GSR discussion paper

Investment strategies for the deployment of broadband and access to the digital economy

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Investment strategies for the deployment of broadband and access to the digital economy

Authors: Iqbal Singh Bedi, Nuno Afonso, Dr Matt Yardley from Analysys Mason

Executive summary

This paper describes common and innovative investment strategies that have been implemented to support the deployment of broadband infrastructure and access to the digital economy. The paper draws upon a number of practical examples from a wide range of countries to deduce current information and communication technologies (ICT) investment trends and to recommend best-practice guidance for regulators wishing to foster and secure new investment opportunities. Although the sample number of case studies is not statistically representative and does not enable significant conclusions to be made, a number of themes have emerged and are summarized in this paper. In this report telecoms investments in developing markets tend to focus mainly on developing mobile infrastructure, with the aim of increasing voice, data and broadband service penetration. In contrast, mobile operators in developed markets are likely to invest in LTE networks to drive declining revenues by offering high-speed mobile data services and apps. Meanwhile, alternative and new-entrant fixed operators in developed markets are investing in gigabit broadband networks, since consumer demand is expected to increase for more online bandwidth-hungry content. Fixed and mobile network investment is also being led through market consolidation in the form of network sharing or mergers and acquisitions. The improved efficiencies and costs savings realized as a result of consolidation can be used by operators to fund network investment. Governments and policy makers can encourage investment in networks and services by creating and supporting 'tech clusters', which have the added benefit of creating jobs and growth in digital industries.

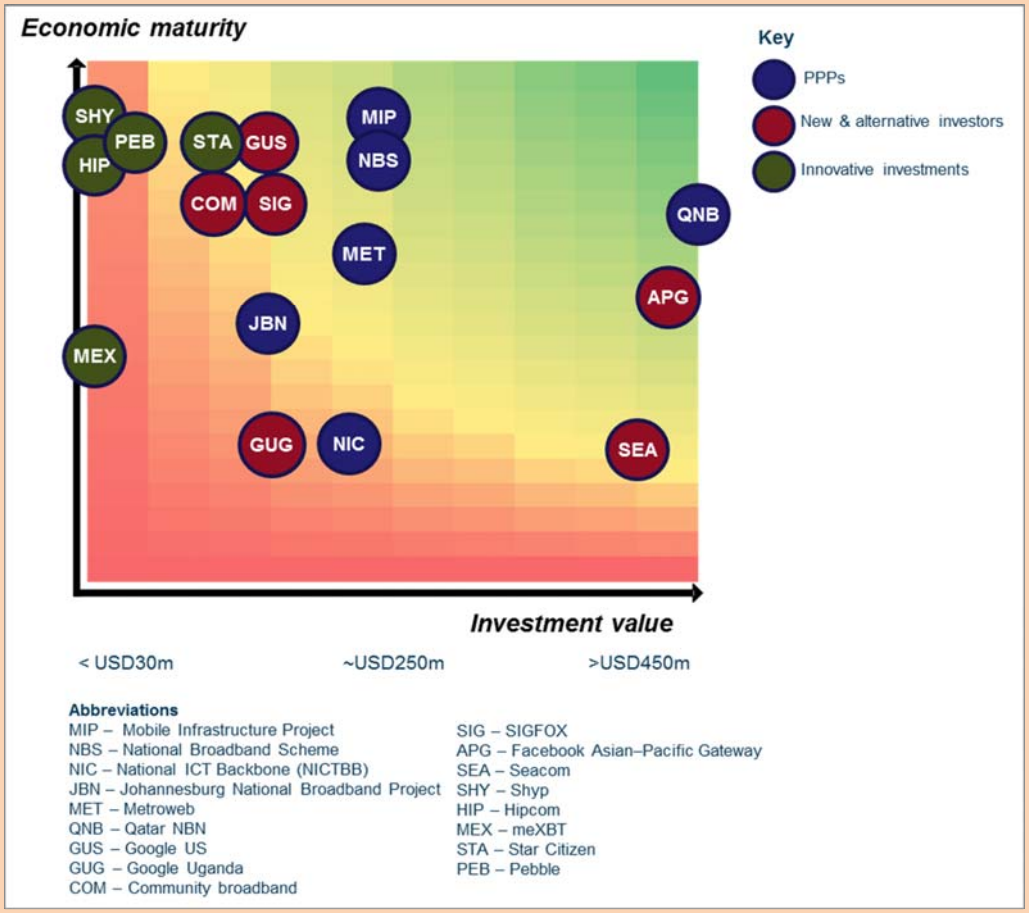
It is still common practice for government-funded broadband networks to use public–private partnerships (PPPs) in areas where it is not commercially viable for operators to invest in broadband infrastructure. There is a distinction in how PPPs projects are implemented in developing markets compared to developed markets. PPPs in developing markets are more likely to focus on building national core networks and metro rings, while PPP projects in developed markets tend to focus on increasing last-mile broadband coverage to the very last few unconnected premises, and on achieving very high broadband speeds.

Regulators can play a key role in PPP projects by encouraging infrastructure sharing, spectrum pooling, and by offering licences with coverage and performance obligations. Regulators should provide operators with existing network coverage and passive infrastructure maps to aid their network planning and ensure that operators offer effective, non-discriminatory and transparent access to dominant or government-funded networks. Detailed analysis will be required to ensure operators are not disincentivized from investing further, however. Subject to local constraints, regulators should also consider allowing incumbent operators to sell assets such as copper networks which can be used to offset future investment in broadband networks.

New market entrants such as Google, Microsoft and Facebook have all invested in broadband networks and emerging technologies. Their motivation is driven by generating revenues downstream through the take-up and usage of their content and services as a result of widespread broadband deployment. Regulators can play an important role in attracting new market entrants by providing clarity on passive infrastructure-sharing rights, working with local and national governments to promote technology pilots and supporting community broadband initiatives. They can also provide new entrants with telecoms infrastructure maps, expedite licence applications and ease 'civil' planning and construction restrictions. Governments and regulators can proactively champion pilot projects investing in disruptive technologies such as making use of TV white-space spectrum for promoting the expansion of broadband into rural areas that are not considered to be commercially feasible when using more traditional broadband technologies.

The case studies in this paper – when the value of the investment was plotted against the economic maturity of the region where the investment was made – provide an interesting insight into investment trends, shown in Figure 0.1.

Figure 0.1: Summary of investment trends



Source: Analysys Mason, 2015. Note figures are not abailable for MGTS

Investments made by new market entrants and alternative investors (technology innovators, not-for-profit investors and financial institutions such as private equity or hedge funds) tend to have a greater vertical and horizontal spread than traditional PPP investments. They are more likely to make higher-value (and therefore higher-risk) investments in broadband projects than broadband PPP investments; these investors are equally likely to invest in developed and in developing markets.

Innovative investments such as crowdfunding, digital currencies, pensions and charities are largely a phenomenon occurring in higher-layer services and in developed markets partly due to the maturity of the Internet ecosystem in developed markets which fosters technical innovation and investment. Most of these investments have initially attracted low amounts of funding – with the exception of crowdfunding – and would therefore be unsuitable for investment in significant broadband infrastructure projects. There is generally less government regulatory involvement in attracting this form of investment. However, this paper argues that governments and regulators should still be responsible for attracting inward investment and for stimulating the demand for broadband services which will drive investment in higher-layer services and connectivity. Any financial regulations being considered in growth markets should safeguard investors and consumers, enable innovation but not restrict business growth.

1 Introduction

This paper identifies strategies that have been implemented by private and public investors to support the global deployment of broadband infrastructure and access to the digital economy. Based on a review of a number of investment cases from around the world, this paper identifies best-practice investment strategies, regional and service variances and identifies key lessons for governments, regulators and investors in order to stimulate investment in broadband networks.

The purpose of the paper is not to focus on the approach followed by any single investment case, or to promote any one particular example, but rather it is to gather an overall view of the best-practice methods used to encourage investment in the digital economy. In doing so the paper highights global investments trends and considers whether there are any geographical or service variations in these trends. The paper also examines the characteristics of public–private partnership (PPP) investments and alternative and innovative approaches being used to fund investments in broadband networks and in higher-layer services and applications.

The paper has been prepared using secondary research based on publicly available information. Unfamiliar investment cases have been deliberately selected to provide a fresh perspective and familiar examples which have already been researched extensively have not been used. Needless to say, the investment cases provided do not represent an exhaustive list of examples; however they have been carefully selected to ensure that a wide a range of cases from around the world are presented so as to allow some investment trends to be identified.

Table 1.1: Case studies covered in the paper by type of investment strategy and region

Types of investment/activity	Developing regions	Developed regions
Public–private partnerships (PPPs)	• National ICT Broadband Backbone (NICTBB), Tanzania • Johannesburg Broadband Network Project (JBNP), South Africa	• Mobile Infrastructure Project (MIP), UK • National Broadband Scheme (NBS), Ireland • Metroweb, Italy • Qatar National Broadband Network (QNBN), Qatar
Alternative approaches	• Google Fiber, Uganda • Seacom, Africa • Asia–Pacific Gateway, Asia	• MGTS, Russia • Google Fiber, USA • SIGFOX, France • Community broadband, Germany
Financial innovations	• mexBT, Mexico • Aentropico, Colombia	• Star Citizen, USA • Pebble, USA • Shyp, USA • Hipcom, UK

The remainder of this document is laid out as follows:

- Section 2 provides an overview of telecoms and ICT infrastructure investment trends worldwide
- Section 3 examines the implementation of open-access initiatives and the investment approaches in broadband infrastructure projects through PPP projects
- Section 4 investigates the alternative funding approaches being used to facilitate the roll-out of broadband infrastructure
- Section 5 provides an overview of financial innovations being used to fund investments in higher-layer services and applications
- Section 6.1 summarizes the investment trends across each of the case studies reviewed in this report
- Section 6.2 provides a summary of best-practice regulatory considerations.

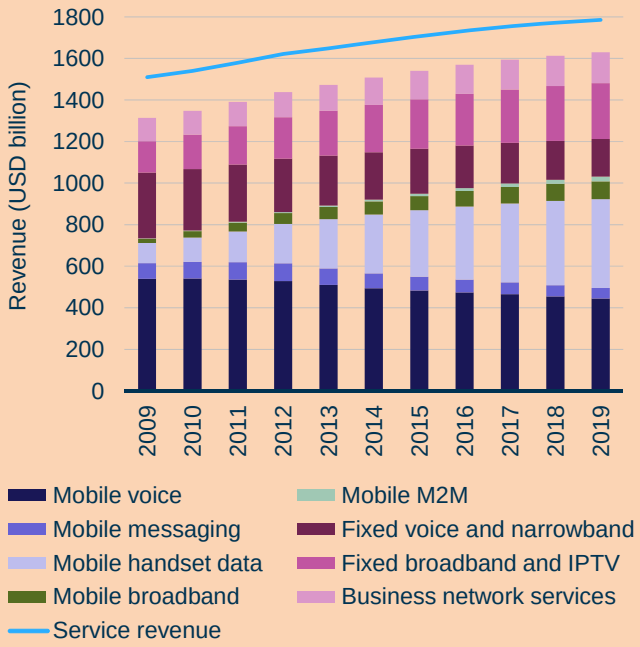
2 Global investment trends

The global telecoms market place is vast and varied, and each market is different, defined by its own unique set of macro-environment characteristics. Fixed and wireless telecoms operators and higher-layer service providers – whether in developed or developing markets – have had to adapt to local market conditions. Consequently, they have developed a range of strategies in order to remain competitive and to invest in broadband infrastructure. This section provides a summary of the investment trends being driven by operators investing in fixed and wireless broadband networks and in higher-layer services.

2.1 Investment: driving telecoms revenue growth

Operator investment in fixed and wireless networks is driving revenue growth in both developing markets and in developed markets. It is estimated that the global telecoms services market[1] will be worth USD1.79 trillion in 2019, up from an estimated USD1.68 trillion in 2014, see Figure 2.1.

Figure 2.1: Telecoms retail revenue by service type and total service revenue, worldwide



Source: Analysys Mason global telecoms market: interim forecast update 2014–2019

In developing markets – where current service availability and penetration rates for mobile broadband (e.g. 19 per cent penetration in Africa and 23 per cent in Asia and the Pacific) and fixed broadband (e.g. 0.4 per cent in Africa, 3 per cent in Arab States and 7.7 per cent in Asia and the Pacific) is low[2] – an increase in investment in 3G and (in time) LTE mobile infrastructure is expected to drive growth and increase service penetration leading to the higher revenues depicted in the figure above. Coupled with increasing GDP per capita, economies such as China, Brazil and India are expected to see the greatest revenue growth driven mainly by investment in mobile infrastructure and mobile broadband services.

In developed markets – where current service availability and penetration rates for mobile data (e.g. 64 per cent in Europe) and fixed broadband (e.g. 79 per cent of all fixed broadband connections are in Europe and in developed markets in Asia) is high – mobile operators have been making significant investments in LTE

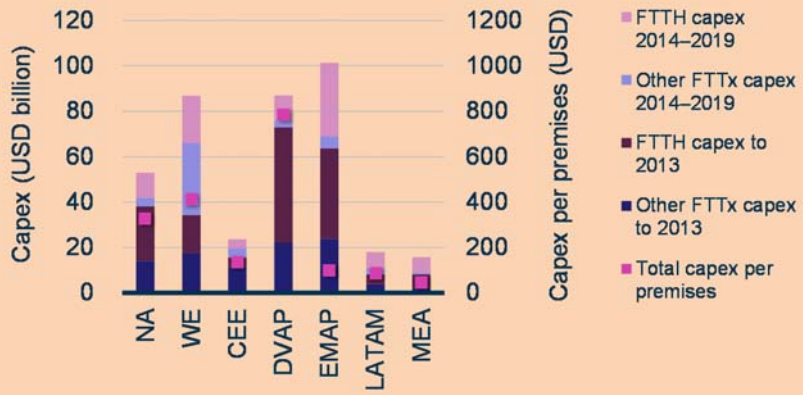
networks and offering attractive mobile data services and applications. As a result of this investment, revenue growth will come from higher consumer spend on mobile data services. Growth will be higher particularly in Japan, South Korea and the USA (which are the world leaders in terms of LTE take-up and data usage), but also in some European markets (as LTE gains traction). Incumbent and alternative fixed operators in developed markets have also been investing in fibre networks to create ultrafast broadband networks capable of speeds of up to 1Gbit/s.

The sections below discuss the fixed and wireless investment trends in some further detail.

2.2 Fixed network investment trends

Operators in developing and developed markets will be making significant investments in fixed fibre networks although the fibre technology chosen will vary. It is forecast that capital expenditure on FTTx technologies will total USD144.2 billion between 2014 and 2019. Of this, USD52.5 billion will be in Western Europe, and USD55.1 billion in developing markets (see Figure 2.2).[3] [4]

Figure 2.2: FTTx capex by region to 2019



Source: Analysys Mason FTTx roll-out and capex worldwide: forecasts and analysis 2014–2019

Note: (NA = North America, WE = Western Europe, CEE = Central and Eastern Europe, DVAP = Developed Asia–Pacific, EMAP = Emerging Asia–Pacific, LATAM = Latin America, MEA = Middle and East Africa)

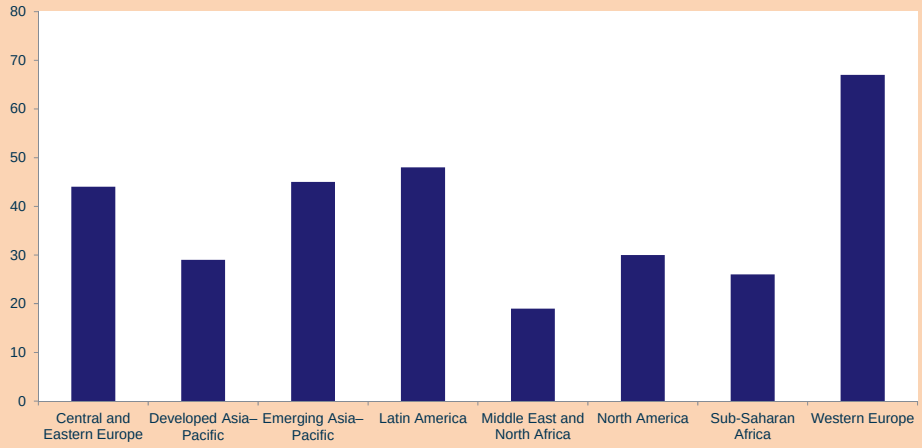
It is forecast that USD92.7 billion of this total will be spent on fibre to the home (FTTH)[5], of which USD46.2 billion will be spent in developing markets. Fibre networks appear to be favoured by fixed network operators in developing markets over copper networks. Also, the low availability of and poor quality of copper plants in developing markets can make them unsuitable for investments based on copper local loops. Fixed incumbent operators in developed markets are more likely to adopt a gradualist investment approach in order to leverage their copper network assets and introduce a mix of FTTx, and in some cases FTTH access technologies. In contrast to incumbent operators, alternative operators and new market entrants are deploying gigabit fibre networks in cities, as they are not restricted by legacy investments in copper networks. This is the case with Gigaclear and CityFibre in the UK, and Google Fibre in the USA and in Africa.

2.3 Wireless network investment trends

Mobile operators in developing and developed markets are expected to make significant investments in 3G LTE networks to leverage the growth in mobile data services. However, mobile broadband penetration in developing markets is still quite low, with a penetration level of 21 per cent in 2014. But mobile broadband is growing fast in the developing regions, where growth rates are twice as high as in developed regions[6], as

mobile operators in developing markets have started to invest in 3G networks and also more recently in LTE networks. Figure 2.3 shows that 308 operators have launched or are planning various LTE deployments worldwide; 138 of these operators are in developing markets, which forms a significant proportion of the global operator base.

