Foreword

We are delighted to present this KPMG Infrastructure Spotlight Report on the roll-out of high speed broadband, referred to as Next Generation Network (NGN) infrastructure. Our report focuses on the approaches being taken by governments to promote the development of NGN in their countries.

The pace of change in the communications sector is relentless and shows no sign of slowing down. The World Wide Web was invented only twenty years ago and there is no doubt that the next twenty years will see the development of further technological breakthroughs that will have profound implications for both businesses and individuals. The case for a new, fiber based, infrastructure is being made in many countries and significant investment programs have already been launched. However, the picture across the globe is mixed, and both the case for investment and the nature it should take is being addressed differently country-by-country.

In the past, communications infrastructure investments have yielded significant economic benefits and there are strong reasons to suggest that a new generation communications infrastructure is essential to the development of our increasingly knowledge-based economies. A number of key questions surrounding these investment programs however need to be answered. For example, who should pay for the fiber roll-out, what form should it take and what are the wider benefits to society and the economy? Of course trade-offs exist between these various questions and different countries have followed different paths in answering them based on their particular circumstances.

We can observe that the market will not in all circumstances deliver NGN and some form of public sector intervention may be required if universal or quasi-universal coverage is to be achieved. This can be challenging as crowding out private sector investment and compromising competition are genuine pitfalls and it may be too early for governments to be able to determine precisely what the outcome of private initiatives will be over the next few years. Yet the urgency to deliver NGN earlier for the sake of economic benefits will remain real.

As advisors to governments and operators, KPMG member firms have worked on many such infrastructure programs, helping clients on best practices throughout the lifecycle of their projects. This spotlight report summarizes some of our international insights and sheds light on some of the approaches that have been followed across the world.

We hope that you will find this report of interest and will not hesitate to get in touch with us if you would like to discuss some of the key issues.

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Key messages

- Next Generation Network (NGN) infrastructure is viewed by governments as essential to economic competitiveness, improving productivity and encouraging growth.
- Studies suggest that in addition to benefits in social inclusion and reduced income inequality, savings can be realized in energy, transport, healthcare and education sectors.
- Whether the efficiency savings and social benefits of NGN are real or not, network operators are only able to capture a fraction of these benefits as fee income, and this suggests that there is a case for government intervention.
- Governments which have intervened in their markets to encourage broadband roll-out have seen higher and earlier levels of penetration and lower subscriber charges.
- The types of interventions by governments vary and fall into three broad categories: regulatory, market and financial.
- Solutions for securing investment in NGNs and ensuring long term competition have often involved a restructuring of the industry into infrastructure and service layers: the passive infrastructure layer, the active infrastructure layer and the services layer.
- A country-by-country analysis shows governments have used different combinations of government intervention by category and layer according to the particular characteristics of each market.
- Singapore provides a case study of how one government has sought to realise the benefits of a vibrant competitive market combined with state of the art telecommunications infrastructure through appropriate, well structured interventions.
- International insights on approaches that have been followed across the world on NGN programs provide valuable examples to ensure that best practices are adopted throughout the lifecycle of broadband infrastructure roll-out.
Introduction

High speed broadband is believed by many to improve productivity and encourage economic growth. This belief stems from past research on the impact of communications infrastructure. There is however a lively debate around the optimal timing for such investments as well as the extent to which governments should be involved in their financing. The nature of demand and propensity to pay for new high speed services are key drivers of the business case for investment. Given the uncertainty surrounding these decisions many operators have decided to phase their investments.

A number of governments around the world are pressing ahead with significant investment programs into Next Generation Network (NGN) infrastructure. The risk of being left behind in the race for economic competitiveness simply seems too great for many countries. Irrespective of the optimal mix between public and private investment to get there, one thing is certain, doing nothing is not going to be a viable option for most countries.

The remainder of this paper looks at why a market failure in high speed broadband might arise and how governments have sought to accelerate investment in NGN. The paper also contains a brief case study of how Singapore has addressed the issues in order to illustrate how policy can be put into practice.

