Final Report for OSIPTEL

Design of optimal policies in a communications and media convergence environment

Final report and recommendations

28 August 2009

Ref: 13896-164

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1 Executive summary

OSIPTEL commissioned Analysys Mason Limited ('Analysys Mason') to analyze in detail the challenges and implications presented by convergent telecommunications services and technologies in Peru from three primary standpoints, namely technology, competition and regulation.

The overall outcome of this project is an optimal set of policy recommendations to modify the current telecommunications regulatory framework in Peru. These recommendations will ensure that the process of convergence in Peru provides the maximum benefit for consumers and the economy at large, whilst serving OSIPTEL's primary objectives such as increasing access and network coverage, and improving key performance indicators (KPIs) of the wider industry.

Traditionally, the type of services or content delivered over a particular network have been intimately tied to the nature of the communications network, as shown in Figure 1.1 below.

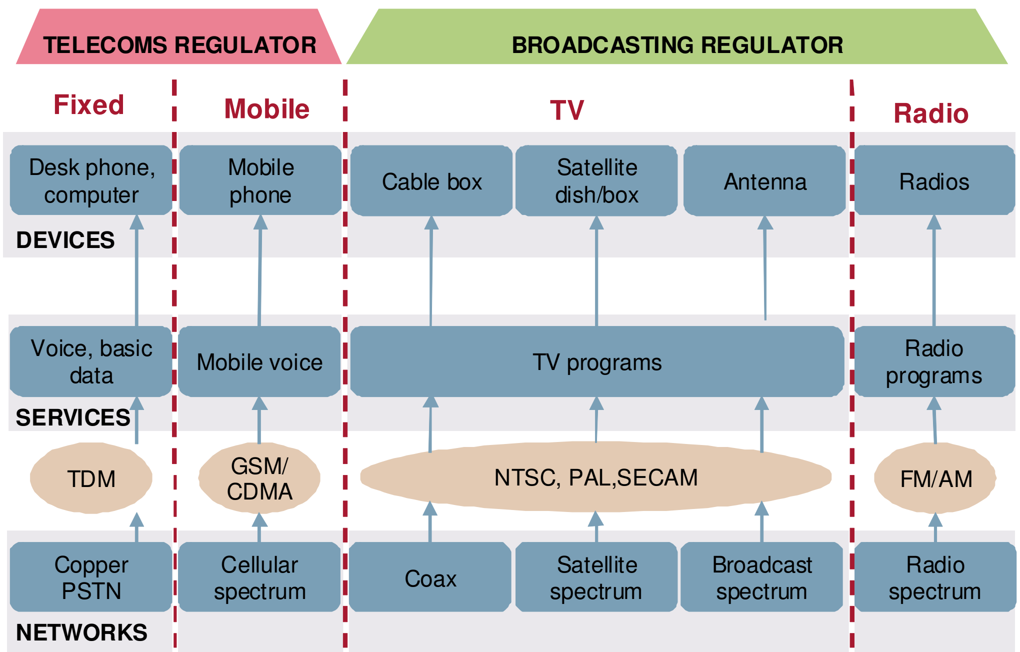


Figure 1.1: Telecommunications, radio-communications and media industries before convergence [Source: Analysys Mason]

However, the development of methods to provide various services using a common protocol – the Internet Protocol (IP) – motivated network operators to begin widening their service portfolios both as a means of generating further revenue, as well as shoring up existing revenue streams imperiled by such developments as product commoditization. The set of actions and consequences arising from this form the basis of convergence. Briefly:

> ***Convergence*** *is the ongoing development and provision of voice, video and data services, either singly or in combination, over IP-enabled networks using a variety of fixed and mobile devices.*

The process of convergence can be distilled under three broad headings:

- **convergence of networks** – the increasing ability of different types of networks to carry IP-packaged content
- **convergence of services** – the increasing ability to offer any subset of voice, data or video services over a particular IP-enabled network
- **convergence of devices** – the increasing ability to offer either multiple services over a single network using the same device or a single service over multiple networks using a single device.

Figure 1.2 below illustrates the structure of the communications and media industry as a result of convergence along these three dimensions. Note that as a result of this process, there is acceptance and support for the idea of converged regulatory frameworks as being the most efficient and optimal structure for governing the industry.

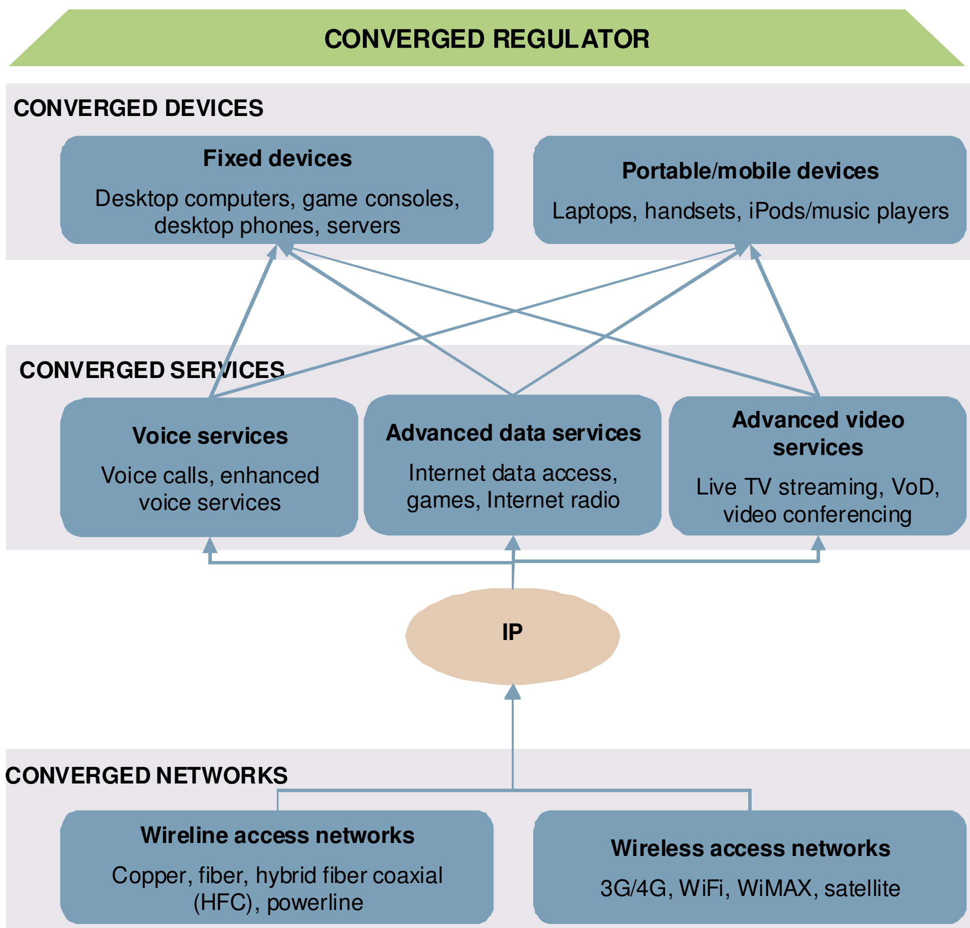


Figure 1.2: Communications and media industry after convergence [Source: Analysys Mason, 2008]

Developing and emerging markets have a unique opportunity in this convergent climate to rapidly close the advanced services gap with the most technologically developed countries. The very swift process of convergence means that network and service providers in emerging markets do not have to go down the same developmental path followed by those in more developed countries – instead, the ability to leapfrog certain steps and deploy the most optimal advanced technologies provides a means to close the gap quicker than would otherwise be possible, and allow the populace a chance to join in the benefits being enjoyed by consumers in more technologically developed countries.

1.1 Network convergence

The key to promoting convergence is to promote broadband Internet access, based on IP. In order to do this, investments will need to be made in upgrading or deploying infrastructure ranging from core or access network equipment to access devices:

There is a massive infrastructure investment required to deploy FTTx architecture, but currently in Peru there is relatively low current demand for bandwidth. Additionally, the fixed subsidiary of Telefónica, Telefónica del Perú (‘TdP’) owns both the main cable and the DSL infrastructure (which reduces the impetus for network upgrades from competition), although there is another significant hybrid fiber coaxial (HFC) infrastructure owned by Telmex.

- In terms of wireless access networks, the best candidates to offer wireless broadband will be 3GPP and WiMAX-based networks. A significant factor in the choice of operators between each of these technologies will be the spectrum made available to each operator. However, as both technology options become standardized in more bands, more flexibility will be available to each operator in choosing the most appropriate technology for a viable business model.
- Core next-generation networks (NGNs) are being widely implemented worldwide due to the cost savings resulting from advanced technologies, and are generally the result of commercial decisions by operators. Implementation can range from complete overhauls (such as that of BT’s core network in the UK) to more gradual implementations on an exchange-by-exchange basis as the need arises (an approach adopted by Telefónica).

Wireline networks have a completely different fixed/variable cost profile compared to wireless networks. Wireline operators in Peru face a significant *variable* cost of extending their networks to reach each additional subscriber, as they have to deploy last-mile loops. Without subsidies, connection charges would have to be significant for each new subscriber to the wireline network, as incremental revenues are not likely to be sufficient to cover costs, particularly for low-income callers with low call volumes.

As such, regulatory recommendations focus on promoting the deployment of wireless access networks as the most efficient means of providing voice services, as well as increasingly fast broadband services. In this regard, universal access funds will be key for addressing underserved and unserved areas. For wireline networks, in order to maximize their potential, the focus is on wholesale access to essential facilities, e.g. through bitstream access for DSL competition.

Operators deploying networks require affordable access to capacity and leased lines, infrastructure for international traffic and Internet exchange points (IXPs). Our analysis of the situation in Peru indicated that affordable and competitive supply is available for international capacity and domestic Internet exchange capability. However, alternative operators have indicated a dissatisfaction with the nature of leased-line services currently available, which focus tightly on cost-based E1 access over defined long distances. The low usage of leased lines suggests more regulatory intervention, particularly in regards to having a broader range of leased-line products both in terms of capacity (products with bandwidths both greater and less than E1 size) and location (local products and not just long-distance products).

Two key factors will play a role in ensuring the rapid deployment and usage of converged networks:

- **Facilitate deployment of access networks** – the over-riding issue highlighted by this study was the burden placed on operators by municipal access policies, which are time consuming, vary from place to place, and could be costly depending on the size and number of fees charged for permits. To remedy these roadblocks, a framework should be put in place that has the following characteristics:
  - it should standardize and expedite rights-of-way permissions to ensure cost- and time-effective site deployments
  - it should ensure that the fees imposed for rights-of-way access are determined on a reasonable cost basis
  - it should centralize the process of obtaining municipal rights-of-way, which provides operators with a much more streamlined and effective method of obtaining permits.

- **Infrastructure sharing** – For existing networks, there are well-established means for sharing infrastructure. The most relevant of these to Peru include wholesale access to Telefónica's network using inputs such as bitstream and wholesale line rental (WLR), national roaming for new entrant operators on existing mobile networks, and third-party ownership of sites for deploying wireless networks.

  There are a variety of ways to promote infrastructure sharing for new deployments such as mandatory joint access to government property, use of the universal access fund, or facilitation of sharing of infrastructure through non-profit entities or public–private partnerships, which would raise capital, deploy infrastructure, and operate the infrastructure.

  In the short to medium term, passive network sharing (in which no active electronics equipment is shared between co-located operators) will remain the form of sharing most likely to have any success in Peru, given the difficulties associated with active network sharing.

> The competitive implications are such that it is inevitable that regulators such as OSIPTEL will have to retain general oversight of sharing agreements, in order to judge when network sharing is adversely impacting the larger goals of affordable universal access to basic and advanced data services. However, in emerging markets such as Peru, the opportunity afforded by infrastructure sharing to spur deployment of advanced services is probably worth the regulatory burden of managing the implementations. In particular, encouragement of infrastructure sharing between wireless operators will be one of the most significant sharing policies that OSIPTEL can implement to spur on universal provision of converged services.

Based on the existing network deployments in Peru and the characteristics of new technologies, we believe that next-generation wireline access technology will have more limited and targeted applicability (mostly in already deployed and new build scenarios), while wireless technology is more suited for mass deployment of network access. This is true not just for existing voice technologies, but also for broadband, given the significant increase in broadband capabilities that can be supported by wireless access.

1.2 Service convergence

Broadband is essential for promoting convergence, as it is the foundation for all converged services based on data, voice (VoIP) or video (IPTV).

There are three particular areas around which regulatory principles facilitate the general deployment of IP-based services. These areas are:

- technology neutrality
- net neutrality
- IP interconnection.

The above principles help to remove potential roadblocks to the adoption of IP-based services that could be put in the way by existing vertically integrated broadband providers offering traditional services. The regulatory framework in Peru is already well set-up to ensure technology neutrality and net neutrality, with enforcement of regulation being the key focus for OSIPTEL. However, IP interconnection is still in its early stages worldwide, and while best-practice policies are still being determined, the primary aim for OSIPTEL in the short term is to ensure that there are no barriers to commercial IP interconnection agreements between operators.

A key effect of convergence is lowering the barrier for service-based competition over access networks.

- Of the various VoIP business models available, mass-market retail VoIP (in the form of direct access over physical connections, or indirect access over broadband connections) will have the biggest impact on converged networks. In this regard, it will be most important to ensure equality of treatment between all providers (including VoIP) that offer services of comparable functionality that compete directly with each other.

- With regards to video services, over-the-top IP video services do not require the same significant commitment to infrastructure as dedicated delivery services. Best-efforts online video is unlikely to ever be a significant competitor to traditional services. However, there is the potential for managed over-the-top video services to provide an alternative means for operators and service providers to deliver content to consumers, and it could provide a means for increasing the level of competition and the availability of video services in Peru.

As the number and type of operators offering services over converged networks increases, a number of issues gain prominence:

- anti-competitive bundling
- licensing of new services
- quality of service and consumer protection.

With all of these, the key principle is to ensure that consumers have the most reliable, innovative and affordable services with the minimum amount of regulation in order to provide operators with the maximum amount of flexibility in designing viable business models.

1.3 Device convergence

To access the advanced services available over IP-enabled networks, there are a breadth of options increasingly available ranging from personal computers to mobile handsets, each with multiple embedded fixed and mobile access technologies. However, the key determinant of the impact of these devices in emerging markets is always going to be tied to affordability of these devices rather than extensive functionality beyond basic minimum requirements.

OSIPTEL has already implemented a policy removing import taxes from mobile telephones in order to make them more affordable for end users, which has resulted in a very competitive market with wide availability of a whole range of devices from basic handsets to smartphones. As convergence progresses apace, the importance of other devices in the context of expanding access will increase, and the extension of this policy to other online-enabled devices will promote more widespread usage of converged networks and services.

1.4 Conclusions

The process of convergence brings many benefits to consumers including new applications and cheaper prices due to greater competition. However, there can also be some negative side effects if the process is not managed smoothly by regulatory authorities.

Figure 1.3 summarizes the key areas of regulatory focus for OSIPTEL with regards to convergence.

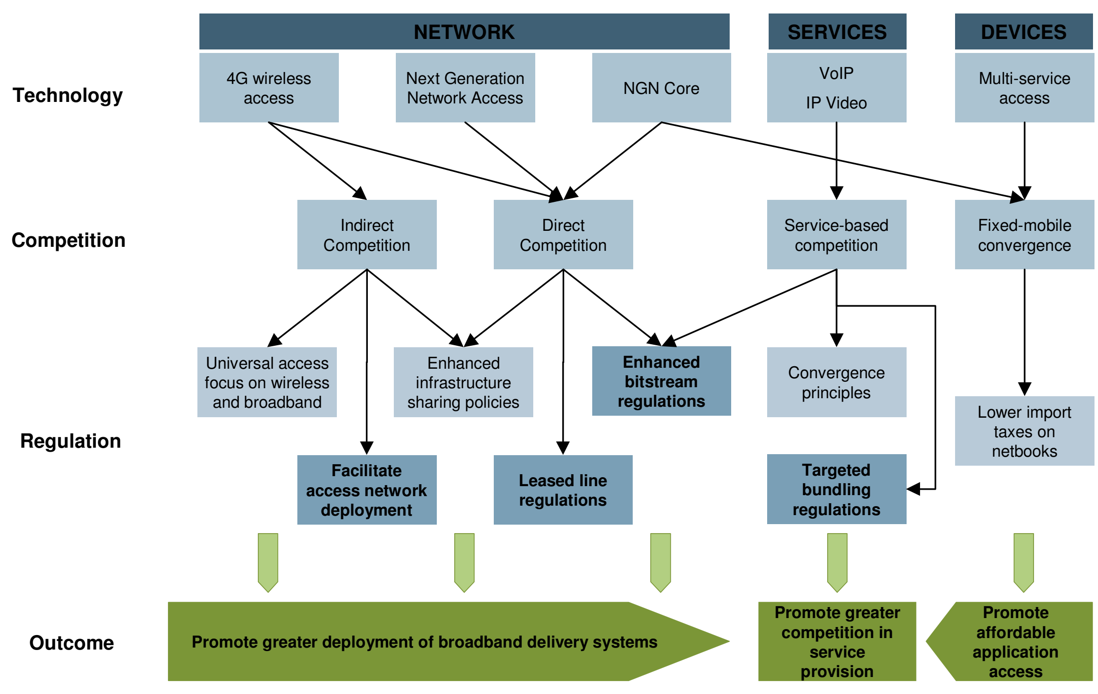


Figure 1.3: Implications and regulatory areas of focus for OSIPTEL with regards to convergence [Source: Analysys Mason]

Our regulatory recommendations in this regards are guided by three key principles:

- **Promote network deployment**. We focus on two types of facilities-based competition
  - *Indirect competition*: deployment in under- or un-served areas to facilitate access
  - *Direct competition*: deployment in served areas to create innovation and choice.
- **Promote converged services**. Service-based competition can be made easier with converged services that can be offered over broadband platforms .
- Work to ensure the **availability and affordability** of the wide range of converged devices that are able to access broadband networks to promote fixed-mobile convergence.

The order of implementation or specific timescales for recommendations is a function of the capacity and time that the regulatory authorities have available. If sufficient resources are available, it is possible to implement the majority of these recommendations in parallel or in rapid succession. However, this situation is unlikely, and as such the diagram above provides a relative indication of the priorities for each recommendation – general policies in the red boxes are of immediate priority.

We can assess at a broad level the impact of the recommendations and the general process of convergence in Peru.

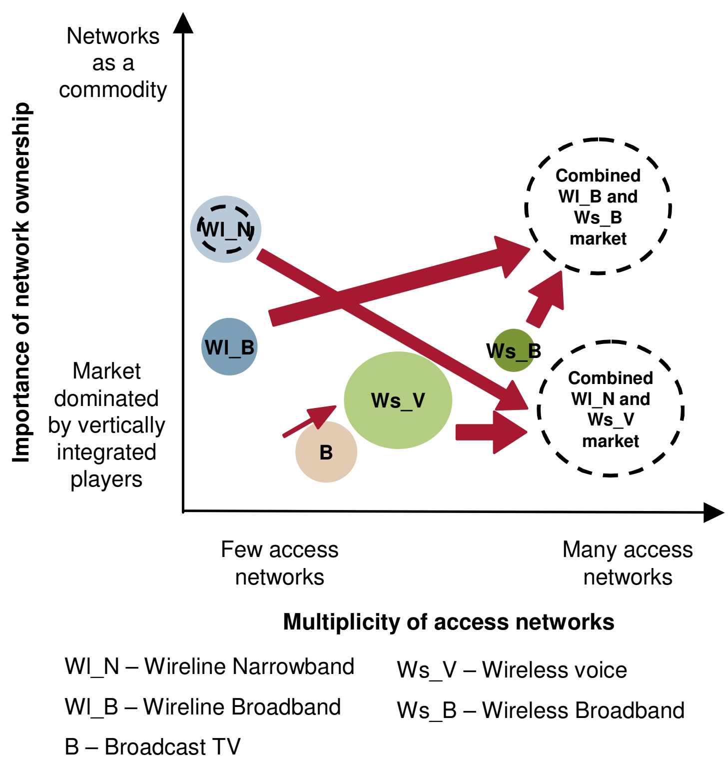


Figure 1.4: The broad Peruvian telecommunications markets in a converged environment [Source: Analysys Mason]

Below we present a few final conclusions on the impact of convergence in Peru:

- The boundaries between wireline and wireless broadband service markets will blur in the short to medium term as commercial developments in the functionality of wireless broadband services, and policies to promote wireless broadband as a universal means of access to Internet connectivity combine to minimize the differences between services offered over the two platform types.
- Similarly, the differences between wireless and wireline voice services may diminish, either through the predominance of wireless voice access, or the merging of solutions that offer a single service over both types of platforms (FMC).
- The dynamics and business models associated with the broadcast TV market indicate that there may be scope in the long term for an increase in the number of access networks available, although significant power will remain in the hands of the vertically integrated players.
- The dynamics of competition and existing business models associated with offering the various telecommunications and media services indicate that, in the short term, there will continue to be key distinctions between broadband, voice and broadcast video services.

Over the longer term, further merging between these markets is possible and certainly likely (such as a single product being used to offer broadcast TV, data and voice), although the actual timescales will depend on specific operator commercial plans and other external factors such as an increase in disposable income for customers and more widespread awareness of the potential of connectivity in the populace.

Finally, we note that such beneficial benefits of convergence will depend on effective competition policy to be vested in OSIPTEL and/or another specialist agency. In particular, ex ante merger review can prevent consolidation between competing broadband networks and prevent the beneficial movement along the horizontal axis above toward more access networks. Likewise, ex post competition review can prevent vertically integrated players from blocking IP-enabled services in order to prevent a beneficial movement up along the vertical access toward effective commoditization of the networks.

2 Introduction

In 2006, Analysys Mason Limited ('Analysys Mason') completed a study for OSIPTEL in which we made a set of recommendations regarding the regulatory strategy and vision for the agency over a ten-year timeframe. One of the key recommendations of the study was for OSIPTEL (in the medium term) to promote the process of convergence within Peru as a means of making the benefits of the technological advancements in telecommunications and media services available to a wider section of the Peruvian society.

Following those recommendations, OSIPTEL commissioned Analysys Mason to analyze in more detail the challenges and implications presented by convergent telecommunications services and technologies in Peru from three primary standpoints, namely technology, competition and regulation. The ultimate aim of this study is to understand how the process of convergence can be best made to work in favor of some of OSIPTEL's primary objectives such as increasing access and network coverage, and improving key performance indicators (KPIs) of the wider industry.

The overall outcome of this project is an optimal set of policy recommendations to modify the current telecommunications regulatory framework in Peru in order to ensure that the process of convergence provides the maximum benefit for Peruvian consumers and the economy at large.

There are two parts to this project. The first part of the project focused on two objectives:

- analyzing the international experience of convergence from technology, competition and regulation standpoints
- proposing regulatory principles and general policy recommendations to address the different issues that may arise during the convergence process in Peru.

The second part of this project consisted of the following tasks:

- modification of the partial report as a result of feedback received from OSIPTEL staff during the first workshop with OSIPTEL
- incorporation of the information obtained from interviews with Peruvian service providers and operators as well as the Ministry of Transport and Communications (MTC)
- specification of a set of policy recommendations to modify the current regulatory framework governing the Peruvian telecommunications market.

This document (the 'Final Report') comprehensively details the findings of the first and second parts of the project. The remainder of this document is laid out as follows:

- **Section 3** introduces the concept of convergence and defines a framework for understanding the process of convergence
- **Section 4** looks at convergence from a technology standpoint, outlining the technologies that influence the process of convergence

- **Section 5** considers the impact that convergence may have on competition between stakeholders in telecommunications and media markets, both worldwide and in Peru
- **Section 6** considers the regulatory implications of convergence given the technology and competition analysis, and provides a series of regulatory approaches towards dealing with convergence.

The report includes a number of annexes containing supplementary material:

- **Annex A** includes summaries of bundled services offered by operators in developed and emerging markets, providing information on bundle characteristics and prices
- **Annex B** provides a transcript of the interviews carried out with five licensed operators and the MTC, setting out views on the major issues with regards to convergence
- **Annex C** includes a glossary of terms used throughout this report.

3 Convergence defined

The implications of convergence have been vigorously debated and discussed by all participants in the telecommunications and media industries (such as regulators, network operators, vendors, service providers) over the past few years as ongoing changes and innovative developments blur the lines between these industries. In order to determine the optimal responses to these events, it is first necessary to be clear on what exactly is meant by convergence.

Traditionally, the type of services or content delivered over a particular network have been intimately tied to the nature of the communications network, as shown in Figure 3.1 below.

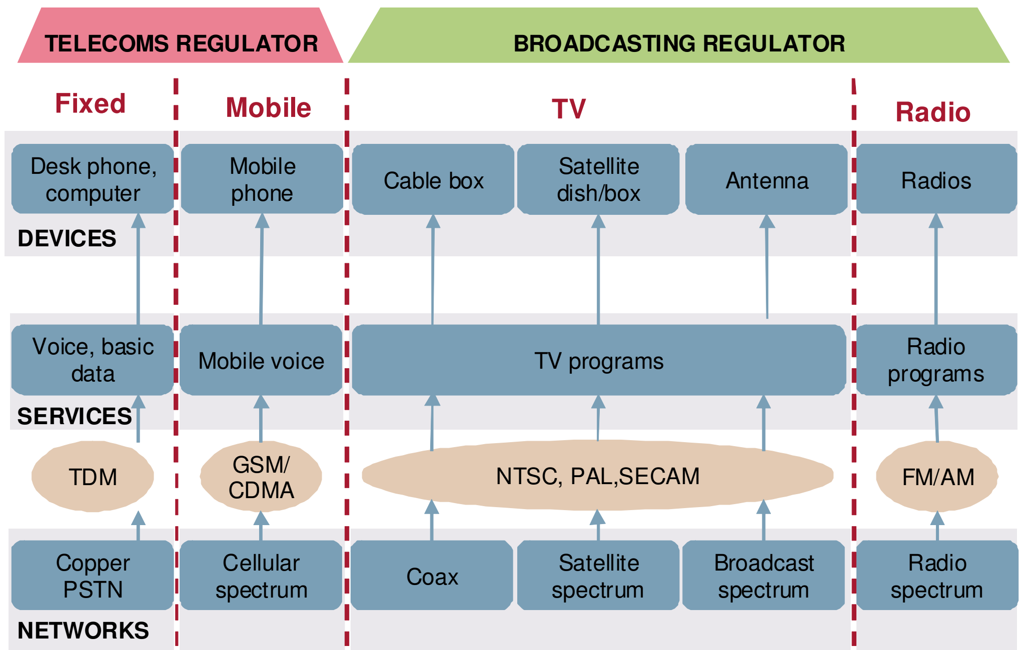


Figure 3.1: Telecommunications, radio-communications and media industries before convergence [Source: Analysys Mason]

As the figure illustrates, TV has been delivered over dedicated broadcast networks, radio shows over radio broadcasting networks, and telephony over telecommunications networks. Under this traditional framework, separate regulatory entities have often been responsible for each particular industry. Additionally, the interfaces connecting each level of the vertical stack have been defined by significantly different standards.

However, the development of methods to provide various services using a common protocol – the Internet Protocol (IP) – motivated network operators to begin widening their service portfolios both as a means of generating further revenue, as well as shoring up existing revenue streams imperiled by such developments as product commoditization. The set of actions and consequences arising from this form the basis of convergence. Briefly:

Convergence *is the ongoing development and provision of voice, video and data services, either singly or in combination, over IP-enabled networks using a variety of fixed and mobile devices.*

As previously mentioned, the primary driver behind convergence is the ability to offer any service using the IP standard. Other drivers that complement this development include:

- the rapid growth and broadening base of Internet usage (spurred on by increasing familiarity with Internet services and bandwagon effects)
- more affordable and faster Internet access
- the increasing availability of desirable content in digital form
- vendor crossover between telecommunications and media supply chains (which leads to the supply of better and cheaper devices and equipment under competitive pressures)
- recognition of demand for, and emergence of, new services
- policies by governmental authorities to achieve specific developmental aims.

As is already being demonstrated around the world, convergence stimulates the provision of new services and business models that can both complement and disrupt existing market structures and industries. In particular, convergence eliminates the intimate ties between networks, service and devices, blurring the vertical divisions between the telecommunications, radio-communications and media industries.

The process of convergence can be distilled under three broad headings:

- **Convergence of networks** – defined as the increasing ability of different types of networks to carry IP-packaged content. This is primarily manifested as the widespread availability and marketing of Internet access (particularly broadband) over all types of networks. For example, Internet data is carried over 3G mobile networks, wireline fiber networks or WiMAX networks using the same IP standard.

- **Convergence of services** – defined as the increasing ability to offer any subset of voice, data or video services over a particular IP-enabled network. As broadband access becomes more ubiquitous, new product and service offers are increasingly predicated on the availability of a high-speed Internet connection. This contributes to a positive feedback in loop in which the adoption of broadband spurs on demand for, and supply of, advanced converged services which when created require new customers to have broadband access. As an example, traditional telecommunications operators are now able to offer bundles of voice, video and Internet data services using the same infrastructure.

- **Convergence of devices –** defined as the increasing ability to offer either multiple services over a single network using the same device or a single service over multiple networks using a single device. For example, laptops come equipped with multiple connection standards such as Wi-Fi chipsets, Ethernet ports and 3G data cards allowing them to access multiple services over any number of IP-enabled networks.

Figure 3.2 below illustrates the structure of the communications and media industry as a result of convergence along these three dimensions. Note that as a result of this process, there is acceptance and support for the idea of converged regulatory frameworks as being the most efficient and optimal structure for governing the industry.

