Strategies for the deployment of NGN and NGA in a broadband environment – regulatory and economic aspects

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This report has been prepared for ITU byDr Roger Steele, CEO of Telzed Ltd. UK, under the direction of the ITU/BDT Regulatory and Market Environment Division (RME). It has been developed based on desk research and on Dr Steele's experiences gained working with operators and regulators in many countries, as well as by using data from the ITU Tariff Policies Survey (www.itu.int/ITU-D/icteye/).

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Executive Summary

NGNs are being deployed across the world. These enable new and better services, in particular they can carry broadband-based services that provide benefits from their ability to enable new ways of working. This creates wider economic benefits, as all industries can benefit from the broadband-enabled economy.

The benefits cannot be fully obtained without the investment in the new technology and migrating old networks and services to the NGN. The pace of this change is varied, even in countries with higher GDP levels, and few countries have adopted approaches for the highest possible broadband speeds, in more than a few selected areas. There are a number of barriers holding back the changes such as: the funding (and payments) for the deployment; technical issues; competition; regulation; and uncertainty whether the approach is optimal to the particular country. The possible solutions are varied and the financial risks, from the major access-network investments, are high. These have combined to slow the change to NGN.

Different approaches have been observed in leading countries. These show how NGNs can be implemented, but the varied approaches also show that there is not one single approach that will be optimal in every situation. These approaches will need to be adjusted to meet the needs of other countries – especially in the developing economies.

Examination of NGN approaches indicates that a number of factors that must be considered. A top down approach is required that starts with a wide-ranging policy that covers all of ICT and addresses service supply, end user demand as well as NGN provision. This should then be supported by regulation and funding approaches that need to be matched to the country and the specific features of NGNs. NGNs have a number of differences from legacy-technology approaches that run deeper than simply allowing faster or cheaper services. These differences require regulatory approaches to be altered. They also require a more radical approach to technical migration because the network structures change the economics of network supply in greater ways than seen with most other technical changes.

NGN Access requires the greatest funding and it also opens up the greatest challenges for policy makers. The major investment per household from fibre in the loop is the key problem. This increases risks – the investment amounts are very high, so failure to recover the investment could lead to catastrophic business failure. Alternative funding methods must also be considered and the potential for government funding increases where commercial investors are unable to make a return. This thinking considers broadband access in similar ways to a key infrastructure such as power or water supply – it is vital so that other industries can flourish. Government or alternative funding may also be required to avoid a "digital divide" where parts of society cannot obtain broadband services and therefore remain disadvantaged.

This report identifies the key issues in NGN migration as well as the benefits from the change. This indicates that moving to a broadband based economy has wider benefits – far beyond the telecoms industry. The movement to NGN in emerging economies has to face other problems, not seen in the developed economies that have generally been the ones to implement broadband. This suggests that emerging economies will have to selectively adapt approaches seen elsewhere and will need to build more on wireless technologies as there are usually only limited fixed-line infrastructures to build on. The limited existing fixed line legacy also provides some benefits: there is less need to maintain dual-technologies and a more radical migration plan can be considered without so much consideration of the inter-working and maintenance of the older systems.

This paper provides a number of proposals that can assist with the development of strategies for NGN deployment. Although any such deployment has some risks, these can be countered with the question of: what are the risks to the economy and national competitiveness if there is *no* NGN investment and peer countries do make the transition.

1 Introduction

Telecom services are a central part of everyday life and they provide a platform for almost every other industry and so enable economic growth. The telecoms technologies that deliver these services have been changing and these changes enable new services as well as lower cost and higher performance versions of existing services. Alongside the technical changes, political and regulatory changes have allowed competition and investment that have helped to optimise the service delivery. These have led to a greater diversity of services and service suppliers which have in turn increased consumer choice and have encouraged better services at lower cost.

Technical changes have always happened and regulatory change has been common in many countries for over 20 years. One particular change is more radical than past technical changes. This is the move to NGN (Next Generation Networks). These technical changes have led to a need to re-consider some of the regulatory approaches which have had to adapt to the altered technology.

Changes have been seen in almost every country, but they can result in different outcomes depending on how they are implemented and on the economic status of the country: what is possible in a small wealthy country may not be appropriate to a large rural country with low income per person. The NGN changes are also more fundamental than past technical changes. The ITU has recognised this and has sponsored a number of studies on regulation and the impacts of the technical and regulatory changes. This paper looks at strategies for the deployment of the technology and in particular the regulatory and economic aspects, in order to give assistance to decision makers. To illustrate the changes, this paper focuses on 1) The experience from countries that have implemented the transition to NGN, for the purpose of providing guidance to developing countries, and 2) Strategies for promoting growth in data communications in particular within developing countries.

This paper provides information on the situation in developed and developing countries with respect to the deployment of NGN. It includes guidelines for making the transition from existing (also termed traditional or legacy) networks to NGN in a broadband environment. Broadband provides higher speed access to customers than were possible over legacy technologies. This broadband access to customers enables multiple services to be delivered over the same broadband connection.

The paper considers both NGN Access (the final connection to the customer over copper, fibre or wireless links) as well as the core network (NGN core) that supports the service-providing platforms. NGN core and Access are both defined here under the generic term: NGN.

New technology in itself is not of fundamental interest: better ways to deliver essentially the same services have always been happening in telecoms. The new NGN technologies create a number of radically new and/or radically better telecom services. Therefore the new telecoms services provide the basis for new ways of working and so provide the enabling platforms for trade and these results in welfare gains for citizens.

Fixed and mobile voice calls have historically provided a key service for almost every industry in every country. In a similar way, the services that are provided over NGNs enable better ways for existing business to function and more importantly they also open up totally new forms of business that were not previously possible. New and better forms of trade and new ways for people to interact, as a result of NGN, change lifestyles and enhance the economy. As a result, NGNs are rightly of major interest to all decision makers in all economies: these NGN services provide the platform for further economic gains, in the same way that voice calls have already delivered huge benefits.

NGNs require investment to obtain the economic benefits. This opens up questions on what are the best approaches. Investments can be all government-based or else NGNs may be left entirely to private enterprise (with many options in between). The provision of NGNs open up competition issues as there may be limited options for multiple investors and multiple network providers. This is especially true in the access network.

NGNs clearly affect the national economy, consumers and investors. As a result, NGNs are of interest to: governments; telecom regulators; telecom industry operators/investors; service providers who make use of the NGN services to deliver other services; as well as the end users (the retail and business consumers). Planning a strategy to deploy NGNs therefore has to appreciate the economic issues, legal frameworks and regulatory implications to ensure NGNS are developed in a way that is most appropriate to the national requirements.

This paper looks at the key issues and examines a selection of NGN approaches. The largest and best known NGN developments tend to be in the more developed economies, which can best afford the investment. Developing countries have also embraced NGN as their needs to modernise and invest are greater, and the modern and cheapest technology is now NGN. As a result, some emerging economies have higher levels of NGN compared to legacy technologies. Lessons from the developed countries can still be relevant to developing economies.

The paper has a strong emphasis on broadband Internet access because it is the primary enabling service for the widest range of end user services and so delivers the greatest economic benefits. This is not the only service that is provided by NGNs: voice, TV, video and business-data services are also usually provided over NGNs. Supporting the NGN services are various network components and service-delivery elements that link together to deliver the end-user service. This paper has a stronger emphasis on the access components as this area requires the greatest levels of investment and inherently has least ability to sustain competitive provision: it is not possible to have many access networks to every customer or to every building.

The approach used in this paper:

- Looks at the definition of NGN and defines the key elements.
- Identifies the key services, economic features and the key issues.
- Examines the migration to NGN by understanding who the key players are and what the key issues are.

This grounding in NGN is then further developed by looking at NGN approaches that have been used to deploy NGN. A top down approach is used with country-specific examples covering:

- Policy.
- Regulation.
- Funding.
- Broadband economics.
- Technical factors.

Next, a number of key lessons are brought together into a summary of strategic points that should be considered in order to optimise the deployment of NGN. These provide guidelines but these should *not* be considered a recommended universal best practice: it is not possible to define what is best in every situation. The proposals should be considered as a framework to help provide a possible direction for further consideration by decision makers when they formulate an optimal plan for NGN migrations in the national and local situations.

2 Background to NGN

2.1 Definition of NGN core and access

The ITU definition[1] of NGN is provided below.

A Next Generation Networks (NGN) is a packet-based network able to provide Telecommunication Services to users and is able to make use of multiple broadband, Quality of Service (QoS) enabled transport technologies, in which service-related functions are independent of the underlying transport-related technologies. It enables unfettered access for users to networks and to competing service providers and services of their choice. It supports generalised mobility which will allow consistent and ubiquitous provision of services to users.

The NGN is characterised by the following fundamental aspects:

- *Packet-based transfer*
- *Separation of control functions among bearer capabilities, call/session, and application/service*
- *Decoupling of service provision from transport, and provision of open interfaces*
- *Support for a wide range of services, applications and mechanisms based on service building blocks (including real time/streaming/non-real time services and multi-media)*
- *Broadband capabilities with end-to-end QoS and equivalent conveyance of all services with the same QoS*
- *Interworking with legacy networks via open interfaces*
- *Generalised mobility*
- *Unfettered access by users to different service providers*
- *A variety of identification schemes which can be resolved to IP addresses for the purposes of routing in IP networks*
- *Unified service characteristics for the same service as perceived by the user*
- *Converged services between Fixed and Mobile networks*
- *Independence of service-related functions from underlying transport technologies*
- *Support of multiple last mile technologies*
- *Compliant with all Regulatory requirements, for example concerning emergency communications and security/privacy, etc.*

Source: ITU, www.itu.int/en/ITU-T/gsi/ngn/Pages/definition.aspx

[1] ITU-T Recommendation Y.2001 (12/2004) - General overview of NGN

It should be noted that NGNs have existed in many countries for several years, so the technology is not the *next* technology, but actually it is an *existing* one. The terminology is however well accepted. To assist with the discussions in the rest of this paper some of the key aspects of the above are expanded on and contrasted to with the traditional way that telecom networks have been structured (also termed *legacy* networks).

Key aspects of NGN include the following:

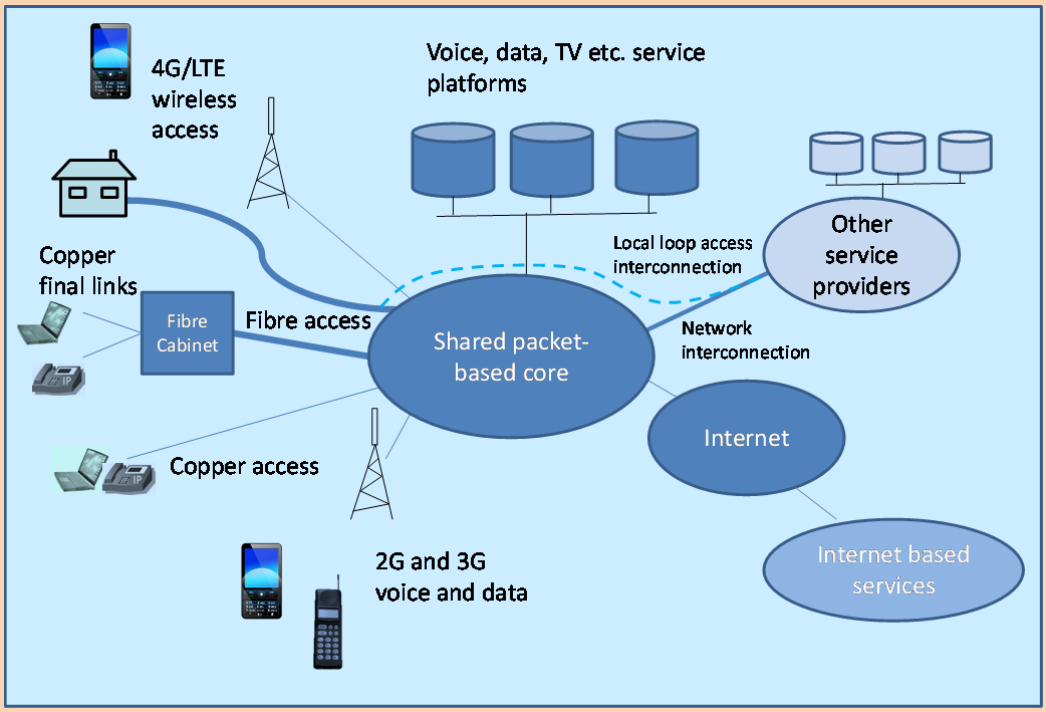
- The use of packet based technology as the transport method. Although IP (Internet Protocol) is the main packet based protocol used to transport services, NGNs are physically separate to the Internet, and are managed independently. NGNs commonly supply broadband services that link a customer to the Internet. Internet access is one of many NGN based services.
- Legacy networks typically have service-providing systems within the network. Therefore voice switches are located within a transmission network that links them together. Each service (voice calls or leased lines etc.) has its own transmission network and its own dedicated systems. In contrast NGNs have the same shared IP based platform to convey the services. The packets may be differentiated by QoS factors (such as the priority over other packets) but are carried over a shared core network.
- Most legacy networks have specific access links for each service: separate copper wires for every voice and data service. NGN access allows multiple higher-speed services to be carried over a single access link – typically fibre or fibre/copper combinations. This enables broadband access at speeds of 100Mbit/s or even more. In contrast copper wires, as used in legacy fixed networks, are limited to a few Mbit/s.
- NGN based services can be delivered over different access technologies: NGN services may be "agnostic" to the access technology. In principle IP based voice, IP-TV or broadband Internet access can all be delivered over one access link which can be fibre, copper or wireless based. The services remain the same (albeit perhaps at different speeds) irrespective of how they are delivered.
- Services are primarily defined by the end user device and the service providing platform. The general purpose packet transport "simply" provides the linkage between the two.

