

**Developing successful Public-Private
Partnerships to foster investment in
universal broadband networks**

September 2012

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1 Introduction

The ITU recognizes the importance of broadband services being accessible to consumers and businesses, irrespective of their location. The purpose of this report is to highlight the best practices used by PPP projects to successfully implement universal broadband projects, and thereby improve broadband access to unserved and underserved locations. A total of 13 Public-Private Partnership (PPP) broadband projects have been researched as part of this project. This report takes a broad definition of what PPP means, i.e. any project where there is a mix of private- and public-sector involvement.

The projects were selected to provide insights and learnings from projects from emerging and developed markets across most world regions. To maximize the number and type and best practices and learnings, the projects were selected to include a wide variety of technologies, investment models and funding sources, as well as a variety of approaches by managing authorities to the projects. One of the projects – Lithuania's Rural Area IT Network (RAIN) project – has previously been described as part of the European Union's Guide to broadband investment themes (September 2011). The EU's report has also been used as a model to provide a suitable structure for this report.

The ITU defines 'broadband' as a service with a minimum download speed of 256 kbit/s, but some of the projects referred to in this report define broadband as a service with a minimum download speed of 128 kbit/s. For the purposes of this report, 'next-generation broadband' refers to an evolution away from traditional, exchange- or central-office-based broadband technologies like Asymmetric Digital Subscriber Line (ADSL); however, it should be noted that there is no globally recognized definition for next-generation broadband.

1.1 Aims of this report

The aim of the report is to promote the sharing of best practices adopted by PPP broadband projects, whether they have been used to provide broadband access nationally, regionally, or in rural areas. The purpose of the document is not to focus on the approach followed by any single PPP broadband project, or to promote any one project, but to provide an overall view of the best practices implemented among all the projects. These best practices have been identified as beneficial for future PPP broadband projects, and which, if followed, should deliver successful outcomes.

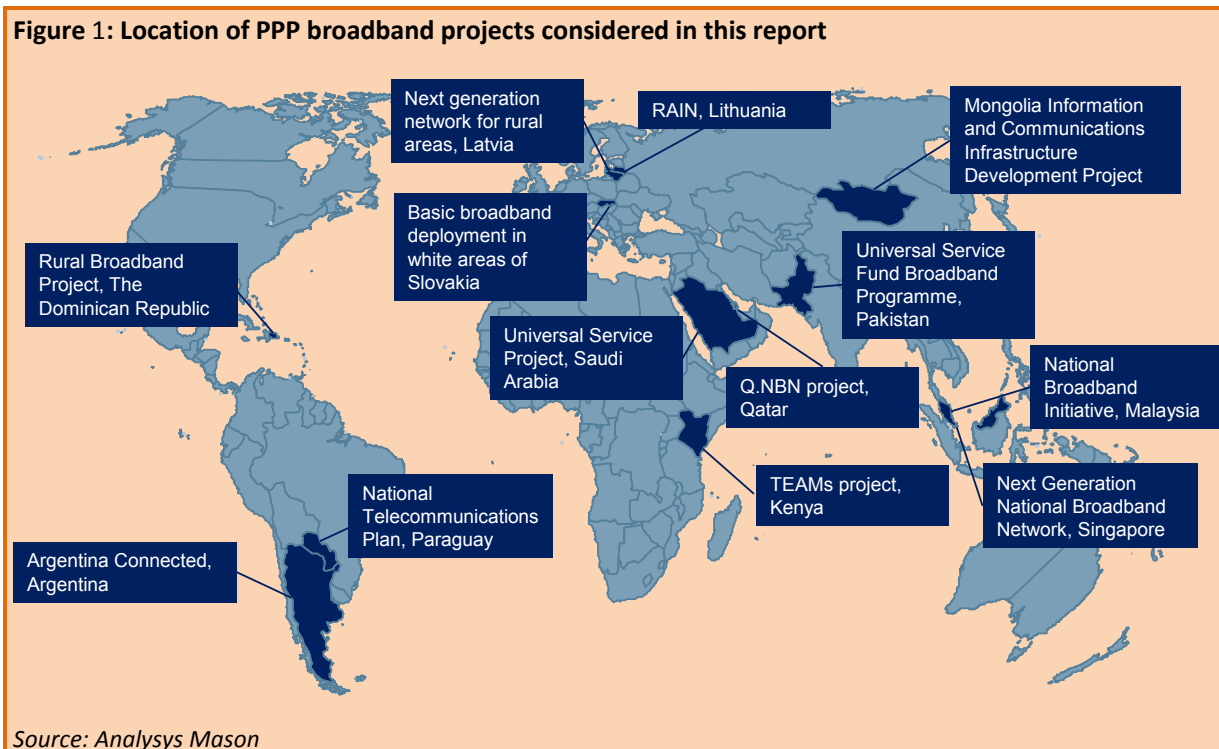
The overall aim of this report is to help PPP broadband projects to achieve successful outcomes by:

- using public funds more effectively
- monitoring outcomes, to ensure the project achieves the aim of providing broadband access or services to the locations/people it is supposed to target
- managing risks, to ensure it is delivered on time and within budget
- stimulating and creating demand to ensure the broadband infrastructure is used effectively.

The report has been prepared using secondary research based on publicly available information aimed at managing authorities with responsibility for preparing for, managing or monitoring PPP broadband projects.

1.2 Overview of the broadband projects considered

This report discusses a total of 13 PPP projects. Figure 1 provides the name of each project and the country in which it is based. Brief details of the projects are provided below, while more detailed information can be found in Annex 1. A summary of the projects grouped by world region is provided in Annex 2, which contains the references that were used as information sources for each project.



- Argentina – Argentina Connected aims to triple the amount of backbone optical fibre infrastructure, adding 30 000km of optical fibre cable by 2015. The project will use a core and backhaul fibre network to provide regional connectivity and facilitate broadband access in unserved and underserved locations. It is funded by government grants.
- Dominican Republic – the Rural Broadband Connectivity Project will provide broadband access of at least 128kbit/s to rural communities, using ADSL and Universal Mobile Telecommunication System (UMTS). Funded using a Universal Service Fund (USF).
- Kenya – The East African Marine System (TEAMS) project aims to deploy a 1.28 Tbit/s submarine optical fibre cable between Fujairah (United Arab Emirates (UAE)) and Mombasa (Kenya) to provide access to international bandwidth. It is jointly funded by the Kenyan government and private-sector financing.
- Latvia – a next-generation network for rural areas is being deployed to provide a regional backhaul/core network to support improved broadband access in rural locations. The project is funded entirely by the European Regional Development Fund (ERDF).
- Lithuania – the Rural Area IT Network (RAIN) project will deploy a nationwide backhaul and core network to improve the connectivity provided by existing access infrastructure, and improve broadband access. Funded using government grants as well as funding from the ERDF.
- Malaysia – the National Broadband Initiative (NBI) is deploying Fibre-to-the-Home (FTTH), ADSL, UMTS and WiMAX to improve broadband access nationally. It comprises two main projects. The High-Speed Broadband (HSBB) project is funded through government grants, and is deploying FTTH to deliver of download speeds of between 10 Mbit/s and 100 Mbit/s to the main economic areas. The Broadband to the General Population (BBGP) project targets other areas

using ADSL and wireless High Speed Packet Access (HSPA) and WiMAX; it is funded through the USF.

- Mongolia – the Information and Communication Technologies (ICT) Infrastructure Development project has the objective of providing broadband access in rural locations using a combination of Wi-Fi and Very Small Aperture Terminal (VSAT) satellite links or pre-existing core fibre. Funded using a USF plus external financing from the government of Japan and the World Bank.
- Pakistan – the USF Broadband Programme aims to improve broadband access (minimum 128 kbit/s) in unserved urban areas and rural communities. The objective is to provide improved connectivity to all Tehsils (administrative districts). Technologies used include ADSL, wireless HSPA and WiMAX, together with a nationwide backhaul and core network. Funded through government grants from a USF.
- Paraguay – the National Telecommunication Plan (PNT) aims to provide broadband access at a minimum speed of 512 kbit/s to underserved and unserved areas by deploying core and backhaul optical fibre cable, ADSL and mobile technologies. Provides grants to operators using a USF.
- Qatar – Qatar National Broadband Network (Q.NBN): a project to accelerate the deployment of fibre to the home (FTTH) nationally, using government funds.
- Saudi Arabia – the Universal Service Project will deliver a minimum of 512 kbit/s broadband access to unserved and underserved locations, using wireless technology. Provides grants to operators from a USF.
- Singapore – the Next-Generation National Broadband Network (NGNBN) will deploy a FTTH network to all homes, schools and businesses, able to deliver 1Gbit/s download and 500 Mbit/s upload speeds. The NGNBN will connect 95 per cent of the population by mid-2012 and 100 per cent of population by 2015. Funded through government grants.
- Slovak Republic – the national broadband project¹ aims to provide basic broadband in so called 'white' areas, consisting of rural regions and other unserved areas: project to deploy a regional backhaul/core network to support improved broadband access in rural and other unserved areas. Funded by the Slovak government, the ERDF and operators.

1.3 Structure of the report

The remainder of this report comprises nine sections, as follows:

- 2: The benefits of investing in broadband: summarizes the reasons why a managing authority may decide to make broadband investments; these are primarily associated with delivering socio-economic benefits, as well as minimizing the digital divide and improving social cohesion.
- 3: Network infrastructure decisions: discusses the infrastructure decisions that an authority may consider to support the delivery of broadband services and provide access to broadband services. Factors considered include the scope of the network (whether it is an access or core network), its capability, and its ability to support competition. An overview of each technology is also provided.
- 4: Investment decisions: presents the investment models used by the 13 PPP broadband projects – bottom-up, private Design Build and Operate (private DBO), public outsourcing, joint

¹ Sources are not clear regarding the official name of this project. Sources state: Basic broadband deployment in white areas of Slovakia

venture, and public DBO. This section provides an overview of each model and considers its strengths and weaknesses, in order to enable an authority to make an informed choice about the investment model to implement.

- 5: Public funding sources for broadband projects: discusses the funding sources used to support the 13 projects. Government grants and universal service funding are the most commonly sources of funds, while external financing from non-governmental organizations (NGOs) has been used less frequently. The amount of funding provided by the public and private sectors for each of the projects is also provided, where this information is available.
- 6: Monitoring and managing broadband projects: examines the various methods by which an authority can monitor/manage public broadband projects and their appropriateness for different situations. Where possible, the information presented is based on how various levels of monitoring and governance mechanisms have been used in practice.
- 7: Creating demand for broadband services: considers the importance of the demand for services in in the context of network investment by an authority. The section discusses two key issues – understanding demand, and encouraging demand to reach the levels needed to make an investment deliver universal access to broadband and realize the required socio-economic benefits or reduce the digital divide.
- 8: Reducing costs and managing risks: assesses the cost of deploying broadband infrastructure and discusses the measures that may be taken minimize costs. Reducing the cost of projects can help to make public funds go further, make business cases more attractive to private operators, and generally maximize the social and economic impact of the investment. The section also discusses some practical measures to minimize the cost of broadband project and manage risk.
- 9: Summary of best practice approach to establishing successful projects: best practices and learnings are provided, which are designed to assist managing authorities to deliver successful broadband projects, and take into account all the broadband projects highlighted in this report.
- 10: Expanding PPP to broadband services and applications: discusses the potential for PPP to be used to promote the development of broadband services and applications and thereby stimulate the need for broadband access and services. The section highlights example projects in which governments and the private sector have invested in PPP programmes to facilitate the development of broadband applications and services, including platforms and incubator programmes.

2 The benefits of investing in broadband

As a first stage in the investment planning process, it is essential for a telecommunication regulator or other managing authority² to define the aims of the broadband investment project – namely what the project needs to achieve, and why. Once a clear set of aims have been defined, these will guide the rest of the project and influence decisions throughout the planning process. These aims can also be used to determine certain milestones, for example the number of kilometres of core network fibre deployed, the number of homes covered by 3G (IMT-2000) or FTTH. These milestones may in turn be used to determine when the private partners in a PPP receive their subsidy payments. A managing authority should consider the appointment of a ‘champion’ to drive the project aims forward, and to monitor progress.

This section looks at a number of reasons why a managing authority may decide to make broadband investments; these are primarily associated with delivering socio-economic benefits, such as creating stronger community relationships, supporting regional development, promoting competition and attracting/retaining investment. A managing authority may also derive benefit from using the network for its own services (including playing the role of anchor tenant, which could help to support the business case).

Above all, it is important for a managing authority to be aware that access to affordable broadband has a positive effect in terms of meeting the most basic needs of the individuals, communities and businesses in a territory. The majority of projects highlighted in this document are intended to reduce the digital divide and improve access to broadband to unserved and underserved areas, whether these are urban or rural. The minimum access speeds to be provided by the various projects vary considerably: in some emerging markets a minimum download speed of 128 or 512 kbit/s is the target, while in other projects 10 Mbit/s is the minimum speed. It is important for a managing authority to keep these goals in mind, and prioritize the long-term benefit of individuals over the short-term gain of private entities.

Some of the example projects which were studied for this guide are in the process of being deployed, while others have already been completed and have been deemed to be a success by the managing authority, or by an external funder (for example, the ERDF).

2.1 Supporting economic development

There are a number of economic benefits that can be achieved by deploying broadband projects, bringing benefits to both consumers and businesses.

Contribution to GDP growth and productivity gains

Numerous academic studies suggest there is a direct link between broadband penetration and economic growth. For example, a recent ITU study³ showed that the impact of broadband penetration growth of 10 per cent, in the growth of the per capita Gross Domestic Product (GDP) is between 0.18 and 0.21 percentage points (pp) in the Arab region, between 0.06 and 0.29 pp in Latin America and between 0.3 and 0.7 pp in Asia Pacific. Finally, broadband appears to be an important contributor to the reduction of unemployment, with a negative effect varying between -0.29 and of -8.6 per cent. These findings confirm the rule of ‘return to scale’ where the contribution of broadband to GDP per capita growth increases with

²To avoid repetition, in the remainder of this report the term ‘managing authority’ is used to refer to whatever organization has responsibility for managing the PPP broadband project: this may be the national regulatory authority, another public authority such as a Ministry, or an agency (e.g. an intermediate body such as a development agency) delegated to provide public support to these networks.

³ Impact of Broadband on the Economy, Telecommunication Development Sector, ITU, April 2012 http://www.itu.int/ITU-D/treg/broadband/ITU-BB-Reports_Impact-of-Broadband-on-the-Economy.pdf

penetration. From a policy standpoint, governments need to fast-forward the deployment of broadband if they want to maximize its economic impact. For example, in Pakistan the Universal Service Fund Company's broadband programme aims to not only improve access to broadband but assist in reducing poverty and use ICT to provide economic benefits to a larger number of people, as well as providing access to services such as e-healthcare. The objective of Malaysia's NBI (commenced in 2007) was to achieve a broadband penetration of 50 per cent of households by the end of 2010, and was anticipated to attract foreign investment contributing to a 1 per cent increase in GDP. According to the government of Malaysia,⁴ the project achieved a penetration rate of 55.6 per cent. A common theme among projects in emerging markets is the use of USFs to provide computer resources (e.g. community-accessible computer labs or free netbooks), as well as software and computer training, to the local population. This is important, to ensure that not only is broadband infrastructure available but that broadband services are also accessible; this maximizes take-up and the resulting contribution to economic development.

Other economic benefits

More affordable broadband connectivity may provide businesses and countries to develop new industries and opportunities for economic growth. The economic impact of affordable broadband connectivity in Africa is providing new opportunities, for example by enabling them to provide business process outsourcing (BPO). BPO is used by firms to contract out activities such as customer care, often to foreign countries where labour is cheaper, is one area to benefit. South Africa is already active in this market, and Kenya has stated that BPO is one of the six pillars fundamental to its ambitious plans for sustained 10 per cent annual economic growth. The necessity for international connectivity is explicitly recognized in Kenya's BPO strategy, which states that it would "launch an international go-to-market marketing strategy to attract investors upon the arrival of the undersea cable."⁵ Given the potential for growth in these industries, the effects of TEAMS and further submarine cables could be as important to east African economies as they are to its telecommunication markets.

Increase in consumer surplus

'Consumer surplus' is a term in economics referring to the amount that consumers pay for a service (or good), compared to the price they would be willing to pay rather than do without the service. In the case of broadband, service outcomes can range from quick access to large amounts of information (e.g. learning and health services), to access to the world's largest portal for social and entertainment services. While none of the projects researched has measured this gain directly, a paper by Shane Greenstein and Ryan McDevitt⁶ showed that in the USA between 1999 and 2006 the gain in consumer surplus generated by switching from dial-up to broadband was between USD 4.8 billion and USD 6.7 billion.

2.2 Minimizing the digital divide

One of the major aims of broadband investment projects for rural areas is to minimize the 'digital divide'. This aim can be described as a 'distributional objective'⁷ to ensure that all regions within a country enjoy similar levels of digital connectivity. Minimizing the digital divide is one of the main targets for almost all the projects in this report, both in emerging and developed markets. The discussion below considers

⁴ SKMM (2010), My Special Edition Convergence, March 2010, National Broadband Initiatives, page 38.

⁵ Kenya ICT Board (2009), "Local Government Shares Services Grant Supported by Rockefeller Foundation"

⁶ Greenstein, S. and R. McDevitt (2012), "Measuring the Broadband Bonus in Thirty OECD Countries", OECD Digital Economy Papers, No. 197, OECD Publishing. <http://dx.doi.org/10.1787/5k9bcwkg3hwhf-en>

⁷ A distributional objective in this context is the attempt to promote equality of welfare between regions (with a comparison either nationally or internationally), frequently through wealth distribution

some of the specific situations that can cause a digital divide, making a commercial business plan more challenging, and therefore discouraging investment in the area by commercial operators. For this reason, public investment in broadband networks in such areas will have the most impact.

- Difficult geographical characteristics – Broadband network development can be restricted by challenging geographical characteristics, such as mountainous terrain (as addressed by the Rural Broadband Connectivity Project in the Dominican Republic) or sparse population (as addressed by the Mongolia ICT Infrastructure Development Project, and the Universal Service Fund Broadband Programme in Pakistan). These factors greatly increase the cost and financial risk of developing broadband services – especially fibre solutions – in an area, and so discourage commercial investment.
- Low level of income – A low level of disposable income within an area (either urban or rural) is likely to reduce the demand for more expensive (newer) services, and in emerging markets may even inhibit the take-up of basic telecommunication services. Low demand reduces the potential for operators to generate a return on investment from deploying broadband infrastructure to such areas, and this is a recurring theme amongst many of the projects studied. Many of the projects use USFs to support the provision of broadband access in unserved and underserved areas: examples include the Universal Service Project in Saudi Arabia, the NBI project in Malaysia and the PNT project in Paraguay.
- Theft and vandalism of telecommunication infrastructure – The theft or damaging of copper and optical fibre cable, or other infrastructure, is a significant factor in the cost of broadband projects in some countries. Orange Kenya, for example, estimates that it loses KES 2 billion (USD 23.7 million each year, as a result of repairing and replacing copper and optical fibre cables that have been cut.
- Power supply challenges – A lack of reliable electricity supply to support broadband access is a problem for rural locations in many emerging markets. Providing a reliable electricity source is important, not only to maintain access to services but also to prevent damage to equipment that can be caused by variations in supply. Ensuring a robust supply of electricity should be taken into account when determining the cost of a broadband project (as highlighted in the Dominican Republic Rural Broadband Connectivity Project).

2.3 Improving social cohesion

Our research highlighted a number of projects whose aims include strong social drivers. These projects aim to achieve a range of benefits from the social impact of broadband. A report by the University of Siegen⁸ on the social impact of ICT classified benefits of this type as follows:

- Provision of e-health services – The ability to access information on healthcare is often listed as a major reason for obtaining access to the Internet. The availability of better health-related information has led to an improvement in healthcare in both the USA and Canada. Among the projects studied, the Broadband Programme in Pakistan uses its core fibre and backhaul network to provide access to telemedicine as well as to supply broadband access in unserved areas.
- Improved contact with community and family – A number of social researchers have concluded that the Internet promotes contact with friends and family, and also allows users to maintain

⁸ University of Siegen (2010), "Study on the Social Impact of ICT" http://ec.europa.eu/information_society/eeurope/i2010/docs/eda/social_impact_of_ict_exec_sum.pdf

contact with people who share similar interests. For example, recent research examining the effects of the OnsNet project in Nuenen, the Netherlands has demonstrated that the project has helped to promote social cohesion among members of the cooperative.