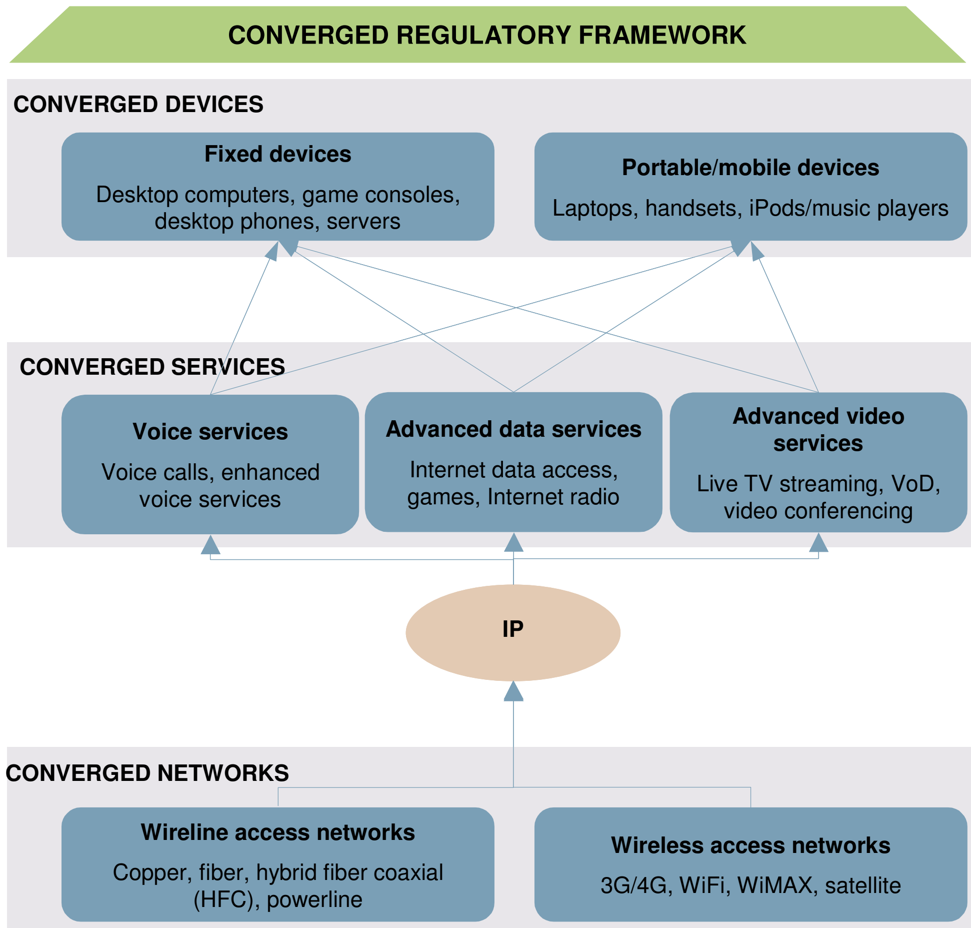


Figure 3.2: Communications and media industry after convergence [Source: Analysys Mason, 2008]

A good illustration of the difference in delivery of services as convergence progresses is the iPhone (see Figure 3.3 below). In 1998, many common devices were still in their infancy, and multiple services were delivered over separate networks. By 2008, a single device – the iPhone – was able to combine the functions of many devices (camera, music player, game system) and deliver multiple services (voice, streaming video, Internet access) over different networks (all services can be delivered over either a Wi-Fi or 3G network).

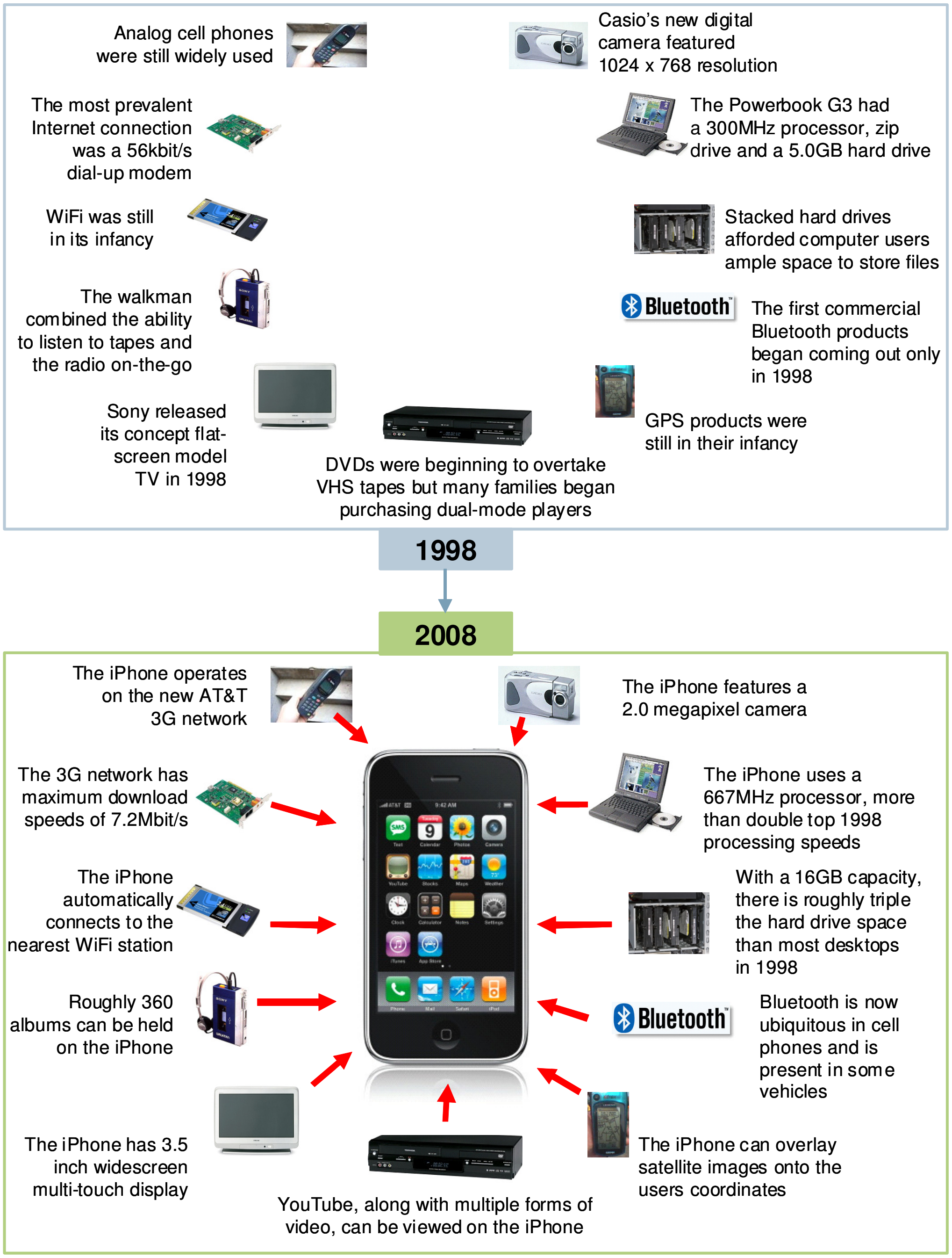


Figure 3.3: Example of service delivery in a converged environment – the iPhone [Source: Analysys Mason]

This richer communications environment poses a number of opportunities and challenges for all industry participants:

- Incumbent network operators and service providers will tend to be primarily preoccupied with shoring up falling revenue streams and trying to ensure that they (rather than new entrants) are best placed to take advantage of the increased revenue opportunities afforded by offering new value-added services.
- On the other hand, changing paradigms and business models offer new entrant network operators and service providers an opportunity to create value by partially negating some of the barriers posed by large incumbent customer bases and historical expertise possessed by incumbent operators.
- Regulators and government authorities may see a new opportunity to streamline and increase the efficiency of industry regulation (although in many cases new regulations will be enacted thereby expanding the number of regulations in place) and provide a boost to the economy at large by encouraging the rollout of these new services. The key challenge is to ensure that the benefits of convergence are realized as fully and rapidly as possible with a minimum level of disruption.
- In every country there is a always a distinction between ministerial functions and regulatory functions, but the specific division of responsibilities is specific to each individual country. The process of convergence does not directly change or impact the distribution of authority between ministries and regulators, and as such any questions regarding this issue are best left to other more directed studies.
- For consumers, it is clear that the primary benefit of convergence is access to a broader range of better services than were previously possible, and education will be key to making sure that these services are taken advantage of.
- For business customers, the benefits of convergence may be even more profound. Access to potentially much larger customer bases and more affordable services due to increased supply competition will allow more business models to meet the key requirements for any successful enterprise – a critical mass of customers and affordable means to reach them.

A crucial point to make is that developing and emerging markets have a unique opportunity in this climate to rapidly close the advanced services gap with the most technologically developed countries. The very swift process of convergence means that network and service providers in emerging markets do not have to follow the same developmental path followed by those in more developed countries – instead, the ability to leapfrog certain steps and deploy the most optimal advanced technologies provides a means to close the gap quicker than would otherwise be possible, and allow the populace a chance to join in the benefits being enjoyed by consumers in more technologically developed countries.

In order for developing countries to take advantage of the opportunities afforded by convergence, there are a number of key decision areas that it will be critical to address correctly:

- **Spectrum management** – making sure that sufficient spectrum is allocated to operators so that there is enough capacity to enable the development and provision of advanced services, while also ensuring that the right number of spectrum blocks are available to spur essential and adequate competition.

- **Downstream bottlenecks** – Internet exchange points (IXPs), backhaul and international connectivity are just three of the potential areas where inadequate supply or pricing principles could retard an otherwise vigorous telecommunications and media market.

- **Innovative approaches to interaction and collaboration** between the public and private sector.

- **Affordability and sustainability of services** from both operator and consumer standpoints.

The previous list is not exhaustive, and the following sections will discuss in much more detail all the likely issues that OSIPTEL will have to consider from the point of view of both regulation and competition as convergence progresses. The discussions in this report will proceed according to the following template:

- detailed discussion of the various technologies that are enabling the convergence process around the world
- building on from the technology discussion, a broader analysis of the impact these enabling technologies are having on the competition and collaborations between firms providing services in these industries
- finally, an examination of the regulatory policies that have impacted the regulatory process and the remedies that are being considered by various agencies worldwide in order to take full advantage of these developments.

Throughout these discussions, we will be focusing primarily on the specific opportunities and challenges faced by stakeholders in emerging markets (particularly Peru). The ultimate aim of our recommendations will be to ensure that the process of convergence in Peru minimizes the destabilizing nature of radical changes to the industry while encouraging the introduction of new services, entrants and business models which will have lasting benefits to consumers and the economy.

Clarification of terms used in the report

At this juncture, it is important to clarify the following specific terminology as it is used in the remainder of this document. In many commentaries on the telecommunications market, 'fixed' and 'wireline' are used interchangeably to describe last-mile access infrastructure that has a physical nature, while 'mobile' and 'wireless' are used interchangeably to refer to last-mile access that is done over an air interface. However that is not the case here; in this report each term has a specific meaning.

Throughout this report, we use these terms with the meaning described below:

- **wireline** refers to access infrastructure in which the user customer premises equipment (CPE) is physically connected to the core network, and as such is used when discussing networks or services with this particular characteristic
- **wireless** refers to access infrastructure in which the user CPE communicates with the core network over an air interface, and as such is used when discussing networks or services with this particular characteristic
- **fixed** is more generally used when the defining characteristic of the object being referred to is that the services rendered are not intended for usage in a mobility context
- **mobile** is more generally used when the defining characteristic of the object being referred to is that the services rendered are suitable for usage while in motion.

Where the term ' 'mobile' appears without additional qualification, it refers to traditional wireless networks based on GSM, CDMA or iDEN standards. For instance, when referring to WiMAX mobility services we will use the term 'mobile WiMAX'.

In light of this, we have the following matrix:

	WIRELINE	**WIRELESS**
MOBILE	*Does not exist*	*Mobile is always wireless*
FIXED	*Wireline is always fixed*	*WiMAX 802.11(d) or WiLL are example of fixed wireless access technologies*

Figure 3.4: Terminology relationship matrix

We use the more specific terms 'wireline' and 'wireless' in those cases where we want to make a clear distinction between networks based on their key technology differentiation (physical versus air interface).

In addition, some further clarifications are note below:

- where we refer collectively to any wireless networks based on the GSM, CDMA or iDEN family of standards, we use the term **mobile network**
- similarly, we refer to operators that offer wireless services using the GSM, CDMA or iDEN family of standards as **mobile network operators** (**MNOs**), distinguishing them from WiMAX operators, who are yet to offer full mobility services over their wireless networks.

4 Technology analysis of convergence

In this section we describe the technological aspects of convergence primarily to understand which technologies will be most appropriate in Peru.

We believe that the key to promoting convergence is to promote broadband Internet access, based on IP. Since 1974, IP has been the underlying basis for sending data between computers connected to the Internet. The most widely used version of IP today is IPv4. However, the number of available IPv4 addresses is rapidly diminishing due to the proliferation of wireless devices, Internet connections and the rapidly growing number of Internet users. The accepted and standardized solution is a migration to IPv6 – which allows the address size to increase dramatically from 32 bits to 128 bits, providing for much longer addresses and the possibility of many more Internet users, and thus removing a potential barrier to even more widespread adoption of IP-enabled services.

Overall, based on the existing network deployments in Peru and the characteristics of new technologies, we believe that next-generation wireline access technology will have more limited and targeted applicability, while wireless technology is more suited for mass deployment of network access. This is true not just for existing voice technologies, but also for broadband, given the significant increase in broadband capabilities that can be supported by wireless access. In order to lower the cost of deployment, we also discuss the technical basis underlying the sharing of infrastructure, for both wireline and wireless deployments.

4.1 Network convergence

A combination of factors is influencing the drive for operators to migrate legacy networks to new converged networks, also known as next-generation networks (NGNs). These factors are related to both costs and revenues:

- on the cost side, investment decisions are driven by a desire to decrease levels of opex and ongoing capex spending that result from deploying NGNs
- on the revenue side, there is a desire to take advantage of the increased revenues from new services that can be offered over converged networks.

Briefly, the main drivers for this network evolution include:

- preparing for the projected decline in revenues of legacy voice services
- replacing aging PSTN networks and providing a lower-cost way to extend wireline networks into under- or un-served areas
- enabling low incremental cost for service integration
- addressing requirements for multimedia services
- leveraging all access networks and providing ’true’ mobility

- creating brand new services and allowing all types of access network operators to compete with each other
- providing enhanced and personalized services and mobility to end users to increase loyalty and reduce churn
- providing MNOs with the opportunity to offer new high-value services such as wireless broadband or mobile TV that will scale with increasing demand.

In the next few sections we describe the current technologies available, the enabling standards, as well as the outlook for Peru regarding NGNs.

First we analyze the following categories of convergent technologies:

- next-generation wireline access
- next-generation wireless access (including spectrum requirements)
- next-generation niche access
- next-generation core network
- next-generation broadcasting.

NOTE: *In the remainder of this report, core network is taken to mean both the core network elements such as switches and the backhaul connecting end-user access nodes (such as DSLAMs , local exchanges, MSANs or the BTS) to the core network elements and switches, as well as the connectivity to other operators, domestically and internationally.*

We then discuss various methods of infrastructure sharing in the context of deploying these technologies.

4.1.1 Next-generation wireline access

Penetration of wireline services in Peru remains modest. The two main wireline access infrastructures deployed in Peru are the incumbent's public switched telephony network (PSTN) and cable networks.

The **PSTN** has traditionally been used by incumbent operators throughout the world to provide voice and data services to end users. It can be segregated in two: the **access network** (which usually includes parts of local exchanges, street cabinets and distribution points, as illustrated in Figure 4.1); and the **core network** (which included everything else). The actual portion of the access network between the exchange and the customer (known as the '**local loop**') is based on copper cabling.

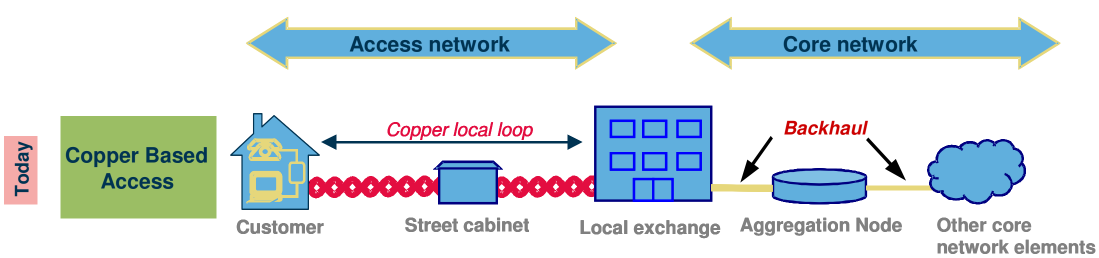


Figure 4.1: PSTN architecture [Source: Analysys Mason]

As well as voice services, the PSTN is used to deliver wireline broadband services in the form of xDSL. This is achieved by placing a digital subscriber loop add/drop multiplexer (DSLAM) in the exchange and placing a DSL modem or router at the customer premises, using the existing copper local loop as a transmission medium.

The main **cable networks** in Peru (owned by incumbent Telefónica and Telmex) are hybrid fiber copper (HFC) architectures, based on the Data over Cable Service Interface Specification (DOCSIS) standard. The HFC/DOCSIS architecture is illustrated in Figure 4.2.

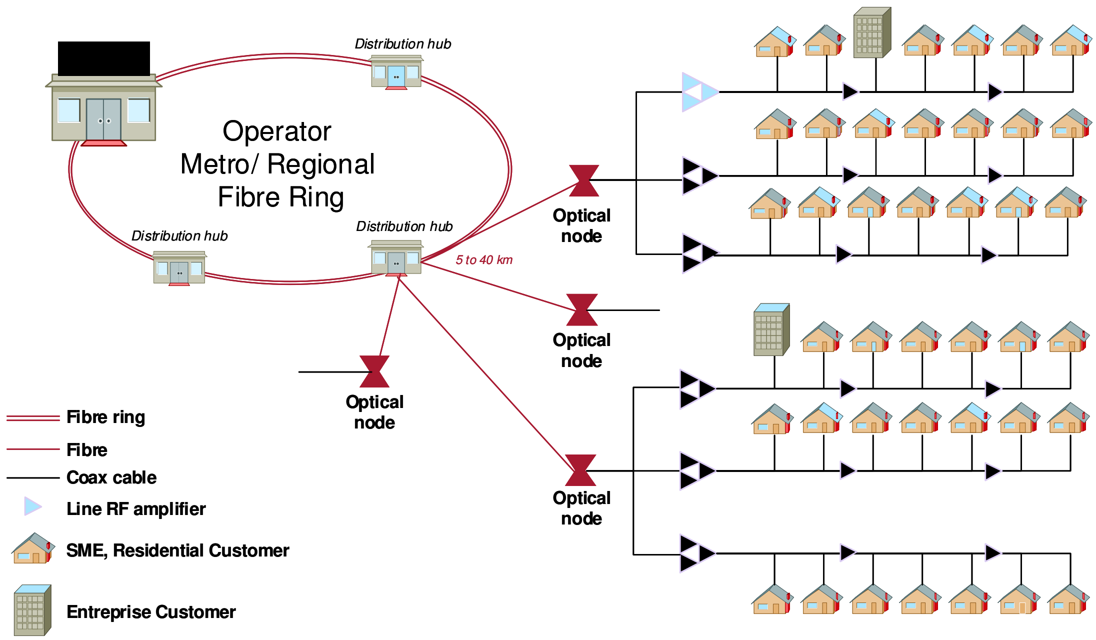


Figure 4.2: HFC/DOCSIS architecture [Source: Analysys Mason]

An HFC/DOCSIS access network is usually composed of a fiber transport ring connecting TV head-end equipment to distribution hubs. For converged cable networks offering the triple play, Internet access and telephone switching is also done in the head-end. Each distribution node is linked to a number of optical nodes in a star topology using fiber. The optical node denotes the boundary between the fiber network and the coaxial copper cable network and can serve up to 2000 homes. The coaxial copper cable distribution network links to each individual household. In this topology, all traffic is carried over the coax cable to all the households served by the nodes, where the CPE (such as the set top box, STB), can separate out traffic for that household. It should be noted that all users served by the same optical node will contend to access the shared available bandwidth, resulting in a degradation of service experience when too many users try to access Internet-based services at the same time.

Enabling standards for current wireline access networks

We will focus on the standards for broadband services, as these are most relevant to providing converged services to end-users.

In the case of the **PSTN**, there has been significant progress in xDSL technologies in the last ten years. Initially, **ADSL** (ANSI T1.413 Issue 2, ITU-T 992.1/2) provided 8Mbit/s download to end-users. Enhancement to the original ADSL standard was ratified in the ITU G.992.3/4 for what we commonly know today as **ADSL2**, enabling a peak download speed of 12Mbit/s. More recently, **ADSL2+** (ITU G.992.5) was ratified and can provide up to 24Mbit/s of download bandwidth per user. As described below, the introduction of fiber in the access network has enabled very high-speed DSL (**VDSL**) and **VDSL2** to be introduced. VDSL achieves data rates nearly ten times greater than those of ADSL by employing advanced transmission techniques and forward error correction to realize data rates from 13Mbit/s to 55Mbit/s over twisted pairs, ranging up to 1.2km. VDSL2 is the next iteration of VDSL providing up to 100Mbit/s in the downlink over a shorter range of 300m of copper.

The bandwidth associated with xDSL technologies is an inverse function of the length of the copper loop connecting the end user to the switch, and the main benefits of upgrading DSL technologies occur in the first 1.5 miles. This is illustrated in Figure 4.3 for the different xDSL technologies. The technology enhancements described in the diagram enable incumbent operators throughout the world to develop new business models by providing advanced services (such as TV) over their networks. However, the restrictions in bandwidth resulting from the length of the copper loop are leading operators to install fiber in the loop up to a point closer to the subscriber in order to reduce the length of the copper loop or eliminate it all together. For example, the deployment of a VDSL2 network needs to be accompanied by the deployment of a fiber-to-the-curb (FTTC) infrastructure, which represents a major infrastructure upgrade for these network operators.

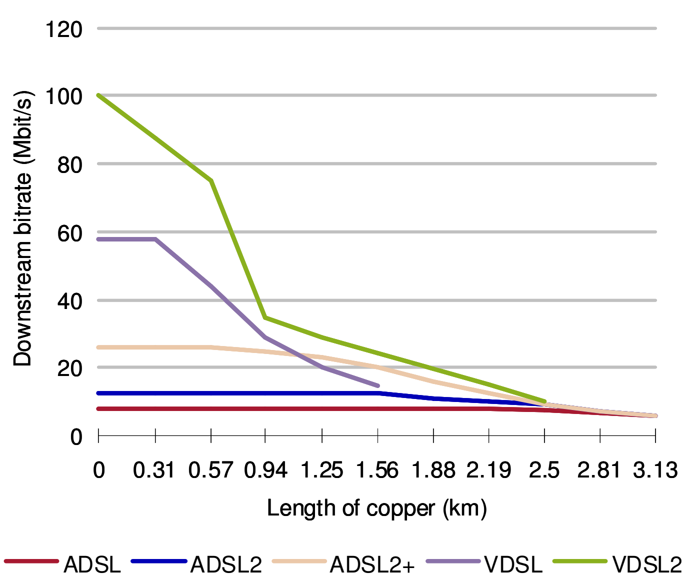


Figure 4.3: xDSL downstream speed versus copper loop length [Source: Analysys Mason]

DOCSIS, the data transmission standard associated with **HFC/DOCSIS** networks, was developed by CableLabs and is used by many cable TV operators to provide Internet access over their existing HFC infrastructure. The first DOCSIS specification was version 1.0, issued in March 1997. Owing to the design of the networks and needs at the time, upstream capacity was quite limited. Because of increased demand for symmetric, real-time services such as IP telephony, DOCSIS was again revised to enhance upstream transmission speeds and quality of service (QoS) capabilities; this revision – **DOCSIS 2.0** – was released in December 2001. Most recently, the specification was revised to provide a number of enhancements, most notably channel bonding, support for IPv6, and support for IPTV. Channel bonding provides cable operators with a flexible way to significantly increase downstream speeds to a minimum of 160Mbit/s, and upstream throughput up to a minimum rate of 120Mbit/s to their customers. This version, **DOCSIS 3.0**, was released in August 2006. Figure 4.4 provides speeds for each version of the DOCSIS standard.

DOCSIS version	*Maximum downstream speed (Mbit/s)*	*Maximum upstream speed (Mbit/s)*
1x	38	9
2.0	38	27
3.0	>160	>120

Figure 4.4: DOCSIS standard [Source: Analysys Mason]

Today, in an HFC architecture, the total spectrum available in the coaxial cable access networks ranges from 550MHz to 1GHz, depending on the system generation. In this document we will assume an 860MHz system.

The spectrum is segregated into an upstream and a downstream band, with the first 65MHz dedicated to the upstream and the remaining 795MHz dedicated to the downstream. The spectrum is further partitioned into a number of applications including:

- analog broadcast
- digital broadcast
- DOCSIS
- switched digital video
- video on demand (VoD)
- IPTV DOCSIS.

This current partitioning is illustrated in Figure 4.5, as is a potential partitioning in the future.

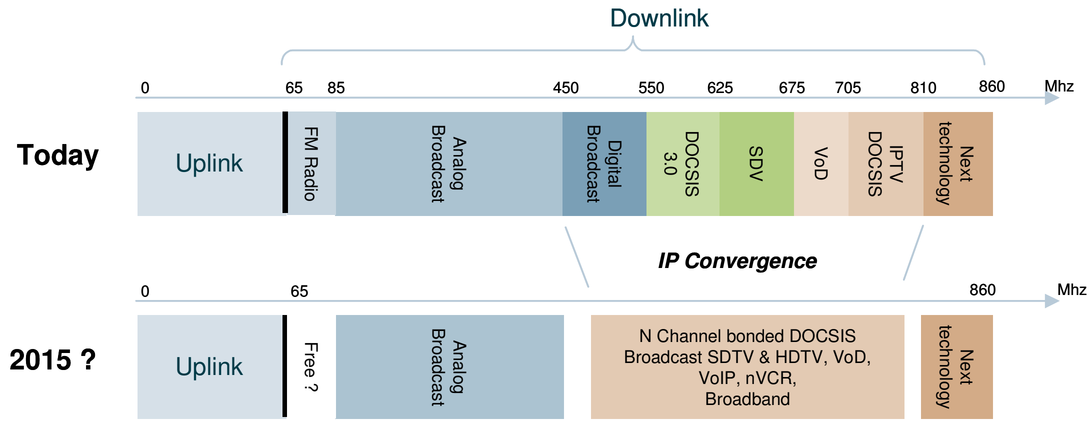


Figure 4.5: Illustrative spectrum allocation in HFC networks [Source: Analysys Mason]

First, it is important to note that the unit channel bandwidth in HFC networks is 6MHz in the USA and 8MHz in Europe. A single 6/8MHz RF channel can carry one analogue TV channel and in excess of ten digital channels depending on the content and compression methods used. Spectrum bands are reserved for analog and broadcast TV as well.

Current implementations of DOCSIS 3.0 require four RF channels, providing high-speed broadband services to users.

Switched digital video (SDV) is a major technology advancement in HFC networks as it allows the optical node to only broadcast channels that are being watched by users served by it. According to Alcatel-Lucent, SDV technology can save up to 40% downlink bandwidth per user group, based on a 200 channel package.[1] VoD will continue to require its own spectrum, where services are typically digital TV services.

Although it is possible to provide linear programming over DOCSIS 3.0 as it was developed to accommodate multiple downstream channels, the cost of the digital TV bandwidth is only a fraction of that of the DOCSIS bandwidth that would supplant it. This difference in cost is mainly explained by the fact that modulators used for digital TV signals are ubiquitous and benefit from economies of scale.

It should be noted that any cable operator will only use a subset of these technologies as some of these technologies are redundant as they provide the same service. For example, SDV can be used to provide both broadcast TV programs and VoD programs. In this case, standard VoD services would not be implemented.

[1] Impact of Bandwidth Demand Growth on HFC Networks, Pradeep Limaye et al, Networks 2008 – FTTH technologies.

Outlook for next-generation wireline access networks

In developed countries, a number of factors have led incumbent PSTN operators to deploy next-generation access (NGA) networks based on fiber-to-the-*x*[2] (FTTx) architecture, namely: the increasing competition from cable access providers based on advances in DOCSIS; the requirement to fight against the average revenue per user (ARPU) erosion of voice-only services; and the demand for ever-increasing bandwidth. As discussed above, NGA is usually characterized by an attempt to shorten or remove the copper local loop, which represents a major technical barrier in providing ever-increasing bandwidth.

In next-generation fiber access, it is important to distinguish between two different architectures:

- **FTTC** – the shortening of the copper local loop by connecting all street cabinets to the local exchange using fiber. The technology used for FTTC-based access networks is VDSL/VDSL2.[3]
- **Fiber-to-the-home (FTTH) –** the complete removal of the copper loop by connecting the end user directly to fiber.