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1 Many authors have found a strong relationship between investment in telecommunications infrastructures and economic developments. More recently Qiang (2009) and Qiang and Rossootto (2009) found a robust and significant growth dividend from broadband access in developed countries. See Qiang, Christine Zhen-Wei, and Carlo M. Rossootto, (2009), "Economic Impacts of Broadband, Information and Communications for Development 2009: Extending Reach and Increasing Impact", 35-50. Washington, DC, World Bank.
The case for fiber

It is often argued that increased access to high speed broadband can be a catalyst for productivity growth and wealth generation. Such access is also posited as a tool to increase social inclusion and to reduce income inequality. A study by OECD\(^2\), for example, suggests that the cost savings that could be realized in the energy, transport, healthcare and education sectors over a ten year period as a result of the investment could alone justify a national FTTH (fiber-to-the-home) network. The study suggests that returns from broadband connectivity can be greater still if social benefits are considered. While the scale of these benefits remain subject to much debate given the uncertainty surrounding both the technology and demand characteristics for future communications services, many governments have now started to review their options for NGN deployment.

Another driver for investment in NGN is the acute need for increased bandwidth. Moore’s Law, which has held true for several decades, means that processing speed doubles every 24 months\(^3\). This implies the copper wire based broadband infrastructure that in most countries is currently being used to transmit data (and whose capacity itself has been expanded significantly in the last ten years thanks to DSL technology) may finally need to be replaced\(^4\), as its limited bandwidth capacity will constrain future development. This has led to the acceptance that all countries must eventually roll-out FTTX (fiber-to-the-x) based broadband infrastructure\(^5\).

While technologies based on wireless will have a role to play in reaching universal coverage for very high speed services the bandwidth limits and spectrum economics of such networks are such that they are likely to be a complement, rather than a substitute, to fiber based infrastructures in the future.


\(^3\) http://www.intel.com/technology/mooreslaw/

\(^4\) Assessment of the theoretical limits of copper in the last mile, Roger Williamson, Jeremy Klein, Mike Reynolds and Ross Jones, a report from Sagentia for Ofcom, 16 July 2008

\(^5\) The main variants of FTTx are fibre to the cabinet (FTTC) — Deployment of fibre to a street cabinet and provision of broadband over copper loops from the street cabinet to end-user premises, fibre to the building (FTTB) — deployment of fibre until the basement of a building and provision of broadband over in-house copper wiring, fibre to the home (FTTH) — an end-to-end fibre solution to end-user premises. In this scenario, the entire copper access network is replaced by fibre, along with the main distribution frame (MDF) and street cabinets. The broadly-defined term fibre to the premises (FTTP) is also sometimes used to describe FTTH and/or FTTB.
Irrespective of the exact scale of efficiency savings and social benefits generated by NGNs, network operators are only able to capture a fraction of these benefits as fee income. This is the principal cause of market failure. The capital costs and the time involved in rolling out NGN are significant. The reported expected investment in Australia, for example, is AUS$43bn (US$40bn), with an eight year roll-out period\(^6\). The requirement for such high value and long term public investment often stems from the decision by the private sector not to invest in new capacity, especially in sparsely populated areas where demand is limited and the cost curve starts to rise steeply. The experience of some firms that invested heavily in third generation mobile network licenses early in the lifecycle of the technology bears some parallels with NGN investment business cases and suggests that the timing of the initial investment is critical if positive financial returns are to be achieved.

Government intervention to ensure wide availability of NGN services may be warranted to provide wider benefits to society as a whole in welfare terms, even if the direct business case from a private investor’s perspective is unlikely to provide adequate financial returns. This can mean a cost benefit assessment at the public level can yield the alternative result to that performed at the narrower private sector financial appraisal of the opportunity. The decision not to invest by the private sector is consequently regarded by government as a possible market failure in NGN roll-out. Examples across the globe — see Table 1 — show that many governments have already decided to intervene in order to accelerate NGN roll-out and meet their public policy objectives.

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It is becoming increasingly clear that countries aspiring to be on the forefront of innovation, global trade and knowledge leadership must have NGN roll-out on their agenda. Not only do businesses and investors demand high speed broadband infrastructure but the general population has come to increasingly rely on broadband access to take care of their various communication needs — voice, data and video.