Both legacy and NGNs have some common features:

- The transmission networks between cities and over international cables use high capacity fibre systems. The capacity on the links may be managed and used differently, but the underlying transport platforms are the same.
- The retail interfaces to customer – billing, customer help desks etc., need to be similar.
- The services seem by the customers are essentially the same. Some are new such as virtual private network leased lines, but most existed before, but at slower speed. Customers buy the service, not the NGN, so the technology itself should not be a selling point.
- The business need to make a profit is not altered, even if the cost base is different. Legacy network managers often struggled to define product margins and to set sensible prices. As costing the different products is harder with NGN, setting profit targets is at least as difficult. The business imperative to control costs, and manage profits by product and by customer segment remain a common requirement.
- The access needs ducts, cabinets, poles etc. to carry fibre, just as they carried copper cables. The masts and backhaul links needed for mobile 2G are similar to those needed for a wireless broadband access network.

A simplified network model of NGN and NGN access is shown in the diagram below.

Figure 1: General structure of NGN



Source: Author

The diagram illustrates the key network features that are central to the strategy, economics and regulation of NGNs. This type of integrated voice/data/mobile network already exists.

As shown above, other service providers require interconnection to the main NGN provider in order to deliver their own competitive services. To achieve this, it requires the packet-transport networks to interconnect, but more problematically the service platforms must also interwork. As these platforms are increasingly IT-based systems, and are not network-based switching systems, there are potential problems with standards and interconnection.

The interconnection point can also be moved to the access network – giving a "low level" access to the customer at the local loop level (also shown above, by-passing the core NGN). This provides the other service provider with full control of the customers' services and avoids the cost of using the main operator's core and service platforms. This is at the expense of having many more points in the network to interconnect to.

NGN access is shown above as combining several diverse access technologies. The diagram shows 4th generation wireless (LTE -Long Term Evolution) combined with other access technologies. Some are legacy technologies but in some networks these are combined with, or are replaced by, new fibre-based NGN Access. Critical to NGN strategies is firstly the best choice of various access technologies and secondly how they are each used together. Any NGN strategy has to also make use of, and combine with, legacy

technologies. Fibre to the home or business has unmatched performance[2], but this has to be traded against the additional cost. This can be considerable, and could be a major barrier in more developing economies. It is a major barrier even in the more affluent countries. This is the central economic issue – how to pay for the access costs. The two general approaches are to:

- Build the minimum for what is required today and so deliver the most affordable solutions. This gives slower performance – perhaps making use of legacy technologies such as enhanced use of existing copper wires. This has a logic for economies that cannot afford full NGN solutions.
- Build of the future. The demand for bandwidth will not diminish and customers in emerging economies will soon need just the same capacities as are available in leading countries such as Korea. This logic supports a fuller deployment *now* of: fibre and the best wireless solutions. This argument is also made in developed countries that are using fibre to the cabinet with copper for the last links to save money. Supporters of this vision support full fibre to the home deployment on the grounds that any copper-fibre solutions will soon become too slow, so: why not build *today* for the inevitable needs of the future?

The approaches represent the alternative strategic visions – one based on short term practicalities and assumes that there will be other technical migrations later. The other approach steps over interim options and plans for the needs further into the future[3].

2.2 Broadband definition

Many services can be delivered over NGNs. A specific interest area is broadband: this is defined here as access services that are delivered at multi-megabit/s. This is a key enabling technology for new services.

Broadband can be delivered over copper wires using DSL (Digital Subscriber Line) technologies. DSL enables data over copper wires, but the speed depends on distance so that several Mbit/s is only possible for customers that are close to the central exchange site. This might be termed a "legacy" technology. Mobile 3G also provides a broadband data access technology, but it is also limited in speed and is another legacy. The next level up in broadband provides more than 10Mbit/s access, typically using fibre over part of the access link with short copper. This NGN Access approach is being widely deployed to make use of the legacy copper and to avoid the high cost of the final fibre link to the premises.

Customers seek ever faster services and so demand has risen for new technology to provide the fastest service – so a new definition of "superfast broadband" has emerged that may be considered as providing the *real* NGN Access. The natural moves towards faster services with better quality (especially in terms of service reliability and less traffic congestion) are held back by the availability of the superfast technology and the affordability issues. Can the customer pay the required price and can the investor take the risk of not recovering the investment or perhaps not getting a return except over a longer period?

Superfast broadband has various definitions but typically it means NGN access services that provide speeds of more than ~30Mbit/s. This can be delivered using various access technologies: fibre to the premises; fibre to the cabinet (with short copper wires[4]); new wireless technologies such as LTE/4G (the

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[2] Fibre has enormous bandwidth potential and the low signal loss means that customers can be far from the central sites. Since it is made of glass there are almost no aging degradation effects of the fibre itself

[3] It is noted that there are already some customers who require more than 100Mbit/s access today. Although a minority, even in developed economies, such high volume users set an example. Other customers will surely *eventually* also make use of such capacity – the question is: *when*.

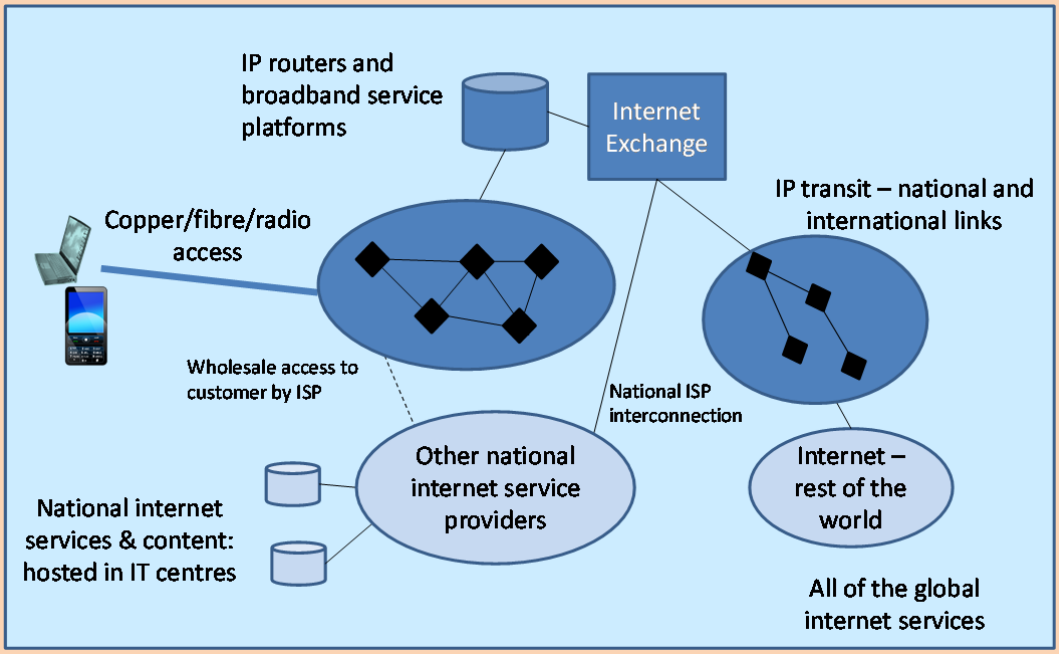
[4] For the highest possible speeds there has to be no copper wires, except within the final premises

latest mobile and wireless standards). Some cable TV networks also enable superfast broadband – using fibre and/or coaxial cable methods.

Broadband access is an enabler for many services: high definition TV or video on demand for example. Internet access is a separate service over the same broadband access technology. Broadband Internet access is the most important service that NGNs provide: it has the greatest impact on the wider economy as it enables the whole diversity of Internet based services. It should be noted that TV and video on demand can also be carried over the Internet as so called "over the top" services (OTT), as well as being delivered as specific NGN services with their own dedicated QoS levels, delivered from platforms that are directly connected to the NGN core.

Understanding broadband Internet economics, access strategies and regulations requires some appreciation of the main components shown in the diagram below.

Figure 2: Broadband Internet access components



Source: Author

Key components for Broadband Internet services include:

- The access network itself. This defines the ultimate speed and whether it is a mobile service (possible, if delivered over wireless technologies).
- The core network that links the customer device to the Internet. The core network connects the access points to central IP routers for onward connection to the Internet. This core network has nodes that concentrate traffic together and link back to central cities and so to Internet exchange sites.
- Links from the core network to the Internet itself. This requires interconnection points that may be nationally located or international. The links to the Internet are made using IP transit services. IP transit links connect the packets to other Internet providers.
- The content and service platforms that the end user connects to. These may be locally located or else they can exist in another country – which increases the use of the international IP Transit.

The policies required and economics behind the provision of Internet access are discussed later and these pivot on these underlying structures.

The interconnection points include Internet exchange points (IXP) for inter-linking Internet sub-networks and Internet service providers (ISPs) with the rest of the Internet. International exchange points are also required to get the basic connectivity in and out of the country, that is needed to carry the Internet traffic along with any other service, such as voice or leased lines. In developing countries these international gateway points are often few in number or may be controlled by one party. The total international capacity may also be limited.

Figure 2 shows national ISPs linking to the main NGN Internet supplier (which owns the NGN) at a high level – after the NGN operator has created the main Internet access service. This means that the main components of the service are provided by the NGN operator. The ISP can also access the NGN at a lower level – and so the ISP obtains a basic "bit stream" link to the customer or even directly connects to the customer at the access network level where it uses only the copper or fibre. The latter approaches give the ISP more control of the customer's service. The ISP would also pay the NGN provider less but it has to provide more systems and network itself in order to connect to the customer over the access fibre/copper or to basic bit stream services.

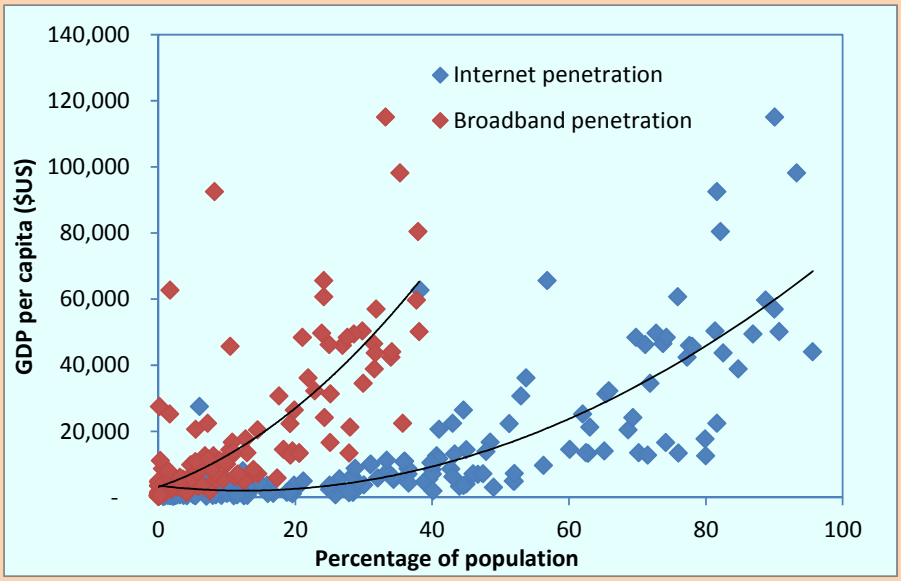
The regulation of NGNs and Internet access requires an appreciation of the differentiation of network provision and service provision. The physical access and core networks may be provided by one (or more) businesses. The actual Internet service could be provided by many alternative service providers. This requires *wholesale* access to the NGN. This enables many ISPs to compete over one supplier's access network. The service providers may each then connect to the Internet in different ways: each has to eventually connect over IP transit to the rest of the world. If there is no national Internet exchange site, then capacity must be bought over international links to an overseas exchange and then IP transit bought there. The international links can clearly be seen as a major restriction on the potential Internet capacity and a major expense for the ISP.