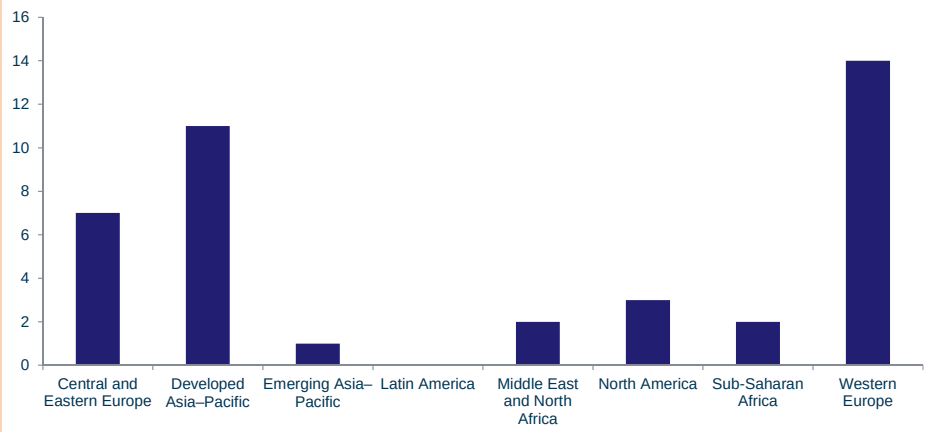
Figure 2.3: The number of operators by region that have launched or are planning LTE deployments



Source: Analysys Mason wireless networks tracker, 2015

Mobile operators in developed markets – where mobile data coverage and penetration is high – are making investments in high-speed LTE-A [7] networks. This investment is being driven by higher smartphone penetration and the take-up of services that require high-speed streaming. Figure 2.4 shows that 40 operators have launched or are planning various LTE-A deployments worldwide; 35 of these operators are in developed markets. South Korea has one of the highest LTE penetration rates worldwide (at 66 per cent of connections in 2014, expected to rise to 89 per cent by 2019).[8]

Figure 2.4: The number of operators by region that have launched or are planning LTE-A deployments



Source: Analysys Mason Wireless networks tracker, 2015

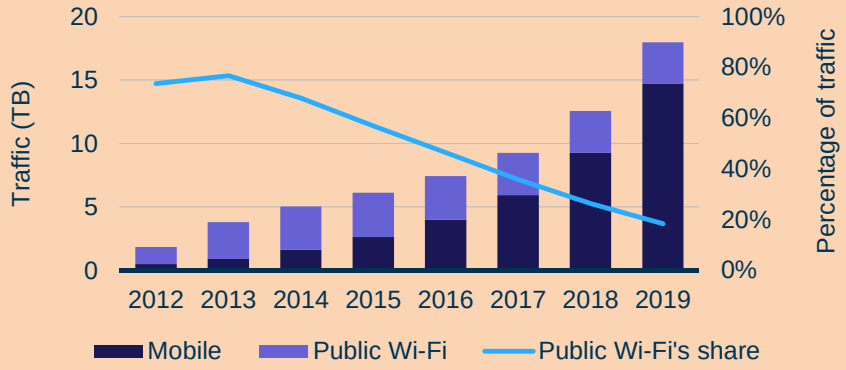
Other wireless network investments are being made by operators in public small cells, public Wi-Fi networks and in low Earth orbit (LEO) satellite broadband.

Public small cell deployments are being used by mobile operators in developed markets to address 3G and 4G network coverage and capacity issues, particularly in city business districts where the demand for data-hungry applications can be extremely high. By 2020, the Asia–Pacific region and North America will together account for 78 per cent of the investment in public small cells.[9]

Mobile players in the Arab States have been deploying small cells since 2010 to help alleviate the strain on their networks and reduce traffic congestion. In the United Arab Emirates, EITC (du) has used a combination of small cells and Wi-Fi to address peaks in data demand levels at the site of the Burj Khalifa, which attracts thousands of visitors daily. Etisalat first used femtocells in 2010. It is committed to deploying more 3G cells in public areas around the country to improve capacity. In Kuwait, Zain launched Zain Cell Access Point, a consumer-grade cell, in 2010 to improve signal coverage indoors. The device can support up to four voice calls at once and was given free to subscribers. In Bahrain, Batelco has deployed a combination of femtocells, microcells and a cell coordinated network (HetNet) to boost capacity, and it would have needed 30–50 per cent more macrocells to achieve the same capacity.

The move to invest in 4G networks and small cells, however, does not constrain the need for public Wi-Fi[10] infrastructure; in fact, the rise in consumer data consumption may drive the need for further Wi-Fi investment. Public Wi-Fi is considered a necessary service for mobile operators. Although operators that deploy public Wi-Fi networks run a small risk of cannibalizing their mobile data revenues, public Wi-Fi offers benefits for operators, such as service differentiation and increased customer retention. In fact, consumer behaviour studies have shown that people like using Wi-Fi and prefer it to mobile data in some cases. When implemented adequately, public Wi-Fi can effectively supplement mobile capacity (particularly in dense urban areas, such as business districts and shopping areas, known as public Wi-Fi offloading) and may also lead to monetization opportunities for operators. The volume of traffic offloaded onto public Wi-Fi is low even in developed markets, with high volumes of mobile traffic and strong Wi-Fi coverage. China is exceptional in terms of Wi-Fi usage – public Wi-Fi data traffic far exceeds that of mobile data, but investment in LTE is reversing this trend (see Figure 2.5).

Figure 2.5: Wireless data traffic by type and public Wi-Fi share of that traffic, China, 2012–2019



Source: Analysys Mason, 2015

Iridium and Globalstar have recently raised funds to launch a second-generation of low Earth Orbit (LEO) constellations to provide broadband and voice services. In addition, a number of satellite operators such as SpaceX and LeoSat have plans to invest in new LEO constellations designed to provide global broadband connectivity totalling an investment of around USD13 billion to USD18 billion.[11] Their plans are deemed to be commercially feasible given the lower cost of satellites and the development of the broadband market.

2.4 Market consolidation

Operator consolidation and mobile-network-sharing strategies are used by operators – mainly in developed markets – to generate efficiency gains and costs savings to fund further investments in fixed and mobile networks and in innovative services.

Scale is critical if mobile network operators (MNOs) are to compete for 4G licences, invest in mobile network infrastructure and develop innovative services in line with their competitors. Take BT's USD19 billion acquisition of mobile operator EE in the UK, for example. At first glance it would seem that the transaction is about BT expanding its market size and services portfolio to offer quadruple play. However, both BT and EE will benefit from synergies in subscriber acquisition costs (SAC) and from lower churn. There is strong evidence from other European markets that quadruple plays have this effect. However, 'in-market' mergers and acquisitions can be expensive and time consuming, and success is uncertain.

Operators in developed markets are under increasing pressure to reduce costs as revenue levels decline.. As network coverage becomes less of a competitive differentiator for operators in developed markets, they will need to consolidate networks (network sharing) as a means of redirecting their investment focus on developing innovative services rather than investing in infrastructure. One way to achieve this is to reduce the costs associated with network infrastructure. In France, Bouygues Telecom and SFR concluded a significant network-sharing agreement in February 2014, enabling the two operators to make about a 40 per cent reduction in sites. This has generated savings of about EUR100 million per year for Bouygues Telecom and EUR200 million per year for SFR.[12]

Network sharing is not constrained to developed markets. For example, eight major mobile operators in the Arab States and Africa (MEA) announced plans in March 2014 to work together on a new network-infrastructure-sharing initiative to reduce costs and to improve rural broadband coverage.[13]

2.5 Tech clusters

It is also interesting to look at how broadband investment is being encouraged by the UK government, particularly by means of the 'Tech City' initiative and through global Fintech intiatives.

Tech City is an initiative publicly endorsed by the UK government and the Mayor of London to attract investment in technology firms, creating jobs and economic growth.[14], [15] Tech City is a cluster of technology companies and supporting services firms based in East London. It has created a significant amount of tech jobs and is reported to be growing faster than other digital hubs. In the last three years TechCity has attracted investment from global markets including the US, Europe and Asia, and from investors such as Rekoo, Facebook, Google, Twitter, Amazon, Cisco, Intel, Microsoft, FourSquare and Pinterest.[16] As a result of the current attraction to and growth in the area, UK operators Openreach and Virgin Media have made announcements to invest in affordable high-speed broadband infrastructure and services in the area.[17], [18]

Other noteworthy technology investment trends include investment in 'FinTech', an industry that develops technology solutions for the finance sector. Global FinTech investment has tripled to USD12.2 billion from 2013 to 2014, creating solutions such as mobile payments, and providing easy access to finance, and reducing fraud and identity theft. These solutions and processes are all factors in the development of a mature Internet ecosystem.[19] Silicon Valley is the world leader in attracting FinTech investment, with over USD2 billion in investments in 2014. European investment totalled USD1.48 billion with the UK (mainly in London's Tech City) accounting for 42 per cent of European FinTech deals in 2014.

3 PPP investment strategies in broadband infrastructure

Telecoms operators make 'business-as-usual' investments in core, backhaul and access networks by utilizing cash piles or by raising private financing through financial markets or, as previously mentioned, through consolidation. These 'business-as-usual' investments are well rehearsed and require little regulatory or govermment intervention and are therefore not discussed in this report. However, telecoms operators can be reluctant to invest in areas where the commercial returns are uncertain. In these cases governments have intervened and entered into PPPs with operators where the government may provide funding to a private operator to invest in broadband infrastructure. This section describes these PPP investment strategies, using case studies to describe the key characteristics of each of these approaches.

3.1 Overview of PPPs

A study on financing broadband networks and PPPs has previously been undertaken for the European Commission[20] and the ITU[21] that broadly defined PPP[22] and identified investment models commonly used by broadband PPP projects. The investment models and funding approaches examined in these reports remain by far the most common approaches to implementing broadband networks.

Most PPP projects in broadband infrastructure tend to fall into one of the following funding model categories:

- **private design, build and operate (DBO)** – where a private operator retains ownership and control of the broadband network. The private operator may benefit from receiving state funds to invest in broadband infrastructure in commercially unviable areas.
- **public outsourcing** – where a private operator has responsibility for running a network under a government-funded contract. The government normally retains ownership of the network after the contract expires.
- **joint venture (JV)** – where a special purpose vehicle (SPV) or separate legal entitiy is created by the private operator and the government to invest in broadband infrastructure in commercially unviable areas. Funding, network ownership and day-to-day management responsibility is shared by the private operator and the government.
- **public DBO** – where the government has full funding responsibility and has full ownership of the network assets. Elements of the day-to-day running may be allocated to private contractors.

The report also identified common funding sources for broadband projects. These included government grants, universal service funding and external funding from non-governmental organizations (NGOs) and international development banks. Note that the 'bottom-up' model has been excluded from the list of the most common investment models. This approach involves communities driving the investment process and it is described in more detail in Section 4, where alternative investment approaches are discussed.

The four above-mentioned models involve variations on a mix of public- and private-sector intervention. Each model's approach varies based on three main characteristics, i.e. i) the funding source for the roll-out and operations of the infrastructure; ii) responsibility for the deployment of the infrastructure and running operations; iii) ownership of the infrastructure (see Table 3.1).

The most suitable investment approach for a particular project can depend on a range of variables including the market structure, level of Internet maturity and the political landscape. The government's experience in funding, owning and running broadband networks is also an important consideration when deciding which investment approach should be taken. The key advantages and disadvantages of the investment approaches are summarized in the sections below. At least one case study is inlcuded in each section for each type of PPP investment approach, which provides details on the role of the regulator in attracting broadband infrastructure investment, and also list key lessons to be taken from each project.

Table 3.1: Key characteristics of investment approaches

Investment approach	Funding source	Deployment and operations of infrastructure	Ownership of infrastructure	Case study
Private DBO	Public and private sectors	Private sector	Private sector	• Mobile Infrastructure Project (MIP), UK • National Broadband Scheme (NBS), Ireland
Public outsourcing	Public sector	Private sector	Public sector	• National ICT Broadband Backbone (NICTBB), Tanzania • Johannesburg Broadband Network Project (JBNP), South Africa
JV	Public and private sectors	Public and private sectors	Public and private sectors	• Metroweb, Italy
Public DBO	Public sector	Public and private sectors	Public sector	• Qatar National Broadband Network (QNBN), Qatar
Source: Analysys Mason, 2015				

3.2 Private DBO

In this investment model the private sector (usually a network operator) designs, builds and operates the broadband infrastructure on behalf of the government. The infrastructure is typically made available to other service providers and Internet service providers (ISPs) on a wholesale and open-access basis. It should be noted, however, that the infrastructure remains under the network operator's ownership and does not transfer to the government.

In this approach government intervention is limited to funding and the private operator retains control over the design of the networks and retains the network assets. The advantage of this approach is that the public sector has limited responsibility and does not have to manage the infrastructure, minimizing its exposure to risk. The private company benefits from the ownership of the infrastructure and minimal government interference. This approach can also be seen as the least complex of the other PPP models as it does not involve the creation of overly complex PPP structures.

There are disadvantages to this approach. Governments have little influence over or control of the network design, build and roll-out strategy, despite funding the network build. The social benefit of the infrastructure may be limited as private operators may be more focused on financial returns than on social investment.

To make the investment case more appealing for operators in commercially unviable areas, the government may provide a grant fund to part-subsidize the cost of building the broadband infrastructure. In return for the subsidy, the government would expect a significant financial contribution from the network operator. The government would also apply strict controls in return for the grant fund; for example, these would

include the setting of roll-out, network quality and take-up targets. In Europe, State-aid mandated 'claw-back rules' prevent the network operator from making excessive profits.

This approach of setting controls ensures that the network operator has a strong financial incentive to construct the network to the required technical standards. In addition, it incentivizes the network operator to achieve the take-up targets set by the government, by stimulating demand and setting reasonable wholesale prices. Therefore much of the operational risk lies with the network operator.

This approach assumes that the network operator is able to build a high-speed broadband network and that it is sympathetic to the concept of operating a wholesale network on an open-access and non-discriminatory basis. Despite no government ownership, monitoring and due diligence by the government are critical in achieving value for money and an effective outcome from this approach. A private DBO is unlikely to make use of state assets in preference to using and building its own assets.

Table 3.2: Selected examples of private DBOs

Name of private DBO	Description
Mobile Infrastructure Project (MIP) (UK)[23]	UK government programme that aims to improve mobile coverage in remote areas by 2016. (See case study below)
Superfast Cornwall (UK)[24]	Project that leverages the resources and expertise of an established operator (BT) to deliver a large and complex project
NGB Wales (Wales)[25]	Grant-funded government intervention has been used to increase the availability of next-generation access (NGA) broadband coverage in rural areas across Wales
InfraCo (Nigeria)[26]	The core tasks of InfraCo will be to build, operate and maintain the fibre-optic communication network, and to lease fibre-optic connections to operators and other companies, as well as to the public
National Broadband Initiative (Malaysia)[27]	This initiative is rolling out high-speed broadband infrastructure through a PPP agreement with Telekom Malaysia Berhad (TM)
Telebras (Brazil)[28]	Telebras, the previously dormant incumbent operator, was re-established in 2007 in order to provide wholesale services to service providers over its backbone network
Rural Broadband Initiative (New Zealand)[29]	This JV between Vodafone and Telecom New Zealand for rural network roll-out is subsidized through a government grant
Mobile network sharing (Sweden)[30]	Mobile operators have entered into a network-sharing agreement to reduce their costs and to help achieve the regulator's coverage obligations
Source: Analysys Mason, 2015	

Two examples of private DBOs are set out in greater detail below.

3.2.1 Case study: Mobile Infrastructure Project (MIP), UK

This case study was chosen since it approached the problem of solving mobile 'not-spots' from a very unique perspective, in that it has funded the build of passive mobile infrastructure in a very tightly regulated UK market.

MIP was initiated by the UK Government in 2011 in order to improve mobile coverage to remote and rural areas within the UK which had either little or no mobile coverage.

Some areas of the UK do not get good quality mobile coverage from mobile operators, or do not get any coverage at all. In some areas, especially remote and rural areas, it might not be cost-effective for mobile operators to provide coverage, as the low subscriber numbers and low subscriber density does not justify investment in mobile infrastructure. These areas are referred to as 'not-spots' and are the primary area of focus for MIP.

The project itself was delivered by a government delivery vehicle named Broadband Delivery UK (BDUK) and the objectives of MIP were to:

- improve the coverage and quality of mobile network services for the 5 to 10 per cent of consumers and businesses that live and work in areas of the UK where existing mobile network coverage is poor or non-existent
- extend coverage to 99 per cent of the UK population.

A GBP150 million capital fund was set aside by the UK government to fund the construction of new masts (passive infrastructure only).[31] The masts, which would be made available to all mobile operators on a wholesale open-access basis, would allow operators to install their own active equipment and offer 2G, 3G or 4G connectivity to end users. The operators would be reponsible for funding their own operating costs.

MIP was funded through a private DBO arrangement. Arqiva, a significant UK infrastructure provider, was awarded the contract to design, build and operate the masts following a competitive procurement. As a result much of the design and planning responsibility was left in the hands of the private sector. However, as MIP was being funded by the state, it was required to gain State-aid clearance from the European Commission in December 2012, which confirmed that the project was compatible with the rules of the single market.

MIP was expected to have connected an additional 60 000 premises out of 80 000 known 'not-spots' by the end of 2013. However, the project has been subject to a number of delays and is not expected to complete until March 2016 – it was originally expected to finish in 2015. The first site went live in September 2013, with little progress made in 2014.[32] By December 2014, only two sites out of potentially several hundred sites had reportedly gone live.

The delays can be put down to a number of reasons:

- it is alleged that Arqiva has not provided the industry with detailed roll-out plans or timescales for the development of the mast sites
- some of the sites have had to undergo lengthy consultation processes to get the necessary planning approvals for the construction of the masts
- there have been technical challenges in getting adequate power supply (3-phase electricity) to some of the most remote sites
- it is challenging to secure backhaul circuits to connect to some of the most remote sites.

The UK telecoms regulator, Ofcom, played an important role in identifying the location of not-spots and is continuing to support the government in delivering MIP.[33] It is too early to tell whether MIP has been successful overall and in particular in eradicating 'not-spots'. However, what is clear is that a project of this scale is not without its challenges and requires significant upfront detailed planning, coordination and stakeholder management. The key lessons and take-aways have been summarized below.

Key lessons: Mobile Infrastructure Project (MIP)

- The UK telecoms regulator Ofcom, played an important role in identifying the location of not-spots and is continuing to support the government in delivering MIP
- The award of State funds to develop broadband infrastructure should require telecoms operators to share their network infrastructure on a wholesale basis to promote competition and reduce costs
- Government interventions should be aimed at funding the construction of passive infrastructure in areas where there was no competing infrastructure. Adopting these key principles was a vital factor in receiving State-aid clearance for the project
- Amendments to legislation and regulation involving the deployment of networks can reduce 'red tape' and speed up delivery
- Stakeholder communications are vital in ensuring all industry players are familiar with the design plans for the project, allowing MNOs to coordinate their own radio planning and service delivery plans
- Private operators should work closer with the industry and key stakeholders to anticipate and overcome the technical challenges of providing power and communications before they become an issue
- A competitive tendering process will ensure that the government achieves a solution that both meets its technical requirements and represents value for money for its citizens
- A single coordinated national roll-out (as opposed to a patchwork of broadband networks) can create implementation synergies, thus reducing the government's overall funding requirement

3.2.2 Case study: National Broadband Scheme (NBS), Ireland

This PPP project was chosen as it was one of the early schemes to use private DBO to improve basic broadband connectivity in rural areas; the fact that it has been fully implemented provides many useful lessons. The project also awarded a contract to a mobile provider rather than a fixed provider, which can provide useful insights to regulators and governments in developing markets where mobile services are more popular than fixed services.

NBS was designed to address the digital divide in Ireland. In 2007, it was estimated that 10 per cent of the population resided in areas where it was not economically feasible for providers to offer services. The NBS scheme was launched in 2008 by the Department of Communications, Energy and Natural Resources (DCENR) to improve the delivery of basic, affordable broadband to certain target areas in Ireland in which broadband services were deemed to be insufficient. These areas were categorized as the NBS Coverage Area. Any fixed residential or business customer located within the designated NBS Coverage Area was eligible to apply for broadband services under the NBS. Approximately 234 000 premises were located within the NBS Coverage Area.[34]

The project cost is EUR223 million,[35] of which the Irish Government made a contribution of EUR80 million. NBS was set up as a private DBO following the conclusion of a competitive tendering process in 2008 which resulted in a contract being awarded to Three (a Hutchison Whampoa company), to design, build and operate the NBS.

Under the NBS contract, Three was required to provide basic broadband services to residents and businesses within the NBS Coverage Area for the duration of the five-year contract. The NBS scheme ended in August 2014 following a 68-month operational period which was limited in duration to ensure compliance with EU State-aid rules. The contract required Three to build mobile infrastructure to provide services at both a wholesale and retail level.

