



Next Generation Access Infrastructure Green Paper



foreword



Delivering a next generation infrastructure is one of the seven pillars of the Smart Island Strategy. Although many may argue that Malta is well served with communications infrastructure our vision is that we are moving ahead of other countries, with a clear vision to achieve our 2010 targets. Our ambitious mission is to be the country of the future, where we realise to the fullest extent the potential of new technologies. Our size helps in deploying nation-wide projects as we manage to bring together all major stakeholders to discuss and partner on initiatives which have a tangible improvement in the way we communicate, attract investment and provide services.

A robust infrastructure helps citizens and businesses prosper in the information age. It is an imperative to attract knowledge workers and the services industry for a thriving economy. The deployment of next generation networks as part of a national high-speed broadband plan will ensure that we do not create new digital divides, between those that have access to very high speed services, thus accessing highly-interactive bandwidth-hungry applications and others who have limitations in speed and are not in a position to access the same services. Government's plans in the provision of e-services are equally ambitious and, among other services, in the coming months we will deploy eLearning solutions in our schools enabling highly interactive solutions to be available to parents, teachers and students. Investment being done in such platforms and services will not be leveraged to the maximum if we have limitations in terms of broadband capacity at the subscriber level.

On a corporate level, access to next generation networks will allow new and existing businesses to operate globally. The presence of next generation

networks, including fibre technology covering the last mile, will enable innovative services at the micro-level as even small locally-based firms will have access to highly interactive tools and applications including the production and sharing of high-bandwidth content. In such an environment the software as a service concept can be truly enhanced as companies will be serviced by applications delivered through the Internet rather than holding their company software applications in-house on a server dedicated to host the applications. This capacity at the local level coupled with a resilient and secure international connectivity infrastructure will dilute our insularity disadvantage; especially since increasingly the location of today's knowledge-based industry is less and less dependent on the geographic position of a country but highly dependent on excellent, state-of-the-art communications infrastructure at the local and international level.

I invite all stakeholders to participate in this consultation, providing feedback on how Malta can exploit to the full the opportunities from the deployment of next generation networks. I believe the next few months represent an excellent opportunity for Malta to excel further and move closer to being one of the leading information societies in the world.

**Austin Gatt - Minister for Infrastructure,
Transport and Communications**

The use of broadband internet is transforming the global economy, integrating regions and countries, transforming them into borderless territories where communication at individual and enterprise level is conducted in real-time and through highly cost-efficient vehicles enabled by IP-based networks.

Broadband has created a new and dynamic societal paradigm where all citizens, wherever they live and commute now have access to information and communication technologies enabling them to participate and consume all aspects of social and professional life.

Government's ICT vision for 2010, as communicated in the Smart Island Strategy is to establish Malta as one of the top 10 information societies in the world.

Technology will be used to eliminate societal disparities and bring new opportunities to those who have been economically disadvantaged and others who due to economical, intellectual physical and other impairments are not reaping the full benefits from the use of information and communication technologies. Government's goal is also to use ICT to improve the quality of life of those residing here and others visiting the country; thus improving the tourist experience by leveraging on the dynamic developments of technology to sustain the contribution of the sector to the country's economy. Through the enhancement of the country's incentive programme to local and

foreign firms as well as a series of other initiatives to be implemented in the coming years, Government has also set the goal of having the ICT industry as one of the main pillars of the economy.

The Smart Island Strategy aims to provide a world-class ICT environment through the availability of highly resilient, secure and reliable ICT infrastructure, capable of supporting the projects to be enrolled over the next two decades by the private and public sector. Although the current nation-wide ICT infrastructure has sustained the country's progress in the use of telephony, internet and other forms of communication used at household and corporate level, developments in technology and the provision of services necessitate further investment in next generation networks (NGNs).

A priority of our strategy is to sustain the investment in the high-speed broadband infrastructure by facilitating the deployment of next-generation infrastructure. The existence of this infrastructure will enable the delivery of new e-services that can significantly improve the quality of life, while positioning the country among the leaders in providing an optimal environment for doing business. The current disparity between countries in the deployment of next-generation infrastructure present a window of opportunity for Malta to roll-out the next-generation access network and attract foreign investment that is aggressively being targeted by other countries.

The purpose of this Green Paper is to present the various issues which have to be addressed by the Government and the private sector in taking the country towards the next generation infrastructure. Its objective is to facilitate a consultation process with the participation of all stakeholders who have an interest in the implementation of new networks, both from the supply and demand end.

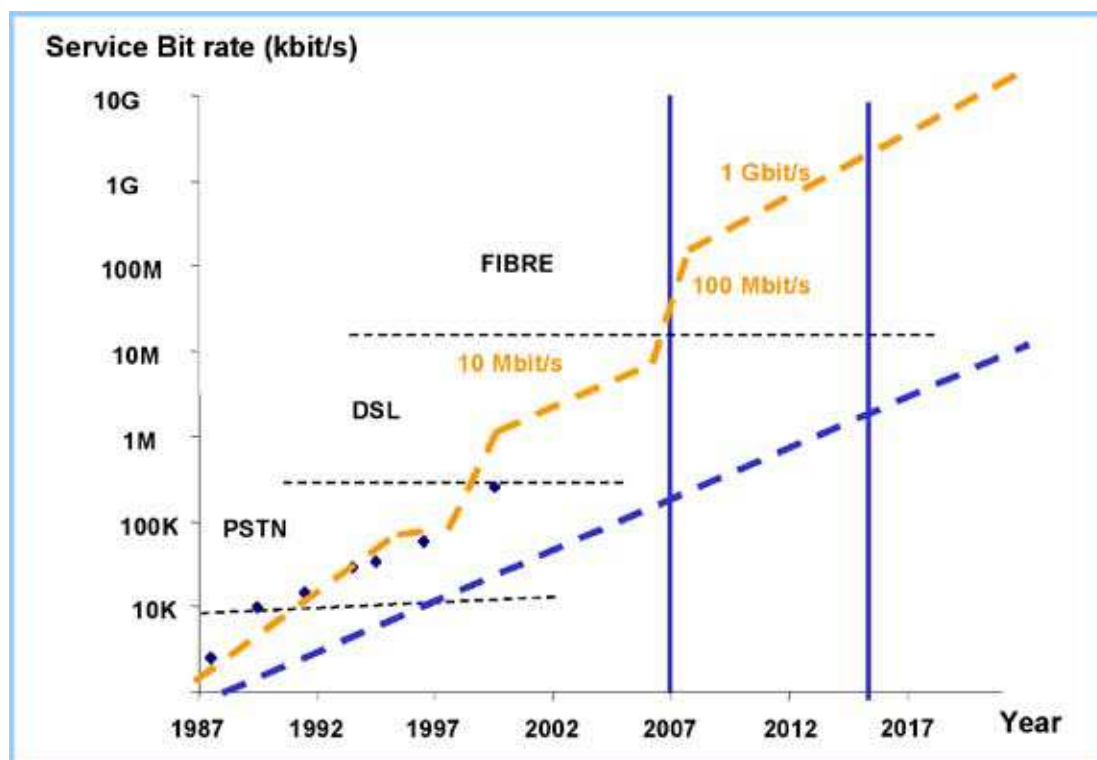
1.0 next generation networks

1.1 BROADBAND TECHNOLOGIES

The so called “Nielsen Law” state that every 10 years the required bandwidth will increase by 100 times. In the last 40 years this ‘law’ has been perfectly followed and there is every indication that this trend will continue.

According to the law, the bandwidth requirements in the next 10 years will arise from 25 Mb/s (Y2007) to 100Mb/s, to 1Gb/s and then fly to 10Gb/s.

Figure 1: Nielson Law Demand for Bandwidth



Generally, broadband is a combination of digital communication technologies with the capacity to transmit significant amounts of data at very high speed, supporting the delivery of a wide range of interactive voice, data and video services, some or all of which can occur simultaneously. The most critical aspect of broadband is what it allows a user to do.