If ISPs can connect lower down in the NGN (say at the access copper or fibre) then this increases the competition in the network supply. This also increases the national investment in networks and systems – which is usually good for competition and the economy. Where the NGN market is split up among many service providers, there could be less economies of scale – so in small markets or where demand is limited, it may not be beneficial to have very many service providers. The optimal approach may be best decided by the ISP market players: regulators or governments are probably not the best parties to dictate on the optimal approach because the market size and technologies are rapidly changing. This leads to a key regulatory recommendation: let competitive markets decide the optimal outcome where ever possible.

2.3 NGN based services and economic benefits

NGN technology is deployed by network operators because it is cheaper to buy and can be cheaper to operate. Furthermore it enables faster services and new services. In turn this provides the benefits to customers of more and better services. The development of NGN services has wider impacts on the overall national economy because broadband Internet access, in particular, is an enabler for so many other businesses. It is well known that the penetration of voice telephony (percentage of the population that has a phone) is directly linked to the overall GDP – talking is essential for trade. Similarly, access to the Internet and broadband access are also related to the national economy.

Figure 3: GDP versus broadband access and GDP versus Internet usage (using any access method)



Source: ITU and World Bank data 2010

Clearly Internet and broadband access and GDP are related. High broadband penetration is related to high GDP. In Figure 3 a square law trend line has been added which emphasizes the greater benefits from higher broadband levels.

A key question follows: whether Internet and broadband usage simply reflects the affluence or actually increases the affluence of the country. This later point has been studied[5]. Although the relative values of the impact vary, depending on the study and the country, the studies do show that increasing broadband penetration actually increases the national GDP. The EU Digital Agenda sees broadband benefits as crucial for economic growth. The agenda has wider policy objectives and notes that broadband and Internet usage is only one part of the wider "digital economy" that includes other services that are provided over the Internet. Broadband enables the new economy and so creates new wealth.

This increase in GDP is in line with natural logic: increasing communications and trade; reducing travel; home/remote working; creating more efficient ways of working etc. are all caused by access to broadband services and all increase the national economy. The positive impact of NGN on the economy means that negative aspects (say less employment in travel industry caused by the ability to conduct online business or else the movement of trade to overseas suppliers) is more than countered by the positive aspects.

[5]See for example ITU studies. "Impact of broadband on the economy" April 2012, "The economic impact of broadband in the Philippines" and "The economic impact of broadband in Panama" available at the ITU Universe of Broadband website: www.itu.int/ITU-D/treg/broadband/

EC documents also report positive GDP impacts e.g. Digital Agenda: Broadband and E-Communications http://ec.europa.eu/europe2020/pdf/themes/09_digital_agenda.pdf.

"Building broadband: Strategies and policies for the developing world" World Bank 2010 noted : "In low- and middle-income countries every 10 percentage point increase in broadband penetration accelerates economic growth by 1.38 percentage points" http://siteresources.worldbank.org/INFORMATIONANDCOMMUNICATIONANDTECHNOLOGIES/Resources/BuildingBroadband_cover.pdf

One aspect of the ITU studies5 is that the relative gains from increased broadband can be less in lower GDP countries than in higher GDP per capita countries (but the World Bank report suggested the opposite). This paper is not specifically concerned with the economic details behind this observation: it may be due to the costs of broadband being relatively higher in low GDP countries or else the negative impacts are relatively higher. What is most relevant is the fact that the economy *is* boosted by broadband. The ITU data implies there is some form of virtuous circle - the relative benefits from NGN (% increase in GDP with each percentage increase in broadband) become greater with more broadband. Intuitively this is logical – more broadband enables more services, and with more end users yet more applications/content can be created more efficiently. This logically supports approaches that maximize broadband penetration as soon as possible, as this moves the country into the higher penetration group of countries that gain the greatest economic benefits.

2.4 The economic aspects of NGN migration issues

Economic gains for the country and lower costs for delivering the same or new services both suggest that NGNs should be deployed as rapidly as possible. This has not happened everywhere: even in high-GDP countries, NGNs often have not been fully deployed and the pace of change is variable. It is too slow for many who want the faster performance now. Clearly migration is not as simple is it seems. The issues therefore need to be appreciated by all of the parties involved. The parties are considered next, and then the issues. The key parties include:

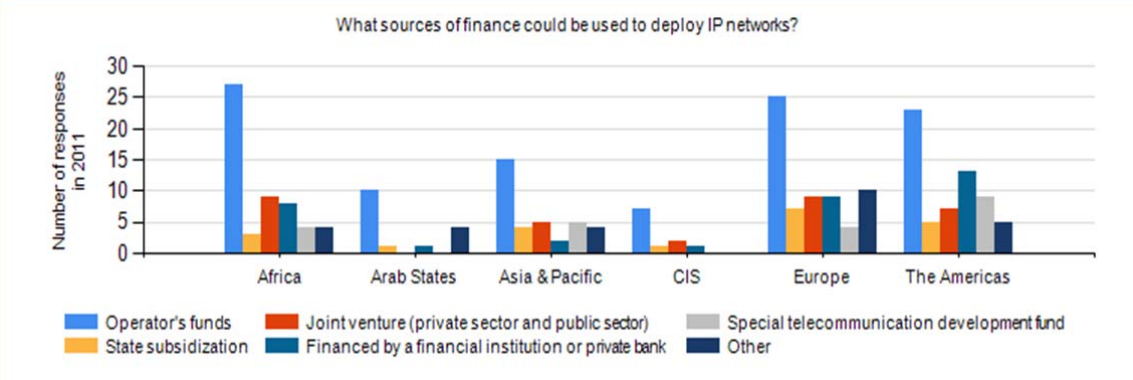
- **Policy makers**. The government and ministries, plus other players, who are responsible for the telecoms industry and the wider ICT (Information Communications and Technology) policy. They set the framework for developing NGN in their National Broadband Plan. These policy makers must consider NGNs and how they affect the wider economy. The policy must consider how NGNs are used and how it impacts other sectors such as: education, e-government, the environment, health care etc. The policy makers have a wider agenda than simply encouraging telecom networks. The agenda must cover *how* they are used.
- The **regulatory authorities** set the practical legal framework for developing NGNs (and other telecom services) to meet the policy agenda. Telecoms regulators are required to foster the right investment and to obtain the best outcomes for the consumers and the national economy. As parts of the telecoms industry have limited competition, regulators have to act to ensure positive outcomes[6]. Typically these outcomes encourage efficient competition, ensure interworking of systems and prices are set fairly.
- **Investors**. NGNs require investment. This can be from government (public money) or else from the industry itself (private investors) or combinations of both. The economic views for making a return on this investment depend on the investor: a government will have different views from a private investor on the time required for re-payment and the acceptable risks and rewards. The ITU Tariff Policies Survey for 2011[7] shows that the use of government investment, special funds, joint ventures and other funding methods are widespread alternative investment approaches to the operators' own funds. Over 55% of countries reported alternative approaches were used instead of or in addition to the operator's own funds (see figure 4).
- The **operators and service providers**. These implement and manage the networks and services. They must make a profit in order to pay the investors and to continue in business and expand.

[6] If markets are fully competitive then there is usually no need for any regulation as an optimal market outcome is assumed to occur if there is full competition

[7] ITU ICTEye database www.itu.int/itu-d/icteye/

- The **consumers** of the services who naturally want the best quality at the lowest possible price.

Figure 4: Source of financing used to deploy IP Networks by region



Source: ITU Tariff Policies Survey, 2011

Each party has a role and the optimum outcome requires some balances: low prices cannot pay back to the investor an adequate amount in a high-risk large-value network. The wider economic gains desired by national policy makers cannot be achieved without investment.

An issue of the broadband economy is shown from the inherent structures (see Figure 2). The direct economic benefits of broadband accrue to the service provider and the end user. The service provider might not be the *network* service provider (when there are Over the Top (OTT) services). The service source can even over overseas, and passes over the top of the national network, without a direct revenue impact. Therefore the NGN provider may have to rely only on the network service revenues, and not on the value added services' revenues. This should not be an inherent problem: an OTT service does not cost any more to deliver even if the customer pays $50 for it, compared to a free service with the same traffic levels. This is returned to in section 3.4 when broadband economics are discussed.

Clearly there are migration issues that have to be addressed to achieve fast NGN services. These issues include:

- **Funding the** investment. If the investments were low, then there would be few problems. The required level of investment required is high. This is particularly so in the access network: building fibre to the premises is expensive. The amount depends on (amongst other factors) the location (rural or urban), population density and whether there are existing networks. Emerging economy countries tend to have lower wage rates so that the infrastructure investment is lower – but this is offset by the lower potential revenues and often limited existing infrastructure to re-use. Wireless access also requires major funding: the costs rise with the speed of access service and the numbers of customers.

  The core network and service platforms also require investment. Core investment is generally less of an issue than access, but in larger countries with lower GDP then the investment needed to link the network nodes and communities together, is significant. International capacity and Internet links also require investment. In developing economies or isolated locations (islands and land-locked states), these international issues are significant. In such locations, the national broadband plans will need to focus on this and link international investment to the expected domestic growth in data.

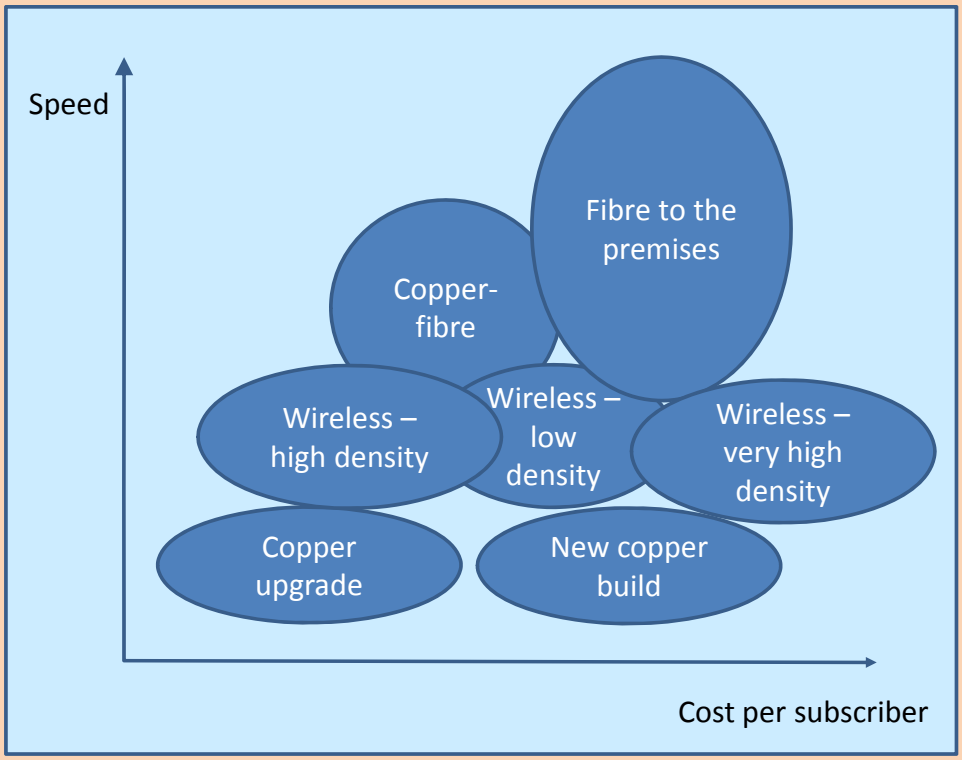
  Related to the funding amount is the funding source – should this be private of public money? Central to the building of NGNs is the question of how the networks are to be funded.

- **Technical**. Changing from legacy to NGN technology introduces issues of interworking and the need for skills and training. NGNs exist and have been made to work with legacy networks, but a number of problems have been seen – examples of this are discussed in section 3.5. These problems depend on the local situation. Where legacy networks are small, then technical migration issues are naturally less (the legacy networks can be left in place or removed with limited impact on customers or the NGN business). This implies that low GDP economies with (usually) low levels of fixed line telephony will be less concerned with the old network as it is more like a move to an all-new network ("greenfield"). Although this is true, such countries are still likely to have more problems with finding skilled resources for the new technology.

  Copper, fibre and wireless options for access have their own specific technical issues – there are several ways in which fibre networks can be structured (one fibre to the premises or a shared fibre that then splits to perhaps 32 premises). These can be addressed and there are solutions that are proven. This paper is concerned here with the wider issue of which of the three technologies is best in which circumstances, or when should they be combined? This is linked to the investment cost – each technical solution has a cost trade-off.