- Remote working – Access to information and communication technology (ICT) enables flexible working practices, in terms of both time and location. This benefits both employers and employees (e.g. parents with young children, who may be unable to work away from home, can now join the workforce). As an example, the introduction of remote working is one way in which the Rural Development Programme in Sweden may achieve its objective of promoting entrepreneurship, employment and helping to sustain Sweden's sparse rural population.
- Education and lifelong learning – While there is little evidence that e-learning will fundamentally replace traditional face-to-face interaction between teaching staff and students, increased ICT penetration can provide large sections of the community with the opportunity to engage in long-term, informal learning. Particularly in rural locations, e-learning can supplement existing face-to-face teaching and provide a wider range of resources and courses that can be studied. Many e-learning programmes are supported by USFs providing free or subsidized computing resources (e.g. in the Argentina Connected project). Engaging students at schools is also seen as important for increasing awareness of the benefits of broadband programmes (as highlighted by the Dominican Republic Rural Broadband Connectivity Project).
- Redistribution of wealth – The provision of broadband services in underserved or unserved areas at similar prices (or even at lower prices) than in more privileged areas helps wealth to be redistributed. Providing local broadband also enables people to spend more time locally, rather than having to travel elsewhere, and encourages entrepreneurs to remain living locally rather than moving elsewhere.

3 Network infrastructure options

This section discusses the infrastructure options that a managing authority should consider when seeking to improve access to broadband services.

There are three important factors that should be taken into account when considering the type of infrastructure to deploy: the scope of the network (i.e. whether it is an access or core network), its capability, and its ability to support competition in the market. These three factors are examined below, followed by a discussion of each type of infrastructure. The table below provides an overview of the throughput speeds and coverage associated with the different infrastructure options.

Finally, this section lists a number of other less important factors that should also be considered when choosing a network architecture.

Table 3.1: Access network infrastructure data throughput and coverage comparisons

Network infrastructure	Download speed	Upload speed	Coverage/range
Fibre to the home (FTTH) Gigabit Passive Optical Network (GPON) (ITU-T G.984).	Up to 2.4 Gbit/s	Up to 2.4 Gbit/s	Less than 60 km
ADSL (G.DMT)	Up to 8 Mbit/s	Up to 1 Mbit/s	Up to 3 km
3G (IMT-2000)	Minimum 2 Mbit/s for stationary or walking users, and 348 kbit/s for a moving vehicle	Minimum 300 kbit/s	Up to 8 km
4G (IMT-Advanced)	Peak data rates of 1 Gbit/s for stationary or walking users, and 100 Mbit/s for a moving vehicle	Peak data rate of 500 Mbit/s	Optimized for up to 5 km
Source: http://www.itu.int/rec/T-REC-G.984.1-200803-I/en , http://www.itu.int/osg/spu/ip/chapter_seven.html , http://www.itu.int/osg/spu/imt-2000/technology.html , http://www.itu.int/net/newsroom/wrc/2012/reports/imt_advanced.aspx			

3.1 Factors affecting the choice of infrastructure

3.1.1 Scope of the network

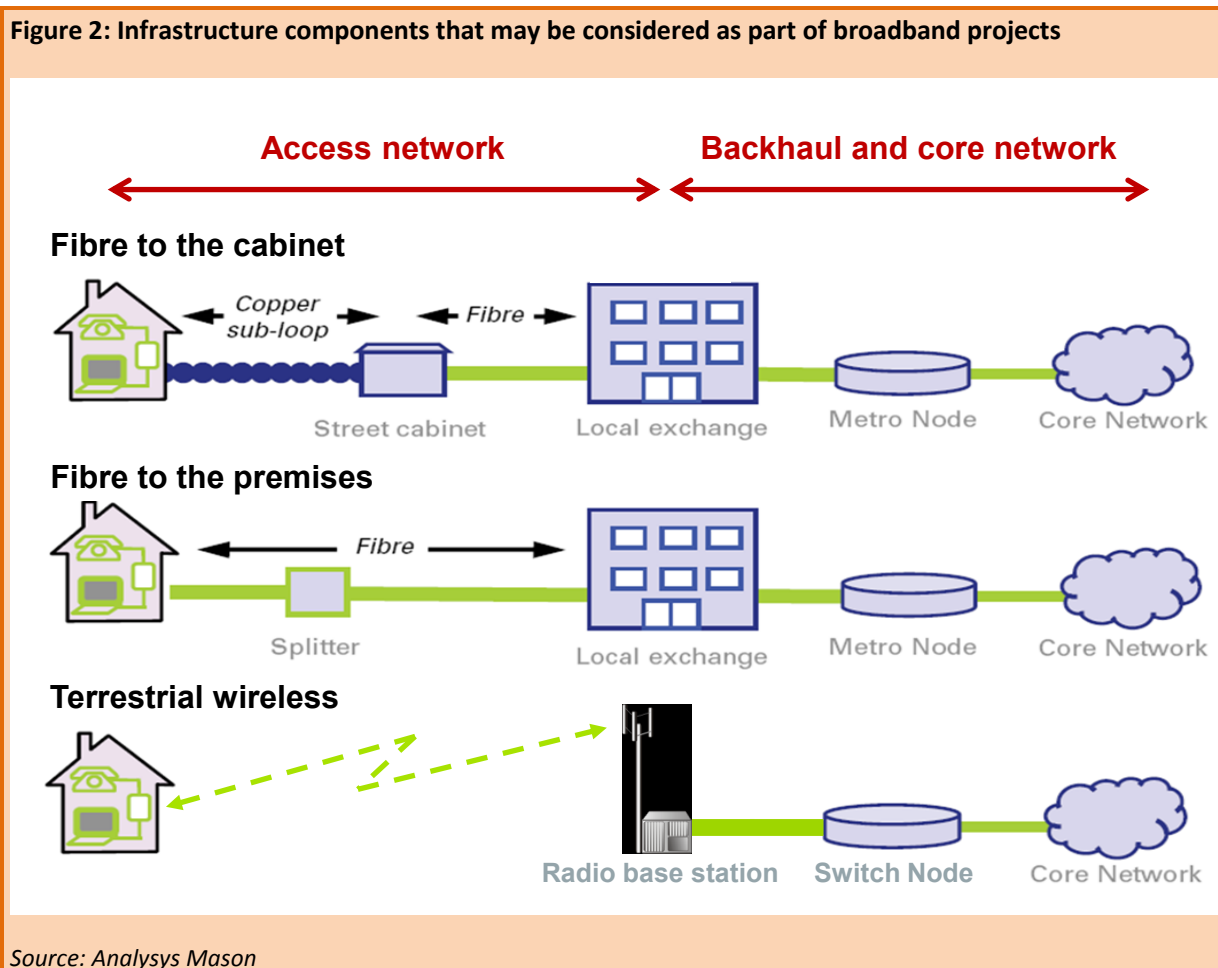
There are two main types of broadband infrastructure that a managing authority should consider investing in: access networks and backhaul/core networks. In addition, infrastructure to provide international connectivity may also be desirable.

An access network provides the connections between end users and the nearest network node (e.g. the local exchange or central office) at which the access network connects with the core network. Various options are available for providing broadband connections in the access network, depending on the requirements and available funding; these options include existing copper lines, new optical fibre cables and wireless networks (including satellite).

Backhaul and core networks provide links between network nodes to allow connectivity over large distances. Core networks link towns and cities across the country (also known as the backbones) and backhaul networks connect local exchanges to core networks. Because traffic from a large number of end

users is aggregated as it passes through the backhaul/core network, optical fibre cable is often the technology of choice due to its high capacity. High-capacity wireless microwave links are also used, particularly in mountainous areas where digging trenches for fibre may be impractical.

The three network infrastructure components that may be considered as part of a broadband strategy are shown in Figure 2 below.



In addition to access and backhaul/core networks, investment in international fibre links (either land-based or submarine) is also sometimes necessary in emerging markets. In many cases the requirement arises because operators want more economical access to international connectivity via fibre, as opposed to low-bandwidth, high-priced satellite connectivity. Operators in emerging markets increasingly need to aggregate traffic from multiple core fibres and connect to international carrier networks which provide access to the Internet and support other data services. Land-based or submarine fibre provides links to international network hubs, to allow the transfer of Internet traffic and other data services. Optical fibre cable is usually used to provide the high-capacity links necessary to support the huge volumes of traffic to be distributed internationally.

3.1.2 Performance of the network

It is essential that a managing authority has at least a broad understanding of the technologies under consideration and the architectures that can be used to meet its requirements, so that it has an appreciation of the trade-off between cost and performance⁹.

It is also important that the managing authority does not specify what technology should be used: rather, it should specify its network requirements in a technology-neutral way. For example, the specification for a broadband access network could require that it should support a particular number of connections at a certain minimum speed. For a core network, the authority could specify that the infrastructure should be capable of supporting service providers requiring access to backhaul links, and also support those service providers' technologies.

It should be noted that a mix of technologies, rather than a single technology, may be appropriate in a particular region. While optical fibre cable usually delivers the highest connection speed, it is expensive to deploy over wide areas, and wireless and satellite technologies are likely to have a role to play in providing cost-effective wide-area coverage.

3.1.3 Ability of the network to support competition

Another important consideration is the impact that the new broadband network will have on competition in the market. In many countries a condition for granting government grants is that the recipient must provide open access to the infrastructure on a wholesale bases, regardless of whether or not the aid recipient has significant market power. It is generally accepted that if operators have access to the passive infrastructure (e.g. copper, dark fibre or underground ducts), they will have more freedom to develop innovative services and compete better with other operators, thereby delivering lower prices to consumers.

For the broadband projects in this report, the relevant guidelines regarding government grants included in the access obligations imposed on the infrastructure operator include providing access to both the passive and active levels of the infrastructure for up to 20 years or the lifetime of the network, without prejudice to any similar regulatory obligations that may be imposed by the regulator. The subsidized network has to be designed in a way that guarantees that alternative operators can have access at all levels: e.g. the infrastructure has to offer sufficient place in the ducts, space in street cabinets, and capacity on active equipment.

In the case of broadband networks, an argument may be put forward that in low-density areas access to the passive level alone will not result in additional competition since it may be not economically feasible to create an alternative network in such areas. Therefore the guidelines regarding government grants for broadband networks require that the new network should be opened at as many levels as possible – not just at the passive level – thus allowing market forces to decide which access products suit the market players best.

Access to the infrastructure (at which ever point it is provided) should not only be open, it should be offered on a transparent and non-discriminatory basis to allow for fair competition between retail service providers. To achieve this, the managing authority will need to design wholesale requirements which

⁹ Analysys Mason has conducted studies which are available in the public domain on the cost and capabilities of both wireline and wireless technologies.
http://www.broadbanduk.org/component/option,com_docman/task,doc_details/gid,1036/
http://www.broadbanduk.org/component/option,com_docman/task,doc_view/gid,1246/Itemid,63/

ensure that operators can compete effectively, regardless of who actually owns and operates the network. Wholesale obligations will need to be detailed in the requirements specification document used in the procurement. If the telecommunication regulator is not the managing authority, then consultation with the regulator will be necessary: the wholesale requirements should be specified so they do not contradict the wholesale obligations stipulated by the regulator, and assurances should also be sought regarding future wholesale obligations that the regulator might advise of.

Example broadband projects in which open-access principles are maintained by ensuring that other market players have non-discriminatory, open wholesale access can be found in Section 6 on monitoring and managing broadband projects.

When considering networks providing fibre to the home, competition considerations will also influence the choice of network architecture. There are two main options:

- A point-to-point (PTP) network provides a dedicated fibre connection to each home. This means that an operator can easily access any particular end user by connecting to the relevant fibre.
- An alternative architecture is a Gigabit Passive Optical Network (GPON) (ITU-T G.984) topology, in which although each customer has their own connection into their home, some of the access network is shared with other users (in a similar way to a cable network).

A GPON network may involve lower costs than a PTP network, but the options for competition are less straightforward as access to different customers must be managed electronically by the network operator. Most of the FTTH projects studied use a GPON architecture, although Qatar's Q.NBN also provides PTP specifically for enterprises, and Singapore's NGNBN supports both GPON and PTP.

3.2 Access networks

3.2.1 Fibre to the home (FTTH)

FTTH involves laying an optical fibre cable to the home all the way from the central office, local exchange or other suitable local access node, such as a public-sector building. FTTH is the technology with the highest capacity, and therefore provides the highest degree of future-proofing. However, due to the long distances involved in deploying a connection all the way to the home, the deployment costs of FTTH can be very high. To date, commercial deployments of FTTH have been limited due to this high cost.

As discussed above, there are two main options for an FTTH architecture: GPON (ITU-T G.984) and PTP. GPON networks usually require less capex to deploy, particularly in less densely populated, rural areas. Studies have shown that the cost of deploying a PTP architecture is on average 10–20 per cent more than an equivalent GPON architecture. The cost difference is higher in rural (less dense) areas than in urban (more dense) areas. As mentioned above, most of the FTTH projects examined in this study use GPON.

However, PTP has the benefit of allowing all operators to have full use of a fibre between the local exchange and the end user (i.e. they allow full unbundling of the fibre local loop). For this reason, PTP networks can be more favourable from a competition point of view. The primary method of competition on GPON networks is via an electronic interface, which may restrict the level of control that an alternative service provider has over the services it can offer. The use of 'wavelength unbundling' technology on GPON networks may in the future offer a similar level of control as a dedicated fibre on a PTP network, but at the time of writing this technology is still being standardized.

PTP networks may also be better suited to providing symmetric services, i.e. connections with the same speed in both directions, as required by some business uses. They are also able to provide higher capacities to end users, and hence are considered to be more future-proof solutions – particularly in light of the prospect of both consumers and businesses moving gradually towards cloud-computing. Cloud-computing provides users on-demand, hosted services – including software as a service (SaaS) and infrastructure as a service (IaaS). These entail the delivery of an application or an infrastructure-related service over the Internet. The solution is hosted by a vendor or service provider and accessible to users (or machines) over an Internet-capable device. The Internet-capable device does not need a special client

to access the solution. The vendor or service provider usually charges the user on a per-month basis for the use of the solution.

Although the cost of deploying an FTTH network depends to some extent on whether a GPON (ITU-T G.984) or PTP topology is chosen, it should be strongly emphasized that for both architectures the cost is much more dependent on the ability to reuse existing infrastructure and the investment model adopted. Furthermore, the sustainability of the project (and therefore the ability to deliver long-term socio-economic benefits) is more dependent on the business model and the expertise of the project partners, than the choice of technology.

In terms of the projects studied, those projects which have already deployed FTTH infrastructure have used GPON architecture. one of the projects is also using PTP. The following projects have deployed FTTH:

- Malaysia, NBI: the High Speed Broadband part of the project aims to provide download speeds of between 10 Mbit/s and 100 Mbit/s in major economic areas, using GPON.
- Qatar, Q.NBN: aims to accelerate the deployment of FTTH and deliver coverage of in excess of 95 per cent (at 100 Mbit/s). Q.NBN FTTH supports GPON for residential and business customers, and PTP for enterprises.
- Singapore, NGNBN: GPON FTTH network to deliver 1Gbit/s download and 500 Mbit/s upload speeds and connect all homes, schools and businesses, reaching 95 per cent of population by mid-2012 and 100 per cent by 2015.

3.2.2 Fibre to the cabinet (FTTC)

FTTC involves laying fibre from the central office (or local exchange) to a street cabinet, or to the basement of an apartment block. Because the fibre does not go the whole distance to the home, significant cost savings can be realized relative to FTTH. However, as the existing copper network is used for the last part of the connection to the home, the speeds available on an FTTC network are significantly lower than with FTTH (the cost to deploy FTTC is around 80 per cent cheaper than the cost to connect a home). As with FTTH technologies, the cost is strongly affected by the ability to reuse existing infrastructure.

3.2.3 ADSL

In developed markets, basic broadband services are most often delivered over the existing copper network using ADSL technology. In contrast, in emerging markets low fixed-line availability may limit the ability to deploy ADSL, and it is often used in conjunction with wireless technologies. ADSL uses the existing access infrastructure and is therefore relatively cheap to deploy. However, the nature of the technology means that speeds are heavily affected by the distance between the local exchange (or central office) and the home; in many cases the speeds available are below 10 Mbit/s.

Four of the example projects involve investment in current-generation broadband (i.e. ADSL), with the intention of providing ADSL access and services to rural areas and unserved locations, delivering a minimum download speed of 128 kbit/s or 512 kbit/s; other technologies are also being used in most of these projects.

- Dominican Republic, Rural Broadband Connectivity Project: provision of broadband access, at speeds of at least 128kbit/s, to 508 mostly rural communities using ADSL and UMTS.
- Malaysia, NBI: the BBGP (Broadband to the General Population) project will provide download speeds of between 256 kbit/s and 10 Mbit/s using ADSL and other access technologies (wireless HSPA and WiMAX).
- Pakistan, USF Broadband Programme: provision of broadband access with a minimum download speed of 128 kbit/s to unserved urban areas and rural communities, using ADSL and wireless HSPA and WiMAX.

- Paraguay, PNT: provision of broadband with minimum download speed of 512 kbit/s using ADSL and other access technologies (wireless HSPA, WiMAX or other wireless technologies).

3.2.4 Wireless and satellite

Terrestrial wireless technologies provide a link between the home and the nearest network node without the need for a physical wireline connection. Terrestrial wireless networks are complementary to fixed networks, and can be advantageous in areas where building a wireline network would be difficult and/or expensive (e.g. in mountainous terrain). However, because several users access the network via the same wireless link, the contention¹⁰ for services can be much higher than on wireline networks, and the actual speed experienced may be much lower than the maximum speed quoted by the service provider. In order to ensure that an end user receives an assured level of service, more base stations may have to be added, depending on the minimum speed set by the telecommunication regulator or managing authority, which will increase costs. It should also be noted that if a large number of users on a wireless network demand high-speed rates, meeting this demand will often require additional investment in the fixed infrastructure (particularly the backhaul network) that supports the wireless network.

Satellite networks offer a useful solution primarily for areas that are not covered by terrestrial networks (either wireline or wireless), e.g. where the existing networks have 'not spots' (localized areas where there is no coverage). Despite their cost and capacity limitations, satellite technologies can therefore play a valuable role in broadband access. As with terrestrial wireless technologies, many users are accessing the same node (i.e. the satellite transponder) and so the effects of contention may have a greater impact than in wireline networks. In remote locations, there may be no choice but to use satellite links (e.g. Mongolia's ICT Infrastructure Development Programme).

Wireless technologies which could provide effective next-generation broadband services include terrestrial wireless broadband technologies such as LTE-Advanced,¹¹ WiMAX based on the 802.16m standard, and high-capacity satellites using Ka-band multi-spotbeam technology.

The costs of terrestrial wireless technologies vary according to a number of factors, including the terrain over which they are deployed, the data rate that must be delivered at the furthest point from the base station, and the overall traffic demand. Indeed, for both terrestrial wireless and satellite access technologies, the cost of deployment depends very heavily on the traffic demand to be supported. This is in contrast to fibre technologies, for which costs do not vary as strongly with traffic demand.

The example projects which feature wireless and satellite technologies are as follows:

- Dominican Republic, Rural Broadband Connectivity Project: provision of broadband access to 508 communities, mostly rural, via UMTS and fixed access ADSL.
- Malaysia, NBI: the BBGP (Broadband to the General Population) part of the project will deliver download speeds of between 256 kbit/s and 10 Mbit/s using ADSL and wireless HSPA and WiMAX.
- Mongolia, ICT Infrastructure Development Project: provision of broadband services using Wi-Fi to rural communities, hubbed to Ulaanbaatar via a VSAT satellite link.

¹⁰ Network contention is a measure of the number of users that are served by a single network node (e.g. a local exchange or a terrestrial wireless base station). The capacity available to each end user at any point in time is dependent on the capacity supplied to the node, divided by the number of users on that node that are currently using services.

¹¹ LTE is the abbreviation for Long Term Evolution; this wireless technology is sometimes referred to as 4G (IMT-Advanced).