Figure 4.6 illustrates the main difference between the two architectures

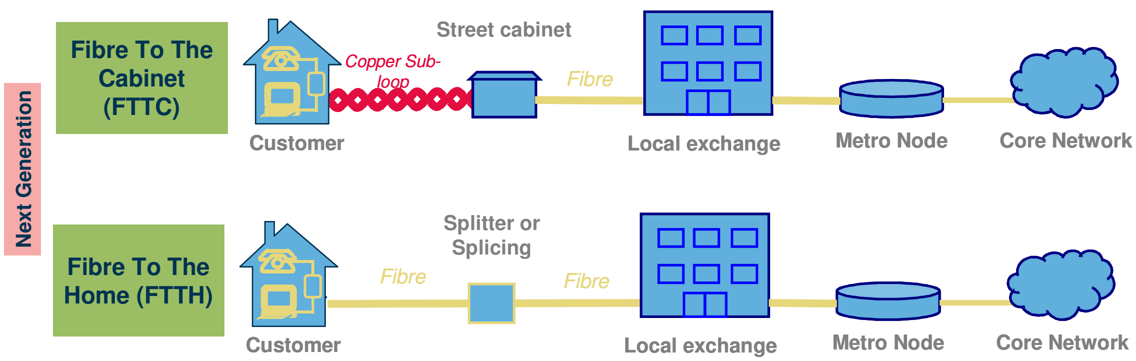


Figure 4.6: FTTx architectures [Source: Analysys Mason]

FTTC as an architecture is equivalent to (and often used interchangeably with) VDSL or VDSL2 architectures, described in previous paragraphs. However, FTTH generally requires more drastic changes to existing network deployments in order to be implemented. We discuss FTTH in more detail below.

► *FTTH architecture*

Two main technologies can be used for FTTH:

- passive optical network (PON)

[2] 'x' in this context represents the fact that there are a number of configurations possible for a fiber access network.

[3] DOCSIS 3.0 is equivalent to VDSL2 (FTTC or FTTN) in terms of the typical access speeds experienced.

- Ethernet point-to-point (EPtP).

By definition, a **PON** is a point-to-multipoint, FTTH-based architecture, in which unpowered optical splitters are used to enable a single optical fiber to serve 16 to 1024 premises. The other PON components include the optical line termination (OLT) at the service provider's central office and the optical network units (ONUs) located with at the end user premises. This is illustrated in Figure 4.7.

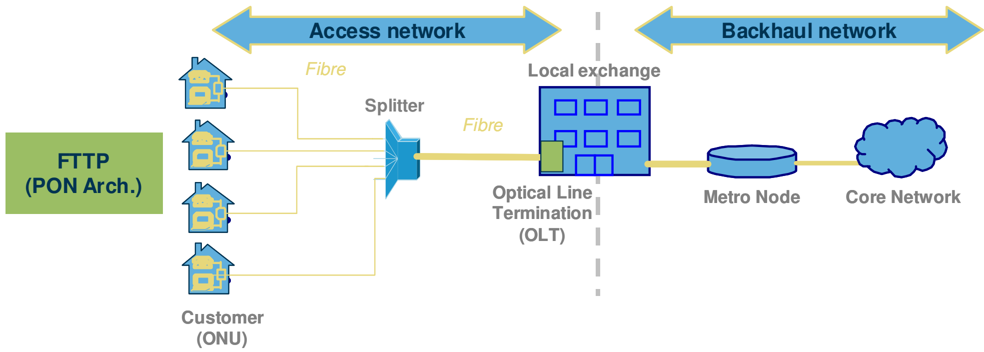


Figure 4.7: PON architecture [Source: Analysys Mason]

A PON configuration reduces the amount of fiber and central office equipment required compared with physical point-to-point architectures, in that a single fiber and optical transceiver (connected to the splitter) serves multiple subscribers, instead of each subscriber requiring their own fiber and transceiver.

In an ideal world, an operator would like as many customers as possible to be connected to a single OLT port to be able to distribute the cost of the OLT across all customers it serves. This desire drives up the number of splits in the passive splitter. However, increasing the number of splits also reduces the distance the signal can travel as it increases the system's loss parameters. Therefore, an increased number of splits results in a reduced link budget (distance) for the system. Due to this compromise, current splitters are typically 32 or 64 way splitters.

There are two predominant competing standards (ITU-T and IEEE) for PON networks:

- **GPON** (Gigabit PON) is an evolution of the BPON (broadband PON) standard. It supports higher rates, enhanced security, and choice of Layer 2 protocol (ATM, GEM, Ethernet). In terms of download speed, 2.5Gbit/s GPON is currently available with an uplink speed of 1.25Gbit/s, shared between all subscribers on the same fiber.

- **EPON** (Ethernet PON) is an IEEE/EFM standard for using Ethernet for packet data. EPON is applicable for data-centric networks, as well as full-service voice, data and video networks. EPON is increasingly lees popular in Europe and the USA, but it is still used in Japan and Korea. EPON offers a download speed of 1.25Gbit/s.

The **EPtP** architecture is based on existing Ethernet technology where a dedicated fiber is deployed for each individual user. This is illustrated in Figure 4.8.

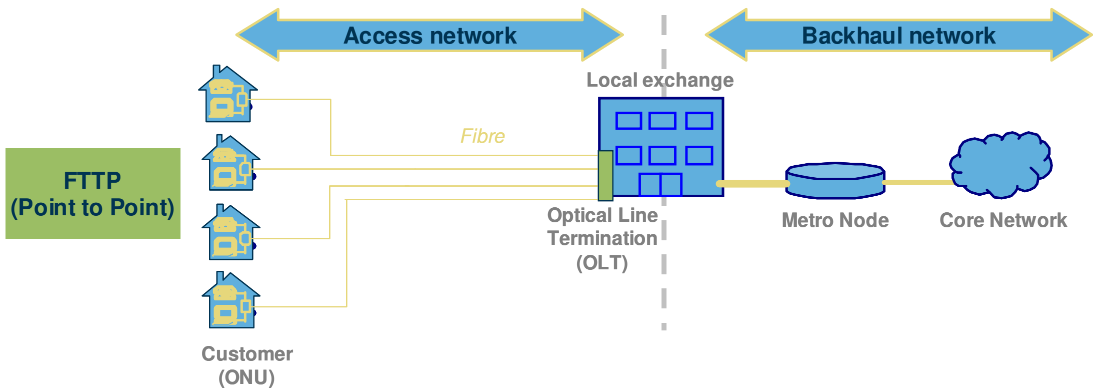


Figure 4.8: Active EPtP architecture [Source: Analysys Mason]

The fundamental difference between a PON-based architecture and an active EPtP architecture is the fact that the fiber is not shared between different users; rather each user has a dedicated fiber pair. The advantages and disadvantages of EPtP versus GPON architectures are summarized in Figure 4.9.

GPON	EPtP
Advantages	**Advantages**
• Reduced central office power and space requirements	• Potentially limitless bandwidth per user
• Potential for central office consolidation	• Technology neutral fibre topology
• Multiple subscribers per fibre	• LLU easier to implement
• Simplified fibre management	• Per customer upgrades possible
• Passive outside plant	• Passive outside plant
Disadvantages	**Disadvantages**
• Shared medium concerns (eavesdropping, jamming)	• More complex CO fibre management
• Potentially more difficult upgrades	• Greater fibre requirements
• LLU difficult to implement	• More resource intensive at CO

Figure 4.9: CEPT's GPON versus EPtP – advantages and disadvantages [Source: Analysys Mason]

The costs of deploying FTTx-based infrastructure to provide NGA services in existing networks are high. For instance, Verizon in the USA has an ambitious plan to deploy an FTTH network to 18 million of its subscribers by 2010 with an estimated budget of USD23 billion – the cost of deploying the network was USD850 per home passed in 2007 (with additional expenditure for enabling service for each household). Concurrently, AT&T indicates that it is deploying a fiber-to-the-node (FTTN) network in its service area, also to 18 million of its subscribers for an estimated investment of USD6.5 billion. This represents a cost per home estimated at USD330 in 2007, which is lower than the estimates calculated for Verizon, since fiber is not extended all the way to the home.

In comparison, the capex to deploy an EPtP network is estimated to be 10% to 15% more expensive than the equivalent GPON solution.[4] This relatively modest increase is mainly due to the higher number of ports required in the Central office (one port per subscriber) and the extra fiber required in the ground when compared with a GPON solution. However, there is a major difference in opex, especially in the central office. EPtP network can consume up to 80% more power (due to the increased number of ports in the CO) and can occupy up to 92% more footprint than their GPON counterpart, according to a study by Alcatel Lucent[5].

HFC network operators and FTTH

Today, the vast majority of cable operators use DOCSIS 2.0 to provide Internet services. DOCSIS 3.0 enables cable operators to provide similar bandwidth to current FTTx deployments, allowing cable operators to provide broadband access speeds of up to 50Mbit/s, in addition to a large number of high-definition TV (HDTV) channels. However, the cost involved in upgrading an HFC/DOCSIS network to provide NGA services is significantly lower than that associated with FTTx. The major difference in cost between FTTx and cable networks (assuming that the cable network has already been upgraded from analogue cable to HFC) is explained by the fact that the requirement for civil work is minimal as the already-installed coaxial cable transmission medium can accommodate higher bandwidth. This is in marked contrast with FTTx networks, which require the extension of the fiber network to the cabinet/curb (FTTC) or to the home (FTTH), and therefore extensive civil work.

According to Comcast, the cost of upgrading its cable network from DOCSIS 2.0 to DOCSIS 3.0 in 2007 was about USD100 per home connected, falling to USD50 per home connected in 2009. It should be noted that, although the implementation of DOCISIS 3.0 is still in its infancy, it is taking place in most developed countries. For example, Comcast estimates that DOCSIS 3.0 will cover 70–80% of US homes by 2012–2013.

As shown in Figure 4.10, the long-term target architecture for cable operators is to move to a full IP infrastructure, removing the need to maintain separate overlay networks (digital broadcast and unicast) and to benefit from cost-effective IP CPE. We do not foresee this to happen the foreseeable future (till 2015) as operators will try to leverage on their existing infrastructure, especially considering they are all in the process of upgrading to DOCSIS 3.0.

Cable operators are currently considering combining the linear TV capabilities of an HFC architecture with the future-proof FTTH infrastructure networks, providing them with a migration

[4] The costs of deploying fiber-based next-generation broadband infrastructure, Analysys Mason, 2008 (www.broadbanduk.org/fibercosts).

[5] Access technologies and FTTH opportunities, Alcatel Lucent, FTTH EUTC conference, March 2007

path to higher bandwidth by substituting coaxial cable with fiber in the access network. The enabling technology is known as Radio Frequency over Glass (RfoG) and consists in modulating voice, data, analog and digital video signals onto two separate wavelengths; one for the forward path and one for the return path. An illustration of how such an architecture can be implemented in provided in Figure 4.10 for a GPON architecture.[6]

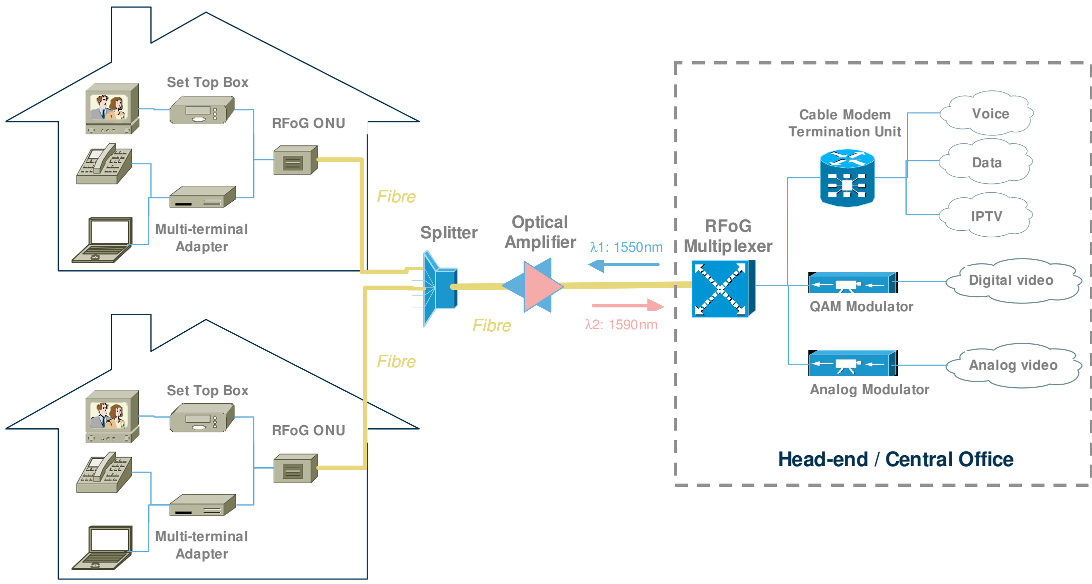


Figure 4.10: RfoG over a physical GPON architecture [Source: Analysys Mason]

The RfoG multiplexer combines all analog, digital voice and data (DOCSIS) signals and provides a forward path modulated on a 1550nm wavelength (λ1 in Figure 4.10). This signal is then amplified by an optical amplifier (typically Erbium Doped Fiber Amplifier) before being split to reach the individual homes. The RfoG optical network unit (ONU) performs the optical to electrical conversion and demultiplexes the different signals present in the wavelength. The RfoG multiplexes the signals on the return path on a different wavelength (λ2) to ensure the outbound and return path do not interfere with each other[7].

One benefit of implementing RfoG for existing cable network operators is that they can leverage their existing back-office infrastructure and terminals (set-up box, multi-terminal adapter). However, we believe that the business case for upgrading the access network to a fiber network is difficult to make for brownfield installations, especially considering that the latest DOCSIS standard can provide more than enough capacity over the existing coaxial cable network for the next two to five years. However, this architecture is more attractive for greenfield applications, where new development would already have fiber in them.

[6] Please note that RFoG can also be supported by a PtP architecture.

[7] Leveraging RfoG to Deliver DOCSIS and GPON Services over Fiber, Motorola white paper, 2008.

For these reasons, RfoG may only address a niche market and we do not foresee any activity in the medium term regarding this technology. From the perspective of existing cable operators, the only attractive feature of RfoG technology is the ability to provide linear TV over their infrastructure. Today, this limitation is partly overcome for standard TV channels by including a DTT tuner in the set-up box. For example, the BT Vision service uses IPTV technology to provide VoD and an integrated digital video broadcasting – terrestrial (DVB-T) for linear TV.

Implications of next-generation wireline access for the Peruvian market

The massive infrastructure investment required to deploy FTTx architecture, the relatively low current demand for bandwidth, and the current global financial crisis are likely to slow significant FTTx deployment in Peru in the near term.

In Peru, the situation is exacerbated by the fact that Telefónica owns both the main cable and the DSL infrastructure. The lack of infrastructure competition does not encourage it to innovate or upgrade its infrastructure. FTTx is likely to be primarily deployed in selected new built areas, which provide a testbed for Telefónica. Supporting this theory is the fact that Telefónica has stopped providing broadband services to new subscribers through its cable network to be able to solely focus on its DSL offering, and the number of cable broadband subscriptions on its network is falling quite fast.

HFC/DOCSIS technology provides a more cost-effective base platform for operators to upgrade to NGA and benefit from the additional revenues associated with next-generation services where there is an existing cable network. In this context, it is interesting to note that the cable network currently deployed by Telmex is already DOCSIS 3.0 compatible (only a few cable networks in the world are currently DOCSIS 3.0 compatible).

However, the cable network will not be sufficient to advance ubiquitous coverage as the reach is currently limited (only present in Lima and seven other cities). Moreover, extending the reach of the cable network may not be feasible, as the incumbent would have to incur costs that are similar to those experienced in deploying an FTTx network, mainly due to the extensive civil work involved. Alternative cable operators such as Telmex may have more of an appetite for expanding their cable network footprint, but the cost considerations remain the same. Also, in Peru, next-generation wireless access solutions may offer a complementary and perhaps more optimal solution for universal access.

4.1.2 Next-generation wireless access

The current wireless access landscape in Peru is relatively fragmented and includes a number of different technologies:

- GSM/UMTS (3GPP) – Telefónica (through subsidiary Telefónica Moviles), América Móvil Perú (America Móvil), Nextel (planned)
- CDMA 2000 (3GPP2) – Telefónica Moviles

- WiMAX (IEEE 802.16x) – Telefónica Moviles, Telmex, Nextel, Americatel Peru, Emax
- narrowband TDMA – Telefónica Moviles
- I-DEN – Nextel del Peru.

In this section, we will focus our commentary on the primary next-generation wireless architectures that have convergence implications, namely 3GPP, 3GPP2 and WiMAX. Figure 4.4 highlights the evolution of these standards.

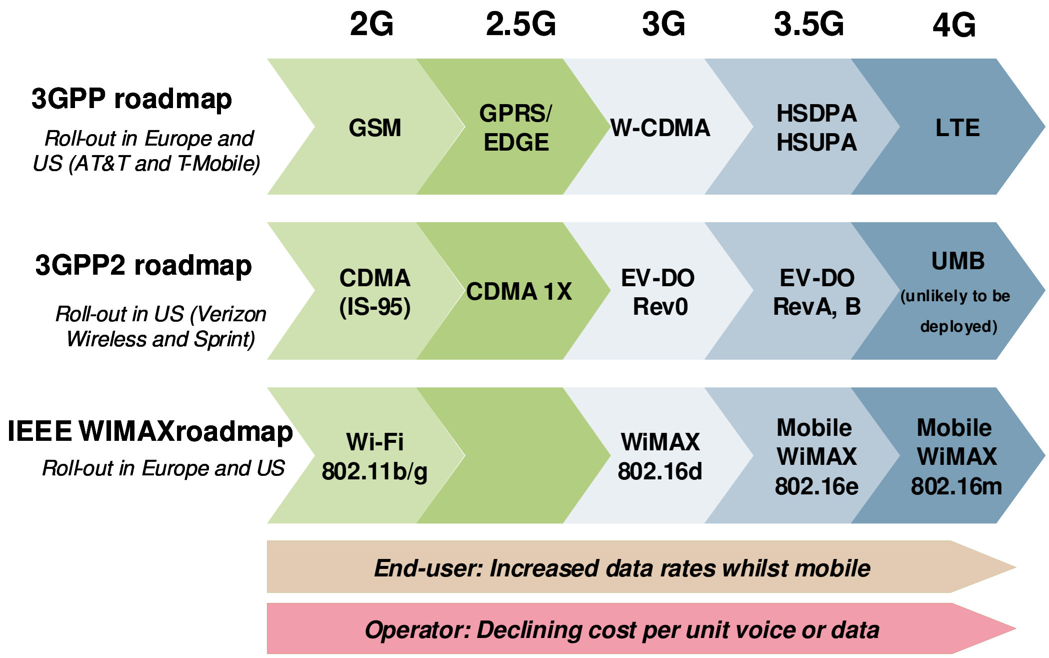


Figure 4.11: Evolution of the main wireless standards [Source: Analysys Mason]

- **Global system for mobile (GSM)** and its associated family of standards are the most popular standards for mobile telephone access in the world; according to the GSM association, as of the end of 2008, there were over 3.5 billion mobile subscribers in over 200 countries with a global market share of 89.5%.[8] The development of these standards is supported by the **Third-Generation Partnership Project (3GPP)**, which emerged from the collaboration of different groups of telecommunications associations[9] throughout the world.

- **Code division multiple access 2000 (CDMA2000)** and its associated family of standards originated from the Interim Standard 95 (IS-95), which was developed by Qualcomm. CDMA2000 was the first CDMA-based digital cellular system, and is therefore a second

[8] GSM association.

[9] The groups are the European Telecommunications Standards Institute, Association of Radio Industries and Businesses/Telecommunication Technology Committee (ARIB/TTC) (Japan), China Communications Standards Association, Alliance for Telecommunications Industry Solutions (North America), and Telecommunications Technology Association (South Korea).

generation (2G) mobile system. Supporting their development is the **3GPP2**, which emerged from the collaboration of ARIB/TTC (Japan), China Communications Standards Association, Telecommunications Industry Association (North America) and Telecommunications Technology Association (South Korea).

- **Worldwide interoperability for microwave access (WiMAX)** is a wireless broadband standard based on the **IEEE 802.16** family of standards. Early iterations of the standard focused on line of sight (LOS) applications using microwave frequency bands (e.g. above 10GHz) for fixed wireless access. More recently, efforts have focused on specifying amendments to the standards to support non-LOS applications in lower frequency bands (typically between 2GHz and 6GHz), providing a more appropriate spectrum for consumer applications such as Internet access.

We discuss these standards in more detail in the following sections. Note that the discussions of these access networks will entail some reference to the core equipment in such networks, as the developments in the core that enable the convergence and evolution of access networks. However, the main analysis of next-generation upgrades to the core network of converged wireline or wireless access operators is done in Section 4.1.5.

Enabling standards for next-generation wireless access networks

► *3GPP*

Although GSM was initially designed to provide voice services, it evolved to accommodate data with the introduction of GPRS (2.5G). The addition of enhanced data rates for GSM evolution (EDGE) (2.75G) over the air interface quadrupled the data rates initially offered by GPRS. In 1999, the standard specification for the third generation (3G) system based on a wideband CDMA (**W-CDMA**) air interface was released. This 3G system is also commonly referred to as universal mobile telecommunications system (**UMTS**).

Today, most UMTS networks implement high-speed packet access (HSPA) whose specifications were Release 5 and Release 6 of the 3GPP standard. HSPA was designed to enable operators to provide wireless broadband services, with current implementation offering a peak rate of 14.4Mbit/s per sector in the downlink (HSDPA) and 1.4Mbit/s per sector in the uplink (HSUPA). HSPA technology is usually referred to as 3.5G technology. The GSMA estimated that there were 83 million HSPA subscribers in the world as of Q3 2008. Due to be ratified in 2009, Release 8 of the 3GPP standard will specify the fourth generation 3GPP standard known as **Long Term Evolution** (LTE).

A typical 3GPP architecture is illustrated in Figure 4.6.

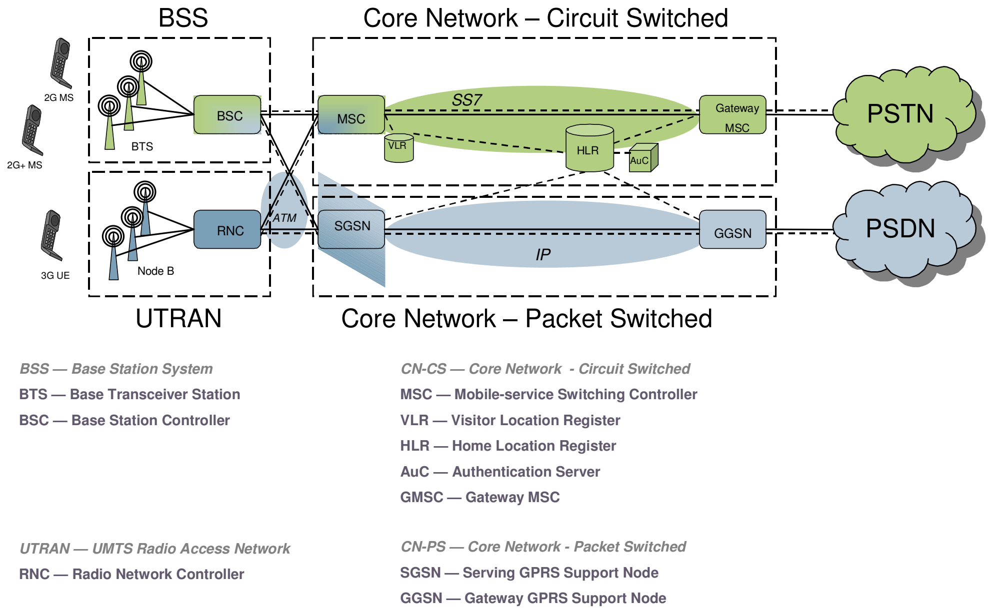


Figure 4.12: Typical 3GPP architecture (R99) [Source: Analysys Mason]

The 3GPP standard segregates GSM/UMTS networks into two parts:

- access network
- core network.

A GSM access network is commonly referred to as the GSM EDGE radio access network (**GERAN**). The GERAN is composed of base transceiver stations (**BTSs**) and base station controllers (**BSCs**). A BTS provides the interface for radio communication between the end user and the network. A BTS site would typically be installed on a steel tower or on a rooftop. The BSC is responsible for controlling and allocating radio resources in the network, and provides mobility functionality to enable users to roam from BTS to BTS, ensuring the continuity of communication. The UMTS (3G) access network is commonly referred to as the UMTS radio access network (**UTRAN**). In a UTRAN, the **Node B** is the equivalent of a BTS, and a **radio network controller (RNC)** is the equivalent of a BSC.

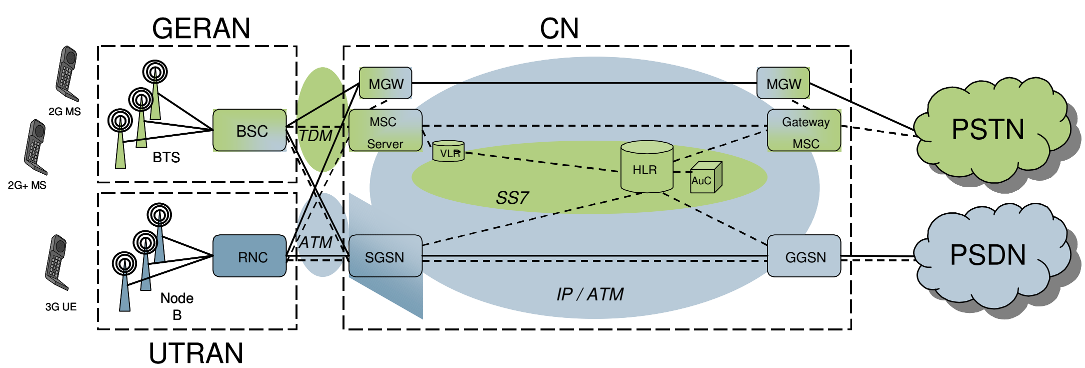
In GSM/UMTS networks, it is important to differentiate between the **circuit switched** (CS) network and the **packet switched** (PS) network. The CS domain carries all traditional voice calls as well as video conferencing services, whereas the PS domain carries all data services. In the CS domain, the **mobile switching center** (MSC) is responsible for establishing and tearing down voice connections as well as switching voice streams to connect call initiators and call receivers. The **visitor location register** (VLR) contains the subscriber profile on the visited network. Finally, a key network element in the CS domain is the g**ateway MSC** (GMSC), which provides connectivity to the external CS network as well as to the PSTN.

In the PS domain, there are only two types of network elements: the s**erving GPRS support node** (**SGSN**) and the g**ateway GPRS support node** (**GGSN**). The SGSN performs a similar function as the VLR and the MSC combined in the PS domain, while the GGSN provides access to services and the external packet switched data network (PSDN).

The **home location register** (HLR) does not belong to either the CS and PS domains and is used by both domains to obtain user-profile information. The permanent information of the subscriber held in the HLR includes permanent identity of the user as well as the services that can be accessed by that user. The user information contained in the HLR is communicated to the VLR in the CS domain and to the SGSN in the PS domain. Finally, part of the HLR is usually the **Authentication Center** (AuC), which holds authentication information as well as other security-related information.

Today, most operators implement a 3GPP R4 **core network**, which allows the GERAN, and the UTRAN access networks to be connected to a **single core** network as vendors now implement integrated media gateways, MSC-servers, SGSN and GGSN, which can be used to connect both UTRAN and GERAN. One option to connect these network elements is to use an IP/ multiprotocol label switching (MPLS) core network, as is discussed later in this section.

In this context, 3GPP R4 standards enable the convergence of 2G and 3G access networks by using a single core network. The convergence of the core network has a crucial impact on the operator as it removes the need to maintain two separate networks. Furthermore, since the core of a 3GPP network can now be based on an IP/MPLS network, operators with a wireline access infrastructure can also leverage their NGN core equipment to also serve the wireless access core network. This is illustrated in Figure 4.13, whilst next-generation core networks are described in more detail in Section 4.1.5.



GERAN — GSM/EDGE Radio Access Network
BTS — Base Transceiver Station
BSC — Base Station Controller

UTRAN — UMTS Radio Access Network
RNC — Radio Network Controller
Node B — UMTS Base Station

CN — Core Network
MSC — Mobile-service Switching Controller
VLR — Visitor Location Register
HLR — Home Location Register
AuC — Authentication Server
GMSC — Gateway MSC
SGSN — Serving GPRS Support Node
GGSN — Gateway GPRS Support Node

Figure 4.13: 3GPP R4 reference architecture [Source: Analysys Mason]

There have been two major developments in the access network that will impact every operator operating a 3GPP network in terms of both creating additional revenue streams and cutting opex and capex costs. These are:

Development of HSPA standards to offer wireless broadband services (3GPP R5 and R6)

The advent of high-speed packet access (HSPA) in R5 and R6 enables MNOs to offer wireless broadband to their customers. HSDPA refers to the downlink bearer, while HSUPA refers to the upload bearer. Figure 4.12 illustrates typical peak rate per sector.

Wireless broadband technology	*Download peak rate*	*Upload peak rate*	*Channel width*	*Frequency duplex*	*Commercial availability*
3GPP (GSM/UMTS)					
W-CDMA (R99)	384kbit/s	128kbit/s	5MHz	FDD	Available
HSDPA (cat 10)	14.4Mbit/s	N/A	5MHz	FDD	Available
HSUPA (cat 6)	N/A	1.4Mbit/s	5MHz	FDD	Available
LTE	>399Mbit/s	>80Mbit/s	20MHz	FDD	Not standardized

Figure4.14: 3GPP wireless broadband evolution [Source: Analysys Mason]

Currently, the highest HSDPA speed commercially deployed is category 10, offering a theoretical sector peak rate of 14.4Mbit/s per sector over a 5MHz frequency division duplexing (FDD) carrier (we discuss FDD in greater detail under spectrum sharing below). In practice, the average peak rate per sector delivered with HSDPA category 10 is around 5Mbit/s, shared between all users on that sector. Similarly, the highest theoretical peak rate for deployed HSUPA systems is 1.4Mbit/s. In practice, the average peak rate achieved by HSUPA category 6 is around 500–700kbit/s per sector, shared across all users on that sector.