- **Costs performance factors.** A simplified view of the cost-performance issues is shown below.

Figure 5: Cost of provision of broadband



Source: Author

Cost and performance analyses are complex and depend on many factors. The above provides only a simplified view.

It is clear that there is little point in building new copper networks – the cost difference from new fibre, is low.

Wireless solutions have more complex cost-performance economics (the view above is simplified as a result). The potential performance may be high but it cannot match fibre's potential. The wireless cost

equation is also complex – a few radio masts can efficiently cover large areas and the unit cost improves as the masts are more fully used: this is part of the reason why 3G data services are less common in rural areas. However once the usage gets very high then the required density of masts gets so high that the costs get worse. If every house makes heavy use of 50Mbit/s access then wireless costs are probably prohibitive, even if the wireless technology was able to provide such a speed. The cost can be reduced with more spectrum – which reduces the need for additional masts.

- **Competition and regulation**. The movement to NGN does not change the role of regulators: their aims remain the same, but they must act on the change (see the ITU Regulation Toolkit[8] for examples of the areas to address). The regulatory aims are to encourage investment, innovation and so provide the best outcomes for citizens through competitive supply. Where competition does not exist, regulators apply remedies – typically aimed at ensuring similar outcomes as might occur if competition did exist. With NGN some of the practical aspects of this are harder. With services provided over one combined network, the differentiation of costs (needed for price control) is harder to evaluate. The high investment in fibre access creates a major new "bottleneck" that must be controlled[9]. It is unlikely that there will be competing access infrastructures in most localities. Wireless might be considered a competing technology but there are fundamental differences in the speed and mobility. Mobile broadband is arguably a different market and so fibre and wireless cannot directly substitute for the other – regulators must address such questions.

Regulation has to consider how competing services suppliers can access this major investment at reasonable prices, yet still ensure the investor and the NGN operator can make a return. Regulatory frameworks and strategies that define how competition is to work, must be clear or else there will remain in place barriers to investment. An investor cannot risk large amounts unless the competitive market and regulated-access prices are clear.

A regulator's task (and the NGN operator's own pricing plans) is complicated because the investments are so very high – therefore the impact of mistakes could be business failure[10]. This means that incorrect price controls create greater dangers than seen in the past for most other services.

- **Demographics**. Generally the more industrialized countries have historically had high fixed line penetration levels. This means the copper network proves a basis for broadband access and the access ducts can be used also for fibre to the premises or to the cabinet. In contrast, developing economies often did not achieve a high penetration rate, so there is not the fixed line infrastructure to build on.

Developing and advanced countries have both seen a huge growth in mobile: this is clearly the preferred method for voice and message communicating. Fixed line traffic and access line numbers are generally steady at best or falling. This move to mobile and lack of fixed network infrastructure to build on, especially in developing economies, raises the question of whether fibre access is the best approach.

The speed performance of fibre is of course far better than copper, but is this enough to overcome its high investment costs or to counter the benefits of wireless mobility? Also if consumers already have a

[8] www.ictregulationtoolkit.org/en/Section.2521.html

[9] It is not reasonable to expect many competing access fibres and wireless networks to exist in the same street – this leads to bottleneck supply with few or no competitors

[10] All investments in new services have risks and some fail to meet expectations, but others do better than planned. This should average out and an overall profit is made. NGN Access investment is so high that a failure (less revenue than expected) could bring down the whole business. This leads to investments being written-off and assets that are then sold off, becoming available at prices that are below the real economic cost. If this happens no other new market entrants can compete with these low cost "fire-sale" assets, so further NGN access investment may stop

wireless device needed for voice and messages, is it economic to have another fixed line device for broadband services including Internet access. It may be better to have just one smart mobile device, especially when PC affordability is low. The significance of mobile is clear in the 2012 World Bank report[11] - there are clear messages that the use of mobile/wireless may be better for some developing economies than fixed networks. Of course this creates a longer term problem as the performance of wireless will always be less than that which is possible over fibre: will this create problems later that result in the emerging economies always lagging behind the network performance of the advanced fibre-based economies?

Although NGN provide lower costs, showing higher profits is less easy to demonstrate. Larger incumbents are often suffering from the migration costs and problems of managing the dual technologies. Many incumbents have staffing issues that make it hard to reduce numbers once the NGN is in place. Alternative providers are often better placed to move direct to NGN, but these "pure NGN" players have to undercut the incumbent prices (their selling point is lower prices) and have smaller product ranges, less economies of scale and may not cover the same geography. As a result, showing clear profit and cost improvements with NGN may require careful analysis of an operator's finances.

2.5 The key questions to be answered

It is accepted (and not questioned) in this report that broadband and NGNs are positive for the overall economy. To achieve the desired outcomes of the best use of NGN, requires the following questions and topics to be addressed:

- What are the policy factors that need to be considered?
- How should NGN (especially infrastructure and access) be funded?
- How should networks and services be regulated?
- What are the technical issues?
- What are the most important economic and financial factors relevant to NGN deployment?
- What are the impacts on consumers?

These questions are expanded on in the next section and examples are used to illustrate the options.

3 Example NGN approaches and issues

In this section the questions posed above, are expanded upon. This further develops the issues that were raised in the background discussion. This section provides illustrations of possible ways to tackle the issues.

Examples are taken mainly from more-developed economies as these have more experience of NGN. They still have relevance to developing countries, though the messages must be adapted to other situations. The examples and ideas in this section should not be taken as recommendations of what is definitively "best practice." What is "best" depends on the local circumstances and in many cases there will no agreement on what is really best. This is clear from the approaches to funding NGN. This varies significantly amongst the higher GDP economies. The different solutions cannot all be best in all situations. The following therefore provides directions and information which form inputs to strategy planners to develop their own best practice approaches.

This section looks at:

[11] "Information and Communications for Development - Maximizing Mobile" infoDev for the World Bank.

- Policy issues. This must cover more than the network provision. It must cover all of ICT and have linkages to other government aims.
- Regulation. This covers NGN and also service provision.
- Funding.
- Broadband economics. These impact all of the above.
- Technical factors. All strategies must appreciate the underlying technologies.

3.1 Policy

The national outcomes depend on the overall strategy and policy. In the absence of this, regulators, investors, consumers and service providers etc. can develop their own approaches. This may still result in the NGN deployment, but whether this is optimal is open to doubt. Even in "free market" economies there is a need for some policy, regulation and direction. Policy needs to consider the overall national needs and both the supply side and the demand side. The supply side is most usually considered: the issue of licenses; the supply of funds; encouragement of investment; spectrum policy etc. The demand side is less often considered, but is highly relevant: development of content and applications to use the NGN; consumers use of government services; education and facilities to exploit the available NGN broadband.

The following policy factors should be considered as part of the national policy. Policies cover not only those of the national regulatory authority but also wider policies that will embrace other government ministries and broader aims than telecom-related ones. Education, license fees and taxation are example areas affected, and telecom regulators may only have an indirect influence on these aspects.

3.1.1 Spectrum

The ubiquity of mobile, especially in developing economies, means that spectrum policy is probably even more relevant to developing countries than advanced ones. It is unlikely that fibre would be economic in the short term, given the current very low fixed line penetration levels seen today. Customers move direct to mobile – a fact that is also true in developed countries where many consumers "cut the cord" and use only mobile broadband, even though the performance is lower. The key point is that the performance may be *enough* and the mobility can counter balance the speed limitations. Developing economies are more likely to have mobile broadband levels exceeding fixed broadband use.

Spectrum policy is critical because it is a finite resource. Policies should consider how wireless services can optimally cover both area and population. The focus should move from voice services (generally already provided) and consider both 3G data and 4G/LTE broadband deployment. The gains from mobile are clear (see World Bank report[11]). Key policy issues should address:

- Availability of adequate quality spectrum to deploy cost-effective mobile broadband networks.
- Allow freedom on how the networks are used.
- Encourage competition between players.
- Focus on gaining the best coverage not maximum government revenues. Traditional mobile networks have been used to gain revenues from: spectrum fees; taxes on handsets or SIMs; high charges for international traffic etc. If carried over to mobile broadband this could impede developments with longer term economic damage. Lower priced end user devices probably have longer term national benefits than any government benefit from higher (taxed) prices.
- Foster the development of broadband services.

This paper cannot cover all of the complexities on spectrum policies and pricing. Governments can benefit from spectrum auction revenues. However if broadband is considered a basic infrastructure similar to roads and water, then it is clearer that higher prices may not be in the best interests of the wider economy. There is little or no reason to treat mobile (and broadband) as a premium service that benefits only the wealthy and so it should not be seen as an easy source of government revenue.

***Korea** has long been one of the leading countries in the world with the take up of broadband and in the access speeds broadband. Many factors help to account for this[12]. One point is clear is that there were specific national policies to foster the outcomes. The policies were wide ranging and had a major focus on fixed network investments – as shown by the world-leading position that Korea has long had in broadband. Many in Korea had 2Mbit/s access when other countries were still using dial up Internet access. These policies also included spectrum for broadband use. This example shows how spectrum is also relevant to countries with exceptionally high fixed broadband levels (such as Korea). Mobile/wireless broadband can fill in gaps (not provided by fixed lines) and it gives synergy effects – increasing the use of broadband when roaming, as an addition to the higher speed access that is available when at a fixed-line location. This increases the demand side pull and increases the use of content and services.*

*Etisalat in the **United Arab Emirates** has implemented an advanced NGN core network with fibre access to the premises. The legacy services have been mostly migrated. LTE is also used to provide coverage in less economic areas. This shows the need for spectrum solutions even in smaller states with high GDP levels.*

***South Africa** has about ten times more mobile broadband subscriptions than fixed broadband[11]. Mobile operators have, in the last few years, invested heavily in data service infrastructure. With very low fixed line penetration and large rural areas and population, the move direct to mobile is clear.*

*Source: Ovum report, company reports, author experience and ITU case studies: Developments of Next Generation Networks (NGN): Country Case Studies (www.itu.int/ITU-D/finance/Studies/)**.** The ITU report covers many other countries and is due to be updated later in 2012.*

Whilst many NGN discussions focus on the access technology and the use of fibre it is clear that spectrum and LTE has a major role to play even where there are high levels of fixed line use. Emerging economies which lack the fixed infrastructure clearly will have a greater dependence on spectrum and wireless broadband. Spectrum policies and wireless solutions are likely to be even more critical in the developing economies. Adequate spectrum, in the right frequency bands is vital. Availability of devices is also required. International standards must be considered and in many places, neighboring countries must be factored in as border overlaps exist. A regional approach may be required.

3.1.2 Services

The policy must look at building the networks, but ultimately it is the policy impact on the supply of services that matters: customers use services not infrastructure or technology. If a service meets a need then it does not actually matter if it is supplied by fibre, copper or radio.

[12]See for example "Broadband Policy Development in the Republic of Korea." A Report for the Global Information and Communications Technologies Department of the World Bank. Ovum 2009

Broadband and Internet based services are primarily developed by private enterprises. Significant benefits also accrue from the delivery of government services. These include: education; government services and information; healthcare etc. This increases the availability and quality of services. This provides economic gains and also adds to the demand side pull for broadband.

By delivering services over broadband this avoids travel/delay and increases accessibility. More efficient supply and better provision can result. Regulatory policies should:

- Facilitate private enterprise and competitive service supply of the end user services.
- Allow competition as deep as possible into the layers of service provision: network infrastructure services (duct, cables, radio-masts); network data-transport services; broadband access; ISP; content and OTT applications.
- Increase the demand side pull for using broadband through government service policies such as the supply of health, education and information.

The higher levels of the service provision tend to require less government funding and less controls, in contrast duct and cable access are typically highly regulated (since there is less competition possible in this area). This does not mean that there is no role for policy makers or government funding even in OTT applications and Internet services. Policies can encourage national services and local content – this impacts the economics of broadband (see section 3.4).

Another aspect of service policy is how Internet services are treated by the network service providers. The issue of Network Neutrality considers how or if the network provider can control some services[13]. A restriction on some traffic such as TV may be required for technical reasons, but this can impact competition and could be unfair especially if the network provider also has its own unrestricted TV services.

Policies on services can lead to some countries or operators blocking some applications (Skype and Voice over Internet Protocol [VoIP]), or else some web sites and their services are prohibited. Such restrictions should be very carefully exercised. Any such controls can distort competition and can be tantamount to a "legalized Luddite" mentality: holding back an alternative service because customers might prefer it over another is unlikely to provide long term economic benefits. Stopping an alternative service because it is cheaper or takes away revenue from another has clear economic dangers, though in a few cases the high protected revenues could be used for worthy cross subsidization.