- Pakistan, USF Broadband Programme: provision of broadband access to unserved urban areas and rural communities, using HSPA, WiMAX and ADSL.
- Paraguay, PNT: provision of broadband with minimum download speed of 512 kbit/s using wireless HSPA, WiMAX, other wireless technologies and ADSL.
- Saudi Arabia, Universal Service Project: an initiative for operators to provide voice and Internet access (minimum 512 kbit/s download speed) to underserved locations using 3G (IMT-2000) wireless access.

3.3 Backhaul/core networks

A large number of the example projects feature investment in fibre-based backhaul and core networks. A fit-for-purpose backhaul/core network is essential for providing effective broadband services. Since a backhaul/core network connects an extensive area, such a network may be a cost-effective way of providing coverage to a large number of end users, especially if there is an existing access network that is already sufficient to deliver broadband (e.g. basic broadband over copper lines). In other cases a new access network may need to be deployed through a separate investment – and sometimes the investment in backhaul/core infrastructure may provide a catalyst for investment to upgrade the access network. It is important for a managing authority to ensure that the new backhaul/core network is built using well-established technical standards, to allow effective competition in the access network.

Among the example projects, many of the backhaul/core initiatives are associated with supporting broadband access and services to specific regions, or to rural locations. Many also support the development of wireless access networks (WiMAX, UMTS) to provide last-mile access. The projects which include investment in a backhaul/core network are as follows:

- Argentina Connected: deploying a nationwide core network to double the amount of optical fibre infrastructure in Argentina from 2011 to 2015, in order to improve broadband access nationally.
- Latvia, Next-generation network for rural areas project: deploying core network to support improved broadband access in rural locations. The network will remain in public ownership.
- Lithuania, RAIN project: deployed a nationwide backhaul/core network to provide improved connectivity to existing access infrastructure.
- Pakistan, USF Broadband Programme: deploying a nationwide backhaul/core network to provide improved connectivity to all administrative districts.
- Paraguay, PNT: deploying a nationwide core network, with 1 000 kilometres rolled out per year over the period 2011–2015, to provide improved broadband access nationally.

3.4 International fibre networks

As discussed earlier, international fibre links – whether land-based or submarine – are necessary within a country to provide cost-effective international connectivity. Just one of the example projects features investment in an international fibre network. The government of Kenya entered a PPP with Etisalat (the main fixed operator in the United Arab Emirates) to deploy a submarine cable between Mombasa, Kenya and Fujairah (in the UAE). TEAMS Limited was created to construct and manage this cable. Originally the consortium was structured with the government having an 85% ownership share, and Etisalat 15%, but the government sold off part of its stake, resulting in ownership in TEAMS being split between private investors (83%) and the government (17%) – the Ministry of Finance holds the stake. Etisalat retains a 15% stake in the submarine cable and TEAMS Kenya 85%. All TEAMS consortium members are able to sell capacity, at a wholesale and retail level, equivalent to their share of the cable's capacity.

3.5 Other infrastructure considerations

There are a number of other factors which a managing authority should take into consideration when choosing network architecture, including the use of appropriate expertise, technology obsolescence, and barriers to take-up. These are discussed briefly below.

3.5.1 Employing experts in the selection process

It is good practice for PPPs to use a range of appropriately qualified, independent experts to evaluate projects and assist in ensuring that all bids are evaluated in a fair and transparent manner against a range of clearly defined criteria. For example, in the Dominican Republic, the Rural Broadband Connectivity Project used engineers, economists and lawyers to evaluate projects and perform on-site visits to check project validity (e.g. engineers checked if a proposed wireless link could deliver line-of-sight connectivity).

3.5.2 Avoiding technologies that are nearing obsolescence

Technology obsolescence is a common issue in telecommunications, as technologies are constantly evolving. In large-scale projects that are intended to provide broadband services for many years, it is important that the technologies used are not nearing the end of their natural cycle. Older technologies will be more expensive to maintain (as fewer equipment vendors support them), and offer fewer opportunities for service innovation.

3.5.3 Using an appropriate technology mix

The use of a mix of technologies should be considered, irrespective of the aims of a project. In unserved and underserved locations, which are quite often rural or have difficult topographies, deployment should not be limited to one type of technology, and the fastest technology (in terms of broadband access speed) may not always be the most appropriate. For example, the national broadband project in Slovak Republic is clear that the core network should be fibre-based as this provides the best throughput, but for backhaul any appropriate technology may be considered – in particular wireless technologies to provide backhaul capabilities in mountainous areas.

3.5.4 Minimizing barriers to adoption

Public broadband investments should be designed to minimize the barriers to take-up by service providers and end users, in order to ensure that services are available and people actually use them. Earlier sections in this report have emphasized the importance of ensuring that service providers have access to active or passive infrastructure at a reasonable price and under conditions that are open, fair, transparent and non-discriminatory. For service providers, it is also important to define operational areas of an appropriate size: if there are too many small areas this may impose a burden on service providers that tender for all of the projects; conversely, defining a few large areas may make it difficult for an operator to create a viable business if those areas include large proportions of low-density users.

For end users, obstacles to take-up can include the cost and accessibility of services. Deploying the right infrastructure and promoting effective competition can help to minimize cost, while developing new services that (for example) do not require the use of a PC can ensure that services are accessible. An example could be to provide a healthcare monitoring service in someone's home to manage their glucose levels, without the need of deploying a PC. Some of the example projects have sought to increase adoption by providing free ICT equipment, or by implementing ICT literacy programmes:

- Argentina Connected: the project aims to provide 3 million netbooks to students. According to Conectar Igualdad, as of July 2012 netbooks had been provided to 1.9 million students since 2010. A Digital Literacy Program has also been used to provide PC and Internet training to communities.
- Malaysia, NBI: netbooks were provided at no cost to secondary school children whose annual household income was less than MYR3 000 (USD 965.0), and computer and Internet training was provided to low-income and rural communities. Over 100 000 netbooks, bundled with

access to Telecom Malaysia's High Speed Broadband (HSBB) network, were distributed in 2010. Broadband Experience Centres have also been developed throughout Malaysia, to increase ICT literacy and reduce the digital divide by providing training.

- Qatar, Q.NBN: the managing authority runs digital literacy programmes and provides free laptops or netbooks to those who cannot afford them.

3.5.5 Liaising with operators and industry stakeholders

Before developing a PPP, it is advisable to liaise with operators and other potential stakeholders, not just for their input on technology issues, but also to help understand the wide range of issues involved, e.g. commercial, regulatory, deployment, demand-side and others. Three examples are provided below:

- Dominican Republic, Rural Broadband Connectivity Project: prior to launching its public tender, the managing authority, Indotel, conducted consultations with industry stakeholders and users, including operators, ISPs, the Ministry of Education, the Ministry of Health and local municipalities. The consultation was used to determine the need for Internet services and consumers' willingness to pay, assess the telecommunication infrastructure available, identify operators' plans, and discuss the challenges faced in deploying broadband infrastructure to rural locations. A technical evaluation team consisting of two engineers, an economist and lawyer supported the consultation process. It should be noted that it is difficult to determine end users' willingness to use and pay for Internet access and services, when end users have never used the Internet. This was a key finding of the project in the Dominican Republic.
- Qatar, Q.NBN: the project was planned in consultation with network operators, such as Qtel and Vodafone, to determine the extent to which existing infrastructure could be used and how the deployment of FTTH could be used to support the development of broadband services.
- Saudi Arabia, Universal Service Project: prior to the project, the Communications and Information Technology Commission launched a consultation regarding the creation of a USF to support its Universal Access and Universal Service policies, originally conceived in 2006. In April 2010, the Universal Service policy was enacted (Decision No. 257/1431). The consultation involved operators, government departments and other organizations, and aimed to determine the effectiveness of the USF in supporting the deployment of voice and broadband services to all locations with 100 or more people.

4 Investment models

This section describes the various investment models used by the projects studied and considers their strengths and weaknesses, in order to enable an authority to make an informed choice about the most appropriate approach to take. Investment models are grouped into five types:

- Bottom-up or local community model – a group of end users such as residents or businesses form a jointly owned organizational group (frequently a cooperative) which oversees the contract to build their own network. The public sector has no role in owning or running the infrastructure.
- Private Design Build and Operate (private DBO) model – a private-sector organization receives public funding (often a grant) to assist it in deploying a network offering open wholesale access. The public sector has no role in the ownership or running of the network.
- Public outsourcing model – a single contract is awarded to a private-sector organization covering all aspects of the design or construction of the network. The infrastructure is built and operated by the private sector, but the public sector retains ownership and some control.
- Joint venture (partnering) model – ownership of the network is split between the public and private sectors. Construction and operation of the network are undertaken by a private-sector organization.
- Public DBO model – all aspects of the deployment and operation of the network are managed by the public sector. A network company is formed by the authority, and offers wholesale and (sometimes retail) services.

Among the example projects, public and private DBO models are the most commonly used method to fund broadband projects. However, there is no single model that suits every situation, and a managing authority must consider the pros and cons of each model and how it might fit the particular situation in which it finds itself. As discussed in Section 2, in public-sector broadband projects the long-term needs of individuals must be prioritized over the commercial aims of private partners, and for this reason a managing authority might favour those models which give the public sector a greater degree of control over the operations of the project, to ensure those long-term needs are met. However, working with the private sector can bring a number of advantages, including access to expertise and commercial discipline that can ensure that the project is delivered efficiently. In particular, the involvement of large-scale private telecommunication operators can help to ensure the sustainability of the project, as their expertise and experience will prove invaluable in adapting to changes in the market or embracing technological developments. Nevertheless, a managing authority should consider private investment from both within and outside the telecommunication sector, including operators, institutional investors, utilities, end users, content providers and equipment providers. It is essential to engage with potential private partners at an early stage of the procurement planning process, to gauge their interest in the different investment models that could be adopted.

4.1 Bottom-up

The bottom-up or local community model involves a group of end users (typically comprising local residents and/or businesses) organizing themselves into a jointly owned and democratically controlled organizational group (frequently a cooperative) capable of overseeing the contract to build their own local network. In this model it is likely that the public sector has no role in owning or running the project, but rather passes the funding to the group itself to oversee the project. Given that the local group is likely to have little experience of telecommunications, it is likely that the day-to-day running of the network will be outsourced to an operator with the necessary expertise.

None of the projects studied have implemented bottom-up models. However, the following examples have occurred in developed markets in Europe:

- Finland, eRegio project in North Karelia¹²: end users provided the investment, and demand often did not materialize until the network deployment reached their premises.
- Netherlands, the OnsNet¹³ project in Nuenen: this included a six-week demand aggregation scheme and free services for the first year.
- Sweden, Rural Development Programme¹⁴: end users provided investment (either financial or 'in kind') to attract additional bottom-up investment.

Advantages of the bottom-up model

- As the investment is generally undertaken by non-profit organizations made up of end users, it is usually considered on a long-term basis. For this reason, infrastructures such as FTTH can be deployed, which provides the highest level of future-proofing.
- Cooperative organizations have the effect of generating and aggregating demand in an area, which ensures that maximum social benefit is derived from the investment, even if only a small amount of funding is available.

Disadvantages of the bottom-up model

- This approach may not be suited to providing widespread coverage, as individual projects can be very localized. This may mean that some areas are missed out and those networks that are built have differing technical standards, which may mean that competition from other operators is limited.
- The cooperative organizations are unlikely to have specific expertise in telecommunication networks, and higher-cost 'turnkey' solutions may be required.
- If the funding is to come from the end users themselves, then the need to produce this funding upfront may create a barrier. In this case, the public sector can help by guaranteeing or underwriting loans.
- It is highly unlikely that end users in unserved or underserved locations in emerging markets would be able to finance any such project without substantial support from the public sector (central or local government). In these situations the public DBO model is more appropriate.

Overall, the bottom-up model is most appropriate for targeting localized areas in developed markets and for gaining the most benefit from small amounts of funding.

4.2 Private DBO

The private DBO model involves a private-sector organization receiving some level of public funding (often a grant) to assist in its deployment of a new network offering open wholesale access. Critically, in this model the public sector has no specific role in the ownership or running of the network, but it may impose obligations relating to either of these in return for the funding.

¹² DG REGIO, available at http://ec.europa.eu/regional_policy/sources/docoffic/official/communic/smart_growth/comm2010_553_en.pdf

¹³ Municipal broadband access networks in the Netherlands http://w3.ele.tue.nl/fileadmin/ele/TTE/ECO/Files/Pubs_2006/Kramer_AccessNets_06_presentation.pdf

¹⁴ State aid to broadband within the framework of the rural development programme http://ec.europa.eu/eu_law/state_aids/comp-2010/n030-10-en.pdf

Advantages of the private DBO model

- The cooperative or partnership organizations are unlikely to have specific expertise in telecommunication networks, and so high-cost turnkey solutions may be required.
- This approach imposes only a limited burden on the public sector, which is not involved in running the network. This in turn can lead to faster deployments than other investment models.
- It has a number of advantages for the private operator, particularly because ownership of the network assets is likely to prove valuable in the long term.

Disadvantages of the private DBO model

- It is essential that sufficient funding is available to attract interest from private operators, as significant investment may be required to make a viable business case, especially in rural areas.
- As the managing authority has limited ongoing control, the social benefit that the public sector is looking to create may be restricted if the private operator has little interest in delivering this and instead focuses on generating a financial return. (This issue can be addressed to some extent by the terms of the agreement).

The private operator is exposed to more risk in this model; in other models the private entity continues to share some portion of financial exposure with the public sector throughout the project. Because of this, an additional risk premium will be included by potential private partners when they specify the funding requirements for the project.

Overall, the private DBO model is appropriate for larger-scale investments than the bottom-up model where sufficient funding is available to attract interest from operators to work in rural areas, and where the operations (and risk) of the network can be effectively transferred to an operator with little ongoing control from the managing authority.

The private DBO model has been used by six of the example projects:

- Dominican Republic, Rural Broadband Connectivity Project: the project was won by Codetel, which did not use the funding available, but instead used 2 × 15 MHz of spectrum in the 3.5 GHz band which was available for no fee. The unused spectrum was offered by the managing authority to another operator as an alternative means to make broadband access available to rural communities.
- Malaysia, NBI: for this project Telekom Malaysia entered into a PPP with the government. The main fixed operator provides open access to its High Speed Broadband (HSBB) network but with no regulation of pricing. At the time of writing there is an ongoing consultation, and service providers are pushing for regulated open access. In March 2012, REDtone signed an agreement to access the HSBB network on a wholesale basis in order to provide services to business customers.
- Mongolia, ICT Infrastructure Development Project: a grant was provided by the government of Mongolia, the government of Japan and the World Bank to provide broadband services in rural communities using Wi-Fi.
- Pakistan, USF Broadband Programme: grants were provided from the USF to operators to deploy broadband to unserved urban areas and rural communities, and nationwide core network. The grants have attracted many operators, and broadband access projects have been awarded to the main fixed operator (PTCL), Wateen and Worldcall, while fibre projects have been awarded to PTCL and Wateen.
- Saudi Arabia, Universal Service Project: grants were used to enable operators to provide voice and broadband access to underserved locations. Four projects were supported between 2010 and 2011, including one pilot, and all have used 3G (IMT-2000) wireless access.
- Singapore, NGNBN: the network is being built and operated by OpenNet, a consortium of the main fixed operator SingTel (30%), Axia NetMedia (30%), Singapore Press Holdings (25%) and

Singapore Power Telecommunications (15%). OpenNet makes use of SingTel's existing passive infrastructure assets, such as ducts, manholes and exchanges – SingTel has transferred these assets to a neutral party (the Asset Company or AssetCo), an independent and separately managed company owned by a registered business trust. By 2014, SingTel is anticipated to reduce its stake in AssetCo to a level approved by the Infocomm Development Authority. From 2013, OpenNet will be subject to a universal service obligation to install fibre to end-customer points. The operating company is called Nucleus Connect; it is responsible for operating the active Layer 2 and administering open access to Layer 3 by retail service providers. It began offering wholesale services on 31 August 2010. Retail services providers are responsible for selling services to end users and businesses. As of June 2012, 12 service providers were delivering NGNBN-based services.

4.3 Public outsourcing

Under a public outsourcing model a single contract is awarded to a private-sector organization, covering all aspects of the design or construction of the network. The major characteristic of this model is that the network is built and operated by the private sector, but the public sector retains ownership and some control of the network.

Advantages of the public outsourcing model

- It is able to leverage both the financial stability of the managing authority, and the commercial and technical acumen of the private sector on an ongoing basis.
- The public sector retains ownership of, and a large degree of control over, the network infrastructure.

Disadvantages of the public outsourcing model

- Next-generation broadband networks can typically take 10 to 15 years or more to achieve a return on investment, and the fact that public network outsourcing agreements typically revert to public operational control after 10 or 20 years (or at least must be outsourced again under a new contract) could reduce the incentive for private companies to invest.
- The outsourcing relationship can create an added layer of bureaucracy between the private operator and the managing authority.
- If the public outsourcing arrangement is facilitated by a legal framework, that framework may impose unfavourable constraints on the operation of the project (e.g. constraining investment in the future).

Overall, the public outsourcing model is appropriate for widespread deployments where the managing authority requires a high level of control over the network, and where the private operator prefers the risk profile of greater financial stability but a lower potential return than that offered by the private DBO model.

The following example projects feature the public outsourcing model:

- Argentina Connected: this project adopted a mixed model consisting of public outsourcing and public DBO. AR-SAT, the managing authority, has responsibility for deploying and operating the national core fibre network; this arrangement follows a public DBO model. To complement this, in large cities and in certain regions where AR-SAT does not have the capability to deploy fibre, it subcontracts deployment via public outsourcing.
- Latvia, next-generation network for rural areas project: the network will remain in public ownership, but a private-sector organization is responsible for constructing, maintaining and administering it. LVRTC, a non-profit organization, is responsible for managing the access of service providers to wholesale services.

- Slovak Republic, national broadband project: the network will remain in public ownership under National Agency for Network and Electronic Services (NASES), a non-profit public enterprise. NASES is responsible for managing service providers' access to wholesale services; the prices of these wholesale services are determined in conjunction with the regulator. There are separate tenders for constructing the network and for maintaining it, so potentially these functions could be carried out by different private-sector organizations.

4.4 Joint venture (partnering)

A joint venture is an agreement where ownership of the network is split between the public and private sectors. Construction and operational functions are likely to be undertaken by a private-sector organization.

Advantages of the joint venture model

- The joint venture model has a number of advantages over the public outsourcing model described above, as both parties can maintain a long-term financial stake in the network. This is attractive to managing authorities which are reluctant to relinquish full ownership of the network as they see long-term strategic value in owning the assets.
- The joint venture approach has the ability to broadly balance the interests of the public and private sectors; it can also balance the sharing of risk – some forms of joint venture have required the private partner to increase its stake in the project when certain key performance indicators (such as take-up) are achieved, which represents a form of risk-sharing arrangement.
- This model often features the creation of special-purpose vehicles (SPVs). These SPVs can be of almost any size, which makes the model very scalable (i.e. able to address from local communities to subnational regions). The SPV mechanism also allows investment to be gathered from comparatively innovative sources, such as institutional investors.

Disadvantages of the joint venture model

- With two stakeholders in the network each with different interests, it may be difficult to align those interests and set up the joint venture, or to continue it over a long period.

Overall, the joint venture model should be used only where the interests of the public and private sectors can be closely aligned. Indeed, only one of the example projects – the TEAMS submarine cable project in Kenya – follows this investment model. The lack of project examples suggests that the joint venture model is likely to be unattractive to both the public and the private sectors.

4.5 Public DBO

A public DBO model involves the managing authority operating without any private-sector intervention, except at a service provider level (involving either wholesale or retail service providers). All aspects of network deployment and operation are managed by the public sector. A network company is formed by the managing authority and typically offers wholesale services, with the potential to offer retail services (although this is not common).

Advantages of the public DBO model

- This model allows the managing authority to retain control of the network, and may have benefits such as: ensuring that social capital targets are given a high priority, ensuring that there are no conflicts of interest in achieving effective competition, and enforcing common technical standards.
- This approach is also suitable when the managing authority does not have confidence that the available legal mechanisms (e.g. competition regulations) will be sufficient to ensure effective competition.