Figure 1 shows the state of broadband penetration in eight countries at intervals of four years. The countries shown have rolled out or have immediate plans to roll out NGN. South Korea was the first country to make conventional broadband available to the population as a whole followed by Japan and Sweden, enjoying the associated benefits before other countries. By the second quarter of 2009, all eight countries included have, however, reached similar levels of coverage for conventional broadband. The countries included in the figure are the more advanced ones in terms of coverage. In June 2009, half of OECD (Organization of Economic Cooperation and Development) members, including six of the eight countries shown, had reached 25 subscribers per 100 inhabitants.

OECD does not provide broadband statistics for Singapore which is used as a case study later in this report.
Figure 1. Broadband\textsuperscript{a} (speeds in excess of 256 Kbps) subscribers per 100 inhabitants

Source: www.oecd.org/sti/ict/broadband
Figure 2 gives the emerging pattern in NGN adoption. Japan and South Korea are in the lead both in terms of advertised speeds as well as FTTH/B (fiber-to-the-home/building) availability. France and Sweden are the two countries in pursuit.

Figure 2. Fastest advertised broadband speed (all technologies, Mbps, Oct 2009) and fiber-to-the-home/building availability (up to 2009)

Source: www.oecd.org/sti/ict/broadband
Some caution should be exercised in interpreting Figure 2. The fact that connection speeds are advertised does not necessarily mean that they are subscribed and realized. Also, the collection of information of fiber based subscriptions has only begun recently. OECD has used “0” value where reliable estimates have not been available.

The eight countries included in the Figures 1 and 2 as well as Singapore (see case study later in this report) have invested or are investing in NGN infrastructure. Many countries will follow suit and can learn from the different approaches that have been adopted internationally. The bespoke approaches are a response to the varying local circumstances. In some instances a market failure has been identified and government intervention has been deemed necessary. In others market forces alone appear to be delivering the investments. By their very nature, some governments have a greater inclination to intervention than others and may do so even if market failure is not immediately apparent.

The interventions by government fall into three broad categories: regulatory, market and financial.

- **Regulatory:** Governments have to design regulatory frameworks that will both maximize welfare and provide certainty to investors. Provisions ensuring third party access to bottleneck infrastructure can facilitate the emergence of a competitive market and has therefore been a key objective of many regulators. In many countries, discussions on the mandated separation of the infrastructure owner can be seen in this light as obligations concerning the provision of equivalent services to third parties are imposed. Such regulatory measures however need to be carefully designed to avoid the risks associated with investors not being able to obtain a fair return on their investment, especially when faced with universal services obligations. Access pricing, potentially alongside market and financial interventions, is one measure that can be deployed to ensure that a competitive market structure develops while investment incentives are not undermined.

- **Market:** Governments may decide that given the economic benefits (and so called externalities) associated with network investment, public sector intervention is warranted. Such economic benefits include productivity gains associated with investment, attracting and development of highly skilled labor, seamless communication and the innovation and new organizational models that can emerge in economies with state of the art communications infrastructures. Government demand guarantees and concessions to private sector operators through open tenders are two examples of market based interventions.

- **Financial:** Financial interventions can take many forms (e.g. tax incentives, assistance funds, direct monetary injection, grant, etc.) and can be aimed at helping private operators achieve higher infrastructure coverage and connectivity. Many countries have to consider state aid regulations and obligations that arise as result of their membership in the World Trade Organization as well as the best way to design the level and structure of financial incentives to maximize their impact. While the exact form of public investment needs to be carefully considered (e.g. direct investment into an infrastructure project, financial grants, special tax deductions, etc.) it is possible that such intervention will be required in countries seeking nation-wide coverage of NGNs.

These three approaches are not necessarily mutually exclusive but careful consideration needs to be given to their interactions and a holistic framework needs to be put in place at the outset. Given the difference in approaches and the relatively recent implementation of such approaches in many countries it is too early to draw firm universal conclusions as to the effectiveness of one method against another. There are, however, useful international lessons that a country contemplating NGN roll-out can build on, whether in relation to policy or transaction design.
Governments can facilitate environments where investment does begin to take place. The three categories of regulatory, market and financial interventions can be aimed at reducing uncertainty, increasing competition and improving returns on investment. It is, however, vital to ensure that governments do not crowd out private sector investment by intervention. Making the maximum use of private sector finance preserves public capital for uses where private involvement alone is not sufficient.