3.1.3 Frameworks

Policies need to consider enabling legal frameworks and structures to ensure services and networks are developed. Often these are beyond a telecom regulator's scope. Examples of these policy areas include:

- Data protection. Consumer rights must be protected and information must not be mis-used.
- Copyright. New services, content and information are provided over broadband. Regulators and legal authorities need to ensure the value invested in this is not lost from abuse. Without this protection overseas service providers might not place content and services within the country – this reduces national investment and increases the international networking costs.

[13] This Network Neutrality issue continues to be discussed in regulatory, legal and economics papers. See for example ITU GSR Discussion Paper on Net neutrality: a regulatory perspective at www.itu.int/ITU-D/treg/Events/Seminars/GSR/GSR12/documents.html

- Security and monitoring. Cybercrime is an increasing issue and broadband increases the potential for crimes and cyber-attacks occurring both nationally and internationally. Systems and policies to tackle this growing threat are required.
- Access rights and obligations. Policies need to set out the targets to ensure there is adequate coverage: so the most affluent sectors are not the only ones addressed. This leads to some directives in licenses (say coverage requirements in spectrum licenses) or else some form of Universal Service Obligation on fixed line deployment. Who decides which locations are to be serviced and what are the criteria to be met for refusal to service marginal economic segments?

The latter point relates to a key social and political policy issue: how to address the "digital divide." This exists in all economies, the only difference is the degree of the divide. The digital divide is the split of those who can be economically provided with broadband services and those who cannot be provided either because they are too expensive to serve or else are they unable to afford the price.

Policies are required to specify obligations to service these consumer segments. In addition financial incentives can be used – such as funding to help rural areas or disadvantaged customers. The issue of funding for NGN is returned to later (section 3.3).

3.1.4 Education and content supply

The supply of educational services over broadband is a commonly considered a benefit and policies to exploit this are desired. This has particular benefits in rural and emerging economies where remote customers can be linked into central educational resources - this has clear benefits when such resources are limited.

Education policies have also focussed on making use of broadband and Internet services. Knowing how to make use of ICT, is clearly vital. Computer literacy enables greater benefits to be made of the NGN services. All users (old and young) may need assistance to learn how to exploit broadband and benefit from the services it carries.

Less frequently considered is education on how to develop applications, content and services. This is vital if the broadband economy is to fully develop nationally. Without these skills, the services will be imported from other countries. This has implications for the broadband economics (see below). Policy should examine how national skills can be enhanced to *develop* the services not simply to *use* the services. This has a clear demand side pull-up effect. The more national content and applications that are developed, then the more broadband usage is made and so economies of scale effects result – lowering costs. This may explain why the benefits of broadband are greatest in the higher GDP economies – these not only *use* the broadband but also *create* more applications and services. This in turn creates more national trade and hence greater welfare gains. This training gap even exists in developed countries – the president of the Institute of Engineering and Technology has claimed (in 2012) that UK ICT education has helped use ICT but not understand how it works, which is needed to develop the "digital economy." This will surely be at least as much of an issue in developing economies.

There is a synergy of local content, more demand and lower prices. Particular benefits result from local content[14]. Local language and culture should be addressed and policies should encourage these developments.

Broadcast TV and radio are specific content supply issues that should be considered as part of the wider policy. Usually such services have their own delivery networks. With the move to NGN then these may be

[14]E.g. "The Relationship between Local Content, Internet Development and Access Prices" Internet Society (ISOC), the Organisation for Economic Co-operation and Development (OECD) and the United Nations Educational, Scientific and Cultural Organization (UNESCO).

conveyed over the same backbone core network and this gives resulting economies of scale and increased coverage. This allows the delivery of these as NGN services – IP TV or video on demand that has its own specific QoS to ensure the service does not suffer delayed packets that can lead to picture-freezing. It also allows the delivery as OTT services. In this case it is an Internet type service and does not have the QoS features. These options have implications for the network migration and capacity. The services also increase the potential revenues per customer – the triple play of voice, broadband Internet and TV over the same network increases the viability of a NGN. The provision of such content is usually subject to certain controls and license provisions and these must to be considered in the wider policy requirements.

3.1.5 Summary of policy issues

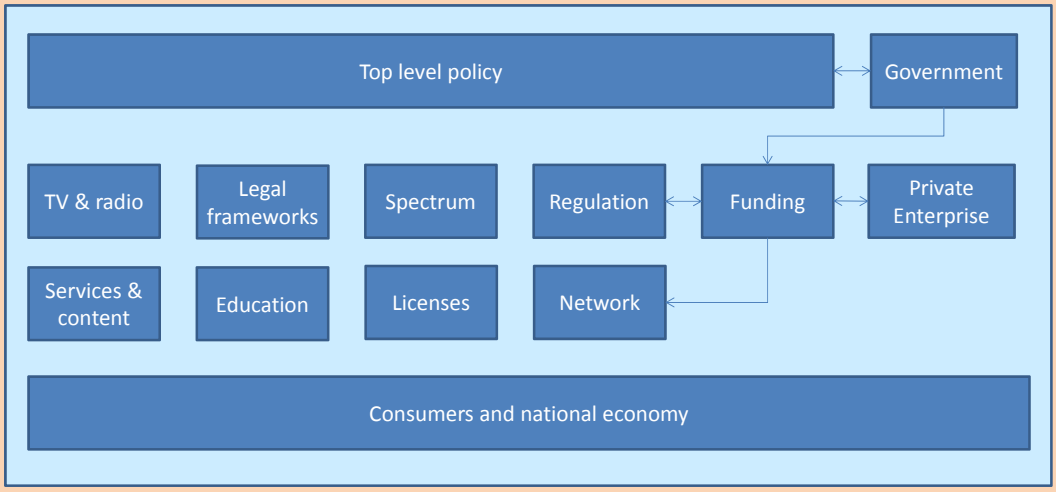
Regulators need to consider the wider perspectives than just network and telecom regulation. The required policy is not simply a NGN policy or a definition of how to fund fibre in the loop. These are necessary but only as part of a wider ICT policy approach. Regulators should examine the overall national needs and this covers demand side as well as the supply side issues. The supply side must consider more than operator service supply – it must also cover the final end-user services that are possible over a broadband Internet service.

It is clear that most countries with major broadband take up had a range of policies and have had frameworks in place to set the agenda for implementing changes. This is clear from the Korean example. Strategy definition is usually a top-down process and the key players need to set the direction using a national strategy.

A policy based approach is also shown by the approach used in the European Union (EU) – there is a Digital Agenda defined, that sets out overall aims. National governments can set their own policies and approaches to meet this agenda. There may be disputes over whether the policies are optimal, but at least there is a policy. Policy and direction should be provided.

The top down structures in forming a policy are summarised in the diagram below.

Figure 6: Key components in developing a policy



Source: Author

All of the components have *some* inter-relationship. These are only shown on the right to emphasise the key connections of public and private funding with regulation and network investment. The more general ICT policy elements are shown on the left. Although these may be not directly connected to the NGN itself they should be part of the wider policy.

This diagram also illustrates how regulation should be separate from the government: this is generally accepted to be best practice, but regulators are *influenced* by government. Each policy component may be dealt with by one or more sets of stakeholders. These will vary by country. No matter where the responsibility lies, the important fact is that an overall policy is still required.

3.2 Regulation

3.2.1 The role of regulation with NGN

Regulation forms part of the implementation of some the policies defined above. Telecoms regulation and content regulation (specifically TV and radio) are usually separate functions with their own policies, as shown above. However the high level policy views *should* embrace them together with the NGN policy.

With the move the NGN, the telecom regulator's fundamental roles and the aims of regulation do not change. These should be technology-agnostic. However there are a number of NGN issues that have posed new questions for regulators. The approach must balance the needs of consumers, dominant players and competitors and yet still fulfill the overall policy aims.

Regulation is easier in areas where market entry is simple and competition can flourish. *In extremis*, regulation can eventually be completely removed. Creating many voice competing services over multiple core NGN networks or even over one or two dominant player's core networks is relatively easy to accomplish. Once these competing retail service providers are established, retail price regulation might be removed. The access to the non-competitive wholesale markets, controlled by only one or two NGN providers, will still need to be regulated. Similarly, competing ISPs can be encouraged to deliver multiple retail Internet services: regulation can ensure these ISPs have the required wholesale access to the NGN-provider. Voice, Internet and other service-level competition is ensured by:

- Definitions of the relevant retail-service and wholesale-network markets.
- Specify the access and interworking requirements.
- Define the minimal-required price and other controls. These are mainly in the wholesale markets – so allowing competitive-supply to control the retail markets.
- Enable service providers to access the NGN at the lowest possible physical levels and combine them into with their own networks.

3.2.2 Altered approaches may be needed

The essential approach described above is not altered by the existence of NGN. What changes is the need to regulate in a more "joined up" approach – this follows as diverse services can share the same NGN. Mobile and fixed services should be considered interlinked. Also the regulation must focus more on the key bottleneck – that of the access network technology. Examples of the converged regulation that may follow includes:

- Mobile Internet access may be looked at in a similar way to fixed line ISP service providers. Mobile operators have often been able to restrict some services, but Net Neutrality requirements could be imposed (no restrictions on the services conveyed). This is controversial, but in developing economies where mobile/wireless Internet might be the dominant (or only) access medium, mobile Internet regulation has a logical basis.
- Service level interworking. Legacy regulation has considered only network interconnection since services are part of the network. NGNs allow service differentiations because the service platforms are separate to the network. This should be encouraged, but it opens the potential for services that will not interwork: business data services, premium-quality voice calls etc.
- Access to customers using a wholesale bit-stream type service could be defined irrespective of the access medium – wireless or fibre. There may be some performance, technical and price

difference, but the essential access rights for re-sale to other network operators might be similar. This follows from the NGN based services becoming "agnostic" to the access-technology.

The approach taken depends on the situation. Spectrum policy and the rights or obligations in the licenses may allow (or restrict) any such regulation. If wireless is to be part of an integrated policy and especially if mobile networks are the primary platform for customer access, then a mobile/wireless-centred regulation becomes more logical. The fact that the more developed economies have usually not regulated mobile-access strongly, but have strongly regulated fixed networks, is not a reason for following such practice in developing economies. This is especially important if the developing market is moving to NGN and there is low fixed line penetration. The regulation will need to be more wireless centric.

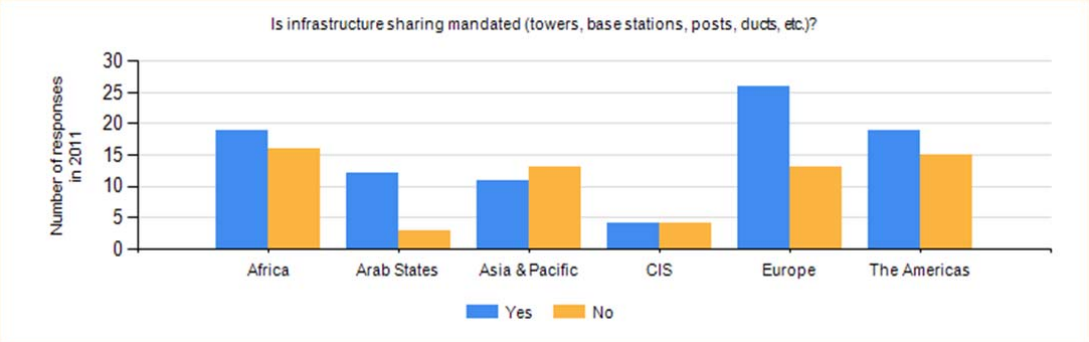
Regulatory aims with NGN remain the same as legacy networks: the encouragement of competition where ever possible. It may not be possible to have more than one core NGN. In this case the access rules and the prices for using this network are critical. How should the regulator ensure the NGN is built efficiently and at lowest cost, without the incentive of competition?

Regulators have had to focus most on the areas with the least competition and these are the ones with the highest barriers to market entry. This means that mobile and fixed access are the most critical areas to regulate. Mobile because the spectrum is finite and this means there can only be a few competing operators, and fixed access because the costs are very high per customer and this is a natural bottleneck - it is not viable to have many cables in each street from different service suppliers. The competitive supply of cables can be increased if infrastructure sharing is permitted or enforced. Ducts and cabinets can then be re-used to reduce the costs for alternative providers to provide links to customers. Other infrastructure such as from electricity, water or sewage links can also be used as conduits for services to customers. The importance of sharing of infrastructure is shown by it being monitored by the ITU Tariff Policies survey[15].