It should be noted that 3GPP R4 networks can be upgraded to HSPA by software only. Additional channel elements (one channel element corresponds to the processing power required to carry one voice call) may be required but are not mandatory, as there is usually spare capacity in every Node B. The license associated with activating HSPA from equipment vendors is usually in the range of USD1000 to USD3000 per site. The price of the upgrade per subscriber from basic 3G is modest – in the range of USD0.5 to USD1.5 – which partly explains the success of HSPA as a wireless broadband technology. An indicative roadmap of HSPA services is illustrated in Figure 4.15 below.

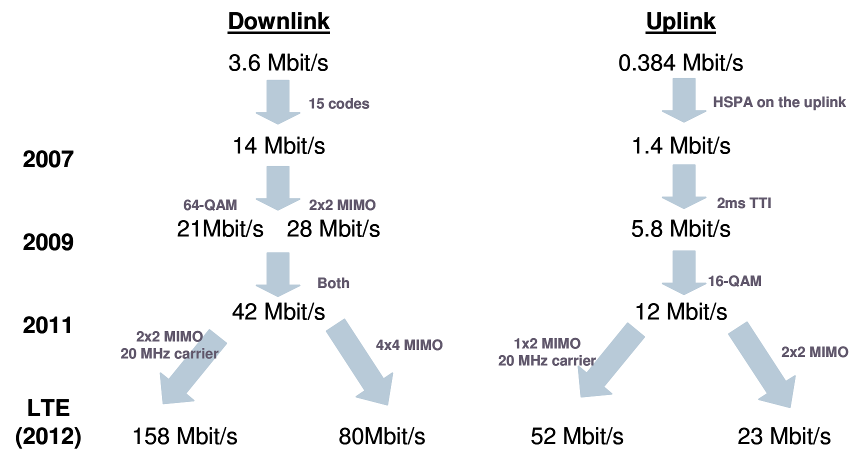


Figure 4.15: HSPA roadmap [Source: Analysys Mason]

It should be noted that, in order to achieve HSDPA peak rates of 28Mbit/s or higher, multiple input multiple output (MIMO) technology will be required. MIMO technology uses multiple antennas at both the transmitter and receiver to improve communication performance. This has significant implications as current BTSs or handsets do not support this feature and would need to be upgraded or replaced (in the case of handsets).

Development of a native IP interface for Node Bs (3GPP R5)

The other major development in the access network is the specification of a native IP interface for Node Bs (3GPP Release 5). The availability of an IP interface for Node Bs has a dramatic impact for operators, especially if they offer wireless broadband services. Up until this development, operators had to carry the traffic using their TDM infrastructure, whose cost is linked to the bandwidth required. However, as the traffic requirements increase, operators do not get proportional additional revenues.

There is therefore a requirement to de-correlate bandwidth increase from cost. IP technology is much better positioned than its TDM counterpart to achieve this because unlike the usage of TDM, the cost of the backhaul does not linearly increase with bandwidth (which it does with TDM as its usage is usually associated with a multiple number of partial private circuits).

Figure 4.16 illustrates the cost of a TDM leased line (PPC) and an Ethernet leased line (wholesale extension service (WES) used with IP) for different bandwidths in the UK:

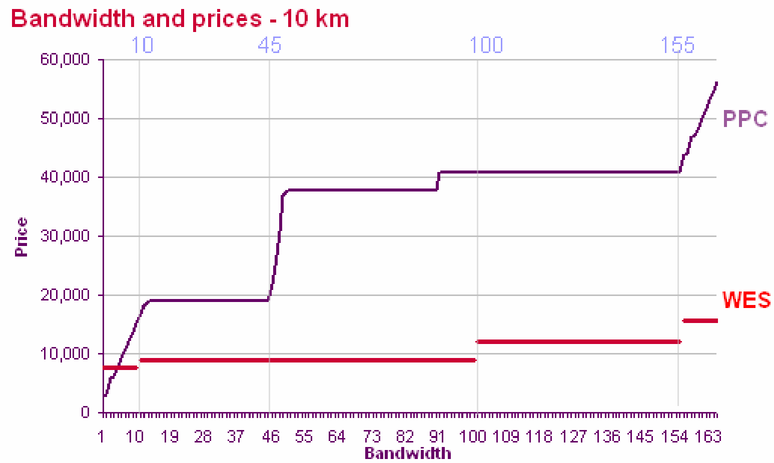


Figure 4.16: PPC versus WES leased-line costs in the UK [Source: OFCOM Business Connectivity Market Review]

As shown above, the specification of a native IP interface will enable operators to decouple bandwidth increase from cost, which is essential to maintain their margin. It should be noted, however, that this is only applicable to UTRAN Node Bs (3G access) given that an equivalent IP interface for GSM has not yet been defined[10]. This implies that TDM traffic generated by the 2G access network will have to be transported over IP using technologies such as pseudo wire edge (PWE3).

Finally, the adoption of IP in the backhaul of the network is consistent with the all-IP evolution target that all wireless networks have, starting from different legacy positions.

► *3GPP2*

Currently, there are about 460 million subscribers on 3GPP2 standards-based networks around the world, spread in 102 countries (mainly in Asia Pacific, the Americas and Africa).

CDMA2000 1xRTT almost doubles the capacity of IS-95, providing peak rates of 144kbit/s per carrier (in 2x 1.25MHz of bandwidth). In 1999, the CDMA2000 high rate packet data air interface specification was released to specify what is commonly known as **CDMA EV-DO Revision 0**, where 'EV-DO' stands for 'evolution data-optimized'. As its name indicates, EV-DO is optimized for data only and is suitable to provide wireless broadband services.

Following CDMA EV-DO Revision 0, Revision A and Revision B have also been made available to further enhance rates per carrier. Typical EV-DO Rev B deployments are expected to include

[10] Release 8 of the 3GPP standard will specify VoIP interface. This initiative is driven by Huawei who have a pre-standard solution.

three carriers for a peak rate of 14.7Mbit/s. In Q3 2008, it was estimated that there was around 100 million CDMA 2000 EV-DO subscribers (Revision 0 and Revision A) throughout the world.[11]

Finally, the 4G version of the 3GPP2 standard is known as ultra mobile broadband (UMB) and was intended to provide peak theoretical download speeds of up to 280Mbit/s. However, in November 2008, Qualcomm, UMB's lead sponsor, announced it was ending development of the technology, favoring LTE instead.[12] Therefore, we do not believe that CDMA2000 technology has an evolution path to 4G.

A typical 3GPP2 architecture is illustrated in Figure 4.17.

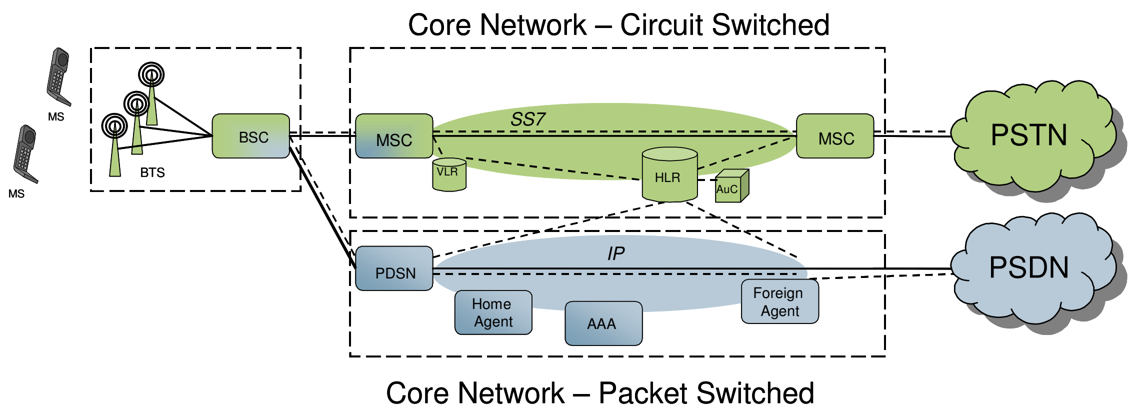


Figure 4.17: CDMA2000 1xRTT simplified architecture [Source: Analysys Mason]

In the access network the 3GPP2 standard uses the same architecture as the 3GPP standard, i.e. BTS and BSC. Please refer to the previous section for a description of these network elements.

In 3GPP2, the core network is also segregated between the CS domain (for voice services) and the PS domain (for data services). Again, the 3GPP2 standard uses a similar architecture as the 3GPP for implementing the CS domain. Please see previous section for a description of these elements.

However, in the PS domain, there is a marked difference. First, the packet data serving node (PDSN) is split into PDSN/home agent and PDSN/foreign agent, which broadly corresponds to the GGSN and SGSN respectively in a 3GPP architecture. Another main difference is the authentication, authorization and accounting (AAA) network node which is used for data service authentication.

The most important development in the 3GPP2 standard was the specification of CDMA2000 EV-DO architecture and services. This provided the technology for operators to implement wireless broadband services over CDMA architecture. Figure 4.18 illustrates the different revisions of EV-DO with their associated speeds.

[11] CDMA Development Group.

[12] *Qualcomm halts UMB project, sees no major job cuts*, Reuters, November 2008.

Wireless broadband technology	*Download peak rate*	*Upload peak rate*	*Channel width*	*Frequency duplex*	*Commercial availability*
3GPP2 (CDMA 2000)					
CDMA 2000 1x	144kbit/s	144kbit/s	1.25MHz	FDD	Available
EV-DO (Rev 0)	2.4Mbit/s	153kbit/s	1.25MHz	FDD	Available
EV-DO (Rev A)	3.1Mbit/s	1.8Mbit/s	1.25MHz	FDD	Available
EV-DO (Rev B)	4.9Mbit/s	1.8Mbit/s	1.25MHz	FDD	Not deployed

Figure 4.18: 3GPP2 wireless broadband evolution [Source: Analysys Mason]

1xEV-DO Revision 0 – offers high data rates of up to 2.4Mbit/s on the downlink and 153.6kbit/s on the uplink. First, it should be noted that CDMA 2000 EV-DO is not backwards compatible with CDMA 1xRTT 2G system as it needs a separate carrier. In terms of architecture, in 1xEV-DO, the BSC communicates directly with the PDSN with no need for a TDM backhaul architecture.

EV-DO Revision A – makes a number of enhancements to Revision 0, while keeping it completely backwards compatible. These enhancements increase the speed of the downlink and the uplink to 3.1Mbit/s and 1.8Mbit/s respectively. The enhancements also allow low latency for low bit rate communications such as VoIP. In the USA, Verizon Wireless and Sprint Nextel have migrated 100% of their EV-DO Revision 0 networks to EV-DO Revision A.

EV-DO Revision B – provides higher rates per 1.25MHz carrier (up to 4.9Mbit/s on the downlink per carrier) and is a multi-carrier evolution of the Revision A. Typical deployments are expected to include three carriers for a peak rate of 14.7Mbit/s. This is comparable with HSDPA category 10 which provide a peak of 14.4Mbit/s over a 5MHz carrier.

As mentioned previously, the fourth generation of the 3GPP2 family (UMB) is unlikely to be deployed anywhere since its main sponsor, Qualcomm, has stopped UMB developments in favor of the 3GPP fourth generation systems (LTE). As such, we do not consider any long-term implications with regards to this technology.

► *IEEE 802.16*

According to Maravedis,[13] there were 2.7 million WiMAX subscribers as at Q3 2008, which is relatively modest when compared to its GSM and CDMA technology counterparts.

Today, there are two versions of WiMAX technology, **fixed** and **mobile**, with separate standards, 802.16d and 802.16e respectively. The initial version of the standard, 802.16d, was published in 2004 and supports fixed applications such as Internet connectivity at a fixed location. This version

[13] *WiMAX Deployments hit by economic downturn as subscription rates and service revenues lose pace*, Maravedis, February 2009-02-23

is also referred to as 802.16 – 2004. The mobile version of the standard, 802.16e, was ratified in December 2005 and supports both 'nomadic' services (portable but not full mobility), as well as fixed services; 802.16e is often referred to as a 4G technology. We believe that although this standard is based on an OFDM interface, the bandwidth and mobility that can be achieved is not consistent with a 4G mobile system.

One major differentiator between IEEE standards and the standards based on 3GPP and 3GPP2 is that the former have been designed to support only data over an all-IP architecture, and were not initially designed to support voice services. Recognizing that the support of voice services is crucial to any operator's plans going forward, the IEEE 802.16 standards include some classes of service in their specification, which allows time-sensitive (such as voice services) traffic to get prioritized over less time-sensitive traffic. This will allow operators to provide good-quality VoIP services over their WiMAX infrastructure, in addition to broadband services.

802.16m, which is the next iteration of the IEEE WiMAX standard, is the only IEEE standard that can qualify as a 4G technology as it will offer full mobility (speed of up to 350km/h) and will provide bandwidth that is comparable to LTE. This standard is due to be ratified in 2009 and will offer theoretical peak downlink data rates of 100Mbit/s and 1G per sector for mobile and fixed WiMAX users respectively. 802.16m will rely on the use of MIMO antenna systems, which will require the replacement of existing network and CPE equipment.

The WiMAX reference architecture is completely different from traditional mobile networks as it is an IEEE standard, so it is more closely related to Wi-Fi (802.11) than to traditional mobile cellular architecture. The main implication of this is that voice services have to be provided over the data network as no CS domain exists. The WiMAX reference model is illustrated in Figure 4.19.

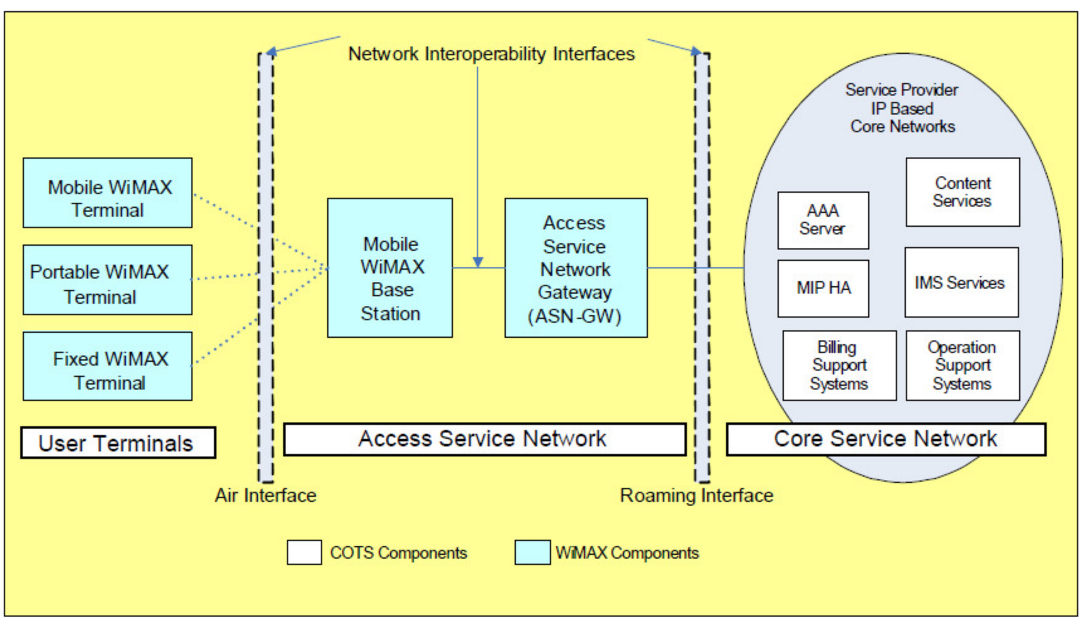


Figure 4.19: *WiMAX reference architecture [Source: WiMAX Forum]*

A typical WiMAX network (similar to 3GPP and 3GPP2 networks) is segmented in two:

Access service network (ASN) – the part of the network which provides for functional interoperability with WiMAX clients, WiMAX connectivity service functions and aggregation of functions embodied by different vendors. The main component of the ASN is the ASN gateway.

Core service network (CSN) – the part of the network that provides a set of network functions that offer IP connectivity services to the WiMAX subscriber(s). A CSN may comprise network elements such as routers, AAA proxy/servers, user databases and networking gateway devices.

The evolution and associated speeds of the WiMAX standard are provided in Figure 4.20.

Technology	*Peak download rate (Mbit/s)*	*Peak upload rate (Mbit/s)*	*Minimum channel width (MHz)*	*Frequency duplex*	*Commercial availability*
IEEE 802.16d	6.55	2.5	1.75	FDD / TDD	Available
IEEE 802.16e	46 / 32	8 / 14	10	TDD	Available
IEEE 802.16m	100 / 1000	TBD	20	TDD	Not standardized

Figure 4.20: WiMAX standard evolution [Source: Analysys Mason]

It should be noted that peak download and upload rates cannot be achieved simultaneously for TDD deployment. For example, based on a 10MHz TDD spectrum block, one configuration of an 802.16e-based system can achieve a peak downlink and uplink rate of 46Mbits and 8Mbit/s per sector respectively. This can be achieved by the operator by reserving ¾ of the TDD spectrum block for the downlink and ¼ of the TDD spectrum block for the uplink. Alternatively, if there is more demand for the uplink (e.g. business applications), the TDD spectrum can be split equally between the downlink and the uplink to provide peak downlink and uplink rates of 32Mbit/s and 14Mbit/s per sector respectively.

The main difference between 802.16d and 802.16e standards is highlighted in Figure 4.21.

	802.16d	*802.16e*
Multiple access method	OFDM	S-OFDM
Duplex	FDD/TDD	TDD
Frequency re-use	1 cell re-use not supported	1 cell re-use supported
Profile and certification testing (bands)	3.5 and 5.8GHz	2.3, 2.5 and 3.5GHz

Figure 4.21: comparison of WiMAX standards [Source: Analysys Mason]

Each standard has a different air interface: S-OFDMA (used in 802.16e-2005) and OFDM256 (802.16d). These two interfaces are not compatible and therefore different CPEs are required. Also, initial 802.16d systems were deployed using an FDD multiplex, and 802.16e systems exclusively use a TDD multiplex. Note also that most vendors today have opted for the development of 802.16e exclusively to optimize their R&D expenditure.

For these reasons, it would be extremely difficult (if not impossible) for any operator to migrate from a fixed WiMAX network to a mobile WiMAX network re-using existing equipment. However, a fixed WiMAX provider wanting to offer mobile WiMAX will be able to re-use its site infrastructure as well as its core network to install 802.16e compatible equipment. In terms of cost of deployment, the average price of a 802.16e tri-sectored base station (active equipment only) in 2009 is estimated to range between USD15 000 and USD25 000 depending on volumes and equipment provider selected[14]. Today, the cost of 802.16d base stations are comparable to those of 802.16e, but as 802.16e technology increases in market share, we expect greater volumes and comparatively lower prices for mobile WiMAX equipment. By 2013, Infonetics predicts that 87% of WIMAX revenues will be associated with mobile WiMAX.

Support for video services over WiMAX handsets is still in its early days. The delivery of IPTV over WiMAX is still largely unproven and has only been deployed in very few niche markets and is at the experimental stage. For example, Bulgarian operator Max Telecom claims to have deployed a WiMAX network in partnership with Cisco and Navini (Smart WiMAX) to deliver nationwide mobile services, which will include IPTV services. However, we have not been able to obtain any detailed evidence of an IPTV service being commercially available or advertised on the operator's website.

Outlook for next-generation wireless access networks

Given the relatively long-term nature of 4G developments, there are many opinions within the industry on how 4G wireless networks will evolve. A number of camps are emerging, influenced by the legacy positions of different vendors and operators. As illustrated in Figure 4.22, there are three main evolution paths emerging to 4G:

- evolution from GSM/UMTS networks (3GPP)
- evolution from CDMA2000 networks (3GPP2)
- evolution from WiMAX networks (IEEE 802.16).

[14] With a 10MHz spectrum block, a WiMAX base station can deliver an average of 10Mbit/s/sector. If you guarantee 500kbit/s per user and if you consider a tri-sector base station, this would lead to 60 concurrent users per site. In addition, if you consider a 20:1 contention ratio, 1200 users would be supported per WiMAX site.

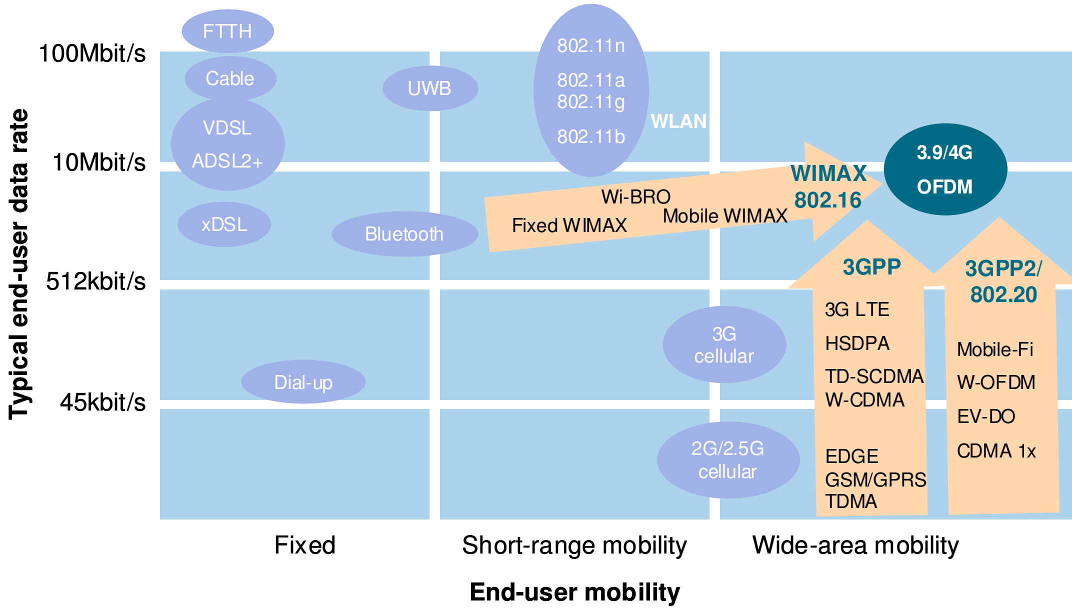


Figure 4.22: Possible evolution scenarios to 4G [Source: Analysys Mason]

It is important to note that the evolution of CDMA2000 is stalled as a number of CDMA operators throughout North and South America have either opted to deploy a GSM network as an overlay to their existing CDMA network, or have stated that they will adopt the 3GPP route to 4G (i.e. LTE). Furthermore, Qualcomm has stopped the development of UMB (3GPP2 fourth generation) in favor of LTE (the 3GPP fourth-generation system). The evolution path chosen by operators will depend on their installed base, the type of services they want to provide, the spectrum made available, and the general market trends regarding the evolution path of 4G. However, all evolution paths have one thing in common: they will all use OFDM as the air interface, thus these evolution paths might end up merging in some future generation.

A number of operators with an existing CDMA network have recently deployed a GSM/UMTS network and are trying to migrate all their users onto the new 3GPP infrastructure. This is to benefit from the lower prices of GSM terminals (economies of scale) and from worldwide inter-operability, and to mitigate the risks associated with the uncertain nature of CDMA2000 evolution. These operators include CTI Movil and Telefónica in Argentina, Vivo in Brazil, America Móviles in Chile and Telefónica in Mexico, Colombia, Uruguay, Nicaragua and Peru. Verizon in the USA has also announced its intention to follow the 3GPP route to deploy its 4G network and services.

Implications of next-generation wireless access for the Peruvian market

As illustrated in the previous section, the best candidates to offer wireless broadband will be 3GPP- and WiMAX-based networks. Figure 4.23 outlines the likely technology options for different types of operators in emerging markets.

Operator	LTE	HSPA	WiMAX	Comments
Existing mobile operator without 3G infrastructure			✓	It is feasible to deploy a WiMAX overlay network for existing 2G operators
Existing mobile operator without 3G infrastructure		✓		It is feasible to deploy a HSPA network, especially if 700Mhz/850Mhz band is available
Existing mobile operator without 3G infrastructure	✓			The operator would have to wait until LTE become commercially available to deploy mobile broadband strategy
Existing mobile operator with 3G infrastructure	✓	✓		Operators who already have invested in 3G technology, and where 3G spectrum is available to deliver data
New mobile operator (Fixed/Mobile broadband providers)			✓	Greenfield/regional operators to provide data services in urban areas, especially if landline penetration is low
New mobile operator (Fixed/Mobile broadband providers)		✓		Greenfield/regional operators may consider HSDPA if it is made available in the 700Mhz/850Mhz bands

Figure 4.23: Technology options for operators in developing countries [Source: Analysys Mason]

► *Existing operators*

The choice of technology will be strongly influenced by the already installed base. Thus, it is possible that Telefónica , which operates both a CDMA and a GSM/UMTS network in Peru, will choose to migrate its next-generation 4G system along the 3GPP path (LTE).

For operators with an existing UMTS network, HSPA offers a cost-effective path to provide wireless broadband, as it only requires a software upgrade of the 3G network. However, this upgrade is only applicable to areas of Peru where there is already UMTS coverage. Telefónica and América Móvil have UMTS networks in specific but limited urban locales around the country including Lima. For both operators, the primary service targeted is wireless broadband services through the implementation of HSPA technology. These deployments are in line with the geotypes in Peru as there is not yet a business case for operators to deploy wireless broadband outside large dense urban areas, where the take-up of these services is likely to be reasonable.

In areas not covered by UMTS, Telefónica and América Móvil will be faced with a difficult decision when/if the business case provides for decent returns on investment for wireless broadband services. We anticipate three distinct potential scenarios that could happen in Peru:

- MNOs expand the UMTS access network to other areas of the countries and use HSPA to provide wireless broadband services
- MNOs take a leapfrog in technology and wait until LTE becomes available to provide an overlay network over the available GSM services
- MNOs adopt a WiMAX approach and deploy a WiMAX network in areas not covered by 3G.

The decision will be based on available spectrum, cost of deployment, cost of terminal, and on maximizing the return on investment of the network already deployed.

Since América Móvil and Telefónica have already deployed a core 3GPP network, and given that the cost of deploying access sites is similar for UMTS and WiMAX (the cost of WiMAX equipment is marginally lower, but the costs of civil engineering are identical), we believe that both operators will follow the 3GPP path to 4G. This will fit with Telefónica's global strategy to follow the 3GPP path, leveraging on global volumes to benefit from cheaper costs when procuring these equipments. What is unclear is whether these operators will wait for LTE to become fully commercially available and mature to directly install an LTE network overlay over their GSM (leapfrogging HSPA deployment) infrastructure, or if they will adopt HSPA as the main technology to offer wireless broadband services in these areas, not already covered by UMTS.

However, the business case of wireless broadband often relies on the cheaper price of Ethernet backhaul services, which do not appear to be available in Peru according to operators interviewed during the course of this study. All wireless broadband network operators purchasing backhaul from Telefónica use TDM E1 leased lines, which are not sustainable in terms of pricing as the carried traffic increases. The success of wireless broadband will therefore depend on the wide availability of large-capacity Ethernet-based services for core requirements (which we discuss in more detail in Section 5.2.6 and Section 6.2.3).

Other key inputs into the choice of technology are the spectrum band and frequency duplexing requirements to deploy these technologies, as these factors dictate the number of sites that have to be built to ensure comprehensive coverage (see the following section for a discussion on spectrum requirements).

► *New entrants*

For new wireless network entrants, the decision regarding the technology to adopt is slightly different. In a greenfield situation, WiMAX is quite an attractive option as the cost of active elements for base stations is slightly lower than that of the equivalent UMTS equipment (about 15% cheaper in 2009), and the cost of the core network is significantly less as it relies on a full IP core network (no CS domain), which is significantly cheaper than a 3GPP core network. There are also a number of suppliers for WiMAX equipment; in the next few paragraphs we briefly look at the supply of WiMAX equipment worldwide today.

Currently, five operators offer WiMAX services in Peru (Americatel, EMAX, Nextel, Telefónica and Telmex). Taking a particular example, Americatel Peru deployed a pre-standard WiMAX network using Alvarion equipment.[15] This solution is designed to address fixed wireless broadband applications for both businesses and small office/home office customers. Although Alvarion

15 Alvarion, a leader provider of WiMAX equipment, provides its BreezeMAX™ product range to Americatel Peru for this deployment. BreezeMax offers a pre-standard version of 802.16d (fixed),), which means that it cannot implement all WiMAX features as defined in the official standard requiring specific CPEs to work with standardized base stations.

claims that its BreezeMax product is upgradable to 802.16e and capable of operating using both TDD and FDD duplexing, we are not aware of any successful migrations.

In terms of worldwide market share of equipment supply, one has to differentiate between fixed and mobile WiMAX. According to Infonetics, fixed WiMAX revenue share in 2008 was in the region of 27% compared with 73% for mobile WiMAX. This discrepancy is forecast to increase to 13% and 87% in favor of mobile WiMAX by 2013.

Due to the early availability of its pre-standard WiMAX implementation, today Alvarion dominates the supply of fixed WiMAX equipment (802.16d). However, Alcatel-Lucent is currently leading the market in the supply of mobile WiMAX equipment, having just pushed Motorola into second place with Alvarion and Samsung appearing in third and fourth positions respectively.

