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Reports (Background Papers)

REGULATORY & MARKET ENVIRONMENT

Developing Successful Public-Private PARTNERSHIPS TO FOSTER INVESTMENT IN UNIVERSAL BROADBAND NETWORKS

Broadband Series

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Telecommunication Development Sector

Developing successful public-private partnerships to foster investment in universal broadband networks

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Preface

The past twenty years has been an extraordinary time for the development of information and communication technologies (ICTs) – and with the 'mobile miracle' we have brought the benefits of ICTs within reach of virtually all the world's people. ITU has been in the forefront of this transformational ascent and is today committed to continue to driving positive change in the sector and beyond. It is now time to make the next step, and to ensure that everyone – wherever they live, and whatever their circumstances – has access to the benefits of broadband. This is not just about delivering connectivity for connectivity's sake – or even about giving people access to the undoubted benefits of social communications. It is about leveraging the power of broadband technologies – and especially mobile technologies – to make the world a better place.

In 2010, ITU, in conjunction with UNESCO, launched the Broadband Commission for Digital Development – to encourage governments to implement national broadband plans and to increase access to broadband applications and services. The Commission is co-chaired by President Paul Kagame of Rwanda and Carlos Slim, President of the Carlos Slim Foundation. We have around 60 Broadband Commissioners – all top-level leaders in their field – representing governments, industry, academia and international agencies. At the Broadband Leadership Summit held in October 2011 in Geneva, the Broadband Commission recognized broadband as a critical modern infrastructure contributing to economic growth and set four clear, new targets for making broadband policy universal and for boosting affordability and broadband uptake. Out-of-the-box models that promote competition, innovation and market growth are now needed to make the broadband opportunity reachable for all world citizens.

At ITU, the United Nations specialized agency for ICTs and telecommunications, we are committed to playing a leading role in the development of the digital economy through extending the benefits of advances in broadband and embracing the opportunities it unleashes. The three ITU sectors – Radiocommunications, Standardization and Development – are working together to meet these challenges and our collective success will be a key factor in ensuring the provision of equitable broadband access throughout the world. The ITU Broadband Reports are one contribution towards this commitment.

Hamadoun Touré

Secretary-General, ITU

Foreword

Broadband has become a key priority of the 21st Century, and I believe its transformative power as an enabler for economic and social growth makes it an essential tool for empowering people, creating an environment that nurtures the technological and service innovation, and triggering positive change in business processes as well as in society as a whole. Increased adoption and use of broadband in the next decade and beyond will be driven by the extent to which broadband-supported services and applications are not only made available to, but are also relevant and affordable for consumers. And while the benefits of broadband-enabled future are manifest, the broadband revolution has raised up new issues and challenges.

In light of these developments, ITU launches a new series of ITU Broadband Reports. The first reports in the series launched in 2012 focus on cutting edge policy, regulatory and economic aspects of broadband. Other related areas and themes will be covered by subsequent reports including market analysis, broadband infrastructure and implementation, and broadband-enabled applications. In addition, a series of case studies will complement the resources already made available by ITU to all its many different types of readers, but especially to ICT regulators and policy-makers.

This new series of reports is important for a number of reasons. First of all, the reports will focus on topical issues of special interest for developed and developing countries alike. Secondly, the various reports build on ITU's recognized expertise in the area augmented by regular feedback from its Membership. Last but not least, this series is important because it provides a meaningful contribution to the work of the Broadband Commission for Digital Development. The findings of the ITU Broadband Reports will trace paths towards the timely achievement of the ambitious but achievable goals set recently by the Commission as well as provide concrete guidelines. As broadband is a field that's growing very fast, we need to constantly build knowledge for our economies and societies to thrive and evolve into the future.

For these reasons, I am proud to inaugurate this first series of the ITU Broadband Reports and look forward to furthering ITU's work on the dynamic and exciting broadband ecosystem.

Brahima Sanou

Director

ITU Telecommunication Development Bureau

1 Introduction

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 public-private partnership (PPP) projects to successfully implement universal broadband projects, and thereby improve broadband access to unserved and underserved locations. A total of 13 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 lessons learned from projects from emerging and developed markets across most world regions. To maximize the number and type and best practices and lessons learned, 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 Guide to broadband investment[1]. The EU 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] http://ec.europa.eu/regional_policy/sources/docgener/presenta/broadband2011/broadband2011_en.pdf

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.

Figure 1: Location of PPP broadband projects considered in this report

Source: Analysys Mason

- Argentina – Argentina Connected aims to triple the amount of backbone optical fibre infrastructure, adding 30 000 km 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 128 kbit/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 sped 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 project[2] 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 Government of Slovakia, 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 divided 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

[2] 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 lessons learned 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 authority[3] 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.

[3] To 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.

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 study[4] 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 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,[5] 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.

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

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

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."[6] 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 McDevitt[7] 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'[8] 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 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

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

7 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/10.1787/5k9bcwkg3hwf-en

8 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

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 Siegen[9] 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 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

[9] 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

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: www.itu.int/rec/T-REC-G.984.1-200803-I/en, www.itu.int/osg/spu/ip/chapter_seven.html, www.itu.int/osg/spu/imt-2000/technology.html, 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.

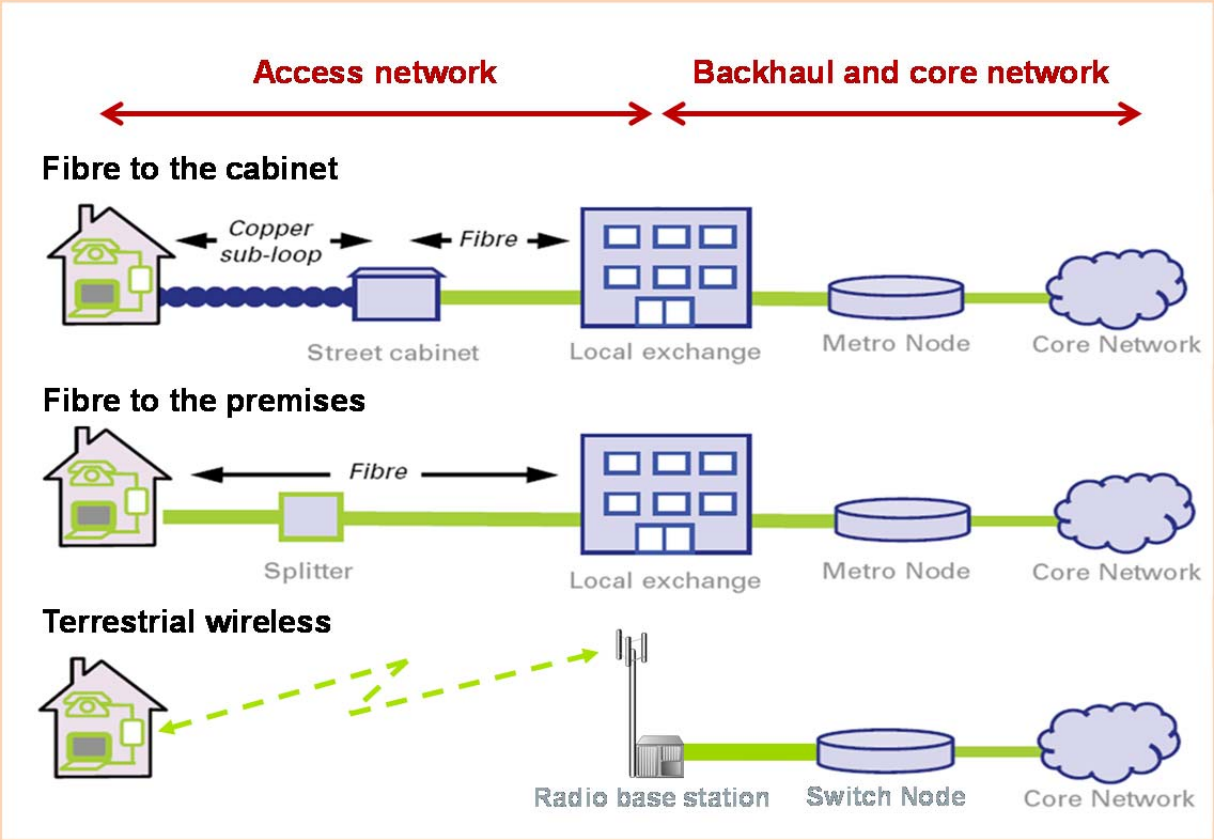
An access network provides the connections between end users and the nearest network node (e.g. the local exchange or central office) at which the access network connects with the core network. Various

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 1 below.

Figure 1: Infrastructure components that may be considered as part of broadband projects



Source: Analysys Mason

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 performance[10].

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 basis, 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 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

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

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.

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 each customer has their own connection into their home, although 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 downloads 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 1 Gbit/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 128 kbit/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 contention[11] 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,[12] 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 downloads 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.
- 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.

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[11] 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.

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

- 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 per cent ownership share, and Etisalat 15 per cent, 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 per cent stake in the submarine cable and TEAMS Kenya 85 per cent. All TEAMS consortium members are able to sell capacity, at a wholesale and retail level, equivalent to their share of the cable 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 MYR 3 000 (USD 965), 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 be 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 Karelia[13]: end users provided the investment, and demand often did not materialize until the network deployment reached their premises.
- Netherlands, the OnsNet[14] project in Nuenen: this included a six-week demand aggregation scheme and free services for the first year.
- Sweden, Rural Development Programme[15]: 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.

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

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

15 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

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.

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 to 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. Latvia State Radio and Television Centre (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 has 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 operators[16] contribute 6 per cent of their service revenues to the fund if their weighted average net revenue exceeds MYR 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.

[16] Excluding content application service providers.

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.
- 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 Government of Slovakia (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 Government of Slovakia (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 (Infocomm Development Authority of Singapore, 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.[17] 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.
- Singapore, NGNBN: the telecommunication regulator (IDA) is responsible for monitoring the coverage delivered by OpenNet. By January 2012, only 86 per cent of the population out of a

[17] See, for example, www.usf.org.pk/publiclot.aspx?lotid=69&pgid=2&bphid=55&phname=Phase - II&lotname=Gujranwala Telecom Region).

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 Government of Qatar. 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).[18] 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.

[18] 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).

- 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.

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 Piemonte[19] 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

[19] Digital Piedmont , Piedmont ICT Observatory www.osservatorioict.piemonte.it/en/broadband.html

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.
- 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,[20] 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 Word 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 (EBCs) and Community Broadband Centres (CBCs). 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.

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

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:

- 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. ITU published a paper at the 2008 Global Symposium for Regulators outlining best practice guidelines on infrastructure sharing,[21] 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.

[21] Available at www.itu.int/ITU-D/treg/Events/Seminars/GSR/GSR08/PDF/GSRguidelines08_E.pdf

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.

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 Europe, 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 HSBB 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.[22]

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.

[22] http://ec.europa.eu/regional_policy/sources/docgener/presenta/broadband2011/broadband2011_en.pdf

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.[23]

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.

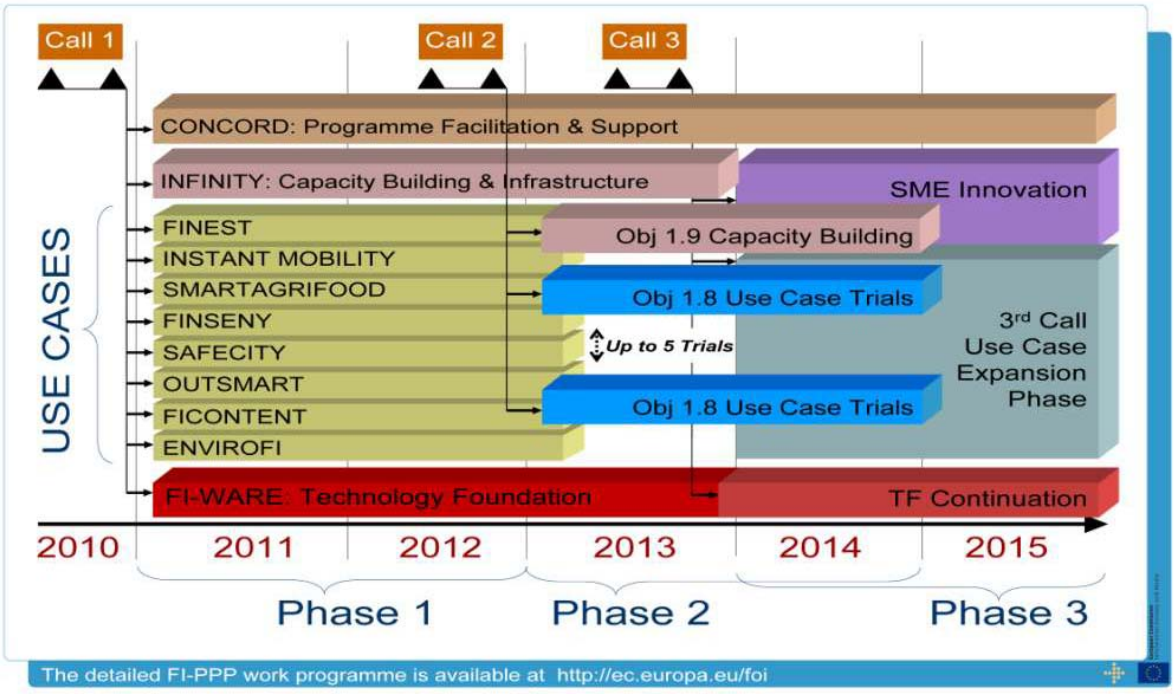
9.1 The EU's FI-PPP programme

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". [24] 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 2 below.

[23] 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 www.itu.int/ITU-D/treg/Events/Seminars/GSR/GSR11/consultation/GSR11_BPG_E.pdf

[24] Source: Future Internet Public Private Partnership http://ec.europa.eu/information_society/activities/foi/lead/fippp/index_en.htm

Figure 2: 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:[25]

- 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 lessons learned 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.

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

[25] Source: http://ec.europa.eu/information_society/activities/foi/lead/fippp/index_en.htm

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.[26] 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 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

[26] Available at http://ec.europa.eu/information_society/activities/foi/lead/fippp/FI-PPP%20Interim%20Assessment.pdf

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 bearers[27] 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-Mitra[28], 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.
- 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

[27] 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.

[28] http://emitra.gov.in/

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 project[29]: 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)[30] 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.

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:

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29 http://baobabhealth.org/

30 http://www.nepad.org/crosscuttingissues/ict

- 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 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 Malaysia Government 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."[31] 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 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.

[31] Source http://www.fi-ware.eu/about/

10 Summary of best practices in establishing successful projects

The best practices and lessons learned 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 lessons learned 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 lessons learned 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 2012[32] 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.

[32] Source: Conectar Igualdad

- 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.

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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.
LVRTC	Latvia State Radio and Television Centre
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 1.28 Tbit/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		USD 130 million	USD 100 million	Mobily (August 2010): SAR 50 million; Zain (2010): USD 10.7 million; STC (2011): USD 7.9 million; Zain (January 2011): SAR 40 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	✓		
Source: Analysys Mason, CITC, Q.NBN, TEAMS				

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 2×15 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)			

		Argentina	Dominican Republic	Paraguay
	Public DBO	✓		
	Other			
Funding sources	Universal services funding		✓	✓
	Government grant	✓		
	External funds			
	Other			
Geographic activity	National	✓		✓
	Regional	✓		
	Rural		✓	
	International			

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

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 MYR 11.3 billion, of which MYR 2.4 billion from the government and MYR 8.9 billion from Telekom Malaysia	USD 11.85 million from the government of Mongolia, the government of Japan and the World Bank	Up to June 2012 the rural programme had received PKR 4.2 billion, and the broadband programme PKR 6.3 billion	USD 2 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

		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 2000 km 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			

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 USD 1 884 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
Source: Analysys Mason, ITU - GSR 2011 Discussion Paper (Setting National Broadband Policies, Strategies and Plans www.itu.int/ITU-D/treg/Events/Seminars/GSR/GSR11/consultation/GSR11_BPG_E.pdf; SECOM www.secom.gov.ar	

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 128 kbit/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
Source: Analysys Mason, ITU - GSR 2009 Discussion paper: Bringing broadband access to rural areas (Dominican Republic) www.itu.int/ITU-D/treg/Events/Seminars/GSR/GSR09/doc/GSR09_Backgound-paper_UAS-broadband-DR-web.pdf ITU GSR11 Best practice; Indotel www.indotel.gob.do	

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 1.28 Tbit/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	The government of Kenya initiated a programme of schemes in 2009/2010 with the aim of promoting availability of broadband services across Kenya: • 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 Word Bank) • provide USD 100 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 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, USD 500 million, needs approval from the Ministry of Finance.
Project progress	The submarine cable was launched in July 2010
Source: Analysys Mason, TEAMS, http://broadbandtoolkit.org/Case/ke/6#note41	

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
Source: Analysys Mason, Public Utilities Commission 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	

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
Source: Analysys Mason, Communications Regulatory Authority of the Republic of Lithuania www.rrt.lt/en/about_rrt.html; Last Mile Solution In Lithuania, www.balticbroadband.net/fileadmin/user_upload/best_practice/Last_Mile_Solution_in%20Lithuania_1.pdf	

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	The National Broadband Initiative (NBI) to improve broadband access nationally was announced in October 2007, and comprises two projects: The High-Speed Broadband (HSBB) project will deploy FTTH to the main economic areas of the country. The Broadband to the General Population (BBGP) project targets other areas using ADSL and wireless HSPA and WiMAX. HSBB is funded through government grants. BBGP is funded from the USF
Broadband objectives	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. Aiming for 75% penetration by the end of 2015
Other objectives and/or linked projects	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 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
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
Source: Analysys Mason, My Special Edition Convergence, March 2010, National Broadband Initiatives, page 38 http://myconvergence.com.my/main/content/view/30/39/;; MCMC Annual Report 2010, www.skmm.gov.my/About-Us/Annual-Reports/Annual-Reports.aspx; MSC Malaysia www.mscmalaysia.my/; Multimedia Development Corporation, Malaysia www.mdec.my; Telekom Malaysia Annual Report 2011 www.tm.com.my/ap/about/investor/Pages/AnnualReport.aspx	

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
Source: Analysys Mason, CRC Mongolia www.csc.gov.mn/; ICTPA www.ictpa.gov.mn/en ; World Bank, Mongolia: Information and Communications Infrastructure Development project www.worldbank.org/en/news/2011/03/31/mongolia-information-and-communications-infrastructure-development-project	

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
Source: Analysys Mason, Ministry of Information Technology, Universal Service Fund Company www.usf.org.pk/Home.aspx	

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 unserved 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
Source: Analysys Mason, Plan Nacional de Telecomunicaciones, Paraguay www.conatel.gov.py/documentos/MANUAL%20PLAN%20NACIONAL.pdf, Conatel www.conatel.gov.py/	

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 singed a number of agreements with operators to support the roll out of the FTTH network: • 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.
Source: Analysys Mason, Q.NBN http://qnbn.qa/	

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, 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 Slovakia 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
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	

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REGULATORY & MARKET ENVIRONMENT

Competition and regulation IN A CONVERGED BROADBAND WORLD

Broadband Series

FEBRUARY 2013
Telecommunication Development Sector

Competition and regulation in a converged broadband world

February 2013

This report was prepared by Dr. Christian Koboldt of DotEcon Limited, under the direction of the Telecommunication Development Bureau (BDT) Regulatory and Market Environment Division (RME).

This report is part of a new series of ITU reports on broadband that are available online and free of charge at the ITU Universe of Broadband portal: www.itu.int/broadband.

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Preface

The past twenty years has been an extraordinary time for the development of information and communication technologies (ICTs) – and with the 'mobile miracle' we have brought the benefits of ICTs within reach of virtually all the world's people. ITU has been in the forefront of this transformational ascent and is today committed to continue to drive positive change in the sector and beyond. It is now time to make the next step, and to ensure that everyone – wherever they live, and whatever their circumstances – has access to the benefits of broadband. This is not just about delivering connectivity for connectivity's sake – or even about giving people access to the undoubted benefits of social communications. It is about leveraging the power of broadband technologies – and especially mobile technologies – to make the world a better place.

In 2010, ITU, in conjunction with UNESCO, launched the Broadband Commission for Digital Development – to encourage governments to implement national broadband plans and to increase access to broadband applications and services. The Commission is co-chaired by President Paul Kagame of Rwanda and Carlos Slim, President of the Carlos Slim Foundation. We have over 50 Broadband Commissioners – all top-level leaders in their field – representing governments, industry, academia and international agencies. At the recent Broadband Leadership Summit held in October 2011 in Geneva, the Broadband Commission has recognized broadband as a critical modern infrastructure contributing to economic growth and has set four clear, new targets for making broadband policy universal and for boosting affordability and broadband uptake. Out-of-the-box models that promote competition, innovation and growth of markets are now needed to make the broadband opportunity reachable for all world citizens.

At ITU, the United Nations specialized agency for telecommunications and information and communication technologies (ICTs), we are committed to playing a leading role in the development of the digital economy through extending the benefits of advances in broadband and embracing the opportunities it unleashes. The three ITU sectors – Radiocommunications, Standardization and Development – are working together to meet these challenges and our collective success will be a key factor in ensuring the provision of equitable broadband access throughout the world. The ITU Broadband Reports are one contribution towards this commitment.

Dr. Hamadoun I. Touré

Secretary-General, ITU

Foreword

Broadband has become a key priority of the 21st Century, and I believe its transformative power as an enabler for economic and social growth makes it an essential tool for empowering people, creating an environment that nurtures the technological and service innovation, and triggering positive change in business processes as well as in society as a whole. Increased adoption and use of broadband in the next decade and beyond will be driven by the extent to which broadband-supported services and applications are not only made available to, but are also relevant and affordable for consumers. And while the benefits of broadband-enabled future are manifest, the broadband revolution has raised up new issues and challenges.

In light of these developments, ITU launches a new series of ITU Broadband Reports. The first reports in the series launched in 2012 focus on cutting edge policy, regulatory and economic aspects of broadband. Other related areas and themes will be covered by subsequent reports including market analysis, broadband infrastructure and implementation, and broadband-enabled applications. In addition, a series of case studies will complement the resources already made available by ITU to all its many different types of readers, but especially to ICT regulators and policy-makers.

This new series of reports is important for a number of reasons. First of all, the reports will focus on topical issues of special interest for developed and developing countries alike. Secondly, the various reports build on ITU's recognized expertise in the area augmented by regular feedback from its Membership. Last but not least, this series is important because it provides a meaningful contribution to the work of the Broadband Commission for Digital Development. The findings of the ITU Broadband Reports will trace paths towards the timely achievement of the ambitious but achievable goals set recently by the Commission as well as provide concrete guidelines. As broadband is a field that's growing very fast, we need to constantly build knowledge for our economies and societies to thrive and evolve into the future.

For these reasons, I am proud to inaugurate this first series of the ITU Broadband Reports and look forward to furthering ITU's work on the dynamic and exciting broadband ecosystem.

Brahima Sanou

Director, ITU Telecommunication Development Bureau

Executive summary

Across the world, broadband networks and the services to which they provide access are becoming an increasingly important part of our daily lives. Technology and usage patterns are changing fast, and the converging ICT sector looks very different from the traditional telecommunication environment of two decades ago.

These changes pose challenges for regulatory policy.

- How should regulators identify the markets that ought to be regulated when the underlying technology is evolving rapidly and broadband networks provide access to a wide and ever-changing range of services?
- How should they go about identifying which operators enjoy market power?
- What types of behaviour should concern policy makers, and how should regulators deal with commercial strategies that can be both efficient and beneficial for consumers, but also have anti-competitive effects?

This report takes as its starting point a number of salient facts about the converged broadband world. Driven by the availability of novel and innovative services, demand for bandwidth is growing substantially. Services rather than the underlying technology drive the customers' choice of broadband connection. The economies of scope brought about by convergence are reflected in bundling of services. A range of different access technologies co-exists with mobile broadband services gaining in importance not just in countries where fixed infrastructure is poor, but also in developed economies with almost universal fixed line coverage.

The paper then discusses the implications of these developments for market definition. It gives a brief summary of the key principles used by regulatory and competition authorities for establishing the boundaries of the relevant market and then looks at the extent to which different broadband technologies can be said to compete with each other in light of these principles.

Even though some retail customers may not have any choice of broadband connection – e.g. because their requirements are so specific that they can be met only by one technology, or because they live in areas where only one network is available – this does not necessarily matter for market definition. Market boundaries are set not by those customers who cannot switch to alternatives, but those who can. As a consequence, very different technologies may be linked through a chain of substitution. At the same time, even if different technologies could compete on the basis of their technical capabilities, markets may be separated because of exclusive agreements between network operators and service providers, or as a result of bundling of services.

A brief discussion of the question whether discussion mobile and fixed broadband services are in the same market provides an illustration of how these considerations may be applied in practice. Unsurprisingly, the answer depends strongly on the extent to which the differences in the capabilities of mobile and fixed broadband networks matter for end users given the range of services available – and it may change over time as new services become available.

More generally, the role of services in the delineation of markets means that market boundaries are not immutable: so even if mobile and fixed broadband services were fairly substitutable at present, they may become less so as more bandwidth-intensive services are being developed. What is important is that market boundaries are not determined by the technologies themselves, but by their capabilities, the capacity they provide and the services that they support.

These changing market definitions matter when it comes to establishing market power. But convergence has further implications that go beyond the simple re-drawing of market boundaries. The strong growth in demand for bandwidth and the need for investment in network capacity – whether it be through improvements to existing networks or the construction of new ones – change the nature of competition. Such investment typically creates excess capacity that will only be filled over time, and competition during

this period might be much stronger than a simple look at market structure might suggest. Wherever possible, promoting infrastructure-based competition can help to foster innovation, support service differentiation and drive penetration.

