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Who should read this guide?

This guide is intended for anyone involved in the planning, implementation, or management of fibre optic network deployment projects. It is particularly useful for:

- Policy makers and regulators who need to understand the benefits and challenges of fibre deployment.
- Business leaders who are considering investing in fibre infrastructure.
- Technicians and engineers who are involved in the technical aspects of fibre deployment.
- Investors who want to understand the potential returns on investment with fibre networks.

The guide provides a comprehensive overview of fibre technology, business models, project planning, and service delivery, making it a valuable resource for anyone in the fibre industry.
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Foreword

The FTTH Business Guide has become a major best-seller. This, the 4th edition, has a following of more than 15,000 readers – either online or in the printed version. The obvious success of this Guide was a big motivating factor in convincing the Business Committee of the FTTH Council Europe to produce a new updated version.

These updates also reflect the changes on the FTTH market. One of the most burning issues today is the question relating to how fibre access networks are financed. Institutional investors are beginning to see FTTH as an asset in their portfolios and the passive part of the network as being a valuable infrastructure investment. This is, of course, due in part to the production by the FTTH Council Europe of this document. Furthermore, in 2012 the Business Committee initiated a dedicated “Investor Project” to address this important target group and to provide neutral information.

At the same time we are beginning to see how different “worlds” start to converge; two years ago there was a strong differentiation between business topics and policy and regulation topics, and now suddenly they are overlapping. The Digital Agenda project has triggered activities such as the Connecting Europe Facility (CEF) that ensures the financing of broadband targets. In addition, innovative business models for FTTH networks include Private-Public-Partnerships that require specific legal and regulatory frameworks.

In such a dynamic environment it is important to have access to neutral and reliable information. The FTTH Council Europe sees the Business Guide as fulfilling this requirement offering the reader all necessary know-how in how to establish a fibre access business. The Guide includes a description of the full process of the development of an FTTH deployment; by beginning with the business case followed by how to plan the networks, to deployment and finally to operation.

We will continue to further develop the Business Guide with the help of your ideas and your feedback. So, please don’t hesitate to contact the FTTH Council Europe if you need more information or would like to see additional chapters included.

Joeri Van Bogaert, Chair of the Business Committee
FTTH Council Europe
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First edition

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Third and fourth edition were revised and edited by Eileen Connolly Bull, Connolly Communication AB.
Who should read this guide?

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

This guide is for:

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

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

http://www.ftthcouncil.eu

http://wiki.ftthcouncil.eu
Chapter 1: Why Fibre?

Broadband technologies compared

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

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

<table>
<thead>
<tr>
<th>Time taken for:</th>
<th>1 GB photo album</th>
<th>4.7 GB standard video</th>
<th>25 GB HD video</th>
</tr>
</thead>
<tbody>
<tr>
<td>FTTH 1 Gbps download</td>
<td>9 sec</td>
<td>39 sec</td>
<td>3 min 28 sec</td>
</tr>
<tr>
<td>FTTH 1 Gbps upload</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FTTH 100 Mbps download</td>
<td>1 min 23 sec</td>
<td>6 min 31 sec</td>
<td>34 min 40 sec</td>
</tr>
<tr>
<td>FTTH 100 Mbps upload</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CATV &amp; DSL 50 Mbps download</td>
<td>2 min 46 sec</td>
<td>13 min 2 sec</td>
<td>1 hr 9 min</td>
</tr>
<tr>
<td>CATV &amp; DSL 10 Mbps upload</td>
<td>13 min 52 sec</td>
<td>1 hr 5 min</td>
<td>5 hr 47 min</td>
</tr>
<tr>
<td>CATV &amp; DSL 8 Mbps download</td>
<td>19 min 0 sec</td>
<td>1 hr 29 min</td>
<td>7 hr 55 min</td>
</tr>
<tr>
<td>CATV &amp; DSL 1 Mbps upload</td>
<td>2 hr 32 min</td>
<td>11 hr 54 min</td>
<td></td>
</tr>
</tbody>
</table>

Notes:
1. All include +4% overhead for IP/Ethernet framing
2. 1 GB photo memory card, 4.7 GB DVD-R SL capacity, 25 GB Blu-Ray single layer capacity
3. FTTH examples: 1Gbps or 100 Mbps Ethernet point-to-point or GPON/XG-PON system
4. CATV example: DOCSIS 2.0 system with a single active user (i.e. no capacity contention)
5. DSL example: ADSL system with typical “up to 8 Mbps” service
6. Other system technologies, e.g. DOCSIS 3.0, ADSL2+M, VDSL2 +, would result in different times

Figure 1: Typical download and upload times

Several access network technologies such as VDSL2 and DOCSIS 3.0 are often promoted as being the “next-generation access”, with the promise of increased speeds. However, even though headline speeds are remarkable, other factors need to be considered that impact on the end-user service.

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

DSL performance is also subject to random noise, other interferences and crosstalk during operation which do impact on the overall throughput. Marketing claims of “up to 8Mbps” or “up to 40Mbps” services may, technically, be correct, however end-users are becoming increasingly dissatisfied with the reduced performance that they actually receive, which in some cases can be less than half of what was advertised.

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

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

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

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

Advertised speeds for wireless and mobile technologies based on 3G and LTE, can also offer comparable headline speeds to fixed-line broadband. But it should be noted that these technologies have a number of drawbacks:
• In the case of DSL, wireless transmission technologies only deliver maximum throughput when the user is located adjacent to the base station. Wireless systems have been heavily optimised to make efficient use of spectrum (airwaves) and are also operating close to the Shannon limit.

• Wireless communication is based on a shared medium, called the air interface. Available capacity is shared by all subscribers in a given cell (the area addressed by one base station). As more subscribers use the system, the average bit rate per subscriber will be reduced.

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

**Bandwidth evolution**

Over the past twenty years, connection speeds to access the internet have steadily increased in line with availability and the adoption of a new generation of services. This is coupled with end-user demand for premium quality as combined with increased computer processing power and software complexity, higher-resolution displays, and the trend to display pictures instead of text, audio or video.

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

In the future, increased popularity of existing services combined with the introduction of new services will continue to push bandwidth requirements higher. As more and more information becomes available digitally, data will need to be accessed more quickly, thus the development of new applications will take advantage of the improved capabilities of the network. For example, future ultra-high definition video may require up to 65 Mb/s. Applications are already envisaged that require more than 200Mbps.

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

Some examples of current and future applications and their bandwidth requirements are shown in figure 2.

**Why does the FTTH CE advertise non-synthetic use of bandwidth by customers?**

Today, video is the major contributor to the growth of global internet traffic; internet video surpassed peer to peer traffic as the largest component of internet traffic with numerous internet applications already depending on video:

• **Catch-up TV services** are becoming increasingly popular. The BBC’s iPlayer service in the UK, for example, requires a consistent 800 kbps of throughput; bandwidth requirements increase to 3.5bps for the HD version.
• **DVD rental** firms, such as Amazon, are now offering film downloads; consumers wishing to download and watch a film on the same night require an internet connection that is fast enough to download the film in minutes rather than hours.