Communications regulators are concerned about the lack of investment for improving the existing network. The re-monopolization of the access network is, however, also a concern. This is because a competitive market structure is seen as a key driver of the long term maximization of end user benefits. Figure 3 illustrates the relationship of fastest available speeds and pricing of capacity (Mbps) in eight markets. Differences in price can be explained by competitive rivalry as well as government policy and national characteristics such as population density. The figure is based on advertised speeds. It is important to remember that these do not necessarily reflect speeds actually realized in practice. It appears that as speeds grow the price per Mbps reduces. High speeds are economical in Japan and South Korea whereas prices in Australia and Sweden are noticeably more expensive.

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**Figure 3. Fastest advertised broadband speed (all technologies, Mbps, Oct 2009) and average broadband monthly price (per advertised Mbps, October 2009, US$ at Purchase Power Parity, PPP)**

![Figure 3](www.oecd.org/sti/ict/broadband)

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10 OECD (2009) Ibid.
Solutions for securing investment into NGN whilst ensuring long term competition also exist. A frequently considered solution consists of splitting the industry into different layers: the passive infrastructure layer (comprising the fiber, the ducting through which it runs and the civil engineering that supports it), active infrastructure layer (comprising the active electronics for provision of wholesale bandwidth that makes services possible) and services layer (end user services) — see Figure 4. Some form of mandated access to the underlying bottleneck upstream infrastructure can also be introduced to ensure that competition will emerge in downstream layers, and contribute to the creation of a vibrant retail service space.

**Figure 4. The broadband market structure**

<table>
<thead>
<tr>
<th>Typical characteristics and elements</th>
<th>Provision of services to retail and business users</th>
<th>Deployment of active electronics (e.g. servers, routers and switches) and provision of wholesale bandwidth</th>
<th>Deployment of passive infrastructure (fibre and ducts) and provision of fibre connectivity</th>
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</thead>
</table>
The infrastructure providers require the prospect of a fair return on investment in order to proceed with roll-outs. This is where the regulators have an important role to play in setting the access charges for the service providers, although from the infrastructure providers’ perspective it needs to be combined with an acceptable and predictable level of demand. This dynamic makes NGN similar to other regulated infrastructure-based industries.

A key challenge is that charges can commercially sustain NGN infrastructure only in a proportion of the market, namely the high density areas. A number of solutions to fund the roll-out of NGN to the rest of the areas have been proposed. Options that have been considered range from universal service type contributions to special taxes on existing fixed telephone lines.

Most countries have a history of formerly state owned, vertically-integrated telecommunications companies. Those incumbent operators are often active in each of the three layers and may hold a dominant market position in some of the broadband markets. Vibrant competition, especially in the services layer, is often argued to yield significant benefits to end users and society as a whole. Renewing the infrastructure can thus be seen as an opportunity to increase competition. Considering the desired competitive landscape post NGN roll-out, this is a plausible way to ensure that the potential benefits from a changing industry structure are realized. Figure 5 captures the structures of the broadband markets in nine countries. The selection of countries from those presented in Figures 1 to 3 is expanded with Singapore.
The roll-out of next generation networks

The color coding in Figure 5 indicates the degree of vertical integration of the industry in each country. The grey boxes indicate where there is competition in the active electronics and services layers by companies that are not vertically integrated. The black vertical lines indicate show where vertically integrated companies compete horizontally. The coding of the active electronics layer for New Zealand and Singapore is explained below. The market from France and Sweden breaks into two distinct parts.

In the case of Australia, New Zealand and Singapore these are planned as opposed to the current actual market structures.

- **Australia**: The market is dominated by a vertically integrated incumbent and the government is focused on establishing open access to broadband infrastructure.
- **France**: The markets in metropolitan and rural areas have different structures. In metropolitan areas, a small number of vertically integrated private sector companies compete with each other. In rural areas, concession-type Public Private Partnerships (PPPs) are used to provide infrastructure which is used by service providers in a competitive environment.
- **Japan**: A small number of vertically integrated companies compete in the marketplace.
- **New Zealand**: Government plans are in place to set up a structurally independent company offering non-discriminatory network access. The intention is to foster competition in the service layer, albeit it is likely that one of the current participants will maintain involvement in the active services layer (note hatched area in Figure 5).
- **Singapore**: See case study later in this report.
- **South Korea**: Three vertically integrated companies compete with each other.
- **Sweden**: The market breaks into two. There is the national backbone network that is jointly owned by a number of vertically integrated competitors, including the incumbent. Cities and local authorities deploy their own open access networks which are connected to the national backbone.