The increasing importance of services and the effects of bundling strategies will need to be taken into account when assessing market power. It may well be the case that market power in the supply of broadband services flows from markets that have traditionally been the subject of regulatory control. This could suggest that the remit of regulators be broadened to include services, such as television programming, that have been shown to be important in driving take-up of broadband services (and this has already happened in some jurisdictions).

However, simply extending the scope of regulatory controls may not be the best way of dealing with these new challenges. Bearing in mind the inherent limitations of regulatory intervention, in particular in relation to stimulating innovation, such intervention should be used sparingly and encourage the development of competition rather than mimic the outcome of competitive markets. Given the sizeable investments that are needed to meet the demand for more bandwidth – both in terms of serving a greater number of end-users and providing more bandwidth over individual connections – regulators need to be keenly aware of the impact of their decision on investment incentives. Well-established approaches, e.g. for setting cost-oriented access charges, have shortcomings in this respect that have not been fully acknowledged but that ought to be addressed going forward.

At the same time, it will become more difficult to establish hard and fast rules for behaviour that should be caught in the regulatory net, and for the choice of remedies or restrictions that should be imposed. As commercial strategies in a converged world become more complex, case-by-case assessment will have to play a greater role. This may mean a greater reliance on general competition policy or a change in the nature of regulatory obligations, making them more competition-policy like. Of course the procedural details under which for example a general fair trading condition that is part of a licence might be enforced could be quite different from the provisions of general competition law, but the remedies may need to become more general and less prescriptive. Even where general competition law gains in importance, the sectoral expertise of regulatory authorities will continue to be extremely valuable.

An immediate consequence of this is that coming up with general recommendations that would be suitable for regulatory policy across a range of different jurisdictions with very different broadband ecosystems and very different economic conditions is impossible. Depending on the specific conditions in particular markets, rather different measures may be needed in order to deal with the issues raised by convergence. All of these, however, ultimately derive from a common understanding of the main policy principles.

1 Introduction

Ex-ante regulation has been a prominent feature of the Information and Communications Technologies (ICT) sector for many years. In particular, when telecommunication networks that had been constructed and operated by state-controlled monopolies were privatized, or the provision of telecommunication services was liberalized, regulation assumed a key role in promoting competition and protecting end users. Regulatory controls were aimed at ensuring that control of network infrastructure that could not readily be replicated could not be exploited to the detriment of end users, either by foreclosing competition in other parts of the value chain or by charging excessive prices to final customers.

This process rested crucially on the imposition of *ex-ante* regulatory obligations on firms with the power to frustrate the development of competition or to exploit customers. Such behaviour would of course also be caught under competition law, and there are examples of countries, such as New Zealand, which initially relied solely on competition law to support the process of liberalization.[1] However, because competition law relies on identifying instances of abusive behaviour *after* the fact on a case-by-case basis, competition law remedies might be slow and the imposition of *ex-ante* obligations was generally seen to be more effective.

Using wholesale access obligations[2] to split the provision of services from the underlying network infrastructure and using interconnection obligations to facilitate the deployment of competing infrastructure has led to competition emerging in both services and network infrastructure. Even though some network elements, such as the local loop, may ultimately not be replicable (or at least not viably so), incumbents' market shares have fallen dramatically almost everywhere as telecommunication markets have morphed into the much wider ICT sector.

In the early stages of liberalization and market opening, establishing which operators should be regulated, and what regulatory obligations should be imposed on them, was relatively straightforward.

- Services could be neatly distinguished with reference to the underlying network technology (fixed and mobile voice services, for example, or local, national and international calls, reflecting the parts of the network that were involved in their provision). This strong link between services and underlying technologies provided national regulatory authorities (NRAs) with a clear basis for the definition of ICT markets - where appropriate separated into retail and wholesale services.
- Having delineated markets with reference to the underlying technologies, establishing which operators should be subject to regulatory obligations was relatively straightforward, too. Simple market share measures would often be sufficient for establishing significant market power (SMP) in the relevant markets (although the US Federal Communications Commission's (FCC) declaration in 1993 that AT&T despite a market share in excess of 55 per cent was no longer dominant in the long-distance market, for example, shows that standard competition analysis has been playing a substantial role throughout).[3]

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[1] The liberalization process in New Zealand started in the late 1980s, and Telecom New Zealand was privatized in 1990, but sector-specific regulation was not introduced until ten years later. For a brief overview see The Practice Notice on New Zealand in the ITU-infoDev ICT Regulation Toolkit (www.ictregulationtoolkit.org/en/PracticeNote.2597.html).

[2] 'Access obligations' is here used as a short hand for a wide range of obligations imposed on regulated firms, covering the requirement to offer access at cost-based priced and on terms that are transparent and non-discriminatory, supported by appropriate cost accounting and accounting separation obligations.

[3] For a detailed description of the FCC's analysis, see Jamison et al. (2009).

- Emerging competition was best promoted through imposing interconnection obligations to support new network operators, and wholesale access obligation to enable service competition where competition in the underlying network infrastructure was lacking. Of course, trade-offs had to be made: for example, lowering access charges would promote service competition, but would make life more difficult for those having invested in new infrastructure whilst higher charges would create incentives for investment in new infrastructure, but hurt end users in the short term. However, starting from a legacy monopoly network infrastructure, most of the choices were not too difficult to make.

The success of regulation in opening up markets to competition has removed many of these certainties. The development of competition creates a need for assessing whether it has become sufficiently well-established to warrant the removal of *ex-ante* regulatory controls. As markets become competitive, the on-going protection of consumers from anti-competitive behaviour can be entrusted to national competition authorities (NCAs) where these exist, or to the application of competition law by NRAs with concurrent competition powers, and regulatory obligation can be removed.

Moreover, fundamental technological changes over recent years have eroded the close link between services and technologies. The European Commission's decision to replace the regulatory framework for telecommunications that pushed the process of liberalization (the so-called 'Open Network Provision' (ONP) framework of 1998) with one that covered all electronic communication networks and services in 2003 is an example of how regulatory authorities respond to convergence, which allows the same service to be provided over a number of different networks. Although this implies on the one hand that competition between networks may become more effective, it also means that any individual network can provide access to a greater range of services than previously, leading to potentially much stronger economies of scale and scope than before.

In line with this, demand for data services and broadband penetration have been growing, and continue to grow. In a number of countries, this has been accompanied by investment in upgrading existing infrastructures (e.g. xDSL services), rolling out new networks (fibre access networks) and/or improving the capabilities and extending the capacity of wireless networks.

Convergence in the broadband world has a number of implications:

- The traditional link between network technology and the service that is provided over the network is weakened or disappears completely, meaning that, going forward, different types of networks are more likely to be substitutable for each other.
- Exploiting the improved capabilities of networks, there is an increased prevalence of bundled offerings (dual, triple and quad play).
- There is a need for substantial investment in network infrastructure to satisfy growing demand.
- Networks turn into platforms that bring together service providers and end users.

This report argues that, as a result of these developments, both defining markets and establishing market power for the purpose of deciding where *ex-ante* regulation is necessary, and on which firms regulatory obligations should be imposed, are becoming more complex tasks:

- Market boundaries are likely to change at the retail level as the specific network over which services are being delivered becomes less relevant, and the characteristics of the service bundle matter more.
- At the wholesale level, whilst different networks may have become more substitutable market power may be exercised in relation to services that have traditionally not been the subject of ICT regulation (e.g. 'must-have' content such as premium television programming which is capable of driving the take-up of connections, or mobile payment platforms that may be available exclusively on some networks).

- Greater emphasis may need to be placed on the platform nature (or multi-sidedness) of markets, i.e. the fact that operators of broadband networks essentially serve two masters – service providers who wish to reach end users, and end users who seek access to services.
- Greater emphasis may also need to be given to promoting investment in new infrastructure and services versus promoting access to existing infrastructure.
- The speed with which markets may change needs to be considered in relation to the time required for regulatory remedies to be adopted and become established – it is important to avoid situations in which regulation that has been designed to deal with yesterday's problems stifles innovation and holds back the development of the markets.

All of this suggests that it will become increasingly difficult to define *ex-ante* where problems might arise, and put in place controls that would effectively address these. Therefore a greater reliance on the *ex-post* application of competition law might be appropriate, be it through greater involvement of NCAs or through the strengthening of concurrently applied competition powers by NRAs. Regulatory obligations may have to move from relatively simple access and cost-accounting obligations to more complex, effects-based restrictions on the behaviour of licensed SMP operators.

This report begins by providing a brief overview of some salient facts about broadband: rapid take-up of broadband around the world driven by attractive services, an increased use of bundled offers and a mix of underlying technologies (Section 2). This is followed by a discussion of the implications of these developments for market definition (Section 3) and the identification of operators with SMP (Section 4). Section 5 then considers the consequences for regulation in a converged broadband world.

2 The changing broadband world

Historically, services provided over telecommunications networks were very specific and closely tied to the underlying network technology. By comparison with today's telecommunications environment, the past may be characterised as a world with single-service networks. The significant and rapid technological developments and the move towards the use of IP-based protocols throughout the network over the past years have changed this substantially. Because understanding the link between networks, their technical capabilities, and the services to which they can provide access is crucial for market definition, this section provides a brief summary of these developments.

2.1 Services as the drivers of bandwidth demand

Broadband traffic is forecast to grow substantially over the next few years. Estimates prepared by Cisco (2011, 2012a) suggest that:

- the monthly traffic of the world's average Internet user will increase from 3.36 gigabytes in 2012 to 24.8 gigabytes by 2015;
- in Western Europe, monthly traffic per subscriber will reach 47.4 Gigabytes in 2015, up 270 per cent from its 2010 level and total monthly traffic per month will grow from 7.2 exabytes per month in 2011 to 24.3 exabytes per month in 2016- a compound annual growth rate of 27 per cent;
- over the same period the Middle East and Africa will experience the strongest growth in IP traffic at a compound annual growth rate of 57 per cent;
- the Asia-Pacific region will lead demand with IP Traffic at more than 40 exabytes per month by 2016; and
- overall, global IP traffic is set to increase from 30.7 exabytes per month to 109.5 exabytes per month from 2011 to 2016.

The forecast growth in traffic is phenomenal – and it is to a large extent service-driven. Unlike the single-service telecommunications networks of the past, broadband networks provide more than a means of

allowing different end users to communicate with each other. Broadband networks support the delivery of a wide range of 'over-the-top' (OTT) services (such as on-demand video services, cloud computing or interactive gaming), and provide the conduit between the suppliers of such services and their customers. In economic terms, this is an interesting and important difference: it is not only end customers but also OTT players who benefit from the connectivity provided by broadband networks, but only the former pay for broadband services whilst the latter do often not make any direct contribution towards the cost of providing the connectivity that allows them to reach their customers.

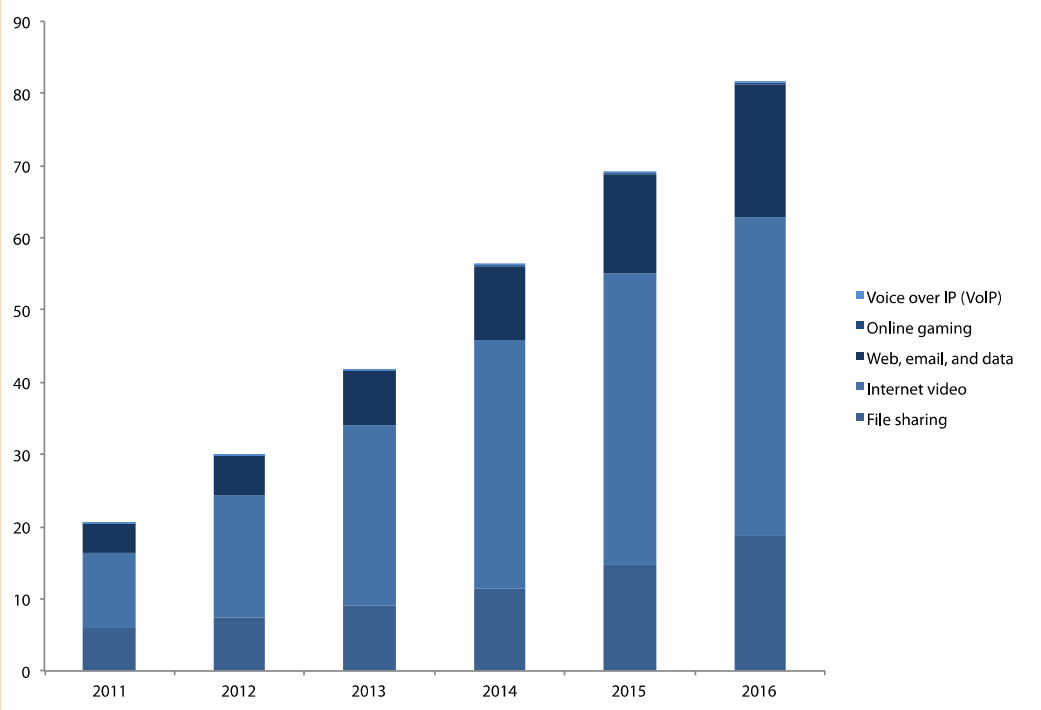
As shown in Figure 1, internet video is the major driver of the growth in consumer internet traffic, which is estimated to increase from 10.4 exabytes per month globally to over 44.2 exabytes between 2001 and 2016 (which corresponds to a compound annual growth rate of 34 per cent). Broadband networks are increasingly used for the delivery of long-form video provided by services such as 'LOVEFiLM Instant' and 'NetFlix'[4] rather than short-form Internet video traffic such as video clips on YouTube.[5] For example:

- in Western Europe, where these services are available over both fixed and mobile networks, internet video traffic is expected to account for 60.3 per cent of all consumer Internet traffic in 2016, up from 44.8 per cent in 2011 (Cisco, 2012a); and
- in China, it is predicted that by 2016, 79 per cent of all consumer internet traffic will be video content, up from 64 per cent in 2011 (Cisco, 2012b).

[4] According to Sandvine (2011), "*Netflix accounts for 29.7% of peak period downstream traffic*" across Americas fixed access networks.

[5] On Monday 9th Jan 2012, Amazon's LOVEFiLM announced having reached two million subscribers, "*driven by a record number of sign-ups in the fourth quarter of 2011. The Amazon-owned service added hundreds of thousands of new customers that now have access to LOVEFiLM Instant, which provides a unique offering of instantly streamed film and TV series, combined with the vast selection of DVD, Blu-ray and Video Game rentals. This is the fastest customer growth rate LOVEFiLM has experienced since 2009*" when it was first introduced. See http://corporate.blog.lovefilm.com/a-press-releases/amazon%E2%80%99s-lovefilm-hits-2-million-members.html#more-1403

Figure 1: Global Consumer Internet Traffic per Application (exabytes per month), forecast 2011-2016



Source: Cisco (2012a)

Users will increasingly require higher broadband speeds in order to make most of applications such as video-on-demand streaming, online gaming, cloud computing or other services. Consequently, the development of newer, faster broadband technologies will be a predominant feature of future broadband markets, both through FTTx services for fixed broadband, and 4G and WiMAX for mobile broadband services. Most countries have also set out ambitious national broadband plans, seeking to achieve widespread coverage of higher speed networks in the not-too-distant future (see OECD, 2011b).

Regulators and competition authorities need to understand the importance of services and content as a driver of demand growth and network choice when looking at a converged broadband world. Because demand for connectivity depends on the availability of services that exploit the capabilities of the network, service availability is key. But at the same time, the incentives for the development of such services depend crucially on the expectation that there will be a sufficiently large addressable market. This can create a co-ordination problem that needs to be overcome if the potential for new services, supported by improved networks, is to be realized.

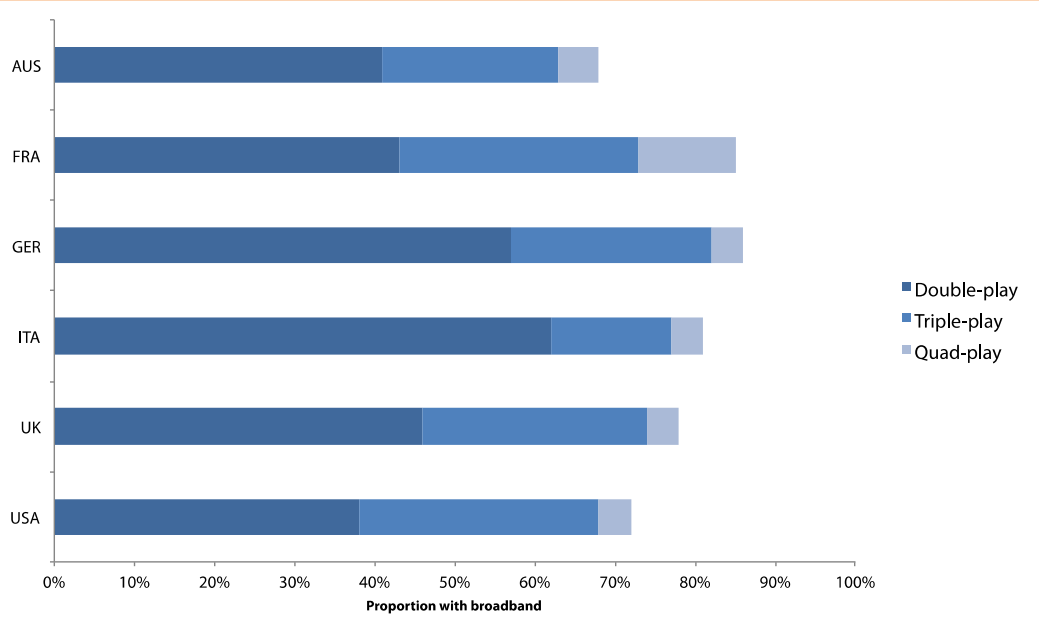
2.2 Bundling

Bundling of services that could – at least in principle – be provided separately has always been a feature of telecommunications markets. Access (line rental) and calling services were traditionally offered as a bundled service, and the fact that with liberalization it was possible to buy access from one provider but get calls from another probably surprised many users. Value added services such as call waiting or call divert were also often bundled with 'basic' telecommunications service. With the roll-out of cable networks, bundling of telecommunications services with television content ('dual play') has became prevalent.

Bundled service offers are becoming increasingly common in the broadband world. Broadband access itself is often bundled with 'traditional' telecommunications services such as line rental and fixed voice

calls, but more typical bundles are 'triple-play' combinations of fixed-voice, data and video services, and sometimes quad-play packages further include mobile services (see Figure 2 below).

Figure 2: Take-up of multi-service 'bundles' among fixed broadband customers, United Kingdom, 2012



Source: Ofcom (2012)

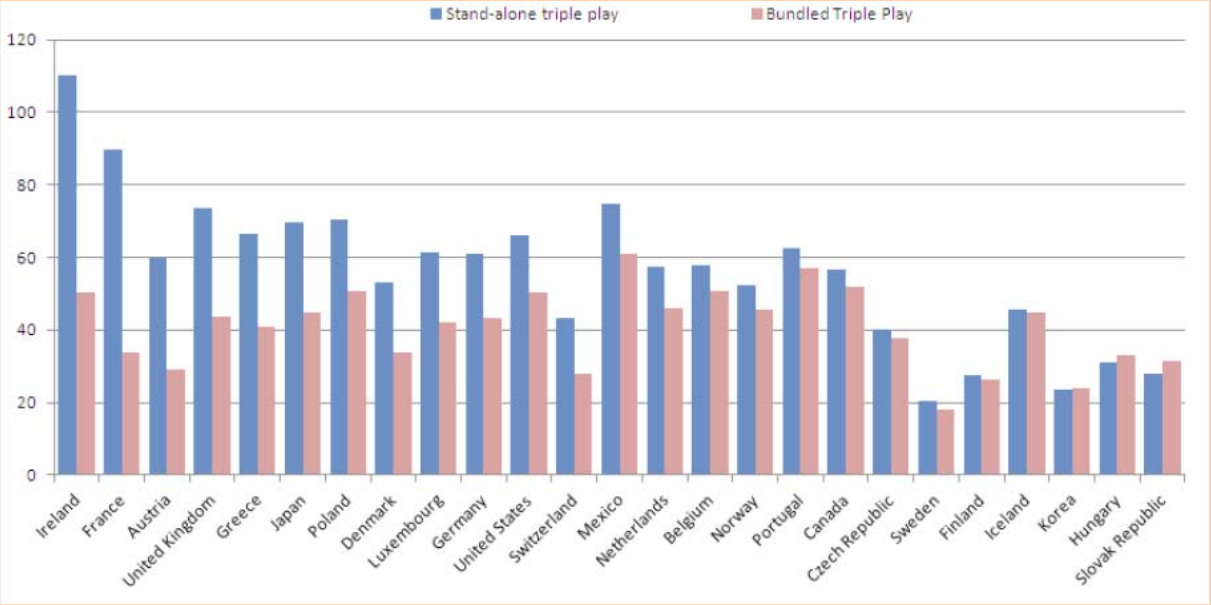
Historically service bundles may have involved multiple networks (e.g. a fixed line and a DTH broadcast satellite). The reason for bundling often was customers' demand for one-stop-shop provision of services, with cost savings being limited to unified billing and customer support. Convergence means that service bundles can be delivered over a single network, creating economies of scale and scope and associated cost savings that go beyond those available before. With increasing bandwidth availability, bundling may become the common form of delivery (for example, internet, VOIP and IPTV all provided over a single broadband connection), and service bundles may grow to include further OTT services.

These bundles are in most cases offered alongside standalone services (so-called 'mixed bundling').[6] The OECD (2011a, p3) finds that "*[b]roadband bundles are typically sold with a significant price discount over stand-alone prices. The average bundled discount compared with buying the services separately is USD 15 (PPP) per month or 26%. The average price of a triple-play bundle across all countries and operators is USD 65 (PPP) per month, while the median price is USD 59 PPP. The average entry-level price for a triple-play bundle is USD 41 PPP per month.*"

Figure 3 below gives an illustration of the savings across OECD countries, based on the most recent survey undertaken by the OECD. The average saving on triple-play bundles is approximately 27 per cent.

[6] This is different from 'pure bundling' or 'tying', where only packages are on offer. A 2011 report by the OECD analysing over 2 000 offers combining broadband, fixed-line telecommunications and television services from 90 firms in 30 countries found that more than three quarters of operators allowed customers to purchase broadband on a stand-alone basis. Tying with a fixed line was relatively common (17%), but tying to a television services was not (at 4%), and only 2% of offers required that all three services be taken in order to obtain broadband. For a general discussion of bundling and tying, and their impact on competition see Nalebuff (1999).

Figure 3: Comparison of minimum prices for video/voice/data if purchased separately and as a bundle, Oct 2009, USD PPP per month



Source: OECD (2011a)

Bundling of service seems to be regarded by operators as a key strategy for driving take-up. For example:

- in July 2011, Zimbabwean ISP Aptics is reported to have procured equipment for the roll-out of a WiMAX wireless broadband service, offering customers a bundle of internet and data services, voice services and mobile services, to drive take-up;[7]
- in February 2010, "*Moldova's incumbent telco Moldtelecom … announced the launch of its IPTV service, offering 30 TV channels, video on demand (VoD) and other interactive services. … The operator has unveiled a range of tariff plans, including three double-play packages – Duo Start, Duo Optim and Duo Plus – bundling the TV service with a broadband internet connection*";[8]
- UAE incumbent Etisalat launched its Abu Dhabi fibre-optic network in December 2009, offering triple-play packages covering landline telephony, broadband and IP television services from May 2010 onwards. By April 2011, Etisalat announced that it had completed its fibre build, making Abu Dhabi "*the first capital in the world to be entirely connected to a FTTx network*."[9]

Exploiting convergent technologies, service bundles may become more differentiated in future and include components such as 'cloud storage' or other content-rich services (e.g. gaming applications). For example, in March 2012, Mauritian telecoms operator Bharat Telecom Ltd has announced its launch of a

7 www.telegeography.com/products/commsupdate/articles/2011/07/29/airspan-equipment-powering-zimbabwe-wimax-network/index.html

8 www.telegeography.com/products/commsupdate/articles/2010/02/24/moldtelecom-unveils-iptv-offering/index.html

9 www.telegeography.com/products/commsupdate/articles/2011/04/27/etisalat-connects-entire-abu-dhabi-to-fttx/index.html

FTTH network that will deliver broadband internet and IPTV, and offer a "*carrier backbone for other service providers in the country operating in the gaming and WebTV business spheres*."[10]

2.3 Different mixes of fixed and mobile broadband technologies

There is notable variation in the role played by mobile and fixed broadband services, and across fixed broadband technologies used throughout the world.

DSL is the main fixed broadband technology worldwide with over 60 per cent of connections in the top ten countries (by number of subscribers) using this type of technology (Point Topic 2011).[11] Cable accounts for almost 20 per cent of broadband connections in these countries, with the US being the largest cable market. The remainder are largely FTTH connections, which are currently prevalent in countries such as the Republic of Korea and Japan (Point Topic 2011) and are expected to play a greater role in the future in other countries.[12] Globally, fixed broadband connections stood at 591 million by the end of 2011, having doubled over the previous five years, and should have reached 612 million by the end of March 2012 (Point Topic, 2012b).