In order to facilitate competition in the area, Three was also required to provide wholesale access to all other authorized operators who wished to serve premises in the NBS Coverage Area. Following the expiry of the scheme, Three is no longer required to make the NBS retail and wholesale services available under the NBS contract, and broadband coverage will continue to be available throughout the NBS areas on a commercial basis.

In 2010, the government announced that it had met the EU target for broadband availability two years ahead of schedule and that broadband coverage was available to 235 000 premises in 1 028 areas (99 per cent of premises) across the country. A separate Rural Broadband Scheme was launched to target the remaining 1 per cent of premises.

A study carried out shows that the spin-off benefits of widespread broadband access can be significant in regional areas. The study estimates that in Donegal, the Scheme will deliver EUR25 million to the local economy, EUR53 million in Galway, EUR40 million in Kerry and EUR26.9 million in Mayo.[36]

The NBS seems to have been a success in Ireland. In 2007, households in Ireland with a broadband connection stood at 31.2 per cent, which was below the EU average of 42.4 per cent. In 2014, households in Ireland with a broadband connection stood at 79.5 per cent, which was above the EU average of 78.3 per cent. Specifically, it is clear that Ireland has a higher percentage of mobile broadband connections than the European Union average as a direct result of the NBS.[37]

Key lessons: National Broadband Scheme (NBS)

- Three was required to offer a wholesale service to other operators on a non-discriminatory basis at an appropriate tariff to ensure compliance with EU State-aid rules
- Once-off state funding is useful to get infrastructure and services into areas that are not economically feasible
- Time-limited interventions can ensure that the retail market has an opportunity to participate in competitive service provision once the intervention period has expired
- More than one intervention scheme may be required to achieve 100 per cent broadband coverage aspirations
- The definition of a coverage area by the number of premises and by region can assist operators in understanding the scope and scale of the intervention

3.3 Public outsourcing

This approach involves the government awarding a contract to a private-sector firm to construct and operate a broadband network on behalf of the government. The government typically funds the entire network and the infrastructure remains in government ownership.

The private sector is normally awarded a contract (after a competitive tender) to construct and operate a wholesale open-access network. It may also be required to market the wholesale services to other ISPs, and in some cases to offer retail broadband services as well. Contracts typically last between 10 and 15 years, after which a competitively procured contractor may be appointed to operate the network.

Most if not all funding for this approach will need to come from the public sector. Unlike the private DBO and JV investment models, the private sector does not make any financial investment in a public outsourcing deal. Instead, the private sector constructs the broadband infrastructure and operates the broadband network on behalf of the government, in return for payments at pre-agreed milestones.

Under this model the government is fully responsible for financing the broadband infrastructure and therefore accepts much of the financial risk. However, this approach does allow the government to have greater responsibility and control over the design of the network and in setting the network's technical- and service-performance criteria. Typically the government will be able to define clear performance

milestones for the private sector to meet (such as network roll-out timescales, take-up and service levels), to be included in the contractual terms. Failure to meet these terms may result in the private sector incurring fines or penalties.

Table 3.3: Selected examples of public outsourcing

Name of private DBO	Description
National ICT Broadband Backbone (NICTBB), Tanzania[38]	National core fibre network built across Tanzania. (See case study below)
City of Johannesburg Broadband Network Project (South Africa)[39]	Fibre network operated across Johannesburg by the government. However, in a recent development the city cancelled the contract and is proposing to convert it into a public DBO. (See case study below)
Auvergne (France)[40]	This model leverages the expertise of the private sector, while ownership remains in the public sector. The private operator receives an income to run the network for ten years
Metropolitan Area Networks (Ireland)[41]	Sells open-access active and passive wholesale services to operators in areas that do not have adequate private-sector broadband provision
Shetland SHEFA 2 Interconnect Project (Scotland)[42]	This project aims to provide adequate backhaul network in the Shetland Islands in areas where such infrastructure is currently unavailable
South Yorkshire (UK)[43]:	Local authorities invested in an FTTC network, with a partnership arrangement for network management. (However, this initiative is no longer running and has reverted to a private DBO)
DORSAL (France)[44]	Collection of local authorities invested in network backbone, DSL and WiMAX services
Project Isizwe municipal Wi-Fi (South Africa)[45]	Private firm Project Isizwe is being contracted by several municipalities to deploy Wi-Fi hotspots in public buildings and schools
Western Cape Government broadband (South Africa)[46]	The Western Cape Government has outsourced the deployment and management of a network connecting all provincial government buildings to Neotel.
Source: Analysys Mason, 2015	

Two examples of private DBOs are set out in greater detail below.

3.3.1 Case study: National ICT Broadband Backbone (NICTBB), Tanzania

This case study will be of interest to regulators and governments that are currently construcing national fibre backbone networks to facilitate the roll-out of broadband connectivity and wider e-Enabling initiatives.

The NICTBB is a fibre network being built by the Government of Tanzania in order to enhance the usage of ICT applications and promote the development of e-government, e-learning, e-health and e-commerce. The NICTBB is broadly intended to achieve the following objectives:

- provide international connectivity to all landlocked neighbouring countries
- establish points of presence (PoPs) across all of Tanzania's administrative districts
- provide all licensed operators with equal access to the fibre network to stimulate competition
- enable the provision of affordable Internet to Tanzanians

- increase the usage of ICT
- facilitate the implementation of e-government initiatives.

The NICTBB is managed and operated by the incumbent fixed operator Tanzania Telecommunications Company Limited (TTCL) on behalf of the government. It should be noted that the NICTBB has a completely independent network from that of TTCL's network. The USD200 million project is being funded by the International Telecommunication Construction Corporation (CITCC) of China at the cost of USD170 million – mainly thanks to a soft loan provided by Chinese Exim Bank[47] and with the USD30 million from the Tanzanian Government. With the support of the loan, the Tanzanian Government deployed a fibre cable on the rail, electricity and gas networks in 2010 and pooled this fibre into a single SPV, the NICTBB.

The NICTBB provides high-capacity long-distance wholesale capacity to fixed and mobile operators and ISPs as well as providing access to international submarine fibre connectivity. The establishment of PoPs across Tanzania allows operators to connect their last-mile networks to a national backhaul network. NICTBB's network spans between major towns and cities across Tanzania and extends to all the borders of the neighbouring countries. The NICTBB has also been connected to the two East Coast submarine cables (EASSY and SEACOM) landing at Dar es Salaam.

NICTBB operates from open-access PoPs in all major towns and cities. Most of the NICTBB equipment has been accommodated in TTCL buildings; therefore operators can access carrier-class hosting and bandwidth services.

The NICTBB has been implemented in phases, with 31 PoPs currently operational. By the end of 2014, NICTBB spanned 7 560km across 24 regions. It has reached all border points and achieved a USD6.7 million contract to provide bandwidth to Rwanda over the next ten years. Third-party research has found that there have been improvements in the provision of e-commerce, m-commerce, e-banking, e-education and e-government since the NICTCBB commenced operations.[48] These improvements have enabled Tanzanians who were otherwise digitally excluded to become proficient in using e-services, which has accelerated Tanzania's economic development.

However, fixed broadband penetration is still very low in Tanzania, standing at only 0.1 per cent of the population at June 2014. This is due to the fact that coverage of fixed broadband metro and access networks is limited. Mobile penetration is still low in Tanzania, standing at 60.1 per cent at the end of 1H 2014, leaving room for continued growth.[49] Improved coverage, especially in rural areas, has helped to make mobile services more accessible. The government awarded contracts to TTCL in February 2014 and Vodacom in April 2014 to expand coverage to underserved areas, and supported them with the universal access fund. The telecoms regulator has also contributed to improving the affordability of mobile services by introducing mobile termination rate (MTR) cuts in March 2013.

Key lessons: National ICT Broadband Backbone (NICTBB)

- NICTBB is operated and managed by TTCL on a transparent and open-access basis. It is operated separately to the rest of TTCL's business. This separation and the provision of transparent and open-access connectivity is essential in ensuring service providers are not adversely affected by the government's intervention in infrastructure
- Other regulatory measures, such as cuts in MTR rates in conjunction with broadband interventions, may be necessary to stimulate growth in mobile services
- Infrastructure intervention backed by a strong business case and development agenda can attract significant development funding or loans
- National backbone networks are not a means to an end. Further investment in metro networks and access networks will still be required to deliver last-mile connectivity to end users
- The lack of specific and defined outcomes makes it difficult to measure the true success of an intervention or investment
- Allocating universal service funds to competing operators can stimulate competition in the development of rural broadband networks

3.3.2 Case study: Johannesburg Broadband Network Project (JBNP), South Africa

This case study has been selected because it provides useful insights into a public outsourcing project that has – for a number of reasons – become a public DBO project. The Johannesburg municipal government took control of the project when contracts with private contractors were terminated.

In 2006, the JBNP was conceived by the City of Johannesburg (CoJ) municipal government in order to address digital exclusion issues and to improve use of digital connectivity among Johannesburg's citizens and businesses. The JBNP's vision was to become a Smart City and it was expected that the JBNP would develop economic growth through the creation of business opportunities, by providing access to public services and increasing employment opportunities for youths.

To realize its vision, CoJ awarded a contract to Ericsson – which was then ceded to CitiConnect Communications – to build a fibre network that would extend coverage across the City's business and residential premises. The fibre network was estimated to be 900km in length.[50] The principle behind this network was to provide businesses and residents with broadband and ICT services at lower cost than was available by enabling service providers to access wholesale capacity from the JBNP on an open-access basis. This in turn would allow service providers to provide end users with low-cost retail services. The CoJ would also act as an anchor client connecting its buildings to the JBNP, however this would only account for a small percentage of network capacity.

The investment was estimated to be around USD100 million in capital with management costs expected to be around USD24 million per annum. The contract was constructed along the lines of a public outsourcing model; after 12 years, Ericsson would return responsibility for the operation of the network back to CoJ.[51]

The network build was expected to go live in 2013; however in 2014 the CoJ terminated the contract with CitiConnect Communications, supposedly on the basis that CitiConnect Communications had breached the agreement, a claim which the latter disputed. The CoJ paid around USD93 million to Ericsson for the infrastructure that had been built to date and in February 2015,[52] the CoJ took responsibility to complete the network build. It is now a public DBO project, meaning that the infrastructure is fully owned and operated by the municipality.

The project has come under scrutiny from independent analysts and politicians who have questioned the need for a municipally owned fibre network. Questions have also been raised about the ability of CoJ to compete with commercial service providers to generate profitable returns. There have been calls for the CoJ to sell the network to private service providers.

Key lessons: Johannesburg Broadband Network Project (JBNP)

- Governments should undertake an extensive market assessment prior to undertaking a broadband intervention to ensure there is a clear market failure that justifies the intervention. In this case a number of alternative fibre networks are already available in Johannesburg, which has called the validity of the project into question
- Contractual obligations upon the public and private sector should be clear at the outset to ensure there is no dispute in the event that either party defaults on the contractual agreements
- Public DBOs should be limited to offering wholesale services on a non-discriminatory and open-access basis to ensure competition is not adversely affected

3.4 Joint venture (JV)

This model assumes a split in ownership between the private sector (typically one or more network operators) and the government. The network operator takes responsibility for the design, build and operation of the broadband network infrastructure. The network infrastructure is typically made available to other service providers and ISPs on a wholesale and open-access basis. The infrastructure remains part-owned by the network operator and the government.

Public-sector funding is required for a JV, but funding is shared with private-sector partners. Much of the initial financial contribution to fund the network build typically comes from the government, to make it attractive to the private sector. The costs of deploying the network infrastructure, associated systems and processes and the ongoing administration of the JV are shared. The exact amount of private- and public-sector capital investment has to be agreed, based on how rewards and risks are shared.

The government takes on greater financial risk with this approach; however, it is able to control the initial stages of the design and construction of the network. Meanwhile the private sector takes on greater responsibility once the project becomes self-financing.

Depending on the terms agreed for the JV the government may retain its ownership in the venture or it may divest its shareholding in order to recoup some of its early investment.

JVs can vary widely, since they need to take account of local tax considerations and the extent to which the government wants to hold shares and voting rights. Examples of JVs are very limited, possibly because they are complicted to set up.

Table 3.4: Selected examples of JVs

Name of private DBO	Description
Metroweb (Italy)[53]	Ownership of the network is split between the public and private sectors by setting up an SPV. (See case study below)
Banda Ultralarga in Lombardia (Italy)[54]	A JV approach enables the government to secure expertise and financing while maintaining public control over the scope of the project
Eastern Corridor (Ghana)[55]	The Ghana Ministry of Communications, in partnership with Alcatel–Lucent, has planned a 800km fibre-optic network in the Eastern Corridor
Kenya LTE[56]	This PPP has been proposed to deliver a national broadband LTE network in Kenya
Source: Analysys Mason, 2015	

An example of a JV is described in greater detail below.

3.4.1 Case study: Metroweb, Italy

This case study – although covered in previous ITU reports – has been selected as it resulted in an infrastructure fund manager acquiring a controlling stake. Metroweb has also recently become the subject of a takeover battle between leading operators in Italy, attracting significant private-sector interest.

Prime Minister Matteo Renzi has an ambitious plan to bring super-fast broadband to 85 per cent of Italy's consumers by 2020. Fixed broadband take-up in Italy is 23 per cent compared to an EU average of 31 per cent and the share of fixed broadband download speeds (greater than 30Mbit/s) are significantly below the EU average of 23 per cent, at just 2 per cent.[57] Metroweb, which generates sales of just USD74 million is seen by the Prime Minister as the right vehicle to achieve his ambitious plans.

Metroweb is an example of a SPV where ownership of the network is split between the public and private sector. It was conceived as a result of Telecom Italia's (the incumbent operator) lack of investment in fibre infrastructure. It is an arrangement between the local gas and electricity utility company A2A and e.Biscom, a new telecoms service provider, to accelerate the roll-out of a large metropolitan fibre network.

Metroweb's mission is to deploy fibre-optic access networks (ducts and cables) in the major metro areas. Metroweb owns a 3 200km fibre network extending almost across the whole municipality of Milan and Northern Italy. Metroweb is a passive infrastructure operator and leases point-to-point dark-fibre service to its customers. Metroweb's main customer is Fastweb (its separate retail arm), but it also serves Telecom Italia, Wind, Vodafone and other service providers in Milan.

As of April 2015, Metroweb is planning to expand its fibre-optic network to two Italian cities, having agreed a EUR100 million loan with two Italian banks.[58] The company will select the metropolitan areas with the greatest housing density among a shortlist including Florence, Parma, Verona, Brescia and Monza. The company has recently expanded its fibre-optic network to Turin and Bologna in separate investments of around EUR125 million and EUR62 million.[59] Although Metroweb is central to the government's broadband aspirations, it has not gained from any State-aid approved funding. However, local municipalities (such as the one in Bologna) have played a key role in creating favourable conditions to attract investment from Metroweb by:

- creating a register of all current network infrastructure in the City
- speeding up the process of getting the necessary planning permits to carry out civil work.

Italian infrastructure fund F2i acquired a 53.8 per cent stake in Metroweb in 2011, as it expecting a growing demand for high-capacity broadband and services such as those provided by Metroweb. It is now looking to divest all or part of its holding. Consequently Telecom Italia and Vodafone have become interested in acquiring Metroweb's national high-speed fibre network. On 13 January 2015 a meeting was held between

F2i and Vodafone to reportedly discuss the possible sale of a controlling stake in Metroweb. The firm is valued at around EUR400 million.[60]

Key lessons: Metroweb

- It is possible to create a public–private SPV without direct funding from the government or without any State-aid or public funds
- Municipalities can play a key role in attracting private-sector investment by reducing bureaucracy and making relevant data available
- Metroweb operates separately to its retail arm (Fastweb), enabling it to offer wholesale services to other service providers. This approach also allows the SPV to generate income from more than one service provider funding immediate cashflow requirements
- SPVs can access commercial financing to fund network expansion just like any other commercial operator
- Public–private SPVs can be acquired by private investment funds. This arrangement has likely attracted further interest in Metroweb from private operators, in the same way that they would approach any other commercial deal

3.5 Public DBO

The public DBO investment model is an extension of the public outsourcing model and requires the greatest level of involvement and financial contribution from the government, and minimizes private sector involvement and investment. This model is used as an intervention method when it is not possible to attract any interest from the private sector. The government typically funds the entire network construction and the infrastructure remains in government ownership.

Public DBO projects work in much the same way as public outsourcing; a private-sector contractor is awarded a contract to design and build the network infrastructure on behalf of the government. However, the government creates a separate public-owned company which has responsibility for management and operation of the broadband network, so the main difference from public outsourcing is in the operation of the network, rather than its construction. The public-owned company takes full responsibility for making the wholesale open-access network available to other service providers on a competitive and open-access basis.

In the case of this model the government is fully responsible for financing the broadband infrastructure and therefore takes on much of the financial risk. The government also takes on additional operational risk compared to the risk inherent in other investment models. However, as with the public DBO this approach allows the government to have greater responsibility and control over the design of the network and in setting the network's technical and service performance criteria. Having ownership control may allow the government to re-use assets from SOCs, providing they are fit for purpose.

It should be noted that the public-owned company will be responsible for meeting the performance milestones, whereas under the private DBO model this is the responsibility of the private sector.

Table 3.5: Selected examples of public DBOs

Name of private DBO	Description
Qatar National Broadband Network (QNBN) (Qatar)[61]	A private company owned by the government of Qatar with responsibility to roll out passive fibre infrastructure across the country. (See case study below)
NBNCo (Australia)[62]	An SPV (NBNCo) was created to leverage Telstra's infrastructure to address rural and urban needs
Asturcon (Spain)[63]	A 100 per cent public-owned and public-run network in an area requiring economic regeneration; Asturcon has attracted a national operator (Orange)
Stokab (Sweden)[64]	A municipality-owned, city-based dark-fibre meshed network
Midtsoenderjylland (Denmark)[65]	A municipality-owned investment in fibre connectivity between city halls to provide FTTH, in partnership with the local electricity company
Piemonte (Italy)[66]	Piemonte is managed by a public ICT administration organization investing in multiple infrastructures to stimulate private investment
Alto Adige (Italy)[67]	Alto Adige is managed by a local council to provide wireless connections to homes and fibre connections to the public sector and businesses
RAIN (Lithuania)[68]	RAIN is managed by a non-profit-making public enterprise investing in a nationwide backhaul/core network.
Source: Analysys Mason, 2015	

Below we describe an example of a public DBO in greater detail.

3.5.1 Case study: Qatar National Broadband Network (QNBN), Qatar

This case study is a recent example of how a government-funded private company can be used to facilitate the roll-out of passive fibre infrastructure, and work with the private sector to reduce infrastructure costs.

Qatar has among the highest broadband penetrations in the world, however it lags significantly behind leading nations in terms of speed, with current maximum speeds of only 8 Mbit/s. In 2011 the Qatari government established QNBN with a mandate to roll out a nationwide, open-access high-speed broadband FTTH network after it was awarded a 25-year licence by the Telecom Regulatory Authority, Qatar. QNBN was formed as a result of Qatar's ambitious digital plans, which are summarized under the Qatar ICT Strategy 2015 and further articulated through the Qatar National Vision 2030. The aim is to become one of the most well-connected countries on earth with respect to broadband.