There is no universally accepted definition of broadband and national definitions vary. In the recent past it was generally agreed that broadband applied to “always-on services considerably faster than ISDN”. Today, considering the large diffusion of DSL, the definition has been upgraded to identify “always-on and large bandwidth bi-directional video services”. Definitions can be based also on technical criteria, such as the capacity of the communication link, both downstream and upstream, or on functional characteristics.

Since the leading edge of technology is running at a fast pace, the capabilities of broadband and the demand for broadband services are expected to evolve considerably. Network operators need to consider growing demand for improved performance when designing and investing in next generation broadband networks.

In a study commissioned by Liberty Global it is predicted that by 2011 the downstream requirements of households would peak at around 50 Mbits and the upstream requirements would peak around 8 Mbits under the assumption that an end user will need less upstream than downstream bandwidth. The breakdown of the bandwidth usage is as per table on the next page.

TABLE 1: PREDICTIONS ON BANDWIDTH CONSUMPTION

Services	Downstream Mbit/s	Upstream Mbit/s
World Wide Web / e-Mail	0.2 - 5	2
HDTV (per channel / device)	8 - 10	0.5
Peer to Peer	0.2 - 5	2
VoIP	< 1	< 1
Interactive Gaming	2	3
Instant messaging	< 1	< 1
Audio, web radio, podcasts	< 0.5	< 0.5
Video conferences	2	3
Home security	2	0.5
e-Government	< 5	< 0.5
Average demand per household	< 50	< 8

Source: Arthur D Little¹

¹As quoted in Developments in Fibre Technologies and Investment (April 2008, OECD), www.oecd.org

The availability of very high speed broadband access enables new services to deliver either for work, leisure and other services to the citizen (e.g. e-administration, e-learning, e-health). High-speed broadband access enables a new enhanced user experience such as TV streaming on a PC, TV picture-in-picture, and new applications such as 3D TV and TV programme interactivity. Content aggregation by multinationals such as Google, Yahoo and AOL are challenging the business model for broadband offerings as the

improved quality of service needed to provide high quality programmes and videos online is presenting new challenges in the last mile broadband provision.

High-speed broadband technologies allows services that require symmetry such as distant access services, including home automation and video surveillance network cameras. Community applications are also facilitated such as peer-to-peer, content sharing, enriched instant messaging, videophones and grid computing solutions.

Wired networks based on existing infrastructures such as PSTN and cable are increasingly augmenting their speeds through technical advancements in the standards they operate (e.g. DOCSIS 3.0 and VDSL2). However, network operators are also increasingly considering complementing these developments with extensive fibre deployments.

xDSL

The speed of DSL connections is dependent not only on the standard in use but more importantly upon the distance between the switch and customer. In order to increase bandwidth per customer, the fibre network will need to be brought to the street cabinets. This kind of network is referred to as Fibre to the Node (FTTN). In the Netherlands KPN has estimated that it will need to go from 1350 local exchanges to its 24-28,000 nodes so it can come within 450 meters for 8 million of its customers. In other areas VDSL2 is used to bridge the last 100 meters in large buildings. These networks allow speeds of up to 100 Mbit/s symmetrical bandwidth.

The main advantages of the DSL-based networks lies in the efficient use of existing infrastructure while the dedicated bandwidth towards and from the user, allows for the continuous streaming of applications without interference from other users.

The disadvantages of DSL-based networks are the negative effect of distance on performance, while the streaming of content (eg. IPTV) may consume the downstream bandwidth of the line, thereby limiting the downstream capacity for other services.

Cable

A number of cable operators have in recent years made investments in transforming their network into a hybrid fibre/ cable network (HFC). This was mainly to offer digital and Internet services to their customers. The new Docsis 3.0 standard which will become operational in the coming years allows for 160 Mbit/s downstream and 120 Mbits/s upstream. However, bandwidth in cable networks has to be shared by multiple customers.

The advantages of cable networks lie in the possibility of offering 160 Mbit/s or more downstream by combining a number of channels to a group of customers; television can be offered separately from data communication, while existing infrastructure can be used for efficient implementation (both in terms of time and cost).

The disadvantages lie in the shared nature of the bandwidth - the more users use the network simultaneously, the less bandwidth available per user. The availability of upstream bandwidth is more limited than downstream, limiting the use of certain applications originating from the end user.

Wireless

Wireless technologies are also used to bridge the first mile towards the end customer. Wi-Fi and WiMax usually allow speeds of up to 54 Mbits, but speeds available are limited in terms of available spectrum capacity and moreover are shared among the users of the network thus limiting the bandwidth available when users are online simultaneously. In WiMax sustaining the maximum speed requires equipping each cell with its own fibre, thus increasing the cost

of deployment. Due to its range and high speed, WiMax is increasingly used in rural areas and in places where wired solutions are not commercially viable. Wi-Fi is limited also by the short range of the signal, positioning the technology as a good solution inside homes and in other confined spaces.

Although the extent that wireless technologies will be competitive in providing bandwidth in the last mile is still uncertain, it is likely that the future of wireless networks will be in converging with other wired fibre or hybrid networks. However, the concurrent existence of wireless technologies with these networks is crucial for improving mobility in and around workplaces and homes.

1.2 BROADBAND IN MALTA

Malta's geographical size and population density have conditioned the development of the electronic communications sector and in the past decade has experienced significant growth in output and services offered. The small size of the market, often cited as the most challenging factor for commercial viability for capital investments of substantial nature, has been offset by the limited geographical areas that facilitated national coverage of broadband technologies. Traditionally Malta was serviced by two fixed network operators capable of offering multiple services over their nationwide DSL and cable network. As of 2007, Vodafone Malta Ltd launched its WiMax network over which it is offering wireless broadband and IP telephony services. Other WiMax networks are expected to be deployed in the near future.

Go plc and Melita Cable entered the broadband market in 2000, and today both operators are vertically and horizontally integrated, and offer converged services and triple / quad play bundles. Go plc operates a fixed, mobile, data and DDTV network while Melita Cable provides cable TV, fixed telephony and broadband services over its own network. Melita's acquisition of the third 3G mobile operator, enables Melita to offer mobile telephony services in the near future.

Both fixed networks pass over 95% of homes in Malta and both have a connection to the majority of households in Malta.

As at March 2008, there were approximately 95,902 Internet connections in Malta - 96% of which were of the broadband-type. This translates in fifty-seven per cent of residential and non-residential units having a broadband connection, and 22.6% in terms of population. As at April 2008, the retail market split between DSL and cable stood at 48:52 respectively. DSL is provided through a number of ISPs, whilst cable broadband is provided through OnVol (Melita's own ISP).

1.3 FIBRE TECHNOLOGY

The maximum bandwidth sustained over a connection and made available to the end user is dependent on the architecture of the network. As above, on some networks users have to share the same physical network and therefore simultaneous usage limits the amount of bandwidth per user. The contention rate is the rate between the maximum amount of the bandwidth needed if all users use the network at maximum speed and the actual bandwidth

that is available. The upcoming services facilitated by web 2.0 as well as the sophistication of the users in using online applications, such as video streaming and peer-to-peer lead to a more continuous use of bandwidth, limiting the fluctuations possible today when for example a group of users read their static pages or make use of low-bandwidth applications, while a few others opt for highly interactive and bandwidth-hungry services. Fibre optics is considered as the only “no limits” technology to connect the end-users directly to the networks.

Optical fibre is a ‘light pipe’ carrying pulses of light generated by lasers or rather optical sources to a receiving sensor (detector). Fibre light transmission can be achieved over considerable distances supporting high speed, high bandwidth applications unsustainable by today’s copper based networks².

Optical fibre is considered to be one of the main building blocks for all future high capacity home and business broadband access networks. Its transmission capacity is virtually unlimited and unconditional, compared to existing cabling systems. Recent investigations have shown little difference between the deployment costs of optical fibre and copper cable systems. Moreover, the advantages of fibre offering very large bandwidths and strong upgrade potential over large distances at much lower maintenance and operational cost, make fibre a clear choice for any new investment in Next Generation Access (NGA).