This number is dwarfed by mobile broadband subscriptions, which stood at 1.09bn globally[13] by the end of 2011. In many developing nations[14] where the fixed network infrastructure is poor, mobile technology provides the main form of internet access. With 62 per cent of the world's total number of Internet users coming from these nations at the end of 2011 (up from 44 per cent five years earlier – see ITU, 2012a), it should not be surprising that mobile broadband penetration in these countries is often substantially higher than fixed penetration, and is expected to grow further.[15]

Growth in mobile broadband connections is however not purely the consequence of poor fixed network infrastructure. Changing usage patterns supported by mobile data cards and smartphones, and substantial improvements in mobile technology (most notably the shift towards 4G networks which offer substantially higher data rates) mean that mobile broadband is becoming a strong contender even in countries with a well-developed fixed network infrastructure (see Box 1).

Overall, Ericsson (2012) forecasts global mobile traffic to increase from around 1 000 petabytes per month in 2012 to over 8 000 petabytes by 2017.

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[10] www.telegeography.com/products/commsupdate/articles/2012/03/20/bharat-telecom-mauritius-launches-ftth-service/index.html

[11] The top 10 broadband fixed broadband markets are (China, USA, Japan, Germany, France, UK, the Republic of Korea, Russian Federation, Brazil, Italy and India.

[12] In particular, ambitious targets for available bandwidth (such as the European Commission's Digital Agenda or the US National Broadband plan (Federal Communications Commission) may have a similar effect as the u-Japan policy set out by the Japanese the Ministry of Internal Affairs and Communications (MIC) in 2005 (see Business Software Alliance, 2012) or the Korean Broadband Convergence Network Initiative (BcN) of 2004 (see Ovum, 2009).

[13] www.itu.int/ITU-D/ict/statistics/at_glance/keytelecom.html

[14] The average fixed penetration is 4.8% in developing economies compared with 26% in developed countries; see ITU (2012a). www.itu.int/ITU-D/treg/publications/trends12.html

[15] Even in some Sub-Saharan African countries where capital cities are connected to 'international fibre' and fixed broadband connections in the major cities is developing it will remain costly to connect rural communities with costs escalating the further away from the core network the communities are (see Bernal, 2011, pp 26-28).

Box 1: Growth of mobile broadband penetration in countries with high fixed penetration, 2009-2011

The table below shows the change in fixed and mobile broadband penetration for some of the countries with the highest level of fixed broadband penetration in 2009. This shows that even in countries where fixed broadband services are well established, and take-up is high, mobile broadband is growing dramatically, with average growth rates of around 26 per cent from 2010 to 2011, compared with a 3 per cent growth in the penetration of fixed broadband over the same period. On average across those countries, there are 56.7 mobile broadband connections per 100 inhabitants compared with 34 fixed broadband connections.

Country	Fixed broadband connections per 100 inhabitants		Growth 2010-11	Mobile broadband connections per 100 inhabitants		Growth 2010-11
	2009	2011		2009	2011	
Netherlands	37.01	38.74	2%	N/A	49.19	29%
Denmark	36.94	38.21	1%	29.61	80.24	26%
Switzerland	35.94	39.20	3%	25.32	36.07	17%
Norway	34.52	36.55	4%	11.12	24.37	26%
Republic of Korea	34.08	36.91	3%	88.93	105.05	7%
France	31.87	36.12	6%	30.44	43.96	20%
Sweden	31.59	31.77	0%	69.91	91.55	10%
Luxembourg	31.37	32.90	-1%	N/A	66.67	9%
Canada	30.51	32.02	7%	N/A	32.91	8%
Germany	30.21	32.47	2%	23.06	34.81	35%
United Kingdom	29.56	32.74	6%	36.98	62.27	44%
Belgium	29.40	32.95	5%	5.77	19.35	99%
Hong Kong, China	28.95	31.54	5%	33.89	51.84	33%
Finland	28.71	29.50	1%	71.29	87.10	3%
United States	25.69	28.75	4%	39.81	65.48	24%

Source: ITU World Telecommunication/ICT indicators database, www.itu.int/icteye.

3 Market definition in a broadband world

As a general principle, the scope of regulatory intervention should be limited to markets where competition is ineffective or cannot develop without some assistance that protects smaller firms and new entrants from being pushed aside by strong incumbents, and regulatory obligations should only be imposed on firms that are capable of distorting competition, harming rivals or exploiting consumers. Regulation should be withdrawn when markets become competitive. This acknowledges the inherent limitations of regulatory intervention that results from regulators generally having less information about the costs of the regulated firms and the needs of customers and having fewer instruments at their disposal than they would need to achieve the outcomes that would occur in an effectively competitive market.

This means that regulators need to establish which firms are likely to be in a position to exploit their customers, or behave in ways that make it more difficult for their competitors to gain a foothold. Such a position is generally described as one of significant market power (SMP), and it can only exist in relation to a particular market within which firms compete. Identifying these markets is therefore a key task.

Defining the markets that are susceptible to *ex-ante* regulation generally involves a process of market analysis that is repeated at regular intervals. It may take a list of candidate markets as its starting point, and may be more or less formalised. As part of the market analysis process, regulators will typically apply

principles for the definition of relevant markets that often resemble those that are used in the application of general competition law where market definition also plays a key role.

In competition investigations, identifying the relevant market is generally the first step, and an invaluable tool helping national competition authorities (NCAs) to understand the nature and strengths of competitive constraints. This in turn is a pre-condition for establishing the presence of market power and to gauge the effects of specific behaviour or agreements on competition. The main difference between market definition in a regulatory environment and in the enforcement of competition law is that regulators need to define markets prospectively whereas competition authorities typically respond to a complaint and look at market boundaries ex post and in the context of a specific investigation.[16]

This section briefly discusses some of the general issues that arise in the course of market definition, and then proceeds to look at the challenges posed by convergence.

3.1 Some general points about market definition

Demand and supply side substitution

In both regulation and competition policy, markets are generally defined in terms of the products and services that are considered to be:

- sufficiently substitutable from the perspective of their users so that demand can readily move between them (demand side substitutability); or
- sufficiently similar from the perspective of suppliers so that a firm supplying one of them would be able to supply the others on short notice and without having to make significant investments (supply-side substitution).[17]

Relevant markets also have a geographic dimension. The relevant geographic market comprises the area within which such adjustments can take place with sufficient ease to impose a competitive constraint.[18]

In some cases, the precise definition of the market may not matter, as a firm may enjoy significant market power regardless of whether the market is defined more narrowly or more widely. For example, if the incumbent fixed line operator also is the sole provider of mobile telephony services, the need for regulatory controls and the identity of the firm that should be subject to obligations does not depend on whether fixed and mobile telephony services are considered to be in the same market or in separate ones. In general, however, identifying market boundaries correctly does matter. The tool commonly used for capturing competitive constraints is the so-called 'hypothetical monopolist test' (see box below).

Box 2: The hypothetical monopolist test

The hypothetical monopolist (or SSNIP) test is a tool that is commonly used by NCAs and NRAs in establishing the boundaries of the relevant market. It is intended to capture demand and supply side substitution by asking whether a firm that is the exclusive provider of a particular set of products or services (the hypothetical monopolist) could profitably increase prices. If this is the case, then the products and services under consideration constitute the relevant market. If it is not the case because customers would switch to alternative products and services in response to a price increase, or suppliers

[16] Merger control where competition authorities will need to define markets prospectively is an obvious exception to this.

[17] The key difference between supply side substation and new entry is the timeframe in which firms who are currently not providing the good or service can commence supply, and the ease with which they can do so. Supply side substitution occurs in the short run without the need for additional investment, whereas entry may have substantial lead periods and may require new entrants to make significant investments. For a brief discussion of market definition in a regulatory context, see Section 2.2.1 of the ICT Regulation Toolkit (www.ictregulationtoolkit.org/en/Section.3538.html)

[18] For a detailed discussion see, for example, European Commission (1997).

of such alternative products or services would commence supply of the products currently offered by the hypothetical monopolist, then the relevant market will have to include at least these alternatives.

Starting from the smallest conceivable set of products (for example fixed broadband connections providing speeds in a specific range), one would ask whether a hypothetical monopolist offering these products could increase its profits by introducing a small but significant non-transitory increase in price (SSNIP). If the answer is 'no' the products to which customers would switch or whose suppliers would offer the reference product will be included, and the test is then repeated until a set of products is found over which a monopolistic supplier could profitably sustain such a price increase.[19] In a similar way to product market definition, a geographic market definition would start from a narrow geographic area and apply the SSNIP test over wider geographic areas as appropriate.

Davies and Garcés (2009) describe a number of techniques that can be used to assess the profitability or otherwise of a price increase.

One potential methodological pitfall in applying the SSNIP test is the so-called 'cellophane fallacy' (named after a US antitrust case involving DuPont, the manufacturer of the cellophane plastic wrap in the US): the cellophane fallacy refers to the observation that a market that is served by an actual monopolist would wrongly be considered too narrow if the SSNIP test were conducted using the market price as its starting point.[20] This is because a profit-maximising monopolist sets its price at the point where any further increase becomes unprofitable. The naïve application of the SSNIP test would thus find that a small price increase above the market price is not profitable and conclude that additional products need to be included in the relevant market. In order to avoid this problem, it is important to consider the profitability of a price increase over and above the competitive level, which will be different from the price if the market is affected by a competition problem.

Requiring knowledge of the competitive price level in order to avoid the cellophane fallacy leads to an obvious conundrum, however: if the competitive price level could be established without reference to the market price, then the difference between the market price and the competitive price could be used to establish the presence of market power, and the entire market definition exercise would be unnecessary.

Source: Author

Retail and wholesale markets

A key distinction can be drawn between retail markets where sales are being made to end users, and wholesale markets where customers are businesses who source inputs that will be used to sell to other businesses or, ultimately, to end users.

Given the history of telecommunications liberalization with service competition being introduced on the basis of regulated access to key inputs, this distinction is particularly important for regulatory purposes.

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[19] If the price increase is not profitable for the hypothetical monopolist because customers would switch away to alternatives, or firms offering products would readily switch some of their capacity to supply the product in question, then the scope is expanded to include those additional products or services. In other words, the products that consumers would credibly switch to in response to such a price increase, or the products whose suppliers could easily satisfy demand, would be included in the relevant product market. On the supply side, practitioners would look at the ability of alternative undertakings to be able to supply that particular product without incurring substantial sunk (non-recoverable) costs. For example, if the focal product under consideration were wholesale access to fixed infrastructure of an incumbent operator, it is unlikely that such technology may be replicated quickly, as significant investment in civil works and rolling out network infrastructure would be required, and most of the costs involved would be sunk. The analysis would be repeated, assuming a hypothetical monopolist of the larger set of products, until the point at which the hypothetical monopolist would be able to sustain profitably a price increase over the set. See OFT (2004).

[20] For a more detailed discussion of the cellophane fallacy see a presentation by Philip Nelson available from the US DOJ website (www.justice.gov/atr/public/hearings/single_firm/docs/222008.pdf).

Scale and scope economies in combination with sunk costs may limit the potential for competition mainly in relation to network infrastructure (or at least some parts of the network), with other parts of the value chain being in principle open to competition.

By identifying wholesale markets and using *ex-ante* regulation to prevent abuses of market power at the wholesale level (for example, through defining appropriate access and interconnection obligations) regulators try to ensure that "*as much of the value chain is open to normal competition processes as possible, thereby delivering the best outcomes for end-users*".[21]

Exposing a greater proportion of the value chain to competition is beneficial because competition is usually more effective than regulation in promoting service differentiation and innovation. The principle that regulation should focus on wholesale rather than retail markets is particularly important in relation to broadband services because these services are far from mature and service innovation is an important dimension of the competitive process (see ITU 2012c).

3.2 Service-driven choice of networks and retail market definition

As discussed above, one of the main characteristics of broadband networks is that they are multi-service networks. Whilst traditional telecommunications networks provided one (and essentially only one) service – namely voice (later augmented by fax) communications between those connected to the network – a broadband connection is a conduit that enables consumers to access a plethora of services, and gives service providers the means to distribute their offerings. This is at the core of convergence, and means that broadband networks can be seen as platforms through which service providers and consumers interact.[22] The platform nature of broadband networks implies that a broadband network will be more attractive to potential end users if it provides access to better services and a greater range of services, and be more attractive for service provider if it allows them to reach a greater number of users.

To some extent, the strength of this specific type of network effect is masked by the fact that – at present, and at least in principle – services provided over the public internet are universally accessible regardless of the network connection used by the customer. However, the bandwidth that is available through particular types of connections imposes practical limitations, and it may well be possible to restrict access to particular services to customers of particular networks.[23]

In any case, differences in the technological capabilities of networks matter largely because of the differences in the range of services to which a customer may gain access. For example, whether there is a single broadband market, or whether it would be more appropriate to distinguish markets for basic and ultra-fast broadband depends on whether some services are accessible through one, but not the other. Similarly, depending on whether there are services that require near-symmetrical upload and download speeds, broadband networks that support such symmetrical speeds may be in a different market from those that offer high download, but limited upload speeds.

This means that the definition of relevant markets in relation to broadband connections is strongly affected by the nature of services to which broadband customers might gain access, and that market boundaries may change over time. For example, broadband services that at present are considered to be substitutable may not be so in the future if services that require high-bandwidth low-latency connections emerge and become mainstream.

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[21] See European Commission (2007a), Clause 15.

[22] For a detailed discussion of the economic issues that arise in multi-sided markets or platforms, see for example Evans and Schmalensee (2008) or Evans et al. (2011).

[23] The 'walled garden' approach originally adopted by AOL is a good example for limiting access to services to the subscribers of the firm that provides the connectivity. Content-rich portals have also been used by many mobile operators aiming to provide their subscribers not just with connectivity, but also exclusive access to services.

NRAs may need to define a number of sub-markets characterized by the ability of the network to provide consumers with the experiences they require. For example, if broadband networks provide the main way of accessing video content in the future, then the question whether a particular type of network provides the bandwidth and the latency to support multiple high-definition video streams may matter for market definition, even if it does not at present. This may well require more complex assessments of substitutability than have been undertaken in the past.

The role of 'marginal' customers

Consider the extreme case of an ultra-fast fibre-to-the-home (FTTH) network supporting near-symmetrical speeds of 100 Mbit/s on the one hand, and a basic ADSL network with an effective download speed of 2 Mbit/s, and upload speeds of 256 kbit/s on the other hand. Those networks appear to be too different to be substitutable from the perspective of customers who wish to access bandwidth-hungry services that only the FTTH network can deliver. Such customers do not have an effective choice.

However, this does not necessarily matter for market definition. If there is a sufficiently large group of customers for whom access to bandwidth-intensive services is not crucially important, and who might therefore be prepared to switch to the slower network if a hypothetical monopolist of FTTH services were to increase the price above the competitive level, such a price increase would be unprofitable. It is such 'marginal' customers who determine the strength of competitive constraints that one type of broadband network exercises in relation to the other. Market definition needs to focus on these customers rather than focusing on those who would not consider switching (so-called 'captive' customers).

The SSNIP test, by focusing on the profitability of a small price increase, should help in this regard. However, it may also sometimes ignore the ability of suppliers to charge different prices to captive and non-captive customers (i.e. to engage in so-called 'price discrimination'). If a supplier can exploit the fact that some customers may not be willing to switch to alternative products by charging them a higher price, then it may be appropriate to identify separate markets, or define markets more narrowly.[24] Such price discrimination may happen in a number of ways, and does not require that the operator is able to identify captive and non-captive customers. For example, offering a menu of tariffs and allowing customers to pick the one that best suits their needs can be used as a way of segmenting customers into different groups.[25] Depending on how effective these strategies are, it may then be appropriate to define separate markets for different types of tariff packages, for example.

Note that the relative proportion of captive and non-captive, marginal consumers may change as the underlying services mature: where in the early stages of development of a bandwidth-hungry services only the small group of early adopters may be considered captive, the proportion of captive customers may grow over time as the service acquires mass market appeal. These changes should be picked up in the course of the periodic market analyses undertaken by regulatory authorities.

Chains of substitution

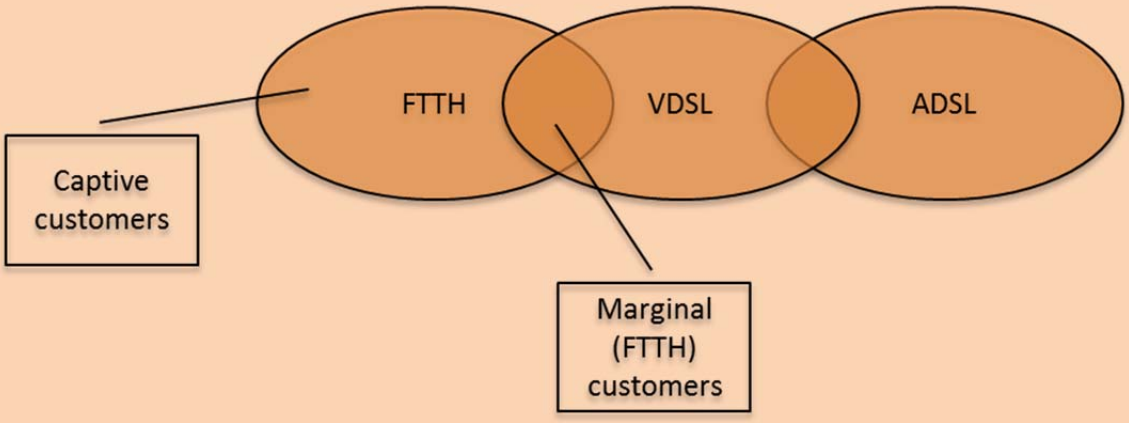
The role of marginal consumers is important when looking at chains of substitution. Even if the two networks described above may not be directly substitutable from the perspective of any particular user, they may be part of the same market if they are linked by a chain of substitution. For example, there may be a VDSL network that provides upload and download speeds that lie between those offered by the FTTH network and those available via ADSL. Even though nobody would consider the ADSL connection to be a

[24] The role of price discrimination in relation to market definition is considered, for example, in the merger guidelines in Australia, Canada, the EC, Finland, New Zealand, the UK and the US (see Leddy et al., 2005). Price discrimination may mean that an otherwise unprofitable price increase pays off, and thus would lead to the identification of smaller markets (see, for example, Strand, 2008).

[25] This is so-called 'third degree price discrimination'. For a simple and accessible discussion of the different forms of price discrimination, see the tutorial provided at http://tutor2u.net/economics/revision-notes/a2-micro-price-discrimination.html.

substitute for a FTTH connection, there may be some customers who would move from FTTH to VDSL in response to an increase in the price of FTTH connectivity above the competitive level, and there may equally be customers who would consider ADSL to be an alternative to VDSL and would switch from one to the other in response to a price increase (see Figure 4). In this case, all three types of networks might be part of the same market.

Figure 4: Chain of substitution – a stylized example



Source: Author

Note that in the case where markets are defined on the basis of a chain of substitution, they may contain products with substantially different characteristics that sell at substantially different prices. This is purely the consequence of the fact that what matters for market definition is the extent to which different products and services constrain each others' prices, whether directly or indirectly through a chain of substitution, rather than how similar their prices and product characteristics are.

Again, it is important to appreciate that a chain of substitution may form or break depending on the adoption of underlying services.

Geographic footprints

The proportion of customers who might be able and willing to switch between networks and the impact that such switching would have on market boundaries is also relevant in relation to geographic markets where networks have different geographic footprints. Specifically, networks that cover different geographic areas may be in the same market if their footprints overlap to a sufficient extent and they employ geographically uniform pricing strategies.

Particularly in the case of fixed broadband connections, a customer's choice between different suppliers will depend on the ability of broadband providers to provide services to a specific location. As such, the ability to switch between different networks will depend on the reach of alternative networks and, importantly for market definition, will also depend on the extent to which alternative operators can quickly expand their reach without significant cost.

While many NRAs continue to define the market for broadband at a national level, often based on the fact that the incumbent has national coverage, some countries have deregulated the market in certain locations on the basis that there are separate geographical markets. For example in 2009, the Portuguese regulator, Anacom, received approval from the EC to deregulate parts of the wholesale broadband access market on a geographical basis. Anacom had proposed to deregulate in mainly densely populated areas where there are at least three operators and a high number of households with access to the cable network – these areas accounted for 61 per cent of all Portuguese broadband lines (OECD, 2010, p 37).

In other cases, regulators may instead decide to impose differentiated remedies in a single, national market. For example, in 2008, as part of the market review process, the Austrian regulator proposed to define a single national market for wholesale broadband in which the incumbent, Telekom Austria (TA) would be designated as having SMP. However, while TA was considered to have SMP at the national level, it was recognized that there were particular regions where there was less competition from other infrastructure operators. For example, in less populated, rural areas, TA was the only operator. The regulatory authority proposed to address these different competitive pressures in different regions by applying differentiated remedies.[26]

The need to define broadband access markets geographically may become increasingly important during the transition to new ultra-fast networks. For example, given the heterogeneity of different geographic areas, ultra-fast networks are likely to be rolled out first in the most 'profitable' areas (e.g. densely populated urban areas) where economies of scale and scope can easily be realized before extending to other areas. Differences in demand and supply characteristics in different areas may require markets to be defined differently by region, at least in the short to medium term, if rollout of new competitive networks is slow.

As noted above, even in some sub-Sahara African countries where capital cities are connected to 'international fibre' and fixed broadband connections in the major cities are gaining in importance, it will remain costly to connect rural communities with costs escalating the further away from the core network the communities are (Bernal, 2011). Thus, in these countries, it may be necessary to consider different markets depending on the geography, as customers in rural areas will not have the same choice of services and networks as in the densely populated urban centres. The increasing coverage of 3G, and the future roll-out of 4G mobile networks may fill gaps in the chain of substitution, as discussed above, but the strength of the constraints this creates need to be assessed on a case-by-case basis.

One-way substitution

It may well be the case that customers would be prepared to switch from the less capable network to the more capable one (e.g. trade up from ADSL to VDSL in response to an increase in the price of ADSL services), but not in the other direction. This means that VDSL prices impose a strong constraint on the pricing of ADSL services, but that the constraining effect in the other direction is perhaps less strong.

While at present no comprehensive analysis in relation to broadband service may have been undertaken, one-way substitutability has been discussed extensively in relation to the competitive interaction between fixed and mobile voice services. For example, as BEREC (2011) reports, the Finnish regulator FICORA found "*that retail fixed access for voice services was fully substitutable with mobile access services, but not the other way around. That is, there was no two-way substitution between these services.*

If there was a SSNIP of retail fixed access services, fixed subscribers would switch to mobile telephony subscriptions. But, if there was a SSNIP of retail mobile access services, mobile subscribers would not switch to fixed telephony subscriptions." Thus, one-way substitution has important implications for market definition. In Finland, FICORA concluded that, "*the non symmetric substitution lead to the definition of two separate markets: retail mobile access is a distinct adjacent product market which gives rise to competitive constraints being exercised on operators in the fixed access market.*"

Similar considerations may well arise in the context of substitution between 'high-speed' and 'regular-speed' broadband services. For example in the United States, the FCC, the Federal Trade Commission (FTC) and the Department of Justice (DOJ) have all independently ruled that the provision of residential

[26] The regulator proposed to divide the country into two areas based on the following criteria: *"(i) the number of large operators present in the footprint of each of the 1,480 Main Distribution Frames (MDFs) operated by TA; (ii) the customer density of the MDF area; and (iii) TA's market share in each of the MDF areas*." However, while the EC concluded that the Austrian regulator's finding of a national geographic market and the imposition of differentiated remedies was based on sufficiently coherent and cogent evidence, the regulator's decision was later appealed and overturned in the national courts. See OECD (2010), pp 39-40.

high speed broadband internet access service is a distinct market in its own right compared to narrow band services due to the benefits of 'trading up' from narrowband to broadband.[27]

Depending on how 'one-way' substitutability is captured in the definition of the relevant market, it may need to be addressed in the context of establishing whether an operator enjoys market power: although narrowband services may be considered to be in a market of their own, for example, operators with a strong position in this market may not enjoy market power because of the competitive threat they are facing from broadband providers (even though they do not impose a strong constraint in the other direction).

Vertical relationships

The range of services to which a broadband customer may get access is not necessarily affected only by the technical parameters of the network. It may also depend on vertical relationships between network operators and service providers. At present, most services are accessible over the public internet, and thus through any network connection that supports the required bandwidth and latency. However, this does not have to be the case. For example, until recently, in the UK BSkyB's video on demand service, 'Sky Anytime+' was available only over a Sky broadband connection.

Some proprietary services also exist in relation to mobile broadband offerings.[28] For example, the mobile M-PESA payment service used in Kenya, and others in Afghanistan and Tanzania is only available on a single operator's network in a given country.[29] For example, in Kenya, where it is estimated that up to 25 per cent of the population uses the M-PESA payment system,[30] the service is only available over the 'Safaricom' network.[31] Other operators may offer their own proprietary mobile payment services, and access to the service may be expected to have a strong impact on mobile network choice.

With the choice of network being service-driven, consumers may be unable to switch between broadband offers if the content in which they are interested is unavailable over alternative platforms. Here again the maturity of the service under consideration (e.g. whether it attracts mostly early adopters or has mass market appeal) is important, and market boundaries may change as services move from niche to general interest. Where the majority of customers is interested in using a particular service such as mobile payments, for example, that is available only over some networks, these networks may need to be considered as being in a separate market. Again, what matters here is the proportion of 'marginal' consumers, i.e. users who are prepared to forego access to such services in response to an increase in the price above the competitive level.

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[27] See Federal Communications Commission (2001), Federal Trade Commission (2000), Department of Justice (2000).