• In January 2010 Skype launched **HD video calling**. The company recommends a sustained 1Mbps of throughput both upstream and down.

• **Connected TV devices** such as Apple TV, Boxee and Roku, as well as some games consoles and internet-enabled televisions from a variety of firms, such as Sony, can stream internet video content from providers such as YouTube, Amazon, iTunes, Netflix and more (sources vary by country). Video quality is often automatically adjusted to suit the speed of the consumer’s broadband connection. Higher quality HD video requires approximately 4 Mbps or more throughput.

• In October 2010, Cisco launched ūmi **home telepresence**. This is a consumer video conferencing system that works in combination with the HDTV in the consumers’ home and a broadband connection. The HD experience requires a minimum 3.5 Mbps of throughput both upstream and down, although 5 Mbps is recommended.

These applications have been designed with the capabilities of the average broadband connection in mind; service providers need an addressable market for their product. However, video compression used to reduce the bit rate of video to these levels does not come without loss of fidelity. HD video is likely to move towards higher quality as and when consumer broadband connections allow, starting with lighter compression, a move to 1080p resolution. 3D content, although so far limited, increases video bit rates by a factor of about 1.4.

Future developments in video can be expected to push bandwidth requirements even higher. The first 3D-enabled television sets became available in the stores in mid-2010 and as Hollywood, film and TV studios prepare for 3D production, broadcasters are waiting in the wings to join them. The world’s first live 3D HD programme was broadcast by the BBC in 2008 and in 2010 the UK satellite TV provider Sky launched the UK’s first 3D channel on their HD platform. According to SNL Kagan, in 2012 5.4% of US TV Households had 3D TV and by 2020, it is expected that more than 50% of US households will be equipped with 3D television sets.

Beyond HD is “Super Hi-Vision”. This has already been demonstrated in a live broadcast in 2008 by the BBC in collaboration with NHK of Japan and is envisaged as a 33 million pixel system (7680 x 4320), offering 16 times the number of pixels as 1080p. This system is currently undergoing standardisation and could enter the broadcast arena as early as 2020 with a target to-the-home bit-rate of 65Mbps.

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

• **Multitasking**: performing multiple, simultaneous activities online. For example, a subscriber may browse a web page while listening to an online music or video service.

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

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

- new revenue opportunities, such as IPTV
- an average of 47% more ARPU being generated
- the possibility to differentiate from other operators by service quality and bandwidth
- lower running costs
- improved network reliability (optical fibre is immune to electromagnetic interference, for example)
- the possibility to consolidate central offices
- a future-proof network infrastructure guaranteeing ease of future upgrades

The ability to offer new services is essential if the service provider is to stay ahead in a highly competitive environment.

- The entertainment services segment is extremely dynamic and has been the driving force behind consumer adoption of new technology. For example, the number of IPTV service subscribers increased to around 21 million worldwide during 2008; the prognosis is a minimum growth rate of 28% per year for the next 5 years. With associated revenues amounting to approximately $6 billion (€4 billion), this is an important and growing revenue source for both established and new entrant service providers.

- The terrestrial analogue TV transmission switch-off deadline of 2012 which is recommended by the European Commission is almost here. The transition to digital terrestrial transmission has already caused major market disruption that is being successfully leveraged by IPTV providers, resulting in increased subscription rates.

- HDTV service is a fertile area for new business strategies providing a differentiator for service providers. Even in developed markets such as the US with 61% of the global total of HDTV households, 43% of all households either do not have or do not watch HD content. This represents a considerable market opportunity. With 150-inch displays already available on the market, it is perhaps only a matter of time before films are premiered directly to the home on IPTV, instead of through cinematic release.

A 2012 study of NGA service portfolios, commissioned by the FTTH Council Europe and conducted by Diffraction Analysis, also showed that FTTH operators received on average 47% higher revenues per user. This is not due to expensive product services rather an increased number of services being purchased by subscribers.
One argument often raised by operators unwilling or uninterested in investing in fibre is they “do not see the demand”. Of course, consumers are unable to demonstrate demand for services that are not available to them. However, the NGA service portfolio study found that FTTH subscribers consume three to five times more bandwidth (aggregate uploads and downloads) than ADSL users. The same study showed that FTTH subscribers are net contributors to the internet, uploading more material than they download. In other words, once subscribers gain access to more bandwidth, they spend longer making use of existing services, as well as becoming proficient in using new ones.

An additional motivator for service providers is that FTTH networks have lower operating costs (OPEX) than existing copper or coaxial cable networks. Therefore the quality of the network and the services offered do lead to increased consumption by the subscriber

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

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

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

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

Incumbent operators while historically committed to their approach are nevertheless aware of the inevitability and are thus planning FTTH deployments in the next few years. Telecom operators and cable TV providers will eventually drive fibre all the way to the home, or go out of business: all recognise fibre as the “end game”.

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

**Socio-economic benefits**

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

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

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

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

A number of studies have noted a statistical connection between higher broadband adoption and increased economic prosperity on both local as well as national levels. Evidence-based studies on FTTH have not yet been conducted as the technology is still relatively new, therefore a real-world analysis on the economic impact of FTTH will be carried out in due course. However, several reports have attempted to make realistic predictions regarding the impact FTTH networks have on job creation and the GDP. For example:

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

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

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

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

It may be difficult for service providers to experience immediate financial benefits from these externalities in the form of service fees; however, other parties involved in the network deployment may include them in their decision-making processes. For instance, the potential social and economic benefits for the community could gain local support for the project, thus paving the way for a smooth local deployment process resulting in increased subscriber numbers. The business case should address all alternative motivators and methods for funding the network rollout.
Chapter 2: Business models

Network layers

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

![Figure 2: FTTH network layers (Source: Alcatel-Lucent)](image)

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

- **Passive infrastructure** involving physical elements required to build the fibre network. This includes the optical fibre, trenches, ducts and poles on which it is deployed, fibre enclosures, optical distribution frames, patch panels, splicing shelves and so on. The organisation responsible for this layer would also normally be responsible for network route planning, right-of-way negotiations, and civil works used to install the fibre.

- **Active network** refers to the electronic network equipment needed to bring the passive infrastructure alive, as well as the operational support systems required to commercialize the fibre connectivity. The party in charge of this layer will design, build and operate the active equipment part of the network.
- **Retail services** become involved once the passive and active layers are in place. This layer is where basic internet connectivity and other managed services, such as IPTV, are packaged and presented to consumers and businesses. Besides providing technical support, the company responsible for this layer is also in charge of customer acquisition, go-to-market strategies, and customer service.