The main fibre architectures used to reach to end users are:

- FTTC / N (fibre to the curb or node) - fibre is deployed to the street cabinet / node and from there the existing copper loop is used to access the home;
- FTTB (fibre to the building) - fibre is deployed up to the building from where copper is used to connect to user premises;
- FTTH (fibre to the home) - the local loop is made up of optical fibre from the optical distribution frame (ODF) of the service provider up to the end user’s home.

In FTTH deployments there are two architectures that can be used for the laying of fibre. These are:

- Point-to-Point - Known as the star topology, the cable plant provides optical paths from the telecommunications operator’s switching equipment to a single close location such that the optical paths are dedicated to traffic to and from this single location;
- Point-to-Multipoint - A shared infrastructure topology using passive optical network (PON), cable plant provides branching optical paths from the telecommunications operator’s switching equipment to more than one close location, so that portions of the optical paths are shared by traffic to and from multiple locations. This is a tree topology.³

Regulatory implications differ with the type of architecture selected.

At the end of 2007, IDATE⁴ calculates that there were just over 1 million FTTH/B subscribers in EU31 (EU 27 and Norway, Iceland, Switzerland and Andorra), which represents 23 percent growth compared with the previous year. However, the number of homes and buildings passed by fibre grew much faster over the same period, reaching 4.9 million (a 79% increase). When compared to Asia and the US, Europe still lags well behind in FTTH deployment. Asian economies continue to outpace the rest of the world with South Korea moving on the top with 31.4% of households connected by FTTH, followed by Hong Kong at 23.4% and Japan at 21.3%. A large gap separates third place Japan from fourth place Sweden, where 7.1% of homes are wired with FTTH, followed closely by Taiwan at 6.8% and Norway at 6%. Denmark is at 2.5%.

In the i2010 mid-term review⁵ the European Commission confirmed that the investment in next-generation networks is not going ahead as quickly as Europe needs. The Commission will issue a communication on the future of networks and the internet later this year together with a recommendation on the regulatory treatment of next generation access networks.

² FTTH Infrastructure Components and Deployment Methods [Barcelona 2007], www.europeftthcouncil.com

³ Public rights of way for fibre deployment to the home (OECD, April, 2008) - www.oecd.org

⁴ A France-based research and consultancy firm that presented its latest FTTH/B statistics at the FTTH Council - Europe’s annual conference 2008 - www.ftthcouncil.eu/articles/Telecommuk_422_12_303.pdf

⁵ Preparing Europe’s digital future, i2010 Mid-Term Review, COM (2008) 199 final

1.4 THE COUNTRY OF THE FUTURE

In a country where access to the internet is at very high speeds - from 10Mbps to 1Gbps - an array of new innovative services will be made possible. A single secure connection can be used to view high-definition digital TV and videos, video conferencing with friends and family, monitoring of homes from remote locations and managing appliances remotely. Different aspects of a citizen's life will be transformed from the way education and health services are delivered to the way transport is managed and interactions with Government and the business community take place.

High-speed broadband enables lifelong learning. Learning will no longer be confined to spaces and time, but will be accessible, anywhere at any time through all internet enabled devices in homes and other places through mobile applications and devices. Video conferencing will be ubiquitous allowing remote lessons between classrooms in different schools and countries. It will strengthen Malta's participation in the vast educational projects taking place across the EU, with the students being able to participate in pan-European projects from their classroom as this mode of learning will be an integral part of their curriculum, rather than an ad hoc opportunity which is only available after logistical preparations including moving students to places where fast connection is possible. An eLearning platform will be deployed and leveraged to its

maximum potential as students and parents will have access to online information about their curriculum, their assignments, their ongoing performance and upcoming exams. Teachers will have access to online productivity tools, freeing up their time to focus on teaching and student support. The communication between the school, teachers, parents and students will be electronic rather than paper based, creating a virtual community of learning and enhancing the teaching and learning experience, leading to better results harvested from the country's investment in education.

Fibre deployments in educational set-ups are quite common across Europe. The City of Stockholm, in coordination with Stokab - the local utility in charge of the city-wide deployment of fibre networks - has connected the city's primary schools and created online educational services. Each of the 175 schools is served by two fibre pairs (one for administration and the other for student traffic), through which each of the 25,000 students and 15,000 administration PCs can receive both streaming and full-motion video. Students from the age of 6 get an ID through biometry solutions and have access to educational films online, high school courses and to the school portal which includes virtual classroom functions.

Patients with long-term conditions who need long-term observation will be able to monitor their condition from home and feed the results of the tests electronically to their doctors. All the medical

professionals will work on the basis of a single, secure electronic patient record, ensuring that the citizen receives the right treatment faster and minimizing the number of medical record errors. Medical test images will be instantly available to any clinician anywhere, be it in the country's state and private hospitals, public and private clinics and in other countries as the use of electronic records elsewhere is gaining momentum and a country's medical practice will be integrated with other systems being adopted in other countries across Europe and beyond. Video links will also make it easier for doctors to get second opinions from the most appropriate specialists in the country and beyond.

In Government administration, widespread access to electronic productivity tools, including online purchasing applications and electronic performance management will reduce low value-added administration tasks, facilitating re-engineering of the backend and allowing departments to focus more on providing a better service to the citizens. Tools to increase interaction between the citizen and public administration can be deployed and managed, providing the citizens the opportunity to shape the services they receive and participate in decision-making. High-speed broadband enables true remote working solutions and access to central systems is not dependant on location. Teleworking allows more work flexibility as time-consuming commuting is avoided and employee productivity is increased as

the work-family balance is facilitated. At the business level medium and large enterprises will generally demand more bandwidth for services like remote security camera, backup and hosting applications.

Various examples of fibre deployment in European cities can be cited. An example is Eindhoven in the Netherlands where through a pilot project (covering 40,000 families - 84,000 people), funded by the Dutch National Government, a wide range of commercial and public services are now available following initiatives to stimulate investment by infrastructure suppliers to provide fibre technology and service providers to develop innovative services for consumers and businesses. The services offered include: visual traffic information for optimal journey planning; security webcams that can be controlled and viewed via the Internet or on mobile phone; self-care online health services such as blood checks or access to individual medicine prescription online; thematic Internet-television channels (e.g one aimed at children that focuses on healthy living); digital courses to help people cope with unemployment; professional computing and IT courses for non-professional users; live online broadcasting of the City Council; commercial services such as digital IP-based television; neighbourhood internet television for and by inhabitants; and conventional broadband offerings such as IP telephony and movies on demand.

Voices from industry operators and other interested

parties argue that the bandwidth provided by the current technologies suffices to satisfy the needs of subscribers and so there is limited scope in investing to roll out fibre closer to the consumer. The surfing of web pages, downloading a few songs, sending and receiving few photographs and watching streaming video at current picture quality levels can be satisfied through the use of the current cable and copper technologies. Yet the development of higher bandwidth applications is going at a very fast pace. People are increasingly looking at uploading their home videos into emails and web pages, while various electronics companies are launching devices that connect televisions to the Internet. High-definition video is becoming a reality (and one high definition movie takes up as much bandwidth as 35,000 web pages⁶). Increasingly news, sporting events and other favourite programmes are seen over the Internet. Applications that have been limited by the amount of bandwidth in people homes will become mainstream with the advent of fibre to the subscriber. High-definition video, highly interactive distance learning, telemedicine and telecommuting will be an integral part of the lifestyle, facilitated by the limitless capacity of the technology which will be present like the other utilities. Moreover availability of high-speed networks will also lead to the development of other innovative services which are not available to date but will be present once the infrastructure is available.