[28] Where a service provider agrees to make services available exclusively over a particular network, it obviously matters how many customers are connected to this network. From the perspective of the service provider, the broadband network will be more attractive the more customers can be reached. This gives rise to the complications of market definition in two-sided markets, where the appropriate basis of the SSNIP test would have to take account of the fact that a reduction in demand on one side will also reduce demand on the other side, which would magnify the impact of a price increase (see, for example, Evans and Schmalensee, 2007, p 173f.).

[29] "*M-PESA is an innovative mobile transfer solution that enables customers to transfer money. It is aimed at mobile customers who do not have a bank account, either by choice, because they do not have access to a bank or because they do not have sufficient income to justify a bank account*." See www.safaricom.co.ke/personal/m-pesa/how-to-register/faqs

[30] See Vodafone's website at http://enterprise.vodafone.com/products_solutions/finance_solutions/m-pesa.jsp

[31] "*M-PESA is only available on Safaricom SIMs, so only a Safaricom subscriber can deposit or send money*." See Safaricom website at www.safaricom.co.ke/personal/m-pesa/how-to-register/faqs

Bundling

Even in the absence of exclusive arrangements, bundling may affect the substitutability of broadband services offered through different networks or by different providers. In the presence of bundled offers, should the relevant market comprise bundles or individual products, or potentially both?

While bundling network connectivity and services may be the most efficient way to overcome the co-ordination problem that can arise from the service-driven demand for bandwidth, it may also have the effect of limiting customer switching to alternative offers and may thus affect market definition.

Customers may sometimes find it difficult to compare bundled offers where packages are different, for example, in terms of channels being offered, broadband speeds and the inclusion of deals on certain calls (e.g. flat rates on national calls). This increases search costs and may be customers less likely to respond to price increases by looking for alternative suppliers and switching their demand to these.

Perhaps more importantly, customers may find themselves locked-in to bundles where an individual component might not be available through any other means or where the contractual terms limit their ability to break the bundle.[32] Certainly in relation to 'traditional' telecommunications service bundles (access, voice calls and potentially value-added services) the ability of operators to compete in the provision of individual components has been limited. This has been one of the lessons from the first phase of liberalization in South Africa, where the fact that Telkom could offer a bundled package of voice, data and value added services was seen by competitors who could only offer value-added services as a major hindrance (see Sibanda, 2006).

Customers may also be averse to unpicking bundles in response to price changes of individual components offered by rivals, given increases in transaction costs. Here again, the key issue is how large the proportion of customers unable or unwilling to consider sourcing individual components (captive customers) is compared with the proportion of customers who would be willing to unpick the bundle and switch to buying individual components.

One approach to addressing the question whether bundled services should be considered to be a separate market that has been advocated for example by the European Commission is to look at whether customers would be prepared to unpick the bundle in response to a price increase and switch to purchasing individual components.[33] This is linked to (though slightly different from) the question whether suppliers of individual bundle elements would be able to attract customers away from buying bundles and source individual components instead.

One needs to be careful, however, in terms of adopting the correct starting point for assessing the effects of an increase in the bundle price. This is because a hypothetical monopolist of the service bundle would be expected to set prices in such a way that any increase in the bundle price would be unprofitable, taking into account the propensity of consumers to switch to individual services, both those supplied by the hypothetical monopolistic bundle provider and potential competitors offering services on a stand-alone basis. This means that, starting from optimally set bundle discounts, any increase in the prevailing price of a bundle will by definition be unprofitable, regardless of whether the supplier of the bundle is facing competition from firms supplying individual components or is setting its bundle price in the face of limited

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[32] For example, "*[a]n OECD data collection of over 2 000 offers of stand-alone and bundled services from 90 firms across 30 OECD countries reveals that broadband services in the OECD are overwhelmingly sold as mixed bundles, allowing users to choose among stand-alone offers or bundled services. Of the 90 operators surveyed, 77% allow users to buy stand-alone broadband service. 17% tie broadband service to a fixed-line voice service and 4% require a television package to obtain broadband access. Only 2% of the offers surveyed required subscribers to take a triple-play service to have broadband*." See OECD (2011a), p 3.

[33] For example, in its explanatory note to the EC Recommendation on ICT markets, the EC notes that *"[i]f, in the presence of a small but significant non-transitory increase in price there is evidence that a sufficient number of customers would "unpick" the bundle and obtain the service elements of the bundle separately, then it can be concluded that the service elements constitute the relevant markets in their own right and not the bundle*" (European Commission, 2007b, p15).

competition, e.g. because not all of the bundle components would be available from other suppliers.[34] This means that, in line with the general principles of market definition, one should use the competitive bundle price as a starting point when examining whether customers would be willing to unpick bundles in response to a price increase, noting that this might be different from the prevailing bundle price.[35]

Establishing the competitive bundle price is of course far from straightforward and might, for example, involve considering the cost savings that can be justified by economies of scale and scope. In addition, information about actual switching between bundles and individual products, or the general take-up of bundles and individual products might be considered by NRAs.

Box 3: Looking at service bundles – an example

A study of bundling in Hungary assessed the impact of an increase in a hypothetically competitive price of certain bundles (using a critical loss test[36]).

The study used results from a survey of 1 000 members of the Hungarian population. A special, situation-adaptive questionnaire design was applied in order to obtain stated preference reactions to a 10 per cent price increase against a hypothetical competitive price for any given bundle of services (this starting price was calculated by applying a discount to tariffs available in the market at the time i.e. acting as a proxy a hypothetical competitive offer).

The study then used a critical loss test to consider whether there is a separate market for triple play bundles. This test establishes "*whether the loss of sales is above a critical level when the variable cost savings and the larger price cannot balance the effect of diminishing quantity*."

The study found that only between 5 per cent and 10 per cent of customers would respond to an increase in the bundle 'price' by 10 per cent by breaking up the bundle (or ceasing to buy altogether). In terms of the stability of bundles, the research found the combination of internet and television to be most stable, followed by the triple-play bundle including internet, television, and telephony. The telephony-TV package was the least stable. This shows that bundles may well be considered to be in separate markets in Hungary.

Source: Papai et al (2011)

There are few general conclusions that hold regardless of the specific circumstances, and depending on the nature of the services and service bundles under consideration, one might find:

- a separate market for the bundled product in addition to markets for the individual components (e.g. a market for broadband access, a market for television services, and a market for dual-play broadband and television services);
- separate markets for the bundle components, but no separate market for the bundle;
- a single market for the bundle and its constituent parts. [37]

[34] This is analogous to the well-known 'cellophane fallacy' encountered in the process of market definition discussed above.

[35] Of course, in this case one would not have to undertake the market definition exercise (see previous footnote).

[36] For a description of the critical loss test see for example Davies and Garcés (2009),

[37] See BEREC (2010b). The case where there is a market for the bundle but no markets for individual components is unlikely if individual elements are bought and sold separately by at least some customers. It has been recognized, however, that in the case of complementary services (which is commonly the case with service bundles) the process of market definition may produce unreasonable results if it starts from an individual component and proceeds by including further services that are offered as parts of a bundle (see, for example, Gual, 2003).

3.3 Wholesale market definition

In order to pursue the goal of minimizing regulatory intervention at the retail level through imposing access obligations at the wholesale level, it is important to identify wholesale services that would enable competitors to provide services to retail customers.

If there is strong competition at the network level, such wholesale services may be offered on commercial terms as network operators can take advantage of strong brand or other specific skills of downstream competitors to expand the retail market. However, in the absence of network competition, such wholesale services will only exist as a result of regulatory intervention. This provides considerable latitude to regulatory authorities in terms of the range of access products they would like regulated firms to provide. Policy objectives therefore play a major role in the identification of wholesale markets.

Identification of wholesale services

Ideally, wholesale access obligations should promote the emergence of competition across the value chain by limiting the ability of incumbent operators to leverage control over infrastructure that cannot be easily replicated (at least not in the short term). Because regulatory obligations should ultimately be limited to these parts of the value chain, it is however also important that such access obligations provide the right incentives for investment in alternative infrastructure wherever economically feasible. Access obligations should provide the right 'build-or-buy' incentives.

In pursuit of these objectives, NRAs may identify a wide range of wholesale services at different layers of the value chain. This will clearly present third parties who have not invested in their own infrastructure with a wide range of opportunities for reaching retail customers, and will thus facilitate retail competition. This is clearly beneficial to end users, and the best option in cases where the roll-out of alternative networks is prohibitively costly.

At first sight NRAs may be tempted to expect that offering a wide choice of wholesale products promotes infrastructure investment by enabling third parties to enter the market at the retail level, attract customers, and then invest in infrastructure in order to replace the purchase of access over time. The underlying idea is that access seekers would climb a 'ladder of investment': having established a presence in the market using initially what might be no more than fully managed connectivity offered on wholesale terms, third parties would invest in their own infrastructure and seek to purchase access services further up the value chain.[38] Offering this opportunity to third parties is intended to reduce the amount of investment required to enter the market in the first place and make it easier to start building a customer base.

The 'ladder of investment' view has particularly shaped the regulation of broadband access and the identification of broadband markets in Europe, where wholesale markets have been identified for both bitstream access and unbundled local loops. However, a layered approach to the identification of wholesale access is also used elsewhere. Box 4 provides some examples.

[38] See Cave and Vogelsang (2003) or Cave (2006).

Box 4: Layered approaches to the regulation of wholesale services

Europe – As recommended by the European Commission in December 2007, the relevant broadband market includes 'Market 5' or 'Wholesale broadband access' that "*comprises non-physical or virtual network access including 'bit-stream' access at a fixed location. This market is situated downstream from the physical access…in that wholesale broadband access can be constructed using this input combined with other elements*". 'Market 4' related to 'Wholesale (physical) network infrastructure access (including shared or fully unbundled access) at a fixed location' is relevant for access to the physical infrastructure that would allow a new entrant to develop and roll-out new services of their own design without the need to install their own physical network.

Japan - In Japan, regulation of fixed broadband access (independent of technology) distinguishes between different 'layers' including physical access, service, platform and content. This framework means that, "*competition, speed, availability, and discrimination are examined within each layer*" however, "*[t]he government generally views competition in a layered model, and tends to work more aggressively to preserve competition at the physical layer*." With the emergence of more IP based services, the need for telecom service providers to enhance their business to include the upper layers such as content and applications was recognized, but together with the shift towards a vertically integrated structure for the regulator, ensuring 'openness' among each layer will be increasingly important.

Malaysia - In Malaysia, the regulatory approach also comprises network layers. The Communications and Multimedia Act (CMA) relates to four categories: 'network facility provider' (owners of facilities, including telecom lines and exchanges, radiocommunications transmission equipment, etc.); 'network service provider' (provides the basic connectivity and bandwidth to support a variety of applications. Network services enable connectivity or transport between different networks); 'application service provider' (provides particular functions, such as voice services, data services, content-based services, electronic commerce and other transmission services. These are the functions or capabilities that are delivered to end-users); and 'content service provider' (a special subset of application service providers. Includes traditional broadcast services and newer services such as online publishing and information services). Under Section 149 (Standard access obligations for facilities and services) of the Communications and Multimedia Act 1998 (Part VI, Chapter 3, Section 149) *"[…] a network facilities provider and a network service provider shall provide access to their network facilities or network services listed in the access list to any other— (a) network facilities provider; (b) network service provider; (c) applications service provider; or (d) content applications service provider, who makes a written request for access to such network facilities provider or network service provider on reasonable terms and conditions*."

Sources: European Commission (2007a); Berkman Center for Internet & Society (2010); Taniwaki (2004); Malaysian Communications and Multimedia Commission.

However, while offering third parties a wide choice of potential wholesale services is an effective tool of promoting retail competition, there is no strong evidence to support the view that such a layered approach facilitates investment in competing infrastructure, as suggested by the 'ladder of investment' concept.

An international study by Bouckaert et al. (2010) looking at the evolution of broadband penetration in twenty OECD countries over the five-year period from 2003 to 2008 and a detailed case study of the evolution of broadband services found that whilst *"[t]he 'ladder of investment' theory argues that it is good to promote intra-platform competition as a stepping stone for new entrants to induce them to invest … there may not be an empirical support for this theory, and that to the contrary intra-platform competition may even give adverse investment incentives. To improve broadband penetration, the promotion of inter-platform competition is likely to be a more effective policy*."

Another study of 15 European broadband markets by Bacache et al. (2011) finds that the ladder of investment appears to work for the step from bitstream access to unbundled loops, but not for the further step towards next generation access infrastructure, where alternative models may need to be pursued. A point in case is the example of Australia, where the government is promoting the roll-out of a national broadband network through a specific company (NBN Co Limited) based on a mix of optical fibre, satellite and fixed wireless technologies with an obligation to provide open access in exchange for public sector support.[39]

The definition of separate wholesale markets for bitstream access and unbundled loops would seem to be difficult to reconcile with the standard principles of market definition if these services are substitutable for each other. If different wholesale services are in the same economic market, however, this has profound implications for the setting of regulated access charges, as these charges determine which of the regulated wholesale services will be most attractive to access seekers. For example, a low access charge for bitstream access will undermine demand for unbundled loops, and vice versa. This is particularly problematic in relation to providing the correct build-or-buy incentives as setting any particular access charge too low would discourage access seekers from investing in their own infrastructure. Put differently, a proliferation of access products increases the chance of getting the build-and-buy incentives wrong because setting any of the access charges too low will not only make this particular access product more attractive than any other access product, but also make buying access more attractive than investing in own infrastructure.

Perhaps it is in recognition of these problems that the layered approach to identifying wholesale markets is not used universally. The US, for example, used to follow an open access approach but in 2002 shifted its focus on inter-platform competition between the two main network infrastructures in the United States, copper and cable networks, even though the fact that there were no open access provisions in the National Broadband Plan attracted some criticism.

[39] Further details on Australia's NBN are at: www.nbn.gov.au/.

Box 5: Inter-platform competition as an alternative intra-modal competition

In the United States, the implementation of the Telecommunication Act of 1996 introduced the concepts of unbundling, interconnection, co-location and wholesale access as elements of open access. While initially implemented for the purposes of competition in the fixed telephony market, as DSL became increasingly important for the provision of internet services the applicability of a similar open-access approach was considered. Moreover, in the late 1990s and early 2000s the emergence of a significant cable network raised questions of the applicability of open access regulation to cable networks. Following a series of appeals from network operators, in 2002, FCC changed its approach to regulation of the internet access market and embraced the theory of 'inter-modal' competition between incumbent telephone companies and incumbent cable companies. The FCC believed that competition between the two networks would be sufficient to discipline the operators within the broadband market. In essence, the FCC was defining broadband as a single market independent of the technology used for its provision. While the Supreme Court questioned the approach, it was eventually approved and inter-modal competition was favoured over the originally proposed open-access regime.

Similarly, in Chile while the regulatory framework is based on free access, "*the unbundling of the telecommunications network is not considered to be part of the current policy agenda*" and the broadband market in Chile is now focused on high levels of inter-platform competition. The importance of platform-based competition has been claimed as one of the key features that have led to the development of the broadband sector in Chile and a reduction in broadband prices. In terms of broadband, Chile is now one of the most advanced broadband countries in Latin America.

Sources: Berkman Center for Internet & Society (2010), Katz and Avila (2010)

Delineating wholesale markets

Ultimately wholesale demand is derived from retail demand, and therefore, substitutability at the retail level needs to be taken into account when considering the appropriate delineation of markets for the purpose of regulatory policy.

A good example for this interaction between wholesale and retail markets is the Austrian NRA's decision to remove regulatory obligations to provide bitstream access for service providers seeking to supply residential customers with fixed broadband services based on its finding that "*there is a residential broadband market at the retail level including DSL, CATV and mobile broadband"* whereas there is a DSL-only business retail market. This meant that "*there is effective, sustainable competition at the residential retail market and there is no more need for a bitstream regulation."* Consequently, the relevant wholesale market was defined *"as a market including only internally and externally provided DSL-lines which are used to provide access to non-residential customers at the retail level.*" (BEREC, 2010a)

In the US, the FCC considers there to be a single broadband market comprising traditional fixed lines and cable, and acknowledging the effects of mobile services, and using the strength of the competitive interaction at the retail level as an argument to roll back regulatory obligations. As Baake (2006) states: "*After a period of rather restrictive regulatory interventions on access and wholesale markets, the national regulator, FCC, now emphasizes the potentially adverse effects of regulation. Focusing on infrastructure based competition, considering fixed line networks and cable networks as close substitutes and taking mobile networks into account, the FCC has almost completely repealed regulation of broadband access and wholesale markets. Additionally, the obligations with respect to access to narrowband network elements have been significantly reduced*."

Such an approach may of course not be suitable in countries where alternative infrastructures do not exist, or their construction would be prohibitively expensive. This may be the case in many developing countries, although here the greater reliance on mobile networks should provide greater scope for infrastructure-based competition, at least in those parts of a country where build-out is driven by the need to provide capacity rather than purely to offer coverage.

Wholesale markets with bundling

Where retail market definition is determined by bundling or the exclusive availability of services on particular networks, a further question is how this is reflected in the definition of wholesale markets. Unfortunately, there is no hard and fast answer, and the specifics of the case matter, as the stylized example in Box 6 demonstrates.

Box 6: Retail and wholesale markets with service-driven network choice

Consider the case of multiple networks that have similar technological capabilities, but one of which (say network A) provides exclusive access to content that is considered as 'must have' (say high-definition 3D video services) by a distinct group of customers, either because of an exclusive supply agreement between the network operator and the service provider, or as a result of a bundling strategy pursued by the network operator. Assume further that it is possible to charge a different price to customers who require such content and to customers who do not. This would suggest that there are two distinct retail markets, namely one for providing connectivity to customers who are strongly interested in the service that is available only through one network, and another market for providing connectivity to all customers that includes all networks.

However, whether this retail market separation is reflected in corresponding wholesale markets depends on the specific needs of the access seeker.

For an access seeker who wishes merely to compete in the provision of connectivity, all networks might be substitutes, as all networks are substitutable from the perspective of end users. This would of course not allow the access seeker to compete for customers who also wish to get access to the premium service; in order to do so, the third party would also need to get wholesale access to the video service (which might be outside any regulatory remit), or be able to obtain a wholesale version of the retail service provided by network A for resale.

For a third party that is seeking access with the aim of offering its own service bundle involving some other type of content (say an immersive interactive gaming service that has similar bandwidth requirements), all networks would be able to provide such a wholesale service, assuming the overlap in end user preferences for the two services is small. This means that the wholesale market may be wider than the retail market as the separation on the basis of exclusive access to a service does not matter for wholesale supply.

If, by contrast, demand for the new service is likely to come largely from those customers who are also interested in high definition 3D video content, then the access seeker is dependent on obtaining wholesale access from network A.

The Telecommunications Regulatory Authority of the UAE, for example, appears to be following the approach of considering wholesale markets for both individual services and service bundles. It matches wholesale markets to retail markets, defining the former as a market including self-supply and supply to third parties on a wholesale basis of the services and service bundles offered to end customers (see Telecommunications Regulatory Authority, 2011, p 13 f.).

3.4 An illustration: Are fixed and mobile broadband in the same market?

Given the growing role of mobile access to the internet, both in developing and developed economies, a key question is whether fixed and mobile broadband are part of the same market. Given the greater level of infrastructure-based competition in the mobile sector where generally multiple mobile network operators compete for customers, the inclusion of mobile and fixed broadband in the same market would suggest that regulatory obligations on fixed broadband providers could be removed (as in the case of Austria, as discussed below).

To some extent, the debate about whether fixed and mobile broadband should be considered as part of the same market echoes the earlier discussion about whether mobile and fixed voice services are substitutes, which began in developed economies at the start of the last decade but is still on-going.[40]

The extent to which fixed and mobile broadband services are substitutable will depend strongly on product characteristics and the intended use by the consumer. This may involve consideration of service speed, service quality and possible restrictions such as data allowances. The European Commission (2009, p 8) for example, has noted that "*in order to correctly assess the substitutability of two different products and with particular regard to fixed-to-mobile substitutability, utmost account should be taken of the different product functionalities used by the end customers, as well as other key factors such as, inter alia, download throughput, upload throughput, latency, network oversubscription, packet loss, service continuity, etc.*"

As noted above, the extent to which fixed and mobile broadband technologies differ in terms of the services to which they give access is key. Even though fixed broadband connections may be capable of providing higher bandwidth and lower latency – at least at present, with 3G networks not even deployed in some countries, and 4G technology only at the start of its deployment – this may not matter if the bandwidth and latency provided by mobile networks is sufficient to support most services that consumers would typically access (taking into account also the mode through which these services are being accessed, e.g. via a smartphone, a mobile data card in combination with a laptop or PC, or through internet-enabled television sets etc.).

What matters also is the willingness of customers to trade off bandwidth limitations against the ability to use broadband services if not 'on the move', then at least in an untethered way. Last but not least, one should consider the extent to which public Wi-Fi services might be capable of plugging any gap that exists in the chain of substitution between high-bandwidth, low-latency fixed broadband services, and mobile services that offer lower bandwidth and potentially higher latency, but the benefits of being usable away from a wired connection. Even though such services at present might be said to occupy a niche, they could well become more important with the award of spectrum that is suitable for the provision of WiMAX services and the corresponding development of equipment that can make use of frequencies that are potentially less attractive for 'normal' mobile services.

In practice, the extent to which mobile broadband technologies are complementary or substitutable for other broadband access technologies will differ across different markets. In broad terms, one might distinguish the following categories:

- **Next generation broadband leaders:** A group of the most advanced broadband economies with fixed broadband predominantly supplied by FTTx, for example Japan and the Republic of Korea. Mobile broadband is also almost ubiquitous in these countries as well.[41]
- **Developed DSL or cable broadband economies:** Countries with widespread coverage of fixed broadband networks and competitively supplied broadband services, largely as a result of wholesale access to copper networks (such as Germany or the UK, where broadband is generally supplied by copper DSL, even though there is some access to cable networks), or because of intense competition between copper and cable (such as in the US, where high penetration levels and widespread broadband coverage are supported by a fairly competitive 'duopoly' of copper and cable). Fibre broadband rollout in these economies at present is limited to small-scale deployments, often in co-operation with local authorities or public utilities, though it may gather momentum not least because of ambitious public policy targets. Mobile penetration is high.

[40] For a discussion of the early literature and some early empirical evidence see Maldoom and Horvath (2002). For a more recent review see Briglauer et al. (2011).

[41] See ITU (2012b). Note that Korea and Japan have 91.0 and 87.8 active mobile broadband subscriptions per 100 inhabitants respectively.

- **Mobile broadband economies:** Nations with low fixed broadband penetration (often because of poor coverage and poor quality of fixed networks), where mobile networks provide most of the communications infrastructure both for traditional voice services and internet access. For example, in Africa mobile broadband penetration, while still low at 3.3 mobile broadband subscriptions per 100 inhabitants in 2011 is higher by an order of magnitude than fixed broadband penetration (0.2 fixed broadband subscriptions per 100 inhabitants, see ITU, 2011, Figure 1.2).

Box 7: Examples of different broadband economies

Japan: A next generation broadband leader - As a leader in fibre deployment, Japan is an example of where large, long-term public capital investments through expenditures, tax breaks and long term loans have helped deployment with strategic planning of broadband going back to 2001. With fixed broadband penetration at 26.4 subscriptions per 100 population in Japan (2011), 58.1 per cent of which was supplied by next generation FTTx services in 2010, Japan is ranked at number 1 worldwide for its broadband speeds by several measures and has already exceeded the level of advancement in a broadband enabled technology which are mere targets for Europe and the USA. Japan has emphasized ubiquitous, seamless connectivity, with its 2005 u-Japan policy, and alongside commitments such as achieving ultra high speeds in 90 per cent of Japan by 2010, there is a focus on seamless connectivity between devices, people and networked objects. The anyone-anywhere-anytime concept while focusing on seamless experience is an ambitious target, which seems to represent a future proof policy definition rather than that of focus on current technological reach.

The Republic of Korea: a next generation broadband leader - Korea has lead the way in "ICT master plans" implementing five year plans first adopted in 1995 to facilitate the transition into an advanced information society. Plans have been wide ranging including the promotion of both demand promotion policies and supply side infrastructure development, unlike most other developed countries where demand has been left to develop on its own. In 2011 the Republic of Korea has the highest household penetration rate in the world (36.9 fixed broadband subscriptions per 100 population) and with 105 active mobile broadband subscriptions per 100 inhabitants is the top mobile broadband economy according to ITU figures.

United Kingdom: A developed DSL broadband economy - Unlike the broadband leaders, with the view that public investment risks crowding out market investment and under guidelines from the EC, the UK and other European economies have invested almost nothing publically in developing broadband infrastructure, instead relying on private investments fostered by a competitive environment. Guidelines do allow for two types of state investments, the first to achieve universal access in first generation broadband technologies in the form of stimulus funding, and second to speed the deployment of next generation broadband technologies in order to harvest the anticipated social and economic benefits of roll out. The idea is that investments should provide passive neutral infrastructure, however without commitments in regulation of next generation broadband services, development of ultra fast broadband networks is slow. As of 2012, the UK for example had a penetration level of 33.9 fixed broadband subscriptions per 100 inhabitants, with less than a 1 per cent penetration rate for fibre broadband services. Mobile broadband penetration stood at 62.3 active connections per 100 inhabitants and spectrum for next generation mobile broadband is still unallocated at the time of writing.

