Adoption, Usage, and Global Impact of Broadband Technologies:
Diffusion, Practice and Policy

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Chapter 8
Best Practices and Strategies for Broadband Deployment:
Lessons Learned from Around the World

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ABSTRACT

Broadband deployment is a necessity nowadays. It could help each country, municipality and region to grow and offer better quality of life to the citizens. Today, the emphasis on the development of broadband networks is on fixed Fibre To The Home solutions The lessons learned from countries that are leaders in broadband penetration and Fibre To The Home deployment could be proven very useful for under-served communities, regions and countries where the broadband penetration is low. Therefore, this chapter summarises the lessons learned from implementing (a) country-wide strategies formulated at the national level, and (b) local strategies formulated by the municipalities. Concerning the role of national and local governments, it should be noted that nowadays it is very urgent the involvement of government in the development of broadband infrastructure. Proposed noteworthy remarkable cases are Japan, South Korea and Singapore.

INTRODUCTION

Broadband technology has emerged as the natural next step in Internet evolution and diffusion (Papacharissi & Zaks, 2006). With dialup connections limiting bandwidth and therefore, Internet applications, broadband technology promises high speed and opens up a seemingly limitless gamut of possibilities (Langdale, 1997).

Broadband networks will be as critical to the 21st century as roads, canals, and railroads were to the 19th Century and the Interstate Highway System and basic telephone networks were to the 20th Century (Copps, 2001; OECD, 2001). In addition, broadband is a key element of the

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developments taking place in the electronic communications markets. Prestona & Cawleyb (2008) refer that the European Commission (EC) has pushed broadband to the fore of social and economic policies in recent years. The same direction adopted by many many national governments in Europe. It has aligned broadband developments with furthering information society and knowledge economy developments. To this direction, EC has been particularly active in promoting broadband developments. In particular, the EC adopted an initiative supporting the Lisbon 2010 goals, i2010 (EU (2005).), where broadband take-up is considered an important factor for the emerging digital economy and competitiveness.

The main focus of this chapter is to summarize lessons learned from implementing (a) country-wide strategies formulated at the national level, and (b) local strategies formulated by the municipalities. The policies adopted by these countries for supporting the broadband growth could be proved very beneficial for countries with very low broadband penetration rate.

The rest of the chapter is structured as follows: the next section presents the current status and trends concerning the broadband deployment worldwide. The third section describes the impact of broadband in the economy of a country. The fourth section presents the advantages of broadband technologies and their positive impact concerning Green Information Technology (IT) infrastructures. The fifth section presents the role of governments in the deployment of broadband as well as the advantages of the broadband services for a country. The sixth section presents broadband policies adopted and applied in various countries as well as these policies proposed by European Union (EU) and Organisation for Economic Co-operation and Development (OECD). The next section presents best practices concerning the deployment of broadband networks. The eighth section presents suggestions for broadband deployment, while the last section (i.e. "Conclusions") summarises the results of this chapter.

BACKGROUND

This section presents the current status and trends concerning the development of broadband networks. According to Berkman Center for Internet and Society (2009) these networks offer the highest available speed, by using fixed line, fixed wireless, or mobile infrastructure. These networks are deployed in households and business places. Therefore they are mainly deployed at high population areas and business centres.

The emphasis concerning the development of these networks is on fixed Fibre To The Home (FTTH) solutions.

However, there are still operators adopting VDSL or VHDSL (Very High speed DSL) technology (ITU-T, 2004). Examples are Tele2 in Netherlands (Telecompaper, 2009) and Vodafone in Heilbronn, Germany (Telegeography, 2009). VDSL is a DSL technology providing faster data transmission over a single flat untwisted or twisted pair of copper wires. Therefore VDSL is capable of supporting high bandwidth applications such as High Definition Television (HDTV), as well as telephone services (such as Voice over IP) and general Internet access, over a single connection. VDSL is deployed over existing wiring used for POTS (Plain Old Telephone Service) and lower-speed DSL connections. This standard was approved by ITU in November 2001. The second-generation of VDSL, namely VDSL2 (ITU-T G.993.2 approved in February 2006), supports bandwidth of up to 30 MHz and provides data rates exceeding 100 Mbit/s simultaneously in both the upstream and downstream directions. The maximum available bit rate is achieved at a range of about 300 meters. However, performance degrades as the loop attenuation increases. VDSL2 is relatively inexpensive solution, in case that the operator has already a fibre backhaul and ADSL2+ network. Table 1 compares ADSL, ADSL2+, VDSL1 and VDSL2.