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

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

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

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

Possible FTTH business models include:

- **Vertically integrated**, which means one operator controls all three layers of the network. Consequently, if a second operator is interested in offering broadband and telephony services in the same area, he would have to build his own infrastructure, operate and market it directly to the end-user. This is a clear form of infrastructure competition.

- **Passive sharing** leverages a single passive infrastructure, which is built and maintained by one infrastructure owner. Active and services layers are owned by different organisations. A second service provider may share the same passive infrastructure with the first service provider, but would be required to invest in active network equipment and operations as well as the services and subscriber-facing activities.

- **Active sharing** is where a single organisation owns the passive and active infrastructure and operates the active network. This vertical infrastructure owner wholesales broadband access to various retail service providers who then compete with each other for customers.

- **Full separation**, as mentioned above, ownership layers are partitioned. Each layer is owned by a different party with the infrastructure owner generating income by providing passive infrastructure access to one or more network operators, who in turn wholesale broadband access to retail service providers.
The interest of an FTTH network owner could be contained in any one of the three levels in the value chain. Each type of business model has its own opportunities and challenges, which are summarized in the following table:

<table>
<thead>
<tr>
<th></th>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vertically integrated</td>
<td>Control total value chain and cash flow profile.</td>
<td>Complex operation and high execution risk.</td>
</tr>
<tr>
<td>Wholesale operator</td>
<td>Gains additional margins for modest incremental investment.</td>
<td>Must be technically credible yet flexible. Small operators may struggle due to lack of commercial and operational standards for wholesale.</td>
</tr>
<tr>
<td>Passive network owner only</td>
<td>Simple operations. About 50% of the revenue potential.</td>
<td>Lack of direct control over the revenue stream and marketing to the end-user.</td>
</tr>
</tbody>
</table>

Deciding which operational model to choose is fundamental as it determines the business model of the activities as well as the financial model. It is also very much dependent on local regulations, competitive environment and the core business activities and competencies of the organisation.
The existence of differentiated business models has opened up the FTTH market to organisations other than traditional telecoms operators, including electricity power providers, housing associations and local authorities.

**Case Study #1: HanseNet (Germany)**

**Summary:** HanseNet Telekommunikation, an established broadband ISP in Germany, has constructed a pilot FTTB network covering 700 buildings in the Eimsbüttel area in Hamburg. Thomas Hartmann, Network Capacity Planning Manager, explains the firm’s business model.

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

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

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

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

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

*Case study written December 2009; updated January 2011.*
Open Access Networks

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

In the context of telecommunications networks, “open access” typically means the access granted to multiple service providers to wholesale services in the local access network enabling them to reach the subscriber without the need to deploy a new fibre access network. The wholesale pricing structure is transparent and the same for all service providers. Wholesale products are offered at different levels throughout the infrastructure based on the type of open access model:

- **Passive open access infrastructure** (ducts, sewers, poles, dark fibre, wavelength) offers telecommunications operators the opportunity to share a passive infrastructure and deploy their own infrastructures on top of delivering services.

- **Active open access infrastructure** (Ethernet layer-2 and IP layer-3) makes it possible for service providers offering residential, business and public services to share a common active infrastructure that is built by a passive infrastructure player and operated by an active infrastructure player.

![Figure 4: Open access models (source: Alcatel-Lucent)](image-url)
Case Study#2: Reggefiber (The Netherlands)

Last year, fibre rollout in the Netherlands exceeded one million homes passed. The total figure is currently at 1.3 million - a number expected to increase to 1.5 million by the end of this year. Almost one-fifth of all Dutch households are now covered and according to research by the University of Twente, the average time spent online each day grew by 24 minutes to three hours and six minutes.

The vast majority of all connections - 85% - belong to Reggefiber, a joint venture between investor Reggeborgh and national telecoms incumbent KPN. Reggefiber was founded in 2005 with the goal of ‘fibreing’ as many households in the Netherlands as possible and is currently active in more than 175 municipalities. In general, the company usually employs a demand-driven approach, requiring participation of at least 30% of all households in a region to make the financial rollout risk viable.

Big commitment

“KPN recently took a 51% share in Reggefiber, up from 41%, and we’re delighted to see this kind of commitment to a long-term vision on fibre,” explains Bert Nijboer, CEO of Reggefiber. “Even though fibre is vital to our country's economy and innovation power, investors are still far too cautious. This is also reflected in our government, which seems to show little interest in our ICT sector. In 2013, we want to pass some 380,000 additional homes with fibre, crisis or no crisis. Despite what other operators may say, fibre is the only option that guarantees sufficiently fast, reliable and symmetrical access to accommodate the needs of tomorrow’s economy and society.”

Another exciting development in the Netherlands is the Communication Infrastructure Fund (CIF) started by Rabobank and investor Bouwfonds. This is attracting pension and institutional funds to fibre investment and is perfectly suited to this type of long-term investor. CIF has adopted a ‘brown field’ approach, buying up older coaxial networks in densely populated areas and laying new fibre alongside. In this way, CIF is able to hold on to existing traffic while building the infrastructure that will support new services.

Fighting the digital divide

“Interestingly, small-to-medium-sized municipalities in the Netherlands are generally well-connected,” explains Bert Nijboer, “while on the other hand, rural areas and the major cities are still catching up, although political pressure is increasing in support of our goals. Interactive services enabled by greater bandwidth were once considered a luxury, but today are considered a basic necessity. Not only for working from home or increasing productivity in the workplace, but also in order to accommodate the rapid increase of mobile computing, smartphones, cloud services and mobile gaming. Our infrastructure is already creaking at the seams - just imagine what would happen if all consumers started to use videochat on a large scale!”

“Essentially, we began as an infrastructure provider, digging trenches and laying fibre, now we are increasingly shifting towards network management. Of course, we’ve come across our share of difficulties in rolling out and maintaining networks and sometimes we wish that legislation was just a little more straightforward. In France, for example, people living in a multi-family dwelling (MFD) can no longer prevent people living above them from getting fibre by preventing access.”
Ambitious targets

Sometimes, new approaches need to be introduced to reach achieve connection targets. Reggefiber and the Dutch construction services company, VolkerWessels Telecom, began deploying a fibre network in the municipality of Noorderveld in the Dutch province of Drenthe, adopting a new, cost-effective roll-out technique. Instead of conventional digging, Reggefiber is using a machine that brushes the trench open, enabling network ducts to be installed at a depth of 30cm beneath the pavement, instead of the normal 60 cm. This makes it possible to lay 600 metres of fibre a day without keeping stretches of pavement open for longer than a day at a time, thus limiting public inconvenience. When completed by mid-2013, the network will provide some 11,000 connections.

“For end users, regulatory bodies and partners, the open nature of an access network is very important,” adds Jan Davids, Director of Corporate and Business Development. “This allows people to choose exactly the type of services they want and need from a wide variety of providers: KPN, Telfort, Vodafone, Lijnbrandt, Concepts, Tele2. At present we are doing business with 24 in total, which means that end-users can pick and choose from a wide range of high-quality business and residential services in different price ranges.”