Considering total WiMAX (fixed and mobile) market shares, Alvarion is in a strong position with 20% of market share in Q4 2008, but with emerging WiMAX vendors such as Huawei and Cisco making fast progress in catching up with traditional WiMAX vendors. This trend was confirmed in our interviews with Americatel who are considering Huawei as an alternative provider to Alvarion.

A significant factor in the decision between the 802.16 and 3GPP evolution paths will be the spectrum made available to the operator. As illustrated in the next section, mobile WiMAX can be deployed at 2.3GHz, 2.5GHz or 3.5GHz. Deploying a WiMAX network in the 2.3GHz band implies that fewer sites have to be built than if deployed at 3.5GHz. If spectrum at 700MHz were made available in a scenario where coverage was the most important factor, one could argue that the reduced number of sites required may make UMTS a cheaper standard for a new entrant operator to deploy compared with WiMAX. However, a full business case would be required to confirm this fact, taking into account the different services (and associated revenues) to be delivered in the service area.

4.1.3 Spectrum requirements for wireless access technologies

Spectrum requirements for each wireless access technology are different, and the regulator has to take this into account when managing its spectrum. Figure 4.24 provides a summary of the wireless technologies suitable for providing wireless broadband, as well as an indication of the spectrum requirements.

Wireless broadband technology	*Download peak rate*	*Upload peak rate*	*Channel width*	*Frequency duplex*	*Commercial availability*
3GPP 2 (CDMA 2000)					
EV-DO (Rev 0)	2.4Mbit/s	153kbit/s	1.25MHz	FDD	Available
EV-DO (Rev A)	3.1Mbit/s	1.8Mbit/s	1.25MHz	FDD	Available
EV-DO (Rev B)	4.9Mbit/s	1.8Mbit/s	1.25MHz	FDD	Not deployed
3 GPP (GSM/UMTS)					
W-CDMA (R99)	384kbit/s	128kbit/s	5MHz	FDD	Available
HSDPA (cat 10)	14.4Mbit/s	N/A	5MHz	FDD	Available
HSUPA (cat 6)	N/A	1.4Mbit/s	5MHz	FDD	Available
LTE	>300Mbit/s	>80Mbit/s	20MHz	FDD	Not standardized
IEEE 802.16 (WiMAX)					
IEEE 802.16d	6.55Mbit/s	2.5Mbit/s	1.75MHz	FDD/TDD	Available
IEEE 802.16e	46/32Mbit/s	8/14Mbit/s	10MHz	TDD	Available
IEEE 802.16m	100/1000Mbit/s	TBD	20MHz	TDD	Not standardized

Figure 4.24: Wireless technology bandwidth and spectrum requirements [Source: Analysys Mason]

In terms of regulation, the adoption of a particular technology by operators has a significant impact on spectrum management since:

- technologies can only be deployed in discrete bands of the spectrum
- technologies dictate the duplexing and therefore how spectrum can be allocated.

In this section, we discuss the potential technology impact of both of these for OSIPTEL.

Frequency duplexing

First, the choice of technology dictates the frequency duplexing access to be used. Frequency duplexing relates to how the downlink and the uplink of a full duplex communication are separated in frequency. As illustrated in Figure 4.25, we will consider two main full-duplex access schemes:

- **Frequency division duplexing (FDD) –** uses different spectrum bands for the uplink and downlink, separating them in frequency.

- **Time division duplexing (TDD)** – separates uplink and downlink signals in time, using the same spectrum band.

TDD has a strong advantage over FDD in cases where there is asymmetry of the uplink and downlink data traffic. As the amount of uplink data increases, more communication capacity can dynamically be allocated to that, and as the demand shrinks capacity can be taken away. Likewise for the downlink traffic. In the case of FDD, high utilization in any of the separated bands cannot be compensated for by dynamically allocating more spectrum from the lower utilization band.

As illustrated in Figure 4.25, 3GPP and 3GPP2-based standards use FDD, whereas WiMAX 802.16e and 802.16m use TDD. WiMAX 802.16d was specified with both schemes, but was mostly deployed in spectrum blocks characterized as FDD allocations. This is one of the reasons why it is so difficult to upgrade a fixed WiMAX (802.16d) network into a mobile WiMAX network (802.16e).

As previously noted, the different frequency duplexing required for the different technologies has a fundamental impact on spectrum management for the regulator. Let us take the case of the 2.5GHz spectrum auction by Ofcom in the UK to illustrate this example.

The 2.5GHz band is suitable for both 3GPP LTE and IEEE 802.16e. However, one standard requires TDD and the other FDD. The Conference of Postal and Telecommunications Administrations (CEPT) has tried to standardize the use of spectrum across Europe, and recommends the following spectrum model:

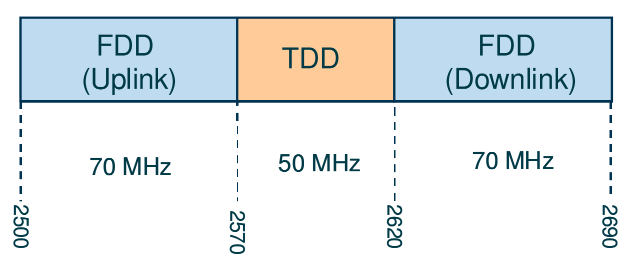


Figure 4.25: CEPT's 2.5GHz band plan [Source: CEPT]

However, in the UK, it is acknowledged that WiMAX networks would need at least 20MHz of TDD spectrum to have the necessary capacity to offer an effective service. The CEPT model would only allow two new WiMAX entrants with the full 20MHz since it only allocates 50MHz for TDD spectrum. In contrast, it would provide enough capacity for two 2×20MHZ and two 2×15MHz LTE network deployments. Ofcom believes that this model may detract from new WiMAX investment. Given that there are already a number of existing MNOs committed to LTE, it has therefore proposed an alternative band plan to spur on WiMAX deployment; a possible outcome of the Ofcom auction process is illustrated in Figure 4.26. Although this band plan does not comply with the European plan, it encourages new WiMAX operators to enter the market.

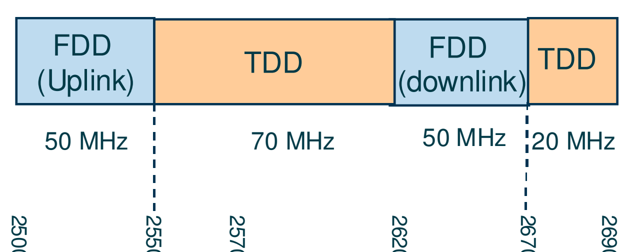


Figure 4.26: 2.5GHz band plan suggested by Ofcom [Source: Analysys Mason]

At the time of writing this report, we understand that the MTC is currently finalizing its auction of the 2.6GHz band, with the entire band allocated as TDD spectrum, and thus for the use of WiMAX. The government could consider a mix of TDD and FDD to potentially provide for LTE deployments in future. The optimal strategy will depend on the particular goals of the spectrum award process.

Spectrum band allocation

The allocation of spectrum in the 850MHz and 1900MHz bands in Peru is summarized in Figure 4.27.

Band		*Range of frequencies (MHz)*		*Company*	*Allowed area*
		Transmission	*Reception*		
850MHz	A	824 – 835	869 – 880	Telefónica	National
		845 –846.5	890 – 891.5		National
	B	835 – 845	880 – 890	América Móvil	National
		846.5 – 849	891.5 – 894		National
	B1	846.5 – 847.75	891.5 – 892.75	Free	Rural areas
	B2	847.75 – 849	892.75 – 894	Free	
1900MHz	A	1850 – 1865	1930 – 1945	América Móvil	National
	D	1865 – 1870	1945 – 1950	Nextel del Perú	National
	B	1870 – 1882.5	1950 – 1962.5	Telefónica	National
	E	1882.5 – 1895	1962.5 – 1975	Nextel del Perú	National
	F	1895 – 1897.5	1975 – 1977.5	Free	N/A
	C	1897.5 – 1910	1977.5 – 1990	Currently in bidding process with América Móvil	National

Figure 4.27: Spectrum allocation in Peru [Source: OSIPTEL]

Operator	*850MHz band*	*1900MHz band*	*Allowed area*
Telefónica	2×12.5MHz in band A	2×12.5MHz in band B	National
América Móvil	2×12.5MHz in band B	2×15MHz in band A	National
Nextel	None	2×17.5MHz in bands D and E	National
In bidding process	None	2×12.5MHz in band C	N/A
Free	2×2.5MHz in band B	2×2.5MHz in band F	N/A

Figure 4.28: Spectrum holdings in cellular bands in Peru [Source: OSIPTEL]

In Peru, networks in the GSM850MHz and 1900MHz bands have been deployed by Telefónica and América Móvil. As illustrated in Figure 4.27, GSM850MHz uses 824–849MHz for the uplink and 869–894MHz for the downlink, while GSM1900MHz uses 1850–1910MHz for the uplink and 1930–1990MHz for the downlink.

We understand that both Telefónica and América Móvil have also deployed a UMTS access network in limited parts of Peru. While UMTS 2100 (1885–2025MHz for the uplink and 2110–2200MHz for the downlink) is the frequency band originally defined by the 3GPP standard and represents the vast majority of deployments, in some countries UMTS operators have started to use the 850MHz and/or 1900MHz bands, notably in the USA by AT&T Mobility, and in Australia by Telstra. We understand that Telefónica and América Móvil have used some of their 850MHz spectrum to deploy their UMTS networks in Peru.

Considering that generally capex and opex are broadly proportional to the number of sites in the access network, deploying UMTS at 850MHz has a significant impact on an operator's business case. We estimate that between 40–50% fewer base stations are required at 850MHz compared with a similar deployment at 2100MHz. However, parts of the 850MHz spectrum are already in use by the GSM system and the amount of spectrum that can be used or re-farmed for UMTS deployment is unclear.

HSPA can share the same 5MHz carrier as the voice and R99 data streams, but this is quite limited in terms of throughput it can offer (limited to a peak of 3.6Mbit/s.). If the voice demand is such that it occupies a significant proportion of the 5MHz and more bandwidth is required for wireless broadband, a second independent 5MHz carrier needs to be deployed. Currently, we do not have full visibility on how each MNO in Peru uses its 2×12.5MHz spectrum in the 850MHz band (how spectrum is allocated between GSM, UMTS R99 and HSDPA traffic) and it is therefore difficult to know what scenario is being implemented. However, if there is enough spectrum for these operators to deploy HSDPA in the 850MHz band, it would provide a cost-efficient way to extend the coverage of wireless broadband in Peru.

In terms of LTE, the main band currently being considered for standardized deployment is the 2.5GHz band. It is still premature to anticipate what band it will be standardized in since LTE has not yet been ratified yet by 3GPP. It is also worth noting that LTE will offer increased spectrum flexibility compared with UMTS, with spectrum slices as small as 1.5MHz (and as large as 20MHz) supported. We anticipate that operators will require at least 2x15MHz of spectrum in Peru to deploy the highest-speed NGA services, but again a more detailed study would be required to support this.

From our experience, mobile WiMAX (802.16e) networks require a minimum of 20MHz of TDD spectrum, and between 30MHz to 40MHz of TDD spectrum should be sufficient to operate a full WiMAX network in Peru. As discussed earlier, although WiMAX can be deployed on any frequency below 66GHz, it is only deployed in discrete spectrum bands in practice. The deployment bands are mainly driven by the terminal equipment certification programs from the WiMAX Forum, in an effort to increase volumes and reduce costs. Currently, terminals for three bands are certified: 2.3GHz, 2.5GHz and 3.5GHz. It is important to note that unlike UMTS, WiMAX terminals are not currently certified by the WiMAX forum in bands lower than 2.3GHz, making deployments in these bands 'experimental' deployments with proprietary CPEs.

The frequency at which any wireless technology is deployed has a significant impact on the number of sites to be built for coverage. In Peru, we understand that Americatel, Emax, Nextel, Telefónica and Telmex are all currently operating WiMAX networks based on 802.16d (fixed) in the 3.5GHz spectrum band, mainly in Lima. Fixed WiMAX(802.16d) is likely to have been deployed using FDD, while mobile WiMAX(802.16e) requires TDD spectrum. Thus, fixed and mobile WiMAX are not compatible and a CPE refresh would therefore be required for customers migrating networks. Mobile WiMAX also requires additional equipment compared to fixed WiMAX in the core network to handle mobility. However, if there were a business case to upgrade to mobile WiMAX, existing sites could be leveraged and the replacement cost would be in the region of USD20 000 per site.

Finally, it is worth discussing the use of WiMAX for backhaul applications in relation to frequency bands. As a native point-to-multipoint technology, one of the applications of WiMAX is the backhaul of wireless network traffic. A common backhaul use of WiMAX is with Wi-Fi hotspots, as a single WiMAX system can be used to backhaul several Wi-Fi hotspots. In our view, the 2.3GHz, 2.5GHz and 3.5GHz bands are too valuable to be used as spectrum for providing backhaul, and should be used to provide connectivity to end users. A more appropriate frequency band for backhaul deployments is 5.8GHz, which is unlicensed in many parts of the world. Fixed WiMAX devices (802.16d) have been certified in the 5.8GHz band, making fixed WiMAX perfectly suitable to be used as a backhaul technology. The maximum radius that can be achieved by a WiMAX system in the 5.8GHz band is around 15–20km in rural areas.[16]

4.1.4 Next-generation niche access

Having discussed the main access technologies, we now turn to three other access technologies that have been investigated in various countries as a means of providing broadband access to consumers, but which are not considered established alternatives.

Wi-Fi

Wi-Fi is a wireless local area network (WLAN) technology that has found its way into access networks in many places, particularly because it is low cost and there is widespread availability of terminal equipment. The industrial, scientific and medical (ISM) radio spectrum where WLANs typically operate (typically at 2.4GHz and 5.8GHz) is also license-exempt in many countries, implying low barriers to entry for many operators. WLAN terminals can be bought for use in homes and private enterprises, to extend broadband coverage and make it wireless, and also can be installed in public locations to create what is known as a public hotspot.

Public hotspots can be provided for free by enterprises for the convenience of their customers (such as at airport lounges) or can be metered as a means of generating revenue. Furthermore, hotspot access can be sold by the enterprise itself, or companies can create networks of hotspots that customers can access with daily or monthly subscriptions.

To create public hotspots, operators typically use some kind of leased line or ADSL backhaul; self-backhaul can also be used within a WLAN mesh network, often in a different license-exempt frequency band (commonly 5.8GHz). Externally mounted directional antennas can be used to provide range and reception improvements.

[16] This is obviously highly dependent on the type of CPE used.

One problem with Wi-Fi is that penetration into buildings from outdoor antennas can be limited depending on the nature of the building construction materials. Thus, indoor coverage can be unreliable as is sometimes the case with more conventional wireless services that employ spectrum at or above 2GHz.

► *Enabling standards for Wi-Fi access networks*

Wi-Fi is underpinned by the family of WLAN standards that have been developed by the working groups of the IEEE 802. Specifically the revisions " a", "b" , "g" and "n" which define the physical (layer 1) and data link layer (layer 2 services). Work continues by the IEEE to produce specifications for WLAN systems that could operate at Gigabit speed, although these are some years away from fruition.

Much of the improvement in Wi-Fi speeds has come from the adoption of MIMO radio antenna technology that improves the efficiency of the air interface. Channel bonding also allows for better use of the license-exempt spectrum in the ISM bands. As a result, the raw maximum speed has increased from 11Mbits/s to around 100Mbit/s. In practice, however, the typical service speeds that users experience can be considerably lower, and other issues such as frequency interference from other appliances that degrade the experience continue to have an impact.

This means that shared Wi-Fi is best suited to non-QoS critical applications – it is largely impractical to deliver a broadcast quality IPTV service over shared Wi-Fi access using the current standards (802.11b/g/n). However, Internet-based 'over-the-top' video services continue to be easily accessible over such a broadband access service.

We note that some work has already been done by various organizations on improving IPTV delivery over Wi-Fi networks.[17] However, to date none of these are standards-based, and commercial deployments (if any) are still at an early stage. The primary use for these technologies would be to extend the reach of wireline IPTV solutions as wireless TV deployments will center around more established wireless standards.

Wi-Fi access architectures based on various methodologies (some defined in the IEEE 802.11 specification) are becoming more commonplace. One example is a mesh-architecture, which allows a network to self-configure among multiple nodes in the network. In a mesh environment, Wi-Fi hotspots can communicate between each other providing a pool of flexible resources in the areas covered by Wi-Fi. The main advantages of using a Wi-Fi mesh architecture are:

- reduction in the backhaul requirements
- consolidation of traffic through packet statistical multiplexing
- resilience
- ad-hoc capability with auto-discovery of new nodes.

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17 For example, Rotani AirReferee and VideoPuck technology (introduced in February 2006) claim to offer end-to-end solutions for wireless IPTV delivery that adds on to existing home networks. Other companies working on IPTV over Wi-Fi networks include Celeno and Ruckus wireless Inc.

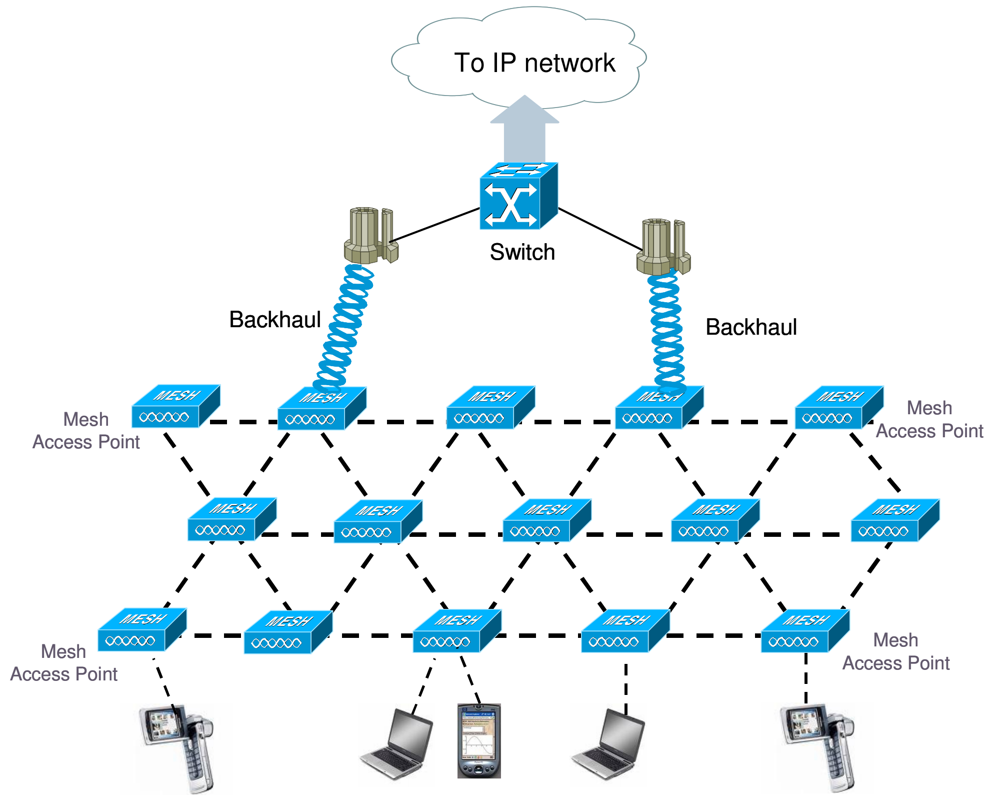


Figure 4.29: Wi-Fi mesh network [Source: Analysys Mason]

A key advantage of using a Wi-Fi mesh architecture is the significant reduction in the amount of backhaul links required. Since meshed Wi-Fi nodes can establish a communication network between themselves, a single backhaul link would be sufficient (provided it is dimensioned correctly) for the meshed Wi-Fi cluster. However, in practice, a minimum of two distinct backhaul links is usually implemented for resilience purposes.

Since the nodes handling the backhaul link aggregate the traffic from all Wi-Fi nodes, packet multiplexing gain is achieved, decreasing the capacity required on the backhaul link itself.

In terms of resilience, mesh Wi-Fi networks are very fault tolerant and if a single node fails in the mesh network, traffic is automatically re-routed through the working nodes.

Finally, the automatic discovery characteristics of meshed Wi-Fi networks enables new Wi-Fi nodes to be added to the network without the need for configuration, making an easily scalable infrastructure.

► *Outlook for Wi-Fi access networks*

Products built on the Wi-Fi family of standards will continue to flourish principally for LAN access in enterprises and the home. WLAN access networks have been shown to be attractive to competitive service providers that often launch services before traditional carriers roll out more conventional broadband access services due to the low barriers of entry noted above. However, the business model for successful services is highly dependent on volume take-up by subscribers, which paradoxically has sometimes been the downfall of such deployments; successful WLAN access services can pin-point pockets of user demand which the larger telecommunications operators can meet with better and more scalable services based on more established access standards.

Nonetheless, Wi-Fi can be an attractive means to provide access at Internet cafes and other public locations, taking advantage of the increasing variety of devices that provide for Wi-Fi access, including mobile devices, iPods, and netbooks (converged devices are discussed below in Section 4.3).

► *Implications of Wi-Fi access networks for the Peruvian market*

With its low cost and relative ease of installation, Wi-Fi still offers much to service providers. In Peru, it is likely to be used in a limited fashion most probably by small-scale operators and entrepreneurs as hot-spot providers seeking opportunities to enter the market in local deployments. When broadband services over licensed wireless access networks become available, they are likely to overhaul many such small-scale Wi-Fi deployments.

Broadband over power-line

Broadband over powerline (BPL) allows the delivery of broadband access over low and medium voltage (LV and MV) powerline cabling to the premise. Figure 4.30 below shows the basic architecture for the LV network solution.

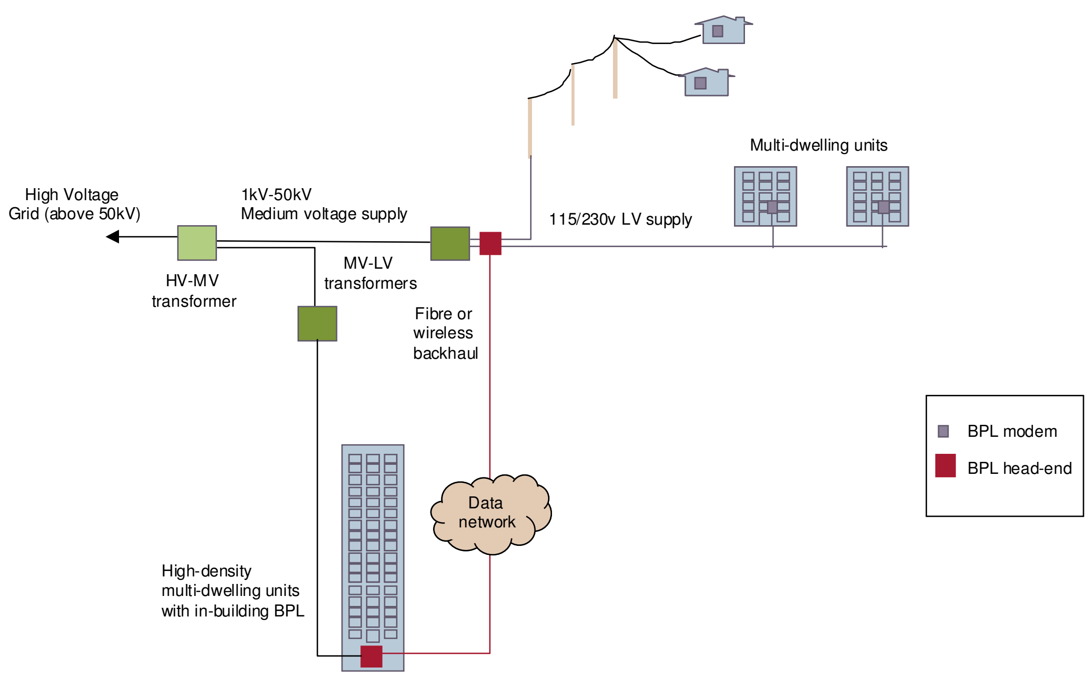


Figure 4.30: LV powerline access [Source: Analysys Mason]

The head-end, typically located at a step-down transformer, injects a modulated set of carriers that convey the broadband access service to the premises where a BPL modem connects the user equipment. The typical operational range between head-end and customer premises is typically limited to a few hundred meters owing to power losses and the need to control unwanted radio-frequency radiation from the cabling system. The limited range means that BPL needs to typically be employed in a nodal FTTC solution, although point-to-point wireless backhaul can be used. The system architecture and capacity means that all connected premises on one power segment share the same available bandwidth – much as cable networks do.

The deployment of in-building BPL using an FTTB or WiMAX access architecture saw some success in various early trials; for example, FTTB plus powerline was adopted by Electro-com (an operator carrying out trials in several Russian cities) in 2005. However, reports in 2008 indicated that the company had shut down the attempts to use BPL for in-building deployment, preferring Ethernet instead going forward.

Most BPL trials have averaged speeds that rival DSL and cable modems that can provide around 3Mbit/s. There have recently been advancements that will allow up to 100Mbit/s transmission on BPL networks, which will equate to between 10 to 30Mbit/s available to the end user.

Relatively few premises can be served compared with other access technologies, and the costs are high. There have been few commercial deployments worldwide that have lasted much beyond initial rollouts. Application support is also relatively limited – BPL is reasonable for basic data connectivity but is less well developed when it comes to practical QoS support for real-time services particularly on public utility cabling where the characteristics of the network vary greatly from location to location.

► *Enabling standards for BPL networks*

For many years the BPL supply industry suffered market fragmentation by having several proprietary solutions from a number of small-sized vendors. In recent years, a working group of IEEE has worked to produce an agreed baseline standard for BPL systems. Such a standard was finally passed at the end of 2008, although it has to be seen as a compromise because it includes three different technology options. As a result, although vendors can now start to work with a more stable situation, there will be fragmentation on the supply-side, meaning that equipment prices will remain high compared with alterative solutions such as WiMAX.

► *Outlook for BPL networks*

BPL systems have proved stubbornly difficult in virtually all markets for utilities to successfully exploit. On top of high system costs, it is also an access network technology that requires a deployment strategy based on relatively deep-fiber or otherwise an extensive wireless overlay for backhaul. Rollout in low-density populations works against it because fiber or other backhaul must be delivered almost to the curb.

To deliver and maintain such a service a relatively expensive mix of telecommunications and power skills are required because of the occupancy of one service on another and high attendant costs, meaning that it is loaded with both high capex and high opex.

BPL industry experts have stated that installing repeaters, which carry and amplify data signals along the medium voltage power lines, could cost between USD1000 to USD5000 per unit. The average cost per home passed in 2004 in some trials ranged from USD100 to 200 dollars[18], however, we were unable to find more recent public information given the paucity of commercial deployment in existence today. Given the overall economics, it is a solution that scales badly relative to other access networks. BPL is largely bettered by most wireless options in most situations.

► *Implications of BPL networks for the Peruvian market*

BPL requires a managed power distribution grid that reaches a substantial proportion of the population. It cannot be assumed that such local power distribution grids exist in many localities in Peru; locally generated power is likely to prevail in certain areas and the resulting incomplete power infrastructure would leave a swathe of premises unable to be served. The in-building solution seen in some other markets might offer some promise for high densities of users in multiple dwelling units (MDUs). We look at the competitive situation of BPL in more detail in Section 5.2.4 of this report.

High-altitude platforms

A high-altitude platform (HAP) is a stationary airship or similar device positioned at a fixed altitude of about 7km providing wireless coverage over a wide area in preference to using tower infrastructure for line-of-sight propagation. Research funding has been provided in recent years to several companies in Europe and the USA, but it remains in the very early stages as no services have yet come close to commercial deployment.

► *Enabling standards for HAP networks*

None specifically – it is an infrastructure alternative for wireless access networks.

► *Outlook for HAP networks*

There are many practical difficulties and conventional tower-based wireless services present a far better solution. In terms of deployment status, cost, standards and lack of deployment in large numbers, the probable outlook is very poor.

The major commercial entity promoting HAP access technology is a company called Sanswire, formed in 1995 as a 802.11 hot-spot provider, wirelessly enabling hotels, apartments and condominiums and making wireless Internet service available to customers in many locations. In

[18] According to an article published in *Electric Utility Week,* April 2004.

2002, Sanswire entered into a series of agreements with different companies to construct a national wireless network via stratosphere-bound airships that would allow Sanswire to provide high-speed wireless Internet access to the USA, Canada, and Mexico. In recent years though, Sanswire has changed its product and service line to align more with the defense sector.

Sanswire now develops and provides an integrated suite of aerospace communications products and services, leveraging its relationships with leaders in unmanned aerial vehicle (UAV) technologies. The company is focused on the design and construction of various aerial vehicles, capable of carrying payloads that provide persistent surveillance and security solutions at various altitudes.

The capabilities page of Sanswire's website includes sections on disaster aid, government and commercial services: the disaster aid and government sections deal with immediate needs of communications and goods at specific times; the commercial section talks about transporting goods to disaster areas via parachute and emergency installation of a telecommunications system.

The newest trial schedule was released in March 2009 and announced the start of the 2009 UAV program, which will begin with the production of the STS-111, which is a 34-meter long, autonomously controlled, rapidly deployed, non-rigid, mid-altitude airship. It appears as though this trial was validated by the Army Science Board and that its new business model is heavily reliant on winning future defense contracts. At this time though, the first prototype has not yet been built.

► *Implications of HAP networks for the Peruvian market*

Although there might be some interest in the ability to reach some hard to reach, the general lack of interest in HAP networks around the world means that they are unlikely to present any particular opportunity in the Peruvian broadband access market as they will likely be very expensive systems if they eventually come to commercial deployments.