However, a pure FTTH solution is the more promising solution for many countries. As re-

Table 1. Comparison of ADSL, ADSL2+, VDSL1 and VDSL2

	ADSL	ADSL2+	VDSL1	VDSL2
Downstream (Mbps)	8	25	100	100
Upstream (Mbps)	1	1	50	100
Range (feet)	>15000	>15000	5000	12000

ported by Schrier (Government Technology, 2009) for the case of United States, the core of a national broadband strategy is fibre-optic cable in every home and business place in the country. According to Schrier's report, such a network is an investment that would last 50 years or more. The network would support many value added services, such as high-definition video streaming, video conferencing station, teleworking, etc. Furthermore, fibre networks would also support high-speed wireless connections, because wireless access points can be added at any place the fibre terminates (such as home and business place).

There are many variations concerning the business model concerning the management of the passive and active layers of the networks as well as their services. The main emphasis is on open access to in-building, last drop, last mile fibres. Also there is a preference for point-to-point topologies focused on competitive access to passive components.

Furthermore, there is a technological debate concerning optical networks. More specifically, the telecommunications industry, having ten years' experience with both active and passive optical networks, debates about the pros and cons of each solution. Optic FTTH can be implemented with both Passive Optical Networks (PONs) and Ethernet Point-to-Point (PtP) fibre optic networks. A PON (Kramer, 2005) is a point-to-multipoint, Fibre To The Premises (FTTP) network architecture. This architecture uses unpowered optical splitters to enable a single optical fibre to serve multiple premises. The typical amount of premises is from 32 to 128. A PON consists of an Optical Line Terminal (OLT) at the service provider's central office and a number of Optical Network Units (ONUs) near end users. A PON configuration uses less fibre and central office equipment than point to point architectures. The standards in this area are the following:

- BPON (Broadband Passive Optical Network).
- EPON or GEPON (Ethernet PON).
- GPON (Gigabit PON).

Table 2 compares BPON, EPON and GPON (Marcheck, 2006; Li, 2005).

Except the above standards, presented in Table 2,there are two new standards, namely IEEE 802.3av-2009 and SCTE IPS910. IEEE 802.3av-2009 (10G-EPON, 10 Gigabit Ethernet PON) has been approved at September 2009. This standard has been created by IEEE P802.3av 10G-EPON Task Force (http://www.ieee802.org/3/av/). It is backward compatible with 802.3ah EPON. 10GigEPON uses separate wavelengths for 10G and 1G downstream traffic. 802.3av will continue to use a single wavelength for both 10G and 1G upstream with TDMA separation. SCTE IPS910 (RFoG, RF over Glass) is an SCTE (Society for Cable Telecommunications Engineers, http://www.scte.org/) Interface Practices Subcomittee standard in development for Point to MultiPoint (P2MP) operations. Its proposed wavelength plan is compatible with data PON solutions including EPON, GEPON and 10G-EPON. RFoG offers an FTTH PON like architecture for MSOs without having to select or deploy a PON technology.

Table 2. Comparison of BPON, EPON and GPON

	BPON	EPON	GPON
Standard	ITU (G.983)	ITU-T (G.984)	IEEE (802.3ah)
Max. Throughput	622 Mbps	2.488 Gbps	1.25 Gbps
Bandwidth Support	Symmetrical (622/622)	Asymmetrical (2.4/1.2)	Symmetrical (1.25/1.25)
Network Interfaces	ATM	ATM, TDM, GbE	GbE
Network Reach	Up to 20 km	Up to 60 km	Up to 20 km
Pros	• Multiservice (TDM, Data, Video) • Fully defined carrier-class management • Widely deployed technology • Supported by major vendors • Carrier-Class TDM (low jitter, low delay synchronous transport for structured and unstructured TDM traffic)	• Leverages Ethernet cost efficiencies • Easy interface with carrier Ethernet networks • More mature than GPON • Maintains benefit of faster development cycles • Lower cost optics • Simplicity of IP management	• Low delay for TDM traffic in mixed mode only • Mixed traffic mapping
Cons	• Lower upstream bandwidth	• "Best Effort" syndrome • Overhead reduces useable bandwidth • Higher delays and jitter due to store and-forward architecture • Undefined Multiservice • Poor QoS without per-flow queuing • Lack of Carrier-Class management	• More expensive than EPONs • System complexity hampers cost reduction efforts • Complex implementation for mixed mode traffic • Higher cost optics