Disadvantages of the public DBO model

- Sole ownership of the network by the managing authority increases its exposure to the risk of a failed venture. Organizations set up in this manner may struggle to meet targets (e.g. for coverage and take-up), often because of their lack of relevant commercial and technical expertise (which few public-sector organizations possess). The public will be aware that its money is being spent, and if any failings receive substantial publicity this could result in a loss of confidence in the project.
- Networks deployed under this model may be limited in size and scope due to the finite amount of expertise held within the managing authority. Therefore the ability for investment under this model to provide widespread network coverage may be reliant upon the network providing a catalyst for other investments.
- The model may potentially exclude certain aspects of private-sector expertise, which could be valuable in ensuring the efficient deployment and operation of the network. More broadly, this model does not exploit the economies of scale and scope that private-sector operators can bring.

Overall, the public DBO model is appropriate when a managing authority needs to have absolute control over the operations of the network (perhaps to ensure competition), or when it is confident that a targeted investment will inspire investment from other sources.

The following example projects feature the public DBO model:

- Argentina Connected: this project has followed a mixed model consisting of public DBO and public outsourcing. AR-SAT, the managing authority, has responsibility for deploying and operating the national core fibre network; this arrangement follows a public DBO model. To complement this, in large cities and in certain regions where AR-SAT does not have the capability to deploy fibre, it subcontracts deployment via public outsourcing.
- Lithuania, RAIN project: this has deployed a new national backhaul/core network using the public DBO model in order to ensure absolute control of the network, and therefore promote effective competition.
- Qatar, Q.NBN: to accelerate the deployment of FTTH, and deliver coverage of in excess of 95 per cent by 2015 (100 Mbit/s). Q.NBN is 100 per cent owned by the Qatari government provides equal, non-discriminatory access to the FTTH network, enabling any operator to use the infrastructure to deliver services.

5 Sources of public funding for broadband projects

This section discusses the funding sources used to support PPP models. Financing from USFs and government grants dominate the projects highlighted in this report; a small number have used external funds.

5.1 Universal service funding

USFs have been used by managing authorities to fund broadband projects, particularly in unserved and underserved areas, and in rural areas. Five of the example projects have used USFs:

- Dominican Republic, Rural Broadband Connectivity Project: the USF is available to support this project, although the winning bidder, Codetel, chose to use some unassigned spectrum that was available for no fee instead of taking the available funding. Operators contribute 2 per cent of their gross income to the USF.
- Saudi Arabia, Universal Service Project: a universal access/universal service policy was created by the telecommunication regulator CITC in 2006, and a USF was created to fund these policies following consultation with the industry. A decision to levy one per cent of operators' revenues was agreed. The USF is used to assist operators to provide mobile voice and broadband Internet access to unserved or underserved communities.
- Mongolia, ICT Infrastructure Development Project: the government introduced a USF in July 2006 and began collecting the levy in December 2006, amounting to 2 per cent of operators' annual taxable income. Between end-2006 and end-2010, the fund accumulated USD 7.5 million.
- Pakistan, USF Broadband Programme: grants have been provided from the USF to operators to deploy core broadband access to unserved urban areas and rural communities. The USF was created in 2006 and has been collected since 2007 at a rate of 1.5 per cent of operators' adjusted revenues. No other government funds have been used to fund the Broadband Programme.
- Malaysia, NBI: the USF was created in 2002, and operators¹⁵ contribute 6 per cent of their service revenues to the fund if their weighted average net revenue exceeds RM 2 million. The fund has been used to provide voice telephony, wireless broadband coverage and to provide communities with access to computers, broadband services and IT training.

Argentina created a USF in 2007, and operators contribute one per cent of their revenues. The fund was set up with the intention of funding telecommunication projects in underserved and unserved areas. However, as yet the Argentina Connected project has not drawn on the USF, but instead has been funded by other government grants.

5.2 Government grants

Government grants have been used to support around half of the broadband projects studied. These projects have followed a variety of investment models: public outsourcing, public DBO, joint venture and private DBO.

- Argentina Connected: this project is using government grants to fund a national core fibre and backhaul network, using a mix of public outsourcing and public DBO.

¹⁵ Excluding content application service providers.

- Lithuania, RAIN: this used government grants as well as external funding from the ERDF to fund deployment of a nationwide backhaul/core network, using a public DBO model.
- Slovak Republic, national broadband project: a backhaul/core network is being jointly funded by the Slovak government (EUR 11.32 million (USD 14.3 million)), the ERDF (EUR 96.22 million (USD 121.1 million)) and operators (EUR 5.66 million (USD 7.1 million)). A public outsourcing model is being followed.
- Singapore, NGNBN: this project is using USD 2 billion of government grants to fund the roll-out of FTTH, in line with a private DBO model.
- Malaysia, NBI: a government-funded project in conjunction with Telekom Malaysia to provide an open-access broadband network, on a commercially negotiated wholesale basis. A private DBO model is followed
- Kenya, TEAMS: the government has a 17 per cent share in this joint venture to build a submarine cable linking Mombasa with the UAE.

5.3 External funds

External funding provided by organizations such as the World Bank and the ERDF, or by foreign governments, has been used to finance a small number of the broadband projects identified in this report.

- Latvia, next-generation network for rural areas: this backhaul/core project is being funded entirely by the ERDF, which will provide a total of EUR 119 million (USD 149.9 million) by the end of 2018.
- Lithuania, RAIN: this backhaul/core project has received significant support from the ERDF, and has also benefited from government grants.
- Mongolia, ICT Infrastructure Development Project: used a mix of external financing from the government of Japan and the World Bank, plus USF funding.
- Slovak Republic, national broadband project: a backhaul/core network is being jointly funded by the ERDF (EUR 96.22 million (USD 121.2 million)), the Slovak government (EUR 11.32 million (USD 14.3 million)) and operators (EUR 5.66 million (USD 7.1 million)).

The projects in Latvia, Lithuania and Slovak Republic all had to meet strict criteria in order to obtain State aid approval from the European Commission, i.e. demonstrating that public funds are being used appropriately.

6 Monitoring and managing broadband projects

This section discusses the various methods by which a managing authority can monitor and manage public broadband projects, and their appropriateness for different situations. Where possible, the information presented below is based on how various levels of monitoring and governance mechanisms have been used in practice.

6.1 Which organization undertakes the monitoring

Managing authorities must implement effective governance mechanisms to ensure that public money is being used appropriately, check how decisions are being made, and ensure the right behaviour from stakeholders. It is also important to ensure that public money that is invested in broadband projects delivers tangible benefits, so that funding continues to be provided for this type of activity.

Periodic monitoring can be undertaken by public organizations with varying remits, as discussed below. The monitoring is usually conducted by the managing authority undertaking the project. This section is not intended to guide the managing authority in making a choice between the options below, but rather to provide an overview of the constraints that it may experience, depending on its management remit.

Monitoring by regional or municipal public bodies can bring greater financial or political strength to the monitoring activity. However, as the public body is further removed from the project, there is likely to be a need for a formal process whereby the operating organization reports to the regional municipality on a regular basis. None of the projects in this report used regional or municipal bodies to monitor activity, but such bodies may be merited depending on the geographic scope of a broadband project.

Alternatively, a project can be monitored by a central government body. This approach has the advantage that the monitoring body has a greater awareness of the high-level objectives of any national broadband policy, and may also have strong links to the market-specific expertise of the regulator. However, despite a central government body having responsibility for all broadband operations in the country, its formal monitoring remit is likely to be limited to those projects which have benefited from public-sector investment.

For all monitoring organizations, monitoring requirements could be set out in the contract with the network supplier, with obligations possibly linked to the payment of public money (e.g. roll-out milestones, 'ready for service' (RFS) dates, number of Internet service providers (ISPs) signed up, or number of customers connected).

A government body (which is likely to be the managing authority) could hold such a contract, and our research has identified the following examples:

- Pakistan, USF broadband programme: monitored by the managing authority, the USF Company, which is responsible for monitoring network roll-out milestones.
- Saudi Arabia, Universal Service Project: this project is overseen by an Executive Committee, formed by the CITC (the telecommunication regulator and managing authority), which is also responsible for monitoring all projects funded by the country's USF.
- Singapore, NGNBN: the project is monitored by the IDA (the telecommunication regulator and managing authority), which has responsibility for monitoring certain key performance indicators such as roll-out of the GPON (ITU-T G.984) FTTH network, number of subscriptions, and provisioning times. The IDA's Telecommunications Standards Advisory Committee is responsible for setting standards for the project, which are designed to maximize performance, for example minimizing delays in provisioning FTTH services. It sets out procedures that OpenNet should undertake to test and monitor the GPON, to ensure the network performs correctly.
- Slovak Republic, national broadband project: monitored by the Government Office of the Slovak Republic and the telecommunication regulator. Monitoring takes place twice a year, and continues for five years once the roll-out is completed. The regulator is also responsible for monitoring and approving the wholesale prices of the backhaul/core network.

Monitoring may also be undertaken by more than one central government body. For example, in Latvia pricing is monitored by the Ministry of Transport, the Competition Authority and the telecommunication regulator, as part of the next-generation network for rural areas project.

It should be noted that any measures that a regulator may apply (such as penalties and remedies) are separate and determined by the regulator itself, and so do not need to be duplicated in any contract with a network supplier. In other words, the investment contract provides 'project-specific' monitoring, while the regulator provides 'market-level' monitoring.

6.2 Monitoring project commercials

A number of options are available for monitoring the commercial aspects of a broadband investment project. These options are outlined below.

6.2.1 Milestone and deployment controls

One way of exercising control over the network deployment is to have predefined milestones at which the contractors will be paid agreed amounts if the roll-out is on target (possibly with bonuses for good performance and penalty payments in the case of underperformance). Payments can be linked to specific deliverables, the achievement of certain milestones within the roll-out plan, or the level of service take-up by service providers and end users. These milestones can be reinforced by the widespread publication of ready-for-service dates; public announcements of this type could be stipulated as part of a deployment contract.

As part of this type of monitoring, it may be necessary to include payment profiles (i.e. schedules for paying the organizations responsible for building the network) which set out how the bonuses and penalties should adapt to changing market conditions during roll-out. For example, if Supplier A is awarded public funding, but part-way through the project Supplier B decides to extend its roll-out to areas targeted for public funding, the payment profile may need to be adjusted (because Supplier A is less likely to reach the take-up levels it expected at the start of the project).

Examples of the use of milestones are as follows:

- Pakistan, Broadband Programme: as part of the programme, the USF Company gives responsibility to a Technical Auditor to monitor operators' milestones. The subsidies are provided in four portions of 25 per cent, and each one is awarded upon the achievement of a particular milestone in the roll-out. At the same time, the operator must have also obtained a predefined number of broadband subscriber agreements (a subscriber must have been a customer for at least 90 days). If the operator fails to deploy the network in time or achieve the agreed number of subscriptions, payment is not provided. For example, Great Bear International Services agreed a Letter of Intent to commence a broadband access project, but failed to meet its objective. As a result, the contract was awarded to one of the other companies that had bid for the project, on the same terms as Great Bear's. The USF Company provides information on its website concerning milestone status.¹⁶ Milestones are also used by the Technical Authority to determine when payments are made to successful bidders of optical fibre networks; payment depends on an audit of the number of districts connected and the length of optical fibre cable deployed.

¹⁶ "See, for example, <http://www.usf.org.pk/publiclot.aspx?lotid=69&pgid=2&bphid=55&phname=Phase II&lotname=Gujranwala Telecom Region>".

- Singapore, NGNBN: the telecommunication regulator (the IDA) is responsible for monitoring the coverage delivered by OpenNet. By January 2012, only 86 per cent of the population out of a target of 95 per cent had been covered. In February 2012, the IDA sought to speed up network deployment, citing delays experienced by retail service providers (e.g. end-user installation delays) and services that did not deliver the required performance (e.g. download speed). At the time of writing, the IDA has taken no action, but is considering the possibility of reviewing OpenNet's interconnection offers. The IDA has enacted wider powers to ensure that building owners, upon the relevant notification from OpenNet, give OpenNet access to the building to deploy its FTTH network. Failure to comply with the Codes of Practice as stipulated in Singapore's Telecommunications Act may lead to building owners facing fines of SGD 10 000 (USD 8 023), or even imprisonment.

In summary, it is good practice for managing authorities to use milestones and deployment controls to ensure that the roll-out goes according to plan.

6.2.2 Pricing and claw-back mechanisms

Managing authorities sometimes monitor wholesale and end-user prices as part of a broadband project, to ensure that competition is not distorted and maximize take-up. As part of the USF Project in Saudi Arabia, the CITC stipulates that the tariff for Internet services funded by the Universal Services Fund "shall be preferential, and shall not be more than the average tariff of such services on fixed networks, in other regions of the Kingdom". The CITC introduced this and other Articles with regards to the USF, following a review of its Telecommunications Act, Universal Service Policy and Universal Service Access.

In Latvia, three government bodies – the Ministry of Transport, the telecommunication regulator and the Competition Authority – monitor wholesale access prices for the backhaul/core network funded as part of the country's next-generation broadband project. These bodies also monitor the impact of wholesale access prices on wholesale services, and may set obligations for the network to ensure that wholesale access pricing is 'reasonable' (meaning that "wholesale access prices will be based on average prices that prevail in urban areas that do not benefit from State funding").

Claw-back mechanisms are used by some managing authorities to recoup some of their investment if the profits generated exceed a 'normal' level – e.g. in circumstances where demand for broadband services is so much greater than forecast that it could have supported a commercially funded project. Claw-back mechanisms have been put in place in two example projects:

- Latvia, next-generation network for rural areas: The LVRTC (the non-profit enterprise responsible for building and operating the network) is not supposed to generate a profit. Any profit generated is refunded to the Ministry of Transport, which is the managing authority.
- Slovak Republic, national broadband project: A claw-back mechanism is in place should any profit be generated by NASES (the non-profit enterprise responsible for building and managing the backhaul/core network). Any profit is reinvested, extending the project to unserved areas not originally covered by the project.

6.3 Monitoring non-commercials

A number of options are available for monitoring the non-commercial aspects of a broadband investment project. These options are outlined below.

6.3.1 Ensuring that open-access principles are maintained

Many of the broadband projects researched as part of this report stipulate that open-access models apply. This model helps to promote competition among multiple service providers, supports innovation in products and services, and minimizes market distortion. It is important to ensure that open access is defined in terms of access to specific services and products (e.g. wholesale bandwidth or duct access). Access should be provided to all products, all the time, for the lifetime of the network.

Mandatory non-discriminatory wholesale open access is always a feature of PPP broadband projects, although each project may view access slightly differently and should be considered on a project-by-project basis, as highlighted in the examples listed below:

- Argentina Connected: AR-SAT has responsibility for deploying and operating a core fibre network nationwide, as part of the country's broadband project. The network operates under open-access principles for wholesale data.
- Latvia, next-generation network for rural areas: LVRTC, a non-profit public enterprise, is obliged to provide wholesale services under equal access conditions on a non-discriminatory basis. Operators are able to access passive network infrastructure (ducts and fibre) and use space in cabinets to deploy their equipment.
- Slovak Republic, national broadband project: NASES, a non-profit public enterprise, is obliged to provide wholesale access on a non-discriminatory basis, including ducts, dark fibre, collocation space and masts. Any wholesale access disputes are managed by the telecommunication regulator under the provisions of the legislation (Act 351/2011).

6.3.2 Monitoring of operational metrics

The metrics below represent some of the operational aspects that a managing authority should consider monitoring on at least an annual basis, to ensure that wholesale and retail users receive a service that is fit for purpose, and overall network roll-out is progressing according to plan. These metrics can be assessed based on an annual report issued by the network operator to the managing authority.

- Operational readiness: the managing authority should monitor the number of network infrastructure elements deployed (e.g. optical fibre, fibre termination electronics, wireless transmitters), and the overall level of service availability on different parts of the network. The USF Company in Pakistan, for example, monitors the length of optical fibre cable deployed and the number of Tehsils (administrative districts) connected.
- Fault occurrence: the managing authority should monitor the occurrence of faults on the network, including those that are notified by customers (e.g. residential vs. business vs. public-sector) and those that are discovered by network staff. The fault monitoring should include analysis of how the number of faults varies with increasing usage, and should seek to identify common causes of faults.
- Maintenance: the managing authority should monitor the frequency and nature of maintenance that is required on the network, including scheduled, corrective and preventative maintenance. In the case of scheduled and preventative maintenance, the managing authority should look to ensure that this is done at a time when it will cause least disruption to customers.
- Network take-up: the managing authority should monitor take-up by wholesale and retail customers. For retail customers, this could include the number of new connections, while for wholesale customers, this could include measuring the installation of their equipment or the take-up of other services. Where a network operator has specific responsibilities to market its broadband services or stimulate demand, the managing authority should also separately

monitor that these activities are taking place (in addition to monitoring the resultant take-up). This is done by the USF Company in Pakistan, which monitors the take-up of broadband connections. In the case of the NGNBN in Singapore, the IDA not only monitors take-up of FTTH, but also the time it takes OpenNet to connect customers – which should be between three and ten days.

- Network performance: the managing authority should monitor the speed and quality of services being delivered to end users, to ensure that the benefits of next-generation broadband can be realized, and to allow comparison with other projects.

Operational metrics may need refreshing if the targets are found to be too aggressive by the managing authority. The managing authority responsible for the Rural Broadband Project in the Dominican Republic considered that it was necessary to continue to review the quality metrics being used, recognizing that the cost of delivering services with equivalent quality as those in urban areas could be expensive and a challenge for operators.

6.4 Governance mechanisms

Among the example projects, there is a broad spectrum of options for a managing authority to influence the decision-making on a project, as discussed below. The choice of governance mechanism will tend to be guided by the choice of investment model, but a managing authority needs to be aware of the different options.

6.4.1 Full ownership and control by a public body

A managing authority has full control over decision-making if it fully owns and operates the network infrastructure. However, this approach may require a separate public organization with the right network operating skills to be set up. In addition, on larger projects, the lack of involvement from commercial operators may make it difficult to align the operation of the network with the needs of the market. Example projects include the following:

- Latvia, next-generation network for rural areas: the LVRTC is responsible for awarding contracts to bidders to roll out core network fibre, which are in turn administered by the Ministry of Transport. The network remains under public ownership through the LVRTC, which manages access to the network on a non-discriminatory wholesale access basis. To maintain transparency and ensure that LVRTC does not generate a profit, the LVRTC maintains a separate accounting system which is monitored by the Ministry of Transport.
- Lithuania, RAIN: RAIN is fully controlled by the managing authority. A ‘Joint Activity Partnership Agreement’ was made between the Ministry of Transport and Communications – which agreed to undertake the project application, collection of funds and participation in the Supervisory Committee (SC) – and PEPI. The SC supervises implementation of the project, monitors timeliness of work and achievement of planned results, assesses the project’s long-term impact, encourages the distribution of the project’s results, and also gives guidance on the project’s activities and implementation. The SC, which meets at least once a quarter, was created by the Ministry of Transport and Communications and consists of representatives of ministries, local governance authorities, educational establishments, etc.
- Qatar, Q.NBN project: the Q.NBN is 100 per cent owned by the Qatari government. It provides equal, non-discriminatory access to its FTTH network, enabling any operator to use the infrastructure to deliver services.

6.4.2 Special-purpose vehicles

An alternative approach is to have a board of public body stakeholders or an SPV to oversee all decision-making. This approach has the advantage of leveraging private operator expertise to operate the network, while retaining overall control within the public sector. However, caution must be exercised with this approach, to avoid a situation where too many layers of bureaucracy cause project delays. In an attempt

to avoid such delays, the IDA in Singapore created OpenNet, a consortium of organizations including SingTel which has responsibility for building and operating the network using SingTel's existing passive infrastructure. OpenNet has transferred SingTel's underlying assets to a neutral party of the NetCo's Contractual and Financial Close (CFC), which was reached in mid-2011. This neutral party, called the Asset Company or AssetCo, is an independent and separately managed company, owned by a registered business trust. SingTel will reduce its stake in the AssetCo to a level approved by the IDA by 2014. Under a Universal Service Obligation, OpenNet is required to install fibre to the end users from 2013.

6.4.3 Mixed ownership

A variant of the public-only board is to have a mixed board of public and private stakeholders. In this way, the public sector has the opportunity to maintain control with a majority stake (e.g. 51 per cent), but the private sector can exert significant influence on the running of the project. Alternatively, the public sector may have a minority stake, as in the case of the government of Kenya, whose involvement in the TEAMS submarine fibre is lower than that of all the private stakeholders.

7 Creating demand for broadband services

This section considers the importance of broadband services in the context of network investment by a managing authority. Two key issues are explored: understanding the expected level of demand for broadband services, and ensuring that demand targets are achieved.