1.5 THE FIBRE NETWORK

An FTTH network can form part of an existing access network, or be rolled out in a Greenfield environment (new construction projects) connecting any number of end users lines back to a central point of concentration, known as an access node. Comparable to the function of legacy central offices in the PSTN, such access nodes will probably change in quantity and in location as compared to existing network architectures. Each access node will contain the required active transmission equipment used to provide the applications and services over optical fibre to the subscriber, as well as backhaul capacity to provide transport services to the core network.

Access Networks connect via optical fibre:

- A large number of subscribers in residential houses, blocks of flats and multi-dwelling units (MDUs);
- Larger user groups or institutions such as schools, hospitals and businesses;
- Key security and monitoring structures like surveillance cameras, security alarms and control devices;
- Fixed wireless networks (for example Wireless LAN or WLANs over WiMAX);
- Mobile network base stations (masts and antennae).

⁶ www.ftthcouncil.org/UserFiles/File/FTTHQ&A.pdf

From the Access Node towards the subscriber, the key FTTH Infrastructure elements needed are as below:

TABLE 2: ELEMENTS OF FTTH NETWORK INFRASTRUCTURE

FTTH Network Infrastructure Elements	Typical Physical Form
i. Access Node (or POP)	Building communications room or separate POP building
ii. Feeder Cabling	Large sized optical cables and supporting infrastructure (e.g. ducting or poles)
iii. Primary Fibre Concentration Point (FCP)	Easy access underground or pole mounted cable closure or external fibre cabinet (passive - no active equipment) with large fibre distribution capacity
iv. Distribution Cabling	Medium size optical cables and supporting infrastructure (e.g ducting or poles)
v. Secondary Fibre Concentration Point (FCP)	Small easy access underground or pole cable joint closure or external pedestal cabinet (passive - no active equipment) with medium / low fibre capacity and large drop cable capacity
vi. Drop Cabling	Low fibre count cables or blown fibre units / ducting or tubing to connecting subscriber premises
vii. Internal Cabling	Includes external building fibre entry devices, internal fibre cabling and final termination unit, which may be part of the optical network unit.

Source: FTTH Infrastructure Components and Deployment Methods (Barcelona 2007), www.europeftthcouncil.com

Passive Infrastructure

The capacity and speed of the core network is scalable with the demand from the customers. The scalability of the network is easily expandable through improvements in the equipment installed at the network edge and access nodes or Points of Presence of operators (POP).

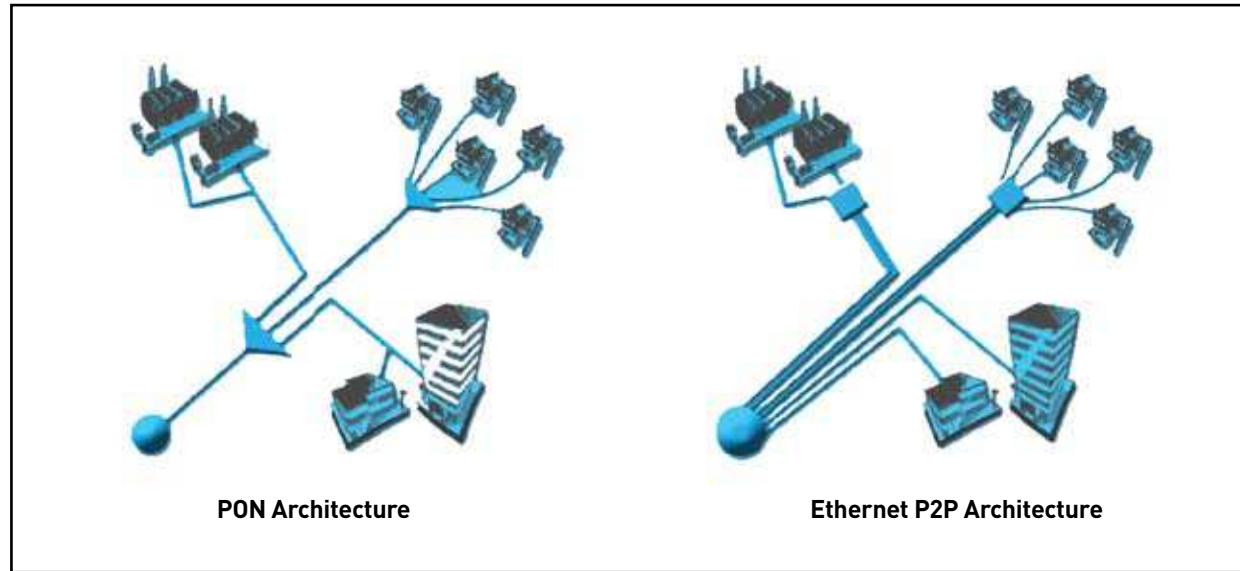
Migration towards Next Generation Network Technologies to replace the legacy PSTN / ATM backbones and transport networks is underway in a number of countries.

As aforementioned, there are two main types of passive architectures, the point-to-point (star network) architecture where a dedicated fibre is run to every end-user and the passive optical network (PON) (tree topology) where one fibre is used to connect multiple end-nodes. Each topology has its benefits and limitations.

The point-to-point architecture is the same design used to connect large corporations with fibre to backhaul networks.

PON architecture is more fibre-lean solution since it uses one laser for sending the data and passive optical splitters split the data towards the individual users. Users send back their data and the splitters integrate the data on the fibre. Like the cable network, the infrastructure is a shared, however in PON the split ratio is 32-64 while on a cable network the split is up to 1,000 users.

FIGURE 2: PON AND P2P TOPOLOGIES



Source: FTTH Infrastructure Components and Deployment Methods (Barcelona 2007), www.europeftthcouncil.com

The fibre deployment can be optimised by using a range of deployment technologies broadly categorised below:

- a) Conventional underground duct and cable
This involves the creation of a duct network (composed of either one large duct or including a network of sub-ducts) to enable subsequent installation of cables. Cables are laid through different techniques, mainly by pulling, blowing or floatation techniques. Duct installation provides the easiest and safest deployment method and also enables further access and reconfiguration.
- b) Blown microducts and cable
This option uses compressed air to blow fibre unit and small diameter cables quickly through a network of tubes to the end user premises. Through this technique fibre deployment can be delayed until the customer requirement has been confirmed. This option may be used in combination with duct, direct buried or aerial infrastructure and the tubes may be housed in constructions designed for any of these three methods.

- c) Direct buried cable
This requires a narrow trench to be excavated in order to effectively bury and protect the cable. Excavation techniques include mole-plough, open trenching, slotting and directional boring. Direct burial offers a safe protected environment for cables but requires careful planning and survey to avoid damaging other buried services.
- d) Aerial cable
This is distribution of fibre using a range of cables supported on poles or other tower infrastructure. The main benefits are the use of existing pole infrastructure to link customers, avoiding the need to dig roads to bury cables and new ducts. Aerial fibre tends to be more susceptible to noise. Besides, maintaining an aerial fibre in an urban area tends to be costly since it has to be constantly re-spliced as new buildings along the fibre path are built.
- e) Other 'rights of way' solutions
Fibre can also be deployed in water and sewer networks, gas pipe systems, canals, waterways and other transport tunnels.

TABLE 3: POINT-TO-POINT VS PON TOPOLOGY

ADVANTAGES

Point-to-point

- Every user has a dedicated connection
- No restrictions from usage by other clients on download / upload speeds
- An individual connection can be upgraded by changing the equipment (laser) at both ends
- No need for high - speed encryption switches in the middle to separate traffic from different users

PON

- Uses less fibre in its roll-out
- One optical port at the central office (less hardware and maintenance)
- Smaller footprints for the central equipment
- The possibility to split the fibre at a later stage (than deployment) to add more clients
- The possibility of long-distance transmissions for up to 60km to reach up to 64 customers

DISADVANTAGES

Point-to-point

- The requirement for a central switch with a dedicated port per customer
- More fibre for roll-out
- No systems are available for the integration of an analogue TV-channel on the same fibre (thus necessitating a dedicated separate fibre to allow analogue TV on the same fibre)

PON

- The sharing of bandwidth between concurrent users
- Difficult to upgrade individual users to higher-bandwidth (but users need to be upgraded all at once)
- Central switches require more encryption to integrate and separate customer traffic

 What are your preferences in terms of network layout? What are the reasons for this preference?