USA: A developed cable broadband economy - While penetration levels are high with widespread broadband coverage (in 2011 28.8 and 65.5 connections per 100 population for fixed line and active mobile broadband connections respectively), in contrast to Europe and others broadband access is predominantly from cable services rather than copper DSL. While the US telecommunications act of 1996 introduced unbundling, and wholesale access as elements of open access, the main focus has lifted from regulated competition within each wire of copper and cable lines, to competition between the two services. Inter-modal competition (competition between firms using different technology to provide the service) therefore forms the backbone of US broadband regulation.

Ghana: A developing mobile broadband economy - Although among one of the first African countries to introduce ADSL broadband, fixed line broadband penetration in Ghana is low, with fixed broadband subscriptions only at a rate of 1 in every 400 of the population, attributable to the poor condition of the fixed line network infrastructure. In contrast however active mobile broadband connections in Ghana were at 23 per 100 inhabitants in 2011 and growing rapidly. Data indicates that over the period 2010 to 2011 the number of active mobile broadband connections per 100 more than tripled. With more than 140 licensed ISPs, the broadband market in Ghana is fairly competitive, even though the market is highly concentrated.

Sources: ITU World Telecommunication/ICT Indicators database, **www.itu.int/icteye**; www.lightreading.com/document.asp?doc_id=217571; www.budde.com.au/Research/Ghana-Internet-and-Broadband-Market-Overview-and-Statistics.html; Berkman Center for Internet and Society (2010).

Developed DSL or cable broadband economies and broadband leaders

At present, mobile broadband is considered to be a complement rather than a substitute for fixed services in those countries with widespread fixed broadband coverage (ITU, 2012a). This appears to reflect the view that mobile allows simple web usage on the go, but that it offers only limited speed and data volumes when compared to fixed.[42] In Ireland – a country with a substantial proportion of the population living in sparsely populated rural areas[43] – a recent market review did not consider mobile broadband to be a suitable substitute for fixed broadband services. According to BEREC (2010a) few customers were found to have cancelled fixed broadband connections[44] in favour of mobile connections and *"…in relation to consumer download profiles on fixed and mobile broadband networks, where download volumes are of orders of magnitude higher for fixed networks. Such variance in the level of utilisation is suggestive of different underlying consumer preferences in using fixed broadband networks for more bandwidth intensive applications, in particular, due to their differing technical capabilities."*

By contrast, the decision of the Austrian NRA to deregulate bitstream access for residential customers was based on the fact that in Austria mobile data cards account for a substantial proportion of total broadband subscriptions,[45] and that the mobile data packages that are on offer are not dissimilar to what is available from fixed providers in terms of both price and bandwidth. RTR – the Austrian regulator - undertook a comparison of product characteristics between fixed (DSL/CATV) and mobile broadband. The standard product for fixed broadband was capable of achieving download speeds of up to 8 Mbit/s whereas mobile broadband could achieve download speeds of up to 7.2 Mbit/s, which is largely comparable.[46]

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[42] In the EC's opinion, *"[t]he speed and quality of mobile broadband access is normally less predictable and reliable and largely dependent on variable elements such as the distance to the nearest network base station or atmospheric conditions. Customers can consequently be more often exposed to disconnections due to weak signals from a base station, jamming, network overloading, etc."* (see European Commission 2009, p. 8).

[43] 62% of the Irish population live in urban areas that take up just 2.4 per cent of the country's land mass (Ireland Central Statistics Office, April 2012, "Census 2011, Press Release Profile 1 Town and Country).

[44] Note that focusing on actual cancellations of fixed broadband connections seems to be overly restrictive. The key question for market definition is to what extent customers would switch to alternative services or providers if prices were increased. In particular where the number of connections is growing fast, the key consideration would not necessarily be the rate at which customers cancel existing connections, but how the share of new connections would respond to differences in prices.

[45] Residential mobile broadband users accounted for 27% of all residential broadband connections (and their share was increasing), with only a quarter of these users also having a fixed broadband connection (see BEREC 2010a, p 11).

[46] Comparing product characteristics between fixed (DSL/CATV) and mobile broadband, the Austrian regulator found that the standard product for fixed broadband was capable of achieving download speeds of up to 8 Mbit/s whereas mobile broadband could achieve download speeds of up to 7.2 Mbit/s (see BEREC 2010a, p 11).

At present there are few services that would require substantially higher download speeds than mobile broadband can offer (in particular when compared with the effective speeds that are typically available over DSL connections, which are far lower than the advertised 'up to' speeds). Therefore, it may be the fact that mobile broadband typically comes with stricter data limits and usage restrictions than fixed broadband connections that limits substitutability. However, as carriers are exploring the option to off-load traffic automatically onto Wi-Fi networks, such tight data limitations may become less and less relevant.[47] Furthermore, in the absence of major differences in quality of services, changing usage patterns may also influence the substitutability of technologies. As consumer may continue to shift away from tethered wireline services and prefer portable devices such as tablets or smartphones, mobile broadband is likely to play a larger role, and the finding that fixed and mobile broadband are in the same market may become more common.

With the deployment of newer mobile broadband technologies such as HSPA+, LTE, WiMAX, mobile broadband may more generally become a suitable alternative for a fixed broadband connection rather than just a complement. These new mobile broadband technologies are expected to be capable of reaching speeds of 150 Mbit/s download for LTE,[48] which would provide a strong match for average fixed broadband speeds at around 15 Mbit/s, 42 Mit/ps and 102 Mbit/s for DSL, cable and fibre respectively as reported by the OCED (2011c). However, there may remain a substantial difference between fixed and mobile networks in terms of the symmetry between upload and download speeds and in relation to capacity: in particular FTTH networks are capable of providing more symmetrical upload and download, and provide dedicated rather than shared capacity. This will only matter as and when services that are making full use of these features are becoming available, however.

To the extent that such services exist in economies that can be classified as next generation broadband leaders, it might be appropriate to consider fixed and mobile broadband to be in separate markets (though it may be more meaningful to distinguish between 'basic' broadband services that can be provided by non-fibre fixed networks and mobile networks, and 'premium' broadband services that are available over FTTH networks). However, the trend in these countries goes towards an integration of fixed and mobile services. As part of the path toward becoming world leaders in both fixed and mobile broadband, both Japan and the Republic of Korea have been striving for ubiquitous broadband coverage. This goal of offering seamless connectivity has resulted in a trend towards mobile and fixed broadband providers bundling their offerings. These integrated offerings are no longer considered substitutable, but together make up components of new 'fixed- mobile convergence' services introducing new considerations for competition and market definition. In Japan, traditionally wireline and wireless services fell under a separate regulatory regime, but the Ministry of Internal Affairs and Communications (MIC) is shifting toward a unified regime to adapt to the change toward an increasingly integrated fixed and mobile market. On this basis, while permitting dominant players to integrate across the fixed-mobile connection, both Japan and the Republic of Korea have begun to expand open access to mobile data networks. While integration of fixed and mobile service providers may reduce facilities-based competition, the requirement of open access to these converged networks is seen to increase competition by allowing new entrants to provide a seamless service to the end user (see Berkman Centre for Internet and Society 2010).

Mobile broadband economies

Considering economies where fixed broadband penetration is typically low because of the poor quality and poor coverage of fixed networks, fixed broadband is unlikely to play a major role and whether or not it is included in the same market as mobile broadband might be largely irrelevant. However, there are good reasons for grouping together fixed and mobile broadband services, at least for non-business users.

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[47] See www.marketwire.com/press-release/new-igr-study-forecasts-3g-4g-mobile-data-traffic-offloaded-wifi-networks-grow-16-times-1681113.htm

[48] See www.telegeography.com/products/commsupdate/articles/2012/04/19/o2-uk-registers-150mbps-downlink-speeds-as-lte-trials-continue/

With mobile broadband being the predominant technology, most of the services available to end users will be tailored to the capabilities of mobile technologies (e.g. in terms of required bandwidth, the design of user interfaces suitable for small screens etc.). Given this, even if fixed networks offered superior technological capabilities, a hypothetical monopolist of fixed broadband network infrastructure might find it difficult to increase prices above the competitive level in light of the fact that mobile broadband connectivity is widely available and that most services are designed to make best use of mobile access technology. On the other hand, a hypothetical monopolist with ownership of the complete mobile network infrastructure (e.g. spectrum usage rights and base stations etc.) might find it profitable to increase prices above the competitive level at both the retail and the wholesale levels. The fixed network would not impose any effective constraint, as fixed broadband connections would not be widely available, at least not in all countries in the short term.

4 Significant Market Power (SMP) designation

Having defined the relevant market, the next step in establishing regulatory obligations is to consider whether any particular operator or service provider holds a position of SMP in the relevant market.

4.1 Some general points about SMP designation

In principle, SMP should reflect the ability of a firm to behave in ways that are detrimental to the interests of end users (e.g. by setting excessive prices, delivering services of poor quality, failing to innovate), or that foreclose the market to more effective competition. This means that the concept of SMP should be closely aligned with the notion of dominance as it would be used in the context of competition proceedings.

This is not universally the case. For example, a number of countries in Africa, the Arab-States, Asia-Pacific and Latin America rely exclusively on market share figures to determine SMP, albeit with widely varying thresholds. For example, according to the ITU World Telecommunication/ICT Regulatory Survey, in Mali any operator holding 25 per cent or more of the market is considered to have SMP, whereas in Bolivia a market share above 40 per cent is required, and in Algeria the threshold stands at a 50 per cent share of the market.

Similarly, under the old European ONP (Open Network Provision) framework that governed the process of liberalisation, a rebuttable presumption of SMP was linked to a market share in excess of 25 per cent[49], which is substantially below any market share threshold that would give rise to concerns about dominance. In the years immediately following liberalisation, this did not matter much – whether the cut-off point was set at 25 per cent, 40 per cent or higher was largely irrelevant when faced with former state-owned monopolies which in many cases controlled the entire market. However, as competition develops, a greater alignment of the SMP concept with the competition law notion of dominance is to be welcomed, in particular where this involves a wider assessment of competitive constraints. Of course a main difference between SMP and dominance will remain: SMP needs to be established *ex-ante*, looking prospectively at whether a firm can be expected to be in a position where it might behave anti-competitively, whereas dominance is normally assessed only after a complaint has been made about alleged abusive behaviour of a firm, i.e. *ex-post*. However, the same analytical steps that underpin the assessment of dominance can be applied in the process of identifying SMP.

Dominance (though being defined in different ways around the world) is in general terms regarded as *"…a position of economic strength enjoyed by an undertaking which enables it to prevent effective competition being maintained on the relevant market by affording it the power to behave to an appreciable extent*

[49] This obviously meant that companies that would not be considered dominant in the context of a competition assessment could have been designated as having SMP for regulatory purposes, but because markets were defined in the ONP Directives rather than case-by-case on the basis set out above, the reverse was also possible. For a discussion, see Freund (2011).

independently of its competitors, its customers and ultimately of the consumers."[50] In economic terms, this means that an SMP operator is able to exploit customers without the fear of losing business to competitors, or to restrict competition without a credible threat of entry (ITU, 2011).

Although neither dominance nor SMP are strongly linked to market share,[51] market share information can be a useful indicator. Operators serving a small proportion of the market are generally not able to exploit customers or restrict competition, and thus a small market share can be used to eliminate the prospect that a firm might be dominant (always provided, of course, that the market has been defined properly). A firm with a large market share may or may not enjoy market power, and further investigation is generally required.

In addition to market share of an individual firm alone, measures such as simple concentration ratios or the Hirschman-Herfindahl Index (HHI) have been, and continue to be used to establish the position of operators within a market.[52]

While market share data or other structural data (such as concentration ratios or indices) are relatively easy to obtain and can be extremely informative, they do not always capture the specific nature of competition in a particular market, or the ability of a player to exercise market power. Where barriers to entry are low, market share obviously does not equal market power.

Other considerations may be relevant, too. For example, there may be countervailing buyer power amongst customers that keeps a check on even the largest suppliers. There may be excess capacity in the market that allows rivals to expand their output quickly and at little additional cost (low barriers to expansion), meaning that competition in a heavily concentrated market can be fierce.

Competition from one-way substitutes where the limited substitutability has not been considered in the context of market definition needs to be taken into account as well. For example, if the pricing of high-bandwidth low-latency services is not constrained by the presence of more basic services, but constrains the pricing of the latter, then this should be taken into account when looking at market power in the separate market for basic broadband services.

In the light of such considerations, some countries have sought to move away from pre-determined thresholds of market shares and instead have focused on case-by-case assessments in an attempt to identify instances of SMP. According to the ITU World Telecommunication Regulatory Survey, many countries including the Republic of Korea, the UK or the US rely on a combination of several different measures when determining dominance or SMP, including, but not limited to, factors such as the control of essential facilities, the strength of the countervailing power of consumers, barriers to entry and potential competition. Box 8 below provides an overview of the criteria used in determining SMP in different regions around the world and also indicates how frequently SMP status is reviewed.

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[50] See Hoffmann-La Roche & Co. AG v Commission of the European Communities. Case 85/76, February 1979.

[51] A close link between market, the behavior of firms and market outcomes that is at the heart of the so-called Structure-Conduct-Performance paradigm that was popular around the middle of the last century (see Scherer and Ross, 1990). However the automatism that links a large market share to market power has subsequently been questioned. The theory of contestable markets shows that under certain, albeit strict conditions, even monopolistic markets produce the same outcome that one would expect to see with perfect competition (see Baumol et al. 1982).

[52] Concentration ratios are typically the sum of the market shares of the largest X firms. For example CR_4=share of total market held by the largest four firms. The HHI is a measure of concentration of an industry measured by the sum of the squares of market share of all firms in the market. Typically, a HHI above 2000 suggests a highly concentrated market. Unlike a simple concentration ratio, the HHI takes the sum of the squares of the market shares of each of the players in the market. By taking the sum of the squares, this measure takes into account the level of asymmetry of market shares. In this case, the HHI highlights the potential differences in the way a market with four symmetric players will compete with each other compared with a market in which one player holds 70% of the market share with the other three players sharing the remaining share.

Box 8: Criteria used in determining 'dominance' or SMP, 2011

Africa – While few countries such as Congo and Mali use only market shares to determine dominance, a significant number of African countries consider market share and the control of essential facilities in determining dominance, for example Niger, Burundi, Equatorial Guinea and Zimbabwe. Ghana considers barriers to entry and potential competition in addition to the market share and control of an essential facility (and the market share at which dominance is considered ranges from between 25 per cent and 65 per cent). The majority of NRAs from Africa responded that they undertake a review of dominant status on an annual basis while others undertake periodic reviews every two to three years.

Arab-States – Algeria considers only market share and acknowledges a market player as dominant if it holds a share above 50 per cent. However, in addition to market share, countries such as Bahrain and the United Arab Emirates consider a wider set of criteria for assessing dominance including: geography, control of essential facilities, easy access to financial resources, economies of scale and scope, barriers to entry, potential competition, technological advantages or superiority. Periodic review of dominant status ranges from every year in Kuwait and Sudan, to as long as every five years in Saudi Arabia.

Asia-Pacific – India, Indonesia, Pakistan and Viet Nam acknowledge market shares only, each setting the threshold for dominance between 25 and 30 per cent. In addition to market shares, Japan considers only the control of an essential facility and Fiji considers only potential competition. In contrast, Singapore and Samoa consider a wider range of determinants while the Republic of Korea includes non-price competition such as the level of innovation, investment and consumer satisfaction.

CIS – CIS countries generally consider more than just market share, but not as comprehensively as regions such as Europe. In Azerbaijan the only stated criterion was the operator's or service provider's capability to influence market conditions.

Europe – In Europe, countries are governed by the Telecommunications Framework laid out by the European Union, and while each country's NRA may have some discretion in the factors they will consider when assessing SMP, survey results show that all countries consider a wide range of factors in addition to market share. Taking account of factors such as potential for competition, barriers to entry, control of an essential facility allow NRAs to establish the ability of an operator to exert its market power. Reviews typically take place every two to three years.

Americas – While the US did not provide an answer to this question, Canada acknowledged its consideration of geography, market share, control of essential facilities, economies of scale and scope, and barriers to entry when assessing market power and dominance. In Latin America, several countries such as Bolivia, Costa Rica, Dominica and Paraguay consider only market share with defined thresholds standing at between 25 and 40 per cent. While Trinidad and Tobago put the onus on the dominant player to apply for its dominant status to be reviewed if they felt that updated analysis would result in their dominant status being revoked. The majority of NRAs undertake regular reviews every two years.

Source: ITU World Telecommunication/ICT Regulatory database 2011, www.itu.int/icteye.

Finally, it is also possible to assess dominance in relation to a combination of players in the market. The concept of collective (or joint) dominance is part of the competition rules in some jurisdictions and allows for two or more firms to be found jointly dominant if no effective competition exists between the players, and each player enjoys the same position in respect of their customers and competitors.[53] Collective dominance is however of limited relevance for the finding of SMP in a regulatory context and is considered mainly under competition law.

4.2 Convergence, demand growth and SMP

With different types of networks being able to provide the same range of services, convergence should be expected to facilitate competition amongst a greater range of technologies. To a large extent, this is reflected in changing market definitions with markets potentially becoming wider. The discussion about the potential combination of mobile and fixed broadband into a single broadband market is a case in point.

This in itself would tend to reduce the scope for any particular firm to enjoy SMP. Even though barriers to entry for new mobile operators are high if not insurmountable unless suitable spectrum becomes available (either as a result of existing licences expiring, or new spectrum being made available), network competition in the mobile sector is generally much more intense, and covers all network layers including the final access layer. Widening the market to include both fixed and mobile broadband services would suggest that no single provider enjoys market power in the retail market. This will both remove the need for promoting retail competition by imposing access obligations, and increase the likelihood that wholesale services will be supplied on commercial terms even without such obligations in place. This is indeed what drove the de-regulation of bitstream access in the supply of residential customers in Austria (see Box 9).

[53] See ITU (2002). The European Court, for example, has stated that, *"[t]here is nothing, in principle, to prevent two or more independent economic entities from being, on a specific market, united by such economic links that, by virtue of that fact, together they hold a dominant position vis à vis the other operators on the same market*" (see Judgment of the Court of First Instance (First Chamber) Società Italiano Vetro SpA v Commission, March 1992). Under Japan's Competition Promotion Program 2010, the concept of join or collective dominance is recognised in relation to the collective business operations of the East and West operations of the incumbent (Nippon Telegraph and Telephone - NTT) and its subsidiaries and affiliates (see Ministry of Internal Affairs and Communications, 2006).

Box 9: The de-regulation of bitstream access for residential customers in Austria

In 2009, there were around 22 fixed broadband connections per 100 inhabitants in Austria, with mobile broadband penetration standing at around 15.4 per 100 inhabitants. One year later, mobile broadband connections had almost doubled (29.3 per 100 inhabitants), whilst fixed broadband penetration had grown by only around 12 per cent.[54]

Having concluded, through consideration of price and product characteristics, consumer surveys and historic price reactions and price quantity developments, that there is a residential broadband market at the retail level that includes DSL, cable and mobile broadband and that competition in this market was effective and sustainable, the Austrian telecommunication regulator, RTR, considered that there was no longer a need for bitstream regulation.

As part of the market investigation, RTR identified two separate retail markets for broadband access, one for residential customers and the other for business customers. This was due to "*profound variations in prices and differences in product characteristics and service levels*" available to residential and business customers, in particular, business customers were more concerned about wide area coverage, maintenance and quick response times. Thus, RTR concluded that the business market was separate from the residential broadband market and included only DSL connection whereas the residential market also included cable and mobile broadband connections. Due to the level of competition at the retail level, RTR considered that it was not necessary to continue to consider that wholesale broadband access used to provide services to residential customers should be subject to *ex-ante* regulation.

Thus the wholesale market was redefined as the "*wholesale broadband access market for the provision of access to non-residential customers*" and includes only internally and externally provided DSL-lines used to provide access to non-residential (business) customers at the retail level.

Initially, the EC had raised 'serious doubts' about the inclusion of mobile broadband into the retail broadband market for residential consumers and the subsequent redefinition of the wholesale markets. However, after further investigation and some minor amendments to the draft measure, the EC withdrew its doubts. The EC acknowledged the reasoning given by RTR for its inclusion of mobile broadband into the residential retail market given its findings of substitutability with fixed line connections. However, the EC also noted the importance of continuing to monitor the situation given evolution of services provided over broadband connection, the development of NGNs and potential constraints on mobile connections as the number of subscriptions and data usage increase.

Sources: BEREC (2010a), European Commission (2010)

Beyond the adjustment of market boundaries, however, there may be changes in the nature of competition that need to be considered in assessing market power.

In many markets substantial investments have been, or will need to be undertaken to serve the growing demand for bandwidth. Such investments tend to be lumpy and create substantial excess capacity that will only be slowly filled up. This is particularly relevant where new fibre infrastructure is being rolled out.[55]

[54] Data from the ITU World Telecommunication/ICT indicators database (www.itu.int/icteye); similar gains in absolute terms were experienced in the following year, with mobile broadband penetration reaching 43.3 connections per 100 inhabitants, compared with 26.5 for fixed broadband.

[55] Where there is need for investment in entirely new technologies, this may create scope for new entry (although new entrants may need to be put on an equal footing with incumbent operators in terms of access to physical infrastructure, e.g. existing poles and ducts).

The presence of such excess capacity may discourage further investment in competing infrastructure. This is because such investments are largely sunk and a new investor can expect to meet strong competition from those who have already built out their networks. For the same reason, however, where competing infrastructures are in place, competition can be expected to be intense even if the market is highly concentrated. Those who have invested in infrastructure have strong incentives to attract customers and fill existing capacity as additional business can be accommodated at little or no additional cost.

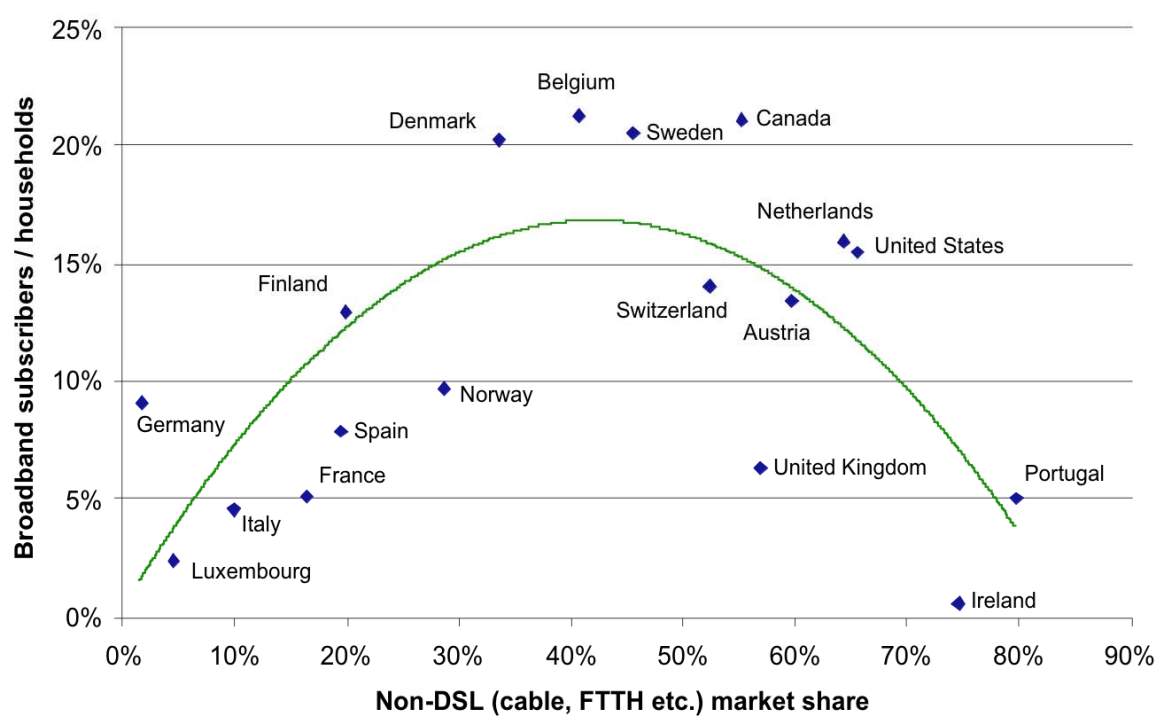
This means that NRAs may have to give particular attention to the timing of investments and the plans for bringing new capacity on stream, and be potentially wary about capacity expansion that discourages investment by competing infrastructure providers. At the same time, NRAs need to acknowledge that in cases where facilities-based competition exists, concerns about market power should be greatly reduced. The risk of collusion should be kept in check by growing demand and the presence of some switching costs which create strong incentives to compete for signing up new customers and build a larger customer base.

The fact that competition incentives are much sharper in relation to competing platforms than they are for intra-platform competition supported by access regulation is possibly one of the main reasons for the positive relationship between inter-platform competition and broadband penetration.

Box 10: Inter-platform competition and broadband penetration

Inter-platform competition has been shown to bring many benefits in the form of increased real choice for customers, incentives for service innovation and downward pressure on costs and prices. There is also evidence to suggest that competition between alternative platforms is a main driver of growing broadband penetration.

For example, an early analysis across OECD countries showed that broadband penetration tends to be higher where DSL and non-DSL platforms have similar market shares, and that penetration is lower where one particular platform is dominant (see below the reproduction of Figure 13 from DotEcon and Criterion Economics, 2003). In contrast no such relationship exists between the take-up of access services by entrants and greater broadband penetration.