The QNBN network will have nationwide fibre coverage and will provide wholesale services to service providers. In 2012 Ericsson was selected by QNBN to deploy the fibre network. QNBN will retain ownership of the fibre network and maintain responsibility for managing and running the network, hence it is classified as a public DBO. The network is expected to cover 95 per cent of the households in Qatar by 2015 and 100 per cent of the business establishments in Doha by 2015, equating to approximately 260 000 connections by 2015.[69] QNBN will focus solely on the deployment of a passive network infrastructure, leveraging existing and new infrastructure in Qatar to maximize efficiency and cost-effectiveness.

According to QNBN typical investors would not be attracted to invest in passive infrastructure because the return on investment is not that high. As a result the government has invested around USD500 million in capital expenditure to overcome these bottlenecks.

In 2011 QNBN signed an Infrastructure Access Agreement (IAA) with service provider Qtel to reduce QNBN civil infrastructure build costs. Under the agreement Qtel will supply QNBN with duct network access and access to other passive telecoms infrastructure over the next 20 years.[70] However, Ooredoo, which dominates the fixed broadband market, is aggressively laying fibre to replace its copper network. It appears that it is continuing to deploy its FTTH network in parallel with QNBN's fibre roll-out. Ooredoo seems to not be giving QNBN access to its fibre network despite repeated attempts from the regulator to force Ooredoo to do so. Ooredoo's lack of cooperation and roll-out delays are hindering the government's plans for nationwide fibre coverage by 2015. The regulator may need to consider a more severe form of intervention to ensure Ooredoo's cooperation.

In 2012 QNBN signed an interim wholesale agreement with Vodafone Qatar,[71] to enable it to use the QNBN network to deliver telecoms services to end users. Vodafone Qatar has deployed very limited fixed infrastructure to date, and relies on QNBN's network outside its original market of the Pearl district. Because of QNBN's slow progress, Vodafone might consider alternatives to offer fast broadband services to it customers by, for instance, lobbying the regulator to force Ooredoo to give access to its passive infrastructure.

QNBN began to roll out fibre infrastructure in Barwa City and Barwa Commercial Avenue in August 2012. It was not until 2013 that it announced the opening of two central offices to serve 30 000 businesses and residences in the West Bay area (the business district) of Doha. The delay has been partly caused by operational complexities in the network roll-out – in particular when re-using Ooredoo's civil infrastructure. At the same time, Ooredoo is continuing to deploy its own fibre infrastructure, regardless of QNBN's mandate. In the meantime QNBN has connected a number of government ministries through point-to-point fibre connectivity, enabling the ministries to benefit from secure high-speed broadband networks.

In 2014, Vodafone Qatar reached a non-binding agreement to buy 100 per cent of NBN for QAR210 million (USD58 million).[72] However, this was scrapped following a due diligence and negotiation process and QNBN is continuing with is build-out strategy.

Key lessons: Qatar National Broadband Network (QNBN)

- QNBN was granted a licence to offer wholesale services on an open, equal and non-discriminatory basis and a mandate to set appropriate national wholesale prices to enable downstream (retail) competion
- Government funding of fibre networks can be used to reduce the investment required to be made by private operators, therefore attracting private sector interest in the network
- Re-using existing passive infrastructure may reduce civil infrastructure build costs. However, dominant operators should be required to provide open access to their networks
- By continuing to roll out FTTH aggressively, alternative operators (in this case Ooredoo) might contribute to fulfilling the broadband vision in a different way than initially expected – in this case independently of QNBN. This would mean putting the government intervention at risk and Qatar might end up with two separate fibre networks. These risks must be taken into account prior to initiating an intervention project
- Operators should be consulted in advance to understand their roll-out plans; doing so may avert the risk of duplicating fibre networks
- National broadband networks can be considered for sale to the private sector subject to regulatory approval and commercial due diligence. However, in this case, Vodafone's proposed deal might have run against the original remit of QNBN, which was to rent wholesale fibre capacity to Vodafone Qatar and its rival Ooredoo, limiting competition further downstream

3.6 PPP implementation strategies

The PPP investment strategies and models descibed in the previous section are still commonly used by operators and governments (and in some cases regulators) to finance investment in broadband networks, particularly where government or other form of state intervention is required, whether in developed or in developing markets. In implementing national broadband PPP projects that include open-access initiatives, a number of considerations need to be taken into account by governments and regulators as described in Table 3.6.

Table 3.6: Requirements for governments to foster and secure investment

☑ Consider local market conditions such as the level of Internet maturity, operator ownership structures and the regulatory and market structure
☑ Have realistic and well-defined broadband objectives with speed and coverage targets
☑ Introduce non-discriminatory, wholesale open access to broadband infrastructure
☑ Implement transparent procurement processes

Each of these elements is described in more detail in the following sections.

3.6.1 Consideration of local market conditions

There is general acceptance among managing authorities of the investment approaches and funding sources described above. As a result, managing authorities are increasingly becoming more focused on how their broadband vision (as defined in their national broadband plans) will be implemented and adapted to local conditions. National broadband plans set out a vision for broadband connectivity and development of ICT, detailing broadband coverage and speed and a set of actions to help achieve their broadband vision. Local conditions and factors that are likely to affect these considerations will include:

- **The development of the digital economy and Internet maturity**: Internet maturity includes factors such as Internet take-up; availability of local and compelling content; and development of e-government initiatives to connect schools, government offices and hospitals. It also includes implementing and enforcing cybersecurity regulations and improving ICT literacy. Economies that can demonstrate greater Internet maturity – or those that show they have plans in place to develop the Internet ecosystem – will drive Internet traffic growth. This in turn will encourage competitive investment in broadband infrastructure.
- **Political landscape and ownership structures**: managing authorities that retain whole or part ownership of incumbent operators (often regardless of their success as operators) are likely to be favoured by politicians to receive funding even if they are not necessarily the best equipped commercial operator. This may dissuade investment in broadband infrastructure from the private sector.
- **Market structure and regulatory effectiveness**: a market where a dominant operator is not required to provide wholesale non-discriminatory open access to its network can hold back broadband development in areas where broadband is most needed and can result in the unnecessary duplication of broadband infrastructure.

Governments and regulators should consider these aspects in the implementation and design of their national broadband plans.

3.6.2 Development of broadband targets

Another factor that influences the implementation of broadband projects relates to how governments and regulators develop their broadband targets and their understanding of the costs and funding requirements

to support that investment. Many managing authorities, particularly in developing markets, have developed broadband targets that are simply too aggressive, given current levels of investment in broadband infrastructure and the relatively low levels of Internet maturity in those economies.

Well-defined and realistic broadband targets will enable a better understanding of the range of technologies required to meet the targets, allowing a more accurate prediction of deployment costs. Knowing the costs will in turn allow managing authorities to establish the required funding contribution and allow operators to define their investment requirements. In some cases this can be an iterative process where the targets are revised until an optimum balance is achieved between optimistic speed and coverage targets, and the availability of funding.

Covernments and regulators could therefore adopt the following principles in defining their broadband targets:

- Targets are to be progressively defined, so that they increase in line with current market trends for the next ten years. The targets should define the broadband speed and coverage (by number of business and residential premises) over that time period.
- Targets need to distinguish between rural and urban areas. It is more likely that urban areas will require higher-speed services than rural areas, but greater funding will be required in rural areas.
- Targets need to be realistic and achievable rather than being over-optimistic and over-ambitious, otherwise it will not be possible to estimate whether the broadband project has been a success.

Coverage targets can be included in mobile spectrum licences or in fixed network licenses therefore investors would need to undertake a detailed assessment of the targets in order to assess the cost of acheiving them. They would also need to assess whether they are achievable at all so as not to commit to a project that cannot be delivered successfully.

3.6.3 Open-access networks

Open-access networks are another vital aspect of implementing broadband projects, particularly in the promotion of competiveness and fairness and, ultimately, to reduce duplication in infrastructure. The provision of open-access networks can ensure that operators have effective, non-discriminatory and transparent access to wholesale networks.

There are two dimensions to the definition of ‘open access’, i.e. an operational and a technical level. At the operational level, access must be:

- **effective**: it should provide the services requested without undue burdens such as onerous processes or overheads
- **transparent**: it should be clear how to use the service, and it must be provided efficiently
- **non-discriminatory**: it should be possible to demonstrate through some level of separation that services are provided in a non-discriminatory way, with some mechanism of recourse if non-price discrimination is suspected.

At the technical level, open-access services can be provided at

- layer 0: civil infrastructure (ducts, poles, towers)
- layer 1: transmission media (fibres, copper)
- layer 2: transmission point-to-point connections
- layer 3: Internet Protocol.

Open access at one level typically allows competition at higher levels. The principle of open-access networks can be applied to a number of the investment models considered in Section 2. Managing authorities will need to decide in which layers duplication should be avoided, and where competition – and duplication – can be encouraged. This will need to be done in advance based on analysis and modelling.

In terms of wireless networks, there is insufficient international experience to suggest what may constitute best practice in wholesale open-access wireless networks. Emerging projects may yet develop best practice, but such networks face significant organizational and strategic challenges.

3.6.4 Procurement

Due to the nature of public PPP projects involving public money funding, PPP projects are normally conducted as public network procurement. Public network procurements (whether financed through a universal service fund state or through other means) should be undertaken according to best-practice principles, ensuring they are fair, equitable, transparent, competitive and cost-effective. It is suggested that as many of these principles as possible are adhered to in the design of any public network procurement involving public subsidy. Broadband projects that are private in nature and do not involve any public funding are not bound by these principles, although many of the principles will still be applicable to private-led procurements. These principles are described in more detail in Annex 1.

4 Alternative approaches to funding broadband networks

The previous sections in this report have looked at strategies used by governments and operators to invest in broadband projects that require public subsidy, often in the form of PPP projects. The methods used by privately owned operators to raise funds from existing cashflows or financial markets to fund network investments is relatively well known and is therefore not discussed in this report. However, a growing number of investors – comprising of existing operators, new entrants and financiers – have developed alternative approaches to fund broadband network investments. To further examine alternative approaches to investment in broadband we have selected examples from four investor categories, as set out in Table 4.1.

Table 4.1: Overview of investor categories and corresponding case studies

Investor category	Case study	Existing parties
Existing market players	MGTS, Russia	MGTS
New market entrants	Google Fiber, USA Google Fiber, Uganda	Google Fiber Google Fiber
New financiers	SIGFOX, France Seacom, Africa Asia–Pacific Gateway, Asia	Elliot Management Convergence Partners Facebook
Not-for-profit investors	Community broadband, Germany	Communities

Source: Analysys Mason, 2015

Moreover, we have provided a detailed description of a project case study for of each of these investor categories below. In each instance the motivation for the financing approach used is given, the role of the regulator to attract investment is discussed and an overview of potential barriers to investment is provided.

4.1 Existing market players

Operators have traditionally invested in broadband infrastructure in commercially viable areas using their own funds that have been allocated for capital investment. In some cases operators have generated funds through selling decommissioned network assets (e.g. copper networks) and using the proceeds to fund their broadband investments. Revenue can also be raised from selling old active equipment.[73]

Bezeq, a fixed and mobile operator in Israel, generated cumulative profits of ILS214 million (USD60.8 million)[74] between 2009 and 2013 by decommissioning its copper network. Another operator

exploring this approach is MGTS, a fixed-line operator in Russia. MGTS is discussed in more detail in the case study below.

4.1.1 Case study: MGTS, Russia

This case study was chosen to illustrate how MGTS, the fixed-line incumbent in the Moscow region, is funding its fibre network roll-out by decommissioning its legacy network.

MGTS is aggressively rolling out gigabit optical passive network (GPON) FTTH. MGTS had a PSTN capacity of 4.994 million lines at the end of 2012 and had passed 2.6 million homes with FTTH at the end of 2013. The ultimate objective for MGTS is to pass 4.4 million homes with FTTH by 2015.[75]

In 2013, the operator agreed to sell its 49 per cent stake of CJSC Business Nedvizhimost, the owner of telephone exchanges in Moscow, to Russian investment company Sistema. MGTS retains a portfolio of buildings in Moscow with a total footage of around 1 million square metres, although the properties already sold are considered to be the most valuable. MGTS notes that the sites will be freed up by the end of 2015 as a result of the GPON deployment.

The value of the transactions was RUB6.3 billion (USD194 million) and the funds will be reinvested to help fund the GPON roll-out. MGTS notes a total cost of around USD2 billion for its FTTH roll-out, of which around 80 per cent comes from homes passed costs – 50 per cent from construction costs and 30 per cent central office-related costs – the remaining 20 per cent comes from connection costs. This equates to USD360 per home passed – the transaction will in effect cover the costs of passing around 12.7 per cent of the total 4.4 million homes that will be covered.[76]

MGTS notes that it could generate more revenue from exchange sales and expects to divest further assets. The first tranche of exchange sales has been relatively more profitable for MGTS compared to other operators such as Bezeq. This reflects sales of high-value property in the Moscow region, Russia's richest area.

The operator also intends to generate revenue from selling copper and is working on the procedures to remove the copper lines. The project to remove and sell the copper will begin in earnest in 2016. MGTS is not yet issuing guidance on how much revenue it expects to generate from copper sales.

MGTS is making good progress in transferring customers to its GPON network. At the end of 2012, 20 per cent of homes passed with FTTH were subscribing to a GPON voice service, a figure that increased to 30.4 per cent at the end of 2013. This transition has allowed the company to improve the average revenue per user (ARPU): at the end of 2013, customers migrating to GPON offers had a 55 per cent higher ARPU than previously.[77]

Key lessons: MGTS

- MGTS commited to a GPON FTTH deployment strategy funded through divestment of key telecoms assets to help fund fibre roll-out and improve the company's competitive position for the medium to long term
- Consequently, MGTS has demonstrated that investment in fibre can generate higher ARPUs. These ARPUs can be generated through offering higher-layer services such as IPTV and video on demand, for example
- However, decommissioning the copper network can also result in losing voice-only customers, who do not want to migrate to the new network. MGTS acknowledges that during the migration process it will lose voice-only customers who do not wish to migrate. However, the company believes that its gains in the fixed broadband market will outweigh these losses
- The regulator allowed MGTS to decommission its copper network and divest the assets. The implementation of this approach is very dependent on whether there are local loop unbundling (LLU) or bitstream services. There is no LLU in Russia. The process of decommissioning the network will be much faster and easier to achieve in countries where the local loop infrastructure is not being shared with other operators

4.2 New market entrants

New market entrants are driven by a desire to address market gaps to serve their immediate or wider interests. For example, ISPs will focus on addressing the generation of connectivity-based revenues, while organizations operating higher up in the Internet value chain – traditionally not ISPs – can benefit from a strong Internet ecosystem that will allow their Internet services to be more widely used. The primary driver for the latter is to act as market catalyst to develop a mature Internet ecosystem, creating a demand for their services downstream.

The approach taken by the new entrants can vary based on the market context. In established economies, the issue is likely to be related to broadband providers' lack of motivation to invest in their legacy networks. In this scenario, the new entrants may be required to go head-to-head with the established players and develop more competitive propositions than the latter group. The desired outcome is that the new market competition will push established players to improve their service. In developing markets, the issue is likely to be the lack of infrastructure, as established providers may not have the funding to roll out and maintain the network. In this case, the new entrant may take the role of partnering with the existing providers, or even the government, to share the infrastructure cost. In the case of Google Fiber, Uganda (see below), our understanding is that the company funded the entire project.

4.2.1 Case study: Google Fiber, USA

Governments or regulators interested in attracting investment from new entrants need to create the right environment for this to occur. This example was selected because it describes how Google, a global player whose traditional core business is to provide services over the Internet, made the decision to invest in broadband network infrastructure and offer broadband services to ISPs and end users.

Google Fiber's initiative is driven by Google's ambition to "help make Internet access better and faster for everyone", as stated in 2010 when the company was still testing how to roll out its fibre network. Google is exploiting the opportunity to cherry pick a handful of cities where operators do not offer high-speed broadband services to offer end users high-speed connectivity. Its motivation for investing in fibre networks is to provide more opportunities for Google to offer advertising and content, generating revenues in addition to broadband subscriptions.

In December 2012, Google Fiber started offering fixed broadband and TV services over its fibre to the premises (FTTP) network, in Kansas City. The city was chosen for its good economic infrastructure and a business-friendly environment; for example, utility conduits avoided the need for digging up streets.[78] Currently three cities are covered by Google Fiber and there are expansion plans for five more across the USA.

There are estimates from analysts of close to USD84 million spent to pass 149 000 households in Kansas City, resulting in a cost per household of USD564. The cost to acquire and connect a broadband customer is estimated to be USD464.[79]

A key differentiator of Google Fiber's proposition is its high-speed broadband, offering up to 1 000Mbit/s. The reaction from other broadband providers has already been felt. In August 2014, Comcast and Time Warner announced that they would be increasing their Internet access speed to customers in Kansas City.[80] And in February 2015, AT&T announced that it would match Google Fiber's price and speed in Kansas City.[81]

In its 'Google Fiber City checklist',[82] Google lists the requirements that applicant cities need to meet to be considered as a candidate for future network expansion. An attractive environment for Google Fiber to expand would offer:

- transparency about existing infrastructure
- clear rules about gaining access to the existing infrastructure
- facilitation of permitting, construction licenses.

Key lessons: Google Fiber (USA)

- Having easy access to economic infrastructure and utility ducts was a key reason behind Google selecting Kansas City, as it reduced the need for street digs which in turn reduced investment costs and the time taken to offer services to the market. Governments and regulators should consider how they can increase the attractiveness of the investment environment to make the business case for new entrant investment commercially viable. This can be achieved through undertaking operators and investor consultations to understand their concerns which may be holding back investment
- Government capital investment needs may be reduced by creating the correct investment conditions for private-sector investment and by working closely with operators. The favourable investment environment in Kansas City which attracted Google benefited the local government as it was not required to make an investment which it would otherwise have been unable to source. According to the Mayor of Kansas City they would not have been able pass a bond issue for the investment required
- The Federal Communications Commission (FCC) played no role in the network roll-out of Google Fiber in Kansas City as the main facilitator was the local government, which expedited the permit process, giving rights of way for little or no cost and allowing Google Fiber to build in desired areas
- Heavy regulation can create a barrier to new entrants. As part of the lessons Google Fiber took from deploying in Kansas City, it said that investment flows into areas that are less affected by regulation than areas that are dominated by it. However, clearly the amount of regulation required is dependent upon the market effectiveness in each country allowing Google Fiber to build in desired areas

4.2.2 Case study: Google Fiber, Uganda

The example of Google Fiber investing in Uganda was chosen to demonstrate that the approach taken by Google in the USA can also be replicated in developing markets. In this case, Google Fiber is not competing with broadband service providers; instead it is selling them network wholesale services.

The lack of adequate infrastructure in Uganda has been a barrier to making high-speed broadband available and to drive Internet maturity. For Google, this situation hinders its ability to grow revenue from online advertising, its core business.

According to the ICT Association of Uganda, there are only a limited number of local players with the knowledge and resources to invest in broadband infrastructure. In addition, those organizations with the capabilities to invest may have been deterred from investing due to the fear of assisting their competitors.

In November 2013, Google Fiber announced that it had deployed a fibre backbone network in Kampala, Uganda. This network enables local mobile operators and ISPs to increase their data speed, with a speed of up to 100 times faster than usual in some parts of Kampala.

Although the investment taken by Google in Uganda is different to that in Kansas City, its motovations are the same. The main motivation is to stimulate broadband take-up and usage among end users, providing Google with more opportunities to sell advertising and generate revenue from content in the future.