2.0 strategic options

2.0 STRATEGIC OPTIONS

The building blocks towards operating a fibre network are:

- Passive infrastructure - the physical infrastructure used to provide the connectivity;
- Active infrastructure - the elements used to transmit, forward and route information packets over the fibre;
- Service offerings - the services offered to consumers and business that require high-speed broadband;
- Telecommunications services and content providers - the companies that provide services and content;
- Operating company - the company that maintains and operate the active and passive network elements;
- Public sector, residential and business customers - end customers that reside / operate in the area served by the infrastructure

The above blocks can be put together in a number of options which depend on both the local context and the role to be played by the Government in facilitating the deployment of the infrastructure and services.

There are three main strategic models:

a) Equal Access

Equal access is a concept where Government invests to a varying degree in the infrastructure to facilitate the market development while maintaining a level playing field.

There are three variants of the equal access model.

The first is where there is significant existing broadband infrastructure in the area. Here the role of Government can be as a facilitator in bringing together private organisations to ensure that existing assets are used to create a thriving market for broadband services. This can be done by Government and the private sector creating a partnership to manage the passive infrastructure as if it were one asset. The active and access layers can be managed by one or more service providers on the basis of a partnership agreement with the joint venture.

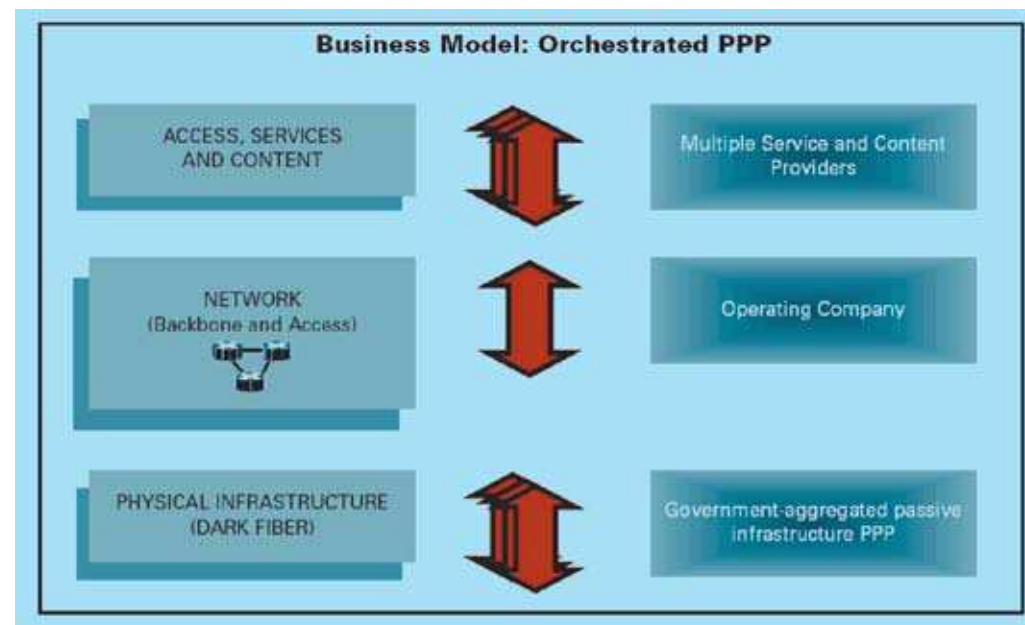


**FIGURE 3:
PPP EQUAL
ACCESS MODEL**

Source: Broadband City, A Roadmap for Local Government Executives, Cisco Internet Solutions Group

An example of this model is the city of Amsterdam. The municipality of Amsterdam has invested in a company to build a fibre-to-the-home broadband access network connecting 37,000 households in Amsterdam. The total equity investment in the project is 18 million euros. The municipality owns one third of the shares, two private investors, ING Real Estate and Reggefibre together another third, while five housing corporations own the remaining third. The wholesale operator of the new fibre network was selected through a tender procedure and provides open, non-discriminatory access to retail operators which offer TV, broadband and telephony services. The project passed through the state aid filter of the European Commission after it was established that the investment made by the municipality was on the same terms that a private investor under market conditions would have accepted (the market economy investor principle). Following an investigation the Commission concluded that the two private companies active in the sector, invested on equal terms with the municipality. In particular, all investing parties would have to support any losses in the event of underperforming business and that the structure of the company ensured that no single shareholder can exert control over the company.

A second option variant is where the public sector takes responsibility for the passive infrastructure.

An example of this model is that adopted in Sweden. The city of Stockholm through Stokab operates a similar model. The model is based on the

philosophy that telecommunications infrastructure should be provided as a 'public good'. In 1994 the City of Stockholm contracted Stokab to lay a public owned fibre optic network throughout the city to provide dark fibre to telecommunications operators and other users at cost-based rates. The fibre-optic ring is an open access network enabling all service providers to use the network for the delivery of their services. Customers of the Stokab network include telecom operators, internet service providers, cable television networks, mobile telephone operators, municipalities, county councils, major banks, insurance companies and new media companies. The service providers are responsible to light their own fibre and provide the wiring in the customer premises. Stokab is not run for profit. A key feature of the Stokab model is having direct access to the city-owned ducts and tunnels. Through its close links to the city, Stokab encounters minimal red tape from municipal agencies. This facilitates the building of new tunnels and ducting.

A final variant of the equal access model is where the public sector takes responsibility for the active infrastructure as well as providing the passive infrastructure

In this model Government builds the passive infrastructure and then leases or sells this to an operating company (or a consortium). The operating company adds the active network layer and sells access to the high-speed network on a wholesale basis to existing and new telecommunications

service providers. The service provider pay a monthly fee per customer to the operating company and independent content providers sell their content through the operating company's portal.

The role of passive layer investor in this model is to stimulate competition at the level of content and services rather than at infrastructure level. By investing in the passive infrastructure it reduces the capital costs for the service providers and lowers the barriers to entry into the market. Regulation ensures a level playing field on which all providers can compete.

In this model the roles and responsibilities of the different stakeholders need to be structured and managed. For example if a customer has a technical or administrative issue, the resolution mechanism need to be clearly agreed upon by the providers. The model necessitates an, extensive governance system and a strong legal framework.

The business case of this model is about splitting the revenues from the different layers of the service offering into the passive network; active components; and services and content. The network owner forgoes part of his income from offering connections, services and content directly to end users for a guaranteed income of the fixed lines from all the operators that are offering the services over the network.

b) Sole Private Service Provider

In this model the operator of the network is also the service provider. The advantage of this model

is that the project has a shorter payback period (than the equal access model) since it becomes more commercially viable at much lower levels of customer revenue. Management of the project is simplified because only one organisation is involved. In areas where there is lack of investment from service providers (for example in rural communities in European countries) public authorities have been involved in all aspects of the project including the passive infrastructure, the active infrastructure and services.

Through this model, competition at the service level is usually limited and the customer will not benefit from competition on pricing. In country's where the model is deployed, the monopoly can be granted as a temporary measure over a fixed term, during which time the sole service provider will generate sufficient numbers of customers to sustain a competitive market.

c) Multiple Networks

The high infrastructure cost involved in the deployment of new networks weakens the commercial case for multiple networks. However a multiple network framework allows multiple players to deploy their respective access network. Ex ante obligations on any of the players can be enforced following a rigorous market analysis by the regulator as per EU regulations for the sector.

Open access to ducts (and other infrastructure for the laying of fibre) through the 'rights of way'

regulation encourages the operators to deploy the new access network, while guaranteeing competitive market developments by extending the access to passive infrastructure for new entrants interested in investing in the passive layer.

There are no straightforward solutions. Rather a model has to fit in the circumstances and priorities of the country.