4.1.5 Next-generation core networks

The next step is to understand the implications of convergence in the evolution of core networks. Core networks are defined by three main functions:

- providing connectivity between the different access network islands that are geographically dispersed in a national network
- providing core capabilities such as authentication, switching and routing

providing interconnection with other networks.

Traditionally, core networks were based on TDM/ATM infrastructure. However, this is changing rapidly as IP has become the protocol of choice today for both wireline and wireless access networks. For example, 3GPP R4 provides the option of using IP in the core, not only for the PS domain, but also for the CS (voice network) domain (see Figure 4.13). WiMAX networks are based on an IP core network.

In wireline access, many incumbents providing voice services have already started migrating their legacy core TDM-based networks (PSTN) to IP-based networks, where voice is now transported in packets. Also, ISPs are starting to migrate their ATM core networks to IP core networks as DSLAMs now have a native IP interface (used to be based on ATM).

IP-based core networks are commonly referred to as NGNs. The concept of NGN enables communication providers to use the same IP core network to provide connectivity to all of their access networks (wireline and wireless), providing significant cost savings. In this context, NGN is closely associated with the convergence of networks as it mainly consists in consolidating all networks that have been deployed to deliver different services into **a single network based on IP**. This is illustrated in Figure 4.31.

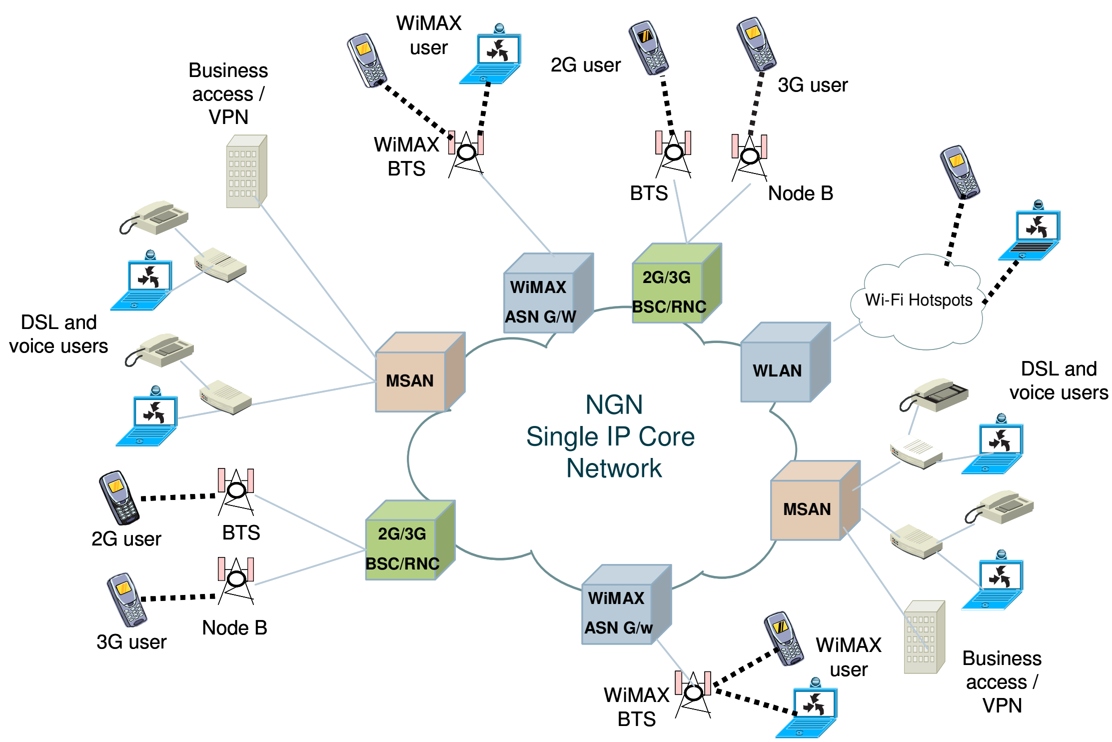


Figure 4.31: Illustrative next-generation core network [Source: Analysys Mason]

We illustrate the concept of NGN by considering the case study of BT's NGN network (21CN network) in the UK. Traditional telecommunications networks were deployed in silos, where specific networks were deployed for specific applications and services in isolation of each other. Figure 4.32 shows BT's legacy network, which in the core is divided up into a number of different physical networks for PSTN, leased lines, and various data services including ATM.

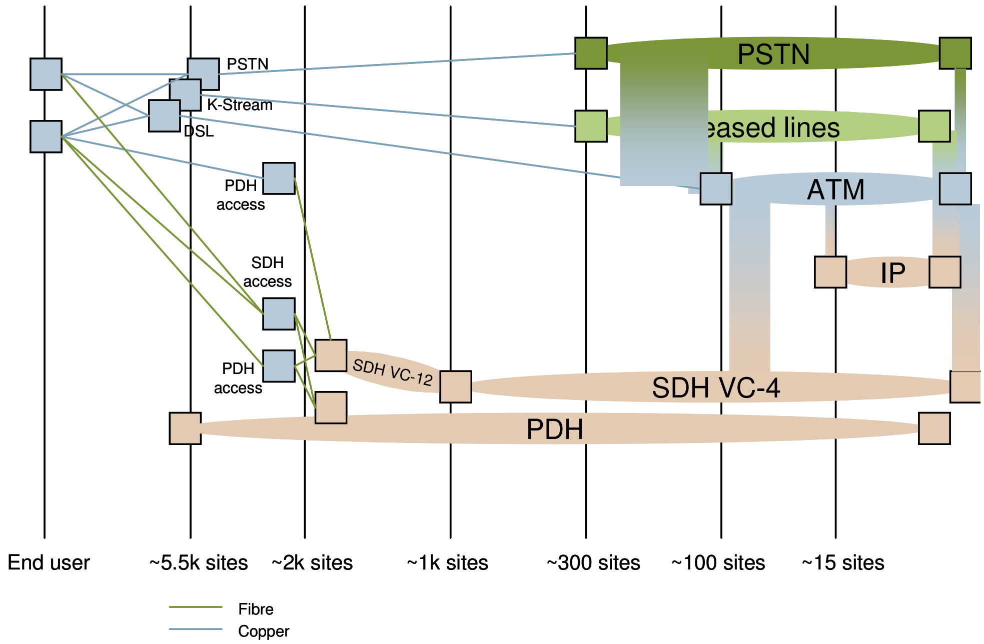


Figure 4.32: BT's legacy network [Source: BT]

As illustrated in Figure 4.33 below, the concept of NGN removes these inefficiencies and provides the operator with a single core network to deliver all of its voice and data services.

A key attribute of NGNs is that traditional circuit switches are replaced by IP-based softswitches. The latter are designed to be extremely modular, and will soon be able to address both wireless and wireline network requirements in the same rack, where plug-in cards will represent different network components (call server, media gateway, switch, international gateway, etc.) of the network. Collapsing the switching functionality of different networks into a single rack significantly contributes to the convergence of networks.

The main advantage of a softswitch-based architecture is the distribution of different functionalities such as the physical connection, control of the sessions and switching across the network. This is in marked contrast to traditional TDM switches, which integrate all of these functionalities in the same equipment.

One of the major benefits of NGN is associated with the significant capex and opex savings to the operator. The sources of cost savings are:

- **Consolidation of the different networks to maintain into a single network** – Often, depending on the technology, different skills are required for field staff (expert in TDM transmission, expert in ATM switching, expert in PSTN and expert in IP networking). The collapse of all these independent networks into a single IP network means that less specialized skills are required.

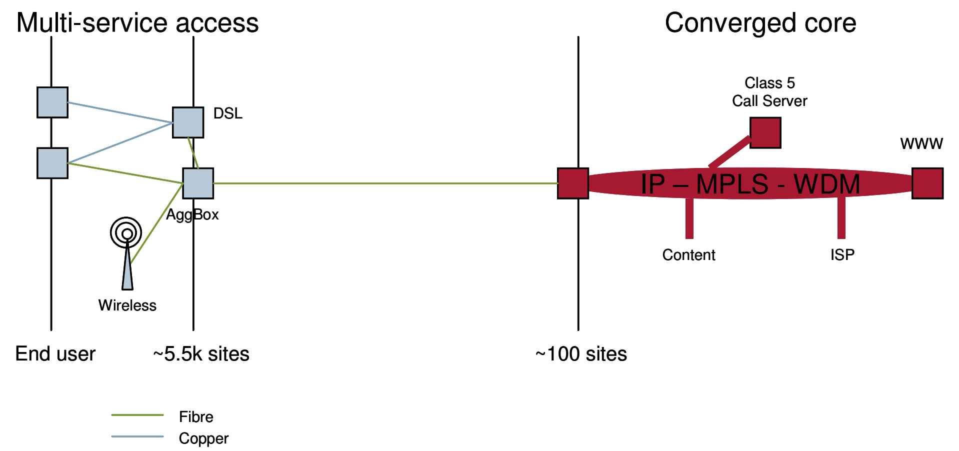


Figure 4.33: BT's NGN [Source: BT]

- **Reduction in the number of network elements to maintain** – The second source of cost savings is associated with the reduction in the number of network elements. For example, dedicated ATM switches were required in legacy networks to provide ATM switching functionality and dedicated SDH/Sonet add-drop multiplexers were required to provide leased-line services. This is no longer the case with new network architectures. This reduction is significant because the contract between the operator and the network operator for level 3 maintenance is a function of the number of network elements.

- **Reduction in the overall number of sites** – As shown in Figure 4.32, some sites were dedicated to a particular network. The reduction of sites for BT is clearly shown, when comparing Figure 4.32 and Figure 4.33. With the advent of softswitches, less switching sites and therefore less exchanges are required. Using another example, in the Netherlands, the sale of redundant exchanges raised an estimated EUR 1.5 billion, which was used to fund the Next Generation Access FTTx deployment.[19]

- **IP network elements such as routers are cheaper than their TDM and ATM counterparts –** Finally, the last source of savings is associated with the cost of purchasing IP equipment compared to legacy TDM/ATM equipment. For example, a study performed by the Ethernet Forum shows that the cost of TDM equipment per Mbit can be as much as double the price of Ethernet/IP equipments.[20] This gap is likely to grow with the increasing adoption of IP as the protocol of choice for both wireless and wireline, realizing economies of scale for equipment vendors.

A key service impacted by this NGN transformation is the traditional telephone service – i.e. the PSTN. In an NGN world, voice that used to be carried over a TDM-based infrastructure is carried over a PS infrastructure along with all other traffic.

[19] www.KPN.com.

[20] Ethernet Services Business Case, A Win-Win Scenario for the Service Provider and the Enterprise, Metro Ethernet Forum, 2005.

Although this provides savings in deploying and operating the network, and the ability to provide new revenues, there are some challenges in migrating voice to this network. By definition, a PS network does not offer permanent circuits with dedicated capacity (unlike the PSTN), but instead provides for a shared transmission network where packets from different services may contend for available resources. In the context of voice, and more generally real-time service, it is crucial that the protocol implemented in the core network is able to differentiate between services, support legacy protocols, and offer a fast switching mechanism to limit end-to-end delay and jitter.

MPLS offers all the above characteristics and has been selected by the vast majority of wireline operators intending to implement an NGN core network. Other contenders such as Provider Backbone Bridge – Traffic Engineering[21] (PBB-TE), which is Ethernet based, have also been considered for this purpose but never been implemented in real networks.

NGN convergence can be taken further by allowing users to roam between different access networks. This is achieved by using the IP Multimedia System (IMS) service delivery platform, which is described in detail in Section 4.4.

Enabling standards for next-generation core networks

As previously mentioned, the key technology used by the vast majority of operators to implement their NGNs is MPLS as it can:

- differentiate between different services, prioritizing real time traffic streams over less time-sensitive streams (as elaborated in IETF RFC 3270, RFC 3564, RFC 4124)
- support legacy services and protocols through the use of PWE3 (IETF RFC 3916, RFC 3985)
- provide fast switching of packets to reduce end to end delay and jitter of time-sensitive traffic streams
- offer some traffic engineering capability to guarantee a minimum bandwidth for real-time services (IETF RFC 2702)
- offer a fast re-route scheme in the case of network failure (IETF RFC 3469).

Note that the implementation of **classes of service** in MPLS is key for multi-service NGN networks as it enables time-sensitive traffic, like voice, to be prioritized over less time-sensitive traffic, such as Internet browsing, so that latency sensitive applications are not impacted by congestion in the core network.

NGN migration requires communications services that can emulate the essential properties of traditional communications links over the MPLS network, as shown in the BT legacy network (Figure 4.32). To do this, NGN networks rely upon what is known as pseudo-wire technology, which is an integral component of these network convergence architectures. PWE3 specifies the encapsulation, transport, control, management, interworking and security of services emulated

[21] Provider Backbone Bridge Traffic Engineering (PBB-TE) is based on Nortel's PBT and is now a draft standard, IEEE 802.1Qay.

over IETF-specified PS Networks (including MPLS networks). Legacy services supported by PWE3 include ATM, Frame Relay, Ethernet, low-rate TDM and Sonet/SDH. In addition, MPLS has been used by a significant number of wireline operators to implement MPLS VPNs, which is a key service connecting different branches of an organization that is geographically distributed to form a virtual network.

Another important standard in NGN is the ITU-T Y.1541 which specifies network performance objectives (or key performance indicators) for IP-based services. The ITU-T Y.1541 defines five classes of service for different types of traffic. For each class of service, the standard defines an upper bound packet transfer delay (TD), packet delay variation (DV), packet loss ratio and packet error rate. This standard has strong implications when designing the next-generation core network as it has to be designed and dimensioned to meet these objectives, for each class of service defined in the network.

The classes of service are defined in Figure 4.34 and the network performance objectives are defined in Figure 4.35.

QoS Class	*Applications (examples)*
0	Real-time, jitter sensitive, high interaction (VoIP, VTC)
1	Real-time, jitter sensitive, interactive (VoIP, VTC)
2	Transaction data, highly interactive (Signaling)
3	Transaction data, interactive
4	Low loss only (short transaction, bulk data, video streaming)
5	Traditional applications of default IP networks

Figure 4.34: IP QoS class definition [Source: ITU-T, Y.1541]

Network performance parameter	*Nature of network performance objective*	*QoS classes*					
		Class 0	*Class 1*	*Class 2*	*Class 3*	*Class 4*	*Class 5 unspecified*
Transfer delay	Upper bound on the TD	100 ms	400 ms	100 ms	400 ms	1 s	U
Delay variation	Upper bound on the 1-10-3 quartile of IPTD minus the minimum IPTD	50 ms	50 ms	U	U	U	U
Loss rate	Upper bound on the packet loss probability	$1x10^{-3}$	$1x10^{-3}$	$1x10^{-3}$	$1x10^{-3}$	$11x10^{-3}$	U
Error rate	Upper bound	$1x10^{-4}$	$1x10^{-4}$	$1x10^{-4}$	$1x10^{-4}$	$1x10^{-4}$	U

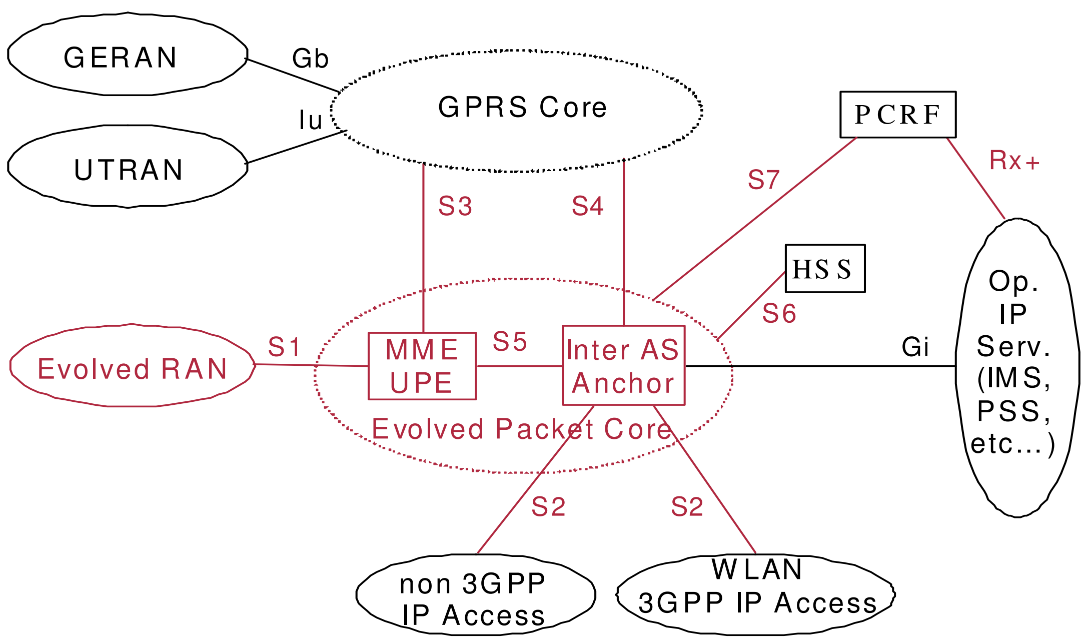
Figure 4.35: IP Network QoS class definitions and network performance objectives [Source: ITU-T Y.1541]

The tables above illustrate the four main dimensions along which QoS class of service is defined:

- time sensitivity (real time versus non-real time)
- jitter sensitivity
- service interactivity
- packet loss sensitivity.

For highly interactive services such as VoIP and signaling applications, the packet transfer delay is key, as it determines how interactive sessions can be. This explain the low upper bound on the TD for these class of services (Class 0).

The current packet switched networks of wireless operators today may not support voice VoIP services, which is why voice is still transported in a different domain (i.e. circuit switched domain). However, to achieve performance targets similar to those set out by the next generation network ITU-T Y.1541 standard, a new packet switched network is required for 3GPP mobile networks. In this context, 3GPP is in the process of specifying an evolution of the packet switched network that will be able to accommodate highly interactive and jitter sensitive traffic such as native VoIP in release 8 of the standards. The System Architecture Evolution (SAE)'s objective is to "*develop a framework for an evolution or migration of the 3GPP system to higher data rate, lower latency, packet optimized system that supports multiple Radio Access Technologies*." The 3GPP standardization body adds: "*The focus of this work is on the PS domain with the assumption that voice services are supported in this domain*".



MME – Mobility Management Entity; UPE – User Plane Entity; AS – Access System; HSS – Home Subscriber Server; PCRF – Policy Charging Rule Function

Figure 4.36: System architecture evolution [Source: 3GPP]

The figure above illustrates that the overlay evolved packet core (EPC) is central to the SAE architecture, and it will support tighter performance objectives than current mobile packet switched networks. However, we do not anticipate EPC to be implemented by any operators before 2011-2012. It is still unclear as to what the performance objectives will be as Release 8 has not been finalized at the time of this report.

Form an end-user perspective, network and service performance is not measured in the parameters discussed above, but is instead primarily related to the quality of experience of the end-user. Taking the example of broadband services, the user will expect a minimum throughput associated with its service. However, often, the bandwidth advertised by the ISP is very different from the delivered bandwidth to the end user, resulting in a negative perception of the service by the user. In this context, a number of regulators/ governments throughout the world have started to investigate how advertised bandwidth of broadband services could be measured/monitored at the end user premise to ensure that the service provided is in line with the expectation of the customer. However, this is still at the consultation stage in many countries and will not be implemented for some time.

Implications of next-generation core networks for the Peruvian market

NGNs are being widely implemented worldwide due to the cost savings resulting from the technology. Migrating to an NGN infrastructure requires a number of steps to be taken by the incumbent. The most important factor when planning this migration is to ensure that legacy services (for example voice POTS) remain unaffected, and this has been successfully achieved by a number of operators throughout the world. Core NGNs are independent of the access network and therefore can be implemented while retaining existing physical access infrastructure, i.e. existing copper network. However, active equipment may need to be replaced to provide inter-operability with the IP-based network. In this context, when deploying an NGN, legacy voice concentrators need to be replaced by an MSAN.[22] In our experience, the cost associated with such equipment is between USD30 and USD50 per wireline subscriber. This cost includes PSTN and DSL service components. It is important to note that in such a migration, the user's equipment remains the same.

Wireless networks based on the 3GPP and 3GPP2 standards can be considered more mature than their wireline counterparts when it comes to NGN core equipment. Many operators already use IP in the core to provide connectivity to both the CS and PS domain. As discussed previously, R4 of the 3GPP implements a next-generation core network by replacing the legacy MSC with two distinct components: an MGW and an MSC-server. The MSC-server is implemented by network vendors as a soft switch, entirely controlled by IP. 3GPP R4 has been commercially available for four years and the majority of MNOs have already migrated to this NGN core architecture.

[22] A multi-service access node is a platform capable of simultaneously supporting a multitude of widely deployed access technologies and services (both existing and anticipated) and providing a gateway to an NGN core network.

In the case of Peru, we understand that in 2003 Telefónica deployed an MPLS network based on Siemens and Juniper equipment to provide virtual private network (VPN) services to corporate and enterprise companies. Telefónica could leverage its MPLS network and use it as a connectivity platform for its next-generation core network. While the migration to NGN would provide significant long-term cost savings, as explained in this section, Telefónica would have to invest in upgrading its exchanges with MSAN equipment. An alternative approach would be to provide voice over broadband directly (VoIP), but we are not aware of any major deployment of this architecture. However, Telefónica indicated during our visit that it does not have any plans to carry out a full upgrade of its PSTN network to NGN. Instead, Telefónica has adopted a case-by-case approach, whereby when an exchange site fails, it considers implementing NGN in it. Telefónica also indicated that it offers NGN services for businesses such as IP Centrex in limited areas.

Finally, in the context of converged networks, Telefónica could also use the same IP/MPLS network to provide connectivity with its GSM/UMTS core network elements, as illustrated in Figure 4.13. Telefónica has implemented a 3GPP R4 architecture, however, it is still using SDH for its transmission requirements (instead of IP/MPLS) and is not planning to migrate to IP anytime soon.

Finally, when considering both wireline and wireless networks, there would be many incentives to leverage core networks to reduce costs. However, according to our interviews with Telefónica representatives in the course of this study, the wireline and wireless businesses of Telefónica do not currently appear to have any synergies and operate distinct networks. Leveraging on these synergies would provide significant savings for Telefónica , and consequently potentially reduce the price of services provided to customers.

4.1.6 Next-generation broadcasting

Broadcast analogue TV in Peru has been delivered using the NTSC standard as originally developed for the North American markets. The MTC has selected ISDB-T (discussed in more detail below) as the new national TV standard, with the first services expected to be introduced during 2010 in areas of Lima.

Mobile TV has been introduced on a range of platforms around the world in recent years, but as is the case with fixed TV, no single standard exists nor is it likely to do so in the near future. Trial services based on digital video broadcasting – handheld (DVB-H) have been running in parts of Peru since 2008.

In more advanced markets convergent wireless services have typically been based on dual-mode handsets using, for example, mobile TV for broadcast video content, but also using 3G/3.5G for on-demand and other enhanced services – typically short clips.

It is also possible to support one-way (push) data and two-way interactive data to augment broadcast services. One-way telematic machine-to-machine (M2M) type services are also possible using such broadcast services.

Enabling standards for next-generation broadcasting systems

► *Fixed services*

Digital terrestrial television (DTT) has been adopted in many global markets over the last 5–10 years using regional standards. In Europe, a consortium of broadcasters, consumer electronics manufacturer overseen by regulators and the European Commission developed the DVB-T standard. Today, it has been successfully deployed in over 100 countries including most of Europe, parts of Asia, parts of the Middle East and Southern Africa. The first services used MPEG2 transport stream for video, but the growth of high-definition services and the growing number of high definition-capable TV receivers means that MPEG4/AVC has also been adopted to achieve a more efficient use of spectrum.

In North America and South Korea the Advanced Television Systems Committee (ATSC) standard is used to deliver both standard definition and high-definition digital television (SDTV and HDTV). There are also experimental services in parts of Central and South America. An additional mobile option ATSC/M-H has been added to the standard and will see gradual adoption in the next few years.

Integrated services digital broadcasting (ISDB-T) has been developed for the Japanese market where consumer retail services were launched in December 2006. Brazil has also adopted the ISDB-T standard. It can deliver TV to fixed locations as well as mobile devices, and supports both SDTV and HDTV services.

► *Mobile services*

DVB-H is a variant standard adapted for mobile TV within the family of the DVB standards developed originally for the European market.

T-DMB has been developed from the original digital audio broadcasting (DAB) standard. It is now both an ETSI and ITU standard. Commercial services employ T-DMB in South Korea where it has proved relatively popular. Other countries also have trial services of mobile TV using T-DMB. DMB is backwards compatible with DAB for audio broadcasts and can also support datacasting (one-way file downloads). Other proprietary standards include MediaFLO developed by Qualcomm.

The mobile version of ISDB-T known as 'One-Seg' has seen a good uptake in the Japanese market in the three years since its launch in April 2006. It delivers broadcast video as MPEG-4 in 320×240 pixel format using a bit rate of about 400kbit/s. The Japanese market is supported by TV-ready mobile telephone handsets, USB TV tuners for PCs and other tuner adapters for the Apple iPhone, Sony PSP, Nintendo DS, as well as other handheld devices from a variety of manufacturers. Overall, sales of such devices run into many millions – with Sharp having shipped over ten million devices alone in the three years since launch. The basic TV service is free to air (FTA), with typical viewing sessions being around the 30-minute mark. If the model is to translate successfully to other markets, then the requirements would appear to be:

- good-quality content, probably free at the point of consumption
- a broad range of easy-to-use, low-cost terminals and adapters – tailored to the appropriate markets (styling, language support, etc.)
- mobile-TV service supported by good DTT services to fixed-location TVs in homes.

Outlook for next-generation broadcasting systems

Fixed DTT typically uses the UHF spectrum and is rapidly replacing analogue transmission in many countries. Analogue switch-off will be achieved in many developed countries by 2012 and many others will follow shortly after that. The freed-up spectrum is typically immediately available for DTT transmissions, although some regulators are releasing part of the UHF spectrum for auction for wireless broadband use.

Mobile TV has been allocated dedicated spectrum in some countries, for example in the L-Band at around 1.4GHz. Other services have used VHF spectrum for both digital audio broadcasts and digital TV. The uptake of mobile TV varies around the world and with many deployments only recently launched operators are still learning how best to sell the proposition. Providing good coverage is a major issue particularly for countries with sparse populations. In many cases it is only likely ever to be deployed in areas of high population density.

For DTT, the picture is favorable. Although many countries historically also use cable networks and satellite for TV broadcast, terrestrial TV is also strong. Some countries with high availability and penetration of cable TV have embraced DTT as a competitive method for program delivery; the Netherlands for example has shown that TV can reinvent itself with a technology shift.

Implications of next-generation broadcasting systems for the Peruvian market

Dedicated networks are needed for all the next-generation broadcast solutions available today, and commercial factors more than the selected technology will dictate the success of mobile TV in Peru. Additionally, with the recent selection of ISDB-T (and its mobile version One-Seg) as the national video broadcast standard in Peru (Q2 2009), there is less scope for potential operators to differentiate themselves on technology, and commercial innovation will take on an even larger role in competition between service providers.

4.1.7 Infrastructure sharing

Where regulation allows, operators look at reducing capex and opex costs by sharing access network assets. Typically, the cost of the access network comprises the largest category (60–70%) of any network investment due to extensive and costly civil engineering works. Consequently, any cost reduction in the access network translates into a significant cost reduction in the overall network build. Network sharing also allows quicker network rollout, therefore reducing the lead time to revenue. With reduced costs and a speedier time to market network infrastructure sharing can significantly improve any operators' business case.

Network asset sharing can be segmented into two main areas:

- **passive network sharing** – the passive elements that can be shared include towers for wireless networks and ducts for wireline networks
- **active network sharing** – active network elements may range from any network element from the access device (antenna, access multiplexer) to an agreed core aggregation de-multiplexing device.

For a number of reasons, passive network sharing is much more common than active network sharing. Passive network sharing is particularly prevalent in the case of wireless networks where masts are often shared by a number of operators. In established markets, mast sharing has been driven not only by cost considerations but also by environmental planning reasons. In many jurisdictions, active network sharing has been inhibited to encourage operators to invest in infrastructure. However, the cost implication for new entrants to build new access infrastructures is often prohibitive and discourages new entrants. Active network sharing in wireless networks has also been inhibited by the availability of suitable technology, however, leading vendors now have products that will allow this for new and recently built networks.

Network infrastructure sharing is particularly advantageous in emerging markets where significant network assets are still being deployed in greenfield locations. In India, for example, where there is an enormous pent-up demand for mobile services, MNOs have created subsidiary companies from their mast operations and these companies are collaborating with each other to build up to 10 000 sites per month, exploiting sharing where possible and commercially agreed. The Department of Telecommunications has actively encouraged wireless network sharing in urban areas. Network infrastructure sharing may, in some cases, be critical in proving an attractive business case in rural areas where subscribers are much more sparsely distributed, especially for radio networks that require a higher density of radio sites due to their using higher-frequency spectrum. Studies also suggest that there are net capex and opex savings to be gained in sharing brownfield sites (i.e. sites with pre-existing deployments) but to a lesser degree due to the cost of de-commissioning superfluous existing sites and the complexity of legacy networks.

For wireline networks, in those countries where there has been a dominant monopoly wireline network operator, regulators look to open up the physical access network through regulation to stimulate competition. Unbundling the local copper loop has typically been the first step towards this, particularly in developed markets, accompanied by other wholesale methodologies such as bitstream access; however, regulators are also looking to open up cable ducts (as in Portugal, for example) and curb located cabinets.