7.1 Understanding demand

Understanding the current level of demand for broadband technology and services within an area should be a fundamental consideration for the managing authority in planning a broadband network investment. One critical success factor for completion of a broadband project is that the project must be initiated at a time that is appropriate, given the prevailing balance of supply and demand. Many of the project examples quoted in this report highlighted the importance of the current understanding of demand held by the private telecommunication operators. Given that many of the investment models involve some level of interaction with operators, this is also an issue for the managing authority. It is possible that if an operator has a good understanding of the demand for broadband technology and services, it may be willing to accept a transfer of risk from the public body (as is the case, for example, in French DSP agreements).¹⁷ Some of the example projects undertook a formal consultation process with industry stakeholders:

- As part of the Universal Service Project in Saudi Arabia, the CITC conducted a public consultation with stakeholders, including operators and government ministries, to collect views on its draft USF Strategic Plan. The consultation aimed to collect views on the CITC's policy to provide broadband services in underserved and unserved locations using one of two potential deployment options. These were based on the results from a country-wide survey of ICT demand undertaken by the CITC in 2008 (the survey assessed user preferences, demand for Internet services and willingness to pay for such services). The two options concerned the minimum size of community that would be provided with broadband access – for example, one option was to provide all communities of 250–500 people with broadband speeds of at least 512 kbit/s.

However, determining demand for broadband access and services can be problematic. The following are the main challenges highlighted by Indotel in the Dominican Republic in relation to its Rural Broadband Connectivity Project:

- Long timelines: collecting statistically significant information may take a long time – in particular, primary research in rural locations can take many months. Conducting surveys in unserved and underserved areas may require people to conduct door-to-door interviews.
- Expense of collecting data: conducting primary research in rural locations can be costly, if it is necessary to conduct a survey face-to-face.
- Reluctance of operators to divulge sensitive information: operators may be unwilling to provide broadband demand, traffic or other commercially sensitive information, which could be used by competitors for their commercial gain.
- Lack of available data: operators and other stakeholders may not have conducted consultations with potential end users in unserved or underserved locations, and so may not have appropriate traffic data to demonstrate how broadband services may evolve in these areas.

¹⁷ Délégation de Service Public (a model defined by French law, under which a private actor is granted the opportunity to manage public services by a public body).

Proxies can be used to determine anticipated demand for broadband access and services. In the Dominican Republic, for example, the Rural Broadband Connectivity Project used a phased approach to determine demand for broadband bandwidth (based on a method used by the Peruvian regulator OSPITEL as part of its rural telecommunication project). This process can be summarized as follows:

- Phase 1: Use Geographic Information Systems (GIS) mapping to determine the location of rural communities – use available GIS to collate demographic information, including number of households, population spread, fixed-line availability, cellular coverage, broadband availability, electricity supply, etc.
- Phase 2: Identify unserved and underserved communities – use information collated in Phase 1 to determine those areas that are unserved or underserved by broadband services.
- Phase 3: Use available historical information on data traffic from previously underserved locations, which then became served.
- Phase 4: Use available traffic information – use historical traffic usage and how traffic grew as broadband access was brought to these locations. Usage can be determined on a per-capita or per-household basis as well as the number of Internet cafés necessary to support communities.
- Phase 5: Determine traffic usage by unserved and underserved communities – overlay data to determine how traffic may evolve in the unserved and underserved locations under investigation.
- Phase 6: Determine bandwidth and infrastructure needs – understanding bandwidth requirements will assist in determining the core and access infrastructure necessary to support the project.

Similar mapping, broadband coverage analysis and consultation with stakeholders have been undertaken by managing authorities in other broadband projects. For example, in Latvia the managing authority responsible for the RAIN project launched a public consultation with operators to collect information about their optical fibre networks, and gathered information from local authorities on anticipated usage of broadband services, which was mapped against broadband penetration. As a result, 363 areas were identified for a roll-out of a backhaul/core network.

Having established the importance of understanding demand for broadband access and services, some example projects also identified various difficulties associated with measuring this demand. For example, the stakeholders in the Rural Development Programme in Sweden were not fully aware of the true demand for broadband access and services at the start of the project.

In some of the example projects, both the managing authority and the telecommunication operators initially perceived a low level of demand for broadband access and services. Indeed, this perception of low demand was one reason why private investors had previously shown little interest in the areas concerned (and hence created the need for an intervention). However, it is possible that the initial assessment of demand may not reflect the real demand:

- The managing authority may not have asked the right questions (e.g. if people with low levels of IT literacy are asked about their interest in technologies they do not understand, they may not be able to indicate their true level of interest as they have not actually seen the technologies in operation).
- The initial demand may be truly latent, as discussed in Section 3.5.5, and so may not be apparent even to the population itself until it is stimulated through a development such as the introduction of a new service.

If the real level of demand is low, projects can benefit from demand aggregation or stimulation, as discussed in the next section.

7.2 Ensuring demand targets are achieved

Demand aggregation and stimulation schemes are likely to be important in ensuring the success of a broadband investment project, and so must be considered by a managing authority. The schemes should ideally be structured to include an element of commitment from users, since this helps to give the managing authority and operators confidence that benefits can be derived from the significant investments required for a new network. Furthermore, once the investment has been made, it may act as a catalyst in revealing latent demand or generating additional investment. These issues are discussed below.

7.2.1 Registering demand

With first-generation broadband, demand registration schemes were rather like an ‘expression of interest’ with no firm commitment. In contrast, the demand registration schemes seen to date for next-generation broadband have all involved consumers making a contractual commitment to take a service several months before that service becomes available.

The aggregation of commitment (and demand) from urban and rural areas allows costs to be shared across both areas, which can help to ensure a feasible business case for investment in rural areas that would otherwise be impossible to achieve. In this case, the urban areas are effectively subsidizing broadband deployment in the rural areas. One example of this is the OnsNet project in the Netherlands.

7.2.2 Stimulating demand

In order to stimulate the greatest possible increase in demand for broadband, a managing authority may consider taking certain actions such as introducing new services or providing incentives to encourage take-up among consumers:

- **Creation of new services requiring broadband:** A managing authority can create demand by introducing useful services that people will use, especially where the technology is used to achieve goals that would not otherwise have been possible to achieve over legacy networks. A good example of this was the creation of alternative customer premises equipment (CPE) in the Piemonte¹⁸ project in Italy, which allowed elderly people to gain access to healthcare services without having to learn how to use the CPE. While this adds complexity to a project, it should be viewed as providing very useful additional value to a broadband investment project. Furthermore, a managing authority may have good contacts with other organizations that can assist in the development of new services. For example, a public body can work with local universities to develop e-learning services, or can work with local hospitals to develop e-health services (again as demonstrated in the Piemonte project, where the main fixed operator offered to upgrade multiple exchanges in return for the project creating services or products with a similar value).
- **Enabling communities to use broadband services:** As part of the Rural Broadband Connectivity Project in the Dominican Republic, service providers and operators were obliged to provide website development assistance for each location where broadband access was provided, as well as provide training to maintain the website – the website contains information about the community, tourist attractions, goods and services.
- **Creation of local content and in the local language:** This stimulates take-up of broadband Internet access and services by maximizing accessibility to end users.

¹⁸ Digital Piedmont , Piedmont ICT Observatory <http://www.osservatorioict.piemonte.it/en/broadband.html>

- Marketing the use of broadband among local communities: Also as part of the Rural Broadband Connectivity Project in the Dominican Republic, road shows and training were provided to schools. The youngsters who participated at these events indirectly stimulated interest in the broadband project – and broadband access – among the wider population.
- Incentivizing broadband: As well as making services available, it is also essential to advertise them to the local people, to ensure that they are aware of their existence. As part of the NGNBN roll-out in Singapore, OpenNet informs households by letter that the FTTH network is soon to pass their location, as a means to stimulate demand. The letter contains information about the offer of free installed fibre,¹⁹ and also explains of the standard cost of connection the household fails to take up the free offer (SGD 220 (USD 176.5) to connect an apartment block). If the household fails to respond to OpenNet's initial offer, a remainder letter is sent to extending the free installation offer.

In addition, demand stimulation should be timed so that it coincides with an increase in supply, whether from the private sector or from any other form of supply stimulation. A managing authority should also recognise the impact of wide-ranging national initiatives on stimulating take-up of broadband services. The list below provides other examples of demand-stimulation techniques:

- Kenya, TEAMS: the government of Kenya initiated a number of schemes in 2009/2010 to promote the take-up of broadband services:
 - Enabled ISPs to access the submarine cable over a 20-year period and offset the cost against taxable income.
 - Created and supported Digital Villages (in partnership with the World Bank).
 - Allocated USD 100 million for mobile computer laboratories for secondary schools.
 - Enabled telecommunication equipment, including cabling, to be depreciated by 20 per cent instead of 12.5 per cent.
 - Made all handsets exempt from VAT.
- Pakistan, USF Broadband Programme: operators that win funds to deploy broadband access in unserved and underserved urban and rural areas across Pakistan are obliged to construct Educational Broadband Centres and Community Broadband Centres. By June 2012, operators had deployed 1 000 EBCs and 300 CBCs. These centres provide students and communities with access to computers, which they would be unable to access using their own financial means. Access to these centres is anticipated to provide improved access to e-health, e-government and other services.
- Qatar, Q.NBN: as part of Qatar National Vision 2030 and Qatar ICT Strategy 2015, a number of initiatives are being introduced to stimulate the take-up of FTTH services. These initiatives include promoting the adoption of cloud computing and ICT adoption by businesses and the government, as well as conducting training programmes to equip people with the right ICT skills.

7.2.3 Catalyzing demand

In order to stimulate the greatest possible increase in demand for broadband access and services, a managing authority must consider a number of interconnected factors:

¹⁹ Free for the first 15 metres, then SGD 33 (USD 26.5) for each additional five metres.

- A project's technology or services may inspire demand that had remained latent: This is especially true where the initial demand has been underestimated due to latent demand that only emerges once people see their friends and family using the technology and services. Demand may be stimulated at the beginning of a project (as in the North Karelia example), or can be inspired for future projects (as was the case in the Rural Development Programme in Sweden).
- Public infrastructure development may overcome private investment inertia: A new infrastructure project can frequently act as a catalyst in dispelling investment inertia, helping to attract private-sector investment as the project develops. As a result, either the cost of the project to the public can fall or the scope of the project can be expanded. Examples of this are provided by the Piemonte project in Italy (where the main fixed operator changed its investment attitude towards the region), and the Midtsoenderjylland project in Denmark (where initial public investment helped to stimulate the local electricity company into undertaking a large investment).

8 Reducing costs and managing risks

Deploying broadband infrastructure is an expensive undertaking, and any measures to reduce the cost of deployment can help to make public funds go further, make business cases more attractive to private operators, and maximize the overall social and economic impact of the investment. This section discusses some practical measures to minimize broadband project costs and manage risk, which are based on the projects researched as part of this report as well as wider experience working on telecommunication projects. The ITU published a paper at the 2008 Global Symposium for Regulators outlining best practice guidelines on infrastructure sharing,²⁰ many of which are discussed below.

8.1 Measures to minimize costs

8.1.1 Reuse passive infrastructure

Reusing existing infrastructure is a key cost-saving measure. For example, if existing ducts can be reused, the very expensive activity of digging new trenches when installing fibre infrastructure can be avoided. Some of the example projects included in this report were able to use existing ducts to avoid digging new trenches (e.g. the Q.NBN project in Qatar leases existing passive infrastructure as a means to facilitate FTTH roll-out).

In such circumstances, the managing authority can play a role in facilitating access to ducts, especially if other public organizations with duct holdings can be persuaded to support the authority in attaining its broader socio-economic objectives. For example, the managing authority responsible for the implementation of the broadband project in Slovak Republic plans to use the existing infrastructure to support the roll-out of a backhaul/core network, including existing telecommunication infrastructure, roads and rights of way.

The managing authority should therefore consider working with local authorities and operators to identify any passive infrastructure that could be reused to facilitate the roll-out of a broadband network. Information requests should be issued to determine the location, capacity and availability of ducts, poles and other passive infrastructure.

8.1.2 Build shallow trenches for ducts

The cost of digging trenches can be considerable. Deeper trenches cost more because they take longer to dig, there is more material to remove from the site, and they are more likely to encroach on other utility services such as electricity cables. Furthermore, the deeper the trench, the more disruption the dig will cause to the surrounding area, e.g. requiring roads or pavements to be closed. This may also impact businesses, e.g. reducing revenues as a result of changes in transport traffic patterns and reduced footfall. By contrast, digging shallow trenches (which typically have a depth of 15 cm) along pavements minimizes disruption for road users and does not damage the road service. The trade-off between cost and quality needs to be considered carefully.

8.1.3 Use aerial fibre

If fibre needs to be deployed as part of a broadband project, it is not always necessary to dig trenches. For example, if poles are used to support the copper wires used for last-mile access, that infrastructure can be reused to support FTTH.

²⁰ Available at http://www.itu.int/ITU-D/treg/Events/Seminars/GSR/GSR08/PDF/GSRguidelines08_E.pdf

8.1.4 Synchronize utility projects

The managing authority responsible for the implementation of a broadband project should seek to coordinate its network installation with other civil works to be undertaken by other utilities. This can have cross-sectoral cost benefits, and in European, such coordination can help circumvent State-aid approval, provided such civil works are open to all potential users and not just electronic communications operators (i.e. they are also open to electricity, gas and water utilities).

8.1.5 Use a single commercial entity to manage the project

The private DBO model or the public outsourcing model could use a single private entity to minimize the cost of designing and building a broadband network. For example, in Malaysia the main fixed operator is responsible for deploying an FTTH network in the main economic areas, giving service providers and operators open access to the network. In its 2011 annual report, Telekom Malaysia reports a 5 per cent fall in total capex spend on the HSBG project in comparison to 2010 as a result of "strategic design of the network architecture, good vendor relations and optimization of resources". It can be assumed that Telekom Malaysia has benefited from certain economies of scale in negotiating equipment supply contracts with vendors as well as the physical roll-out of the project. The cost savings are shared with the government, which has funded the project through grants.

8.2 Measures to manage risks

In designing public broadband investments, careful consideration should be given to potential market developments that may lead to the infrastructure being superseded by other technologies. For this reason, contracts should be structured so that they can react to significant changes in take-up, pricing or wholesale product requirements. It is also important for a managing authority to arrange for thorough due diligence to be conducted as part of a project, to ensure that its plan is credible and will not be subject to significant delays, cost increases or other potential difficulties. A managing authority should ensure that it has access to the necessary skills, either internally or externally, to design interventions and identify any risks that could emerge in future.

The RAIN project in Lithuania provides a good example of how to reduce costs and manage risks when designing a broadband network. The principles underlying the design of the RAIN network were:

- Cables only to be laid in areas where no other cables existed. Information on planned routes was provided to operators, allowing them to highlight any duplication of lines.
- Ensure coverage of 98 per cent of Lithuania and to knowledge centres (schools, libraries, Internet cafes, etc.).
- Install fibre connection points in all settlements that a route passes, allowing future connections to the network.
- Fibre cables to terminate at locations agreed by the municipalities and the operators.
- Minimize the total distance of cable, while considering how to avoid natural obstacles (lakes etc.) and use protective zones such as those under roads.

A simultaneous network access project entitled "Creation of a Broadband Data Transmission Network in Lazdijai Region and Alytus Region Municipalities" (PDPT), and the infrastructure created during its implementation, were also taken into account when selecting fibre routes for the RAIN network. The towers built during the implementation of the PDPT project were connected to the RAIN network, and so were the remaining unconnected infrastructure assets of other operators as well as establishments and organizations throughout the region.

A non-profit public enterprise called PEPI was established to implement the RAIN project and manage the new infrastructure. Operators provided PEPI with information about the communications infrastructure that they managed, to aid planning of the fibre routes. In return, PEPI provided information about planned fibre routes to any interested parties, and precise information about planned lines (i.e. with

coordinates) was provided to parties that entered into a confidentiality agreement. Planned fibre routes were adjusted upon receipt of operators' comments on their future plans, including changes in the use of their infrastructure and other comments.

8.2.1 Conduct pilots

A managing authority can conduct pilot projects to assess the viability of a project. For instance, the CITC in Saudi Arabia launched in 2010 a pilot project to assess the viability of its Universal Service Project. Mobily, which was the only bidder, was awarded SAR 50 million in 2010 to provide telephony and broadband connectivity in five provinces, using 3G (IMT-2000) to provide broadband access. On completion of the successful pilot project, the CITC issued RFPs for USF and awarded three projects, two to Zain (in 2010 and 2011) and one to STC (in 2011). The managing authorities in both the Dominican Republic and Mongolia have also conducted pilot programmes.

8.2.2 Manage planning rules or rights of way

Planning rules and rights of way can greatly affect broadband projects, by increasing the time to roll out a network and associated costs. Local authorities or private land owners may charge fees for a broadband network to be rolled out across their land or one that crosses their area jurisdiction, and sometimes these costs can be excessive. For example, wayleave costs can be excessive and the process for agreeing fees may not be transparent. Many broadband projects also have to take into account local planning laws, which can also contribute to project delays and increased costs. Managing authorities should consider implementing regulations or working with local authorities and land owners to manage the risks associated with planning rules and rights of way. For example, in its 2010 annual report, the CITC said it plans to draft guidelines concerning the use of roads to extend telecommunication infrastructure.

Planning rules may also affect the roll-out of base-stations for fixed wireless and cellular infrastructure. Managing authorities should consider working with planning authorities to streamline laws/processes for acquiring sites/rolling out infrastructure.

9 Expanding PPP to broadband services and applications

The previous section showed how many of the projects studied include initiatives to stimulate the take-up of broadband access and services, including the provision of ICT training, free computer equipment and educational broadband centres. This final section discusses two other ways in which PPPs can be used to increase demand by (a) stimulating the development of broadband services and applications, and (b) investing in research and development.²¹

It is anticipated that governments will increasingly turn to PPP to develop broadband applications and services, in order to benefit the private and public sectors. The objective of projects is to accelerate the development of applications and services to market and more cost effectively, and develop applications and services that enable the public and private sectors to operate more productively and cost effectively.

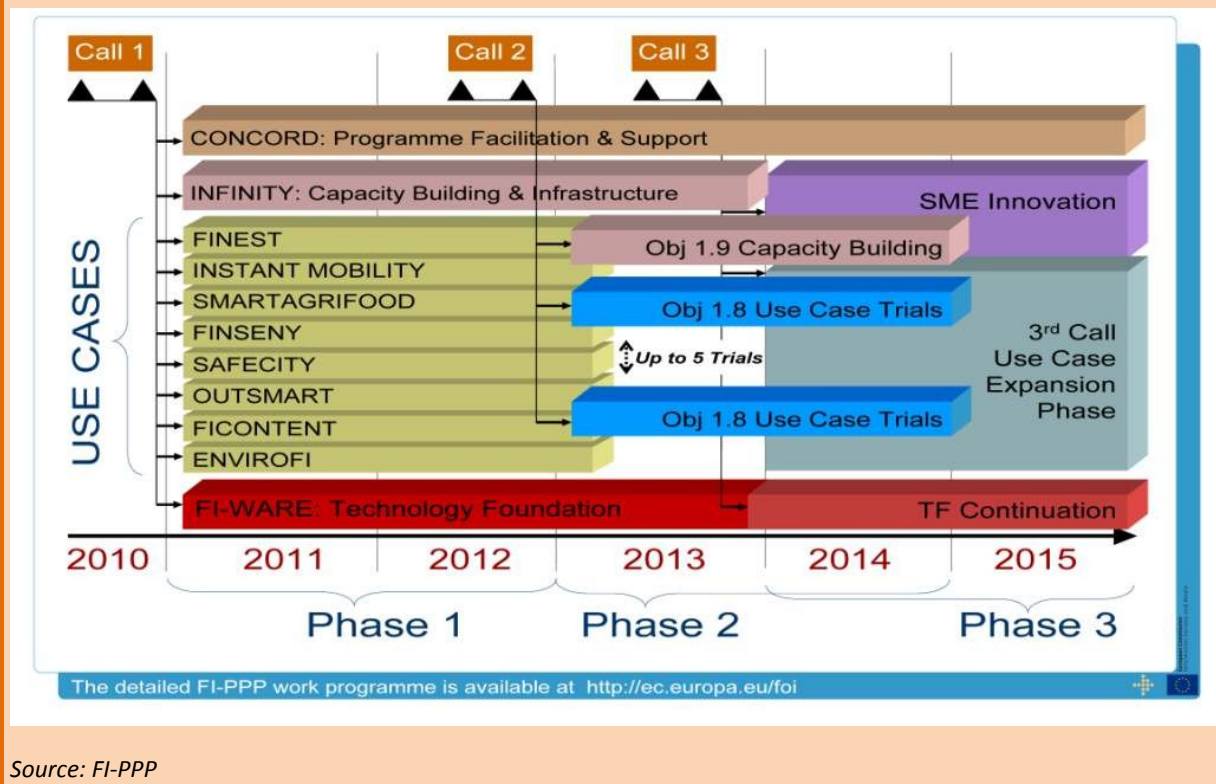
9.1 The EU's FI-PPP programme

One such project is the EU's Future Internet Public-Private Partnership Programme (FI-PPP). The main purpose of the FI-PPP is "to advance Europe's competitiveness in Future Internet technologies and systems and to support the emergence of Future Internet-enhanced applications of public and social relevance".²² The programme, launched in July 2010, aims to improve the competitiveness of European businesses across the telecommunication, media and technology industries by supporting the development of applications and improving the effectiveness of public infrastructure and business processes. Total funding for the project is EUR 300 million (USD 377.8 million), spread across three phases: Phase 1 (EUR 90 million (USD 113.3 million)), Phase 2 (EUR 80 million (USD 100.7 million)) and Phase 3 (EUR 130 million (USD 163.7 million)). These phases are shown in Figure 3 below.