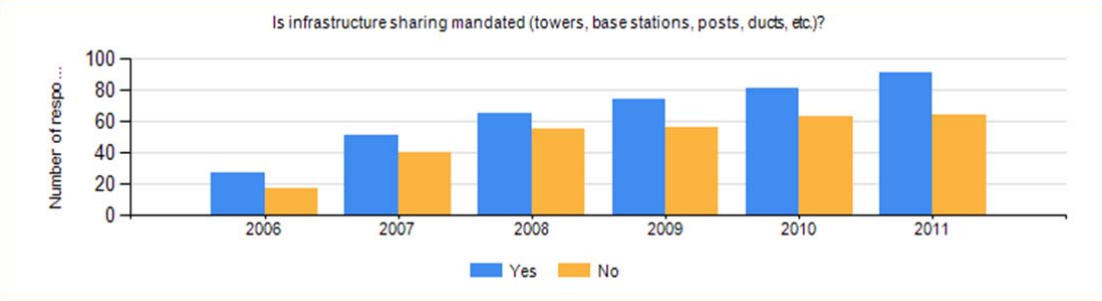
[15] ITU ICTEye, Tariff Policies database: www.itu.int/ITU-D/ICTEYE/Default.aspx

Figure 7: Infrastructure sharing mandated

By region



World



Source: ITU/BDT Tariff Policies Survey.

The prices and access service points need to be defined. Bit stream access over copper provides a few Mbit/s service on to which service providers can build an ISP business. Alternatively the raw copper wires can be leased (local loop unbundling - LLU) or else only a higher level IP wholesale service may be provided. These issues exist on the legacy network but also have parallels in the NGN environment:

- Should fibre (or duct space) infrastructure be released – similar to LLU?
- Should bitstream over fibre be allowed?

The answers should surely be yes, even in developing economies. The key question is then: defining the correct price that allows competition but also encourages the investment in the first place. This is a complex issue. It also depends on the policy and the source of the funding: public funding could mean lower prices from a longer return period with lower pay-back. However this could harm private enterprise investors.

However there may be situations where these wholesale service access rights are not given. Smaller NGN access investors might not have the access obligations imposed on them while an incumbent investor would. Locally, the smaller operator would be the only provider. This is seen in many developed economies where the incumbent is fully regulated but the alternative providers are not.

This leads to other regulatory questions:

- How might the price of copper affect the take up and prices of fibre services? They may both exist.
- Should copper legacy (or core legacy) services be removed? This is of major relevance as NGNs may reduce costs, but costs cannot be reduced if legacy networks co-exist. Two parallel

technologies must be more expensive than providing just one. Savings only fully result from the elimination of the old technology. This relates to technical factors that are returned to later (see section 3.5). This is a particular problem for the developed economies that have developed significant LLU services. Alternative operators have invested to use this service, and this investment would be "stranded" if copper were removed. This can lead to the "regulated inefficiency" of copper and fibre operations remaining in place together.

When legacy copper and new fibre exist in parallel then they serve the same market which introduces additional regulatory problems. Copper and fibre share the same duct and digging infrastructure. This means there are costs that are common to both. This creates a problem when regulating prices. Should there be relatively higher prices for the slower speed copper or for the higher performance fibre? The outcome impacts the take up and the return on investment. This issue has been a major topic in EU regulatory circles recently.

The answers to these questions are non-trivial – this is seen by the many regulatory discussion papers and consultations on the matter. They are also related to the issues of funding and legal requirements. Regulator's powers are defined and actions must conform to national rules. Competition law for example provides an overall framework that cannot be overridden by regulators. Where this does not exist telecom regulation may have its own competition rules that must be applied. This can create some additional complex problems in a NGN situation. Examples of this include:

- A fibre deployment may have taken place. Competition and regulatory rules mean that this should be accessible to other service providers at a cost-based price. This is the wholesale price. Due to the high costs of fibre (especially in rural areas) the wholesale price might be more than the retail price that a customer is willing to pay. How should wholesale and retail prices be set, if the cost is greater than the retail price? Similar problems occur if wholesale prices are set on a retail-minus basis16. Both approaches lead to loss making services for some parties.
- Broadband access allows multiple services to be delivered over the one fibre. The marginal cost of adding voice services on top of broadband and IP-TV is very low. Should free or cheap voice traffic be allowed, if a voice-only operator cannot compete with this "free17" service?
- Should Voice over IP be allowed? This is an "OTT" type of service and can be cheap to deliver. The quality may be less than normal voice, especially if it is voice over the Internet. Alternatively it could be provided with assured QoS and be comparable to legacy voice services. Should this be allowed or would the low price "unfairly" undermine the high prices of voice services – especially high prices international calls. Should the revenues of these services be protected in order to subsidise other services or disadvantaged customers – and so help to close the "digital divide?"

Solutions are linked to the policy. Policy aims to cross subsidise parts of the economy may over-ride normal regulation principles that would recognise that voice over IP and voice over Internet based services should be considered as: competitive retail services or else are addressing different markets. In many cases there should be no regulated cross subsidies or any restrictions on voice over Internet services: but there may be exceptions in some rare situations.

It is clear that NGN adds some new factors that regulators must consider. The approach must vary depending on the circumstances. Even within the EU, where there is some similarity of GDP levels and the

[16] This prices the wholesale service at a discount to the retail price. The discount percentage gives the other service provider a margin to cover its own costs and compete with the service supplier

[17] No service is free, but the marginal costs may be low and bundling an additional service for little or no charge is not a problem in a competitive market. This type of regulatory problem and the related issues of competitive supply will increase with NGNs as services share the same networks

overall policy set by the EC, there are different approaches adopted nationally. Clearly a developing economy cannot simply take these approaches and not consider modifying them to suit. There is of course a wealth of experience in these countries that have or are deploying NGN that provide a basis to build on: "a wise man learns from the mistakes and the gains made by others."

3.2.3 Functional and structural separation

A specific approach to regulation with the development of NGN is that of separation. There are two main forms of this:

- **Structural separation.** This creates a separate access business. This business has most of the enduring bottleneck services where competitive supply is unlikely to ever be viable. This business would be strongly regulated, and all downstream networks and other service providers are then lightly regulated. This separate business provides the services to the other players on a wholesale basis. The Australian NBN Co is one example of this thinking (this is described below).
- **Functional separation** does not require separate businesses - the access-service provider remains part of a larger business. The access business is *functionally* separated (but not legally a separate business) so that it delivers equivalent services to its own downstream business as well as to other service providers. This requires accounting separation and careful governance to ensure equivalence. All services and interfaces must be equivalent within the operator as those provided externally. This reverses many years of integration of systems and processes that most operators have been trying to achieve.

This functional split has been used in the UK. Some similar outcomes are expected as a result of EC policy statements which have requirements to give equivalent treatment of all downstream service providers[18].

The equivalent service supply rules (service interfaces and prices) have particular relevance for NGNs. If the prices are the same then this reduces the need for regulators to define the prices. An access network business can set a very high price: but then its own downstream business cannot sell it. If set too low then the access business makes a loss. This gives some self-regulation of prices and reduces some of the regulator's problems but increases other problems such as regulatory accounts and governance of the equivalence of services.

Regulatory separation may not be appropriate in all situations. There might not be legal powers to force the changes or else the costs of separation could be greater than the benefits: giving equivalent services may require extensive development of network management systems and interfaces. Even so, the concept is powerful for understanding the issues and possible remedies. Regulators will probably have to consider some types of controls that consider a least some equivalence of outputs to other service providers and so avoid a possible "re-monopolisation of access" under a transition to NGN. This monopolisation effect can reverse past regulatory successes with legacy copper networks where service providers' access to LLU and to bit-stream services have allowed downstream competition. Fibre access links could extend far back into the network leaving only a few central points of interconnection. This results in more value being locked within the access links: this that cannot be competed against as multiple fibre suppliers are not viable. The result could be one monopoly fibre service provider with investments that have no competitive supply – in turn this in may lead to inefficient operations and higher prices.

[18] "EC Enhancing the broadband investment environment" – policy statement by Vice President Kroes 12/7/2012

3.3 Funding

The issues of policy, funding and regulation are related. However it is important that regulation is kept as separate as possible. The role of regulation is to ensure the best outcomes and assist with competition. Regulation is not directly concerned with *creating* the funding for building the NGN – it regulates what is built. Clearly the connection of the two issues is clear when the "best outcomes" include fostering investment – regulation should encourage this.

There are four main funding options. These are mostly discussed with respect to access (fibre) investment, but each could be also used for core NGN and international capacity links.

3.3.1 Government funding

This takes a view that the fibre access is an essential facility that is akin to roads or water supply: it is needed to enable the wider economy to function. It cannot be supplied in a competitive manner. There cannot be two roads or multiple fibre cables to the same house. Furthermore the investment cannot be paid for at rates that private enterprise requires.

This thinking leads to government funding to ensure the infrastructure is developed and the wider economic gains from greater commerce will indirectly provide the payment. Most advanced economies have well developed infrastructures (railways, roads, power, water) that support all industries, and these are often government funded.

The access network may be funded centrally and then the fibres can be leased to other operators or else they can be operated by a single commercial or government organization. The services can then be used by multiple broadband service providers – there can typically be several core networks and many service platforms over these fibres to ensure downstream competition.

> ***Australia*** *is perhaps the prime example the government funding approach. This is a result of a strong visionary policy that believes having almost universal access to very high speed services will increase the overall economy. The aim is to give fibre to 93% of premises and to use wireless and satellite for the others. This provides a wholesale-only service for network operators to use and compete with each other in the downstream markets.*
>
> *The approach directly tackles the digital divide: the entire country is served by a standard service.*
>
> *The approach is not a complete government-only monopoly of supply. The NBN Co supplies the access services but downstream providers compete to deliver the end users' retail services. These are based on wholesale services from NBN Co with prices that do not have the variability by location that naturally follows on from when* costs *are the basis of the input price. This is the case if a vertically integrated provider were to build the fibre and also deliver the end services – the costs to itself will vary depending on the customer.*
>
> *The approach has had to address many issues such as how the deployment interfaces to existing operators and how it is going to be run efficiently. The former point addresses the inevitable fact that other operators have or also plan some fibre access networks – this creates public and private competition, but each have different investor-demands to meet. The latter point follows from the general economic assumption that any service that is provided by government and is not open to competitive forces is likely to be inefficient.*
>
> *Source: Author*

3.3.2 Localised government funding

This approach is like that above but on a smaller scale. Typically the funding only addresses select areas. These may be part of the digital divide – areas that are not economic to fund by commercial investors. Local government and municipalities can invest in fibres or subsidise investments. This approach has been seen in Sweden (and elsewhere) where local municipalities have helped with fibre deployments to help the local economy. The funding is typically at the lowest levels – duct and fibre. Other operator service providers can then lease these and deliver the end user services

This can help attract other industry in much the same way as the existence of good water supplies and roads are vital for investors.

This approach is not without problems. If there are public funds available, even if only locally, then this could alter the investment incentives for the commercial operators who may wish to compete in the same or nearby localities. Lower prices in the next community could stop other services being viable. This has for example led to some objections in the USA by some operators.

The approach could require consideration of general rules on public subsidies. Many countries have rules about the use of public subsidies and public funding – especially where these can impact competitive operators' actions. These may be more of an issue in local funding schemes in contrast to where there is a national investment such as Australia where specific acts may be passed and there are no local anomalies. Such anomalies can result in negative outcomes, where objections from network operators on the basis of competition or unfair subsidy effects, could stop all investment. This can leave the locality with no NGN at all as the region is too marginal for private industry to service.

3.3.3 Public-private funding

The UK is an example where it has used some central government funding to address some for the digital divide. Any network operator can bid for these funds to help fund investment in the rural areas. This forms a public-private funding combination. This is most commonly aimed at fibre access.

Similar approaches may be applied for any investment. This could include backbone networks and international links where there is a need to help get investments in emerging economies that do not yet have the market demand that can sustain private-only investment.

3.3.3 Commercial (private) funding

The funds can come from the operators themselves (probably using debt funding[19]) or from equity investors. Any such investor has to consider the risk to the investment and the payback rewards. What will be the revenues and the costs over time? Is this worth doing, given the uncertainties of both future prices (revenues) and customer numbers? The considerations are different to government funded investments – this creates the fundamental problems identified above when public funding "competes" alongside commercial funds.

Commercial business cannot afford to take on a large loss making investments and so marginal areas (rural and low income customers) might not be addressed. This is a central problem for the lower income/developing economies.

[19] A few wealthy operators can fund NGN access from cash funds. The risks are then much lower, as even if the investments cannot be recovered there are no external parties to pay, leading to fiscal embarrassment, not fiscal disaster. Such examples should be examined carefully before they are copied by other operators who risk not being able to pay their creditors.

Commercial funding is successful in many areas and it is the general solution for most content and end user applications. It becomes less viable in some areas such as backbone networks in large/low population density countries and of course in lower-density/less-affluent access network locations. This is where public-private partnerships or public-only monies may be necessary.