<table>
<thead>
<tr>
<th>Services layer</th>
<th>Australia</th>
<th>France</th>
<th>Japan</th>
<th>New Zealand</th>
<th>Singapore</th>
<th>South Korea</th>
<th>Sweden</th>
<th>United Kingdom</th>
<th>United States</th>
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<tbody>
<tr>
<td>Active electronics layer</td>
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<td>Passive infrastructure layer</td>
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**Code**

- One or several “dominant” players
- Open to third parties (see Singapore case study)
- Competition including a number of non-vertically integrated players
- Horizontal competition among vertically integrated players
- Government initiative to be open to third parties (see New Zealand below)
• United Kingdom: The passive and active infrastructure layers are held by a single business unit that has been operationally separated from the rest of the incumbent’s business units. This business unit provides equal access to all service providers.

• United States: Three vertically integrated companies compete in the broadband market. These companies have overlapping infrastructure networks.

In advance of considering the type of interventions that the different governments have made or are making it is important to acknowledge that each country is unique. Figure 6 gives the Gross Domestic Product (GDP) per capita and population density for each county. GDP per capita is an often used indicator of economic prosperity and may influence how much a country is able to invest in NGN. GDP per capita of Singapore is almost twice that of New Zealand, albeit the group as a whole is one of developed countries.
Population densities also shown in Figure 6 reveal wide variations across the nine countries. Australia, New Zealand, Sweden and the United States have low population densities at one end of the spectrum whereas Singapore occupies the other end on its own with a population density close to 6,700 inhabitants per km², whereas Australia has only three. This is likely to have an impact on the cost effectiveness of rolling out broadband and reaching universal coverage. Population density alongside the existing market structure and other factors will drive the interventions governments will make in order to facilitate roll-out of NGN — see Table 1.
### Table 1. Government interventions — category and type

<table>
<thead>
<tr>
<th>Category</th>
<th>Intervention type</th>
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| Regulatory | **Australia**: separating the incumbent’s infrastructure company from service provision  
             **UK**: separating the access infrastructure provider from the incumbent operationally and mandating equal access  
             **Sweden**: coordinating the development of the backbone infrastructure |
| Market | **France**: using the Public Private Partnership model (with both government and local authorities funding) to develop broadband in rural areas  
         **Singapore**: imposing a specific market structure through competitive tendering involving demand guarantees to encourage investment |
| Financial | **Australia**: co-investing in rolling out infrastructure  
             **France**: granting subsidies for building infrastructure in rural areas  
             **Japan**: supplying tax incentives and loans at preferential rates  
             **New Zealand**: co-investing in infrastructure and providing subsidies for rural areas  
             **Singapore**: providing a grant to make a transaction economically viable  
             **South Korea**: supplying tax incentives and loans at preferential rates  
             **Sweden**: proving tax incentives for investment in general and subsidies for rural areas in specific  
             **UK**: new government considering some form of public subsidy for NGN in rural areas  
             **United States**: granting stimulus monies to encourage deployment in underserved areas |
Case Study – Singapore NGN

Singapore is a city state with a population of over 4.5 million. The land mass of the country is a modest 697 km² giving it a population density of 6,700 inhabitants per km². Singapore is one of the most prosperous countries in the world with a per capita GDP of US$50,300.

In June 2006, when the government of Singapore presented its ten-year master plan — Intelligent Nation 2015 (iN2015), the country was already enjoying relatively high broadband penetration levels (in excess of 60 percent) and high broadband speed of up 100Mbps. Whilst the telecoms market was liberalized, the industry was dominated by three incumbents. The iN2015 master plan was aimed at harnessing the full potential of the information and communications industry, in large part, through the building of the NGN infrastructure. The objectives for that plan were to realize nationwide coverage, high take-up and competitive as well as affordable end users pricing. The project’s success will be ultimately judged based on outcomes: the extent to which a vibrant information and communications industry develops over the next few years once the FTTP network is fully rolled out by 2012.