²¹ These are referred to in the "Best practice guidelines on regulatory approaches to advance the deployment of broadband, encourage innovation and enable digital inclusion for all" issued at the ITU's 11th General Symposium for Regulators (2011). Available at http://www.itu.int/ITU-D/treg/Events/Seminars/GSR/GSR11/consultation/GSR11_BPG_E.pdf

²² Source: Future Internet Public-Private Partnership
http://ec.europa.eu/information_society/activities/foi/lead/fipp/index_en.htm

Figure 3: Programme architecture of the FI-PPP



Source: FI-PPP

The programme includes three 'Calls' – processes to evaluate proposals for funding from the private sector – and is supported by three activities termed Concord, Infinity and FI-WARE. These are described by the FI-PPP as follows:²³

- CONCORD: Coordination and Collaboration Facilitation for Next-Generation FI-PPP. Designed to facilitate the development of an overall programme view across all FI-PPP projects, and support standardization, SME involvement, links with regulatory and relevant policy activities, and dissemination and awareness of the programme.
- INFINITY: INfrastructure support and capacity building for the Future INternet community. Its aim is to create a PPP community which will collaborate to deliver the future Internet, establishing a common approach that applies to application developers and infrastructure owners by using existing key learnings and programmes.
- FI-WARE: Future Internet Core Platform. Supports the development of future Internet applications in multiple sectors by using a command service platform built using open specifications. Also aims to develop specifications that influence future Internet standards. FI-WARE is discussed in more detail in Section 10.3.2.

²³ Source: http://ec.europa.eu/information_society/activities/foi/lead/fipp/index_en.htm

Eight 'use cases' have been developed, of which FICONTENT is the most important in terms of application and service development.

- FICONTENT: Future media Internet for large scale CONTENT experimENTation. Project that consists of wide range of TMT companies working to develop new forms of content for audiovisual, games, Web, metadata and user-created content, for use by many different user devices. Phase 1 of this project is to propose new content scenarios, rejecting unsuitable scenarios, and progress them in phase 2.
- FINEST: Future Internet enabled Optimisation of Transport and Logistics Business Networks.
- INSTANT MOBILITY: Instant Mobility for Passengers and Goods.
- SMARTAGRIFOOD: Smart Food and Agribusiness: Future Internet for Safe and Healthy Food from Farm to Fork.
- FINSENY: Future INternet for Smart ENergy.
- SAFECITY: Future Internet Applied to Public Safety in Smart Cities.
- OUTSMART: Provisioning of urban/regional smart services and business models enabled by the Future Internet.
- ENVIROFI: The Environmental Observation Web and its Service Applications within the Future Internet

The Fi-PPP is also designed to facilitate SME innovation and involvement. All elements of the programme are designed to increase the participation of SMEs, for example FI-WARE aims to support SMEs that are developers and providers of Internet services and applications.

In May 2012, an independent panel published an Interim Assessment of FI-PPP.²⁴ The panel concluded that the programme was broadly meeting its objectives, but observed that private organizations needed to increase their cooperation with the programme; governance of some projects needed improvement; each project needed an effective governing body; more coordination was required; and the process to select proposals should be re-engineered to ensure projects achieve the greatest impact.

9.2 Application and service development

The use of public intervention to support the development of local, compelling applications, services and content is sometimes necessary to increase demand for broadband access. PPPs can be used to increase demand from both consumers and businesses by investing in applications and services that benefit people financially, educationally and socially, increasing their well-being. There are a range of applications that can be used to deliver these benefits, including the provision of e-government applications and services, e-health, e-business and e-learning services. These objectives are often part of governments' wider national ICT strategies or frameworks, for example Qatar's National Vision 2030 and its ICT Strategy 2015.

9.2.1 e-Government

The provision of e-government applications and services may not only improve business processes performed by central and local government, but also increase people's ability to access government services, irrespective of their location (distance from the government agency) and financial means (being

²⁴ Available at http://ec.europa.eu/information_society/activities/foi/lead/fipp/FI-PPP%20Interim%20Assessment.pdf

able to afford to travel to the government agency). It will also assist in creating inclusive/empowered societies by providing equal access to information and services.

e-Government initiatives such as the digitalization of processes like applying for a driving licence or submitting a tax return can benefit citizens and businesses by significantly reducing waiting time and making these processes more convenient and efficient – a journey from a small rural community to government offices may take several days. Similar initiatives could be applied to other services, such as income tax collection, benefit payments, company registration, collection of VAT and so on. Such initiatives may also benefit government and create value for the public sector by streamlining processes and allowing better management of the country's finances – e.g. more efficient tax collection .

e-Government can go far further than the digitalization of government processes, however, encompassing e-learning, e-health and other applications and services used by citizens (see below).

To maximize take-up of e-government applications and services, governments in emerging markets should consider the importance of wireless networks and the types of mobile devices in use. To ensure that services are as inclusive as possible, governments should consider making them accessible to basic mobile phones as well as more sophisticated smart phones. A mix of IVR, SMS, USSD and WAP-over-GPRS bearers²⁵ can be used to support the delivery of mobile applications (and data) and enable subscribers to interact with applications, maximizing the use of applications by all mobile subscribers. Such an approach can be used to foster the use of new technology and services in the short term, whilst governments initiate other projects in parallel to migrate citizens towards the use of broadband technologies and services.

Other PPP application and service projects should also consider the importance of wireless networks and the availability of mobile devices when developing a project.

Many e-government projects are fully government-funded, but in most cases the private sector is involved in the development of e-government applications and services. In some cases, e-government projects also include investment in community broadband centres or multimedia kiosks where people can access the applications and services that have been developed.

The following are examples of e-government initiatives:

- India: the government of Rajasthan has developed E-Mitra²⁶, a project to provide people with access to e-government in urban and rural areas at kiosks and service centres, known as common service centres. The regional government is responsible for providing the front-end e-government services to customers, whilst the back-end systems are supported by a technology partner (but owned by the government of Rajasthan). As of June 2012, over 2 100 kiosks were operational across 33 districts and supported over 370 000 transactions during that month. Services supported include registration of births and deaths, payment of local government bills, and purchase of train tickets and stamps.

²⁵ IVR (interactive voice response) allows a caller to dial a short code to listen to pre-recorded information and select options, either using voice commands or using DTMF (dual tone multi frequency); SMS (short code messaging), a maximum of 160 characters can be sent in each text message. SMS is a store-and-forward service; USSD, (unstructured supplementary service data) a set of codes, normally menu-based, which enable users to interact with services. A maximum of 182 characters can be sent in each message. For example, used by prepaid subscribers to check credit or top up their account; WAP (wireless access protocol) over GRPS, GPRS is an example of a 2.5G network technology, with a peak downlink data rate of up to 80 kbit/s using four 20 kbit/s time slots.

²⁶ <http://emitra.gov.in/>

- A similar initiative is the Samadhan Project, also in India, which provides people with access (at local service centres) to government services such as banking services, bill payment, access to members of parliament and renewal of arms licences.

9.2.2 e-Health

The provision of e-health is important in both developed and emerging markets. In developed markets healthcare providers are increasingly looking to e-health to support healthcare delivery, both on-site and in people's homes, as a means to minimize costs. Here healthcare providers are exploring e-health initiatives as they seek to make do with flat financial budgets, whilst at the same time having to cope with a growing, ageing population as well managing an explosion in obesity, diabetes and other diseases and conditions.

In emerging markets, the use of e-health can provide people with access to healthcare where previously there was none. Similar to e-government, e-health initiatives can benefit patients in other ways, for example reducing their need to travel to see clinicians. In many cases the provision of e-health applications and services are put in the hands of health professionals who are local to their patients.

The following is an example of an e-health initiative:

- Malawi, Baobab e-health project²⁷: a project between a non-governmental organization and the Ministry of Health. The project provides nurses and clinicians with touchscreen devices and applications to help them treat patients. The applications were developed by the government and clinicians. In the period from launch in 2002 until July 2012, over one million consultations had taken place and 800 000 patients have been registered at five sites. Information collected using the touchscreen devices is shared with the Ministry of Health.

9.2.3 e-Learning

Education providers and governments can improve access to information and teaching tools for pupils, students and teachers by implementing e-learning projects. e-Learning can be used to increase the number of students and pupils that can be supported and taught by teachers and lecturers, and assist in setting exams and monitoring performance.

The following is an example of an e-learning initiative:

- The e-schools initiative of the New Partnership for Africa's Development (NEPAD)²⁸ equips primary and secondary schools with ICT equipment (for example, PCs, phones, scanners and network access) and trains students and teachers in ICT skills. The initial phase of the project in 2004 consisted of trial deployments, to schools in 11 countries (including Kenya, Mauritius and Uganda), funded by consortia made up of the public sector (the participating governments) and private-sector organizations (led by AMD, Cisco, HP, Microsoft and Oracle). Other participants included the ITU, the South African Department of Communications, and the African Development Bank. The ultimate aim of the project is to deliver a minimum of 20 PCs and other ICT equipment to each of a total of 600 000 schools throughout Africa. The project is due for completion in 2014.

²⁷ <http://baobabhealth.org/>

²⁸ <http://www.nepad.org/crosscuttingissues/ict>

9.3 R&D

The development of applications and services can be encouraged by using financial resources from government and the private sector to support research and development projects. Funds may be provided, for example, to construct and maintain business parks, provide grants to start-up businesses, or develop ICT platforms to enable government or businesses to create and launch applications and services. The ultimate aim of such investment is to support the creation of applications and services that benefit society as well as businesses. In many cases R&D projects are run in parallel with broadband projects, as in the Digital Malaysia programme discussed below.

The public and private sectors should also consider collaborating to overcome certain obstacles to the widespread dispersal and use of applications and services. These include, but are not restricted to:

- Identification of users: a common and consistent tool is needed to enable people to be readily identified in order to access e-government and other e-services.
- Common infrastructure and standards: a common and consistent set of infrastructure and standards is required to enable government and the private sector to collaborate to deliver e-government applications and services and other e-services. This also includes important aspects such as e-payment and online security.
- Net neutrality and open access: there should be common and unrestricted access to the Internet, and to the passive and active infrastructure of PPP broadband projects.

Example government-led R&D project:

- The Malaysian government has initiated a national programme called Digital Malaysia, which will assist the country to become a digital economy by 2020. The programme is built on three transformative strategies: (1) 'Supply to demand-focused' includes the NBI project and supporting initiatives designed to stimulate demand for broadband access; (2) 'Consumption to production-centric' aims to enable consumers to use the Internet as a means to develop revenue streams through the digital economy; and (3) 'Low knowledge-add to high knowledge-add' helps SMEs to benefit from the digital economy by improving ICT penetration and helping them to generate revenues from the digital economy.

9.3.1 Company- and project-specific incubator projects

PPP incubator projects may take one of two forms: providing support to a company, or to a specific project. Incubator projects are similar to the broadband projects discussed above, in that without public funding the company or project would not reach the marketplace. Incubators have been used by governments to assist non-commercial organizations, e.g. to support a university research project to commercialize a prototype portable medical scanner. The form of funding may vary, from providing facilities such as a business park in which the company can set itself up, to providing funding directly for the company to find its own facilities. Funding may also be project-specific, in cases where a specific product or service requires public funding to reach the marketplace.

Example incubator projects include the following:

- MSC Malaysia (formerly Multimedia Super Corridor) is part of the government's national programme to transform the country into a digital economy. The Multimedia Development Corporation (MDeC) is responsible for managing MSC Malaysia, and is fully funded and owned by the Malaysian government. Part of MSC's remit is to support the development of local ICT companies and attract foreign ICT companies to Malaysia, through the provision of grants. The MSC Malaysia R&D Grant Scheme (MGS) is designed to provide investment in R&D projects in Malaysia, including the development of commercial applications, services and digital content. Grants of up to 50 per cent of a project's costs (up to a maximum of RM1.2 million) are available to businesses that are at least 51 per cent Malaysian-owned. A similar fund, the MAC3 Co-Pro Fund, is available to businesses developing multimedia applications and services such as animation, computer games and graphics.

- To catalyse the NGNBN project in Singapore, the telecommunication regulator IDA developed a programme to co-fund application and service development with the private sector. The Next Gen Services Innovation Programme (NGSIP), launched in 2009, offered private companies the opportunity to win funding to develop a service/application. The funding could be used to support employee costs, training, hardware, software, IPR fees and professional services fees. Funding was restricted to companies who planned to develop a service wholly or partly in Singapore. The IDA ran two such funding schemes, in 2009 and 2011, and assessed each proposal against a range of criteria including: the business model, anticipated adoption rate, deployment schedule, amount of innovation, and impact on the NGNBN. As a result of the NGSIP, a variety of applications and services have reached the market, for example ScaleNow from Asiasoft Solution (software as a service) and LittleStore from LittleLives (an e-learning service).

9.3.2 Investment in platforms

Businesses and individuals may have the ideas and skills to develop applications and services, but lack the resources to build, design and launch them. The concept of Platforms as a Service (PaaS) is intended to address this lack by providing businesses and people with the infrastructure and tools to design, build and launch applications and services. PaaS is one of three services associated with cloud computing, along with software as a service (SaaS) and infrastructure as a service (IaaS). A PaaS may contain a preconfigured set of tools and services accessed by a private network or the Internet, and used by developers to build, design and test applications and services for different devices and operational systems (e.g. Windows). Some PaaS provide operational support and billing support systems that enable developers to take their applications or services to market, providing all the necessary provisioning, fulfilment and billing tools. The EU's FI-PPP programme includes the development of the FI-WARE platform, which has similar objectives as a PaaS, namely to minimize the cost of developing applications, as well as other objectives. This is discussed below.

Investment in platforms is costly: in many cases operators provide developers with access to a PaaS on a pay-as-you-use basis, or take a percentage share of revenue generated from any applications or services that reach market. PPP can be used to invest in PaaS, increasing the ease with which companies and businesses can develop and applications and services for use over broadband networks.

The following are examples of PPP platforms:

- My1Content is a content service delivery platform, developed as part of the Malaysian government's Digital Malaysia programme. It has been developed and funded by Telekom Malaysia and the MDeC (which is ultimately responsible for MSC Malaysia). The platform can be used by businesses to develop and distribute applications, services and content, through a portal which can support mobile and other digital devices. The platform is accessible for free by application and service developers, although they can expect to be charged a revenue-sharing service charge some time in 2013. As of June 2012, end users could access a range of applications, films and music via the portal.
- As part of the FI-PPP, the FI-WARE platform is designed to “deliver novel services building upon elements (called Generic Enablers) which offer reusable and commonly shared functions, making it easier to develop Future Internet Applications in multiple sectors.”²⁹ The ultimate aim is to minimize the cost of developing applications, and to develop them more quickly and reliably. As of August 2011, three grants of EUR 12.3 million (USD 15.5 million) had been

²⁹ Source <http://www.fi-ware.eu/about/>

awarded. Applications for grants are reviewed in terms of their contribution to one of three sets of Generic Enablers (GEs), which should be open-source and royalty-free:

- Advanced Web-based User Interface GEs: to enhance web interfaces, offering improved user experience of applications and services – e.g. interactive 3D graphics and augmented reality software/services.
- Stream-oriented GEs: to enhance the streaming of content and data (media, sensory data and other).
- Cloud Proxy Extended Development and Management Platform GEs: to enhance the development and delivery of cloud-based applications, by providing common tools and support services.

10 Summary of best practices in establishing successful projects

The best practices and learnings provided below are designed to help managing authorities to deliver successful broadband projects, and take into account all the broadband projects highlighted in this report. No single recommendation should be taken in isolation and used as a basis for a broadband project, and similarly no single example project should be taken in isolation as representing best practice. Rather, managing authorities should draw on all the best practices and learnings provided below, and use them to guide the planning, implementation, monitoring and management of their own broadband projects.

10.1 Conduct a public consultation

The managing authority should consider consulting with all potential stakeholders, including end users, telecommunication operators, other government agencies, local authorities and equipment vendors. Such a consultation can provide a lot of critical information such as the requirements for broadband access, the likely level of demand, consumers' willingness to pay for services, the degree of interest of operators in participating in broadband projects, and the most suitable technologies and investment models. The consultation can also consider other projects that the managing authority may initiate to stimulate or catalyse demand for broadband access, as discussed in Section 9.7.

Introducing a broadband plan without a proper consultation process may result in a lack of participation from operators, the use of an unsuitable mix of technologies, and limited take-up by the intended end users.

Among the example projects, consultations by the managing authority took place as part of the following projects:

- Dominican Republic, Rural Broadband Connectivity Project: Indotel conducted a consultation with industry stakeholders and end users to determine the need for Internet services, assess the willingness to pay, identify the telecommunication infrastructure currently available and planned, and discuss the challenges in deploying broadband infrastructure to rural locations.
- Qatar, Q.NBN: network operators, such as Qtel and Vodafone, were consulted to help determine the extent to which existing infrastructure could be used, and how the deployment of FTTH could be used to support the development of broadband services.
- Saudi Arabia, Universal Service Project: the CITC conducted a public consultation to collect views on its draft USF Strategic Plan, and its policy to provide broadband services in underserved and unserved locations. The consultation helped to identify broadband projects that would deliver the best value for money, and stakeholders agreed that a levy of one per cent of operators' revenues should be raised to support the initiative.

10.2 Consider implementing multiple investment models and funding sources

A broadband project that consists of deploying a backhaul/core network and access network, and/or a mix of national, urban and rural deployments may consider using a mix of different investment models and sources of finance. For example, the use of funds from the USF may not be appropriate for a project to develop national backhaul/core and access networks, if other funding sources were available, but would be appropriate for the part of the project delivering broadband access to unserved rural locations. When no other sources of funding are available, managing authorities may consider using USF to fund any part of a broadband project. Using more than one investment model for different parts of a broadband project provides the managing authority with different levels of control over the network deployed.

Two of the example projects use multiple investment models or funding sources:

- Argentina Connected: this project is financed by government grants and employs a mixed investment model consisting of public DBO and public outsourcing. The managing authority AR-SAT is deploying and operating the national core network, following a public DBO model; at

the same time, in large cities and regions where it does not have capability to deploy fibre, it subcontracts deployment via public outsourcing.

- Malaysia, NBI: the two parts of the project use different investment models and different funding sources. The HSBB project is deploying FTTH to the main economic areas and is funded through government grants. The BBGP project targets other areas using less advanced access technologies and is funded through the USF.

10.3 Be technology neutral

It is challenging to deliver broadband access to unserved and underserved locations, which are quite often rural or have difficult topographies. In such areas, deployment should not be limited to one type of technology, and the fastest technology may not always be the most appropriate. ADSL technology will not be appropriate in locations where there is a lack of last-mile copper access, so wireless technology may need to be implemented. In remote locations backhauling broadband traffic may be problematic, and the use of fixed or microwave backhaul technology may not be appropriate so satellite hubbing may be required.