? Which strategic option or options are more feasible for the deployment of Next Generation Networks in Malta?

2.1 COMPETITION AND REGULATION

Competition policies covering the deployment of fibre can be broadly categorised in two: (i) facilities-based competition and (ii) service-based competition. The former occurs where separate networks are rolled out by different players which offer a vertically integrated offer by owning the passive infrastructure, the active layer (that is the equipment to light up the dark fibre) and service offerings to its subscribers (at household and business level).

Service-based competition occurs where investors in dark-fibre make available the passive infrastructure to service-providers who will operate their own active infrastructure and offer their services on the network.

This is referred to as the open access model (or equal access model). A variance of this model (and also referred to as service-based competition) is when a wholesale operator is established with the sole purpose of providing access to the network (lit fibre) to service providers.

In a facilities-based competitive environment, where the sharing of networks is not mandatory, the different topologies for the deployment of fibre may not result in any changes to the regulatory framework. The impact of the different topologies used for the deployment of fibre may have an indirect impact on the services offered and the pricing models, depending on the ability of the deployed technologies to add-on subscribers in a piece-meal manner and to compete with other technologies available in the last mile.

In a service-based competitive scenario, where network sharing and unbundling is part of the policy framework, the topologies used for fibre deployment have regulatory implications.

As discussed earlier the different topologies in fibre deployment (PON vs Point-to-Point) have implications for the sharing of the network through wholesale broadband access and for local loop unbundling (LLU).

There are four levels at which sharing and/or unbundling can happen:

- Conduit and collocation facilities
- Physical layer unbundling (dark fibre leasing in FTTH networks)
- Data link layer unbundling (dark fibre and link-layer electronics at each end)
- Network layer unbundling

The sharing of the network in a PON topology is only possible if LLU has been taken into account from the start of the network and multiple networks can access splitters in street cabinets or local exchanges. LLU in PON topology is more costly for the alternative operator since its network will need to be deployed up to the street cabinet. This becomes only feasible if there are sufficient customers served by that street cabinet that switch to the alternate operator. LLU is possible in Point-to-Point fibre network and in this case the costs for backhaul are similar to the current ones.

Wholesale broadband access is possible on both types of network, albeit with limitations. In PON networks it is hard to guarantee all the service providers the same quality of service and maximise the usage of available bandwidth simultaneously.

Both LLU and wholesale broadband access can only be imposed following an identification of a significant market player through a market analysis exercise.

New entrants in markets that mandate network sharing can be further facilitated in their initial investment if for example access to the ducts is made on a cost-sharing basis and road works include the setting up of large capacity ducts⁷.

2.2 RIGHTS OF WAY AND IN-HOUSE WIRING

One way a number of Governments and

regulators are facilitating FTTH roll-outs is through provision of improved access to rights of way. Utility infrastructures are increasingly being used for fibre networks since they have an advantage of connecting all buildings. Sewers were used for FTTH networks in Tokyo, Vienna, Hamburg and Berlin. In Paris, the city is offering assistance by providing access to sewers and other conduits available at a lower price and it is also lowering the price of the final drop into buildings. Access to sewer system for FTTH deployment is also a key component to reduce costs in the fibre-laying project in Vienna. The project is run by the municipal utility Stadtwerke Wien, which is wholly owned by the city. The target is to have thirty percent of households in Austria connected to the fibre. The network is offered to service providers through an open access model.

Water systems are also increasingly being examined for FTTH use, while aerial infrastructure is excellent where it exists, although increasingly environmental friendly measures are leading to the burial of overhead cables.

Access to rights of way and the sharing of already existing infrastructure has difficulties in its practical implementation. For example the issue of space in the ducts for the laying of new cables can be an issue together with network integrity. The space issue can be mitigated through the sharing of new civil works as existing operators and new entrants pool together

for an investment in the laying of the infrastructure.

A number of countries have specific regulations that govern the sharing of ducts. In the UK the regulator has taken a soft approach in regulating access to ducts (although currently options for the duct access are being reviewed). However any provider of electronic communication networks (applying for powers under the Electronic Communication Code) must confirm that they are willing to share their infrastructure if requested. In France parties are expected to reach to an agreement on the shared access. There are no legal requirements for the sharing of ducts in Denmark, Belgium and Switzerland. In Finland, the regulatory authority has the right to impose an obligation for access if the construction of parallel infrastructure has a negative impact on the environment.

Sharing of in-house wiring is considered crucial for the deployment of fibre to the home. With in-house wiring being a substantial cost component in the deployment of the network, it is unlikely that there will be multiple wiring systems in the same dwelling. Moreover in the construction of multi-dwelling projects, the owner grants rights to one operator, while inhabitants can opt for a service of a different operator.

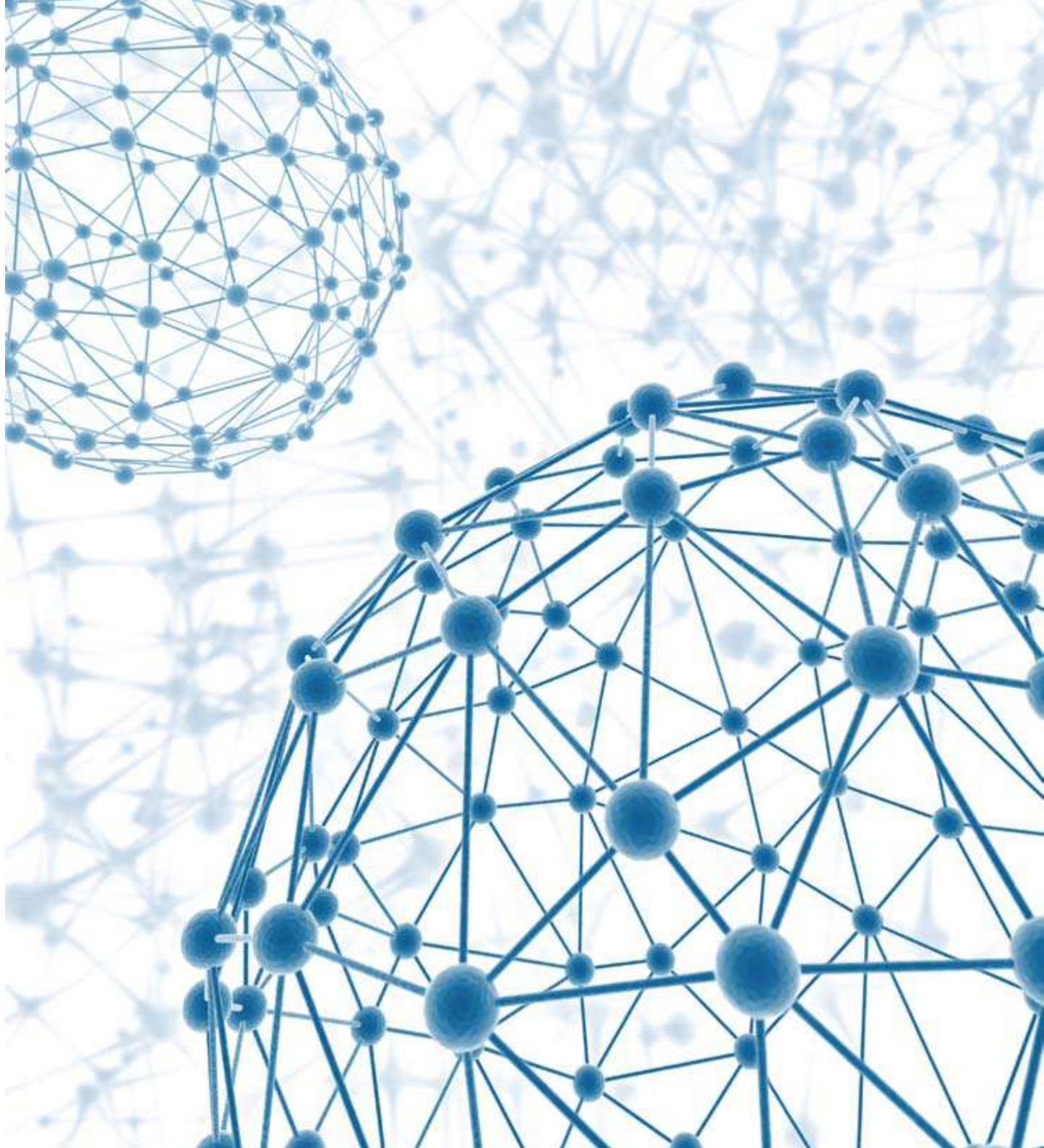
The regulatory scenario for in-house wiring varies between countries. For example in the UK there is no specific legal requirement to allow access

⁷ In the case of Malta the Utilities Act covers the placement of cables and wires below, above, or by the side of any tenement (which includes any road, path, building or water) on a cost-recovery basis.