Everyone wins

“We believe in fully separated ownership of the different layers,” adds Jan Davids. “For example, in some parts of the Netherlands, 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 services which they then offer and sell directly to end-users. The Dutch competition authority NMa and the telecoms regulator OPTA even joined in our initial negotiations with KPN as they were interested in the creation of a framework that would guarantee equal access to providers and infrastructure competition without holding back investment.”

For providers, working with this open access model means they instantly have the required large footprint they need to make their business models a success. And users everywhere have access to a high-quality network with top of the range services. End users are generally delighted with the vastly enhanced speeds and symmetry and the business partners benefit from being able to consult with Reggefiber, who have built up a vast knowledge regarding OPTA and NMa regulations. Essentially, everyone wins.

Written January 2013
Chapter 3: Project Planning

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

Distinction should be established between building an FTTH network and operating the network. Different skills are required and therefore it is likely that people will be employed who have construction competences and others who can deal with the operation stage of the network.

Project timeline

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

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

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

A check list of actions:

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

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

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

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

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

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

**Initial budget**

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

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

**Go decision**

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

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

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

A number of key sales considerations:

• a business model for revenue sharing should be complete before starting sales process
• price used to attract early adopters; however, limit extent of any possible connection fee offers
• do not underestimate the installation time
• sales results should steer installation schedule
• set demand registration targets: one for starting the design and the second for entering into right-of-way agreements
• services must be ready at the same time as connectivity; there is limited value to the end user otherwise
• streamline installation activities to limit time from sale to connection as short as possible

**High-level engineering**

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

Some key considerations include:

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

Permissions

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

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

Some important issues are:

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

Detailed engineering

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

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

Some key considerations are:

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

Civil works

Even though fibre infrastructure can be considered high tech, most of the costs are related to digging. Investigate methods and material to minimize digging and work on site to bring down total cost.
A major issue is actual access to homes, particularly MDU’s (Multi Dwelling Units). Installation often requires co-ordination where several individuals have to provide access to their homes to support a sequence. This together with the handling of keys often disrupts the installation process and results in unexpected costs.

Some key issues are:

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

**Service activation**

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

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

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

Some key issues are:

- physical installation takes time
- active equipment at the user end is needed but will create support costs
- clear demarcation points between different parties (network owner, operator and service provider), should be in place for the benefit of the subscriber
- the party with subscriber contact should handle front line support
- in a multi-service network, a single source of front line support may be separate from the services
Chapter 4: Services

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

The evolution of services is closely linked to bandwidth availability and the positive affect these services have on each other. New services create new revenue sources; encourage adoption of new devices, change end-user behaviour and drive the need for increased bandwidth capacity. Expanding bandwidth capacity will allow for the accommodation of additional content, encourage application growth, spur new services and open the door to new business opportunities.

Retail services can be divided according to market segments:

- residential
- business
- carrier
- public sector

Residential

In the past typical services offered to the residential sector included basic telephony, internet access and IPTV (triple-play). Today most of the operators go beyond triple-play (the name given to a package offering all three elements) to offer services that will differentiate them from the competition and create increased revenue potential. Examples of such services are web space, online backup, gaming, home surveillance etc.

These services may be bundled together in a basic package or in a separate service package aimed at specific market segments.

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

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

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

Many internet applications also require good upstream data rates. Examples are: back-up to an online data vault or online video calling.
The network owner may also wish to offer specialised services, for example:

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

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

**Business**

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

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

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

Cloud services, and application outsourcing, are becoming popular with businesses, as they create genuinely new methods to reduce operating costs. Although available bandwidth is an important network requirement for Cloud services - it is not the only criteria. In cloud computing, where information can be stored anywhere in the world, low latency is one of the critical requirements. Fibre to the home technologies fulfils these requirements and offers guarantees to the operator against a cycle of network upgrades.

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

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

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

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

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Case study #3: Mälarenergi Stadsnät

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

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

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

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

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

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

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

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

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

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

Written September 2010.

Infrastructural cost sharing between FTTH 2 wireless services

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

Public sector

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

Pricing strategies Adapt to the study carried out by Diffraction Analysis

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

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

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

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

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

- The broadband-utility strategy focuses on customer acquisition aimed at providing affordable internet access to as many users as possible. This is a typical strategy for municipal networks and alternative operators.
The *expand-and-cash-in* strategy consists of a wide network deployment with few added-value services offered until a critical mass of subscribers has been achieved.

The *keep-it-premium* strategy involves providing attractive new services at premium prices, aimed at a smaller, niche subscriber base without cannibalising existing revenues. This kind of behaviour is often found in incumbent operators.

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

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

![Figure 6: Undiscounted payback period with $1000 per home connected and 45% gross margin. Source: Yankee Group, 2009, webinar “Making that business model work”](image)

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

The competitive environment will be the major influence in the size of an expected achievable market share. The maturity of broadband and triple-play local markets varies greatly across Europe. Greece, for example,
has only had affordable, broad penetration cable television and ADSL since 2008. Whilst in Sweden a large number of areas where FTTH and cable compete has resulted in the exclusion of ADSL on the market.

In general, it is easier to gain traction in a growing market, although it is also entirely possible to convert a local market from lower broadband speeds to high-speed broadband. Places not currently served by broadband clearly offer the best prospects; however, broadband “notspots”, which are locations too far from the telephone exchange to receive DSL services, tend to be geographically remote and therefore more expensive to connect with fibre.

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

See Appendix D, White Paper, for more detailed information. This document has been created by the Content and Applications Committee.
This chapter looks into the all-important issue of cost. How much investment is required to build the network, and how much will be required to keep it going? What are the main influences on those costs? Possible strategies for network deployment and their impact on the business case will also be discussed.

Expenditure falls into three main categories:

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

**Capital expenditure**

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

The other main items are:

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

**Figure 7: Cost breakdown of a FTTH project**
Network architecture

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

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

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

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

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

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

The debate over P2P vs P2MP has been closed for several years. Both technologies proved their value and are adopted today by incumbents, alternatives and utility/municipalities.
Choosing the right network architecture depends on operator requirements as well as business and technical priorities. Whatever the network architecture, it is important to consider how the design of the cable plant may affect the evolution of the network in the future. An FTTH network is a long-term investment. The anticipated lifespan of the cable in the ground is at least 25 years (this is the manufacturer’s guaranteed minimum lifespan) however the working lifespan is likely to be much longer. The active equipment will need to be upgraded several times in this timeframe, but the infrastructure should be re-usable. Decisions relating to the cable plant made at the start of a project will have long term consequences.

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

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

**Active equipment**

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

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

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

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

Some other variables to consider include:

1. **Space** – point-to-point networks require more floor space in the central office since each incoming fibre must be patched through and terminated individually on an active module, whereas a single PON active module is connected to many subscribers with just one fibre.
2. **Security** – GPON is a shared medium and different techniques need to be implemented to ensure data protection (encryption, watchdog features, packet filters etc). Very often business services are offered over dedicated fibre connections even though there are many business subscribers using PON networks. The operator’s choice to serve business users over P2P or P2MP network has more to do with history, scalability, service offering etc rather than concerns over security.