Ethernet Point-to-Point (PtP) systems are also often deployed. Examples are Metro Ethernet switches and IP edge routers (KEYMILE, 2008). However, optical Ethernet technology can also be used economically for direct subscriber connection via fibre optics. To date, existing systems in the IT world were simply converted and therefore not cost effective. Current FTTx systems offer very high fibre optic port densities, low power consumption and functions specifically for FTTH/FTTB applications. In contrast to PON systems, today's FTTx systems are cost effective and designed specially for use in harsh environmental conditions in public networks. Ethernet PtP systems use standard Ethernet technology for transmitting services to the end subscriber. Commonly available components, such as switches and routers with optical interfaces, can therefore be used for the subscriber as CPE (Customer Premises Equipment).

BEST PRACTICES AND STRATEGIES FOR BROADBAND DEPLOYMENT

Broadband and Economy

Broadband infrastructure is fundamental for the efficient participation of companies and organisations in today's economic. According to a study from Strategic Networks Group (SNG, 2009) local economy development and the secondary investment which is done through broadband is ten times the initial broadband investment. Broadband today is so vital like the electricity in 1930 and increase the participation of digital economy and improve the quality of life (Copps, 2001; OECD, 2001).

Broadband is needed as a complementary investment to other infrastructure such as buildings, roads, transportation systems, health and electricity grids, allowing them to be characterized as "smart". Broadband networks increase

the impact and efficiency of public and private investments which depend on high-speed communications. Some governments have realised the importance of broadband and they have invested public funds to address the limitations of the communication market. These investments fall into two general categories: (a) these for extending access to unserved or under-served areas and (b) these for upgrading networks with optic fibre technologies capable of supporting competitive services in regions and municipalities. Announced government stimulus spending on communication infrastructure will largely target these two types of investment. For example the American Recovery and Reinvestment Act of 2009 (Recovery Act) was signed into law on February 17, 2009. The Broadband Initiatives funded in the Act are intended to accelerate broadband deployment across the United States (AAR, 2009). In addition, as part of Canada's Economic Action Plan (BC, 2009), $225 million was provided to Industry Canada over three years to develop and implement a strategy to extend broadband coverage to as many unserved and underserved households as possible, beginning in 2009-2010. Moreover the UK Government has issued "The Digital Britain Report" (DB, 2009) which describes the Government's strategic vision for ensuring that the UK is at the leading edge of the global digital economy. The report introduces policies to maximize the social and economic benefits from digital technologies.

Economic crisis presents serious challenges and opportunities for structural reform and targeted investment in strategic areas such as broadband. The above raises various issues concerning the best manner that governments could accomplish these goals without displacing or disrupting private investment.

According to Organisation for Economic Co-operation and Development (OECD) (OECD, 2009) the recent economic crisis has led policy makers in OECD countries to consider policies for helping their economies. Most of these policies involve large government expenditures to support demand for goods and services while simultaneously increasing the longer-term productive capacity of the economy. Investments in public infrastructures such as electricity, gas, water, transportation and communications are key elements of most policies because they have immediate impact on demand and employment as well as their strong potential to expand future supply.

The strongly pro-cyclical nature of communication network investment also means that skilled labor and equipment may be left idle and planned projects shelved until the economy improves. This labor and equipment could be quickly shifted to government-funded projects. At the same time, governments must ensure that interventions do not interfere with properly functioning markets or displace private investment.

Broadband and Green IT

Fibre optics could be characterized as "green" technology. It dissipates much less energy than copper based cables and. Furthermore, it saves a lot of materials because one single strand of glass can carry as much data as many thousands copper cables, and it can do over a longer distance without using electronic equipment to regenerate it.

For example the fibre-optic submarine cables provide an efficient approach for supporting an ever growing need for international communications.