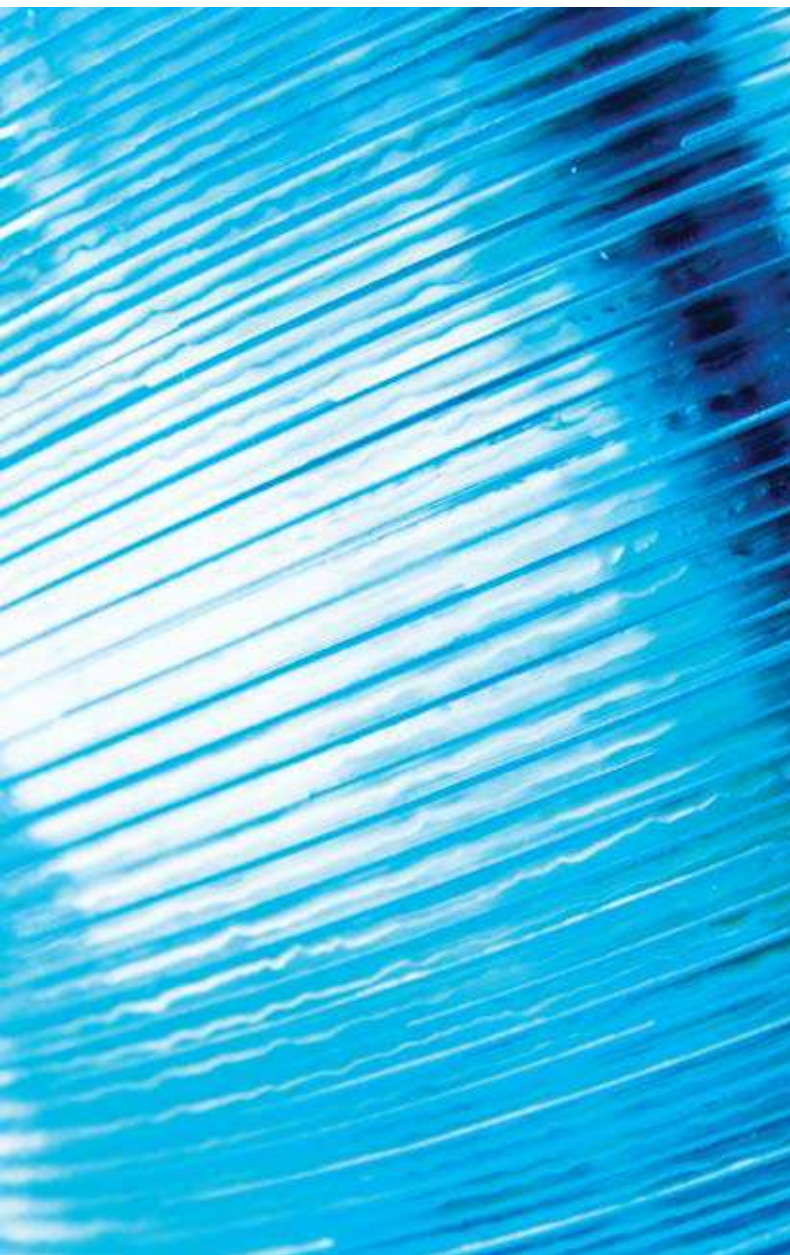
⁸ Brussels, 14-15 May 2007

for networking infrastructure in buildings. No regulations on in-house wiring exist in Denmark, Finland and Switzerland. In Germany a competitor has a right to wiring in accordance with the civil law provisions on rights of property, while the first operator is obliged to grant access but compensated with the cost that covers the granting of access. In Canada the Public Utility Co-ordinating Committee (PUCC) developed regulatory principles governing access to multi-dwelling buildings. The guidelines cover contractual agreements between the operators and the building owners and sets rules on the use of equipment rooms, ducts and in-house wiring.

As confirmed by the 'Bridging the Broadband Gap' Conference Conclusions⁹ public-funded projects targeting passive infrastructure (such as ducts, fibre and antenna sites) are considered to be the least distorting from the point of competition, and local authorities should grant rights of way on a non-discriminatory manner, coordinate the works and encourage the sharing of ducts and other facilities to avoid inefficient duplication of basic infrastructure. The same conclusions state that local authorities could rent ducts to operators on an open and non-discriminatory basis and impose open access obligations. Any road and energy infrastructure works should take into account telecommunications needs since sharing the infrastructure works is cost efficient.



3.0 the role of government



In the deployment of fibre-based networks Government can be a facilitator or investor. Government's role is highly dependent on the competitive situation in the place where the investment will be made, as well as the economic viability of the same investment. In any circumstance, Government needs to communicate a clear vision on its role, and its targets as well as play an active role in balancing the demands of the different stakeholders.

3.1 FACILITATOR

A number of municipalities in Europe took an active role in the deployment of fibre projects. The objective is that the presence of fibre in their territory will increase the competitiveness of the area, resulting in economic benefits to the region mainly through the attraction of foreign investment.

In a facilitator role, Government can have the following roles:

- a) Coordinate the cooperation between the owners of multi-dwelling units and telecommunications providers, such that the infrastructure to fibre deployment is considered as another utility to be made available as part of the building. Government could also work with property owners in raising awareness on the value of property with fibre-ready infrastructure such that multi-dwelling units with such infrastructure are positioned at a higher end of the property market. In France, efforts are being undertaken to persuade building companies by providing a certification which indicates the presence of a fibre cable accessible to all operators in the basement of the building.
- b) Facilitate access to ducts, including those owned by public entities such as utility companies taking into consideration the rights of access during any privatisation process undertaken for the same public entities;
- c) Provide tax or other incentives for ancillary work related to the deployment of fibre, for example repaving and renovation of public spaces where infrastructural works had been completed for the deployment of fibre;
- d) Provide tax incentives on investment in the passive and/or active layer of the network;
- e) Providing incentives at household and business level to ease the cost of the equipment needed by the end-user;
- f) Coordinate the timing of infrastructure digs by different operators in order to limit disruptions in roads and duplication of effort;
- g) Consolidate demand for bandwidth for the use of the public service and entities such that it either leases part of the network (for example have part of the fibre network dedicated to its administration - education, health, public administration) or else procures the service from the different providers;
- h) Drive the demand for NENs through the deployment of highly interactive and personalised eServices in areas such as health and education

3.2 INVESTOR

In a number of countries Government (through municipalities) has invested in the roll-out of fibre-based networks. Such investments were made on the basis that the increased bandwidth enabled by the new networks increases the competitiveness of the region and enables services which have a positive impact on the lives of people living in these communities. The absence of such networks is increasingly a deficiency in the unique selling proposition of the country (or region). Moreover, countries and regions moving fast in the deployment of these networks will temporarily leverage the first-mover advantage. In cases where Government has invested in the deployment of fibre networks, the open access principle to foster competition was adopted.

From the provision of passive infrastructure to the services layer, Government intervention can cover

- (a) decreasing the costs for the laying of the passive infrastructure through the digging of trenches, laying of ducts and providing free access to 'rights of ways';
- (b) provide passive infrastructure to which network providers can connect their active equipment;
- (c) provide the active layer through which service providers can provide their services to the end user; and
- (d) provide the services over the network to the end-users.