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 in the CO for high penetration rates as there are more subscribers sharing the same CO infrastructure resulting in the need for less equipment, less floor space and less power needed for cooling the CO. However, PON high-speed transmitters must be powered even when there are only a few active subscribers on the branch resulting in higher power consumption costs per subscriber at lower penetration rates. PON CPEs typically have a higher power consumption due to higher speed and higher complexity.

4. **Ease of troubleshooting** – since there are no optical elements in the link between the central office and the subscriber, P2P networks can be tested from the central office saving time and money. The splitter in a PON makes this more difficult, although not impossible.

5. **Impact of a cable cut** – in the event of a complete cable cut in the feeder part of the network, architectures with fewer fibres will take less time to repair. Independent of the architecture, the time to repair could also be reduced by using more cables (i.e. fewer fibres per cable) in the network design, which makes it possible for repair teams to work in parallel.

6. **Unbundling** – Both P2P and P2MP networks can be unbundled, as proved by many open access networks worldwide. More details on unbundling options can be found in Chapter 5 Feeder fibres.

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

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

The lowest cost solution in the case of a non-existent building involves making use of an aerial route. Power or similar poles are used to support the fibre. This clearly is advantageous to all power providers interested in the fibre based business. A similar approach that may be considered is stapling. Here the fibre is literally passed around the outside of the building and stapled in place. However, these solutions in general require a higher OPEX service.

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

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

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

Whatever the method of building fibre around a town or city, the average length of fibre per home passed will have a serious impact on the financing. Individual homes will clearly be the highest cost to connect whilst MDU’s being the cheapest. (MDU cabling also has its complexity and a higher cost.)

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

Potential improvements:

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

Final drop

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

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

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

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

The cost for negotiating individual subscriber contracts must also be included. Worst case scenario is where terms must be agreed with individual residents and then problems arise which require a meeting with all the tenants at the same time. This may not always be possible so several meetings may need to be held to gain agreement.

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

Potential improvements:

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

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

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

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

**Subscriber equipment**

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

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

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

Potential improvements:

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

**Deployment Strategies: including some elements from the latest Diffraction Analysis study**

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

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

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

Take-up criteria:

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

Cost criteria:

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

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

<table>
<thead>
<tr>
<th>Lower ROI</th>
<th>Higher ROI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower broadband penetration</td>
<td>Vs. Higher broadband penetration</td>
</tr>
<tr>
<td>Lower ARPU</td>
<td>Vs. Higher ARPU</td>
</tr>
<tr>
<td>Lower housing density (SFU’s)</td>
<td>Vs. Higher housing density (MDU’S)</td>
</tr>
<tr>
<td>Rural areas</td>
<td>Vs. Urban areas</td>
</tr>
</tbody>
</table>

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

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

Operating costs

Typical operational expenditure posts will include:

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

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

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

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

If the network is to be rented to one or more established service providers their areas of responsibility could also involve marketing, billing and subscriber care, therefore a suitable margin covering these posts must be included in all calculations. Established service providers are not generally interested in small-scale, special cases as cost-affectivity lies in the mass market.
Case Study #4: The Red Apple building (Netherlands)

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

Rotterdam, with a population of 607,000, is the second-largest populated city in the Netherlands. The city centre comprises of a number of modern, luxury MDU’s which have been built to attract young people; the Red Apple is one such building.

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

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

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

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

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

Written November 2009
**Right-of-way**

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

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

**Marketing**

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

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

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

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

**Backhaul**

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

Bitstream costs for a fibre operator can be substantial, depending on availability, local pricing, and the degree of competition. The challenge then is to estimate and cost the correct usage per user, decide how
much backhaul oversubscription (if any) is permissible and whether to place a cap on usage. This is not an uncommon practice in regions with high IP transit costs.

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

**Case Study #5: SkåNet (Sweden)**

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

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

To achieve this, the regional council (Region Skåne) and the Association of Municipalities in Skåne (Kommunförbundet Skåne) set up SkåNet in 2003 as a public-private partnership. SkåNet’s main task was to coordinate the planning, procurement and monitoring of an Open Access fibre network across the county.

The idea was to establish an operator that could offer fibre connections to smaller towns and rural areas throughout the region. By investing substantially in infrastructure to all the locations with more than 200 inhabitants, resources would be freed for other market players to invest in the local access network.

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

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

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

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

Last mile connections are typically provided by municipalities or telecoms operators using ADSL or WiMAX technologies. Of the 34 municipalities involved, 15 have their own municipal networks. With bandwidth requirements steadily increasing since the project first started in 2003, SkåNet’s attention turned to FTTH:
would it be possible to provide everyone in Skåne with fibre all the way to their homes? As a result, SkåNet has been encouraging “DIY fibre” – offering specialist advice to communities that are willing to dig to install their own fibre between their homes and a telehouse facility on the BAS network. SkåNet provides advice on all aspects of the process, from choice of the correct ducts and cables, to contract templates for the drawing up of operation and maintenance agreements.

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

*Case study written December 2009; updated January 2011.*
Chapter 6: Regulation

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

Principles of regulation

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

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

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

There are two main mechanisms for market regulation:

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

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

- Directive to establish a harmonised framework for the regulation of electronic communications networks and services (the “Framework Directive”)
Directive on the authorisation of electronic communications networks and services (the “Authorisation Directive”)  
- Directive on access to, and interconnection of, electronic communications networks and associated facilities (the “Access Directive”)  
- Directive on universal service (the “Universal Service Directive”)  
- Directive on the processing of personal data (the “Privacy and Electronic Communications Directive”).

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

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

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

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

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

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

<table>
<thead>
<tr>
<th>Step 1: Market Definition</th>
<th>Step 2: Market Analysis</th>
<th>Step 3: Market Remedies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market 4: Wholesale (physical) network infrastructure access at a fixed location (including shared or fully unbundled access)</td>
<td>Market 4: Always dominated by the former incumbent operator in a copper context. Cable is excluded from the market. In a FTTH context, different results are possible, e.g. no-SMP finding in Romania based on multiple FTTB networks.</td>
<td>Market 4: Grant access to the physical path of the network. If not technically or economically feasible other remedies are permitted.</td>
</tr>
<tr>
<td>Market 5: Wholesale broadband access</td>
<td>Market 5: Can still be competitive even if SMP on market 4 (dependent on product definition and geography).</td>
<td>Market 5: A range of possible remedies include different levels of bitstream access, different pricing mechanisms, etc.</td>
</tr>
</tbody>
</table>
NRAs look at the entire value chain from the passive infrastructure to the retail services. It is obvious that the choice of where and how to award access in the value chain will impact on operators’ opportunities to enter the market and determine the nature and range of services delivered to retail consumers. In extremis, even if wholesale products are available but few, if any, alternative operators enter the market to supply at the retail level, NRAs may regulate the retail product directly via price caps in an effort to protect end-users. An overwhelming preference is to allow as many to operate as are interested by making appropriate wholesale products available and allowing competitive processes to work as freely as possible.