Studies supported by, or associated with, telecommunications companies in various countries, suggest broad potential for broadband technologies in supporting activities relative to energy consumption reduction and consequence carbon emissions reduction. When we talk about broadband, connectivity comes to mind. When we talk about broadband technology it shouldn't be limited to technology that supports broadband. The broadband technology includes also technology which is supported by broadband.

The information and communications technology (ICT) industry contributes to 2 per cent of total global CO2 emissions (EU, 2008) but ICT industry can significantly contribute to control and reduce the 98% of CO2 emissions caused by other activities and industries.

Importance of Government Intervention in the Development of Broadband

Nowadays it is very urgent the involvement of government in the development of broadband infrastructure. This involvement can take place either directly with the finance of broadband development projects or indirectly with the creation of an attractive investing and regulatory environment. The creation of an attractive environment aims at private investments for broadband development.

The main reasons concerning the importance of broadband development are summarized in the following paragraphs.

First of all, broadband could be regarded as the new public utility. In other words Broadband is our generation's infrastructure challenge. Broadband is as important as electricity and highways were for past generations. Broadband can facilitate:

- Flexibility on education and training: Distance learning could not substitute the entire educational experience, but it can be used in conjunction with online meetings or weekly face-to-face meetings to create a rich flexible and collaborative educational environment. Broadband services make that possible today, and faster Internet access will enrich these online environments supporting a more flexible and accessible learning environment.
- Medical care improvements: Broadband also can save medical costs and improve access to health care. Delivering radiological scans via broadband requires fat pipes and rapid speeds, but the benefit to patients, insurers and doctors would be many: fewer scans, faster delivery of images where they are needed and lower costs associated with this process.
- Telecommuting expansion: Another benefit of better broadband would be the ability for people to telecommute. This has far-reaching benefits, from fewer cars on the roads to increasing a family's resilience in the face of economic uncertainty.

The above are some examples about the necessity to boost broadband access through governmental policies. Broadband can help promote an educated citizenry, could help lower the costs of providing health care and could increase workforce flexibility and decrease traffic.During the last years it is common the opinion that broadband can contribute to overcome the latest economy crisis (EC, 2009). According to OECD studies (OECD, 2009), broadband networks increasingly contribute to the development of the economy and the society. Broadband networks are increasingly recognised as fundamental for economic and social development. They serve as a communication and transaction platform for the entire economy and can improve productivity across all sectors. Advanced communication networks are a key component of innovative ecosystems and support economic growth.

Broadband Policies

The following paragraphs provide information about some representative broadband policies. More specifically we provide brief description of EC broadband policies, OECD broadband policies as well as national broadband policies of leader broadband countries such as Japan, Korea and Singapore.

EU Policies

Information and communication technologies are a powerful driver of growth and employment. A quarter of EU GDP (Gross Domestic Product) growth and 40% of productivity growth are due to ICT (EC 2005). Differences in economic performances between industrialised countries are largely explained by the level of ICT investment, research, and use, and by the competitiveness of information society and media industries. ICT services, skills, media and content are a growing part of the economy and society.

In recent years, ICT developments have presented a massive growth in information society and media, due to widespread fast communications, connecting multiple devices. Multimedia content (such as films, video, music) is now available in digital formats, and new digital services, such as interactive television, are emerging. The digital convergence of information society and media services, networks and devices is finally becoming an everyday life: ICT will become smarter, smaller, safer, faster, always connected and easier to use.

Proactive policies are needed to support the technological evolution. Digital convergence requires policy convergence and a willingness to adapt the current regulatory frameworks in order to be consistent with the emerging digital economy.

EC proposes a strategic framework, i2010 – European Information Society 2010 (EU, 2005), laying out broad policy orientations. It promotes an open and competitive digital economy and emphasizes ICT as a driver of inclusion and quality of life. i2010 will build towards an integrated approach to information society and audio-visual media policies in the EU.

Drawing on a comprehensive analysis of information society challenges as well as on wide stakeholder's consultation on previous initiatives and instruments, the EC proposes three priorities for Europe's information society and media policies:

- the completion of a single European information space, which promotes an open and competitive internal market for information society and media
- strengthening innovation and investment in ICT research to promote growth and more and better jobs
- achieving an inclusive European information society that promotes growth and jobs in a manner that is consistent with sustainable development and that prioritizes better public services and quality of life.