At this juncture, we take a moment to briefly discuss an issue receiving increased attention in many countries where wholesale access to incumbent networks is mandated, namely the ability to deliver TV signals (categorized as either VoD or linear/broadcast TV) over bitstream inputs. The key point to make is that technically, there is no reason why bitstream cannot be used to deliver TV and video services. However, two conditions determine the ability of bitstream to be able to deliver linear TV or VoD:

- **QoS** – effective VoD delivery requires more stringent QoS parameters than regular broadband data usage. As such, existing bitstream offers that have been designed for general data access may not have sufficiently defined parameters to enable VoD delivery.
- **Multi-casting** – the delivery of linear TV requires both sufficient QoS standards and the technical capability to offer multicasting. This is because it is very inefficient to deliver linear TV without the downstream ability to replicate a single TV stream to the multiple users that request that particular channel. Without this feature, capacity could become strained very quickly, especially if operators are to have means of offering different services from each other.

Turning to wireless networks, 3G and LTE network sharing could provide a solution to improve the business case of MNOs. During the next few years, MNOs will have to contend with several significant expenses, including investments in new technology, potentially including femtocells, LTE equipment, broadcasting networks, wireline broadband equipment, as well as content and the marketing of new services. As a result, most MNOs will be unable to invest sufficient amounts quickly enough on their own to exploit the full potential of 3G. Infrastructure sharing could alleviate operators' cost burden and enable them to provide high-quality, high-performance 3G services with ubiquitous coverage.

MNOs in most developed markets are expected to implement network sharing of some sort during the next few years. For example, Analysys Mason undertook market research to identify the propensity for European MNOs to share their RANs, the results of which are summarized in Figure 4.37.

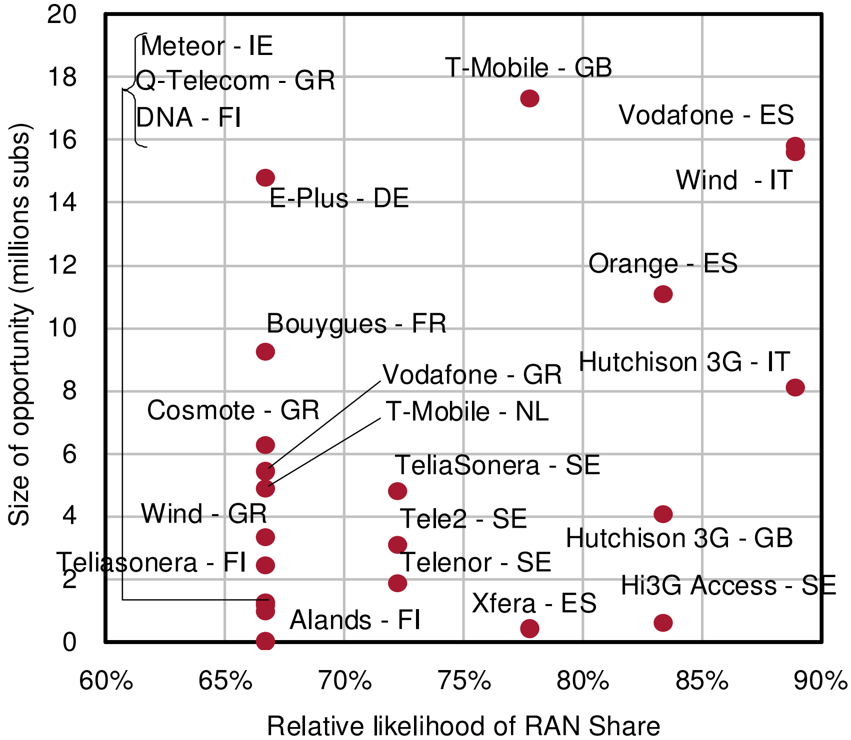


Figure 4.37: Propensity for MNOs to share their RANs [Source: Analysys Mason, 2008]

Network-sharing agreements announced by major MNOs, such as Hutchison 3G, Orange, T-Mobile and Vodafone in the UK indicated the early signs of this trend, as shown in Figure 4.38.

Operators	*Country*	*Date of announcement*	*Date of launch*	*Comments*
Telstra and Hutchinson 3G	Australia	Aug 2004	Sept 2005	
Optus and Vodafone	Australia	Nov 2004	Q3 2005	Reduction in Optus's capex of AUS100 million in the first three years. Reduction in opex for maintenance, operations and site leases of approximately AUS10 million per year
Vodafone and Orange	Spain	Nov 2004	Oct 2007	Improvement of the 3G network coverage provided by both operators by approximately 25%. Reduction in the number of base stations needed to deploy both the Orange Spain and Vodafone Spain networks by around 40%
Vodafone and Orange	UK	Feb 2007	Looking at site sharing only	20–30% savings on RAN opex and capex in the middle term, one-third reduction in combined sites, faster 3G rollout and improved coverage
T-Mobile and 3	UK	Dec 2007	Expect to take two years to consolidate the networks	Cost savings of GBP2 billion (USD4 billion) over ten years, by decommissioning over 5000 duplicate base station sties

Figure 4.38: Examples of wireless network sharing [Source: Analysys Mason]

However, infrastructure sharing constitutes the greatest upheaval to cellular networks since their inception, and will be a considerable undertaking, in particular for brownfield networks.

RAN sharing can take many forms, ranging from sharing physical radio sites through to full integration of wireless networks. The two potential network architectures are shown in Figure 4.39, with the shared RAN option (lower architecture) being the most common.

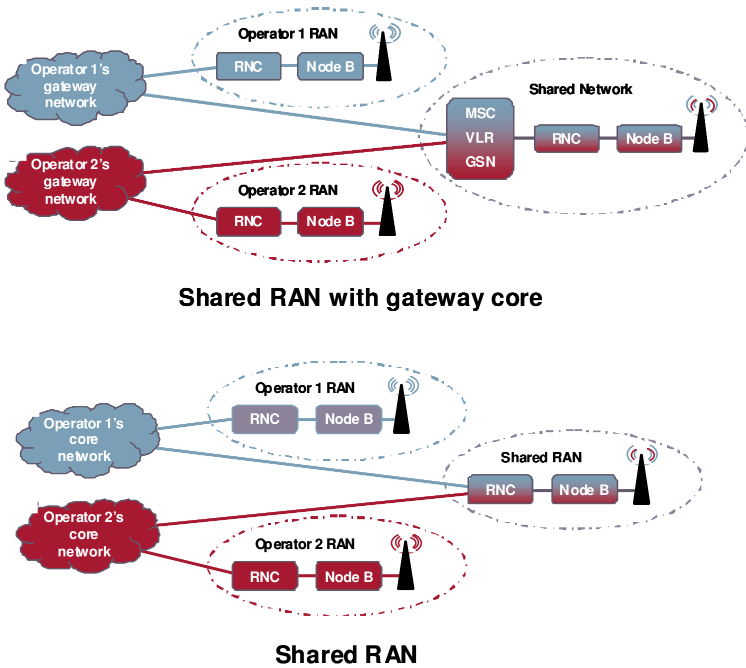


Figure 4.39: RAN sharing architectures [Source: Analysys Mason]

The most likely approach for those MNOs that decide to go down this road is to share their RANs – as well as the associated sites, masts, power and transmission – but will retain separate core networks so that they can differentiate their services. Sharing RANs will enable MNOs to make major savings in capex and opex, which will in turn allow them to:

- accelerate coverage rollout
- increase their influence over equipment vendors
- achieve competitive advantage by deploying the latest network technologies early.

Business case modeling of 3G deployment scenarios demonstrates that RAN sharing can achieve substantial cost savings. For example, Figure 4.40 considers the case of a typical 3G-only MNO sharing a 3G RAN with a typical 2G/3G MNO. The model indicates that 3G RAN sharing would enable the two operators to save a combined USD4 billion over ten years, comprising about USD2 billion in capex (by eliminating the need to build new base stations) and USD2 billion in opex (by reducing the number of sites that they need to operate). The specific cost benefits will vary according to the MNOs' characteristics, such as whether they have both 2G and 3G networks, and the extent to which they have deployed 3G networks. As a result, it is important for MNOs to examine their sharing options early, so that they can identify the most appropriate partners.

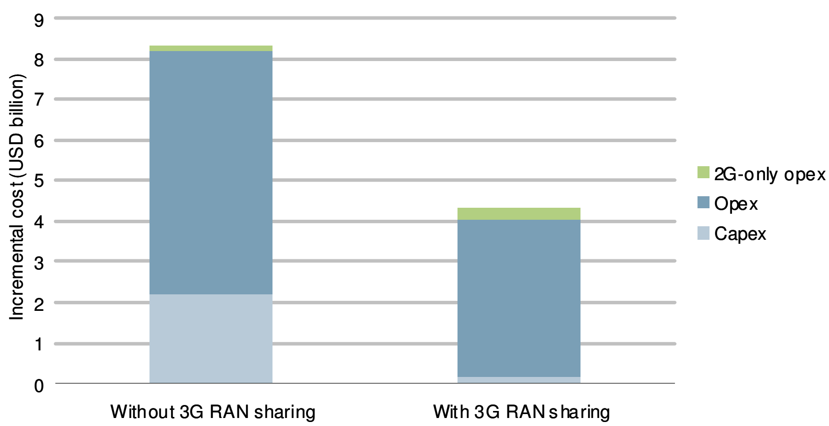


Figure 4.40: Incremental capex and opex over ten years for a 3G-only MNO and a 2G/3G MNO, with and without 3G RAN sharing [Source: Analysys Mason 2008]

Operators may be able to achieve further cost reductions by sharing 2G networks too – particularly because these carry the majority of mobile wireless traffic. However, operators would probably have to replace a substantial amount of equipment and availability of this equipment is scarce and expensive. Before MNOs embark upon 2G-network sharing, they need to consider how quickly they will migrate their customers to 3G services and, therefore, how long they will continue to operate their 2G networks.

Network sharing is a major undertaking for MNOs; they will have to co-operate closely with one or more competitors on what could be a multi-billion dollar project. The risks are significant and success will depend on: clearly defined, common goals; robust technical, commercial and legal agreements; high-quality project management; and close relationships with partners and suppliers.

The widespread implementation of network sharing will have far-reaching consequences for all MNOs, equipment vendors and regulators:

- MNOs will be forced to increase their focus on differentiation at the brand and service level
- equipment vendors will have to contend with a diminishing market for products and business growth will become critically dependent on building market share
- vendors will need to develop technical solutions that enable MNOs to migrate from independent networks to shared networks that allow them to share costs while continuing to differentiate their services
- MNOs will also need commercial solutions that enable them to replace, upgrade and decommission equipment in a cost-effective way, and that minimize the risk of the major upheaval of network sharing
- regulators will need to adapt their approach so that they can achieve the benefits of network sharing – such as reduced environmental impacts, improved quality of service, new services and lower prices – without compromising competition in the market.

Mobile virtual network operators (MVNOs)

We will now discuss a particular type of infrastructure sharing over wireless networks, namely MVNOs. Ofcom, the UK regulator, defines MVNOs as follows: "*Mobile Virtual Network*

Operators (MVNOs) offer mobile telecoms services to customers by reselling wholesale minutes that they have purchased from an existing infrastructure owner (a Mobile Network Operator, MNO). In this way, MVNOs avoid the need to own and operate their own end-to-end mobile radio access networks."[23]

There are a number of nuances in the MVNO business models which have strong implications on the network architecture and therefore on the capex and opex required. In this section, we will consider the three main categories of MVNOs; these are listed below in ascending order according to the level of network investment required by the operator:

- licensed reseller
- thin MVNO
- thick MVNO.

Each of these is discussed in turn below.

[23] *The Communications Market*, Ofcom Interim report, February 2006.

► *Licensed reseller*

The network architecture for a **licensed reseller** is provided in Figure 4.41.

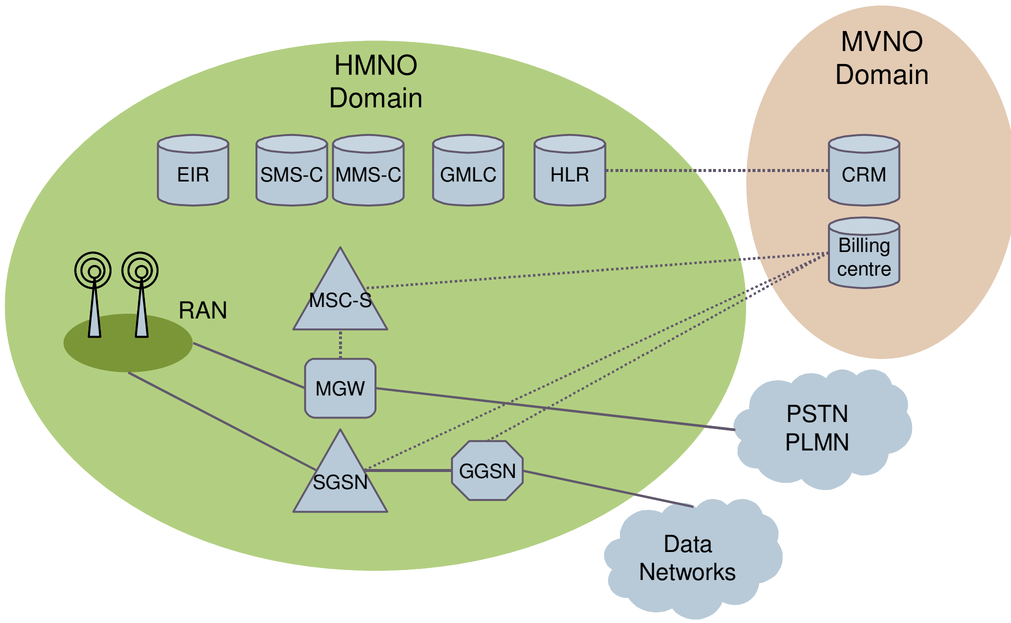


Figure 4.41: Licensed reseller model [Source: Analysys Mason]

A licensed reseller makes no investment in physical network equipment; it simply resells the services provided by the home mobile network operator (HMNO)[24] and has a direct relationship with its end user through its own brand and billing/CRM systems. The level of investment required to launch a reseller is the smallest compared to the other MVNO models. In this scenario, the HMNO provides the entire network infrastructure and the MVNO only has its own billing system and customer administration system, as depicted in Figure 4.41.

► *Thin MVNO*

In marked contrast to a licensed reseller, a **thin MVNO**'s self-built infrastructure is typically limited to IN prepaid, billing system, CRM system and HLR. The fact that thin MVNOs typically use their own HLR means that they are in control of SIM cards and are assigned their own mobile network code (MNC), which is a major difference when compared with a licensed reseller. In this scenario, the HMNO provides all network infrastructures except the HLR, as depicted in Figure 4.42. It also requires national roaming to be set up between the MVNO's HLR and the network elements of the HMNO (MSC-S, SGSN and GMLC).

[24] An HMNO is the operator which provides its access network (and core network depending on the business model) to the MVNO operator.

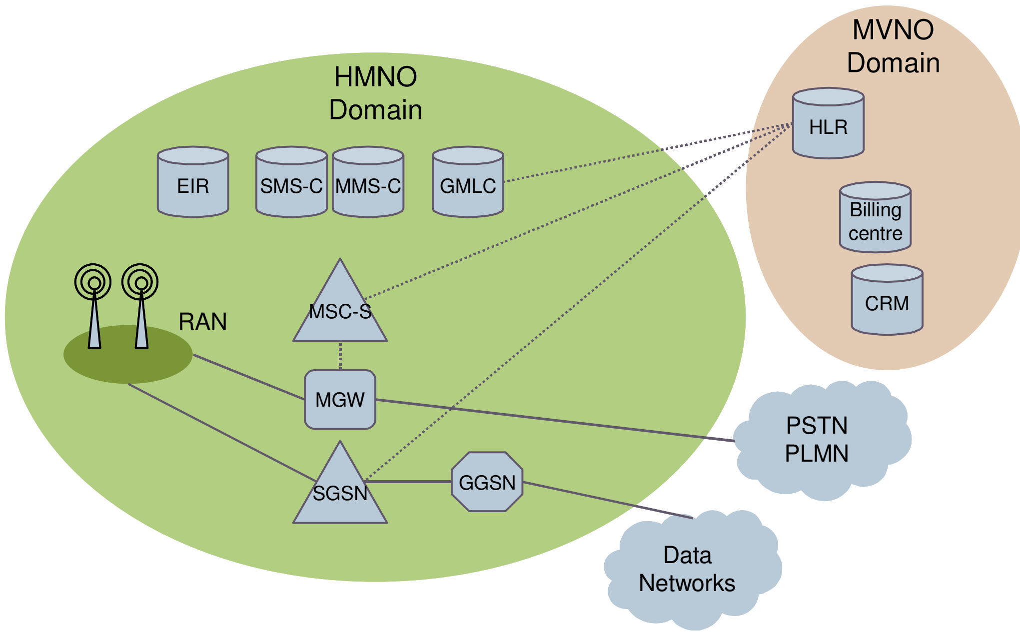


Figure 4.42: Thin MVNO model [Source: Analysys Mason]

► *Thick MVNO*

The **thick MVNO** model involves maximum investment in infrastructure by the MVNO. In this scenario, the HMNO only provides the RAN. All other elements are owned and managed by the MVNO, including HLR, AuC, EIR, SMS-C, MMS-C, etc., as depicted in Figure 4.43. From a network technology perspective, this scenario requires that the RAN can be connected to two core networks simultaneously: the MVNO's core network and the core network of the HMNO. Charging, call routing and session control are done completely by the MVNO.

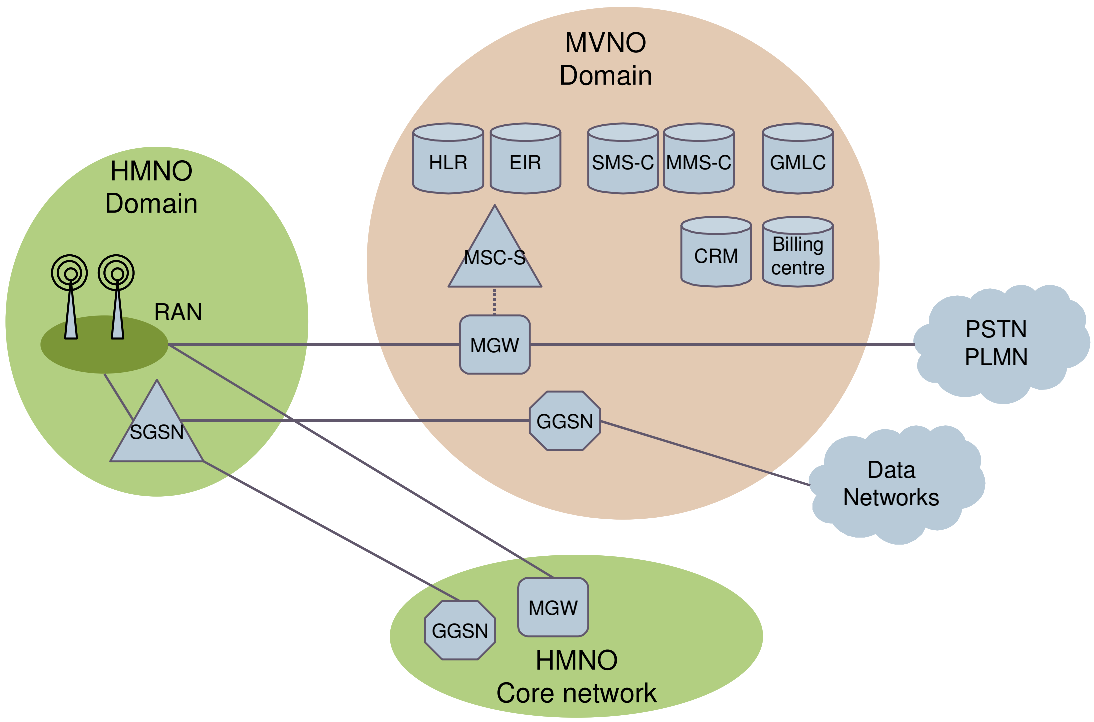


Figure 4.43: Thick MVNO model [Source: Analysys Mason]

Figure 4.44 summarizes all MVNO business models in terms of ownership of branding, operations, content and applications, and infrastructure.

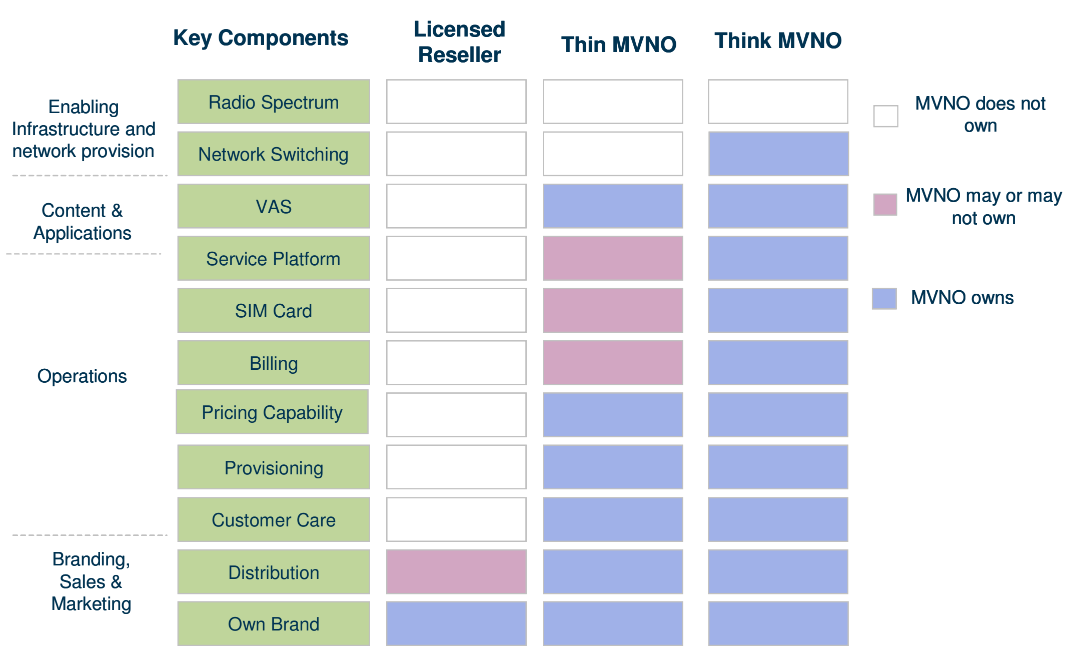


Figure 4.44: MVNO business models [Source: Analysys Mason]

Implications of infrastructure sharing for the Peruvian market

For MNOs, site/RAN sharing represents a unique opportunity to save costs. We strongly believe that site/RAN sharing could find two applications in the Peruvian market:

- Firstly, it could be used as a tool to encourage existing operators to deploy their networks in more rural areas, where the business case is unfavorable. This would in effect help to tackle the digital divide that exists in Peru. Governmental authorities could play an active role in this, for example, by creating an infrastructure provider (also commonly referred to as tower company) that would provide telecommunications infrastructure (power, tower, etc) and allow operators to use this infrastructure in exchange for a reasonable rental fee.

  Another way the government could facilitate site/RAN sharing would be to create an independent body that facilitates the implementation of site/RAN sharing between operators. In the UK, intervention by the Office of the Deputy Prime Minister led to the formation of the MNO Association (MOA). The MOA facilitates the co-ordination of different operators when sharing infrastructure. One of the key roles of the MOA is to track each key milestone in the implementation of infrastructure (sites and towers) sharing between the different parties involved.

- Secondly, site sharing in Peru is likely to be critical for the deployment of 4G networks. Some believe that the only business case in favor of LTE will be closely associated with RAN/site sharing. This is due to the high backhaul capacity and core network requirements for each of the sites which could be shared in a site/RAN share scenario.

As previously discussed, in those countries where there has been a dominant monopoly wireline network operator, regulators have looked at opening up the physical access network through regulation to stimulate competition. The monopoly of Telefónica in the wireline domain and the relatively low penetration of wireline services mean that wireline access sharing policies such as unbundling the local copper loop or regulating duct access are likely to be less effective. We discuss further in Section 5 the competitive implications of infrastructure sharing.

The MVNO business models described above generally offer opportunities for wireline incumbent operators to consider a strategic partnership/acquisition to provide fixed–mobile convergent (FMC) services to their customers. These business models are therefore often seen as key market enablers for incumbent network operators. However, in the case of Peru, the various MVNO business models are more likely to provide opportunities for service-based competition over cellular infrastructure. In its simplest form (license reseller), the MVNO does not encourage investment in infrastructure, which is one of OSIPTEL's key aims given the penetration levels in Peru. Typically, MVNOs are introduced in mature markets where investment in infrastructure has already been carried out and/or where service-based competition is desired or feasible, and as such we do not see MVNOs playing any significant roles in the Peruvian market in the near future.

4.2 Service convergence

Having discussed the actual technologies that underlie the physical networks over which converged services are provisioned, we now turn to a discussion on the technology features of the various services that can be provided.

The usual development progression seen in other markets starts with the simple bundling of services such as voice, data and in the case of consumers often broadcast entertainment within a package and typically presented on one bill. Such offers are used to enhance the overall value to the customer and to build brand loyalty and minimize churn.

As other players emulate such offers, so increases the need of operators to offer more sophisticated offers and to reduce costs. This then leads to a convergence of technologies around IP. The availability of IP-enabled core and access networks, together with highly capable terminal equipment and scalable server infrastructure, gives operators the opportunity to drive costs and complexity out of the early offerings. The associated software platforms in management and support also allow faster service development and service introduction that often underpin the competitive advantage of one operator over another.

The scope of convergence then becomes:

- basic bundles of multiple services (voice, video, data) over a single platform
- multi-platform service convergence, e.g. entertainment and voice/data possibly in a wholly wireless context
- more advanced services for the minority of (largely urban) customers served by both wireline and wireless offerings – more akin to the sort of convergence we have seen in advanced markets.

In the two sections below, we look in more detail at the two most relevant converged services – VoIP and IPTV services – being provisioned today by various converged operators around the world, and which are of interest to emerging market operators.

4.2.1 VoIP

The main issue that is consistently raised with regards to convergence and voice services is QoS. Over private networks, VoIP can provide CD-quality sound. Over the general Internet, QoS and latency problems can raise their heads. Clever coding techniques being developed today can minimize some of these problems, and as these techniques are perfected the cost advantages as well as innovative opportunities offered by VoIP will make the move to VoIP even more inevitable for all voice service providers.

There are several flavors of VoIP that can be seen in various markets worldwide:

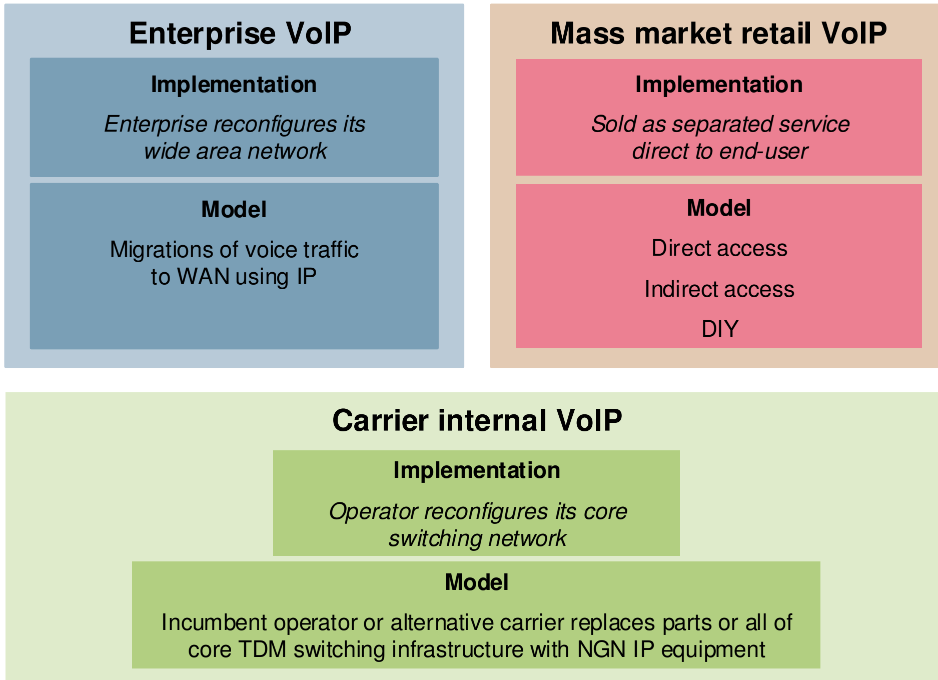


Figure 4.45: VoIP implementations [Source: Analysys Mason]

Of these different types VoIP implementation, enterprise VoIP and carrier internal VoIP are primarily the result of business decisions about saving costs and (in the case of carrier VoIP) upgrading networks to carry other IP service data streams such as IPTV. We will focus most of our discussion on mass-market retail VoIP, which has the greatest impact on converged networks:

- **Direct access** – The most common model of mass-market retail VoIP worldwide is the so-called direct access model. In this model, the broadband access connection is sold by the same operator as the voice calls. This model usually comprises a bundle of Internet access and voice, but the broadband pipe can be used for voice only. Full triple-play bundles (with IPTV) are increasingly common in many markets.

  If the access network provider and the ISP are the same company, it has greater control over the QoS for voice. This is the case with incumbent and unbundler services, as well as services offered by network operators using alternative broadband technologies (principally cable modem and fiber).