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

Proposed remedies:

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

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

**The Digital Agenda**

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

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

The Digital Agenda is one of seven initiatives in the Europe 2020 strategy. The complete Digital Agenda element, published in May 2011, sets targets to speed up the roll-out of high-speed internet and reap the benefits of a digital single market for consumers and businesses.
The Commission has identified the need to increase European access to high-speed internet connections. The Digital Agenda restates the objective endorsed by the European Council to bring basic broadband to all Europeans by 2013 and adds a more ambitious target for 2020: 30 Mbps available to all households with a 50% subscription rate to offers of 100 Mbps minimum.

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

Many of these measures are currently nearing finalisation. The European Union budget (2014-2020) includes the ‘Connecting Europe Facility’ (CEF) that will contain a specific finance allocation finance to encourage investment in access networks that meet the Digital Agenda targets. This is expected to be settled in 2013. In addition the European Commission work programme for 2013 anticipates a Regulation (legislation) addressing measures to lower deployment cost through the reuse and sharing of civil infrastructures.

NGA Recommendation

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

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

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

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

NGA’s are also guided to mandate access to the terminating segment of the access network to any operator with SMP. This includes access to wiring inside buildings. In this context NRAs are obliged to provide the SMP operator with detailed information on its access network architecture and, following consultation with potential access seekers on viable access points, determine where the distribution point of the terminating segment of the access network should be for the purpose of mandating access.
The Recommendation further advises that NRAs should take into account the fact that any distribution point will need to host a sufficient number of end-user connections to be commercially viable for the access seeker. NRAs are also asked, where possible under national law, to oblige the operator with SMP to deploy multiple fibre lines in the terminating segment.

Where the SMP operator deploys FTTH, NRAs should in principle also impose fibre unbundling, regardless of the network architecture, with an access point at the metropolitan point of presence. The Commission suggests that technological development will address unbundling difficulties in time (e.g. through wavelength unbundling) and that in the meantime alternative options such as “virtual unbundling” (e.g. VULA as in the UK) could be offered as a substitute for a transitional period. However, NRAs are recommended to “mandate physical unbundling as soon as technically and commercially feasible”.

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

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

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

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

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

The European Commission has now proposed to bring forward another Recommendation in 2013, entitled ‘Recommendation on consistent non-discrimination obligations and costing methodologies’ to clarify and fine tune aspects of the NGA Recommendation. The final form and application of this Recommendation could significantly impact business decisions on both network choice and timing.

A list of NRA’s is contained in Appendix A.
Case Study #6: ARCEP (National regulator in France)

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

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

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

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

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

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

Discussions regarding regulations for Zones 2 and 3 are ongoing. Topics still to be decided include options relating to a single, open network infrastructure, public funding, the position of the vertical sharing point, and much more.

*Written January 2010*
Chapter 7: Finance FTTH

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

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

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

**FTTH Push: Maximising early take up rates**

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

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

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

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

**FTTH Pull: New applications bring obsolescence to existing networks**

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

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

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

**The investment case strongly dependent on local situations**

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

The existing local situation relating to investment opportunities and competition can vary considerably from place to place. In the city with a high density of homes, it is more cost-efficient to connect the subscribers than in less densely populated areas.
In the areas where it is difficult to finance an FTTH Business case, the involvement of the public sector to ensure the funding may be a realistic option. The argument being that FTTH is not only of interest to traditional investors but is essential to the development of a region.

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

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

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

According to Heise Netze 25.02.2010 (www.heise.de/netze/58elding/FTTH-Konferenz), the OECD, which always promotes the policy that governments should not interfere with the private sector, are of the opinion that in the case of FTTH they will make an exception. The OECD favours an active and supportive role by the public sector to develop FTTH Networks.

**FTTH Operators**

New FTTH operations could involve a number of stakeholders.

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

<table>
<thead>
<tr>
<th><strong>Municipalities &amp; Utility companies</strong></th>
<th><strong>Alternative Operators</strong></th>
<th><strong>Incumbents</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>• Long term investments</td>
<td>• Enter a competitive market</td>
<td>• Own a telecommunication network already</td>
</tr>
<tr>
<td>• Regional projects</td>
<td>• Limited cash flow</td>
<td>• Limited by „shareholder value requirements“</td>
</tr>
<tr>
<td>• Project costs relatively small</td>
<td>• Challenge of low equity</td>
<td>• Short-term (and sometimes mid-term) planning</td>
</tr>
<tr>
<td>• Business case based on open access in many cases</td>
<td>• Short-term planning</td>
<td>• „big and slow“</td>
</tr>
<tr>
<td>• Lack of experience in planning, operating and marketing telecommunication networks</td>
<td>• High risk</td>
<td>• „bound“ to national perspective</td>
</tr>
<tr>
<td></td>
<td>• Good experience in operating and marketing telecommunication networks</td>
<td></td>
</tr>
</tbody>
</table>

**Electricity providers:**

These organisations do not often have an existing customer base in telecommunications. They enter this business for a variety of reasons and, through the nature of their core business, most probably have one or several duct systems which are suitable for the deployment of FTTH.
An additional and common motivator for them is to expand the functions of the energy network: Smart Grid. It is obvious that as far as the electricity providers are concerned, this will become strategically important to their business in the future. Information Technology will be a key factor to realising success, optimising production and consumption and structuring supply and purchasing in the energy world.

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

**Alternative Operator:**

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

**Incumbent:**

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

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

**FTTH Investors**

**Institutional Investors:**

Institutional investors look for major investment situations with relatively low risk. Today, more and more insurance companies and pension fund investors are becoming increasingly interested in FTTH. The reason is that this business offers long term investment opportunities in a stable market, such as property, roads and infrastructure. (see Figure 11)

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

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

Business Angels and Venture Capital

In most cases these are interested in helping start-up businesses. Their intention is to help the business grow to a size where it can be sold or floated on the stock exchange. Most businesses receiving business angel support are medium sized with new approaches and innovations within existing business sectors. These companies often attract the attention of businesses already operating in the same field.