The authority should also consider the capabilities of the operators who are bidding for the projects: their expertise and knowledge of working with particular technologies should be encouraged and supported. Restricting the number of technologies that can be proposed by bidders to use as part of a broadband project, particularly broadband access, may restrict the number of bids received.

The following example projects have considered multiple technologies for broadband access, as part of the bidding process:

- Dominican Republic, Rural Broadband Connectivity Project: the project included the opportunity to use ADSL, WiMAX and UMTS.
- Malaysia, NBI: ADSL, WiMAX and UMTS were considered as options for the BBGP project to provide broadband access to regions outside the major economic areas.
- Pakistan, USF Broadband Programme: the provision of broadband access to unserved urban areas and rural communities considered the use of ADSL and wireless HSPA and WiMAX.
- Saudi Arabia, Universal Service Project: four projects have been funded so far; all of these use 3G (IMT-2000) technology to provide broadband access to underserved locations, although WiMAX and other technologies were also available for consideration.

10.4 Conduct pilot projects

Pilot projects can be used by a managing authority to test the ability of the project to meet its objectives, and to identify risks and other issues that may arise. Such an approach is advisable before rolling out large-scale and costly projects, as the key learnings from the pilot phase can be incorporated in the main project. For example, in Saudi Arabia the telecommunication regulator CITC launched a pilot project to test its Universal Service Project. On successful completion of the pilot, CITC then issued Requests for Proposal and awarded a number of contracts. Pilots have also been used by the example projects in the Dominican Republic and Mongolia.

10.5 Provide funding in line with agreed milestones and targets

The timing of the payments to the organizations implementing the project should be based on the achievement of a mix of milestones and targets, including agreed milestones in the roll-out plan, target levels of take-up of wholesale services by operators and service providers, and take-up of access services by end users. Using such a mix increases the likelihood of a successful project – not just in terms of the physical roll-out, but also adoption by service providers and end users, since the ultimate success of a

broadband project depends on not only making sure broadband is accessible to end users but that it is actually used by them.

For example, as part of the Universal Service Broadband Programme in Pakistan, a technical auditor monitors the achievement of milestones by operators in rolling out broadband access networks, and targets for the number of subscribers (a subscriber must have been a customer for at least 90 days). Only when milestones have been achieved for both roll-out and number of subscriber agreements is an operator provided with its funding, which is paid in four 25 per cent portions.

10.6 Mandate open access to the network, and monitor compliance

Many of the example broadband projects stipulate that an open-access model should apply to the infrastructure. This helps to promote competition among multiple service providers, supports innovation in products and services, and minimizes market distortion. It is important to ensure that open access is defined in terms of access to specific services and products (e.g. wholesale bandwidth, dark fibre or duct access). Access should be provided to all products, all of the time for the lifetime of the network.

The following projects ensure that open-access principles are followed:

- Argentina Connected: the managing authority AR-SAT has responsibility for deploying and operating a national core network, which operates under open-access principles for wholesale data services.
- Latvia, next-generation network for rural areas: LVRTC, a non-profit public enterprise, is obliged to provide wholesale services under equal access conditions on a non-discriminatory basis. Operators are able to access passive network infrastructure (ducts and fibre) and use space in cabinets to deploy their equipment.
- Malaysia, NBI: the telecommunication regulator monitors the provision of open access to the HSBB network, which is provided on a commercially negotiated wholesale basis.
- Singapore, NGNBN: the telecommunication regulator is responsible for monitoring open access to the FTTH network. Nucleus Connect is the operating company, responsible for operating the active Layer 2 and administering open access to Layer 3 for retail service providers.
- Slovak Republic, national broadband project: the public enterprise NASES is obliged to provide wholesale access on a non-discriminatory basis, including ducts, dark fibre, collocation space and masts. Any wholesale access disputes are considered by the regulator.

10.7 Consider setting up parallel initiatives to stimulate demand

The roll-out of infrastructure alone does not ensure the success of a broadband project: this is only achieved when there is take-up and use of broadband access and services. To help achieve this take-up, it may also be necessary to stimulate or catalyse demand, for example by providing free or subsidized laptops/netbooks, establishing community centres to educate people in the use of broadband, and providing general ICT training. Such initiatives can easily be incorporated into broadband projects, and can be funded publicly, privately or through PPPs.

The following projects have included initiatives to stimulate demand:

- Argentina Connected: netbooks were provided to 1.9 million students between 2010 and July 2012³⁰ as part of a project to deliver 3 million netbooks. A digital literacy programme has also been used to provide PC and Internet training to communities.
- Dominican Republic, Rural Broadband Connectivity Project: demand for broadband access and services has been stimulated by obliging service providers and operators to provide website development assistance for each location where broadband access was provided, as well as providing training in maintaining that website. The websites created contain information about the community, tourist attractions, goods and services.
- Malaysia, NBI: the USF has been used to fund the construction of and Community Broadband Libraries, which provide communities with access to computers, broadband services and IT training.
- Pakistan, USF Broadband Programme: demand has been stimulated by requiring participating operators to build Community Broadband Centres and Educational Broadband Centres.

³⁰ Source: Conectar Igualdad

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Glossary and abbreviations

3G	Third-generation mobile network or service. Generic term for the next generation of broadband digital mobile cellular systems, which has expanded broadband capabilities for mobile data applications. See IMT-2000.
4G	Fourth-generation mobile network or service. Mobile broadband standard offering both mobility and very high bandwidth.
access network	The portion of a telecommunication network between the central office (also known as a local exchange) and the end-user premises
active	The portion of the infrastructure which includes active electronics (as opposed to passive infrastructure such as fibre and underground ducts)
ADSL	Asymmetric digital subscriber line. A technology that enables high-speed data services to be delivered over twisted pair copper cable, typically with a download speed in excess of 256 kbit/s, but with a lower upload speed. Corresponds to ITU-T Recommendation (standard) G.992.1.
backbone	The portion of the telecommunication network that links towns and cities across the country (also known as the core network)
backhaul	A high-capacity line dedicated to the transport of aggregate communication signals from base stations to the core network (also ITU-R F.1399).
BBGP	Broadband to the General Population
bitstream	A form of network unbundling. With bitstream access, the incumbent maintains management control over the physical line. Unlike full unbundling and line sharing, access seekers can only supply the services that the main fixed operator designates.
broadband	Network or circuit capacity of 256 kbit/s or more. For the purposes of this report, some of the broadband projects define broadband to be 128 kbit/s.
cabinet	A piece of passive infrastructure that houses active electronics close to the end-user premises
CBC	Community Broadband Centres
CBL	Community Broadband Libraries
CITC	Communications and Information Technology Commission (CITC), telecommunication regulator for Saudi Arabia
cloud computing/ service	Typical cloud computing providers deliver common business applications online, which are accessed from a web browser, while the software and data are stored on servers.
Contel	Comisión Nacional de Telecomunicaciones, telecommunication regulator in Paraguay
core network	The portion of the telecommunication network that links towns and cities across the country (also known as the backbone network)
CRC	Communications Regulatory Authority, regulator Mongolia
dark fibre	Optical fibre cable which has not yet been connected to active electronics and carries no data
DBO	Design, Build and Operate (an investment model)
digital divide	A socio-economic effect whereby one area of a country (usually rural areas)

	falls behind another area (usually urban areas) in the availability of digital services such as broadband
DSL	Digital Subscriber Line
DSLAM	Digital Subscriber Line Access Multiplexer
duct	tube or passage that confines and conducts cables (copper or fibre optic) of a physical network.
EBCs	Educational Broadband Centres
EC	European Commission
ERDF	European Regional Development Fund
Ethernet	A protocol for interconnecting computers and peripheral devices at high speed. Recently Gigabit Ethernet has become available, which enables speeds up to 1 Gbit/s. Ethernet can run on several types of wiring including: twisted pair, coaxial, and even fibre optic cable
EU	European Union
EUR	Euro. The official currency of the Eurozone (European Union member states that have joined the European Monetary Union)
exchange	A network node that serves anywhere between about 2000 to 20 000 lines (also called a central office)
FI-PPP	Future Internet Public-Private Partnership Programme
fibre	A type of cable whereby information is transmitted as light waves through a thin filament of glass
FTTB	Fibre To The Building. A high-speed optical fibre Internet connection that terminates at a domestic residence or commercial premise
FTTC	Fibre To The Cabinet. A high-speed optical fibre Internet connection that terminates at a street cabinet
FTTH	Fibre To The Home. A high-speed optical fibre Internet connection that terminates at a residence
FTTx	Fibre-to-the-x, where x is a home (FTTH), building (FTTB), curb, cabinet (FTTC), or neighbourhood (FTTN). These terms are used to describe the reach of an optical fibre network.
GDP	Gross domestic product. The market value of all final goods and services produced within a nation in a given time period.
GE	Generic Enabler
GIS	Geographic Information Systems
GPON	Gigabit Passive Optical Network
GVA	Gross Value Added
HSBB	High-Speed Broadband
HSPA	High-Speed Packet Access
ICPTA	Information, Communication Technology and Post Authority
ICT	Information and communication technologies. A broad subject concerned with technology and other aspects of managing and processing information, especially in large organizations.

ID	Identification
IDA	Infocomm Development Authority, telecommunication regulator of Singapore
IMT-2000	International Mobile Telecommunications-2000. Third-generation (3G) “family” of mobile cellular standards approved by ITU. For more information see the website at: www.itu.int/imt
Indotel	Reguladora de telecomunicaciones en Republica Dominicana, telecommunication regulator of the Dominican Republic
ISP	Internet service provider. ISPs provide end users access to the Internet. Internet access providers (IAPs) may also provide access to other ISPs. ISPs may offer their own proprietary content and access to online services such as e-mail.
JV	Joint Venture (an investment model)
last mile	The topology denotes the operator’s ownership of the access network.
Layer 2	Data link layer, part of the Open Systems Interconnection (OSI) model. The concept of layered network architecture divides a network at any specific point into layers, each of which adds value to the physical medium of communication.
Layer 3	Network link layer, part of the Open Systems Interconnection (OSI) model. The concept of layered network architecture divides a network at any specific point into layers, each of which adds value to the physical medium of communication.
Main fixed operator	The telecommunication operator in each country that is or used to be owned by the government. Passive infrastructure such as ducts and copper cable is usually owned by the main fixed operator.
managing authority	(In the context of this report) The public organization that has responsibility for managing the PPP broadband project. Can be the regulator, another public organization such as a Ministry, or a specific agency (e.g. an intermediate body such as a central/regional/rural development agency) delegated to support the project
MCMC	Malaysian Communications and Multimedia Commission, regulator Malaysia
MYR	Malaysian Ringgit
NASES	The National Agency for Network and Electronic Services (a non-profit public enterprise which is the managing authority of Slovak Republic's national broadband project)
NBS	National Broadband Strategy
NEPAD	New Partnership for Africa's Development
NetCo	Network Company
next-generation	
NGA	Next-Generation Access
NGISP	Next-Generation Services Innovation Programme, project in Singapore
NGN	Next-Generation Network. A broad term for a certain kind of emerging computer network architectures and technologies. It generally describes networks that natively encompass data and voice (PSTN) communications, as well as (optionally) additional media such as video.

NGNBN	Next-Generation National Broadband Network, broadband project Singapore
Node	A point of aggregation in a telecommunication network, whereby data from several users is collated to be sent through the network
NRA	National Regulatory Authority (of telecommunications)
OpCo	Operating Company
OpenNet	A consortium consisting of SingTel, Axia NetMedia, Singapore Press Holdings and Singapore Power Telecommunications as part of the NGNBN project in Singapore
outsourcing	A business model whereby a third party is contracted to undertake a business process or service (e.g. building and operating a network)
overlay	The concept of deploying new broadband infrastructure without removing the existing infrastructure
PTP	Point To Point (an architecture used in fibre networks)
passive	Collocation or other forms of facility sharing, including duct, building or mast sharing (Directive 2002/19/EC).
PC	Personal Computer
PDPT	A project in Lithuania for the creation of a broadband data transmission network in the Lazdijai region and the municipalities of Alytus region
penetration	The amount of take-up of a service within an area
PEPI	Public Enterprise Plačiajuostis Internetas (a non-profit public enterprise established in Lithuania to implement the RAIN project and manage the new infrastructure)
PaaS	Platform as a Service
PNT	National Telecommunications Plan, broadband project Paraguay
Q.NBN	Qatar National Broadband Network
PPP	Public-private partnership. An arrangement or partnership combining funding and activities of both government and private-sector entities to build network infrastructure.
RFP	Request for Proposals
RFS	Ready For Service
Rights of way	Strip or area of land, including surface and overhead or underground space, which is granted by deed or easement for the construction and maintenance of specified infrastructure elements such as copper or fibre optic cables, etc.
ring	A network topology which provides redundancy whereby all nodes are connected on ring. If a section is cut or damages, the other portion of the ring can continue to provide services
SaaS	Software as a Service
SC	Supervisory Committee
SECOM	Secretaría de Comunicaciones, NRA Argentina
SGD	Singapore Dollar
SME	Small or Medium-sized Enterprise

SPV	Special-Purpose Vehicle
STC	Saudi Telecom
switch	Part of a mobile or fixed telephone system that routes telephone calls or data to their destination.
TEAMS	The East African Marine System
TV	Television
UK	United Kingdom
UMTS	Universal mobile telecommunications system. The European term for third-generation mobile cellular systems or IMT-2000 based on the W-CDMA standard. For more information, see the UMTS Forum website at: www.umts-forum.org
USA	United States of America
USD	US Dollar
USF	Universal Service Fund
VSAT	Very small aperture terminal. A two-way satellite ground station with a dish antenna that is smaller than three metres, as compared to around 10 metres for other types of satellite dishes.
Wi-Fi	Wireless fidelity. A mark of interoperability among devices adhering to the 802.11b specification for wireless LANs from the Institute of Electrical and Electronics Engineers (IEEE). However, the term Wi-Fi is sometimes mistakenly used as a generic term for wireless LAN.
WiMAX	Fixed wireless standard IEEE 802.16 that allows for long-range wireless communication at 70 Mbit/s over 50 kilometres. It can be used as a backbone Internet connection to rural areas.
wireless	Generic term for mobile communication services which do not use fixed-line networks for direct access to the subscriber.
Wireline (fixed)	A physical line connecting the subscriber to the telephone exchange. Typically, fixed-line network is used to refer to the PSTN to distinguish it from mobile networks.

Annex 1: Overview of example projects by region

This annex contains summaries of the 13 broadband projects researched as part of this report, grouped by their geographical location. For each project, the following information is provided:

- Project – the name of the project.
- Managing authority – the public organization managing the project.
- Summary of investment – an overview of the project, the type of technology and network deployed.
- Investment value – the amount of financial support provided to the broadband project.
- Infrastructure – the type of infrastructure deployed as part of the broadband project.
- Investment model – the type of model used to support the broadband project.
- Funding sources – the type of public funding used to support the broadband project.
- Geographical activity – the geographical aims of the broadband project.

Table A1: Broadband projects in Africa and the Middle East

		Kenya	Qatar	Saudi Arabia
Project		The East African Marine System (TEAMS)	Q.NBN (Qatar National Broadband Network)	Universal Service Project
Managing authority (ministry/regulator)		TEAMS, a collaboration between the government of Kenya, Etisalat and other commercial organizations	A non-profit enterprise that is 100% government-owned	The Communications and Information Technology Commission (CITC)
Summary of investment		Deploy a 1.28Tbit/s submarine optical fibre cable between Fujairah, the UAE and Mombasa (Kenya). Launched in July 2010	Accelerate the deployment of FTTH, and deliver coverage in excess of 95 per cent of households and businesses by 2015 (minimum 100 Mbit/s download speed)	Grants made available to operators to provide voice and Internet access (minimum 512 kbit/s download speed) to underserved locations
Investment value		USD130 million	USD100 million	Mobily (August 2010): SAR50 million; Zain (2010): USD10.7 million; STC (2011): USD7.9 million; Zain (January 2011): SAR40 million
Infrastructure	FTTH		✓	
	FTTC			
	DSL			
	Wireless and satellite			✓
	Backhaul/core			
	International fibre	✓		
Investment model	Bottom-up			
	Private DBO			✓
	Public outsourcing			
	Joint venture (partnering)	✓		
	Public DBO		✓	
	Other			

		Kenya	Qatar	Saudi Arabia
Funding sources	Universal services funding			✓
	Government grant	✓		
	External funds			
	Other			
Geographic activity	National		✓	✓
	Regional			✓
	Rural			✓
	International	✓		
<i>Source: Analysys Mason, CITC, Q.NBN, TEAMS</i>				

Table A2: Broadband projects in the Americas

		Argentina	Dominican Republic	Paraguay
Project		Argentina Connected	Rural Broadband Connectivity Project Part of the wider e-Dominican strategy	National Telecommunications Plan (PNT)
Managing authority (ministry/regulator)		Strategic Coordination Commission with support from the Ministry of Federal Planning, Public Investment and Services and Secretaría de Comunicaciones (SECOM) (the telecommunications NRA)	Indotel (the telecommunications NRA)	Comisión Nacional de Telecomunicaciones (Conatel) (the NRA)
Summary of investment		Nationwide backhaul/core infrastructure	Government grants to telecommunication operators to deliver broadband access to rural locations	Grants to subsidize network roll-outs to underserved and unserved areas (optical fibre cable, ADSL and mobile)
Investment value		USD1.844 billion from 2010 to 2015	USD4.65 million for Rural Broadband Connectivity Project, subsequently Codetel requested the use of 2x15 MHz of spectrum in the 3.5 GHz band, which was made available by Indotel in the bid document for no charge. Codetel took no subsidy	USD600 million
Infrastructure	FTTH			
	FTTC			
	DSL		✓	✓
	Wireless and satellite		✓	✓
	Backhaul/core	✓		✓
	International fibre			
Investment model	Bottom-up			
	Private DBO		✓	✓
	Public outsourcing	✓		
	Joint venture (partnering)			

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		Argentina	Dominican Republic	Paraguay
	Public DBO	✓		
	Other			
Funding sources	Universal services funding		✓	✓
	Government grant	✓		
	External funds			
	Other			
Geographic activity	National	✓		✓
	Regional	✓		
	Rural		✓	
	International			
<p>Source: Analysys Mason, Conatel, Indotel, ITU-GSR09 Background Paper (Bringing Broadband Access to Rural Areas), ITU - GSR 2011 Discussion Paper (Setting National Broadband Policies, Strategies and Plans), SECOM</p>				

Table A3: Broadband projects in the Asia–Pacific region

		Malaysia	Mongolia	Pakistan	Singapore
Project		National Broadband Initiative (NBI)	Information and Communications Infrastructure Development Project	Universal Service Fund (USF) Broadband Programme	Next-Generation National Broadband Network (NGNBN)
Managing authority (ministry/regulator)		Malaysian Communications and Multimedia Commission (MCMC) (the telecommunications NRA)	Communications Regulatory Authority (CRC), and Information, Communication Technology and Post Authority (ICTPA)	An independent non-profit enterprise, overseen by the Ministry of Information Technology (the telecommunications NRA)	Singapore Infocomm Development Authority (IDA) (the telecommunications NRA)
Summary of investment		Multiple projects to improve broadband penetration in urban and rural areas using FTTH, high-speed packet access (HSPA) and WiMAX	Provide mobile and wireless broadband access to soums (districts). The project commenced in 2006 and was completed 2012 Output-based funding approach. The initial pilot was launched in 2010 and provided Internet access to 34 soums	Multiple projects to improve the regional core and backhaul fibre network and broadband access in underserved and unserved area	Project to provide FTTH access to 95% of the population by mid-2012, and to 100% of the population by 2015
Investment value		High-Speed Broadband (HSBB) project worth RM11.3 billion, of which RM2.4 billion from the government and RM8.9 billion from Telekom Malaysia	USD11.85 million from the government of Mongolia, the government of Japan and the World Bank	Up to June 2012 the rural programme had received PKR4.2 billion, and the broadband programme PKR6.3 billion	USD2 billion over 25 years
Infrastructure	FTTH	✓ In high economic impact zones, open access, prices not regulated		✓	
	FTTC	✓ In high economic impact zones, open access, prices not regulated			
	DSL				
	Wireless and satellite	✓ Rural areas using HSPA and WiMAX	✓		✓ Wi-Fi plus satellite used for delivery