The amount invested by Google Fiber has not been disclosed. However, as an indication, in 2006 the Ugandan government tried to implement a similar broadband infrastructure project which was worth USD100 million; this provides a useful proxy for the level of investment required.

Google Fiber emphasizes the importance of local governments in creating the right environment to attract new entrants. According to Google, "[l]ocal government can actually play a large role in reducing the complexity of fibre networks just by giving new entrants access to maps of infrastructure, including maps of gas and water mains and things like expedited construction permits".[83] Making infrastructure available to new entrants is key to promoting network coverage expansion.

Key lessons: Google Fiber (Uganda)

- Local operators may be deterred from investing in broadband infrastructure through the fear of assisting their competitors, e.g. if required to offer parts of their network on a wholesale open-access basis. This concern can be reduced if governments or regulators offer incentives such as a limited period of exclusivity allowing the operator to recuperate their intial investment before offering the network for wholesale access
- Local governments in developing markets have a central role in attracting new providers. As in the previous case study, it is very important for new entrants to be clear about which infrastructure (e.g. ducts, poles) is available to them and where it is located
- Google Fiber succeeded in installing the network in Kampala whereas the Ugandan government failed to do so in 2006 while partnering with a network equipment vendor. Therefore a service provider that is incentivized by end-user revenues can be more successful than using a third party merely to deploy the network.

4.3 New financiers

Investment in broadband infrastructure may also be sourced from more unlikely institutions such as hedge funds or corporate organizations which do not traditionally invest in broadband infrastructure. These organizations are normally driven by the opportunity to recoup their investment through public listing or

when the company is sold or through downstream revenues, i.e. the enablement of the broadband infrastructure allows broadband dependent products and services to be sold.

The investments that can deliver the high levels of return sought by hedge funds normally carry a reasonable level of risk. This risk could be due to the sheer scale of the project or the uncertainty around the deployment of a new technology. As a result, these investments tend to involve multiple investors to spread the investment risk.

As an example, Gigaclear, a new UK-based fibre broadband network operator, has been able to fund its business expansion with the support of equity funds. Gigaclear is focused on rolling out fibre networks across rural areas in England. In February 2015, the company secured GBP6.5 million from investors such as CF Woodford Equity Income Fund and Forward Private Equity[84].

Providers of Internet services such as Google and Facebook have also been involved in large-scale investments in broadband infrastructure. Both companies' business growth depends on people having adequate Internet access. The yearly USD multi-billion revenue generated by these type of organizations allows them to bear the risk of participating in large-scale investments.

4.3.1 Case study: SIGFOX, France

This case study was chosen as it demonstrates how a hedge fund has invested in a start-up to support the development and expansion of a global cellular technology developer, as opposed to investing in broadband infrastructure. This also demonstrates the interest in investing in emerging technologies.

Elliot Management is a hedge fund founded in 1977 and is based in the USA. The company invests in debt and equity securities and its investment focus tends to be on companies undergoing restructuring. In 2015, Elliot Management participated in SIGFOX's Series D funding round.[85]

SIGFOX is a French start-up that developed a cellular connectivity technology for the Internet of Things. It has developed a very low-power, long-range, low message-size RF protocol that runs in the sub-GHz spectrum band to enable a number of smart intiatives, but the technology is new and the applications are still evolving.

Elliot Management has demonstrated its intention to support the expansion of the SIGFOX network in the USA. This support is driven by the belief that the company can provide a high return on investment in future years. The Series D investment round raised USD115 million[86] from a number of investors, including Elliot Management, which was the only financial institution involved. Other investors included leading mobile operators (Telefonica, SK Telecom and NTT DOCOMO) and industrial partners (GDF SUEZ, Air Liquide and Eutelsat).

The investors collectively stand to benefit from the development of 'smart' intiatives such as energy management, energy efficiency, sustainable cities, Internet of Things and machine to machine.

The funding will be used to accelerate SIGFOX's worldwide network roll-out programme in Europe, Asia and the Americas in association with international telecoms operators.

SIGFOX-based devices have been deployed in a number of instances. SIGFOX has signed a contract with TDF, continental Europe's biggest owner of broadcast and telecoms masts, to expand its national coverage. In 2014, SIGFOX partned with broadcast tower provider Arqiva, to build a UK network dedicated to the Internet of Things. In 2015 it announced that it was collaborating with Texas Instruments to integrate their technology into its chipsets.

Key lessons: SIGFOX

- Investing in more unfamiliar areas can raise the risk for investors but can offer an upside with high potential. Investing in new technologies is not Elliot Management's typical type of investment, but if SIGFOX succeeds as the prevailing technology to enable the Internet of Things market, the return on investment can be significant
- Other fixed and wireless operators could consider investment from hedge funds, particularly for the expansion of fixed broadband networks. However, the lack of notable examples suggests that some hedge funds may be hesitant to to invest in long-term infrastructure projects
- It is interesting to note that the Series D funding was not made in isolation by a hedge fund alone, but in collaboration with a number of high-profile global partners which stand to benefit from the success of the technology as it evolves. These investors would provide financial investors with a higher degree of certainty and reduce the risk of the investment. This approach should be considered by technology companies looking for alternative sources of investment
- Telecoms regulators or governments had no direct involvement in the investment in SIGFOX. However, regulators do still have overall responsibility for ensuring that the market environment is competitive and attractive for investment. In this instance, regulators will also have responsibility for making spectrum available for low-power wireless networks

4.3.2 Case study: Seacom, Africa

This case study was chosen as it demonstates that financial institutions (particularly those that focus on and understand the technology sector) also invest in broadband infrastructure projects.

Convergence Partners is an investment management company focused on the telcoms sector in Africa. The company is based in South Africa and its investments are typically targeted at ICT infrastructure development.

Seacom was established in 2007 and in 2009 launched the first submarine cable system along East Africa linking South Africa, Tanzania, Uganda, Kenya and Mozambique, with major Internet connection hubs in Europe and Asia. Seacom's aim was to bring affordable and high-quality broadband to Southern and Eastern Africa as an alternative to expensive satellite technology, which was limited in service capability. The case for investment was supported by the potential long-term economic growth benefits which resulted in an 'open-access' undersea cable system supporting high bandwidth connectivity.

Seacom provides open-access PoPs and global partnerships to provide end-to-end wholesale connectivity for African operators, but it is not regulated. Broadband was previously limited, expensive and low in quality. The consequent broad take-up of broadband across East Africa has largely been attributed to Seacom.

Seacom is 100 per cent privately funded. Convergence Partners was one of the investors in Seacom. The project cost USD650 million, of which Convergence Partners contributed USD37.5 million[87]. This investment gave the company an equity share of 12.5 per cent of the asset. Other investors in Seacom included Nedbank (offering long-term commercial loans), and various African economic development funds.

Convergence Partners made the investment in Seacom because it expected significant growth in data traffic following growth of mobile take-up in Africa. A major part of its strategy is to focus on projects that improve access to communications, broadband services and technology offerings throughout Africa.

In July 2009, the Seacom cable went live. According to Remgro, a listed investment fund with a 25 per cent share of Seacom, the cable infrastructure company had losses at least since 2011 and until 2013. In 2014,

Seacom's headline earnings were ZAR40 million (USD3.34 million[88]), compared to a loss of ZAR32 million (USD2.67 million[88]) in the previous year[89].

The financial performance of Seacom is an indicator of the high level of risk that large infrastructure projects involve. Over time it is likely that terrestrial connectivity prices will decrease, and the demand for Seacom's service is likely to increase; however, its future earnings potential remain uncertain.

Key lessons: Seacom, Africa

- The role for regulators in this case is limited. There would need to be a case for regulatory intervention which is currently unclear, particularly as the cable has brought about significant economic benefits and is available on an open-access basis. In addition, coordinating regulatory efforts across a range of countries can be complex to implement. Regulators would need to undertake a comprehensive regulatory analysis and consider whether there is a case for intervention
- Funding was not made in isolation but in collaboration with a number of high-profile global investors, which reduced the risk of the investment. However, in this instance there was no investment made by operators that stood to benefit from the infrastructure directly. This may be a contributing factor to it being loss-making
- Investors should be fully aware of the demand characteristics behind their investments. Investment in large infrastructure projects carries high risk due to the high investment required. For example, the infrastructure may be made available too soon and there may not be enough demand to make the project commercially feasible in the short term. A reason for Seacom's poor financial performance is that the demand for data is not high enough
- High prices for terrestrial broadband, lack of broadband penetration and low usage of high bandwidth services and applications are some reasons why the demand for data is not high enough. Regulators and governments can take actions to improve broadband take-up and the availability of broadband services to improve the market attractiveness for investors

4.3.3 Case study: Facebook Asia–Pacific Gateway, Asia

This case study was chosen because it demonstrates an example of an established corporate organization investing in relatively new area – outwith its traditional business model – in the expectation of generating downstream revenues.

The Asia–Pacific Gateway (APG) is a 10 000km undersea cable project designed to improve Internet speeds for citizens and businesses in Asia. The cable will run directly from Malaysia to South Korea and Japan, with links branching off to other countries. The fibre-optic cable will help users in these countries to send and receive data faster and lower the dependency upon Singapore as the main gateway for Internet traffic. This cable is also expected to minimize the the number of hops made by Internet traffic, improving latency and user experience.

It will also provide countries in the region with an alternative to existing cables that have suffered from several cable breaks. In April 2015, Internet users from Vietnam faced connectivity issues from problems with the Asia-America Gateway cable. These issues were expected to last three weeks.[90]

The existing broadband infrastructure in some countries in South Asia was limiting the user experience of Facebook users. Despite the region being seen as one of the fastest-growing markets for Facebook, the company wanted to provide further support to that growth. Facebook is known worldwide as a provider of online social media services. Its core revenue is driven by online advertising. Facebook's motivation is therefore similar to that of Google and other software companies in that it wants to boost its membership

in growing markets so that its business can grow. Facebook has noted that the APG will improve the Facebook experience for users in India, Indonesia, Malaysia, the Philippines, Hong Kong and Singapore.[91]

In 2012, Facebook joined a consortium of investors supporting the roll-out of the APG. The participation of Facebook in 2012 was a very important factor in helping to launch the project, as the consortium had been struggling with lack of funding since 2009. The project to construct and maintain the APG is funded by a group that includes significant operators such as China Mobile, China Telecom, China Unicom, Chunghwa Telecom, KT Corp, LG Uplus, NTT Communications, StarHub, Time dotCom (Global Transit), Viettel, Vietnam Posts and Telecommunications Group (VNPT). The total investment from the 12 members of the consortium was USD450 million. It has not been disclosed how much Facebook invested.

The APG cable is expected to be completed in 2016.[92] The intervention of regulators is unlikely, but is is expected that consortium members will have equal access to broadband capacity.

Key lessons: Facebook/Asia–Pacific Gateway (APG)

- Facebook's investment was seen as the enabler from a financing perspective. Notably, a number of high-profile global operators (and co-investors) will be users of the undersea cable and as a result are likely to direct international traffic onto it, contributing to its growth
- The APG will use an open-access model to ensure all end users are able to utilize the asset without discrimination. This will be difficult to regulate due to the multiple jurisdictions that the cable runs through; instead, it will be self-regulated and the success of the self-regulation will depend upon cooperation between the operators
- Although governments and regulators in Asian countries did not play a prominent role in the formation of the APG, they will still play an essential role 'in-country' to extend broadband penetration and to drive user demand

4.4 Not-for-profit investors

In this context, not-for-profit investors refer to a socially responsible entity (e.g. cooperative) that invests in the construction and operation of broadband networks that are – for the most part - separate from the networks of commercial service providers.

The key difference between a commercial operator and a not-for-profit investor is that commercial operators are more likely to require greater returns on their investment; by contrast a not-for-profit investor is more likely to invest its profits (clearly depending on the agreement of the legal entity) back into the construction and operation of broadband networks. For this reason, not-for-profit broadband investments can be more commercially feasible in areas where the returns are too low for commercial operators.

Community broadband networks, for example, tend to be driven by communities as 'self-build' networks located in remote geographical areas, where there is typically a lower commercial incentive for operators to roll out their networks. Project funding can be mortgaged to make it more affordable. An alternative is to use crowdfunding – which is discussed in more detail in Section 6 – to raise funds to finance the network build. This type of approach is expected to be more common in regions where people have a relatively high disposable income. According to a report published by the Plunkett Foundation[93], the cost of rolling out fibre per property can be GBP2 000 (USD3 138) using overhead cables and higher if it requires digging trenches.

Self-build community broadband networks are normally based on FTTH technology. Communities can build these networks at much lower costs than commercial operators, as they do not charge commercial rates for undertaking the work or may offer to do it free of charge. By the very nature of communities, self-build networks can be small in scale, and may need to overcome a number of challenges: i) they are often run by volunteers, which may not be a sustainable situation in the long term; ii) they may not be vertically

integrated and therefore cannot offer consumers the choice of services that larger commercial operators may be able to offer.

Some governments have supported these initiatives. The Scottish Government, for example, through its Community Broadband Scotland (CBS) scheme, provides financial support to communities that decide to engage in community broadband projects[94]. Eligible communities can receive grants across the different stages of the project:

- initial scoping and feasibility assessment grant from GBP2 000 to GBP5 000 (USD3 138 to USD7 845)
- detailed project planning grant from GBP7 500 to GBP15 000 (USD11 767 to USD23 538)
- capital investment in the broadband project, up to a maximum of 89 per cent of capital infrastructure costs.

So far the CBS has invested in over nine projects in rural Scottish communities.

4.4.1 Case study: Community broadband, Germany

This case study has been chosen because it shows how communities in rural Germany successfully joined efforts to finance the construction of a high-speed broadband network. The investors included a mix of local governments, businesses and individuals.

These communities are located in the German provinces of Nordrhein-Westfalen and Schleswig-Holstein and previously did not have access to adequate broadband services. These communities are in less populated areas that lack the commercial incentive to attract the investment from private service providers. In addition, the government only provided funding for broadband connections with speeds up to 2Mbit/s.

Through crowdfunding, these communities invested in broadband infrastructure. This infrastructure is then rented to service providers, financing the investment cost.[95] A minimum investment of EUR10 000 (USD11 392) could offer investors an annual interest rate between 3 and 5 per cent.[96] For the investment to go ahead, a minimum of 70 per cent of households in that community must sign up for a connection.

The approach is seen to have been a success. The largest example is from the province of Schleswig-Holstein. This initiative represents an investment of EUR70 million. It started in 2010 and involves 50 communities, of which 11 have completed their infrastructure deployment.[97]

Key lessons: Community broadband

- Community broadband networks can be successful in deploying fibre networks in areas which are commercially unviable for operators. However, they are relatively new and still in the early phases of deployment, therefore it is not clear how commercially sustainable they can be in the long term
- Community broadband networks will often require external financing to get them started. Investments can be made by private crowdfunded investments, by government grants or a mix of the two. Governments offering grants should vet every stage of the grant award process to ensure the project is fully compliant with its investment criteria
- Regulators may wish to ensure that communities in receipt of government grants offer the infrastructure on an open-access basis. However, this may reduce the returns to the community broadband network and so the community should consider the impact of this in its early business-planning stages
- Communities should consider how the services portfolio might evolve over time as consumers become increasingly demanding of over-the-top and streaming services. These services will require high reliability networks. In addition, communities might find it difficult to negotiate competitive content deals that commercial operators are able to offer
- Innovative business approaches can make it feasible for communities to invest in broadband infrastructure. In this case study, the investors retain ownership of the infrastructure and are entitled to an interest rate. This return could be used to offset a possible borrowing used to invest in the project

4.5 Investments in disruptive technologies

The term 'disruptive technologies' referes to technical innovations that are being developed – and not yet in full deployment – which may offer the potential to provide an alternative to current technical solutions for the provision of broadband services.

Investing in disruptive technologies can be high risk, as it may be difficult for new technologies to challenge well-established ones which have been trialled and tested. Disruptive technologies may also face implementation barriers from regulatory concerns or market players that feel their business model is threatened. Therefore the financial backers of disruptive technologies tend to be non-traditional operators looking for alternative low-cost means to address specific connectivity issues (e.g. in remote areas) which may satisfy their wider business objectives.

One such technology that is gaining prominence in developing and developed markets is the transmission of data using UHF white space. The term 'TV white spaces' usually refers to unoccupied portions of spectrum in the VHF/UHF terrestrial television frequency bands in some geographical areas.

This approach can address issues such as the lack of available spectrum, because it is licence exempt[98]. It also benefits from the strong propagation characteristics allowed by the UHF spectrum, meaning less base stations are required to cover a given area.

The interest in white-space technology is not confined to any particular region. Pilot projects have been launched across the world for different types of applications, such as connecting remote health units in Bhutan and providing Internet access on a ferry boat in Scotland [99]. Some countries have staged trials of TV white-spaces operations. Other countries – such as the US and UK – are developing TV white-space regulations[100].

5 Financial innovations in funding services and applications

So far this study has looked at funding strategies used by investors and governments to finance broadband networks. However, the digital ecosystem has evolved so that there is a very tight and direct relationship between the development of broadband infrastructure and the evolution of higher-layer services and applications. For example, the demand for broadband infrastructure is being driven by an increase in take-up and usage of higher-layer services and applications; and without broadband it would not be possible to run the higher-layer services and applications. Given this tight relationship and in the context of investment strategies this section reviews what financial innovations are being used to fund investments in services and applications which are dependent upon broadband connectivity. The financial innovations considered are alternatives to other more common financing sources such as bank loans, angel investment, venture capital or private equity – which are well-known means of financing and therefore not discussed in this report – and include innovations in the following categories which appear to be gaining in popularity. Links to relevant case studies are also provided:

Table 5.1: Types of financial innovations and related case studies

Financial innovation	Case study	Executing parties
Crowdfunding	Star Citizen, USA Pebble, USA Shyp, USA	Individuals Individuals Private investors
Pension funding	Hipcom, UK	Business owner
Bitcoin currency	mexBT, Mexico	Seedcoin
Charity or non-profit institutions	Aentropico, Colombia	INNPulsa and Fundación Bavaria
Source: Analysys Mason, 2015		

In the section below a description is provided of the funding approach used and then examples of companies that have benefited from that type of investment are presented. Note that regulators have played a minimal role in the deployment of higher-layer services and therefore the role of regulators is not included in this section.

5.1 Crowdfunding

Crowdfunding is a significant and recent financial innovation that has brought down investment barriers, making investment more accessible to entrepreneurs. As the name suggests, crowdfunding raises investment from a large number of people over the Internet on a crowdfunding website such as Kickstarter, RocketHub or AngelList. It is also often referred to as peer-to-peer lending.

Individual investments can be as small as USD15[101], making it affordable enough for many people to invest. Given the large numbers of people that can invest in a crowdfunded project, the risk to individuals is reduced, making it an attractive investment vehicle for semi-professional or first-time investors. Entrepreneurs are required to submit their projects to a crowdfunding website, define the investment target, the deadline for funding and the reward to investors.

The amounts raised by project can vary from USD thousands to USD millions. This funding approach is typically used by start-up companies from varied sectors (e.g. real estate, consumer products, technology). However, crowdfunding can also be used to support investment in broadband infrastructure. Crowdfiber is a crowdfunding platform designed to raise funds to invest in high-speed broadband in communities across the USA. This tool allows communities to advertise their campaigns and collect funding[102]. A more advanced version of the tool is available to service providers[103].