OECD Policies

OECD argues that policy makers should evaluate the costs and benefits of any public investment in telecommunication infrastructure. Therefore they should fund projects, which can deliver both strong immediate aggregate demand effects and strong longer term aggregate supply-side effects.

In most cases, governments try to create suitable environments for supporting innovative and robust participation by the private sector. Over the past three decades, the role of governments in OECD countries has been to increasingly support market-led innovation and investment in the ICT sector. At the same time, governments recognise that competitive broadband communication networks are crucial for supporting economic and social development. Broadband networks are viewed as a general purpose technology that will not only support critical services but are necessary for innovation, competitiveness and economic growth. In this direction some governments wish to address areas of potential market failure (e.g. reaching under-served areas) through their stimulus packages.

Other Policies

The following paragraphs present significant national policies adopted for broadaband deployment.

Japan has one of the fastest broadband services in the world due to an increase in government support (DOGC, 2009). Recent investments have been directed towards (optic) FTTH network installations which have resulted in broadband speeds of up to 1Gbps. In Japan FTTH is not only fast and reliable, but it is also offered with one of the best prices to speed ratio in the world. Moreover the Japanese government regularly provides subsidies of up to 33% for the maintenance and upkeep of the entire network infrastructure with the aim of propelling Japan to the forefront of the fast growing global digital economy. The Japanese government has introduced a new "zero broadband areas elimination" policy, which will spread broadband coverage to the entire country within two years, to confront this issue. Japan remains the world's leader in connecting homes to optic fibre networks with over 30 million people connected to high-speed networks. Other developed countries around the world are now embracing optic fibre technology so as not to be left behind. It is however not certain if any country can compete with the Japanese, who have already begun investing in high-speed wireless network (Wimax) and 4G mobile transmissions which will be closely followed by the commercialization of 10 Gbps optic fibre networks and eventually 160 Gbps high speed optical connection.

The Korea Communications Commission (KCC, 2009) has announced that about 34.1 trillion won (which is composed of about 32.8 trillion won of private funds and about 1.3 trillion won of government funds) will be invested to change the domestic wired, wireless and broadcasting communication network into an Internet network. They plan to make the world's best converged infrastructure of wired, wireless and broadcasting systems with a guaranteed speed of 1 Gbps for wired networks and 10 Mbps for wireless networks. When this Ultra Broadband convergence Network (UBcN) is built, customers can use all converged services including phone calls, TV, online shopping, and interactive TV finance with UDTV. Furthermore, customers will also be able to use high quality and interactive services like tutoring, medical care, civil affairs solutions, and e-commerce. When people are outside of the house, they can use multi-converged services like Internet access, phone calls, and IPTV 10 times faster than now, using their mobile phones or private portable devices. The Singapore Government has decreed the structural separation of new national broadband network infrastructure from the operating company that will operate its switches and routers (IDA, 2009). The Singapore Government would provide up to S$750m of funding for the network.

The Singapore government in the corresponding Request for Proposal for the passive infrastructure defines that a Network Company, or NetCo, will be selected to design, build and operate Layer 1 passive infrastructure that will carry the NGN traffic, expected to range between 100Mbps and 1Gbps to the end user, with a minimum upload speed of 50Mbps. A separate Layer 2/3 Operating Company or Opco will deploy the electronics such as switches and routers to manage the flow of traffic on the passive infrastructure. This same entity will offer wholesale broadband access to downstream Retail Service Providers, or RSPs. There must be operational separation between the Opco and the RSPs. The network is expected to be complete by 2015 with 50% coverage by 2012.

Best Practices

This section presents best practices concerning the deployment of broadband networks from two viewpoints. The first one regards the business models adopted by several regions or municipalities. The second viewpoint regards the technological solutions adopted by regions concerning their broadband networks.