A recent study by Bouckaert et al (2010) provides further evidence for inter-platform competition being the main driver for broadband take-up. The study considers the effect of different forms of regulated competition on the evolution of broadband penetration in a number of OECD countries. Three regimes are considered: inter-platform competition (competition between multiple networks); facilities based intra-platform competition (on the basis of mandatory access to unbundled local loops); and service-based intra-platform competition (built on regulated bitstream access).

Taking total broadband penetration as the dependent variable, a linear regression model is estimated using a panel data set for 20 OECD countries covering December 2003 to March 2008 which shows broadband connections per quarter broken down by type of platform, incumbent wholesale connections (both incumbent retail and bitstream/resale) and unbundled connections. Explanatory variables grouped into three categories (competition variables, broadband service variables and market demographics) provide a robust set of results.

The analysis found that inter-platform competition is the main contributor to a higher broadband penetration: a more equal share of the market for a cable and DSL operator leads to higher broadband penetration. While facilities-based intra-platform competition was found to have an insignificant impact, service-based intra-platform competition was shown to have a negative impact on broadband penetration.

These results cannot be generalised to developing economies – most certainly not with regard to the replication of fixed network infrastructure. However, without ignoring the substantial benefits that flow from increased levels of competition supported by facilitating access to existing infrastructure, they show that competition over a greater portion of the value chain can have beneficial effects that are not easily replicated through regulatory intervention. Of course, replication of networks may often not be an option – and in these cases, the open access model is the only option for improving the availability of communications services for a greater proportion of the population

Sources: DotEcon and Criterion Economics (2003); Bouckaert et al. (2010)

4.3 Vertical arrangements and bundling

The increasing importance of OTT services can augment or reduce SMP of some broadband suppliers and means that attention will need to shift to some extent to include also those who are able to supply such content.

The importance of service availability for network choice implies that vertical relations between network operators and service providers will have an important bearing on the assessment of market power. In particular, arrangements under which content with 'must-have' status is being provided exclusively over a particular network would need to be assessed very carefully.

In any case, if market power of a broadband provider is linked to exclusive access to an OTT service, the source of such market power is not control over network infrastructure, but rather control over the service. Any advantage that a network operator may gain from being able to provide exclusive access to a particular type of content may have been competed away in the process of signing an exclusive agreement with the content provider. For example, a broadband provider that is in a position to offer exclusive video-on-demand access to premium movies might face reduced competition from other broadband providers and may be able to sustain higher prices, but much of the profit that results will ultimately flow to the content provider.[56]

[56] As Armstrong and Wright (2005, p 22) explain, *"[w]hen agents on one side of the market multihome, platforms might offer exclusive contracts to them to prevent them multihoming, thereby profiting from the increased demand from agents on the other side. Such exclusive contracts can be "cheap" to offer, since by tying up one side of the market (say sellers), the*

Any regulatory access obligation aimed at addressing this problem would have to be linked to access to the content, possibly in addition to access to the network infrastructure. For example, an obligation to provide bitstream access imposed on a broadband operator who enjoys market power because it provides exclusive access to on-demand premium video services would do little to rectify the problem, as an effective competitor would require access to such (or similar) content.

In the presence of bundling strategies the assessment of SMP needs to consider whether and how other providers can replicate specific bundles with sufficient ease. Where bundles are difficult to replicate, competition concerns may arise. Replicability will need to be assessed on a case-by-case basis, and conclusions cannot easily be generalized. Replicability depends, for example, on "*the network architecture of the SMP operators, on the wholesale obligations imposed and its implementation, on the network infrastructure owned by alternative operators and, especially in the case of TV services, also on access to contents.*"[57]

In developed economies, television services have been identified as the component of the bundle that may be expected to raise the strongest concerns with regard to replicability, and one where the ability of NRAs to intervene is currently very limited.[58] In other words, particular concerns may arise where service bundles constitute separate markets, and the bundle includes television content, access to which is not generally under the remit of ICT NRAs.

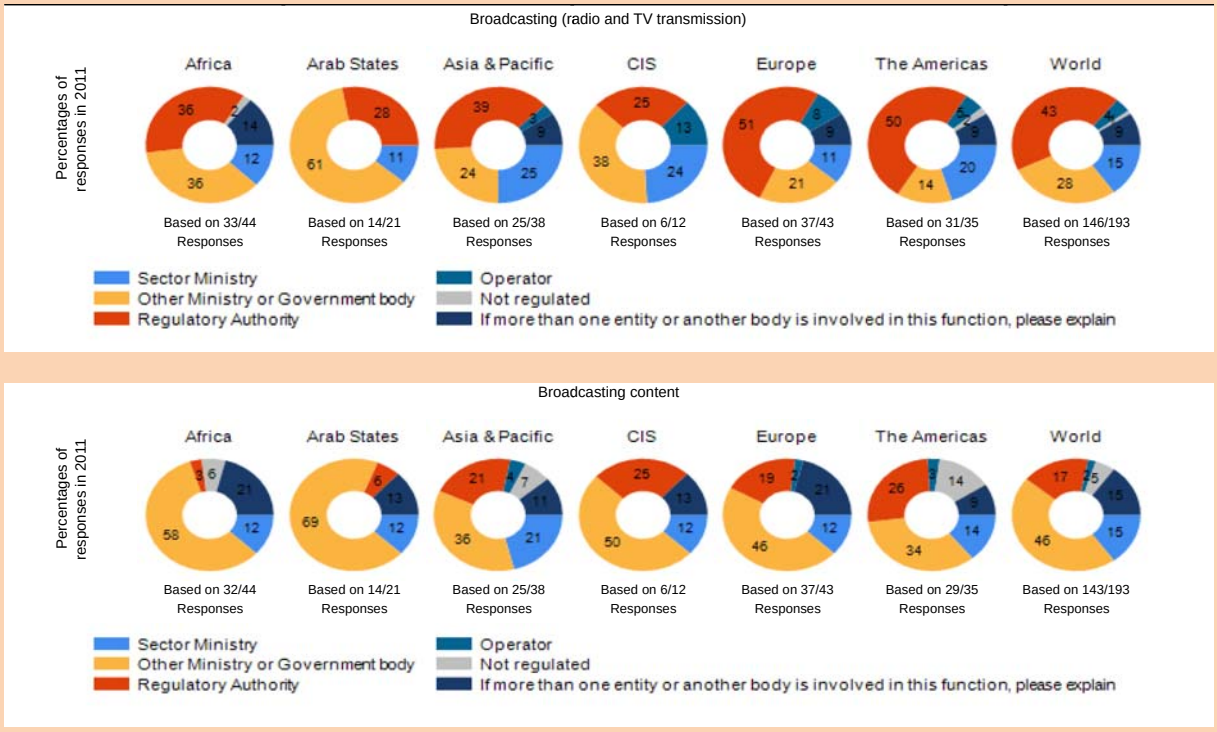
For example, Figure 5 shows that while the ICT regulator in a number of countries also regulates broadcasting transmission, in fewer cases it is also responsible for the regulation of broadcasting content. This may create problems where access to broadcasting content may be needed in addition to network access for third parties to be able to compete at the retail level.

platform attracts the other side (buyers), which reinforces the decision of sellers to sign up exclusively." A full assessment of the complexities that arise in the context of two-sided markets, or better: multi-sided platforms, is beyond the scope of this report, but see, for example, Evans and Schmalensee (2007).

[57] See ERG (2009a), p 6.

[58] The ERG study goes on to note that "*TV services and access to content for these services have been considered by NRAs [in European Member States] as the ones with the highest probability of raising doubts regarding the replicability of bundles. In connection with this, the majority of the few interventions reported by NRAs are centred on TV services and some NRAs exposed the possibilities of imposing multicast on the Relevant Market 5 "Wholesale broadband access". Although access to content is considered as an issue likely to raise doubts on replicability, most of the NRAs state that they cannot act as they have no competences on content*" (see ERG 2009a, p 30).

Figure 5: Authority responsible for regulation of broadcasting transmission and content, 2011



Source: ITU World Telecommunication/ICT Regulatory Database, www.itu.int/icteye..

Similar concerns may of course arise in relation to other services. In developing markets, mobile payment applications and other business-enabling services may have the status of 'must have' content, and may therefore be an issue that NRAs should keep under review.

Also, as noted above, the complexity of bundled offers can make it difficult for customers to compare service prices and characteristics. This can create barriers to switching that allow operators to exercise market power even in the case where, on the face of it, bundles should be replicable.

From a regulatory perspective, the greatest challenge in dealing with bundling and exclusive vertical arrangements is that these practices can both create substantial efficiency benefits and harm competition. Bundling, for example, may allow the supplier to share some of the cost savings from economies of scale with its customers. It may reduce transaction costs and respond to customer preferences for a single bill. It may avoid double marginalization, and allow firms to engage in output-increasing price discrimination, broadening access to services (see Box 11). At the same time, it can limit the competitive pressure exercised by other firms and soften, distort or restrict competition.

Box 11: Bundling as price discrimination – a stylized example

Consider an example with three groups of customers (A, B and C) of equal size who differ with regard to their willingness to pay for broadband and television services. The following table shows the maximum willingness to pay of each customer type for broadband and television. The willingness to pay for the package is simply the sum of the individual valuations.

	A	B	C
Broadband	4	5	2
Television	4	8	12
Package	8	13	14

Assuming marginal costs of zero, the profit-maximising price for broadband services would be 4, and only groups A and B would be served. The profit-maximising price for television services would be 8, at which only customers of type B and C would obtain access. The profit-maximising bundle price would also be 8, and all customer groups would gain access to both broadband and television services. Both profits and consumer surplus increase as a result.

The reason for this is that bundling is an effective form of price discrimination. Customers of type A obtain television services for an additional price of 4, which matches their willingness to pay. Customers of type B and C will effectively get broadband 'for free' compared with the stand-alone price they would pay for television in any case. The bundle price effectively allows the operator to cut prices for television services to customers of type A without having to reduce the price charged to other customers, and to cut the price of broadband to customers of type C. As a result, a larger number of customers obtain access to services, and consumer surplus increases.

Source: Author

Whether the net effect of a particular bundling strategy, for example, is positive or negative can only be established in the specific context. There are no hard and fast rules that would allow one to separate 'good' from 'bad' practices. This makes it difficult to come up with clear rules that could be imposed in the form of regulatory obligation in the same way that, for example, an access obligation can be imposed on an SMP operator.

The question what remedies have traditionally been imposed on SMP operators, and how this might change in a converged broadband world, is the subject of the next section.

5 Regulation in a converged broadband world

As the above discussion has shown, convergence implies shifting market boundaries and potentially more complex considerations in the assessment market power. These complexities together with the need to provide appropriate incentives for investment in upgrading existing network infrastructure or constructing new networks pose substantial challenges for regulators.

As market power may be exercised in relation to services that have traditionally not been the subject of ICT regulation, and as the behaviour that might potentially be of concern is more difficult to pinpoint with accuracy, it will become increasingly difficult to define *ex-ante* where problems might arise. Rather than extending the scope of regulation to cover all forms of behaviour that could conceivably frustrate competition or harm consumers, there may be scope for a greater reliance on *ex-post* application of competition law.

This section discusses the new roles to be played by NRAs and NCAs with regard to regulation of SMP operators with the aim of providing some guidance for practitioners.

5.1 Traditional regulation of SMP operators

The mandates of NRAs

The mandates of ICT regulators have generally been tightly circumscribed to ensure that only those products and services that are not provided competitively are caught in the net of regulatory policy.

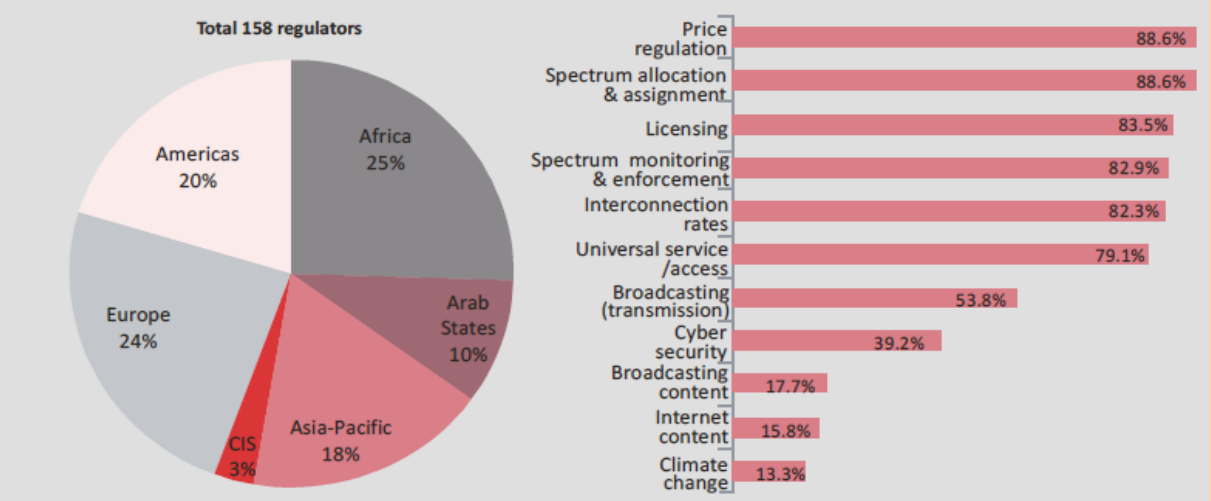
Amongst others, NRAs have to:

- regulate charge controls for retail tariffs where competition is weak or emergent;
- mandated access to SMP providers' infrastructure;
- regulate wholesale charges, and where necessary the terms and conditions upon which access must be granted (e.g. in the form of Reference Interconnect Offers (RIO) that include specific obligations in relation to order fulfilment times, fault handling etc), and where required impose obligations on SMP providers that assist in this task (e.g. accounting separation and cost accounting obligations); and
- enforce provisions to ensure interoperability where this is required by new entrants or competitors.[59]

Box 12 below summarizes the current mandate of the ICT regulators and describes the most common obligations adopted around the world.

[59] In general terms, the remit of regulatory authorities also includes the assignment of spectrum, the enforcement of provisions to guarantee that appropriately defined universal services are available to all customers on terms that are set with reference to the underlying policy objective, and the protection of vulnerable consumers (and consumers in general).

Box 12: Mandate of ICT regulators, 2011



Survey results suggest that where regulators have acknowledged SMP or dominance, a wide range of *ex-ante* obligations are imposed including: transparency, non-discrimination, interconnection and access obligations, regulatory accounting, accounting separation and price controls. In general, the majority of regulators impose several if not all of these obligations on operators considered dominant or with SMP. While no obvious pattern emerges across different regions with regard to which obligations are imposed exclusively, or which combinations are favoured, there are some countries that chose only to impose one or two obligations or have specified 'other' *ex-ante* obligations. Some of these unusual cases are highlighted below.

Africa & Arab States – The most common obligations applied include transparency, non-discrimination, interconnection and access obligations, and accounting separation.

Asia-Pacific – While most countries reported the imposition of multiple obligations, Fiji reported only transparency as the most common *ex-ante* regulation, Mongolia acknowledged only non-discrimination obligations, while Malaysia highlighted transparency and interconnection and access obligations as the most common.

CIS & Europe – The majority impose a wide range of measures, however, France responded only with an acknowledgement of imposition of transparency obligations. Latvia noted that in addition to obligations of transparency, non-discrimination, interconnection and access obligations as well as regulatory accounting and accounting separation, it may oblige the SMP operator to provide a minimum number of leased lines.

Americas – El Salvador imposes only transparency obligations, and Jamaica only provided acknowledgement of non-discrimination and interconnection and access obligations. Paraguay acknowledged some other kinds of measures, such as specific interconnection regulations including on collocation and local transit as well as specifying maximum and minimum tariffs.

Source: ITU World Telecommunication Regulatory Database , www.itu.int/icteye.

NRAs are normally expected periodically to review the scope of their controls, withdrawing them from those products or services where competition has become sufficiently established and where competition law can be expected to protect customers and access seekers. In practice, this has meant a strong focus on traditional telecommunication services (voice and data services), where NRAs have traditionally

imposed a number of *ex-ante* regulatory obligations on SMP operators.[60] Often, these have focused on wholesale markets: *"(r)egulatory controls on retail services should only be imposed where national regulatory authorities consider that relevant wholesale measures or measures regarding carrier selection or pre-selection would fail to achieve the objective of ensuring effective competition and the fulfilment of public interest objectives*" (European Commission 2007a).

Wholesale regulation exposes a greater range of services to competition, and generates more benefits in terms of product differentiation and innovation, responding to changing customer preferences and needs. These are natural outcomes of competitive supply that cannot be easily replicated through regulatory intervention, which by its very nature tends to be very specific and prescriptive. Regulated access creates scope for competition at the retail level through a wide variety of routes, for example through innovation in customer services or via alternative and novel pricing models, benefitting end-users more than any rigid retail control could ever do. This is particularly important in relation to broadband markets where there is much more room for service differentiation than in the case of 'plain vanilla' voice telephony, for example (see ITU, 2012c).

Similarly, interconnection obligations in combination with regulated interconnection charges create opportunities for the deployment of alternative infrastructure where scale and scope economies are potentially weaker, for example because existing capacity is insufficient to accommodate growing demand (as has been, for example, the case in long distance transmission).

The interaction of regulation and competition policy

Much of the behaviour that is addressed by *ex-ante* regulation (e.g. discriminatory pricing, refusal to supply, excessive pricing) would also be caught under competition law – mostly under the provisions aimed at preventing the abuse of a dominant position.[61]

There are indeed many cases where competition law provisions have been used to tackle issues in relation to access charges. For example, in November 2011, the Chinese authority responsible for assessing price-related anti-competitive behaviour (the National Development and Reform Commission of China (NDRC)), confirmed that it was investigating China Telecom and China Unicom (which together account for over two thirds of China's broadband access market) under the Anti-Monopoly Law (AML) about alleged abuse of dominance in that market. As part of the investigation, the NDRC found that *"[t]he two companies had charged rival broadband access operators higher fees for broadband access while prices for non-competing companies were lower. The NDRC official determined such behaviour to constitute abusive price discrimination. … The companies had deliberately allocated an insufficient amount of bandwidth … for the interconnection services offered to rivals, resulting in lower interconnection speed which in turn, resulted in significantly slower internet speed for end users in many parts of China*."[62]

Such issues are of course at the heart of regulatory policy, and are addressed through obligations to provide access at regulated prices and in a non-discriminatory fashion. However, discriminatory practices can sometimes be very subtle and focus on secondary services rather than headline prices. Order lead

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[60] For example, the European Commission has identified a number of markets susceptible to *ex-ante* regulation on the basis of three criteria, all of which must be met: *"(a) the presence of high and non-transitory barriers to entry. These may be of a structural, legal or regulatory nature; (b) a market structure which does not tend towards effective competition within the relevant time horizon. The application of this criterion involves examining the state of competition behind the barriers to entry; (c) the insufficiency of competition law alone to adequately address the market failure(s) concerned.*" (See European Commission 2007a).) This test has since been adopted in many other countries outside of Europe including Moldova, Oman, Saudi Arabia and the United Arab Emirates (see ITU 2012c).

[61] Unlike sector-specific regulation, however, competition law enforcement takes place after a particular case has been investigated, either following from a complaint, or driven by an investigation carried out by the NCA on its own initiative. Although the threat of fines imposed by NCAs will have a deterrent effect, any behavioral remedies that an NCA might introduce would be *ex-post* rather than *ex-ante*.

[62] http://competition.practicallaw.com/6-517-0485?q=broadband+price+discrimination

times, for example, or the time taken to deal with reported faults can in principle differ substantially between an integrated operator's own downstream operation and third party access seekers. It may not be possible to come up with an exhaustive list of conditions that a regulated firm needs to comply with, and *ex-post* investigations of allegedly abusive discriminatory behaviour may be needed.

Similarly, even where *ex-ante* regulatory controls are in place and firms are subject to obligations to provide access on terms and conditions set by the regulator, they may engage in a 'margin squeeze' resulting in limited, restricted or no competition in the downstream markets. Margin squeeze occurs where a firm supplying wholesale products to third parties with whom it competes at the retail level sets its retail price at a level that, at the given wholesale price, leaves an insufficient margin to the competitors that require the wholesale product in order to compete downstream.[63] A margin squeeze does not involve discrimination as the same wholesale price can notionally be charged to the vertically integrated firm's own downstream operation, which might lead to notional losses downstream. The access charge is a direct cost for the third party competitor but only a notional transfer charge for the vertically integrated incumbent, and therefore the access seeker would be suffering actual rather than notional losses. This may point towards regulated charges being set inappropriately, but may also be the result of predatory behaviour in the retail market. The specific circumstances of the market, the relevant cost standards adopted, and the level of product aggregation to reflect entry decisions and business models clearly matter.[64]

5.2 Implications of convergence for regulation

Regulatory policy is affected by convergence in a number of ways:

- The dynamic nature of the sector, and the need to serve a fast growing demand for bandwidth means that setting the right investment incentives is crucial.
- Because services are a key driver of demand and substitutability in a converged broadband world, concerns may arise not just in relation to access to traditional communications networks, but also with regard to services traditionally outside the scope of ICT regulation.
- The platform nature of broadband networks implies that a much richer set of commercial strategies might need to be examined, and that case-by-case assessment becomes more important.

Each of these points is discussed in more detail below.

Regulation needs to be alert to the importance of promoting investment

Meeting the growing demand for bandwidth is likely to require substantial investments in network infrastructure. Extending the supply of broadband services to those who currently have limited or no access to connectivity, and supporting the development of new services is important not least because there seems to be agreement that improved broadband access has substantial positive spill-over effects.

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[63] See OECD (2009, p1): *"A margin squeeze occurs when there is such a narrow margin between an integrated provider's price for selling essential inputs to a rival and its downstream price that the rival cannot survive or effectively compete*." Margin squeeze and established tests were considered in detail in the last broadband series ITU paper (see ITU 2012c, Box 10).

[64] The approach taken toward margin squeeze differs across countries and regions. In some countries, a finding of margin squeeze behaviour is necessarily considered as abuse of dominance, whereas in other cases such behaviour may only be considered abusive if certain other criteria are met. For example, in Europe and New Zealand, price squeezing is typically regarded as being either directly or indirectly related to an abuse of dominance. By contrast, in the United States, price squeezing is regarded as a normal market activity unless the firm engaging in price squeezing practices is obliged to provide wholesale services to alternative operators, or where the price squeezing is considered to be predatory pricing. More examples are available at Annex 2 of the ICT Regulation Toolkit, "Comparative Approaches to Price Squeezes and Abuse of Dominance" (available at www.ictregulationtoolkit.org/en/PracticeNotes.html#3096).

A number of empirical studies have sought to establish a link between broadband penetration and GDP as well as broadband penetration and employment, with the research focus shifting towards the impact of higher speed services.[65] These studies demonstrate the benefits of increased broadband speed and the roll-out of ultra-fast networks. For example, a recent study conducted by Ericsson, Arthur D. Little and the Chalmers University of Technology found that doubling a country's broadband speed could lead to a 0.3 per cent increase in GDP growth.[66] Katz et al. (2009) estimate that meeting the German National Broadband Strategy targets would create over half a million new jobs as a result of construction alone, with almost the same number added as a result of additional growth and service innovation after completion. Overall, the effect of significant investment in ultra-fast broadband networks on GDP would likely be equivalent to 0.6 per cent of annual growth over the ten-year period from 2010 to 2020.

ITU (2012) reports similar effects for other parts of the world. In Latin America, a one percentage point increase in broadband penetration is estimated to generate an additional 0.016 per cent in GDP growth, indicating a contribution of between USD 6.7 billion and 14.3 billion between 2007 and 2009. Similarly across the Arab States a ten per cent increase in the broadband penetration rate is estimated to e increase GDP per capita by between 0.18 and 0.21 per cent on average. This would amount to an average annual contribution of broadband to per capita GDP growth in the six years to 2010 of 0.7 per cent in the UAE and 0.92 per cent in Jordan, for example. In India, a one percentage point increase in broadband penetration is estimated to increase the employment rate by 0.028 percentage points, and a ten per cent increase in the penetration rate is estimated to increase Indian regional GDP by 0.313 percentage points.