According to an industry survey report from Massolution[104], crowdfunding globally is expected to reach USD34.4 billion in 2015, growing from USD16.2 billion in 2014. Of the amount raised in 2014, 59 per cent was in North America, 21 per cent in Asia and 20 per cent in Europe.

The risk of crowdfunding will vary by the type of crowdfunding used, the company or project receiving the funds and the amount invested. Three types of crowdfunding are considered: donation, equity and debt.

- Donation crowdfunding carries the risk of committing funds to a project that may not materialize.
- Equity crowdfunding investments can face the risk of lack of liquidity, equity dilution or loss of investment if the company defaults.
- Debt crowdfunding is subject to risks such as loss of investment and interest payments.

Financial regulation plays a very important role in making crowdfunding accessible to people. In the USA, the Securities and Exchange Commission (SEC) announced in March 2015 that it will be possible for non-accredited[105] investors to invest using equity crowdfunding.

Investors in donation crowdfunding tend to be driven by personal motivation. They are likely to have a connection to the company, brand or project being financed. In some cases, the reward of donating is the personal gratification of contributing. In other cases, the investor may have access to privileges such as a discount or free access to a service or product.

In equity crowdfunding, investors receive an equity stake in return for the investment made in a company. Entrepreneurs define the amount of equity stake for the target funding. Investors' corresponding equity share will depend on how much they invest in the project. The crowdfunding platform may also offer recommendations to investors on the opportunities considered most attractive. This service can assist investors in their decision as these opportunities have already gone through a filtering process.

In debt crowdfunding, the investor will lend funds to a company and expect this amount to be returned plus interest by fixed dates. Mini bonds is a type of debt crowdfunding approach that has been recently made available to potential investors. Typically, debt funding is used more by companies that are already well established and are generating a profit. There are still only a few examples available of companies that used this investment approach. It is possible that as it matures, it will be used by companies developing Internet-based services and applications.

5.1.1 Case study: Star Citizen, USA

This case study shows how donation crowdfunding can successfully attract investment through crowdfunding platforms as well as through the company website.

Start Citizen is a video game created by Chris Roberts. It is a game that can be played online in a multiplayer mode. A good gaming experience requires the user to have a fast and low-latency broadband connection.

Chris initially failed to convince private investors to invest in the video game. He then turned to crowdfunding. His strategy was to raise around USD2 million from this source and hope that this would demonstrate to private investors that there is demand for the product, convincing them to contribute with the remainder to reach a minimum of USD14 million.[106]

The crowdfunding was done using Kickstarter's online platform and the company's own website. The benefit of using its own website to host the crowdfunding is that the company does not have to pay fees to crowdfunding platforms. If a project is successfully funded in the UK, Kickstarter will charge 5 per cent of total funds raised plus payment processing fees.

This approach proved to be so successful that Chris no longer needed to source funds from private investors. Since October 2012, the company raised over USD81 million[107]. This value is of May 2015 and is still growing as people keep pledging funds to the project. The vast majority of the funding was crowdfunded from the game's website. Only USD2 million were raised from Kickstarter between October and November 2012[108]. Overall, the game received funds from almost 900 000 people, each paying an average of USD90.

The investment risk is measured by the likelihood that the project will be completed once the target funding is achieved and by how much has been invested. For this project, the investment risk is measured by the following:

- the low minimum investment required (only USD90)
- the project founder's strong track record in developing video games.

In return for their investment, people can influence how the game is developed based on how much they invest. In addition, investors also have early and free access to the game[109], which should come available in 2015[110].

Financial services regulators do not typically regulate donation crowdfunding. This crowdfunding model corresponds to the provision of money for charitable reasons or for a non-monetary reward. As a result it is not seen by regulators as an investment and is exempt from regulation.

Key lessons: Star Citizen

- Donation crowdfunding is typically exempt from regulation by financial services regulators, and can therefore be relatively straightforward to set up and to attract investors. However, investors should be aware that the lack of financial regulation may introduce risks and that they should be prepared to undertake their own due diligence to asses the level of risk when considering an investment
- The Star Citizen project was funded using a combination of crowdfunding from a private platform (Kickstarter) and from the project's own website. Using the own website for crowdfunding means that the company does not have to pay fees to a private platform. This two-pronged approach can limit the fees that businesses need to pay to the crowdfunding platform. On the other hand, the project may lose visibility, particularly if the website is new
- Donation crowdfunding is more likely to be successful in developed markets where investors are also potential end users

5.1.2 Case study: Pebble, USA

Pebble is a company that develops technology for smart watches. It sells a range of smart watches, which allow users to access a range of apps that rely on the connectivity provided by a smartphone. For this proposition to be feasible, there needs to be a good quality data connectivity to the smartphone.

The company is relatively small and on its own lacks the funds required to invest in product development. During its most recent fundraising session (April 2015), Pebble raised over USD20 million from more than 78 000 backers on the crowdfunding platform Kickstarter.

For investors, the risk is measured by the likelihood that the project will be completed once the target funding is achieved and by how much is invested. The minimum required investment is USD159. In return for their investment, people will receive a Pebble watch at a price lower than the retail price. The higher the investment, the lower the price per watch. Backers of the project will also receive the watch before it is made available to the general public.

Pebble used Kickstarter as it believed this was the most easy and efficient way to get its latest product to the people who were likely to want it the most. The company achieved its fund-raising target within three months.

As mentioned in the previous case study, the intervention of the financial services regulator in this type of fund-raising approach is unlikely.

Key lessons: Pebble

- Pebble used crowdfunding to finance the product development of its smart watch. The funds raised met the company's target, allowing it to proceed with the development of the new version of the smart watch
- Using a crowdfunding platform allowed Pebble to target the people that are more interested in its products. These investors are likely to be 'early adopter' consumers that follow the industry closely and are keen to have possession of the latest 'must-have' gadget. Attracting early adopters is essential to any start-up company's business as they wil be the most honest critics providing essential product improvement feedback

5.1.3 Case study: Shyp, USA

This case study was chosen as the firm Shyp used equity crowdfunding which is gaining in popularity and is subject to financial regulation.

Shyp provides logistic services requested over a smartphone app. Customer using the app take photos of an item they wish to order and select the delivery address. A large part of Shyp's business is dependent upon the growth of the e-commerce industry, e.g. delivering packages for online shops and easing online returns for consumers.

As a start-up, Shyp did not have the funding required to launch its business. The entrepreneurs behind Shyp wanted their business to be featured on AngelList, a crowdfunding platform, so they could raise their visibility to potential investors. A featured business is recommended as an interesting investment by AngelList. These opportunities suggest a lower level of investment risk, making them more attractive for investors.

Shyp succeeded in being featured and raised USD2.1 million from two syndicated investors over the equity crowdfunding platform AngelList. It has not been disclosed which amount of equity corresponds to that investment. The investment risk for investors was high as Shyp was a start-up when it initially received funding support from investors via AngelList. The fund raised was at an early seed stage.

Shyp is available to download in iOS or Android but the service is only available to customers in San Francisco, New York City, Miami and Los Angeles. Shyp has been experiencing 20 per cent month-over-month growth, with online returns representing 15 per cent of its business.

Financial regulators have an important role to play to make equity crowdfunding an attractive alternative funding source. The requirements enforced upon crowdfunding platforms protect the consumer and the market's growth as a result. In February 2015, the Financial Conduct Authority, the UK's financial services regulator, introduced rules to regulate equity-based crowdfunding. These rules were designed to allow investors to assess the risk and to understand who will ultimately borrow the money. In the UK, the rules also applied core consumer protection requirements to firms operating in this market. For example, client money must be protected and firms must meet minimum capital standards. Finally, firms running these platforms must have resolution plans in place so that, in the event of the platform collapsing, loan repayments will continue to be collected and those lending money therefore do not lose out.

Key lessons: Shyp

- Shyp used equity crowdfunding to raise the funds to launch the company. Securing a 'featured' position in the crowdfunding platform enhanced Shyp's chances of succeeding on its fundraising
- The popularity of equity-based crowd-funding means that financial regulators and governments may need to start applying rules to protect consumers and to protect investors in the event the firm collapses, for example
- The ability of firms to attract funding is dependent upon the growth of the digital industries and e-commerce sectors. Governments therefore have a responsibility in promoting the use of e-services to drive take-up and demand

5.2 Pension funding

This financing approach allows entrepreneurs to use their own pension fund to secure a loan. The pension manager will act as the investor by granting a loan that can be secured by the pension fund of the entrepreneur or by the entrepreneur's business assets. Alternatively, the pension fund manager can also buy an asset from the business and lease it back.

The amount that can be raised by entrepreneurs would be dependent on their loan collateral and the fund manager's risk aversion. For the pension fund managers, this approach allows them to generate additional revenue from available resources. Pension funding is used by businesses at different stages of maturity. Some entrepreneurs use it to fund their start-up, others to fund business expansion.

People dissatisfied with their pension fund's performance and unwilling to give up ownership of their business to other parties may find this approach appealing. As a preliminary step, entrepreneurs need to transfer part or all their pension savings into a self-invested personal pension or small self-administered scheme. These pensions give their owners investment powers such as the ability to invest in their own businesses. Only then can the fund manager provide the financing service. Our research shows that this funding approach is currently available only in the UK, although it is possible that other countries could offer it in future.

The investment risk for this approach can be relatively low for the investor. The loan cannot exceed 50 per cent of the pension fund's net asset value and may also be secured against an asset of similar or higher value[111].

5.2.1 Case study: Hipcom, UK

This case study was chosen as it shows how the government can facilitate the use of financial resources that otherwise would be relatively static.

Hipcom is a Cloud communication company whose main business is buying telecoms licences from providers and upgrading them to sell on. This process is lengthy and for the business to grow it requires additional sums of capital to buy new licences.

Allan Murdoch, Hipcom's former owner, wanted to invest in the company without diluting his equity. He also wanted to retain control of the company. Allan decided to use his own pension fund to access the required capital to expand the business. The fund manager provided a loan to invest in Hipcom based on Allan's pension fund amount. In return, Hipcom pays an interest rate to the fund manager.

The level of risk for the lender is relatively low. The loan value must not exceed 50 per cent of the pension fund's net asset value and other company assets can additionally be used as collateral. Allan raised GBP684 000 over three stages (GPB329 000, GBP155 000 and GBP200 000). With this approach, he managed to strengthen Hipcom and retain the same equity in the business.

Key lessons: Hipcom

- Hypcom obtained loans to invest in its business by using the owner's pension fund as collateral, allowing the business to expand and be more competitive
- For pension fund managers, this funding approach can generate additional revenue from using existing funds as collateral for loans
- This type of investment approach is dependent on the government allowing pension funds to be used for such a purpose. By facilitating the use of resources that otherwise would be static, the government can create an incentive for people to increase their savings and help businesses to find alternative financing sources

5.3 Bitcoin currency

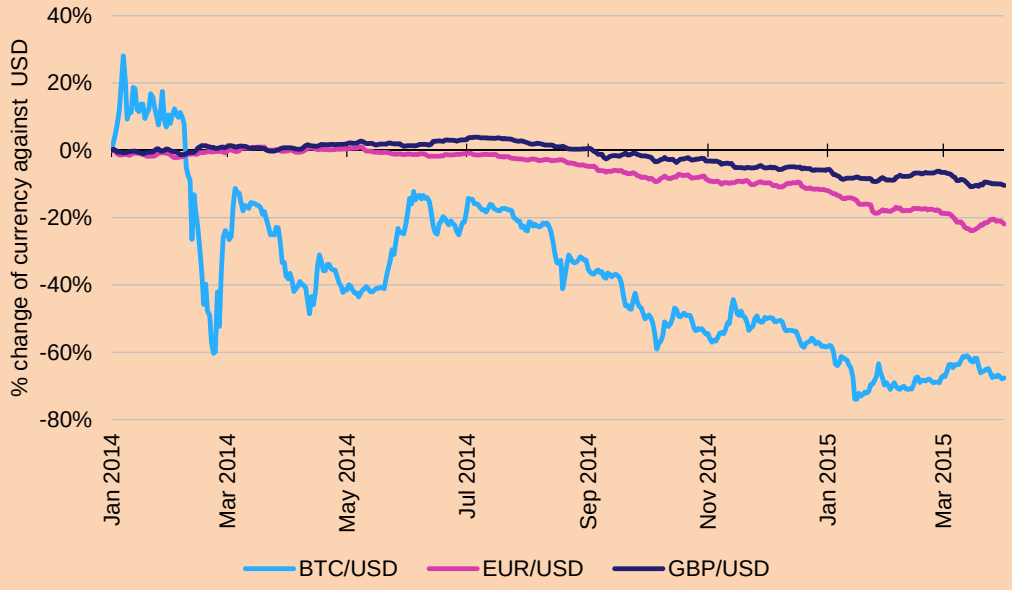
Bitcoin is a digital currency (represented by the currency symbol BTC) which can be used to finance companies. Seedcoin, a start-up incubator, has invested in businesses using bitcoin currency exclusively. The incubator is focused on supporting businesses that can help to develop the bitcoin currency. This financing approach is typically made available to start-ups.

Seedcoin also raises funds in bitcoin currency. This task can carry considerable risk due to the currency's volatility. Between January 2014 and April 2015, for example, bitcoin has lost over 60 per cent of its value against USD. Over the same period, the EUR lost 22 per cent and GBP 10 per cent (see Figure 5.2). This strong value volatility suggests digital currencies may have a higher level of risk compared to more stable primary currencies. Entrepreneurs receiving funding in digital currency need to consider its volatility risk. Another example of the high level of risk is the hacking theft of BTC750 000 (USD575 million) from the bitcoin exchange MtGox in 2014[112]. The uncertainty around digital currencies has led countries such as China and Russia to restrict how they can be used.

Based on previous funding rounds from Seedcoin, the size of the investments per company has ranged from BTC100 to BTC500. At the time of the latest funding round, April 2014, these values would have corresponded to around USD50 000 and USD250 000, respectively. The target markets of the start-ups vary by region and can include Africa (TagPesa) and Latin America (mexBT). TagPesa is an exchange and remittance company based in Kenya. The company aims to make it easy and convenient for people to make transactions and transfer money internationally[113]. One of the service's features is the ability for Kenyans to deposit and withdraw money from their M-Pesa account[114]. In 2015, TagPesa was acquired by igot, an Australia based Bitcoin exchange. The digital currencies trading platform mexBT will feature in the next case study.

The lack of regulation of digital currencies is a key factor in its associated risk. The uncertainty and distrust around digital currencies means that governments are reluctant to regulate it. The impact of regulation on the success of digital currencies was shown in January 2015, when Coinbase was announced as the first bitcoin exchange in the USA. The value of the currency immediately rose to reflect that news. This momentum was short-lived as the California State Government denied the veracity of the announcement shortly thereafter[115].

Figure 5.2: Percentage change of selected currencies against the USD from January 2014 to March 2015



Source: Oanda, 2015

5.3.1 Case study: meXBT, Mexico

This case study was chosen as it demonstrates how governments can promote the development of the digital currencies market by implementing adequate regulation.

meXBT is a digital currencies trading platform (i.e. for currencies like bitcoin and litecoin). One of its objectives is to cater for the remittances market, particularly between Mexico and the USA. The company is based in Mexico and provides services in Latin America.

One of the objectives of mexBT is helping the unbanked population to move money using their mobile phones. The company has partnered with cash payment processors to facilitate deposits and withdrawals. The company required funding to develop its trading platform. It applied to receive support as a start-up to Seedcoin, an incubator focused on bitcoin-based businesses. In 2014, the incubator invested BTC250 in mexBT.[116] At the time this amount corresponded to around USD150 000; currently it would be worth close to USD62 000.[117] The equity share received by Seedcoin is not disclosed but it typically varies between 10 and 20 per cent.[118]

meXBT claims that the support from Seedcoin was very important not only for funding but also from a mentoring perspective, due to the incubator's expert knowledge of the bitcoin market. In November 2014, mexBT announced the launch of its trading platform. The investment risk for Seedcoin was very high as meXBT was a start-up when it received the funding support. The currency's volatility added to the risk by making the value of the funding amount uncertain.

Joel Cano, Operations Director of mexBT, believes that a market as nascent as this one should not be slowed down by regulation. In March 2015, the UK government regulated bitcoin exchanges to prevent them from being used for money laundering. This initiative was applauded by the UK Digital Currency Association as being very important to increase the adoption of digital currencies.

Key lessons: meXBT, Mexico, 2014

- mexBT received funding in bitcoin from Seedcoin, an incubator, to develop a trading platform. Seedcoin's strong knowledge of bitcoin benefited mexBT. In very nascent markets it is important to select partners that have a strong market knowledge as this can determine the success of the start-up
- Governments can promote the development of the digital currencies market by implementing adequate regulation. This framework should protect the consumers and by doing so increase their trust and consequent adoption of digital currencies. Regulation in growth markets should enable innovation and not hamper growth

5.4 Charity or non-profit institutions

A number of charity or non-profit institutions are involved in financing businesses. The investments are normally related to the mission of the institution. Businesses eligible for this type of financing would be seen as drivers of economic and social development. Start-up companies are typically the beneficiaries of this type of support.

For entrepreneurs, this funding approach usually means not having to give up on equity from their business to the investor. The amounts made available by these institutions to businesses can vary significantly. Fundación Bavaria in Colombia claims to have financially supported 388 start-ups with USD8 million[119]. This support represents an average of USD22 000 per business. In the UK, Nesta, an innovation charity, supports businesses seeking first-phase investment of between GBP150 000 (USD235 379) and GBP1 million [120] (USD1 569 190).

The investment risk is usually high as it typically targets start-ups. However, risk taking is not necessarily driven by return on investment but rather by the expected socio-economic contribution from those companies. Local institutions are also expected to be more sensitive to the needs of local entrepreneurs. This initial support can provide the base for those businesses to develop and to become sufficiently attractive to other investors.

These funding initiatives can be driven by financial regulation. A common example is providing tax breaks to institutions that dedicate funds to support businesses or projects expected to have a positive social or economic impact.

5.4.1 Case study: Aentropico, Colombia

This case study was chosen as it demonstrates the importance of receiving grant funding early on in order to attract private-sector investment later in the process.

Aentropico is a 'big data' company that provides predictive analytics services to businesses. The company aims to make its service easy to use and as a result accessible to a large base of customers. This type of service is typically delivered over a web-interface and therefore requires a reliable broadband connection.

The company was founded in 2012 in Colombia. That year, Aentropico started its search for funding with a small team and a platform at a very early stage of development. It succeeded raising USD45 000 from private investors.[121]

In 2013 Aentropico raised USD110 000, of which USD20 000 was received from INNPulsa, a government-funded incubator,[122] and Fundación Bavaria, an institution that sponsors initiatives that are expected to have a positive socio-economic impact. Both institutions' mission is to support the growth of Colombia's business sector. The funds were offered to Aentropico as grants. Fundación Bavaria and INNPulsa were not expecting to receive a financial return. For Aentropico, this type of funding means that it does not have to

offer equity, which can be later used to attract investment from other parties or to retain ownership of the business.

The grants, together with funding received from investors such as Start-Up Chile and StartupBrasil, allowed Aentropico to keep growing its team and develop the platform. Today the company is selling its product to clients across Latin America.