Private Equity

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

Governments

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

European Investment Bank EIB

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

<table>
<thead>
<tr>
<th>Institutional Investors</th>
<th>Banks</th>
<th>Risk Capital &amp; Business Angels</th>
<th>EIB</th>
</tr>
</thead>
<tbody>
<tr>
<td>- High volume</td>
<td>- Low volume</td>
<td>- Medium volume</td>
<td>- High volume</td>
</tr>
<tr>
<td>- Stock exchange listed companies only (with some exceptions)</td>
<td>- Risk averse (Basel III)</td>
<td>- Need to be addressed directly</td>
<td>- Official „role“ to finance FTTH</td>
</tr>
<tr>
<td>- Require a „professional“ business case</td>
<td>- Lack of understanding of FTTH</td>
<td>- Need for a good „business story“</td>
<td>- Good understanding of FTTH</td>
</tr>
<tr>
<td>- Some understanding of FTTH</td>
<td></td>
<td>- Short term investments</td>
<td>- „slow“</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Lack of understanding of FTTH</td>
<td>- Trigger private share</td>
</tr>
</tbody>
</table>

Figure 10
Type of Investments

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

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

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

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

Figure 11

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

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

**Cooperatives**

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

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

**Cooperations**

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

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

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

**City of Basel (Public Private combined with cooperation)**

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

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

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

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

**Italy**

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

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

Germany

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

<table>
<thead>
<tr>
<th>Country</th>
<th>Name of Regulator</th>
<th>Abbreviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>Rundfunk und Telekom Regulierungs <a href="http://www.rtr.at">www.rtr.at</a></td>
<td>RTR</td>
</tr>
<tr>
<td>Belgium</td>
<td>Institut Belge des services Postaux et de Télécommunications <a href="http://www.bipt.be">www.bipt.be</a></td>
<td>BIPT</td>
</tr>
<tr>
<td>Bulgaria</td>
<td>Communications Regulation Commission <a href="http://www.crc.bg">www.crc.bg</a></td>
<td>CRC</td>
</tr>
<tr>
<td>Croatia</td>
<td>Hrvatska agencija za poštu i električke komunikacije <a href="http://www.telekom.hr">www.telekom.hr</a></td>
<td>HAKOM</td>
</tr>
<tr>
<td>Cyprus</td>
<td>Office of the Commissioner of Electronic Communications and Postal Regulation <a href="http://www.ocenepr.org.cy">www.ocenepr.org.cy</a></td>
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</tr>
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<td>Czech Republic</td>
<td>Český telekomunikační úřad <a href="http://www.ctu.cz">www.ctu.cz</a></td>
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</tr>
<tr>
<td>Denmark</td>
<td>Televiretelsen - National Telecom Agency <a href="http://www.itst.dk">www.itst.dk</a></td>
<td>NTA</td>
</tr>
<tr>
<td>Estonia</td>
<td>KONKURENTSIAMET <a href="http://www.konkurentsiamet.ee">www.konkurentsiamet.ee</a></td>
<td>KONKURENTSIAMET</td>
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<tr>
<td>Finland</td>
<td>Viestintävirasto Kommunikationsverket <a href="http://www.ficora.fi">www.ficora.fi</a></td>
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</tr>
<tr>
<td>France</td>
<td>Autorité de Régulation des Communications Electroniques et des Postes <a href="http://www.arcep.fr">www.arcep.fr</a></td>
<td>ARCEP</td>
</tr>
<tr>
<td>Germany</td>
<td>Bundesnetzagentur für Elektrizität, Gas, Telekommunikation, Post und Eisenbahnen <a href="http://www.bundesnetzagentur.de">www.bundesnetzagentur.de</a></td>
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<td>Greece</td>
<td>National Telecommunications and Post Commission <a href="http://www.eett.gr">www.eett.gr</a></td>
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<td>Hungary</td>
<td>Nemzeti Hírközlési Hatóság <a href="http://www.hif.hu">www.hif.hu</a></td>
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</tr>
<tr>
<td>Iceland</td>
<td>Póst- og fjarskipastofnun <a href="http://www.pta.is">www.pta.is</a></td>
<td>PTA</td>
</tr>
<tr>
<td>Ireland</td>
<td>Commission for Communications Regulation <a href="http://www.odtr.ie">www.odtr.ie</a></td>
<td>ComReg</td>
</tr>
<tr>
<td>Italy</td>
<td>Autorità per le Garanzie nelle Comunicazioni <a href="http://www.agcom.it">www.agcom.it</a></td>
<td>Agcom</td>
</tr>
<tr>
<td>Latvia</td>
<td>Sabiedrisko pakalpojumu reģulesanas komisija <a href="http://www.sprk.gov.lv">www.sprk.gov.lv</a></td>
<td>SPRK</td>
</tr>
<tr>
<td>Liechtenstein</td>
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<tr>
<td>Country</td>
<td>Name of Regulator</td>
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<tr>
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<td>------------------------------------------------------------------</td>
<td>--------------</td>
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<td>Lithuania</td>
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</tr>
<tr>
<td>Luxembourg</td>
<td>Institut Luxembourgeois de Régulation [<a href="http://www.ilr.lu">www.ilr.lu</a>]</td>
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</tr>
<tr>
<td>Republic of</td>
<td>Agency for Electronic Communications [<a href="http://www.aec.mk/eng">www.aec.mk/eng</a>]</td>
<td>AEC</td>
</tr>
<tr>
<td>Macedonia</td>
<td>Malta Communications Authority [<a href="http://www.mca.org.mt">www.mca.org.mt</a>]</td>
<td>MCA</td>
</tr>
<tr>
<td>Luxembourg</td>
<td>Onafhankelijke Post en Telecommunicatie Autoriteit [<a href="http://www.opta.nl">www.opta.nl</a>]</td>
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</tr>
<tr>
<td>Norway</td>
<td>Post- og teletilsynet [<a href="http://www.npt.no">www.npt.no</a>]</td>
<td>PT</td>
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<tr>
<td>Portugal</td>
<td>Autoridade Nacional de Comunicações [<a href="http://www.anacom.pt">www.anacom.pt</a>]</td>
<td>ANACOM</td>
</tr>
<tr>
<td>Romania</td>
<td>Autoritatea Naţională pentru Administrare şi Reglementare în Comunicaţii [<a href="http://www.ancom.org.ro">www.ancom.org.ro</a>]</td>
<td>ANCOM</td>
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<tr>
<td>Slovak Republic</td>
<td>Telekomunikacný úrad Slovenskej republiky [<a href="http://www.teleoff.gov.sk">www.teleoff.gov.sk</a>]</td>
<td>TO SR</td>
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<tr>
<td>Slovenia</td>
<td>Agencija za pošto in elektronske komunikacije RS [<a href="http://www.apek.si">www.apek.si</a>]</td>
<td>APEK</td>
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<tr>
<td>Spain</td>
<td>Comisión del Mercado de las Telecomunicaciones [<a href="http://www.cmt.es">www.cmt.es</a>]</td>
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<tr>
<td>Sweden</td>
<td>Post- och Telestyrelsen [<a href="http://www.pts.se">www.pts.se</a>]</td>
<td>PTS</td>
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<tr>
<td>Switzerland</td>
<td>Office fédéral de la Communication [<a href="http://www.bakom.ch">www.bakom.ch</a>]</td>
<td>OFCOM</td>
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<tr>
<td>Turkey</td>
<td>Bilgi Teknolojileri ve İletişim Kurumu [<a href="http://www.tk.gov.tr">www.tk.gov.tr</a>]</td>
<td>BTK</td>
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<tr>
<td>United Kingdom</td>
<td>Office of Communications [<a href="http://www.ofcom.org.uk">www.ofcom.org.uk</a>]</td>
<td>Ofcom</td>
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</table>
Appendix B: Suggested Further Reading


2. **Opportunities in Fibre to the Home (FTTH) and How to Make a First Assessment** – an independent report by Ventura Team LLP for the FTTH Council Europe. Contact Ventura Team.