Business Models

International experience records various business models (OECD, 2003) on broadband infrastructures exploitation, and a few indicative ones are mentioned in the following paragraphs. In general, significant efforts in Europe can be recorded in Ireland, Sweden, The Netherlands and Spain. Furthermore, remarkable examples could be recorded in Canada, New Zealand and United States

- **The Irish development model**. Metropolitan networks are designed as general-purpose networks and not as a technical solution, at least, for a limited number of service suppliers. The networks have been selected and designated by the local authorities, in the perspective of social and economic development. The operation of the metropolitan networks is effectuated centrally, through the establishment of a specific service that operates and administrates the networks. The channel network is planned and constructed so that it can support both fibre optic and copper wire infrastructures. In this particular case the open access model has been adopted.
- **The Swedish model**. The Stockholm case (Stokab): Stokab constitutes a business plan, which is being applied in the wider region of Stockholm, Sweden, aiming at the development and operation of fibre optic communication networks, as well as at leasing of fibre optic connections. The Stokab company was established for this purpose and belongs to the Stockholm Stadshus AB group, which, in turn, belongs entirely to the Municipality of Stockholm. The company was supposed to achieve this goal by providing the market with network infrastructures that are going to permit both operators and different service providers to offer their services to the end-users.
- **The Netherlands' model**. The case of Amsterdam: In the case of the Netherlands, the policies and goals concerning the implementation of broadband technologies regard also the municipalities of the country. The most indicative example is the case of Amsterdam: The Municipality of Amsterdam opted for fibre optics, considering that copper and coaxial cables are soon going to be obsolete. The model selected consists in the creation of a utility service in which the Municipality participates with a 20% percentage, while it owns and exploits the passive network (fibre optic). The other sides participating in the Public Private Partnership (PPP) are private carriers and companies. The network's active part belongs to a private company.
- **The case of Catalonia**. The LocalRet (or Local Network for these Catalonian Municipalities) was formed in 1998 and its intention is to connect 300 municipalities. The main concept of LocalRet network is that the service providers of the network will be its final operators and among its major stake holders. LocalRet will design a homogenous network for all Catalonia, at least at passive infrastructure level. This will be open and parallel to Telefonica's network. LocalRet will start integrating the small parts of the networks that the municipalities and Generalitat (government) control, as part of their ownership of railways, highways, streets, and so on. LocalRet will design Metropolitan Area Networks (MANs) in every city with more than 10.000 inhabitants.
- **United States (US)**. In the US, the cases of the State of Utah (UTOPIA network) and the city of Philadelphia are of great interest, concerning the successful application of business models for exploiting broadband metropolitan area networks. In the State of Utah, eighteen (18) cities have committed

to ensure that citizens and enterprises will keep on being successful and competitive in the 21st century, by securing access to advanced telecommunication services. For this reason, they established the Utah Telecommunication Open Infrastructure Agency (UTOPIA). UTOPIA will develop the infrastructure and will install fibre optic connections to every house and enterprise. Private contractors will undertake the construction of the network and will participate in its operation. All important parts of the network have been funded by government contributions. The UTOPIA business model is classified as an open access/wholesale provider model, which becomes feasible through the interlocal agreement between the participating communities. Apart from the Utah project, in the USA, municipal fibre optic networks are being developed in fifteen (15) states, while wireless networks have been realised in 30 states. The attempt of creating a huge wireless network in the city of Philadelphia presents special interest. The Wireless Philadelphia Project received both public and private funding and its target was the provision of wireless access in the whole city, so that the digital gap would be surpassed and the quality of living of all residents would be improved. Steps have been taken towards the direction of establishing an organisation that assigns the network's planning, development and administration to private companies. The same organisation will provide network access to service suppliers, who will, in turn, offer services to subscribers.

- **The case of Canada (CANARIE)**. The great majority of the current and proposed initiatives for the encouragement of broadband infrastructure development in Canada may be classified into two broad strategies: the demand aggregation model and the public infrastructure support model. The former promotes collective regulations that aggregate the demand for broadband services, on a community or even larger scale, so that the scale economies required for the development and support of a broadband network are achieved. The latter is based on direct public funding for the construction of broadband infrastructures. Although these two models can be applied independently, it has to be noted that, in many cases, they are often combined.
- **New Zealand: The case of Wellington**. The CityLink company was established by the Municipality of Wellington, New Zealand, aiming at the development of a low cost telecommunication network, intending to offer a comparative advantage to the local enterprises and governmental organisations. This network provides the citizens of Wellington with a variety of services, but it also gives massive company users and Internet Service Providers (ISPs) the possibility to lease part of the network (dark fibre) at cost-oriented prices. One of the innovative and most interesting network features, which contributes enormously in its viability, is that it uses low-cost passive and active equipment (i.e. Zebra on Linux), and not expensive commercial network devices.