A variant structure is where communities act together to help with funding. Businesses and householders might combine (perhaps also including the local government) to form a local business to invest in fibre. This is either operated as a local network or leased to other service providers. The **community business** is therefore able to ensure fibre investment that might not happen otherwise. For this to work, there must be access to backhaul services from the main operator, that link from the community-network *back up* to other competing centralised service providers. This is a different approach to access interconnection that is more usually set at higher levels in the network *down to* the end user. This local-community approach provides clear benefits in breaking the digital divide and can substitute for commercial operator-investors' reluctance to service the community. The local community investors may be willing to accept different commercial terms than a commercial network investor.

The community investors may benefit from: house price increases; home working; enabled local broadband businesses etc. This helps to justify the local investment.

> *An interesting commercial funding example is **Google Fiber**. Google Inc. is building in 2012/13 fibre to homes and businesses in Kansas USA. Access speeds of 1000Mbit/s are possible. Although few customers could make use of this speed today, the development is likely to show some of the possible directions that NGNs could take with almost unrestricted capacity. New services and applications are likely to evolve. This shows a commercial visionary approach: build the access and assume that demand and services will follow. This approach does not identify the demand and then build the network to deliver* just enough *capacity.*
>
> *The approach is therefore more visionary than even Australia or Korea. The approach is probably more of an experiment: to learn what might be possible. If the venture were truly commercial (and profitable) then many cities would be covered. This example should certainly be watched by all parties.*

The funding issue and resulting risks can be countered in policy decisions by the question: what are the risks if there is no broadband – how can the country compete against peers who are investing? This should not lead to rash decisions. It is not long since many operators made bad investments in international carrier markets: the demand for international capacity was certainly there but the revenues were elusive. NGNs do not alter fundamental business economics – someone has to pay for the investment.

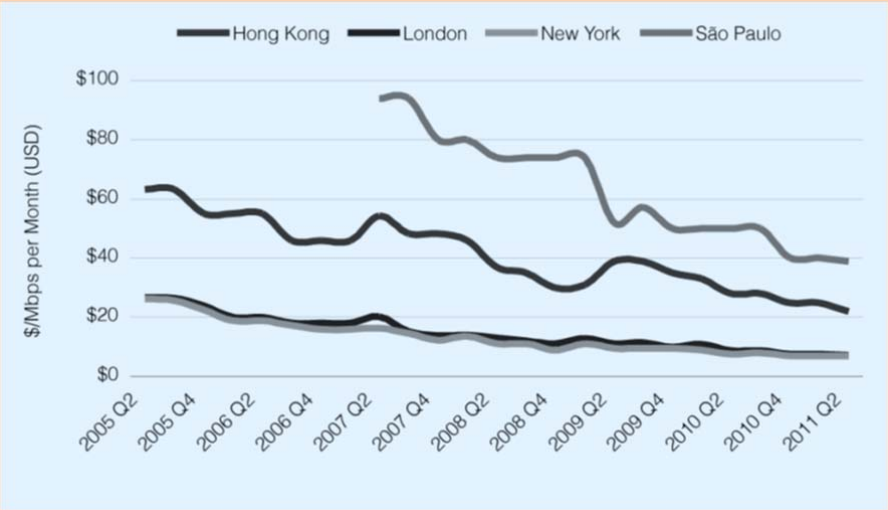
3.4 Broadband deployment economics

This section explores the economics of broadband in greater detail. The key components were shown in the diagram Fig 2 above:

- Access (fibre or wireless and efficient combinations of each).
- Core.
- Service platforms (content and applications).
- Internet connectivity.

The introduction noted how international Internet connectivity is essential for broadband Internet services. Developed economies tend to have many international cables and competing suppliers of capacity to the global Internet. The prices of IP transit therefore are low. The IP transit prices tend to fall and this counters the never ending increase in demand as Internet growth continues (more customers using more services that need greater speeds).

Figure 8: IP transit price trends



Source: Telegeography

Prices are falling, but developing economies have higher IP transit prices. This leads to higher Internet services prices and so reduces take up and so helps to reduce demand and so helps maintain the higher prices.

The use of IP transit can be reduced however by:

- *Creating* more local content and applications. This avoids using the IP transit. Also local content that is in the right language increases national business and clearly improves the user-experience (as noted earlier[14]). Government services, TV, films, education and other information services that help with national development also reduce the dependence of foreign sources.
- *Moving* content and applications from overseas. When demand is sufficient, service providers wish to improve the user experience and response time and so they may duplicate services so they are available locally. This can lead to the development of Content Delivery Networks that service providers help to fund in order to ensure the delivery of the content. This requires national facilities that can support the applications and Internet exchanges to link to other countries.

Policy and investment decisions can also reduce IP transit costs by facilitating more international links and encouraging competitive supply. This is highly relevant in developing countries and also those that are land-locked or island economies. Lower IP transit costs can then be passed on to the end user. The end result should be that the IP transit cost is only a relatively small contribution to the total ISP cost in developed economies. The IP transit cost is reduced by competition and the economies of scale to well less than 1$ per month per customer – helped also by the use of *national* content.

The impact of IP transit on Internet provision is clear from the earlier diagram (Figure 2) and the prices in Figure 5. A broadband customer may have physical access speed of 2Mbit/s. The *average* download might be only 30kbit/s at the busy hour (peak period of network usage). If 75% of content and services are from overseas, and then if there are high IP transit costs of $100 per month per Mbit/s, this means a cost-contribution of $2.25 per month for IP transit. This could be significant for low income segments in a developing economy.

The core NGN is typically funded commercially in the developed economies. Where distances are large and in lower income areas, this may be subject to additional funding.

***South Africa** for example has identified a need to fill gaps that were not being addressed by commercial operators. Broadband Infraco is state owned and it aims to fill gaps in the value chain and so facilitate private sector development and innovation in telecoms services and content offerings. Its services are based on high capacity managed bandwidth over a national long distance fibre-optic network.*

This provides capacity for national services to be provided.

Interestingly there are also privately funded backbone networks in South Africa such as FibreCo. This illustrates how two funding solutions can exist within one country.

Source: Author.

The access network is typically the most expensive part of providing a broadband service. The fibre access costs depend on:

- Distances to customers (location of core nodes and customers).
- Density of customers.
- Deployment costs. These vary depending on labour rates and if there are existing ducts.
- Technology – fibres can be shared or else one per customer can be deployed. Copper can also be used to reduce the cost of the "final drop" to the customer but with reduced performance.

The whole broadband economy depends on the access speed. So legacy mobile and copper solutions of a few Mbit/s at most, will restrict growth of services and hence not only restrict NGN revenues but more importantly the whole economy of services that rely on broadband.

There is a virtuous circle in broadband. As demand increases, capacities rise and costs fall. As prices fall, so demand increases. This general fact (it is true for many services) is helped by broadband factors such as the development of local content to reduce international capacity needs. Clearly the synergy effects are encouraged by more local content and as the number of users rise, overseas content providers will move platforms into the region – further reducing the "trombone" effect as users reach out to overseas applications and then down load these back over the IP transit links.

Developing economies should consider how this affects the approach to funding and the higher level policies. Content creation and the IT systems that deliver them may be commercially developed in the more advanced economies, but some assistance may be required to provide some secure platforms to get these services started. This includes secure IT server sites. Once the market develops, and the cost of providing such services fall, then IT systems, Internet exchange points, national and international links should become commercially funded and will be part of a competitive market.

3.5 Technical factors

NGN deployment has been successful in many countries both in the access and the core. Many phone calls are carried over IP networks and the end user is often unaware that the core technology has changed. Although many networks have migrated to all-IP or part-IP networks, there are still a number of dangers and this impacts the approaches used. This can have knock on impacts that affect regulation and the eventual economic benefits of NGN. Some of these technical factors are explored in this section.

As shown in Section 2, NGNs provide a common platform for many services, this gives lower costs to provide. However the legacy costs are only fully avoided once the older networks are completely migrated to NGN and can be eliminated. This is relatively easy to do where there are few legacy services – as is often the case in developing economies. In contrast to such countries, the more highly developed telecom operators in advanced countries may have a number of problems to overcome:

- They have often created many sophisticated services and features. These may be bespoke to only a few customers, but they cannot be easily terminated and in some cases these services

may be difficult to migrate to the NGN. This means that a full NGN migration is not always possible.

- Regulatory or contractual requirements may also require the continued provision of these legacy services.
- The prices of these services might also be fixed. This creates a further problem as the cost of providing these services rises as fewer are provided. This can result in a loss making service until eventually the last customer is removed.

In such situations the migration to NGN is not easy and the operator is burdened by the legacy network costs that are difficult to eliminate.

Even the migration of fixed voice services to IP is complicated and may not be totally successful. There are often special voice service features that cannot be easily replicated on the NGN platforms. Technical problems have been noted by major providers in United States such as AT&T and Verizon[20]. Some of the points noted include:

- "To think we can in the next five years we force the issue and reduce our cost structure by shutting down the old network, is unrealistic."
- "Any transition needs to take into account the back office operations that have existed for decades."
- "It is very tricky to work towards new platforms and new services because there are a lot of processes for these legacy services that are highly embedded in customer operations so there's a lot at risk there…. having 6,000 or so nodes of old platforms and going to 4,000 interim nodes to retire for the long run does not make a good business case."

Some similar issues have also been noted in the UK: BT has been developing a NGN based core platform but its plans to integrate the voice and data services has been scaled back and the voice services will partly remain on a separate network.

These problems have further implications. Retaining a legacy voice network and the large numbers of local switch sites maintains a technical legacy structure that makes the radical benefits from a full NGN harder to achieve. Revising the structures to have far fewer sites and eliminating legacy copper reduces the costs: this is hard when voice services remain structured as before. A radical approach is needed to move to new structures: this may be hardest in the most developed networks that are held back by legacy structures.

Broadband access cost analysis (in particular fibre to the premises) should *not* be considered divorced from the core network structures and its costs. NGNs do not have the same rigid demarcation of core and access that resulted with legacy copper networks. NGNs allow radical change:

- Far fewer central network notes sites.
- Longer access links to the customer.

This leads to much more efficient service provision. Thousands of local exchange sites are not required (the reason that they exist is the limited distances possible for legacy phone lines over copper). Fewer, larger central nodes reduce costs dramatically. The elimination of older technology, especially copper based, reduces faults and operational costs. This requires a radical change to the network structure. It is not simply "adding some fibre in the loop." The potential for developing economies is clear. They can

[20] PSTN-to-IP migration must be done with care, say Verizon, AT&T: www.fiercetelecom.com/story/pstn-ip-migration-must-be-done-care-say-verizon-att/2012-05-15

more easily leap to the best NGN structures and they do not have the migration costs and worries about legacy-network provisions. There may be few legacy local exchange sites to migrate from.

Fibre is often the most practical way to also provide the links to wireless nodes. Fibre to the customer strategies can therefore fit with wireless strategies. A trade off of access technology choices must be considered depending on the situation: it is inevitable that fibre will not be viable in all situations.

The technical problems noted in the USA, above, have implication for other countries. An optimal approach might seem to be a fully integrated network with few sites and fibre in the loop, but it shows that practical issues can slow the change. This exacerbates the problems that result from the fact that traditional fixed network voice-call business is a slowly declining business – both in terms of volume and price. The telecom operator has to maintain a business that becomes less important over time using a technology that increasingly is out of date. This does also mean that traditional switched-voice services are not going to disappear rapidly. The introduction of voice over IP services have taken away some of the traditional traffic, but the legacy service has not gone away[21]. At some point the decision has to be made – migrate and kill off the old network. This could be easier in the emerging markets where legacy networks are very small. The AT&T and BT examples show that large legacy networks may remain.

Other technical factors include the fact that fixed line voice is a combination of an access line plus a core switched service. The two must interwork. Moving to fibre removes the traditional copper wire interface. This is mostly a problem that can be overcome but it does also mean that the end user phone will have no power supply, unless there are also wires along with the fibre – which defeats many of the benefits of fibre access. The customer's equipment can be powered by the customer's own power supply. This is not an issue where there is reliable and affordable power. In some rural areas and some lower income countries, this might not exist.

3.6 Consumer impacts

The end users benefit from high speed, reliable competitive network services and access to the whole global potential of the Internet. The services and ways of working that exist today, are known. It is not known what these will be in the future. It is not the job of policy makers or regulators to foresee these and set limits to broadband. History is full of predictions that were woefully wrong. Innovation and competition will determinate the outcomes. NGN strategy and policy makers can be sure of:

- Demand will continue to grow.
- New ways of working and services will emerge.
- What is considered adequate today (say 100Mbit/s broadband) for only a select few customers, will be considered as normal in just a few years.
- Demand for broadband capacity will rise to fill or exceed the capacity available.