Key lessons: Aentropico

- Grant funding from not-for-profit organizations means that companies do not have to relinquish any of their any equity or shareholding, which can be significant in attracting further private-sector investment
- Not-for-profit funding is particularly relevant during the initial stages of a business when it can be very challenging to attract private investors
- Governments can foster not-for-profit initiatives in different ways. A direct approach is to form agencies such as INNPulsa which help fill in the gaps where there are no private investors. Other less direct approaches could include rewarding companies that invest in projects of socio-economic importance with fiscal benefits

6 Conclusions

Based on the case studies presented in this report this section summarizes the key lessons and best-practice approaches to implementing regulatory frameworks and policies in order to attract investment in broadband networks and higher-layer services. This section also summarizes the investment trends across each of the case studies reviewed. However, care should be taken when interpreting these trends as the sample of case studies would need to be significantly greater to be statistically representative. Therefore the trends, at best, can be considered to be illustrative and would need to be tested further through further analysis and research.

6.1 Investment trends

This section summarizes the investment trends across each of the case studies reviewed in this report. By plotting the value of the investment of each case study (x axis) and the economic maturity of the region where the investment was made (y axis) it is possible to derive an investment trend for:

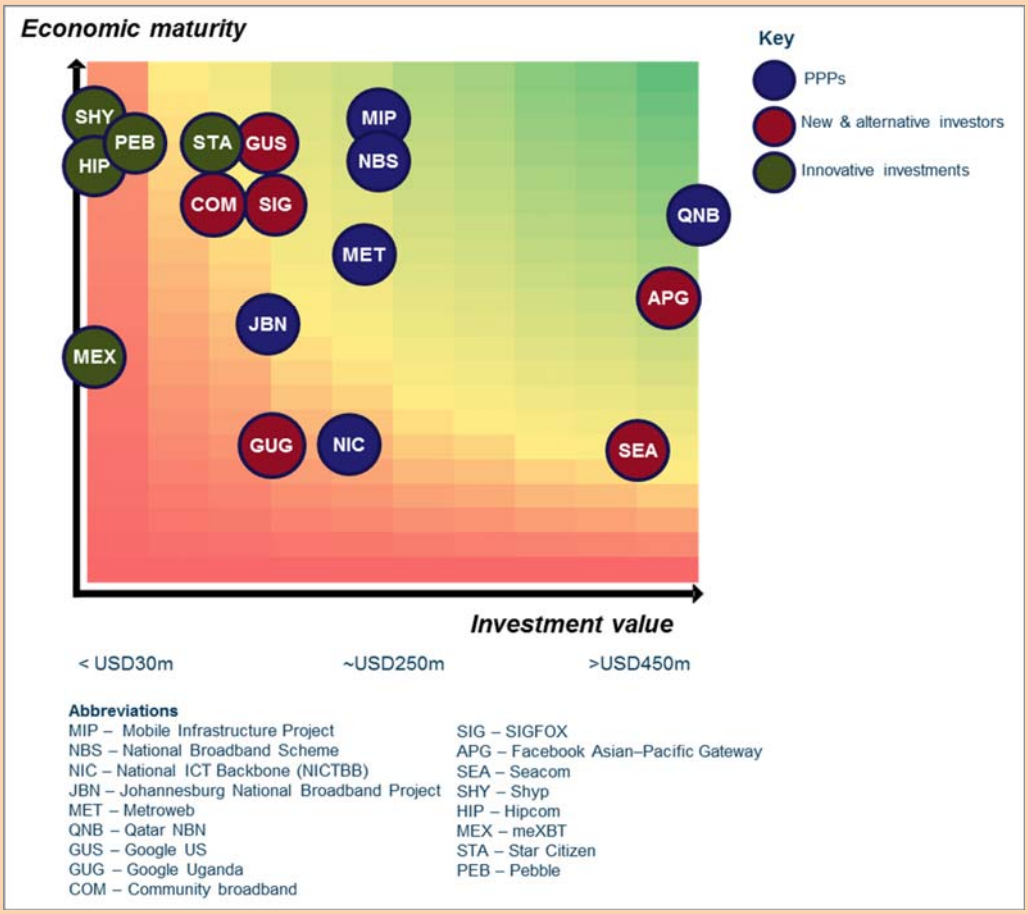
- traditional PPP broadband investments
- new market entrants and alternative investors
- innovative investors financing higher-layer services.

This results in the chart in Figure 6.1. As previously mentioned, however, care should be taken when interpreting these trends as the sample size is small and not statistically representative. Therefore the trends, at best, can be considered to be illustrative and are by no means conclusive. However, it is interesting to make the following observations and implications upon investing in broadband networks:

- PPP investments in developing and developed markets are largely similar in value, e.g. ranging from around USD100 million to USD245 million. The exception is Qatar, which has access to significant funds. This would suggest that investments are of a similar scale, however investments made in developing markets are likely to focus on achieving different outcomes to those in established economies. For example, PPPs in developing markets are largely focused on building core national infrastructure, while in developed markets PPPs are focused on maximizing last-mile broadband coverage to rural areas and in increasing broadband speed.

- In contrast to PPPs, investments made by new market entrants and alternative investors tend to have a greater vertical and horizontal spread to traditional PPP investments. The horizontal spread suggests that these investors are prepared to invest in higher-value broadband projects as well as those of lower value. The vertical spread suggests that the alternative investors are equally likely to invest in developing and developed markets.
- Investment in higher-layer services is predominant in developed markets. This is partly due to the maturity of the Internet ecosystem in developed markets which fosters technical innovation and investment. With the exception of crowdfunding, these investments have initially attracted low amounts of funding, suggesting that most of these options would currently be unsuitable for investment in any significant broadband infrastructure project.

Figure 6.1: Summary of investment trends



Source: Analysys Mason, 2015. Note figures are not abailable for MGTS

6.2 Summary of best-practice regulatory considerations

Based on a review and critique of the case studies presented in this report, the following considerations have been identified:

- Regulatory frameworks have had a direct impact on government-funded broadband PPP projects where a national broadband infrastructure was being partly funded by the state or through other public funds. Often this resulted in the regulator mandating wholesale access to the infrastructure on an equal open-access basis. Regulators will play a key role in ensuring wholesale networks owned by dominant operators – particularly when funded by government or public funds – are made available on an open-

access and non-discriminatory basis to help reduce the costs and barriers for new market entrants wishing to invest in broadband infrastructure. Open access can be mandated by the regulator through a licensing process or by ensuring government fibre deployments are designed on an open-access basis to promote infrastructure competition.

- Rural interventions have largely resulted in wireless solutions being deployed due to the challenging economics of rural and hard-to-reach areas. Regulators played an important role in encouraging operators to explore alternative ways of reducing costs for wireless deployments. The interventions vary in their nature, from building shared passive infrastructure to regulators encouraging active radio infrastructure sharing and spectrum pooling. Regulators will need to set up processes to monitor the market to ensure operators are being treated fairly. They will also need to set out guidelines for sharing infrastructure and for pooling spectrum if these are being considered.
- Network-sharing deals (particularly for mobile operators) have been subject to much less onerous regulatory and competition reviews and conditions than in-market consolidation deals. A wave of network outsourcing deals has convinced regulators that networks and services can increasingly be seen as separate. End users benefit from improved coverage, particularly in rural areas, as it allows them to reduce operating costs and share ongoing investment in new sites.
- Regulators may play a role in directing investment or offering licenses to encourage broadband investment in those areas needing it most. Regulators can also ensure that performance standards are being met by licensed operators, that interconnect agreements are being upheld and that prices are competitive. In these cases regulators will need to set up processes to gather market information and monitor the market on a regular basis. Other less direct roles include facilitating information sharing by providing up-to-date broadband coverage and mapping data to allow infrastructure investment to be prioritized in those areas where market failure has occurred.

Regulators have also played a key role in making the market more attractive to new market entrants, leading to innovative approaches to broadband investment.

- Regulators can allow operators to decommission their copper networks, which can provide an attractive cash source to invest in broadband networks. However, this will only be possible in countries where wholesale services such as local loop unbundling (LLU) and bitstream services are not present. The existence of wholesale services can create barriers to this approach, as LLU and bitstream services may have to be preserved for a period of time.
- Regulators can also ensure that the market conditions are conducive to attracting investment from new entrants. For example, it is important for new entrants to be clear about the existing infrastructure (e.g. ducts, telephone poles) that can be used and the rules that guide its use. Other important aspects include having quick access to construction and permission licences.
- Regulators can consider granting permissions for pilots to attract market interest, in order to promote investment in new technologies. Reluctance from regulators to facilitate technical trials, particularly with wireless technologies, may result in investors being put off from investing in that region by the risk of interference with other wireless technologies.
- Regulators can also play a role in encouraging community broadband networks. In February 2015, the FCC, the USA communications regulator, allowed two community broadband providers in the states of Tennessee and North Carolina to expand the geographical provision of their services. The law in these two states had previously prevented such expansion from taking place.

Some of the regulatory factors which investors would consider as being particularly important are written about extensively in the report *"Trends in Telecommunications Reform",* published in 2009 by ITU.[123] These aspects are still valid considerations that regulators and governments should take into account when developing or considering regulatory policy.

Regulatory factors relevant for investors

- **Design of legal framework**: whether the telecoms act or law recognizes the existence of a regulator and defines its role, scope of responsibility, accountability and market objectives.
- **Licensing regime**: the extent to which licence obligations are transparent and come with additional burdens such as administration, reporting, fees and the flexibility to adapt to new legislation.
- **Interconnection regime**: whether there is a well-designed and implemented interconnection regime that protects investors from below-cost interconnection payments from operators or unreasonable rates from regulators.
- **Regulatory fees and taxation**: whether there are excessive fees and taxes which can increase operating costs and discourage innovation and further investment.
- **Universal service funds (USF)**: whether operators are obliged to contribute to USFs and have the ability to access USFs to fund investment in areas of market failure.
- **Competition policy:** the effectiveness of the regulator to protect new operators against the abuse of market power from existing dominant operators and to promote fair competition through non-discriminatory wholesale open access to dominant operator infrastructure.
- **Tariff regulation:** the ability of the regulator to implement tariff regulation in developing regions or in the provision of services where there is ineffective competition.
- **Spectrum management**: whether scarce spectrum is over-priced and overburdened with coverage obligations, therefore decreasing the capital available to operators to invest in infrastructure.

Abbreviations

ARPU	average revenue per user
DBO	design, build and operate
FCC	Federal Communications Commission
FTTH	fibre to the home
FTTP	fibre to the premises
GPON	gigabit optical passive network
ICT	information and communication technologies
ISPs	Internet service providers
LLU	local loop unbundling
MNOs	mobile network operators
MTR	mobile termination rate
NGOs	non-governmental organizations
POPs	points of presence
PPPs	public–private partnerships
SAQ	subscriber acquisition costs
SPV	special purpose vehicle
WAN	wide-area network

Annex 1 – Procurement principles

Fairness and equitability

Fairness and equitability require that a procurement process be procedurally fair and non-discriminatory. The procurement specification and decision-making criteria (evaluation criteria) should not favour any particular bidders. Also, the procurement specification should be written in a manner that is technology-neutral, i.e. defines a clear set of output requirements and service quality standards independent of the technology used to achieve these requirements. All participants in the procurement must be given the same information prior to and during the process, including any clarifications or modifications to the specification or to decision-making criteria.

Transparency

Transparency requires openness throughout the entire procurement process. The process should be undertaken in a transparent manner, in public and not behind closed doors. All information regarding the tender specification and the procurement process must be made available and accessible to all potential bidders prior to, during and after the process. For example, a pre-tender information notice published on a central website or leading broadsheet newspaper can be used to alert all potential bidders to the intended procurement.

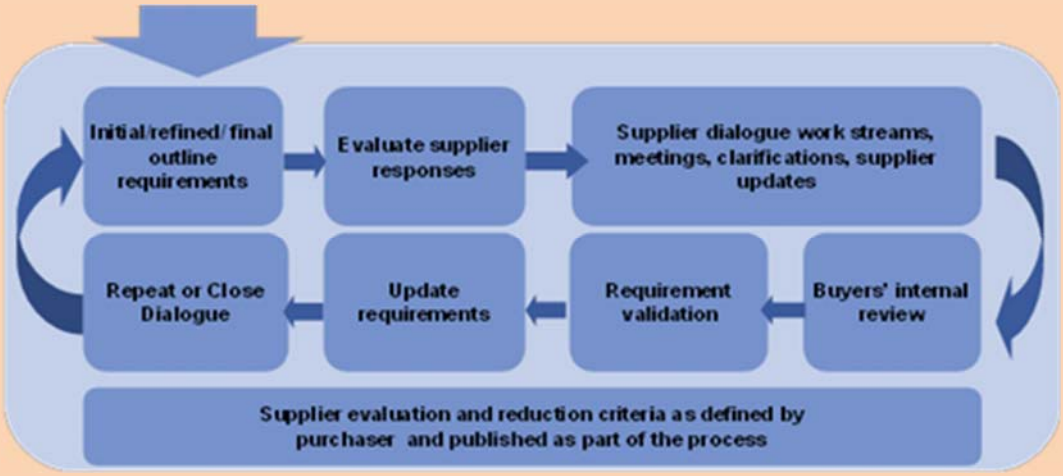
In addition, bidders should be given access to a publicly available detailed broadband network coverage map to demonstrate where public investment will *not* be targeted, i.e. where broadband networks are already available. This exercise should be conducted as an open market consultation.

The requirement specification and decision-making criteria should be made clear and adhered to throughout the procurement process, to demonstrate transparency in the tender requirements and in the awarding of the contract. Upon selection of a preferred bidder, where government aid is involved, a contract award notice should be published detailing the name of the beneficiary, the amount of aid to be provided, the intensity of aid and the technology chosen.

Competitiveness

Bidders should be selected on the basis of a competitive procurement procedure, to minimize the need for public subsidy. Projects involving public subsidy can be particularly complex to procure. In Europe, a competitive dialogue procedure has been designed that improves communication between the contracting authority (in this case the government) and bidders. This can lead to better designs and innovative solutions. Competitive dialogue can also increase competitive tension and allows better value to be extracted from bidders. However, competitive dialogue can be complex (see Figure A.1) and costly in terms of time and procurement resources, and therefore other options should also be considered.[124]

Figure A.1: Overview of competitive dialogue process



Source: Analysys Mason, 2015

Where government subsidy is awarded – following a competitive procurement – to an already dominant operator or an operator that may subsequently become dominant, this may limit market competition. Therefore public network procurements should enable competing operators or retail service providers to offer competitive and affordable services to end users. The award criteria should favour bids proposing wholesale or passive network models.

Cost-effectiveness

A government entity should try to procure the equipment for the broadband network at the lowest possible cost, and get value for money. This can be achieved by selecting a bidder on the basis of a competitive procurement procedure (as described above) based on those offering the most economically advantageous offer. This approach is contrasted to awarding a contract to the bidder with the lowest cost – which does not take non-price-related criteria into account. Consequently the evaluation of a tender should not exclusively depend on cost alone. The relative weight between price and other criteria will vary. Bidders should be advised in advance in an open and transparent manner of the weighting given to cost, and the other criteria against which their tenders will be evaluated. Such criteria may include, for example:

- geographical coverage
- broadband speeds offered
- competitive wholesale pricing
- projected initiatives to stimulate broadband take-up
- sustainability of the technological approach
- proposed re-use of existing infrastructure
- impact of the proposed solution on competition in the market.

Value for money can be achieved in a number of ways, for example by:

- Writing procurement specifications in output terms, enabling suppliers to consider and recommend cost-effective solutions that meet the requirements.
- Ensuring that the requirements are met but not exceeded – e.g. bidders may propose building a network in an area that is not considered to be a priority. Making network coverage maps available will be vital as part of this process.
- Introducing longer-term incentives into the contract to ensure continuous cost and quality improvements are made to the broadband network throughout its lifetime.
- Optimizing the cost of delivering the network over a longer-term contract such as 15 years or more.

Use of existing infrastructure

Bidders should be encouraged to re-use existing infrastructure (where this is fit for purpose) to avoid infrastructure duplication and reduce the amount of State subsidy required. The government should consider setting up a national database containing information on the availability of existing infrastructure that could be re-used for broadband roll-out.

Demand and rights of way

All efforts should be made to not only aggregate demand from government, but to also enforce rights of way. Demand aggregation can encourage operators to make broadband infrastructure investments in regions that they may otherwise consider as being commercially unviable. By demonstrating the demand for broadband services, operators may be convinced that there is a commercial case for investment.

Governments and regulators can also take steps to ensure that operators are not put off making investments in broadband infrastructure due to the high cost of acquiring the rights of way to lay fibre and due to the length of time it can take for a rights of way application to be processed.