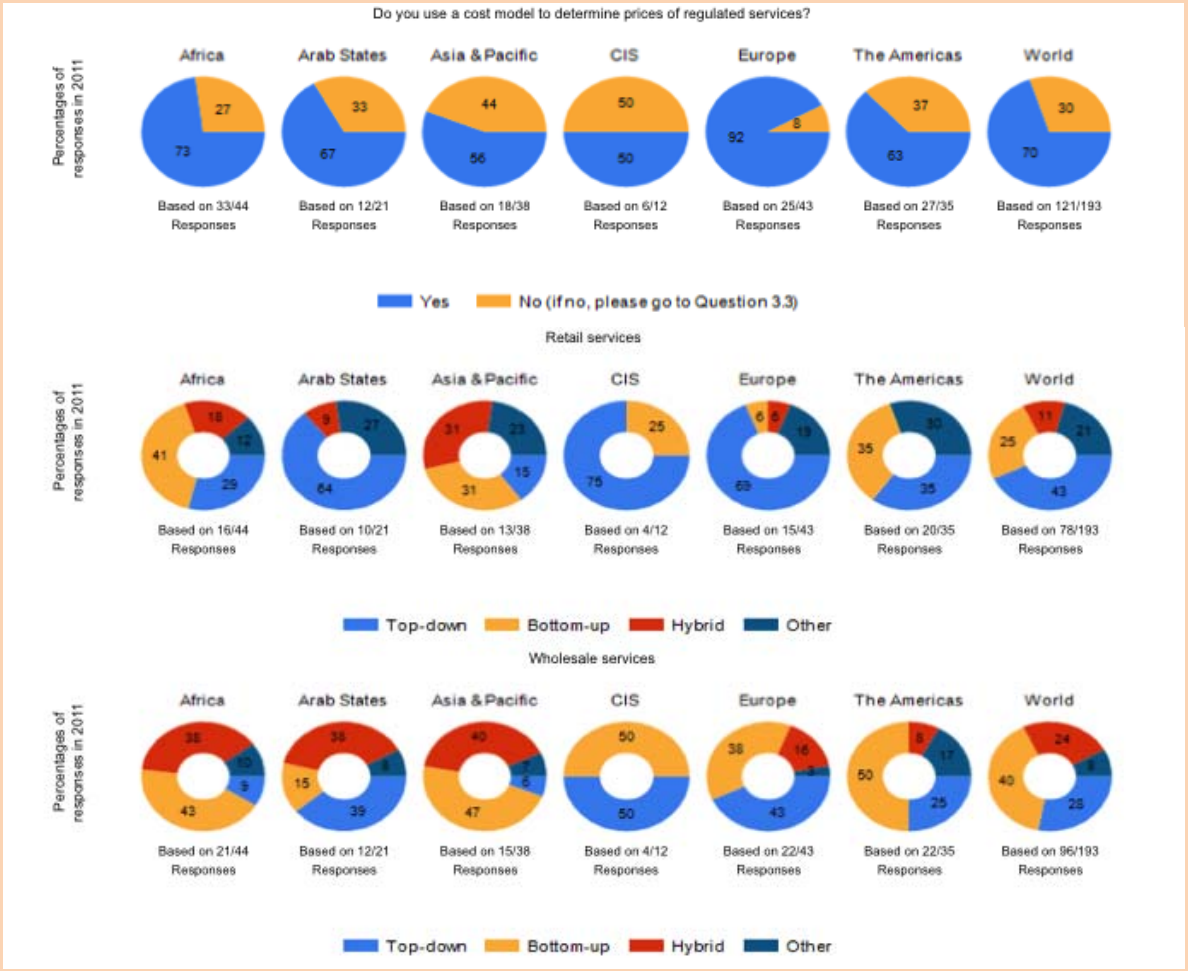
Of course, regulators and policy makers have always been concerned about setting the right incentives for investment in infrastructure. However, with substantive investment being needed in upgrading existing networks or constructing new ones, getting the investment incentives right becomes much more important. Providing the right investment incentives to operators is far from straightforward particularly where new access networks could be subject to cost-based regulation.

NRAs generally rely on cost models when setting regulated charges, using a mix of approaches as shown in Figure 6.

[65] For example, Czernich et al. (2011), who investigate the effect of broadband infrastructure on economic growth. Koutroumpis (2009) considered that for the EU-15, between 2002-2007 the impact of broadband on GDP was 0.63%, contributing 16.9% of total growth over the period (). For an overview of research into the economic impact of broadband see ITU (2012d).

[66] The findings rest on an econometric analysis of a panel of 33 OECD countries over the period 2008-2012 using publicly available data. The positive effects of increases in broadband speed for the economy are broken down into three main categories with direct and indirect effects providing a short-to-medium term stimulus, and 'induced' effects having a long-term impact. The direct effects include job creation through civil works, construction and equipment required for building the new infrastructure. The indirect effect includes the spill-over arising from efficiency improvements resulting from the availability of high-speed broadband. Induced effects capture new styles of business caused by the increased speeds including the creation of more online services. See "Need For Speed – a new study confirms the positive effects of an increased broadband speed on GDP" September 2011 found at www.ericsson.com/networkedsociety/media/hosting/Need_for_speed.pdf

Figure 6: The use of cost models when establishing regulated charges, 2011



Source: ITU World Telecommunication/ICT Tariff Policies Database, www.itu.int/icteye.

Unfortunately, the standard cost measures established through these cost models often fail to take proper account of all the risks associated with infrastructure investments. Standard regulatory approaches for establishing cost-based access charges might therefore fall short of providing sufficient returns for investors. Such investments tend to be largely sunk, and future demand is uncertain, which creates particular challenges and generates potentially large option values associated with delaying the investment. These option values are normally not reflected in cost-based charges. Neither is the option value that is provided to access seekers who can rely on pay-as-you-go access services without having to commit resource. The box below shows that forward-looking long-run incremental cost modelling – the standard cost concept used by many regulators – on the basis of an operator's weighted average cost of capital (WACC) may often fail to provide the correct investment incentives.

Box 13: The standards method for establishing cost-based charges is insufficient to encourage investment

Although common practice, using the operator-specific Weighted Average Cost of Capital (WACC) in the calculation of cost-based access charges provides insufficient incentives for making investments that are sunk and where returns are uncertain.

Imagine, for example, a network operator considering whether to commit substantial resources to a network upgrade enabling the provision of higher bandwidth in a regulatory environment where a regulator sets access charges to limit the return of that firm from the provision of regulated access to the operator's WACC. Whilst this means that the firm does not earn economic profits on a successful investment, it ignores that at the point at which an investment is made, future returns are uncertain, and may include cases in which the investment has to be written off completely, as well as cases in which the return absent the regulatory constraint might be well above WACC.

The investment will only be undertaken if the net present value (NPV) of future returns, calculated at the operator's WACC is positive (and possibly above a certain project-specific hurdle rate that may be applied for good reason), but not otherwise. However, the effect of the regulatory constraint is asymmetric in that it will 'bite' only in the case where the firm would otherwise earn a return in excess of WACC, but not in cases where for example the willingness of customers to pay for high bandwidth or the take-up of the service is lagging far behind expectations.

Limiting the return on successful investments without accounting for the risk of failure will mean that the expected return at the point at which the investment decision has to be made is less than WACC, resulting in a negative NPV and discouraging investment.

This means that successful investments may need to earn a return that is above WACC, resulting in what after the event might look like economic profits supported by excessive prices, but what is simply the reward for the investor having taken the risk of committing resources that might have to be written off in part or completely. The excess over WACC – and thus the apparent excess profit – has to be larger the greater the risk, potentially leading to a situation where an initial commitment by the regulator to allow higher returns may become unsustainable in the face of public pressure to curb what looks like profiteering by an incumbent operator. For this approach to be effective, there would have to be a clear indication of the magnitude of the reward successful investors would be allowed and a commitment from the regulator to protect returns on successful investment from being eroded in the future. If regulators cannot credibly commit to maintaining the promised higher rate of return to operators (e.g. where the permitted rate of return could easily be reduced as part of a regular review process) there will be limited impact on investment incentives (see Levine & Rickman (2002) for a discussion of the commitment problem).

Similar asymmetries exist between access providers and third party access seekers. Whilst the former have committed substantial resources, the latter enjoy the flexibility of a 'pay-as-you-go' service: they can purchase access services at regulated prices if demand is sufficiently high to allow them to earn a return, but are not committed to making any payments or investment otherwise. Put differently, the provision of regulated access includes a potentially very valuable option to take access services (but not the obligation to do so), often for free. This again has the effect of discouraging investment unless access providers are allowed to charge a premium for pay-as-you-go access, or require long-term commitments from access seekers.

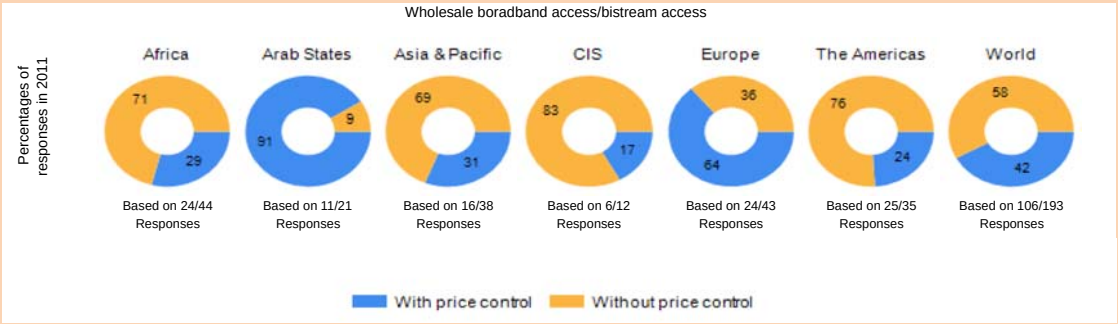
Source: Author

There are a number of ways in which regulatory policy could correct for distorted investment incentives from the application of standard cost-based regulation. Regulatory holidays (i.e. a commitment not to impose access obligations and set regulated charges) for a period of time are one option of rewarding investors. Enabling NRAs to include additional risk premiums when setting regulated charges is another possibility (though, as noted in the box above, this may create commitment issues if the premiums that would be required are so large that successful investors will earn returns that look excessive to the public). Allowing regulated operators to make use of more differentiate pricing, charging more for short-term access without any commitments on the part of the access seeker and discounting access charges where access seekers make commitments and share some of the risk associated with the investment can also have a positive impact (though such differentiated pricing schemes may open the door for anti-competitive discrimination that regulators could find difficult to control).

A fairly general point in this regard is that a proliferation of access products disproportionately increases the risk of discouraging investments. This is because there is an asymmetry in the sense that under-pricing any one access product will reduce the returns on investment, whilst over-pricing some will only affect the mix of access services that third parties will use. For example, with LLU and bitstream access, a high price for unbundled loops will be ineffective if bitstream access is priced too low as third parties will tend to use the latter instead of unbundled loops, and vice versa. The access product with the lowest regulated charge effectively caps the return the access provider can expect to earn.

In this regard it is noteworthy that not every country seeks to regulate the price of wholesale access. Figure 7 below shows that while the majority of regulators in Europe and the Arab States set regulated charges for wholesale access to the dominant player's network, this is not the case in the United States or in some of Latin American countries (e.g. Argentina, Brazil and Paraguay). Similarly, countries in the CIS region tend not to set an explicit wholesale charge control.

Figure 7: Price regulation of wholesale broadband access/bitstream access, 2011



Source: ITU World Telecommunication/ICT Tariff Policies Database, www.itu.int/icteye.

Looking beyond access obligations and regulated charges, policies that promote risk-sharing for example through providing the right incentives for co-investment may help to stimulate infrastructure investment. This may be tied, for example, to suspending regulatory controls where co-investors can be expected to compete effectively in downstream markets. Such competition could emerge where co-investors in fibre access networks obtain control over individual fibre strands, which effectively means that competing access networks are in place.

Given the platform nature of broadband (as discussed above), co-investment strategies may however involve not only potential competitors, but also providers of complementary services. For example, policies to encourage co-investment between network operators and content producers may encourage roll-out of the 'ultra-fast' networks because it addresses the co-ordination problem of needing services to drive infrastructure take-up, and needing infrastructure to encourage service development. Network investments by OTT players can more generally help to provide customers with a service-rich broadband environment that will encourage take-up and assist with roll-out.

However, such agreements may require some preferential treatment of some services or types of traffic in return for contributing to investment costs, which would raise concerns in relation to the principle of net neutrality. This might not be an insurmountable problem if consumers are well informed in advance of the traffic management policies that will be used by their network provider, and be given the option to opt out of such restrictions in exchange for paying more towards the cost of providing the connection. In any case, regulators will need to think very carefully about the appropriate definition and scope of net neutrality requirements in light of the importance that services play for the adoption of broadband in a converged environment[67].

All of these options are at the leading edge of the current debate about the appropriate regulatory policy towards next generation access networks in Europe, and the subject of intense discussion and research.[68] This debate is fluid, and far from producing general accepted recommendations or principles. At least for the foreseeable future, case-by-case analysis taking account of the specific conditions in particular markets, will in all likelihood be required.

Services not traditionally covered by sector specific regulation may matter

The greater role played by services to which a broadband user can get access and the dynamism of the broadband sector will make it more difficult to establish *ex-ante* relevant markets and identify operators with market power. Market power and the potential for abusing it may not arise from control over assets and services that have traditionally been the subject of sector-specific regulation (i.e. telecommunication networks and services derived from these), but be linked to control of 'must-have' content.

Television (or perhaps more generally video) services have been identified as potentially giving rise to concerns, certainly in developed economies. Mobile payment services or other add-on services that provide support to businesses such as tools that improve information about prices in various locations etc. may play a similar role in developing economies. As a result, market definition and SMP designation may require consideration of services currently beyond the scope of ICT regulators.

It is interesting to note that, in some countries, technological convergence has already sparked a review of the mandates of ICT regulators. So far, three different responses have been observed:

- first, adding to the more traditional functions, certain NRAs are now being given the mandate of managing both broadcasting transmissions and content (see Box 14 below) and/or internet content - areas previously left unregulated or as the preserve of ministries or central government departments;[69]
- second, some countries have sought to form multi-sectoral agencies, regulating a wider range of services than just telecommunications. Some have incorporated many sectors, for example, the Danish Business Authority - brought into existence in January 2012 - has not only taken on the specific functions of the IT and Telecommunications Agency (NITA) but has also taken on commerce functions related to all businesses in Denmark;[70] and
- third, some countries have sought to transfer functions back to relevant sectoral ministries, for example in Ethiopia and Kazakhstan, where independent industry regulators were abolished in 2010 (ITU, 2012a).

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[67] For an in-depth discussion on the issue, see the GSR12 Discussion Paper on "Net neutrality: A regulatory perspective", available at: www.itu.int/ITU-D/treg/Events/Seminars/GSR/GSR12/documents.html

[68] See, for example, WIK Consult (2011), Plum Consulting (2011), Charles River Associates (2012).

[69] "*Over the past five years, a growing number of telecom/ICT regulators have seen their mandate expand to include information technology and broadcasting. More recently, electronic content, cybersecurity, data protection, privacy and environmental issues have entered into the purview of regulators*"; See ITU (2012), p 12.

[70] See www.dcca.dk/sw63084.asp.

Box 14: Broadcasting (radio and TV transmission) and broadcasting content under the remit of a single converged regulator.

Given the growing importance of bundled offers including both traditional telecommunications services and broadcasting services such as television, several countries now have a converged regulator responsible for both the traditional ICT sector as well as broadcasting transmission and content.

For example, in Hong Kong, China, the Office of the Telecommunications Authority (OFTA) was on 1 April 2012 replaced by the Office of Communications Agency (OFCA), merging the tasks of OFTA with those of the Broadcasting Division of the Television and Entertainment Licensing Authority (TELA).

In Thailand, the NRA Organisation Act of 2010 established the National Broadcasting and Telecommunications Commission (NBTC) as a single converged regulator for telecoms and broadcasting sectors. The new Act requires NBTC to issue a broadcast master plan as a five-year guideline for broadcasting business and spectrum policy, and as a successor of the former telecoms regulatory body (National Telecommunications Commission), the NBTC is also responsible for regulation in the telecoms sector. The converged regulator has joint authority and responsibility for adopting policy and regulation to promote free and fair competition across both sectors giving due regard to the public interest.

Similarly, in addition to its role as the internet and telecommunications regulator, the Australian Communications and Media Authority (ACMA) is responsible for both broadcasting transmission through planning the radio spectrum to be used by radio and television services and the issuing of licences and broadcasting content regulation covering both radio and television.

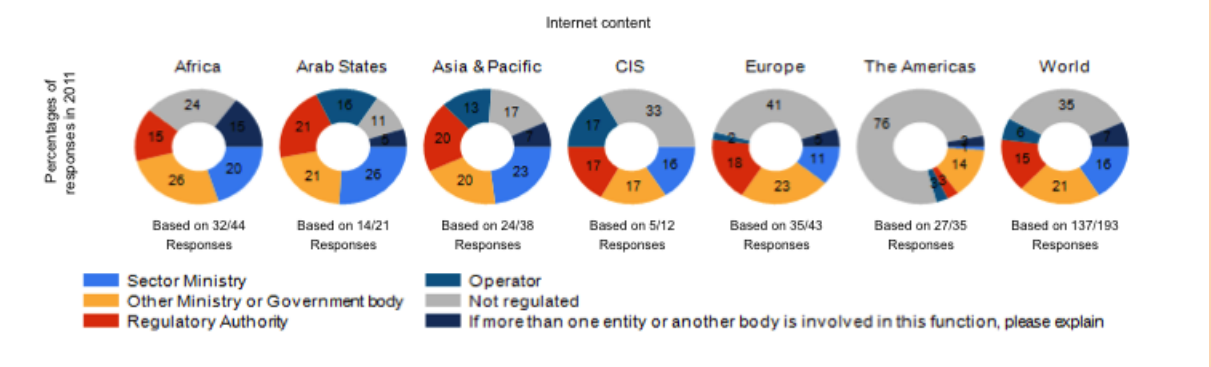
There are a number of other countries with converged regulators responsible for both broadcasting transmission and content together with traditional ICT regulation including: Austria, Bahamas, Canada, Chile, Georgia, Guinea, Korea (Republic of), Mongolia, Panama, Slovenia and Switzerland to name just a few.

Sources: www.ofca.gov.hk/index.html; http://www.nbtc.go.th/wps/portal/NTC/eng; Thaveechaiyagarn; www.acma.gov.au/WEB/LANDING/pc=BROADCASTING_MAIN; ITU World Telecommunication/ICT Regulatory database, www.itu.int/icteye.

Box 15 provides an overview of the changing regulatory mandates, based on ITU survey data. This shows that an increasing number of countries are expanding the mandate of the NRA to Internet content in addition to traditional functions such as licensing, interconnection rates and price regulation.

Box 15: Expanding mandate of regulators, 2011

Whilst regulators are generally in charge on functions such as interconnection rates and price regulation, some countries also see their regulators responsible for monitoring Internet content. The following diagram provides a summary overview, and more detailed descriptions follow below.



Africa – Of the countries that responded, regulators were responsible for monitoring Internet content in four countries including Congo Dem. Rep., Mauritius, Nigeria and Zambia. In eight countries (29 per cent of respondents) internet content was not regulated (the remaining respondents noted that internet content was monitored solely by the sector ministry or other ministry/government body).

Arab States – Of the 14 countries that responded, regulators were responsible for monitoring Internet content in four countries including Comoros, Iraq, Mauritania (together with the sector ministry) and Oman (together with another ministry/ government body). In one country, Jordan, Internet content was not regulated whilst the remaining respondents noted that internet content was monitored solely by the sector ministry, other ministry or government body or the operator(s)*.

Asia Pacific – Of the countries that responded, the regulator was responsible for monitoring Internet content in countries including Australia, Korea (Rep. of), Malaysia, Mongolia, Sri-Lanka and Vanuatu. Internet content was not regulated in Micronesia and the Solomon Islands, whilst the remaining respondents noted that content was monitored solely by the sector ministry or another ministry/government body.

CIS – Of the four countries that responded, the regulator was not responsible for monitoring Internet content in any country although there are seven functional separate regulatory authorities for telecommunications/ICTs in the region. In two countries (Azerbaijan and Moldova) Internet content was not regulated whilst the remaining respondents noted that it was monitored solely by the sector ministry or another ministry/government body.

Europe - Of the 35 countries that responded, the regulator was responsible for monitoring Internet content in five countries (14 per cent of respondents) including Finland, Hungary, Romania (together with the sector ministry), Serbia and Turkey. In 18 countries (51 per cent of respondents) Internet content was not regulated whilst the remaining respondents noted that it was monitored solely by the sector ministry or other ministry/government body.

Americas – Of the 27 countries that responded, the regulator was responsible for monitoring Internet content in only one country (Panama). 78 per cent of respondents noted that Internet content was not regulated whilst the remaining respondents noted that it was monitored solely by the sector ministry, another ministry/government body or the operator(s).

Source: ITU World Telecommunication/ICT Regulatory database, www.itu.int/icteye.

**in this case, interconnection agreements are determined entirely by commercial negotiations between operators without regulatory intervention.*

Simply expanding the scope of regulation by broadening the jurisdiction of NRAs and regulating services that at present are not subject to such controls is however not necessarily the best way forward. Because many of the strategies that operators in a converged world might pursue can have both efficiency benefits and anti-competitive effects (and sometimes both) depending on the specifics of the case, they do not easily sit within a framework of relatively rigid *ex-ante* controls. Regulatory policy is most effective in an environment where it is easy to come up with rules that produce broadly the right outcome in almost all cases – but this is unfortunately not the case where multiple services and complex commercial strategies are concerned, as discussed next.

More complex behaviour with ambiguous effects may need to be addressed

Exclusive agreements between network operators and service providers limiting the availability of must-have content to particular networks can result in very narrow markets and the creation of market power, and might therefore seem an obvious target for regulatory intervention. However, such arrangements may be the most effective way of addressing the co—ordination problems that might otherwise hold back the deployment of improved networks and the development of better services. They can therefore have substantial efficiency benefits. This means that "*one needs to consider whether the efficiencies from exclusive contracts—for example, in helping to create a platform that might not otherwise exist for the benefit of consumers—offset possible costs from reducing competition*."[71] Whether a particular practice is overall harmful or desirable is likely to be very case-specific, and an outright ban on using exclusive arrangements to limit access to services could well be counter-productive.

Similar issues arise in relation to bundling practices. Whilst bundling can have anti-competitive effects, it is also a source of potentially considerable efficiencies, and simply banning bundling of services because it might lead to competition concerns would be inappropriate. It is difficult, if not impossible, to establish hard-and-fast rules for determining what particular bundling practices should not be permitted. [72]

Some examples of how NRAs and competition authorities have dealt with bundling in the context of ICT services are provided in Box 16. They show that restrictions have been imposed as part of a general case-by-case assessment. The Danish example is interesting because it involves the imposition of an access obligation that should enable third parties to replicate the bundles offered by the incumbent, which would of course require that they will also be able to get access to the television content that the incumbent offers as part of the bundle. Such access may not always be easily available.

[71] See Evans and Schmalensee (2007), p 179.

[72] See, for example, Arlandis (2008).

Box 16: Restrictions on bundling

In Luxembourg, the standard triple-play offer includes fixed telephony, data and mobile voice but not television services. Television is not included in the incumbent's bundle due to a ruling by the Competition Council (Conseil de la Concurrence) in 2008 that stated the integration of IPTV into a bundled offer by the incumbent constituted an abusive practice of bundling. The incumbent is not allowed to incorporate IPTV into the integral bundled offer or in any other bundled offer until alternative operators are in a position to replicate it (EC, 2009).

In Mexico, concerns about the market power of Telmex, the fixed-line incumbent, led in 2011 to the refusal to award a licence to Telmex to offer video services over its broadband network. This has delayed the introduction of triple play services from the incumbent but the combined services are available via cable in areas with network coverage. Mexico has not adopted local-loop unbundling to foster competition in the broadband market and Telmex maintains one of the highest market shares in the entire OECD, likely leading to the fear that Telmex could use its market power, combined with bundling, to limit competition.

Similar concerns about bundling re-enforcing market power in Poland led to a 2010 European court ruling finding that countries are allowed, in some circumstances, to prohibit making the conclusion of a contract for the provision of services contingent on the conclusion, by the end user, of a contract for the provision of other services. Essentially the ability to limit certain types of bundling was upheld under European law, but the ruling also clarified that countries would not be able to simply ban the selling of bundled goods in most circumstances.

In Slovenia, in its 2005 analysis of the retail fixed access market, the Slovenia regulator APEK proposed to prohibit the tying of the broadband access connection to ISDN telephony services, i.e. to prevent the incumbent to make the purchase of the broadband connection conditional on the purchase of the SMP product 'retail narrowband access'. The Commission invited APEK to impose a general obligation on the local incumbent not to require consumers of fixed access products to subscribe to any particular type of access product unless it is technically necessary for the provision of a given service.

In the context of the market for wholesale broadband access, the Danish NRA proposed in 2010 to impose on the SMP operator an extended access obligation giving access to additional functionalities such as multicasting, which allows IPTV. This obligation was intended to enable alternative operators to replicate the bundled retail services of the incumbent. The Commission stated that it is possible that the market for wholesale broadband access develops in such a way that a TV offering becomes indispensable to effectively compete at the retail level, in which case such a remedy may be justified.

Sources: OECD (2011), "Broadband Bundling Trends and policy implications", p 40; BEREC (2010), "BEREC report on impact of bundled offers in retail and wholesale market definition"

Discounts for bundles that include regulated products (e.g. broadband access and television services) may also give rise to margin squeeze concerns, even if the stand-alone price of the regulated product (broadband access) passes a margin squeeze test. If the bundle is offered at a (potentially substantial) discount from the sum of the standalone retail price for broadband and the standalone price of television services (which may be competitively determined), a sufficient margin between the regulated wholesale price and the stand-alone broadband price to allow an equally efficient competitor profitably to offer stand-alone broadband services may be of limited practical relevance. The margin squeeze test may be passed on the basis of an inflated retail price for the regulated product on a stand-alone basis, which may be notional if most customers buy the bundle, and the access seeker has to compete with the bundled offer.

Appropriate adjustments to the margin squeeze test may need to be made. Such adjustments are potentially difficult because they essentially involve an assessment of the reasonableness of bundle discounts, and in some cases the regulatory response has been to prohibit 'undue' bundling by SMP operators.[73]

5.3 Conclusions

Regulatory policy in a converging broadband world is facing a number of challenges. First, it becomes more difficult to define relevant markets and identify firms that enjoy market power. Second, there are likely to be many forms of behaviour that are of potential concern, but not easily addressable through regulatory obligations that can be clearly defined and relatively easily monitored and enforced.