Although emerging economies will lag behind, the degree of lag may be small. This is seen with mobiles: the mobile phone usage is almost as pervasive as in the more advanced economies. Some countries such India have much higher minutes of use per month per mobile customer than in many western European countries. India also demonstrates how low mobile costs per minute can be delivered, even to customers who spend small amounts per month. If this can be translated into a low data service cost, then this should have major impacts on the lower income consumers in the emerging economies.

[21] Many Internet bases voice and video services are not actually substituting for traditional voice calls – they provide a type of communication that is purely incremental. No traditional voice call would have been made at all if the service was not possible.

The consumer is impacted by the end-user service. With NGN, this is often not delivered by the network provider. This is most clear with OTT services. Therefore the commercial relationship is defined more by the device and the final service provider. The network provider must profit "only" from the network services. Changes in the value chain therefore happen in the broadband economy. Policy makers should be wary of distorting the changes to fit with a legacy approach where the network provider was also the service provider and controlled all of the customers' revenues.

4 Key messages for NGN broadband deployment and some possible approaches

There are wide ranging issues to be addressed to ensure NGNs are deployed and consumers benefit from the services. In the following, a selection of the key messages identified earlier are summarised and some approaches are recommended. These are more focussed at developing economies and so they must adapt approaches seen in the more wealthy countries. There is no reason that an approach that works well in one country can translate directly to another economy. Clearly, as there is no one solution that is being universally being adopted and proven to be successful, there is not a single panacea. Some guidelines for regulatory authorities can be found in the ITU Global Symposium of Regulators 2011 best practices[22].

Define a policy and define a plan[23]. This should be debated and all parties should participate. Over time the policy and resulting approaches specified in the broadband plan may need to be adapted, but countries that are leading with broadband do have some direction and policy. No policy is likely to result in no change or else monopoly provision of services in only a few areas.

Ensure the national policy covers all of ICT. NGNs and broadband may be the key investment area and are where the main telecoms issues reside, but all other aspects should be linked in to obtain the wider social benefits of a broadband economy.

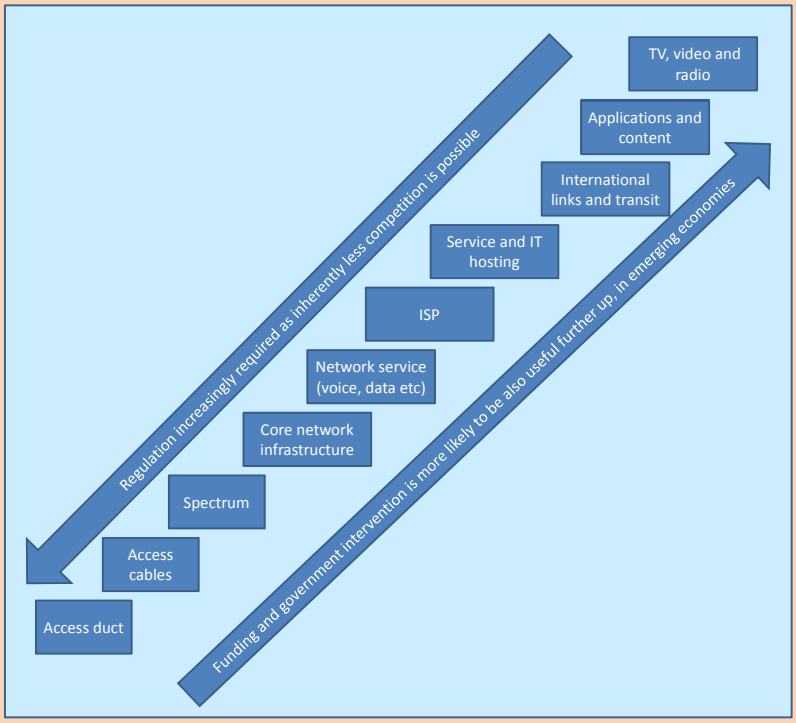
Invest in key areas that move service-provision levels up, and broadband-costs down, as fast as possible. There is a virtuous circle of more usage and lower cost. Combined with national content development this reduces costs and increases benefits.

Look at the "layers" in the value chain of the broadband economy and identify where resources need to be focusses. Developed countries may focus more on the lower level investments and bottleneck supply of the access network. Emerging economies are likely to have to consider other parts of the chain. Regulation or funding inputs, may be needed to enable the other service layers to become fully established (after which they are de-regulated and become totally privately funded).

[22] www.itu.int/ITU-D/treg/bestpractices.html

[23] See also for example the ITU paper on Setting National Broadband Policies, Strategies and Plans www.itu.int/ITU-D/treg/Events/Seminars/GSR/GSR11/documents/03-Broadband%20Policies-E.pdf

Figure 9: broadband value chain



Source: Author

Look more at spectrum supply. Developing economies tend to have much lower fixed line penetrations but high mobile usage. Although not able to deliver the speed of fibre, mobility can more than compensate and it is likely to be a more economical solution. Even in advanced economies that are planning high speed fibre access, high speed wireless technology has a role to cover less economic areas and to add mobility as an additional service feature. Fibre strategies should be linked to wireless solutions – fibre provides the backhaul capacity needed for wireless sites. Wireless is also the preferred solution within premises.

Make sure the strategy is far reaching. Many strategies aim for too low an access speed. Surely an aim for 10Mbit/s access by 2018 is too low a figure for a 2013 strategy – even for an emerging economy. Demand for capacity is never-ending and so, setting a target for something that is merely "good for today," will be overtaken by events. Such a strategy locks in a lag behind other economies and ensures an emerging economy will never catch up. The additional cost of additional speed is low, so building-in future capacity into the plan ensures the strategy is future proof.

Consider regional policies. International and regional backbone capacities can be developed more economically if there are linked policies to ensure joint investment. This is most clear for island economies needing to ensure cables are built. Some countries may need to combine in order to ensure cables and systems are developed to facilitate the spiralling benefits from broadband.

A slow speed for everyone or no broadband for all? Low broadband speeds are partly encouraged by the fact that high speeds will not be economic for everyone. There is an inevitable digital divide unless a universal approach such as Australia is considered. An Australian style investment is unlikely to be feasible in an emerging economy. This leads to investment only in a few areas – and so this may increase the wealth divide in the country. Avoiding an increase in this division of society can lead to no action or else everyone getting only a slow service. Is an affordable strategy that gives slow service to everyone better than one that allows faster services in selected areas? There are political/social/economic factors to

balance, but it is logical that if there is a demand for high speed broadband and it is economically viable then it should be provided in those areas. Keeping some customers un-served by high speed broadband does not clearly help the un-servable customers.

Consider a variety of funding options. Community, public and private options help to maximise the investment and speed the build out of broadband. The faster the growth then the better it is, as it creates circular synergies - once there is broadband then costs fall and usage rises. Community networks may need new *backhaul* services.

Minimise costs, even if this might reduce some aspects of competition. Sharing of infrastructure such as masts and duct might reduce competitive investment but it lowers overall costs: the short term benefit may be better than the longer term gains from competitive infrastructure. This is probably most true in emerging and small economies.

Share and re-use digging investments. Some simple steps could give longer term benefits. Emerging economies also have roads, electricity, water *et al* projects that broadband can link with. All infrastructure projects can include installation of empty ducts. This provides a platform for later fibre and other cable deployments. The digging costs far exceed the duct cost. Similar to this, forcing diverse service providers to share digging costs can help to reduce costs and it gives consequential benefits of less frequent upheaval. This is something that is a major problem in many cities that can lead to rules of "one dig per year."

Allow retail re-sale. A general regulatory rule is to reduce controls and restrictions. Most retail services could be re-sold to create some end-user market options. In the case of broadband this might allow a 100Mbit/s customer to share this with neighbours or to allow local wi-fi or Internet shops. It is unlikely that restrictive regulation in this area will have significant benefits[24]. By allowing resale, it enables more users access to broadband and this starts the cycle of benefits. Related to this is the in-building distribution policy: how can multi-tenanted buildings be provided if the network-service ends in the basement?

Ensure technical migration plans are as radical as possible. Removing legacy network systems and structures that create many sites and maintain copper wires, are key ways to reduce costs. This requires access and core designs to be considered together. Since costs are not avoided until the older systems are completely removed, plans that simply "add in NGN" will not give the benefits of lower costs and better services.

Look carefully at detailed technical issues. Equipment vendors will have major inputs to the migration – especially in developing countries. Back office and network management systems are critical to efficient operations. Skilled staff are needed to operate and manage systems: this might be partly outsourced. Fault repairs may be more complex in an integrated NGN. Therefore the migration has to consider the whole of the migration – not just of the cables but also the higher level network and service management platforms.

Align regulation to encourage NGN investment and migration. There is no simple answer, and sources of investment will inevitably be a problem in many areas. Some examples that can help include:

- Give clarity of regulatory remedies and actions. Uncertainty over a regulator's future approach is certain to discourage investment.
- Ensure that investments can be recovered. This means that pricing policies must not undermine the NGN investor or the operator's business plan.

[24]This approach reflects an alternative approach to how some country's regulators may think: regulate o*nly* when there is a real need, and not regulate/control everything and t*hen* consider what are the areas in which regulation can be lifted

- Allow or even encourage older networks and systems to be terminated. If they are prolonged, then the cost savings will not be realised.
- Look carefully at the pricing of older services and networks such as copper access. Although this has lower performance, a large price differential to fibre based networks is likely to discourage the customers' move to fibre.

5. Key messages for promoting growth in data communications in developing countries

Developing countries can learn from more advanced countries and the more successful approaches can and should be adapted. Clearly affordability and sources of investment will be primary concerns. Globally it is seen that many diverse funding approaches have been used, so some forms of government intervention and subsidies are likely to be a required solution in some areas: they are even required in many high GDP countries. A mixed approach of public and private investment is likely to be needed. The approaches adopted in wealthier countries for rural areas can give useful directions that can be applied. These include novel local funding approaches; community networks; and radio/microwave/combined-fibre solutions.

As broadband will improve the national economy it is reasonable to assume that this will result in greater tax revenue and this can eventually pay for government investments needed in the early stages. Directly taxing the NGN or it services is likely to work counter to the general aims – the tax revenues are realised in unrelated business areas, as they grow from using the NGN.

This logic of government investment is similar to the approach of universal service funds that have been used in the past to ensure basic telephony is available to all. The fund for broadband can be centrally supported or by other parts of the industry. The concept can be extended to encourage other parts of the broadband economy get started – this includes central infrastructure, platforms and content. The difference of universal service funding and universals obligations should be noted. If there is an obligation to provide broadband in certain uneconomic areas then this might be counter-productive as the profitable areas might not be addressed to avoid being caught by the obligation. An *obligation* does not remove the need to address the *funding* to support the obligation.

As noted earlier local content has clear benefits – it helps the citizens and also it reduces the costs of international capacity. Relevant information and service in local languages should help emerging economies and reduce their reliance on international service providers. Once local content as service are started then it will create a synergy of other developments.

Education was noted earlier to be a key aspect of NGNs, and this is particularly relevant to emerging economies. Broadband can help provide educational services. Youth and female segments may lack access to schools and colleges in some emerging economies. Using broadband can help them access the information and central teaching facilities and it will encourage interest in ICT. Sharing a few broadband nodes in a community will help with this until eventually broadband is more available[25]. In addition to general education, specific developments to enable citizens develop new local services and applications have clear benefits. The benefits of *creating* new services are potentially greater than education on how to *use* a broadband service. Getting this embryonic new broadband based industry started in an emerging economy should be a priority.

Education should also consider enabling basic NGN construction training as early as possible. The supply of basic skills to enable infrastructure and basic installation work to be carried out should be valuable to

[25] Sharing a few broadband links in a community can be very beneficial in the same way that sharing the use of just a few mobile phones in a community was able to help trade compared to the days with no phones at all.

enable the basic ducts and cables etc. to be installed. If there are enough skills to deliver the labour intensive cable installation work, then this provides a platform that enables the final services to be built on.

Delivering government information and services, healthcare and agriculture-advice are examples that typically will benefit emerging economies. This can help to bridge the physical distances and travel difficulties faced in such countries. Giving on-line access to such services might also reduce bureaucracy.

Affordability is a central issue – affording the investment and making the services affordable for consumers. Ideas in this paper can be used to address this: sharing of broadband (including resale); transfer of customer pre-paid credit; low cost end user devices; selective subsidies; careful use of universal service funds or obligations; avoiding unreasonable tax burdens; promotion of competition; and the targeting of aid and government investment, can all help with affordability in the developing economies.

Observations in developed countries show a diverse set of approaches to funding, policies, plans and technologies. These are needed to suit the local requirements. This lesson is surely also relevant to emerging economies: one approach is unlikely to be optimum for all areas. Rural and urban solutions have to be adjusted and a single approach from a developed country, no matter how successful it was there, is unlikely to be the only approach needed.