For example, the Nigerian Ministry of Communications and Technology announced in June 2013 that it had reduced the time for a rights of way application to be processed and reduce the cost per km to help with the implementation of its national broadband plan. [125]

Annex 2 – Sources

Case study: Mobile Infrastructure Project (MIP), UK, 2011

Sources:

- http://www.ispreview.co.uk/index.php/2014/12/gbp150m-uk-mobile-infrastructure-upgrade-project-makes-slow-progress.html
- https://www.gov.uk/government/policies/making-it-easier-for-the-communications-and-telecoms-industries-to-grow-while-protecting-the-interests-of-citizens/supporting-pages/improving-mobile-coverage

Case study: National Broadband Scheme (NBS), Ireland, 2007

Sources:

- http://ec.europa.eu/competition/state_aid/cases/221646/221646_729738_49_2.pdf
- http://www.thejournal.ie/national-broadband-scheme-ending-1609666-Aug2014/

Case study: National ICT Broadband Backbone (NICTBB), Tanzania, 2010–14

Sources:

- http://www.nictbb.co.tz/news.php
- http://www.telecompaper.com/news/ttcl-to-supply-bandwidth-to-neighbouring-countries--886443

Case study: Qatar National Broadband Network (QNBN), Qatar, 2011

Sources:

- http://www.telecompaper.com/news/qnbn-pledges-to-have-fibre-optic-network-in-qatar-by-2015--901175
- http://www.gulf-times.com/qatar/178/details/374129/ambitious-plan-for-high-speed-broadband
- http://qnbn.qa/qnbn_release/heads-of-agreement-announced-between-qnbn-vodafone-qatar/

Case study: MGTS, Russia, 2013

Source:

- http://www.analysysmason.com/Research/Content/Viewpoints/Copper-decommissioning-costs-Oct2014-RDTW0/

Case study: Google Fiber, USA, 2012

Sources:

- http://www.businessinsider.com/the-cost-of-building-google-fiber-2013-4?IR=T
- http://www.cnet.com/uk/news/google-to-test-ultrafast-broadband-to-the-home/
- http://www.technologyreview.com/news/510176/when-will-the-rest-of-us-get-google-fiber/
- http://www.techrepublic.com/article/comcast-time-warner-take-on-google-fiber-in-kansas-city-can-the-incumbents-compete/
- http://www.theverge.com/2015/2/17/8050935/att-google-fiber-kansas-city-gigapower-internet-price-match

- http://www.fastcompany.com/3036659/elasticity/lessons-from-googles-first-rollout-of-google-fiber

Case study: Google Fiber, Uganda, 2013

Sources:

- http://www.google.com/get/projectlink/
- http://www.iwayafrica.com/iwayafrica-uganda-launches-high-speed-fibre-access-to-sme-customers/
- http://www.ibtimes.com/google-goes-africa-why-western-tech-giant-digging-kampala-uganda-1487814
- http://www.technologyreview.com/news/521801/google-tries-to-turbocharge-internet-service-in-uganda/
- http://www.ibtimes.com/google-goes-africa-why-western-tech-giant-digging-kampala-uganda-1487814
- http://telecoms.com/200521/uganda-is-next-stop-for-google-fibre-project/

Case study: Elliot Management, USA/SIGFOX, France, 2015

Sources:

- http://www.reuters.com/article/2015/02/11/us-sigfox-fundraising-idUSKBN0LF06720150211
- http://www.fiercewireless.com/tech/story/iot-startup-sigfox-launching-902-mhz-network-nationwide-us/2015-03-03

Case study: Convergence Partners, South Africa/Seacom, 2009

Sources:

- https://manypossibilities.net/african-undersea-cables/
- http://www.pidg.org/impact/case-studies/seacom-undersea-cable

Case study: Asia–Pacific Gateway, Malaysia and Japan, 2012

Sources:

- http://www.bbc.co.uk/news/technology-18725728
- http://www.cnet.com/uk/news/intra-asian-submarine-cable-system-going-live-in-2015-as-koreas-kt-hooks-up/
- http://www.pcworld.com/article/258844/facebook_buys_a_stake_in_450m_asian_undersea_cable_consortium.html
- https://www.time.com.my/aboutus/newsroom_detailed.asp?id=236&ddlYear=2015
- http://www.thanhniennews.com/tech/intl-connections-in-vietnam-may-fully-recover-in-3-weeks-42574.html

Case study: Community broadband, Germany, 2008, 2010 and 2012

Sources:

- http://www.governancereport.org/home/governance-innovations/featured-innovations-2014/broadband-crowdfunding-germany/
- https://books.google.co.uk/books?id=XlL1AgAAQBAJ&pg=PA86&lpg=PA86&dq=crowdfunding+broadband+germany&source=bl&ots=RvNI8TVdFr&sig=5

- http://www.breitbandnetzgesellschaft.de/die-initiative/ausbauplan/

Case study: Star Citizen, USA, 2012

Sources:

- https://www.kickstarter.com/projects/cig/star-citizen
- https://robertsspaceindustries.com/funding-goals
- http://www.itworld.com/article/2694217/networking/internet-operators-explore-improving-african-interconnections.html
- http://www.crowdfundinsider.com/2014/11/55071-brief-star-citizen-creator-discusses-crowdfunding-video-games-development-video/
- https://ignitiondeck.com/id/crowdfunding-a-video-game/
- https://www.kickstarter.com/help/fees?country=GB
- http://www.cnbc.com/id/102021804
- https://www.kickstarter.com/projects/cig/star-citizen/description
- http://www.polygon.com/features/2015/3/2/8131661/star-citizen-chris-roberts-interview

Case study: Pebble, USA, 2015

Source:

- https://www.kickstarter.com/projects/597507018/pebble-time-awesome-smartwatch-no-compromises/description

Case study: Shyp, USA, 2013–14

Sources:

- http://blog.angel.co/
- https://medium.com/@kevingibbon/how-we-built-shyp-on-angellist-and-raised-2-1m-1c723714f713
- https://medium.com/@kevingibbon/how-we-built-shyp-on-angellist-and-raised-2-1m-1c723714f713
- http://www.fca.org.uk/static/documents/crowdfunding-review.pdf

Case study: Hipcom, UK, 2015

Source:

- https://www.pensionledfunding.com/case_study/hipcom/
- https://www.pensionledfunding.com/press_release/10-things-you-need-to-know-aboutpension-led-business-funding/

Case study: meXBT, Mexico, 2014

Sources:

- http://www.coindesk.com/seedcoin-gives-btc-sx-500-bitcoins-funding/
- https://www.cryptocoinsnews.com/mexican-bitcoin-exchange-mexbt-launches-trading-platform/
- http://www.coindesk.com/bitcoin-startup-incubator-seedcoin-raises-2000-btc-funding-round/
- https://www.cryptocoinsnews.com/mexican-bitcoin-exchange-mexbt-launches-trading-platform/

- http://eleconomista.com.mx/tecnociencia/2015/04/06/mexbt-quiere-llevar-bitcoins-mundo-reglas-innovacion
- http://www.independent.co.uk/life-style/gadgets-and-tech/news/bitcoin-government-to-regulate-cryptocurrency-to-avoid-money-laundering-says-treasury-10117566.html

Case study: Aentropico, Colombia, 2012

Sources:

- http://thenextweb.com/la/2013/12/28/12-latin-american-startups-look-2014/
- http://lavca.org/2014/01/29/entrepreneur-profile-sebastian-perez-saaibi-ceo-juan-pablo-marin-diaz-cio-aentropico/

List of endnotes

[1] Telecoms services market is defined as retail and wholesale, fixed and mobile voice and data services

[2] Source: https://www.itu.int/net/pressoffice/press_releases/2014/23.aspx

[3] Includes fibre to the cabinet (FTTC), fibre to the building (FTTB) and fibre to the distribution point (FTTdp)

[4] Analysys Mason FTTx roll-out and capex worldwide: forecasts and analysis 2014–2019

[5] Includes all deployments in which fibre runs all the way to the subscriber's premises. FTTH includes passive optical network (PON) and point-to-point (PTP) architecture, and includes (despite the acronym) broadband fibre connections to business sites. However, it does not include uncontended dedicated fibre-leased lines.

[6] ITU, World Telecommunication/ICT Indicators database and Measuring the Information Society report, 2014, http://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx

[7] LTE-A LTE Advanced is a mobile communication standard and a major enhancement of the Long Term Evolution (LTE) standard

[8] Source: Analysys Mason Global Telecoms Market Interim Forecast update 2014–2019

[9] Source: Analysys Mason public small cells worldwide forecast and analysis 2015 to 2020

[10] Public Wi-Fi is Wi-Fi service provided in public areas, such as retail districts, tourist attractions, food chains, coffee shops, business districts, railway stations etc. Private W-Fi is service provided within a home or business intended for use by the home occupants, or by employees of the business.

[11] Source: Analysys Mason, 2015

[12] See http://www.analysysmason.com/About-Us/News/Insight/France-consolidation-Jun2014/#17%20June%202014

[13] See http://www.zdnet.com/article/middle-east-africas-mobile-giants-take-first-steps-on-sharing-networks-to-cut-costs-boost-rural-coverage/

[14] See http://www.growthbusiness.co.uk/news-and-market-deals/business-news/2443992/david-cameron-heralds-growth-of-londonand39s-tech-city-on-threeyear-anniversary.thtml

[15] See http://www.londonandpartners.com/media-centre/press-releases/2014/12032014-tech-city-launch

[16] See http://www.techcityuk.com/investors/#investor-top

[17] See http://www.ispreview.co.uk/index.php/2015/01/virgin-media-business-brings-faster-broadband-londons-tech-city.html

[18] See http://www.theguardian.com/business/2014/jul/30/bt-trial-broadband-system-london-slow-tech-city

[19] See http://techcitynews.com/2015/03/26/uk-accounts-for-42-of-european-fintech-deals-in-2014/

[20] Seehttp://ec.europa.eu/regional_policy/sources/docgener/presenta/broadband2011/broadband2011_en.pdf

[21] See http://www.analysysmason.com/About-Us/News/Press-releases1/Broadband-PPP-projects-Oct2012/#03%20October%202012

[22] It defined PPP as referring to any project where there is a mix of private- and public-sector involvement.

[23] See https://www.gov.uk/government/publications/2010-to-2015-government-policy-communications-and-telecomms/2010-to-2015-government-policy-communications-and-telecomms

[24] See http://www.superfastcornwall.org/

[25] See http://gov.wales/topics/businessandeconomy/broadbandandict/broadband/ngbw/?lang=en

[26] See http://www.ncc.gov.ng/thecommunicator/index.php?option=com_content&view=article&id=787:ncc-announces-mainone-ihs-winners-of-infraco-licence&catid=117:editorials&Itemid=5

[27] See http://www.skmm.gov.my/Sectors/Broadband/National-Broadband-Initiative.aspx

[28] See http://www.senado.gov.br/noticias/Jornal/emdiscussao/banda-larga/telebras.aspx

[29] See http://www.med.govt.nz/sectors-industries/technology-communication/fast-broadband/rural-broadband-initiative

[30] See https://www.itu.int/osg/spu/ni/3G/casestudies/sweden/Sweden_fin3.doc

[31] See http://www.ispreview.co.uk/index.php/2014/12/gbp150m-uk-mobile-infrastructure-upgrade-project-makes-slow-progress.html

[32] See http://www.ispreview.co.uk/index.php/2014/12/gbp150m-uk-mobile-infrastructure-upgrade-project-makes-slow-progress.html

[33] See http://stakeholders.ofcom.org.uk/market-data-research/market-data/communications-market-reports/cmr12/telecoms-networks/uk-5.20and5.21

[34] See http://www.thejournal.ie/national-broadband-scheme-ending-1609666-Aug2014/

[35] See http://www.thejournal.ie/national-broadband-scheme-ending-1609666-Aug2014/

[36] See "Broadband now available in every district in Ireland", http://www.dcenr.gov.ie/Press+Releases/2010/Broadband+now+available+in+every+district+in+Ireland.htm

[37] Source: EU Digital Agenda for Europe (DAE) Scoreboard, 2014

[38] See http://www.slideshare.net/CommonwealthTelecommunications/broadband-infrastructure-development-challenges-in-tanzania

[39] See http://www.joburg.org.za/index.php?option=com_content&task=view&id=1223&Itemid=168

[40] See http://www.auvergnetreshautdebit.fr/qui-sommes-nous/
[41] See http://www.dcenr.gov.ie/Communications/Communications+Development/Metropolitan+Area+Networks/
[42] See http://www.shetland.gov.uk/news-advice/ShetlandIslandsCouncil-InformationBulletins-TelecomCableInfrastructure.asp
[43] See http://www.digitalregion.co.uk/
[44] See https://broadbandeurope.wordpress.com/public/
[45] See http://projectisizwe.org/funding-for-free-wifi/
[46] See https://www.westerncape.gov.za/speech/state-province-address-2014
[47] See http://www.balancingact-africa.com/news/en/issue-no-602/top-story/tanzania-government/en
[48] See http://waset.org/publications/9997991/the-impact-of-nictbb-in-facilitating-the-e-services-and-m-services-in-tanzania
[49] See Analysys Mason Tanzania telecoms market report 2015.
[50] See http://www.fin24.com/Tech/News/Joburg-takes-back-control-of-broadband-project-20150219
[51] See http://www.iol.co.za/news/south-africa/gauteng/r1bn-joburg-broadband-project-under-fire-1.1741234#.VV7uLbnbJ_I
[52] See http://www.fin24.com/Tech/News/Joburg-takes-back-control-of-broadband-project-20150219
[53] See http://www.eib.org/epec/resources/epec_broadband_en.pdf
[54] See http://www.reti.regione.lombardia.it/cs/Satellite?c=Redazionale_P&childpagename=DG_Reti%2FDetail&cid=1213693098477&packedargs=NoSlotForSitePlan%3Dtrue%26menu-to-render%3D1213542547392&pagename=DG_RSSWrapper
[55] See http://www.ghana.gov.gh/index.php/news/1293-president-mahama-inaugurates-38-million-fiber-optic-backbone-project
[56] See http://allafrica.com/stories/201305270024.html
[57] See EU Scoreboard, based on June 2014 data
[58] See https://www.telegeography.com/products/commsupdate/articles/2015/04/01/metroweb-looks-at-two-new-fibre-markets/
[59] See http://www.telecompaper.com/news/metroweb-plans-to-expand-network-to-two-more-cities-report--1074238
[60] See https://www.telegeography.com/products/commsupdate/articles/2014/11/20/telecom-italia-still-circling-metroweb/
[61] See http://www.qnbn.qa
[62] See http://www.nbnco.com.au/
[63] See http://www.gitpa.es/en/the-asturcon-network.html
[64] See http://www.stokab.se/In-english/
[65] See https://broadbandeurope.wordpress.com/jv/
[66] See http://www.csipiemonte.it/web/en/documentazione/documentation-en/profile-en/592-brochure2014/file
[67] See http://www.investintrentino.it/Government/Infrastructures-and-strategic-projects/Telecommunication-infrastructures
[68] See http://www.elard.eu/elard/national-leader-networks/en_GB/lithuanian-rural-communities-union
[69] See http://qnbn.qa/qnbn_article/delivering-on-the-vision/
[70] See http://qnbn.qa/qnbn_article/delivering-on-the-vision/
[71] See http://qnbn.qa/qnbn_article/delivering-on-the-vision/
[72] See https://www.telegeography.com/products/commsupdate/articles/2014/10/03/vodafone-qatar-agrees-to-buy-qatar-national-broadband-network/
[73] See more detail at http://www.analysysmason.com/Research/Content/Viewpoints/Copper-decommissioning-costs-Oct2014-RDTW0/#28%20October%202014
[74] See http://www.analysysmason.com/Research/Content/Viewpoints/Copper-decommissioning-costs-Oct2014-RDTW0/#28%20October%202014
[75] See http://www.analysysmason.com/Research/Content/Viewpoints/Copper-decommissioning-costs-Oct2014-RDTW0/#28%20October%202014
[76] See http://www.analysysmason.com/Research/Content/Viewpoints/Copper-decommissioning-costs-Oct2014-RDTW0/#28%20October%202014
[77] See http://www.analysysmason.com/Research/Content/Viewpoints/Copper-decommissioning-costs-Oct2014-RDTW0/#28%20October%202014
[78] See http://www.forbes.com/sites/eliseackerman/2012/08/04/how-kansas-won-the-google-fiber-jackpot-and-why-california-never-will/
[79] See http://www.businessinsider.com/the-cost-of-building-google-fiber-2013-4?IR=T
[80] See http://www.techrepublic.com/article/comcast-time-warner-take-on-google-fiber-in-kansas-city-can-the-incumbents-compete/
[81] See http://www.theverge.com/2015/2/17/8050935/att-google-fiber-kansas-city-gigapower-internet-price-match
[82] See https://fiber.storage.googleapis.com/legal/googlefibercitychecklist2-24-14.pdf
[83] See http://telecoms.com/200521/uganda-is-next-stop-for-google-fibre-project/

84 See http://www.gigaclear.com/gigaclear-secures-additional-6-5m-to-accelerate-rollout-of-gigabit-rural-broadband/
85 See http://techcrunch.com/2015/02/11/sigfox-raises-115m-to-take-its-internet-of-things-network-global/
86 See http://techcrunch.com/2015/02/11/sigfox-raises-115m-to-take-its-internet-of-things-network-global/
87 See http://www.convergencepartners.com/wp-content/uploads/SEACOMAnnouncement-ver3.pdf
88 Assumes an exchange rate of USD0.084 per ZAR
89 See http://remgro.com/wp-content/uploads/pdf/2015/Results_31Dec2014.pdf
90 See http://www.thanhniennews.com/tech/intl-connections-in-vietnam-may-fully-recover-in-3-weeks-42574.html
91 See http://www.pcworld.com/article/258844/facebook_buys_a_stake_in_450m_asian_undersea_cable_consortium.html
92 See https://www.time.com.my/aboutus/newsroom_detailed.asp?id=236&ddlYear=2015
93 See http://www.carnegieuktrust.org.uk/getattachment/49d067b8-5836-4906-bfe0-70978c6ca5e9/Rural-Broadband---Reframing-the-Debate.aspx
94 See http://www.hie.co.uk/community-support/community-broadband-scotland/funding/default.html
95 See http://www.governancereport.org/home/governance-innovations/featured-innovations-2014/broadband-crowdfunding-germany/
96 See https://books.google.co.uk/books?id=XlL1AgAAQBAJ&pg=PA86&lpg=PA86&dq=crowdfunding+broadband+germany&source=bl&ots=RvNI8TVdFr&sig=5#v=onepage&q=crowdfunding%20broadband%20germany&f=false
97 See http://www.breitbandnetzgesellschaft.de/die-initiative/ausbauplan/
98 See License-exempt framework refers to devices operating on a non-interference/non-protection basis in compliance with technical specification and/or band rules without the need for an individual device license. See ITU, Trends in Telecommunication Reform- special edition- 4th generation Regulation, Chapter 3 – TV white spaces: managing empty spaces or better managing inefficiencies? www.itu.int/specialtrends
99 See http://www.scotsman.com/news/scotland/top-stories/rural-scotland-to-lead-with-white-space-internet-1-3569913
100 See ITU, GSR14 Discussion paper on new frontier in spectrum licensing, http://www.itu.int/en/ITU-D/Conferences/GSR/Documents/GSR2014/Discussion%20papers%20and%20presentations%20-%20GSR14/Session4_GSR14-DiscussionPaper-SpectrumLicensing.pdf
101 See https://www.crowdcube.com/pg/investing-your-money-1513
102 See http://www.crowdfiber.com/campaigns
103 See http://www.crowdfiber.com/service-provider-edition
104 See http://www.finextra.com/news/fullstory.aspx?newsitemid=27188
105 See the definition of accredited investors by SEC at http://www.sec.gov/answers/accred.htm
106 See http://www.crowdfundinsider.com/2014/11/55071-brief-star-citizen-creator-discusses-crowdfunding-video-games-development-video/
107 See https://robertsspaceindustries.com/funding-goals
108 See http://www.cnbc.com/id/102021804
109 See https://www.kickstarter.com/projects/cig/star-citizen/description
110 See http://www.polygon.com/features/2015/3/2/8131661/star-citizen-chris-roberts-interview
111 See https://www.pensionledfunding.com/press_release/10-things-you-need-to-know-aboutpension-led-business-funding/
112 See http://www.telegraph.co.uk/finance/currency/10686698/Bitcoin-exchange-MtGox-faced-150000-hack-attacks-every-second.html
113 See http://www.seedco.in/home/havelock/sf2
114 See http://www.howwemadeitinafrica.com/bitcoin-exchange-expands-to-kenya-sees-potential-in-using-m-pesa/47442/
115 See http://www.coindesk.com/california-regulator-coinbase-exchange-regulated-licensed/
116 See http://www.coindesk.com/seedcoin-gives-btc-sx-500-bitcoins-funding/
117 See http://www.coindesk.com/seedcoin-gives-btc-sx-500-bitcoins-funding/
118 See http://www.coindesk.com/bitcoin-startup-incubator-seedcoin-raises-2000-btc-funding-round/
119 See http://www.marketsgroup.org/news/destapa-futuro-and-angel-investment-in-colombia
120 See http://business.scotland.gov.uk/view/funding/nesta-venture-investment
121 See http://lavca.org/2014/01/29/entrepreneur-profile-sebastian-perez-saaibi-ceo-juan-pablo-marin-diaz-cio-aentropico/
122 See http://lavca.org/2014/01/29/entrepreneur-profile-sebastian-perez-saaibi-ceo-juan-pablo-marin-diaz-cio-aentropico/
123 See https://www.itu.int/pub/D-REG-TTR.11-2009
124 See EPEC, *Procurement of PPP and the use of Competitive Dialogue in Europe. A review of public sector practices across the EU*, available at http://www.eib.org/epec/resources/epec-procurement-and-cd-public.pdf.
125 See http://www.internationallawoffice.com/newsletters/detail.aspx?g=681de6db-6cb0-4064-b8f9-f1f3feb4059e