Whether Government decides to invest in the deployment of next generation networks or not, its position should be analysed within the framework of penetration rates, investment by the private sector, cost of services and the country's attractiveness for foreign high - value added investment.

In an environment where the Government invests in FTTH, access to fibre should be on a non-discriminatory basis and at cost-based prices through an independent entity established to administer access to the network.

? What role should Government play in the deployment of Next Generation Networks?

3.3 REGULATOR

Network topology choices and the role Government will play in the rollout of Next Generation Networks will influence the work of regulators, whose primary aim is to facilitate the conditions of competition and mimic its effects were it is found lacking.

In the area of communication services, this is done through established regulatory tools such as market analysis. The foundation for this work is the relevant EU regulation and any position or guidelines issued by the European Commission on the subject. The European Commission is expected to issue a specific recommendation on this issue later this year. Flexibility is key to ensure that the

regulatory frameworks adopted by the respective countries reflect the characteristics of the competitive scenario, the roll-out costs for deploying fibre closer to the subscriber and the size of the market.

In other areas, the regulatory role may develop a framework that allows joint construction of ducts that can be shared by different investors in FTTH. A regulatory framework, including guidelines for administrative and financial procedures could also be setup for access to third parties to rights of way owned by Government (including water, sewer, electricity).

4.0 nation-wide FTTX deployment

When building a fibre network, investment is made in the following components:

- * Fibre and infrastructure to lay it in. This investment is in the aerial plants, the trenches, the locations for Points of Presence and other physical infrastructure. This often account for 30-80% of the project cost. The infrastructure lasts for about 30 years although it is often written off in 15 years;
- * Active components in the network (the optical and electric systems that make the network send and receive signals, such as switches and repeaters). These need to be replaced every 5 - 7 years.
- * Customer premises equipment (modems, decoders for IPTV / digital TV)
- * Personnel charges: management, network administration, billing, etc

On a European level the capital expenditure per subscriber is estimated at 2,000 Euros⁹.

TABLE 4: CAPITAL EXPENDITURE PER SUBSCRIBER

	Euros
Infrastructure and Buildings	1,000
Optical Cable	50
In-house wiring	350
Connection	100
Active network components	300
Active subscriber components	200
Total cost	2,000

The cost of this investment is influenced by several factors, mainly: the size of the area where fibre will be rolled out; the building density of the area; the choice of method for deployment (aerial, ducts, sewers etc); type of buildings (multi-dwelling, single units, height of buildings etc); cost of access to rights of way and buildings; urban regeneration charges (cost of repaving, administration charges, taxes etc); type of area (rock vs sand etc); the need for special works for example to cut across crossroads and bridges and the network topology selected (ie PON vs Point-to-Point). These costs can seriously have an impact on the commercial viability of the project since they are mainly sunk costs with minor variances regardless of the number of subscribers.

The capital investment can be reduced through the following:

- * Use culverts in roads where these are available;
- * Use aerial, tunnels and water galleries for the laying of fibre, where these are available. This will eliminate the need to dig new ducts to lay the passive infrastructure;
- * Include the laying of fibre optic cabling in greenfield construction projects;
- * Execute the connection of buildings with the works for power and/or water connection;
- * Coordinate the infrastructure digs of different operators in order to reduce costs of ducts and trenches;

Many policy makers, regulators and industrial investors concur that the levels of investment required to deploy new access lines is a bottleneck for new entrants. However a number of community projects around Europe are today demonstrating that if the cost of passive infrastructure is lowered to the right threshold, the private sector, even the smaller new entrants, will invest in next-generation networks.

Given the size and importance of the challenge, the new access fibre optics network will require unprecedented dialogue, cooperation and consensus between all stakeholders. In order to maximise the benefits of such an investment from a societal and economic perspective, the new network has to rely on pro-active public policy and balanced access regulation that promotes investment, innovation and competition and protects the interests of consumers.

⁹BARCEP in Developments in Fibre Technologies and Investment, OECD, April '08 (www.oecd.org)

5.0 conclusion

Next generation networks present a number of regulatory, administrative and financial challenges which require the concerted effort of public and private stakeholders. On the demand side the next leap to telecommunications infrastructure after the deployment of DSL, cable and mobile technologies will result in an array of new services to be enjoyed by subscribers at a business and household level. On the supply side, the rolling out of this new infrastructure will shape new models and frameworks of competition and cooperation between commercial undertakings, regulators, and new telecom companies considering entering the market.

FTTH deployment in Europe has been rather sporadic, with a limited number of countries taking the lead to roll-out fibre networks. Generally this is done at the municipality level, with direct intervention of the city council in facilitating the deployment of the new network. The next few months present a window of opportunity for Malta to actively consider its programme towards fibre deployment in the country, leveraging on the small size of the country to decide on a nation-wide policy to facilitate the presence of next generation networks.

There exist a number of strategic options to be considered by Government in facilitating the deployments of NGNs. The open access model

introduces service-level competition, where infrastructure is considered as another utility and competition is on the basis of content and services offered to the subscribers. Allowing access by service providers at the passive and active layer is another option, which often results in a shorter payback period to the investor. Facilities-based competition is the third option where multiple networks co-exist and investment in the passive layer by multiple operators is encouraged.

Decisions on the extent of the role of Government as a facilitator or investor have to reflect the characteristics of the country's market as well as its targets in the information society programme. Government's clear vision to establish Malta as one of the top ten information societies in the world includes a set of initiatives aimed to improve the ICT infrastructure at a local and international level. The opportunities released through the availability of very high-speed broadband networks will position the country as one of the most innovative countries where the provision of new e-services demanding high bandwidth and symmetric speeds is catalysed through the availability of today's future-proof technology. From an investment point, the next generation infrastructure will substantially increase the country's attractiveness to foreign investors who are looking for jurisdictions

which go beyond the availability of the fibre service on a purely-demand basis but rather have deployed the infrastructure as a ubiquitous resource. The availability of a nation-wide infrastructure will not only contribute towards the *raison d'être* for companies to establish in Malta but will also help the country attract a new niche of service providers which are looking for a nation with fibre to the subscriber to test new offerings and service the Mediterranean and European region.

Government's target as set out in the Smart Island Strategy is that 20% of the households will be connected to the next generation network by 2010. Government will embark on a series of efforts to establish the framework for investment in next generation networks. Through a set of coordinated actions Government will seek to establish the environment for the eventual ubiquity of the next generation networks, establishing Malta as one of the leading countries that is leveraging on the opportunities of the new high-speed networks on a social and economic front.

Feedback on this Green Paper can be sent to MITC on nisco@gov.mt by Thursday 30th September. MITC will then analyse the feedback and decide on the next steps that Government will pursue in the process for the deployment of Next Generation Networks.

REFERENCES:

1. Broadband City, A Roadmap for Local Government Executives, Cisco Internet Solutions Group
- <http://www.cisco.com/web/about/ac79/docs/wp/2010/broadband/Broadband-City.pdf>
2. Developments in Fibre Technologies and Investment, April 2008 - www.oecd.org
3. Fibre-to-the-Home: Basic Questions and Answers - <http://www.ftthcouncil.org/UserFiles/File/FTTHQ&A.pdf>
4. FTTH Infrastructure Component and Deployment Methods, Barcelona, 2007 - www.europeftthcouncil.com
5. FTTH in Europe: Forecast & Prognosis, 2006 - 2011, Heavy Reading - http://www.ftthcouncil.eu/documents/studies/Heavy_Reading_FTTH_Europe_2006_final.pdf
6. Market Review - Wholesale Broadband Access, April 2008 - www.mca.org.mt
7. Public Rights of Way for Fibre Deployment to the Home, April 2008 - www.oecd.org



168, strait street, valletta VLT 1433 malta
main line: +356 2122 6808 fax: +356 2125 0700
www.mitc.gov.mt

