the access network.

Alternative operator Tele2 was contracted to build, own and operate major parts of the BAS network in an agreement that runs for 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, although it has since been extended to additional locations. The BAS network now consists of 2,000 km of fibre-optic cable, reaching more than 290 locations in Skåne, and bringing broadband to a total of over one million inhabitants in those locations.

Another part of SkåNet's job was to co-ordinate government subsidies for broadband. Skåne was allocated just over SEK 250 million for the BAS network expansion, and SkåNet coordinated the municipalities' grant applications for the project. This was highly successful, the organisation claims. Thanks 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, and the municipalities' purchase of communications services – although there was no obligation for them to do so.

Last mile connections are mostly provided by telecoms operators or municipalities using ADSL or WiMAX technologies. Of the 33 municipalities involved, 15 have their own municipal networks, or citynets.

Roughly 30 percent of the 2000 kilometers of fibre in the BAS regional network is owned by citynets – the remainder is owned by Tele2 – although customers buying wholesale capacity on the BAS network do not see any difference; they pay the same price regardless of the network owner.

With bandwidth requirements steadily increasing since the project first started in 2003, SkåNet's attention has now turned to FTTH: would it be possible in the future to provide everyone in Skåne with fibre to their homes? The region has set a target of providing 100 Mbps broadband to everyone by 2020.

As a result, SkåNet is encouraging "dark fibre access" – 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 and business plan, from choice of the correct ducts and cables, to contract templates for the creation of operation and maintenance agreements.

At the end of 2008, about 15% of the Skåne population was connected with fibre.

Suggested Further Reading

1. *FTTH Handbook* by the D&O Committee of the FTTH Council Europe. Available at www.ftthcouncil.eu/media_centre/studies/?cid=31 [retrieved 08/12/2009].
2. *Opportunities in Fibre to the Home (FTTH) and How to Make a First Assessment* – an independent report produced by Ventura Team LLP for the FTTH Council Europe.
3. *Understanding the Market – Assessing the Prospects for a New Fibre Business*, by Ventura Team LLP, available at http://venturateam.com/site/download.html [retrieved 5/2/10].
4. Summary of EU Telecommunications legislation in force: http://ec.europa.eu/competition/sectors/telecommunications/legislation.html [retrieved 06/01/2010].
5. *Commission 2nd public consultation on a revised draft Recommendation on regulated access to Next Generation Access networks* – available at http://ec.europa.eu/information_society/policy/ecomm/library/public_consult/nga_2/index_en.htm#responses [retrieved 06/01/2010].
6. *Checklist of Actions for Public Authorities considering Broadband Interventions in Under-Served Territories* – prepared by the European Broadband Portal (EBP). Available at www.broadband-europe.eu [retrieved 08/12/2009].

Glossary

ADSL	Asymmetric Digital Subscriber Line
ARPU	Average revenue per user
CAPEX	Capital expenditure
CO	Central office
CPE	Customer premises equipment
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
HDTV	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
OLT	Optical line terminal – the PON equipment in the central office
ONT	Optical network terminal
ONU	Optical network unit – PON equipment in the home
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)

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