9. **ICT Regulation Toolkit** *infoDev* in cooperation with the International Telecommunication Union (ITU) [http://www.ictregulationtoolkit.org](http://www.ictregulationtoolkit.org) [accessed 16/01/2011]
## Appendix C: Glossary

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

FTTH: Shaping the Future of a Content-based World

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

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

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

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

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

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

Back to the Future

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

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

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

Striking changes in communications usage have also taken place in the home. Over a decade ago, receiving a phone call when online usually resulted in a dropped connection.
Consumers today would baulk at such levels of service. Instead their requirements are growing in line with the simultaneous use of several residential broadband applications. And there is every sign that consumers’ demands will grow, with the next stage in delivering content and interactive video broadband services requiring more capacity than today’s legacy networks can provide. If service providers are to avoid their customers cancelling their subscription and going to competition, then they will need to invest in infrastructure that can cope with huge capacity requirements from both fixed and wireless usage.

Figure 12: The evolution of services and bandwidth is closely connected

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

New Investors in Infrastructure

Today most consumers’ upload capacity is a small fraction of their download speeds. A large jump in two-way bandwidth capacity in the form of FTTH promises to unlock a raft of new applications that will benefit consumers, businesses and the suppliers of content, health and education services.
Practically unlimited capacity enables several members of the family to use high definition video applications simultaneously, whether they are watching TV, playing a 3D video game, making a low latency video call to a friend, consulting with a doctor, or posting film clips to social networks. Residential fibre networks will also open up new uses of cloud computing and enable a more flexible and creative approach to work. Not only will home-workers be able to quickly access shared enterprise applications, high upload speeds will make it practical to send, store and share large files of video, music and photos in the cloud. Meanwhile, small businesses will be able to work collaboratively online with suppliers and customers around the world in ways that are today only possible for larger enterprises equipped with fibre access.

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

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

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

**Investing in Innovation**

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

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

**Home Networking**

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

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

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

In June 2011 Facebook and Skype, announced a tie-up to provide a social-networking video application. The companies initially will make a low-quality video calling facility available from within Facebook, which will encourage video communication between Facebook users. The move follows Google’s development of an online multi-user video-conferencing application, called ‘Hangout’, which is part of its social network Google+. 
Bandwidth requirements for all segments of end-users are set to grow rapidly, in line with the availability and adoption of new services. Cloud based applications; video streaming, large file sharing etc. are pushing today’s bandwidth boundaries both in upstream and downstream direction. Although available bandwidth is an important network requirement for next gen services - it is not the only one. In cloud computing, where information can be stored anywhere in the world, low latency is one of the critical requirements. Only fibre to the home fulfills these requirements and future-proofs operators against a cycle of network upgrades.

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

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

Workplace revolution

Of course the transformational effects of broadband reach far beyond an individual’s personal sphere. Today’s broadband infrastructure already enables individuals to connect and do business with a global...
network of companies, from home or the office. The resulting flexibility in working practices benefits employers, employees and contractors alike.

Yet the next step change in how companies and workers collaborate will require FTTH.

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

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

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

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

Transforming healthcare

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

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

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

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

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

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

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

![Figure 14: Collaboration between service providers and different stake holders will further drive richness of Next Gen Services](image)

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

Similar changes could be expected in e-education. One vision is that in the future students could follow individual classes from different Universities and lecturers all over the world. This type of educational system is tailored to fit personal and professional individual interests, but would require the involvement of government educational institutions to address questions such as education program recognition and diploma certification.
Other video-based health care applications include physical rehabilitation systems that run over high-speed broadband, which allow patients to practice movements while imaging sensors pick up any mistakes.

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

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

**Home Study**

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

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

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

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

**Collaborating for the Future**

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

In Europe, larger-scale deployments of FTTH by private operators are only now getting underway. However, municipalities in Sweden, the Netherlands and France have built FTTH networks, which already offer a glimpse of what can be done once enough subscribers exist to encourage innovation by content and application companies.

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

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

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

\(^1\) Verizon’s Q4 2010 quarterly earnings

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

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

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

**It is Time for Change**

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

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

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

Appendix E: FAQs

Deploying Fibre-To-The-Home today...

“The 10 most frequently asked questions”

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

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

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

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

Below are the 5 steps of FTTH deployment:

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

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

**Deploy your outside plant (put your fibre in)**

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

**Implement your connectivity (light your fibre)**

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

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

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

**Enable service models with third parties (wholesale?)**

Expand beyond your traditional 3play services, negotiate quality of service agreements and promote application stores
Step 1: Prepare and keep detailed documentation of all decisions (go or no go?)

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

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

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

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

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

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

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

Additional questions:

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

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

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

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

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

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

In general, considerable cost savings can be realized through a better coordination of civil works in the public domain. For that purpose, infrastructure builders are incorporating GIS (Geographical Information Systems)
-based network design together with planning and documentation tools. This facilitates the exchange of public infrastructure information and offers a more synchronized workflow management between the various infrastructure builders. Field practices have shown that the cost per Home Connected/Passed can be further decreased with improved OSP project management.

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

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

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

Other questions:

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

**Question:** What is the impact of local regulation?

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

**Step 3: Implementing connectivity (light your fibre)**

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

**Question:** Choosing active technology?

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

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

**Question:** How green is FTTH?

Independent studies show that fibre technology, in comparison with legacy systems, significantly reduces the amount of carbon dioxide which is produced by communication activities. Fibre optic systems can transport
different types of data over one cable and one network, thus eliminating the need for parallel infrastructures and power provisions for CATV, fixed telephony and fixed line Internet. Furthermore, fibre optic systems can transport data over much greater systems at lower power utilization rate.

Additional questions:

**Question: How can technology continuity be assured?**

**Question: How can truck roll be minimised?**

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

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

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

**Question: Why choose FTTH?**

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

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

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

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

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

Furthermore, policy makers consider FTTH a motor for socio-economic development as well as providing the opportunity to introduce services such as e-health, e-learning, e-government to citizens. Providing services relevant to personal lifestyle and bringing added value to society will further accelerate the mass market acceptance of FTTH.
Step 5: Enable service models with third parties (wholesale?)

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

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

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

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

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

Question: How to expand beyond traditional triple play offerings?

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

Additional questions:

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

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

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