A greater role for competition-law like regulatory provisions

Apart from the old problems related to strong incumbent control over essential network infrastructure, a host of additional issues might need to be addressed to allow competition to develop so that customers reap the full benefits of technological developments. Exclusive vertical relationships and more service bundling are examples of the richer set of commercial strategies pursued by broadband service providers that could potentially restrict or distort competition. However, much of this behaviour can have a strong efficiency rationale and create substantial benefits as well as competitive harm. It is therefore impossible clearly and unambiguously to identify behaviour that is detrimental to the interests of consumers and competition. And even in relation to the regulation of network access, the goal of encouraging investment in upgrades of existing infrastructures, and the deployment of new networks means that regulators may need to tread more carefully.

Therefore, the tools that NRAs should deploy may have to change at the same time as the scope of regulatory control might need to extend to a wider range of activities and services. Instead of fully specified obligations that can easily be enforced, a greater reliance on regulatory provisions that are more akin to the obligations created by general competition law, e.g. fairly general 'fair trading' obligations imposed on licensed operators, may be needed.

For the avoidance of doubt, this is different from simply relying on general competition law. Such obligations may be enforceable by NRAs, and the procedural rules may be very different from those that govern competition law enforcement. Small differences in relation to timetables and the burden of proof could have significant effects on the effectiveness of such provisions. For example, where under general competition law, a competition authority might have to demonstrate that a particular form of behaviour has an anti-competitive effect, under a general fair trading condition the licensed operator may be required in the first instance to demonstrate that the practice under question does not frustrate competition, or has a strong countervailing efficiency benefit. The ability to penalize rapidly any failures to comply with licence conditions or the ability to impose temporary or interim measures, the ability to impose immediate desist orders may also imply that special regulatory provisions might be more effective than general competition law, even though they seek to address the same behaviour that would also be caught under general competition law provisions. In this regard, it is important that operators are not exposed to double jeopardy, and that suitable safeguards are in place to prevent the strategic abuse of such fair-trading provisions for example through vexatious complaints.

Even if countries decide to wind back the scope of regulatory control and rely to a greater extent on the application of standard competition law, NRAs may be involved, e.g. by giving them concurrent powers to apply competition law in their respective sectors. NRAs have the advantage of greater sectoral expertise in relation to the traditional components that make up broadband service bundles. They may be in a better position to take into account the effects of existing *ex-ante* obligations, for example in relation to

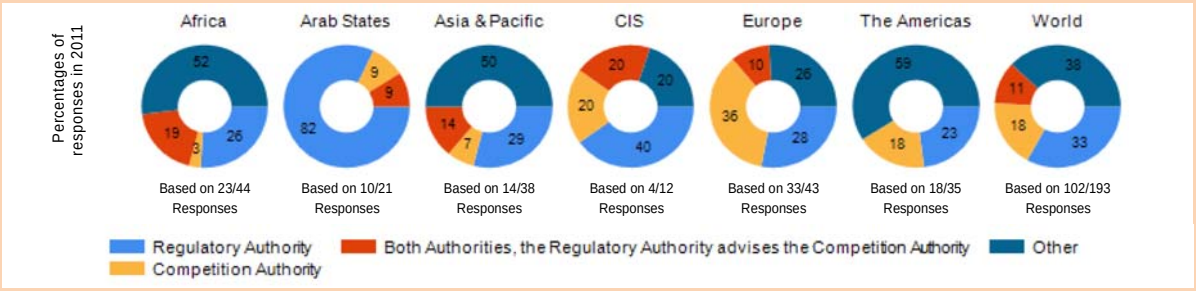
[73] See ERG (2009b) for a discussion of the methodological issues and the potential regulatory responses in relation to margin squeeze tests for bundled offers where some of the bundle components may be unregulated.

wholesale access to particular components that are crucial for effective competition. They may more easily identify how these obligations might need to be adjusted in light of the actual issues that arise, and may therefore be better placed than a general-purpose NCA to deal with such matters.

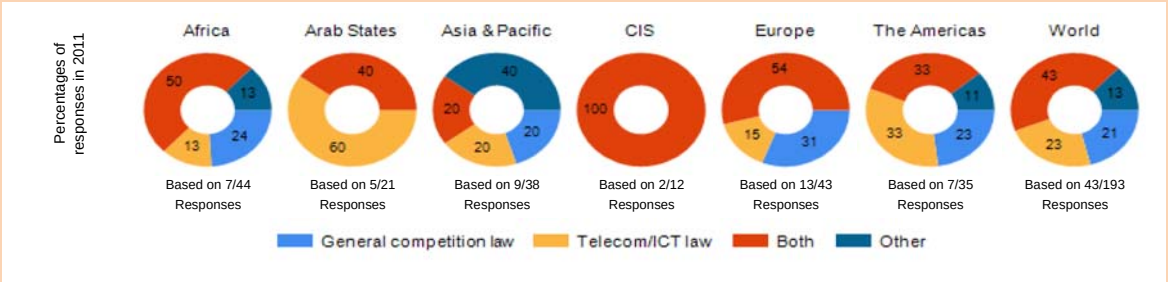
Figure 8 below summarizes how competition matters in the telecommunications/ICT sector are dealt with in different regions of the world, and the legal instrument under which competition issues in respect of the ICT sector are considered. Overall, approximately 33 per cent of cases involve the NRA handling competition cases alone, approximately 18 per cent involve the NCA handling an ICT case, approximately 11 per cent involve both parties (with the NRA advising the NCA on a case) and the remainder of the cases involve other approaches including, for example, where concurrent regimes or memoranda of understanding (MoUs) are relied upon.

Figure 8: Jurisdiction over competition issues in the ICT sector and legal instruments

Who has jurisdiction over competition issues related to telecommunications/ICT sectors?



In what legal instruments is the provision of competition defined?



Source: ITU World Telecommunication/ICT Regulatory Database, www.itu.int/icteye.

Different countries have adopted different approaches to tackling jurisdictional overlaps in ICT cases, which can serve as a model for how the evolution of regulation towards sector-specific competition policy might best be dealt with:[74]

- In some countries, NRAs simply provide advice to the NCA, perhaps through an expert panel called for an individual case. For example, amongst other countries, NRAs provide advice to the relevant NCA in Cote D'Ivoire, Croatia, France, Mongolia, Namibia, Tunisia and Viet Nam.
- Other countries have established a formalized Memorandum of Understanding (MoU) to deal with competition cases as and when these arise. This is the case, for example, in Bulgaria, Finland and Mauritius.[75]

[74] All data comes from the ITU World Telecommunications Regulatory Database, www.itu.int/icteye.

[75] For more on how MoUs can be made to work see the Practice Notice "Facilitating Cooperation between Regulatory Agencies – Memorandums of Understanding and Cooperation Protocols" provided as part of the ICT Regulation Toolkit (www.ictregulationtoolkit.org/en/PracticeNote.3274.html).

- In other countries still, NRAs are charged with dealing with all competition issues in ICT sectors, in part given their detailed knowledge of the sectors that they regulate. This approach is being used, for example, in Greece, Korea (Republic of), Kyrgyzstan, Morocco, Saudi Arabia and Singapore.
- Finally, some countries operate alterative systems such as, for example, MoUs or a system of 'concurrency', whereby sectoral regulators have been designated with the power to apply competition provisions on behalf of the relevant NCA. The latter approach is used in the UK, where all sectoral NRAs have been designated with the power to apply competition law provisions on behalf of the UK competition authority, the Office of Fair Trading (OFT). The concurrent regulator of communications in the UK, Ofcom, is therefore charged with handling competition cases that arise in the ICT sector that could otherwise have been assessed under both the auspices of the UK Competition Act 1998 and the UK Communications Act 2003 (Ofcom has also noted that it will give primacy to the application of the Competition Act 1998 when assessing cases).[76] A similar approach is followed in the US, where the NRA and the appropriate competition authority have both independent and concurrent jurisdiction.

Regardless of the specific ways in which this is being achieved, NRAs and NCAs should find the most effective way of working together and sharing their responsibilities without creating the spectre of double jeopardy.

One size does not fit all

Another lesson is that specific market conditions matter. There are substantial differences between economies in terms of their broadband infrastructure, and therefore finding a set of regulatory policy prescriptions that fit all economies is likely to be impossible.

Where mobile broadband is in the lead because of poor fixed infrastructure, or where geography is better suited to mobile networks it will be increasingly important to ensure that the mobile market remains competitive. In particular, attempts by MNOs to monopolize particular services should be regarded with caution, as this might reduce the benefit from the generally stronger infrastructure competition that exists between mobile networks (and which should provide strong incentives to upgrade networks to keep pace with technical developments).

For countries with a well-developed DSL or cable broadband economy, the challenge may be the most effective migration to ultra-fast broadband based on a greater deployment of fibre. The incentives for operators to upgrade their networks and build new ones will need to be considered very carefully, while guarding against the risk that the migration to ultra-fast networks leads to a re-monopolization of network infrastructure. The extent to which mobile broadband services could provide a competitive constraint should be considered and kept under review – what could be a constraining influence at present might not remain so as fixed network capabilities increase and a whole new service ecosystem develops.

Developing economies that rely mainly on mobile networks need to ensure that the benefits from increases in available bandwidth through new mobile technologies will be realised and that key services will be available to all. This will require them to strike a delicate balance between providing the right incentives for operators to innovate and invest and ensuring that services are used to drive demand, but not to restrict competition.

[76] See UK Department of Trade and Industry and HM Treasury (2006).

Economies that are at the leading edge of ultra-fast broadband deployment (such as Japan, the Republic of Korea or Singapore) may perhaps be closest to being able to re-focus their attention on securing effective competition on the basis of ensuring third party access to infrastructure, limited of course to instances where infrastructure competition is not effective.

Overall, technological convergence will create its very distinct challenges in different economies. These need to be met with different responses, though all of these should flow from a common understanding of the main policy principles.

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Annex 1: A sample of broadband market definitions

Europe

Since 2003, the EC has provided recommendations to NRAs in Member States on the relevant products and services within the electronic communications sector that it considers may be susceptible to *ex-ante* regulation. Whilst the recommendation does not necessarily mean that Member States must impose obligations in those markets, the EC does require each NRA to carry out regular analyses of the relevant markets, confirming the precise delineation of the market (which could if need be differ from the EC's recommendation, subject to the EC reviewing and agreeing to the analysis). The European Commission (2007a) also notes that "*…regulation cannot be imposed or must be withdrawn if there is effective competition on these markets in the absence of regulation, that is to say, if no operator has significant market power*." In cases where the market is found not to be competitive, the NRA must identify SMP players and impose on them *ex-ante* obligations as may be needed.[77]

In December 2007, an EC recommendation was released outlining seven markets (one at the retail level and six at the wholesale level) that may be subject to *ex-ante* regulation (European Commission, 2007a), This represented a significant reduction from the 18 markets (seven at the retail level and 11 at the wholesale level) that it had recommended in 2003. The reduction in the number of markets over the years reflects the EC's view that competition has become increasingly more established – notably so in retail markets - and that the need for *ex-ante* regulation is largely reduced, with *ex-post* competition rules sufficient to protect consumers within the deregulated markets.

The most directly relevant market in respect of broadband services, as recommended by the European Commission in December 2007, was 'Market 5' or 'Wholesale broadband access'. The recommendation noted that, "*This market comprises non-physical or virtual network access including 'bit-stream' access at a fixed location. This market is situated downstream from the physical access…in that wholesale broadband access can be constructed using this input combined with other elements.*" In addition, 'Market 4' related to 'Wholesale (physical) network infrastructure access (including shared or fully unbundled access) at a fixed location', is also relevant insofar as access to the physical infrastructure may allow a new entrant to develop and roll-out new services without the need to install their own physical network elements such as ducts and poles, for example, thus encouraging innovation and competition.

In the context of broadband, most Member States have sought to include traditional copper (ADSL) networks but to exclude mobile, wireless and satellite from their definition of broadband services. Convergence has, however, led to questions about the extent to which mobile and other services might in fact be included in current market delineations. Indeed, a recent noteworthy case arose in Austria where mobile broadband was considered by the regulator, RTR, and included within the retail market for broadband (see Box 9).

In 2011, a number of NRAs also completed further rounds of market analysis of wholesale broadband access. Some of these countries, such as Belgium, Germany, France and Bulgaria, included fibre in the relevant market definitions (European Commission, 2012). While a significant number of European NRAs have now proposed to include fibre in their market definitions, some have adopted a different approach, imposing less onerous regulatory obligations on fibre providers, for example, in France where physical unbundling and bitstream access have not been imposed on fibre (European Commission, 2012).

[77] See http://europa.eu/legislation_summaries/information_society/legislative_framework/l24216a_en.htm

Americas

In the United States[78], the implementation of the Telecommunication Act of 1996 introduced the concepts of unbundling, interconnection, collocation and wholesale access as elements of open access. While initially implemented for the purposes of competition in the fixed telephony market, as DSL became increasingly important for the provision of internet services the applicability of a similar open-access approach was considered. Moreover, in the late 1990s and early 2000s the emergence of a significant cable network raised questions of the applicability of open access regulation to cable networks.

Following a series of appeals from network operators, in 2002, the FCC changed its approach to regulation of the internet access market and embraced the theory of 'inter-modal' competition between incumbent telephone companies and incumbent cable companies. The FCC believed that competition between the two networks would be sufficient to discipline the operators within the broadband market. In essence, the FCC was defining broadband as a single market independent of the technology used for its provision. While the Supreme Court questioned the approach, it was eventually approved and inter-modal competition was favoured over the originally proposed open-access regime.

In Canada, the concept of access to an 'essential facility' plays a large role in the regulatory framework for wholesale services in the telecommunication market. Canada's Telecommunications Act (1993) designates the role of the regulation of wholesale internet access to the Canadian Radio-television and Telecoms Commission (CRTC) while retail internet access is exempt from regulation.[79] In 2008, the CRTC revised its regulatory framework for wholesale services and the definition of essential services. The review of wholesale network services resulted in a plan to remove up to a third of existing services from the list of 'essential facilities' subject to regulation (Canadian Radio-television and Telecommunications Commission, 2008).

Having consulted on its definition of an essential service, the CRTC classified existing wholesale services into six categories: essential, conditional essential, conditional mandated non-essential, public good, interconnection, and non-essential subject to phase-out. Applying the definition of an essential service to the relevant wholesale markets, the CRTC considered "*whether a carrier can use market power over a facility's supply in the upstream market to substantially lessen or prevent downstream competition*." The CRTC acknowledged that "*if a facility can be duplicated practically and feasibly by competitors, it is unlikely that the carrier could use upstream market power to substantially lessen or prevent downstream competition.*"

A complete list of wholesale services by category is provided as an appendix to the decision. However, broadband specific services are categorised as follows:

- DSL access services (conditional essential);
- Aggregated ADSL access services (conditional mandated non-essential); and
- Ethernet access (Non-essential subject to phase out).

The CRTC recognise that "*the definition of an essential service… is the keystone of its revised regulatory framework, [and] is based on economic principles associated with competition policy, adapted to the telecommunications regulatory environment. As a result… the revised framework for wholesale services sends the correct regulatory signals to all TSPs, thereby increasing incentives for investment in, and construction of, competitive telecommunications network facilities.*"

[78] This summary is based on Berkman Center for Internet & Society (2010).

[79] See TeleGeography, "GlobalComms Database, Canada Country Overview" (2011).

Asia

In some countries,[80] NRAs have gone further than simple wholesale and retail market splits, focussing instead on a 'layer' approach. By way of example, in Japan, where regulation of fixed broadband access (independent of technology) falls under Japan's Telecommunications Business Law, the regulatory approach distinguishes between different 'layers' including physical access, service, platform and content. This framework means that, "*competition, speed, availability, and discrimination are examined within each layer, but integration between services in different layers is not prohibited.*" Moreover, "(*t)he government generally views competition in a layered model, and tends to work more aggressively to preserve competition at the physical layer*."

By taking this approach, the NRA seeks to act as an enabler of competition, reviewing continually the dependencies between various network elements or layers. This approach to regulating the broadband market also ensures the consideration of net neutrality concerns as "*…this approach becomes part of the definition of net neutrality, which is understood as a mandate to ensure openness of the platform layer functions and openness of interfaces between layers, so that every user (end user and intermediate) should have equal access to every layer, based on well-defined technical standards that offer ready access to content and application layers.*"

Africa and Arab States

In Nigeria, broadband is driven by wireless access technologies (including UMTS, HSPA and LTE networks) and wireline services are rarely present.[81] Fixed network infrastructure is typically very limited outside the capital. Fixed (wired)-broadband penetration is extremely low in Nigeria with just 0.13 per 100 inhabitants having subscriptions to fixed broadband in 2011, compared with 2.83 per 100 inhabitants for active mobile-broadband subscriptions which is of course still low by developing country standards.[82]

According to Bernal (2011), "*[t]he Nigerian Communications Commission (NCC) has generally used effective, proportionate regulation.*" *Ex-ante* regulation in the form of local loop unbundling has been imposed on the incumbent Nitel, however, due to the poor state of the infrastructure it is not used in practice. As such the NCC has focused on access to spectrum as a means to facilitating market provision of broadband.

With regards to market definition in telecommunication markets, the Nigerian Communication Commission (NCC) defined two markets for the purpose of SMP designation. The two markets were considered to be the market for mobile telephony services (focussing mainly on retail services) and the market for International Internet connectivity (i.e. wholesale access the international internet backbone and related leased line data connectivity).

The Nigerian Communications Commission (2009) has identified an International Internet Connectivity (IIC) market that consists of "*the connection of leased high-speed data circuits, including, predominantly, circuits connected to the Internet backbone*." The market for mobile telephone services includes the "*retail supply of wireless mobile telephony and related features*" and includes voice, sms/text and data connections. However, there may be scope or further delineation of this market into separate markets such as mobile voice, mobile SMS and its related services and the mobile data and mobile broadband market.

In Qatar[83], markets are defined and designation of dominant power identified under the country's Market Definition and Dominance Designation (MDDD) review process. The MDDD follows a pre-defined process

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80 This summary is based on Berkman Center for Internet & Society (2010).

81 See Bernal (2011).

82 See ITU World Telecommunication/ICT Indicators database, www.itu.int/icteye.

83 See ictQATAR (2011)

in which baseline markets are identified and relevant markets defined: "*Baseline Markets are typically Relevant Markets from previous MDDDs or follow international best practices and specific circumstances in the country.*"

Following the market definition stage, ictQATAR - the ICT policy and regulatory body in Qatar - determines whether any of the service providers in the relevant marker hold a dominant position, acknowledged as, "*…the ability to behave independently (of competitors and/or customers) in the market.*" Finally, obligations are imposed on the Dominant Service Provider (DSP), which are "*largely predefined in the Applicable Regulatory Framework in Qatar or are levied additionally on a case by case basis by ictQATAR.*" As part of the 2010 review process, ictQATAR identified 14 relevant markets in the telecommunication sector comprising seven retail markets (of which five related to fixed and two to mobile) and seven wholesale markets (of which five related to fixed and two to mobile). Those markets referring directly to broadband include:

- M4 – Broadband services at a fixed location (includes fibre);
- M7 – Broadband services via a mobile device; and
- M11 – Wholesale access to broadband services at fixed locations.

Further, the regulator recognises that some of these markets are fast moving and has designated them as 'dynamic' requiring pro-active quarterly analysis to assess dominance designation in these markets.

In the UAE the Telecommunications Regulatory Authority (TRA) has defined several markets in the telecommunication sector. The approach taken follows the principles of the SSNIP test (see Box 2) and examines demand and supply-side substitution between products using qualitative assessment in addition to quantitative tests.

When defining the market for broadband services, the TRA considered that while services provided over fibre, copper, cable and WiFi could all be considered to be part of the same market, dial-up and mobile data services could not. In the case of mobile, the TRA considered that it could not be considered as a suitable substitute for fixed broadband services due to the limited data allowances and download speeds available over mobile networks. Further, the TRA considered that broadband services for residential and business consumers must be considered to in separate markets due to the higher quality of service required by business customers.[84]

Following its market analysis, the TRA defined the following retail broadband markets:

- Post-pay retail mobile voice and data services;
- Pre-pay retail mobile voice and data services;
- Fixed residential broadband access services;
- Fixed business broadband access services; and
- Business connectivity services.

Wholesale markets were defined in line with the retail markets, and defined as follows:

- Mobile access and call origination including wholesale data access;
- Residential wholesale fixed broadband access;
- Business wholesale fixed broadband access; and
- Wholesale trunk and terminating segments of fixed connectivity services.

In addition, the TRA noted that fixed broadband access included bundled services including for example, voice and internet and IPTV.[85]

[84] See Telecommunications Regulatory Authority (2011) p 50 f.

[85] See Telecommunications Regulatory Authority (2011) p 10 f.

Annex 2: Examples of approaches towards margin squeeze

In Europe, cases have included landmark rulings in the cases of Deutsche Telekom and Telefonica. Both these cases resulted in large fines on the providers. The Court of First Instance's judgment in the Deutsche Telekom case confirmed that margin squeeze was a distinct pricing practice that constituted an anti-competitive abuse under Article 82 (now Article 102). The case defined a margin squeeze as an instance where "*the difference between the retail prices charged by a dominant undertaking and the wholesale prices it charges its competitors for comparable services is negative, or insufficient to cover the product-specific costs to the dominant operator of providing its own retail services on the downstream market*" (see Commission Decision of 21 May 2003, COMP/C-1/37.451, 37.578, 37.579 — Deutsche Telekom AG, 2003 O.J. L 263). The Court also established that the *ex-post* methodology should apply *ex-ante* in a regulated context.

In the Republic of Korea certain acts of dominant firms are prohibited by the 'Monopoly Regulation and Fair Trade Act', however there is no direct provision for the control of margin squeeze. In contrast to some other countries, cases involving margin squeeze in the telecommunication sector are not considered under competition law, but fall under direct jurisdiction of the Korean Communications Committee (see OECD, 2009).

In Mexico, margin squeeze is not identified as a standalone concept by the Federal Law of Economic Competition (FLEC), nor in sectoral regulations. However the FLEC does provide economic and legal criteria to deal with such cases. Article 10 of the FLEC typifies four monopolistic practices that could encompass characteristics of a margin squeeze: discriminatory pricing at the wholesale level; raising rival's costs at the wholesale level; predatory pricing at retail level; or cross subsidisations between wholesale and retail pricing (OECD, 2009).

In 2009, the New Zealand Commerce Commission alleged that the incumbent operator (Telecom Corporation of New Zealand Limited/Telecom New Zealand Limited) had abused its dominant position by charging a wholesale price to other telecom service providers (TSPs) for access to 'data tails' at a high level relative to the retail price thus causing a price squeeze. The Commission argued that Telecom's action violated the Commerce Act (the NZ Act) and "…*used its dominant position in the relevant wholesale market for data tails (and, from 26 May 2001, the substantial degree of power it had in that market) to set wholesale prices and other terms on which it supplied data tails to TSPs at a level which would prevent or deter existing or potential TSPs from competing in the relevant retail market and deter those TSPs from competing in the wholesale market for 'backbone' transmission services*" (see New Zealand Commerce Commission v. Telecom Corporation of New Zealand Limited and Telecom New Zealand Limited, 9 October 2009, CIV 2004-404-1333). As part of the investigation by the High Court of New Zealand a counterfactual test was used to consider whether the prices charged were in fact higher that the prices a non-dominant player in a hypothetical competitive market would have set. The Court found that prices charged were above those determined by an "Efficient Component Pricing Rule" (ECPR) (pricing that permits efficient entry by competitors) and that this would not have been the case for a non-dominant firm, and that Telecom had therefore abused its dominant position.[86]

[86] ICT Regulation Toolkit, "Comparative Approaches to Price Squeezes and Abuse of Dominance". Available at www.ictregulationtoolkit.org/en/PracticeNotes.html#3096

In the United States, margin squeeze complaints are typically filed under the American anti-trust legislation, the Sherman Antitrust Act. In 2009, the United States Supreme Court (USSC) concluded on a case brought forward by a group of independent internet service providers against Pacific Bell Telephone (AT&T) on the basis that AT&T had squeezed profit margins by charging them a high price for wholesale DSL services while providing its own customers with retail services at low cost.[87], The USSC considered that, in general, businesses have the freedom to choose who they deal with and on what prices, terms and conditions they do so. Only if the price squeezing behaviour is counterpart to predatory price behaviour, or where the operator engaging in margin squeeze is under obligation to provide the service at a wholesale level to competitors, may such behaviour be considered anti-competitive. "Since AT&T was not required to provide wholesale service to the competitive Internet service providers and since the Internet service providers had failed to raise the issue of predatory pricing in its pleadings, the USSC determined that AT&T's pricing did not violate §2 of the Sherman Act."[88]

[87] ICT Regulation Toolkit, "Comparative Approaches to Price Squeezes and Abuse of Dominance". Available at www.ictregulationtoolkit.org/en/PracticeNotes.html#3096. The ISPs argued that the price squeeze behaviour of AT&T violated §2 of the Sherman Act which states that "*[e]very person who shall monopolize, or attempt to monopolize, or combine or conspire with any other person or persons, to monopolize any part of the trade or commerce among the several States, or with foreign nations, shall be deemed guilty of a felony, and, on conviction thereof, shall be punished by fine not exceeding $10,000,000 if a corporation, or, if any other person, $350,00, or by imprisonment not exceeding three years, or by both said punishments, in the discretion of the court*."

[88] ICT Regulation Toolkit, "Comparative Approaches to Price Squeezes and Abuse of Dominance". Available at www.ictregulationtoolkit.org/en/PracticeNotes.html#3096

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