FTTH Deployment

The following list presents noteworthy efforts concerning FTTH deployment:

- **OneCommunity** (Ohio, US, www.onecommunity.org): The communities in northeastern Ohio have long suffered from deindustrialization and loss of population. In order to revitalize the local economy, OneCommunity, a nonprofit organisation, was created in Cleveland in 2003 to serve a variety of public and nonprofit organisa-

tions in 22 counties across Northern Ohio. The fibre network deployment has been leveraged by government and nonprofits to jumpstart new investment, improve healthcare, education, and engage thousands of area leaders in collaboration over regional economic development.

- **BVU OptiNet** (Bristol Virginia, US, www.bvu-optinet.com): Optinet is recognised as Broadband Fibre Network of Year in US by the National Association of Telecommunications Officers and Advisors (NATOA). OptiNet, which extends from Bristol Virginia approximately 850 miles through eight Southwest Virginia counties, was recognised for "pioneering community fibre to the home and for demonstrating how true broadband can bring jobs and economic development to rural America." Bristol Virginia Utilities (BVU) is a city-owned public utility that provides electric, water, wastewater, cable and advanced fibre-optic broadband services to customers in a 125-square-mile area that includes Bristol, Abingdon and Washington County. In 2003, BVU became the first municipal entity in the United States to build and successfully maintain a fibre-to-the-premises broadband network offering phone, cable and data services.
- **blizznet** (Vienna, Austria, http://www.wienenergie.at): In the field of telecommunications, the Wien Energie subsidiary Wien Energie Wienstrom offers Vienna's extra broadband network (blizznet), which is one of the most modern and fastest broadband fibre optic networks in Europe. Around 12,800 households spread across nine districts in Vienna are currently connected to blizznet. Consequently, the current network consists of more than 1,400 km of fibre optic cables - a network which is constantly being expanded. Moreover, there are 2,200 km of existing empty piping available to expand the network. blizznet offers top-level quality for all (Internet access, TV, telephone, security, data protection and gaming) supporting high-speeds (100 mbps, upload and download).
- **TRE-FOR** (East Jutland, Denmark): TRE-FOR is a multi-utility (for water supply, district heating, electricity and broadband telecom) serving an area of about 28km radius in East Jutland, Denmark. There are three principal towns – Fredericia, Kolding, and Vejle – and about 300,000 customers. The company is organized as a cooperative and is essentially owned by its customers, who can be elected to the 115-member Stakeholders' Committee, which, among other things, helps to set strategic priorities and directions. TRE-FOR has crafted a role for itself as a middleman between its customers and service providers. It's rolling out fibre-to-the-home (FTTH) and Ethernet infrastructure, offering customers a self-service portal for them to order services, and providing a platform that makes it easy for third parties to provide those services. TRE-FOR is not taking on any of the risky business of guessing what applications will prove a hit with its customers. It is still in the utility business, where investments can be amortized over a long period, and thus it's able to keep a lid on costs. At the same time, it's created an environment that encourages innovation and competition among service providers so that its customers (who are also its shareholders) get a wide choice of offerings at low prices. The TRE-FOR network is based on a core-plus-aggregation layer. The core is a dual 5-node redundant IP/MPLS backbone using routers with 10-Gigabit Ethernet interfaces.

FUTURE RESEARCH DIRECTIONS

Concerning the broadband deployment the European Broadband Portal has created a thorough check list for public authorities that covers all steps to be taken in the complex process of developing structural actions and interventions in broadband, mainly for under-served territories but valid also for any other territories (European Broadband Portal, 2009). The guide describes aspects to be taken into account in 5 main aspects of the process:

- **The Mapping and the Coordination**: concerning this aspect the guide proposes actions for gather information about existing infrastructures in the territory; mapping the territory and identifying gaps in provision and opportunities to exploit other infrastructure; identifying the key players (suppliers and users) in the territory; promoting the benefits of broadband; creating a demand aggregation strategy; reviewing best practices in similar territories worldwide.
- **Developing the Business Case**: concerning this aspect the guide proposes actions for developing the action plan and obtaining the support of all key players in the territory; elaborating feasibility study; comparing alternative technological solutions etc
- **Funding rise and find**: concerning this aspect the guide proposes actions for identifying available sources of funding
- **Business models available**: concerning this aspect the guide proposes actions for developing an appropriate business model; ensuring economic/business sustainability dependent on commercial success, etc,
- **Implementation**: concerning this aspect the guide proposes among others actions for preparing open calls for procurement under the "neutral technology approach" for suppliers to build the network and for operators to operate; elaborating plans for providing the appropriate training for public sector employees; designing and establishing systems for monitoring and evaluation