In spearheading the development of the NGN, the Singapore Government adopted a consultative approach and sought non-binding proposals from the market. By 2007, it had arrived at a three-layer structure for the broadband industry. This consisted of a passive layer (also known as the Network Company or NetCo), an active layer (also known as the Operating Company or OpCo) and service providers. The NetCo was to be responsible for the deployment of the passive infrastructure and related connectivity services. The OpCo would be responsible for the roll-out of active electronics and providing with associated service offerings as well as providing services to end customers in the retail space.

In December 2007 and April 2008, the Infocomm Development Authority (IDA) launched the tenders for the set up and operation of NetCo and OpCo respectively — a market intervention. Up to S$1 billion (US$0.7 billion) government funding was available to support the transactions — a financial intervention. The government believed that open access infrastructure was critical to foster competition among service providers, including the incumbents. Open access was achieved through the need for NetCo and OpCo to provide service offerings that do not discriminate against any of the service providers. NetCo and OpCo were also subjected to structural and operational separations respectively.

In September 2008 and April 2009, the NetCo and OpCo projects were awarded to OpenNet consortium and Nucleus Connect respectively. The OpenNet consortium is led by Axia Netmedia of Canada with the other shareholders being Singapore Telecommunications (SingTel), Singapore Press Holdings and SP Telecommunications. The incumbent SingTel has leveraged on this opportunity to build a business case for the winning consortium, OpenNet, which would allow it to monetize its assets. The OpenNet proposition made use of SingTel’s existing underlying passive infrastructure to support the deployment of the NGN network.

Nucleus Connect is a wholly-owned subsidiary of StarHub, a Singaporean telecommunications company.

The competitive tender process has helped to yield attractive access prices. A 100 Mbps residential plan is currently offered at approximately S$90 per month. As comparison, Nucleus Connect will offer a wholesale price of S$21 per month. Even with a generous retail services margin, users could still expect price points to reduce drastically. This price outcome has also been credited to clear and pragmatic structuring of the transactions as well as fair and transparent procurement processes.

OpenNet is committed to meeting 60 percent network coverage by 2010 and 95 percent by 2012. Nucleus Connect expects to launch services in stages during 2010. Expressions of interest to use the open access NGN infrastructure have been received from more than forty possible service providers. The levels of interest and commitment shown at this stage, provided they can be realized, point to the development of a vibrantly competitive, state of the art telecommunications landscape in Singapore.

11 In the context of this case study, the NetCo was required to be structurally separated from downstream operators, thereby preventing it from participating in the provision of downstream services. The OpCo, which was subject to the less onerous operational separation between itself and RSPs, was required to maintain separate operations, branding, personnel and board of directors. One key differentiating element is that structural separation includes prohibiting the NetCo from owning more than 30% equity in downstream operators and vice versa.

12 The main difference between structural and operational separation is that structural separation involves the separation of the relevant businesses into separate legal entities and the separation of ownership of those entities, whereas operational separation leaves the relevant business under the same ownership and as a result, legal separation is not performed.
The roll-out of NGN is not only about speed. There are a number of competing policy objectives such as geographical coverage and price to end users. This spotlight report has looked at the potential challenges in NGN provision and briefly considered the market structures as well as possible government interventions in nine countries, including a case study on Singapore. The pattern that emerges is that governments do often support NGN roll-out. They do so through a variety of means — regulatory, market and financial. There is no clear consistency in the application of specific policies across countries as the optimal policy design has to be based on key parameters such as market structure, level of economic prosperity or population to landmass ratio.

While the size of the net benefits of NGN adoption are uncertain it is clear that our increasingly knowledge-based economies will require significant infrastructure investments in the future to support new products and services. In that context, not investing does not appear to be a long term option.

The structure and interventions used by Japan and South Korea stand out as ones that have delivered early adoption and speeds amongst the highest. However, this model may not work in other countries as each national market is unique. Higher speed networks seem to follow through to provide lower average costs for consumers and tend to encourage higher subscriptions, as in South Korea.

Government support, at least in a co-ordinative capacity, is one route for encouraging adoption of NGN. The Singapore case study serves to illustrate that where government highlights broadband infrastructure as a key priority, and is willing to provide at least some significant initial capital, the private sector can be incentivized to take on network installation and maintenance. Irrespective of the source of financing it is also paramount for the stakeholders to benefit from robust assessment, planning and procurement methodologies in order to successfully implement such large scale investment programs.
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