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		Malaysia	Mongolia	Pakistan	Singapore
	Backhaul/core		✓		
	International fibre				
Investment model	Bottom-up				
	Private DBO	✓	✓		✓
	Public outsourcing			✓	
	Joint venture (partnering)				
	Public DBO				
	Other				
Funding sources	Universal services funding	✓ (for rural access)	✓		✓
	Government grant	✓ (for HSBB)		✓	
	External funds				✓
	Other				
Geographic activity	National	✓	✓	✓	
	Regional	✓	✓		
	Rural	✓	✓		✓
	International				
Source: Analysys Mason, CRC, MCMC, Telekom Malaysia, ICTPA, World Bank					

Table A4: Broadband projects in Europe

Project		Latvia	Lithuania	Slovak Republic
Project		Next-generation network for rural areas	RAIN (Rural Area IT Network)	Basic broadband deployment in white areas of Slovak Republic, and in rural and other unserved areas
Managing authority (ministry/regulator)		Non-for-profit public enterprise	Non-for-profit public enterprise	Non-for-profit public enterprise it owns and manages the network
Summary of investment		Regional backhaul/core network	Nationwide backhaul/core network	Regional backhaul/core network
Investment value		Total investment of EUR 119 million (USD 149.9 million), all provided by the European Regional Development Fund (ERDF). Runs from 1 January 2012 to 31 December 2012, in two phases: first phase (by 2015) involves the deployment of a 1900 to 2000km optical fibre network; phase two (2014 to 2018) involves the deployment of a 7000 km optical fibre network	Total investment of EUR 50.1 million (USD 63.1 million), out of which ERDF support is EUR 42.6 million (USD 53.6 million)	Total investment of EUR 113.2 million (USD 142.5 million), out of which ERDF support is EUR 96.22 million (USD 121.1 million). The remainder is from government grants and co-financing from operators. Planned implementation between 2012 and 2015
Infrastructure	FTTH			
	FTTC			
	DSL			
	Wireless and satellite			
	Backhaul/core	✓	✓	✓
	International fibre			
Investment model	Bottom-up			
	Private DBO			
	Public outsourcing	✓		✓
	Joint venture			
	Public DBO		✓	
	Other			

Developing successful Public-Private Partnerships to foster investment in universal broadband networks

Project		Latvia	Lithuania	Slovak Republic
Funding sources	Universal services funding			
	Government grant		✓	✓
	External funds	✓	✓	✓
	Other			✓ 5% co-funding by operators
Geographic activity	National		✓	
	Regional	✓		✓
	Rural	✓	✓	✓
	International			

Source: Ministry of Transport (Latvia), Telecommunications Regulatory Authority of the Slovak Republic, Ministry of Transport and Communications (Lithuania), Government Office of the Slovak Republic, Telecommunications Regulatory

Annex 2: Details of example projects

This annex provides details of each of the 13 broadband project researched as part of this report. Projects are listed in alphabetical order of their host country. For each project, the following information is provided:

- Managing authority – the public organization managing the project.
- Project description and funding used – an overview of the project and the source of funding used.
- Broadband objectives – the objectives of the broadband project, which may include information about the speed of roll-out, coverage aims and minimum broadband speeds.
- Other objectives and/or linked projects – initiatives within the broadband project or other projects designed to stimulate or catalyse broadband access and service take-up.
- Project progress – indicators of the progress achieved so far

Table B1: Argentina – Argentina Connected

Project information	Description
Managing authority	Strategic Coordination Commission with support from the Ministry of Federal Planning, Public Investment and Services and SECOM (the telecommunications NRA)
Project description and funding used	Project to triple the amount of backbone optical fibre infrastructure across the country, adding 30 000km of optical fibre cable (by 2015), funded by government grants. A mixed funding model, consisting of public outsourcing and public DBO. (AR-SAT) has responsibility for deploying and operating a core fibre network. AR-SAT subcontracts deployment via public outsourcing In certain regions where it does not have the capability to deploy fibre, and in large cities
Broadband objectives	Use the core and backhaul fibre network to provide regional connectivity, and facilitate broadband access in unserved and underserved locations.
Other objectives and/or linked projects	Part of a wider USD1 884 billion project announced in October 2010 to improve access to broadband – Netbooks were provided to 1.9 million students between 2010 and 10 July 2012 (according to Conectar Igualdad), as part of a project to deliver 3 million netbooks. A Digital Literacy Program has also been implemented to provide PC and Internet training to communities.
Project progress	The project is ongoing: as of June 2012, over 1 000 km of fibre had been deployed
<p>Source: Analysys Mason, ITU - GSR 2011 Discussion Paper (Setting National Broadband Policies, Strategies and Plans http://www.itu.int/ITU-D/treg/Events/Seminars/GSR/GSR11/consultation/GSR11_BPG_E.pdf; SECOM www.secom.gov.ar</p>	

Table B2: Dominican Republic – Rural Broadband Connectivity Project

Project information	Description
Managing authority	Indotel (the telecommunications NRA)
Project description and funding used	Provision of broadband access, residential and public telephones to 508 communities, mostly rural. The Tender was issued in August 2007 and the project was awarded in January 2008, with the aim of completing it by September 2009. The Rural Broadband Connectivity Project used its Universal Access Fund to support this project. However, the winning bidder for the project, Codetel, chose to use some unassigned spectrum that was available for no fee instead of opting for the available funding
Broadband objectives	Provision of broadband access, at least 128kbit/s, to 508 mostly rural communities using ADSL and Universal Mobile Telecommunications System (UMTS)
Other objectives and/or linked projects	In January 2012, Indotel held a public consultation for its Biennial Plan of Development Projects (2012–2013). The consultation included the potential to provide Wi-Fi access in public places and further develop the country's core fibre backbone and broadband access
Project progress	By March 2011, 440 communities had been connected
<p>Source: Analysys Mason, ITU - GSR 2009 Discussion paper: Bringing broadband access to rural areas (Dominican Republic) http://www.itu.int/ITU-D/treg/Events/Seminars/GSR/GSR09/doc/GSR09_Background-paper_UAS-broadband-DR-web.pdf ITU GSR11 Best practice; Indotel www.indotel.qob.do</p>	

Table B3: Kenya – The East African Marine System (TEAMS) project

Project information	Description
Managing authority	TEAMS, a collaboration between the government of Kenya, Etisalat and other commercial organizations. TEAMS investors (actual stake in TEAMS, not TEAMS Kenya) include: Safaricom (17%), Telekom Kenya Limited (17%), Kenya Data Networks Limited (8.5%), Econet/Essar Telecom (8.5%), Wananchi Group 4.3%, Jamii Telecom Limited (3.2%), Broadband Access/Access Kenya (1.1%), Africa Fibrenet (Uganda) (1.1%), InHand Limited (1.1%), IQuip Limited (1.1%) and Flashcom Limited (1.1%).
Project description and funding used	Deploy a 1.28Tbit/s submarine optical fibre cable between Fujairah, the UAE and Mombasa (Kenya). Government and private-sector funding
Broadband objectives	Provide international data and Internet connectivity
Other objectives and/or linked projects	<p>The government of Kenya initiated a programme of schemes in 2009/2010 with the aim of promoting availability of broadband services across Kenya:</p> <ul style="list-style-type: none"> • provide ISPs with access to the submarine cable over a 20-year period, and offset the cost against taxable income • create and support Digital Villages (in partnership with the World Bank) • provide USD100 million investment in mobile computer laboratories for secondary schools • enable telecommunication equipment, including cabling, to be depreciated by 20 per cent instead of 12.5 per cent • exempt all handsets from VAT <p>In May 2012, the government of Kenya announced a plan to deploy an open-access LTE network by 2013 using a PPP, but a definite decision will only be made following the forthcoming elections, due in March 2013. The cost of the project, USD500 million, needs approval from the Ministry of Finance.</p>
Project progress	The submarine cable was launched in July 2010
<p>Source: Analysys Mason, TEAMS, http://broadbandtoolkit.org/Case/ke/6#note41</p>	

Table B4: Latvia – Next-generation network for rural areas

Project information	Description
Managing authority	Latvia State Radio and Television Centre (LVRTC), non for profit public enterprise (100% state ownership), managed by the Ministry of Transport
Project description and funding used	Deploy a regional backhaul/core network, funded entirely by the ERDF
Broadband objectives	The roll-out a network to support improved broadband access in rural locations. The network will remain in public ownership, but a private-sector organization is responsible for constructing, maintaining and administering the network. LVRTC is responsible for managing wholesale service provision to service providers.
Other objectives and/or linked projects	Latvia 2030 Sustainable Development Strategy of Latvia 2030 and National Development Plan 2007 to 2013, to increase Latvia's competitiveness through sustainable development including the provision of broadband access, and innovation in R&D
Project progress	Project is ongoing, first phase due for completion by 2015
<p>Source: Analysys Mason, Public Utilities Commission http://www.sprk.lv/?sadala=133 , State aid SA.33324 – Latvia Next generation network for rural areas http://ec.europa.eu/competition/state_aid/cases/241947/241947_1276709_83_2.pdf</p>	

Table B5: Lithuania – Rural Area IT Network (RAIN)

Project information	Description
Managing authority	Non-profit public enterprise, A 'Joint Activity Partnership Agreement' between the Ministry of Transport and Communications and Public Enterprise Plačiajuostis Internetas (PEPI).
Project description and funding used	Deploy a nationwide backhaul and core network, using government grants as well funding from the ERDF
Broadband objectives	To provide improved connectivity to existing access infrastructure to support improved broadband access
Other objectives and/or linked projects	The Lithuanian Information Society Development Programme 2011 to 2019, to increase the number of Internet users and ICT usage in Lithuania and development of digital content and services
Project progress	Project ongoing. The network is due to be completed by March 2013
<p>Source: Analysys Mason, Communications Regulatory Authority of the Republic of Lithuania www.rtt.lt/en/about_rtt.html; Last Mile Solution In Lithuania, http://www.balticbroadband.net/fileadmin/user_upload/best_practice/Last_Mile_Solution_in%20Lithuania_1.pdf</p>	

Table B6: Malaysia – National Broadband Initiative (NBI)

Project information	Description
Managing authority	Malaysian Communications and Multimedia Commission (MCMC) (the telecommunications NRA)
Project description and funding used	<p>The National Broadband Initiative (NBI) to improve broadband access nationally was announced in October 2007, and comprises two projects:</p> <p>The High-Speed Broadband (HSBB) project will deploy FTTH to the main economic areas of the country.</p> <p>The Broadband to the General Population (BBGP) project targets other areas using ADSL and wireless HSPA and WiMAX.</p> <p>HSBB is funded through government grants. BBGP is funded from the USF</p>
Broadband objectives	<p>The HSBB aims to deliver download speeds of between 10 Mbit/s and 100 Mbit/s in the major economic areas, and the BBGP aims to provide download speeds of between 256 kbit/s and 10 Mbit/s in other areas.</p> <p>Aiming for 75% penetration by the end of 2015</p>
Other objectives and/or linked projects	<p>The Malaysian government has adopted a national programme, which known as Digital Malaysia, which will assist the country to become a digital economy by 2020. The programme is built on three strategies: one of these strategies is 'supply to demand-focused', which includes the NBI initiative. Other initiatives are designed to stimulate demand for broadband access</p> <p>The USF has also been used for the construction of CBCs and Community Broadband Libraries (CBL), which provide communities with access to computers, broadband services and IT training</p>
Project progress	HSBB achieved 1.2 million premises passed in 2011, up 53% on 2010, and according to Telekom Malaysia the project was on track
<p>Source: Analysys Mason, <i>My Special Edition Convergence</i>, March 2010, <i>National Broadband Initiatives</i>, page 38 http://myconvergence.com.my/main/content/view/30/39/; MCMC Annual Report 2010, http://www.skmm.gov.my/About-Us/Annual-Reports/Annual-Reports.aspx; MSC Malaysia http://www.mscomalaysia.my/; Multimedia Development Corporation, Malaysia www.mdec.my; Telekom Malaysia Annual Report 2011 http://www.tm.com.my/ap/about/investor/Pages/AnnualReport.aspx</p>	

Table B7: Mongolia – ICT Infrastructure Development Project

Project information	Description
Managing authority	Communications Regulatory Authority (CRC) and Information, Communication Technology and Post Authority (ICTPA)
Project description and funding used	Output-based funding, using a USF and external sources from the government of Japan and The World Bank.
Broadband objectives	Provision of broadband services using Wi-Fi to provide access in rural communities. Using Wi-Fi to provide access in rural locations, hubbed to Ulaanbaatar by a very small aperture terminal (VSAT) satellite link or other pre-existing core fibre. 34 prime district centres have broadband Internet access for public and private users at the same tariffs as in the capital, Ulaanbaatar; schools are connected at discounted rates, and in all of these 34 communities people are benefitting from access to public Internet cafés.
Other objectives and/or linked projects	e-Mongolia National Programme 2004 to 2012 and ICT Vision 2021, including programmes to develop a knowledge-based economy by improving the availability of broadband access, stimulating demand for broadband access by providing free PCs to rural areas, digitise government and health content and develop e-government services.
Project progress	Launch initial pilot and provided Internet access to 34 soums in 2010
<p>Source: Analysys Mason, CRC Mongolia www.csc.gov.mn/; ICTPA www.ictpa.gov.mn/en ; World Bank, Mongolia: Information and Communications Infrastructure Development project http://www.worldbank.org/en/news/2011/03/31/mongolia-information-and-communications-infrastructure-development-project</p>	

Table B8: Pakistan – USF Broadband Programme

Project information	Description
Managing authority	USF Company, overseen by the Ministry of Information Technology (NRA)
Project description and funding used	Improve broadband access through the provision of government grants from the country's USF. Broadband defined as 128 kbit/s download speed Programme commenced in 2007.
Broadband objectives	To deploy broadband access to unserved urban areas and rural communities, using ADSL and wireless HSPA and WiMAX, and a nationwide backhaul and core network to provide improved connectivity to all Tehsils (administrative districts)
Other objectives and/or linked projects	The project is also being used to provide telephony and telemedicine in rural areas. Operators that succeed in winning funding to deploy broadband access in unserved and underserved urban and rural areas are obliged to construct EBCs and CBCs, by June 2012 1,000 and 300 had been deployed respectively. These centres provide students and communities with access to computers, which they would be unable to access using their own financial means. Access to these centres is anticipated to provide improved access to e-health, e-government and other services.
Project progress	As of July 2012, 12 contracts signed by USF for over 430,000 broadband connections (broadband programme) in 44 un-served districts and six contracts for 6,523 km core fibre network to provide access in 102 unserved Tehsils
<p>Source: Analysys Mason, Ministry of Information Technology, Universal Service Fund Company http://www.usf.org.pk/Home.aspx</p>	

Table B9: Paraguay – National Telecommunications Plan (PNT)

Project information	Description
Managing authority	Comisión Nacional de Telecomunicaciones (Conatel) (the telecommunications NRA)
Project description and funding used	Use its Universal Service Fund to subsidize network roll-outs to underserved and unserved areas (optical fibre cable, ADSL and mobile), but also promote sharing of infrastructure (e.g. towers) and collaboration between companies to deploy fibre to municipalities – specifically for fibre (RFP issued in 2011)
Broadband objectives	Deliver broadband access to unserved and underserved locations, with a minimum speed of 512 kbit/s
Other objectives and/or linked projects	Investment part of a wider PPP project to increase mobile teledensity and fixed-line penetration
Project progress	In December 2011, an RFP was issued for a core optical fibre network project, but none of the bids was accepted because bidders wanted to use technologies other than fibre. The project is ongoing
<p>Source: Analysys Mason, <i>Plan Nacional de Telecomunicaciones, Paraguay</i> http://www.conatel.gov.py/documentos/MANUAL%20PLAN%20NACIONAL.pdf, Conatel www.conatel.gov.py/</p>	

Table B10: Qatar – Q.NBN project

Project information	Description
Managing authority	Q.NBN (Qatar National Broadband Network), which is part of Qatar National ICT (Information and Communication Technology) Strategy 2015 and Qatar National Vision 2030
Project description and funding used	Accelerate the deployment of FTTH using government funds
Broadband objectives	Deliver coverage in excess of 95 per cent of households and businesses by 2015 (100 Mbit/s). A passive infrastructure deployment using existing operators' or other organizations' infrastructure (for example duct space), providing equal access to all operators Q.NBN is responsible for setting wholesale prices nationally in order to ensure the retail price of broadband access is minimized
Other objectives and/or linked projects	Qatar National Vision 2030 and Qatar ICT Strategy 2015. A number of other initiatives are being used to support the take-up of FTTH services, including promoting the adoption of cloud computing and ICT adoption by businesses and the government, as well as running training programmes to provide people with ICT-skills
Project progress	Since formation March 2011, Q.NBN signed a number of agreements with operators to support the roll out of the FTTH network: <ul style="list-style-type: none"> • in September 2010, signed an agreement to install FTTH using with the Barwa City's project ducts. In March 2012, a total of 6,000 units were connected, enabling operators to use the FTTH infrastructure and provide services, including telephony, broadband Internet access and other data services. • in April 2012, signed an agreement to access Qtel's duct network and other passive infrastructure until 2032. • in May 2012, signed an agreement with Vodafone, providing it with access to wholesale services.
<p>Source: Analysys Mason, <i>Q.NBN</i> http://qbnbn.qa/</p>	

Table B11: Saudi Arabia – Universal Service Project

Project information	Description
Managing authority	Communications and Information Technology Commission (CITC) (the telecommunications NRA)
Project description and funding used	Universal service fund used to provide grants to operators to provide Internet access to unserved and underserved locations
Broadband objectives	Deliver a minimum of 512 kbit/s to unserved and underserved locations
Other objectives and/or linked projects	Provide voice access to unserved and underserved locations
Project progress	Four projects funded to deploy broadband access to underserved locations. Three operators – Mobily, Zain and Saudi Telecom (STC) – have used 3G to provide wireless access

Source: Analysys Mason, CITC Annual Report 2010, http://www.citc.gov.sa/English/MediaCenter/Annualreport/Documents/PR_REP_006E.pdf, CITC www.citc.gov.sa

Table B12: Singapore – Next-Generation National Broadband Network (NGNBN)

Project information	Description
Managing authority	Singapore (Infocomm Development Authority), the telecommunications NRA
Project description and funding used	Announced in 2006, a project to deploy a FTTH network to all homes, schools and businesses using government grants of USD 2 billion OpenNet a consortium consisting of SingTel, Axia NetMedia, Singapore Press Holdings and Singapore Power Telecommunications, is the network company (NetCo), and has responsibility to build and operate the network. Nucleus Connect is the operating company (OpCo), responsible for operating the active Layer 2 and administer open Layer 3 access to retail service providers
Broadband objectives	To deploy a FTTH network to deliver 1Gbit/s download and 500 Mbit/s upload speeds and connect all homes, schools and businesses, 95% of population by mid-2012 and 100% of population by 2015
Other objectives and/or linked projects	The IDA has developed a programme to co-fund application and service development with the private sector. The Next-Generation Services Innovation Programme (NGISP), launched in 2009, offered private companies the opportunity to submit proposals to try and win funding to develop a service/application.
Project progress	In January 2012 86% coverage had been achieved and 100,000 subscriptions. In June 2012, a total of 133,000 subscriptions had been attained

Source: Analysys Mason, IDA www.ida.gov.sg/

Table B13: Slovak Republic – National broadband project

Project information	Description
Managing authority	The Government Office of the Slovak Republic and the Telecommunications Regulatory Authority. The network is owned and managed by the National Agency for Network and Electronic Services (NASES), a non-profit public enterprise.
Project description and funding used	Deploy a regional backhaul/core network funded by the Slovak government, the ERDF and operators.
Broadband objectives	To support improved broadband access in white areas, rural and other unserved areas. The network will remain in public ownership under NASES. NASES is responsible for managing wholesale service provision to service providers, with wholesale rates determined in conjunction with the telecommunications NRA.
Other objectives and/or linked projects	Operational Programme Information Society 2007 to 2013, a programme to develop a knowledge-based economy, including the broadband project above, the implementation of government e-services and digitization of content
Project progress	The project is ongoing. The network is due for completion in 2015
<p>Source: Analysys Mason, Telecommunications Regulatory Authority of the Slovak Republic www.teleoff.gov.sk, State aid SA.33151 (2011/N) - Basic broadband deployment in white areas of Slovak Republic http://ec.europa.eu/competition/state_aid/cases/240945/240945_1330243_110_2.pdf</p>	