Furthermore, Intel Corporation (Intel, 2009) has identified five essential best practices that can help countries successfully expand broadband penetration:

- **Adopt supportive regulations that embrace innovation and competition**: A wide range of regulatory reforms can be made to create an enabling environment. Hundreds of countries now have national regulatory bodies. Market liberalisation and privatisation can increase private sector investment and healthy competition, and strengthening regulations and making them more transparent can build the trust necessary to spur greater investment and encourage infrastructure sharing.
- **Form mutually beneficial public/private partnerships**: successful broadband deployments begin with a strong commitment from the government that is then carried out through extensive collaboration and partnerships among government, industry and private groups.
- **Invest in infrastructure and the latest innovative technology**: Particularly in developing nations, where the infrastructure is not likely to be fully developed, investment is necessary to support the intermediate infrastructure — including everything from utilities to computers — that in turn enables successful diffusion of broadband networks.
- **Encourage competitive ecosystems**: When policy and regulatory reforms are considered, the encouragement of competition should be a priority, as competition is

critical to the market growth seen in nearly 80% of countries worldwide (ITU, 2008).

- **Release spectrum suitable for sustained broadband deployment**: Releasing spectrum offers a clear benefit: It enables governments to place bandwidth in the hands of private businesses that can then develop its use through emerging industries and technologies, thus offering a significant source of sustained revenue. The question is whether to release spectrum now or later, and based on basic economic realities, the clear answer is that the time is now.

According to Intel, when these best practices are combined with a firm governmental and national commitment and with private and public partnerships, developing nations can achieve the many benefits of broadband networks.

CONCLUSION

Broadband infrastructure is fundamental for the efficient participation of companies and organisation in today's economic. Broadband today is so vital like the electricity in 1930 and increase the participation of digital economy and improve the quality of life.

Furthermore, broadband could have positive impact not only because it offers value added services and it is a vital infrastructure in a country, but also because it can support the vision of many countries for Green IT. Fibre optics is a very "green" technology. It dissipates a lot less energy than copper based cables and it saves a lot of materials.

Concerning the role of governments, it should be noted that nowadays it is very urgent the involvement of government in the development of broadband infrastructure. The involvement of government could take place either directly, with the finance of broadband development projects, or indirectly, with the creation of an attractive environment in order to attract private investments for broadband development. The policies adopted by each country and its government are vital for the broadband deployment. Both EU and OECD are trying to support their members by proposing such kind of policies. Furthermore, almost each country with high broadband penetration elaborates broadband strategies as well as policies in order to support their strategies. Proposed noteworthy cases are Japan, South Korea and Singapore.

Concerning the process of broadband deployment there are many lessons learned from the leading countries in broadband penetration worldwide. However, it is vital to map the process of broadband deployment. Such a map has been elaborated by the European Broadband Portal in the form of a thorough check list for public authorities. This list covers all steps to be taken in the complex process of developing structural actions and interventions in broadband, mainly for under-served territories but valid also for any other territories (European Broadband Portal, 2009). The main aspects to be taken into account are (i) the mapping and the coordination; (ii): the developing of the business case; (iii) the funding rise and find; (iv) the elaboration of business model; and (v) the implementation.

In addition, Intel proposes a list of best practices that can help countries successfully expand broadband penetration: (i) adoption of supportive regulations that embrace innovation and competition; (ii) formation of mutually beneficial public/private partnerships; (iii) investment in infrastructure and the latest innovative technology; (iv) encouragement of competitive ecosystems; and (v) releasing of spectrum suitable for sustained broadband deployment.

To conclude, it could be said that broadband deployment is a necessity nowadays that could help each country, municipality and/or region to grow and offer better quality of life to their citizens. The lessons learned from countries that are leaders in broadband penetration and FTTH deployment could be proven very useful for under-

served communities, regions and countries where the broadband penetration is low.

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