- **Indirect access –** Another form of mass-market retail VoIP service is based on the Indirect access model. ISPs using a different player's broadband access can also offer retail VoIP. Where a service provider uses another player's access connections, or where it uses shared-line unbundling, the end user will continue to pay a PSTN charge to the incumbent. These services tend to have the following features in common:

- can use an analogue telephone with a number from the national numbering plan
- the analogue telephone adaptor sits between the broadband connection and the telephone
- the box can be taken to any broadband connection and keep the 'local' telephone plan and number
- value-added services such as voicemail and conference calling from web pages are relatively easy to add.

- **Do-It-Yourself (DIY) –** The last type of mass-market retail VoIP is the DIY model popularized by services such as Skype. In the original model, the supplier provides software that enables free voice calls between end users with the same software. Calls generally can be made over any type of broadband connection unless restricted by the broadband access provider. More recently, many suppliers also provide for pay facilities to make and receive calls from the PSTN.

Note that cellular VoIP taking any of these three forms (particularly DIY) is also technically feasible, but in practice it is quite rare.

In terms of the impact of VoIP on converged networks, large players with integrated wireless and wireline networks (such as Telefónica) will likely be among the first operators to move to wireless VoIP, as they will be keen to offer converged services by using a single core network implemented using IMS, which we discuss in more detail below.

Some large, wireless-only operators may also move quickly to wireless VoIP, thereby releasing capacity for data-intensive services, such as mobile TV and wireless broadband Internet access. MVNOs and wireline VoIP service providers will look for opportunities to deliver their own wireless VoIP services and may find allies among smaller wireless operators that will be keen to attract customers to their networks and can harness the greater capacity per user they have available (compared with larger operators that have more saturated networks).

The widespread implementation of LTE will eventually allow MNOs to join PSTN operators in completely migrating from their legacy CS services to more efficient VoIP services. After the introduction of enhanced cellular technology, it will likely take several years for MNOs to offer a fully evolved cellular VoIP service, while user adoption of VoIP-enabled handsets will be gradual and ultimately dependent upon the long-term replacement cycle of handsets.

4.2.2 Video over IP

Most often the discussion of video services delivery under a convergence framework centers around IPTV. Technically, IPTV refers to a switched video service delivered in IP packets over a broadband connection. However, restricting any discussion to this strict definition imposes artificial constraints in understanding and estimating the size of TV service delivery over converged network infrastructures. For example, the FiOS service offered by Verizon in the USA over FTTH access networks simply use existing broadcast TV standards for delivery of the most popular content, and IPTV standards for VoD.

The impact of convergence on video and TV services can be analyzed around two delivery paradigms:

- **over-the-top video** – streamed or downloaded content over general Internet connections
- **dedicated delivery** – content delivered using dedicated broadcasting standards and/or networks.

We define IPTV as video services delivered to the TV over a closed, managed IP network (fitting into the dedicated delivery paradigm). This definition excludes video services that are usually (though not always) delivered to the PC, rather than the TV, over the public Internet, such as YouTube and iPlayer. We analyze these two delivery paradigms below.

► *Over-the-top video*

Content delivered in this manner can be of two types:

- Best-efforts video that can vary in quality – lower quality (from sites such as YouTube) to higher quality (from sites such as NBC, which streamed many of the events at the Beijing 2008 Olympics over standard Internet connections using Microsoft's Silverlight Internet video framework).

- Managed services with higher-quality download feeds which can be output to TVs and serve up VoD content. For example, FilmOn, a UK-based over-the-top video site, indicated in December 2008 to have developed a new technology called 'HDi' which allows it to stream high-definition video content through the broadband connections with relatively low access speeds (~2Mbit/s) using cloud computing. This technology is also the basis for high-definition streaming over the Internet by a company called Vudu. The company promises that FilmOn users can appreciate live TV programming and VoD content without any buffering times, but has not disclosed further technical details.

However, the best-quality streaming video, particularly real-time low-latency content, typically requires more bandwidth than is generally available on most last-mile access networks at the moment.

In addition to the standards mentioned above, other popular standards that enable delivery of video programming over standard Internet connections include Flash, DivX and FLV.

► *Dedicated delivery*

Existing cable and satellite broadcast TV standards offer QoS and latency guarantees that are hard for best-efforts Internet video to match. Dedicated mobile broadcasting standards and networks (such as DVB-H in Europe and MediaFLO in the USA) promise to offer the same reliability and quality.

Current bitstream services in many countries are not adapted (technically and economically) to provide TV services. Adoption of LLU is still low in emerging markets or even not yet introduced, and this is a prerequisite for many IPTV operators as it allows better control of QoS. In addition, it is clearly not efficient and economical to send multiple channels to multiple subscribers simultaneously – and the existence of 'multicast' bitstream platforms on a wholesale basis is still in its early days.

The investment required for the deployment and rollout of IPTV services means that operators offering IPTV are generally going to be competing with pay-TV operators rather than free-TV services. For these services to be successful, telco TV services first need to be able to offer similar services as regular pay-TV platforms, and then exploit the service differentiators offered by IPTV.

However, in many developed markets, a package of digital TV channels, supplemented by VoD and personal video recorders (PVRs), is no longer sufficient to attract and retain subscribers, no matter how competently it is delivered. Traditional competitors, such as cable operators, are converting their legacy analogue TV subscriber base to digital packages and are improving their services. IPTV operators need to clearly differentiate their services from those of their competitors, using IP networks to offer converged services to multiple devices within the home and beyond, while enabling consumers to navigate through an ever-growing maze of content from multiple sources with higher levels of personalization.

4.2.3 Next-generation interconnection

As core and end-user voice platforms move to an IP packet-based transport architecture, it will increasingly make sense for interconnection between platforms to be via an IP interface rather than traditional analogue and TDM-based mechanisms. Moving to IP-based interconnect alleviates the need for transcoding between CS and PS bearers, which requires additional equipment elements (‘gateways’) and has a negative impact on the quality of experience of the end users making the voice calls.

In additional to voice traffic, there is a requirement to consider interconnect for non-voice applications and multimedia services that can now be regarded as candidates for transport over converged interconnect links between operators and between the end user and the operator. Such applications may include:

- multimedia real-time services such as video telephony
- streaming services (audio, video and data)
- data connectivity services (e.g. LAN-LAN interconnect, IP VPN).

Providing an NG interconnect framework will enable services that have been confined to the Internet or within a single network, to be offered across network boundaries increasing the options for service delivery for the end user and encouraging competition.

As shown in Figure 4.46, next-generation interconnect needs to be considered in two parts:

- **end-user to network interconnect** – typically the connection between end-user equipment (PBX or key system) and the network (important for business customers)
- **network-to-network interconnect** – between operators.

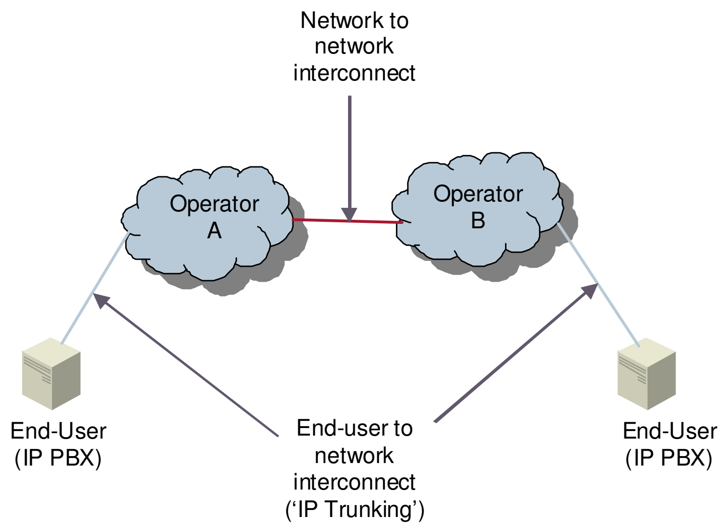


Figure 4.46: Next-generation interconnect types [Source: Analysys Mason]

► *End-user to network interconnect*

Traditionally, connectivity from the end user to the PSTN service provider has been via T1/E1 ISDN (ITU Q.931), analogue or basic access ISDN links. However, as end-user equipment PBX equipment increasingly migrates to IP transport infrastructure, as shown for the USA in Figure 4.47, a requirement is for the connection to be made to the PSTN using an IP interface. Already in many countries, some business inter-office voice traffic is being transported between sites over a data WAN infrastructure along with some outgoing traffic using IP voice providers.

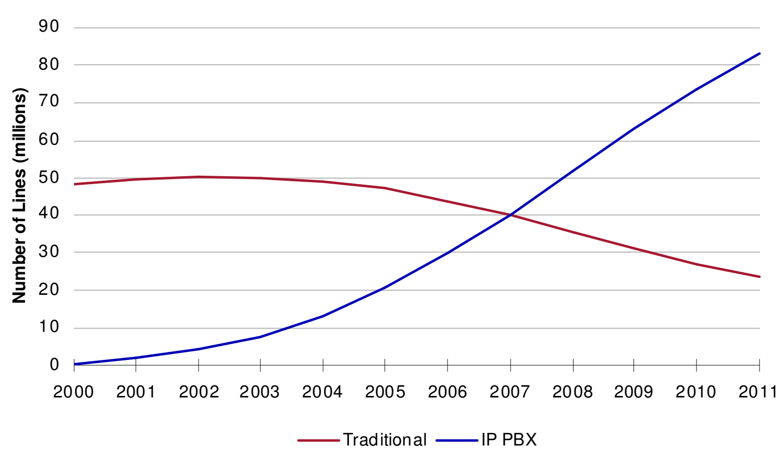


Figure 4.47: PBX installed bases in the USA [Source: TIA 2008 Telecommunications Market Review and Forecast]

► *Network-to-network interconnect*

As operator networks transform to call server-based voice infrastructures that utilize an IP-based transport infrastructure, it will make sense for next-generation interconnect to be used to reduce hardware requirements and maintain quality of experience for end users. Traditionally, interconnect between operators has been based on TDM connectivity, but transition to next-generation interconnect provides an opportunity to increase efficiencies in the interconnect infrastructure and the introduction of different commercial models.

The GSM Association has been particularly active in the commercial models area and has been examining the potential for broker models such as its IPX framework. Traditional PSTN interconnect models allow for bilateral transport and transit services, but the IPX framework allows for IPX exchange to act as a broker for a group of service providers ('multilateral hub service') with the IPX providing a single commercial and network interface for the operator.

During the transformation from a traditional PSTN network to an NGN there will be a mixture of technologies in the network for some considerable time as different operators evolve their networks at different rates. Mixtures of traditional and NGN, like those illustrated in Figure 4.48, will provide challenges in maintaining the quality of experience for the end user, which can be eroded by delay, network performance and transcoding induced quality degradation. To maintain the integrity of the PSTN, it will be important to understand the performance issues and ensure, wherever possible, that traditional network performance is maintained.

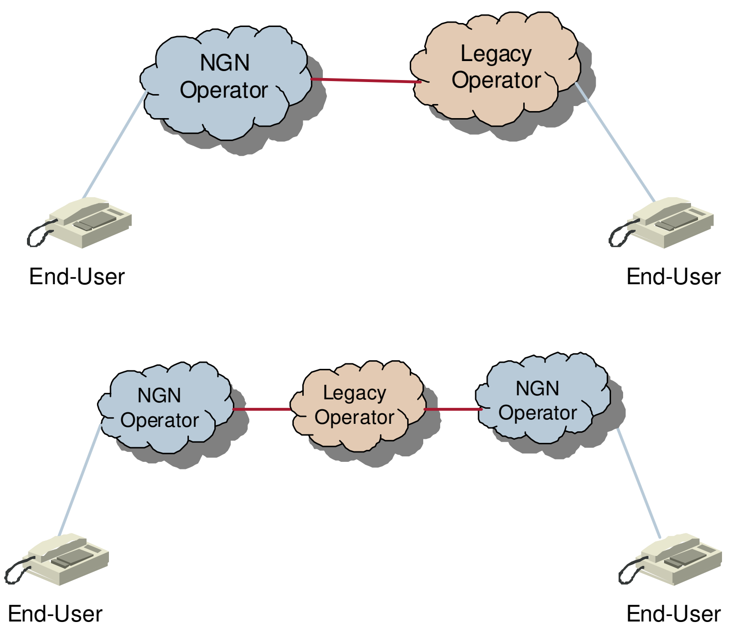


Figure 4.48: Possible network scenarios during network transformation [Source: Analysys Mason]

Enabling standards for next generation interconnection

► *End-user to network interconnect*

IP-based end user to network interconnect has been available for some time with early deployments being based on the ITU H.323 signaling standard adopted by IP PBXs. In recent years, there has been a move to the IETF Session Initiation protocol (SIP), which is generally considered more aligned with NGN concepts of horizontally layered networks and has been adopted by key NGN architectures such as IMS. However, as with all evolving standards, there are issues that need to be considered relating to interoperability, which is exacerbated by the plethora of end-user and network systems that need to be considered.

One prominent attempt to address this issue is the SIPConnect initiative promoted by the SIP Forum. SIP is a widely adopted protocol of choice as it provides native inter-operability with IP and supports the session control (session set-up and tear-down) of multimedia services. SIP provides an alternative to traditional SS7 which is a voice-only control protocol based a TDM architecture. SIP is also central to the IMS architecture. In addition to the SIP signaling itself, SIPConnect defines standards for other interconnect issues such as media standards, feature support, billing and security. SIPConnect also runs a compliance program, but as of January 2009 stage compliance is limited with just 12[25] vendors and service providers claiming being certified.

► *Network-to-network interconnect*

Network-to-network interconnect has traditionally been based on international and national variants of SS7 signaling with bearer traffic being transported over T1 or E1 links. The move to next-generation interconnect will include a move to Ethernet-based interconnection based on 100Mbit/s, 1Gbit/s and 10Gbit/s interfaces. Such scalability will help to drive implementation efficiencies when compared to traditional deployment.

The SS7 signaling protocols contain an extensive feature set within the ISUP signaling protocol that will still be required for PSTN emulation services in an NGN world. It is therefore necessary to ensure that this functionality is not lost, to allow PSTN emulation services to be delivered across the NG interconnect and to allow inter-working with legacy networks in mixed environments. It has been widely agreed by 3GPP, ETSI, 3GPP2 and ITU that SIP will form the basis of next-generation session control signaling. SIP-I containing SS7 ISUP messages has been defined to allow PSTN services to be emulated within the NGN infrastructure. As with end-user-to-network signaling, other aspects of the interconnect must also be addressed and defined. This work is, has been, and continues to be undertaken by international and national bodies including such aspects as:

[25] SIP Forum / SIPConnect Website http://www.sipforum.org/content/view/273/227/.

- QoS – for voice, but also to consider other services introduced over the IP interconnect
- security considerations – e.g. authentication, network protection, encryption
- numbering database – ENUM, that allows mapping between E.164 PSTN numbers and SIP based addresses; carrier-based and 'private' ENUM are the implementations most likely to succeed because public ENUM has encountered too many obstacles too date in many markets
- IP address allocation and VLAN numbering between operators
- performance objectives (e.g. packet loss, packet delay, permissible codecs, delay variation, use of echo control, etc.).

Beyond PSTN-based services, it is expected that services requiring session control in the NGN will follow the IMS framework defined by 3GPP and developed further for ETSI TISPAN. The IMS framework is dependent on SIP for session control and will incorporate presence and location signaling to support functionality that is expected to feature strongly in the NGN environment. Consequently, SIP will be important for interconnect for session controlled services, but with other protocols such as Ethernet and MPLS being important interconnect protocols for other services such as streaming and data connectivity.

It is important to note that the basic SIP does not replace all the functionality of the SS7 signaling protocol. A variation of the SIP – SIP (I) or SIP ISUP has been developed to encapsulate the SS7 ISUP messages within the SIP signaling messages, which enables the SS7 functionality to be maintained in a SIP environment.

Outlook for next-generation interconnection

► *End-user-to-network interconnect*

As more businesses and operators transition to an IP-based infrastructure, the provision of IP-based interconnect to the network will increasingly be driven by the cost and quality of experience of the end user. IP interconnect between end-user organizations and the PSTN has not been deployed to any great extent to date with Q.931 and analogue links still proliferating. However, as operators roll out their NGNs it will be to their advantage to promote IP interconnect and reduce the requirement for TDM to IP gateways at the edge of their network. This will further be driven by consumer demands for converged infrastructure solutions and the growth of converged services.

However, this needs to be backed up by a standards-based approach to interconnect that will build end-user confidence and enable operators to offer services that can scale as demand increases. While SIPConnect would appear to provide a way to achieve this wide adoption, it is still in the formation stage as a critical mass of end-user application providers and network operators is still sought.

► *Network-to-network interconnect*

Next-generation interconnect on a large scale will require the operators at each end of the link to be rolling out NGNs. To date, operators have been using IP interconnect in a limited way, particularly to take advantage of reduced international transit costs. However, where interconnect partners are rolling out NGN infrastructures, it does make a lot of sense to incorporate NGN interconnect into the plan. Session border gateways, used as the interface between operators for NGN interconnect, are a lot more cost-effective than media gateways that convert between IP and TDM environments, and the reduction of transcodings between TDM and IP will improve the quality of experience.

At a national level, NGN interconnect deployment is very limited with deployment largely still in the trial or standards definition stage in line with the NGN deployment by incumbent operators. As well as interface requirements, there are implementation and commercial considerations to be made. The scalability of the NGN infrastructure does provide an opportunity to reduce the number of interconnect points between operators, but the commercial considerations also need to be taken into account as operators seek to maintain and improve their business model.

Studies in the UK,[26] [27] suggest that existing settlement regimes still have a place within the NGN infrastructure, although with some adjustments to take account of NGN differences, with duration, capacity and time of day being elements in deriving interconnect charging.

4.2.4 Implications for converged service delivery in Peru

One of the key drivers behind the explosive growth of VoIP services was the fact that it enabled much cheaper voice communications between consumers in developed and emerging markets. Emerging market operators face the same technology choices when deciding how to implement or deal with VoIP. Emerging market consumers have access to a smaller set of retail market VoIP propositions given the general paucity of managed indirect access services such as Vonage; however, the fact that these services only need a general broadband data connection to work has given rise to instances where a consumer could connect a Vonage telephone (registered with a US telephone number) to a broadband connection in a country such as Peru and use the telephony services as they normally would in the USA, paying only for the cost of the broadband access in Peru (although we note her again that since broadband penetration in Peru is low, this is unlikely to be a widespread occurrence in Peru at present).

In terms of video, over-the-top IP video services do not require the same significant commitment to infrastructure than dedicated delivery services. While best-efforts online video is unlikely to ever be a significant competitor to traditional services, particularly in emerging markets, there is the potential for managed over-the-top video services to provide an alternative means for operators and service providers to deliver content to consumers, and it could provide a means for increasing the level of competition and the availability of video services in Peru. Sections 4 and 5 look in more detail at the competitive implications of the availability of converged services in Peru and the appropriate regulatory responses to deal with these developments.

[26] NGN Interconnection: Charging Principles and Economic Efficiency (NGNuk, July 2007).

[27] Summary of NGNuk Member views on Charging for PSTN Emulation over NGNs (NGNuk, June 2008).

Section 4.2.3 above described the technical aspects of interconnection for NGNs. However, most of the really influential issues relating to interconnection worldwide have had more to do with commercial realities and regulatory decisions than any technical limitations or features. Thus in Section 6.3.1, we will discuss in more detail the regulatory principles that should guide next generation interconnection in Peru.

4.3 Device convergence

In the early days of the Internet, fixed desktop computers (or even larger computing machines) were the only devices that could connect to the Internet. Since then, the number and nature of devices that are fitted out with Internet access capabilities has increased dramatically over the past few years, and so has the installed base of these Internet-enabled devices. Not only has the number of such devices increased but also there has been a tendency towards lower prices and increased functionality. This section gives a brief overview of the breadth of Internet access capable devices available today, focusing particularly on the connectivity enabled by such devices, and then discusses the implications on availability in these emerging markets.

Internet access on converged devices

Building on the theme of any-to-any connection as a driver of convergence, the availability of multiple Internet access standards on any given device is the determinant of that device as a converged device, rather than the availability of advanced services over the device. Thus a mobile phone which could only access a 3G network could be considered an advanced data device, but not necessarily a converged one.

The pool of connectivity standards from which all user end-devices implement Internet access is listed below. The technology underlying most of these standards has already been discussed previously, and so we focus our commentary here on the inclusiveness of these standards generally in end-user devices:

- **Wi-Fi** – together with Ethernet, this is the most successful of all Internet connectivity standards on consumer devices.
- **Bluetooth** – has found more success as a personal area network standard than as an Internet connectivity standard, although it can be used to allow mobile phones to act as Internet access modems through tethering i.e. the connection of an Internet capable device (such as a laptop) to a mobile device in order to allow the Internet capable device to access the Internet using the mobile devices data connection.
- **Dial-up modems** – the first widely available Internet connectivity standard on personal computer, it is still included on many devices today given the continued dominance of the PSTN in many countries.

- **Ethernet** – the defining standard for most local area networks, and fixed Internet connectivity on personal computers.

- **WiMAX** – the push to put WiMAX chipsets in personal computers and other devices is being driven in a large way by Intel, one of the significant stakeholders behind the WiMAX standard. Given Intel's dominance in the chipset market, the availability of WiMAX enabled devices is likely to continue to increase.

- **3G** – MNOs initially faced the problem of underutilization when deploying 3G networks, and one solution to this was to get data intensive services and devices using the network. As such there are an increasing number of devices other than mobile handsets which now include 3G chipsets to enable them to connect to various networks.

- **Mobile TV** – DVB-H, T-DMB, DTT and other TV standards can increasingly be included in a wide range of devices as work is done on making the chipsets standardized and available to vendors.

Converged devices available today

It is useful to group the wealth of converged devices available today under three general headings, which we will discuss in turn.

► *Personal computers*

We use the term 'Personal computer' here to include the whole class of general purpose devices used to run multiple applications over operating systems (OS) such as Mac OS X by Apple, Windows by Microsoft, or Linux OS variants such as Ubuntu. Thus this term includes desktop computers, laptops, netbooks. This class of devices is often the most connected over all end-user devices, including the options of including almost all connectivity standards:

- **Desktop computers –** Most new desktop PCs come equipped with multiple connectivity standards and at least the option for all standards, including dial-up (V.90 and V92 modems, etc), wireline interfaces such as Ethernet or wireless interfaces such as Wi-Fi in any of its versions (802.11b, 802.11d, or 802.11n being the most common) and increasingly WiMAX (802.16d/e). Even TV standards can be accommodated by installation of the appropriate PC card (such as a TV tuner card) or using USB adapters.

- **Laptops** – Laptops are personal computers designed for mobile or nomadic use and that are small enough to carry around with little trouble. While historically underpowered compared to desktop computers (and in fact high end desktops today still boast more computing power, storage and technical features than comparably priced laptops), technological advancements have closed the gap to such and extent that the price/feature distinction is less significant to many consumers, meaning that portability plays a much bigger role now in purchase decisions. In 2007, iSuppli reported that laptop sales had topped desktops for the first time. Laptop sales continue to grow at a faster rate than desktops: iSuppli has forecast a 15% sales increase in 2009 despite the ongoing economic uncertainty. Intel provided a big push in increasing the connectivity capabilities of laptops when it launched its Centrino platform in 2003 that supported Wi-Fi natively. This allowed notebooks to connect to wireless access points without needing any external devices such as PCMCIA cards. The company, having a significant stake in the success of WiMAX is making investigations along the same lines for this technology.

- **Netbooks** – Netbooks have been described by Intel as small laptops that are designed for wireless communication and access to the Internet. Although technically a part of the Laptops category, their impact over the last two years has been such that they are now often treated as a separate third category of personal computer. In particular, the fact they typically cost about USD250, make them a potentially disruptive and high volume market segment. Often they are underpowered relative to other laptops, but in the same way that laptops began surpassing desktops once the became powerful enough to provide the majority of services required by end-users a reasonable price along with the added value of mobility, netbooks have the potential to surpass other laptop sales by adding very low price as a feature. In actual terms of connectivity, netbooks tend to be the most limited class of personal computers, often only including Wi-Fi in order to keep costs down. However a number of higher end netbooks will include mobile connectivity to 3G networks as well, and WiMAX is almost certain to start making appearances in netbooks once Intel finds a cost effective way to include it in netbook chipsets.

► *Mobile handsets*

Bluetooth has become basically a default standard on mobile phones, particular for connecting accessories such as headsets. Early on during the process of inclusion, the ability to use these mobile handsets as Internet modems by tethering the devices to other Bluetooth enabled devices such as laptops was indicated as a key use of the technology. However, some MNOs were reluctant to allow such use over their networks and the terms and conditions attached to mobile contracts indicated this. Since the Bluetooth standard has the ability to specify connection profiles defining connectivity services allowed for each device, it is relatively straight forward now for mobile phones to include Bluetooth connectivity while restricting the ability to use these devices as Internet modems.

An increasing number of mobile devices have begun including Wi-Fi as a connectivity option. More specifically, the particular class of devices where this is most prevalent are known as smartphones. Representative examples of this class of devices include the Blackberry and the iPhone (from Apple). While there is no industry wide standard definition for a smartphone, a key differentiator between smartphone and other mobile phones is the existence of a general purpose operating system such as is available on PCs capable of running many applications. Such general purpose OSes include Symbian (by Nokia), Windows mobile, Blackberry OS, iPhone OS and Android (by Google).

At the leading edge, some smartphones are beginning to include mobile TV connectivity. For example, the Nokia N96 includes DVB-H for mobile TV reception. Additionally, as we discuss later with regards to FMC, there are handsets that include Unlicensed Mobile Access (UMA) standards which allow these devices to roam easily over wireline and wireless access networks without interruption. An example of this is the wireless handset offered by BT as part of its Total Broadband Anywhere package.

According to Cisco,[28] Scartel (Russia's first provider of high-speed wireless Internet) is now offering a converged service using an HTC GSM/WIMAX capable handset. This will allow the operator to offer innovative tariff 'friend and family', where tariff between two HTC handset users will be cheaper as the call will be routed through the WiMAX network, using VoIP. We do not have any information regarding tariffs, price of the handset and take-up of such service, but we believe it to be very modest as it has just started in February 2009. It should be noted that such handsets could also be used to provide FMC services to the enterprise market, by placing WiMAX femtocells in all offices and using the service in a similar way to UMA.

► *Other devices*

Outside the general purpose computers and mobile devices discussed above, a number of technological developments are widening the pool of devices that are able to access the Internet in multiple ways, or offer multiple services over the Internet using a single device.

In the first category, the most significant development is the availability of wireless 3G datacards which allows any device with an OS and USB ports to connect to access the Internet over the mobile network. In effect, the USB standard makes it possible to adapt any connectivity standard for usage over general purpose machines, which is what 3G wireless dongles take advantage of.

In terms of multiple service offering over a single device, continuing development of multimedia entertainment devices such as gaming consoles and music players has now expanded the number of ways to access voice, video and data services over the Internet. Thus, the XBOX 360 console from Microsoft, in addition to delivering interactive gaming over the Internet can now be used as a home media hub delivering streaming video over the Internet as well as basic Internet access and voice communications. Similarly, the iPod touch from Apple can now be used to watch videos over Wi-Fi connections as well as access the Internet and download music.

Cloud computing

In the context of providing robust and effective access to Internet service, one solution is increasingly gaining prominence is cloud computing. Cloud computing can be a very broad term and its particular usage can depend on the context in which it is used. Various scenarios that have been included on the umbrella of cloud computing include the following:

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[28] Cisco Powers First 4G Network in Moscow and St. Petersburg, Cisco press release, 2009.

- **Grid computing** – involves networking a large group of servers located in data centers together to harness their power.

- **Utility computing** – the delivery of services to end-users using a multi-tenant architecture. Effectively it means that consumers are able to access services they need (be it actual applications such as spreadsheet programs, computing power for enterprises or any other service that can be delivered over a data connection) without laying out expenditure on either hardware or software (cost or licensing), while providers only need to incur the costs of maintaining a few services. Additionally both parties can take advantage of quick upgrade cycles to the services provided.

Of these two, utility computing is most relevant to emerging market stakeholders. While the idea itself is not new – there have been various attempts since the advent of computing to centralize computing and storage needs while making end-user devices primarily input/output terminals – the reason for the increased focus on cloud computing now is the increase in the critical mass of consumers connected to the Internet as well as the critical level of access speeds being reached which make interactivity over long distances a much more agreeable user experience.

Cloud computing is likely have significant impacts on the use of Web services:

- cloud computing shifts computing power back into the core (as in the days of mainframes) and away from the edges of the network (as resulted from the innovation of the PC)
- users can access the power of the network from an increasing array of devices including mobile devices and even "dumb" terminals similar to those used to access mainframes
- companies can access the power of the cloud of companies such as Amazon or Google as a "utility" service rather than having to invest in their own servers and software.

Some of the biggest proponents of cloud computing services today are companies which make their living by providing services over the Internet. Google and Amazon in particular have taken leading roles in deploying the infrastructure necessary to have a robust web application service platforms.

However, the cost of deploying infrastructure that is capable enough to deliver the services required by end-users reliably is quite significant. In the US for example, Google reported USD1.9 billion in spending on data centers in 2006 and USD2.4 billion in 2007, and is believed to operate at least 39 such centers containing at least one million servers and adding new ones at a rate of four per year by one estimate. As such, the barriers to entry for new entrant service providers wanting to offer infrastructure based cloud computing can be quite high.

Converged devices in emerging markets including Peru

We have discussed extensively in this section about the breadth of options increasingly available to access IP enabled services, and the standards that make this possible. However, the key determinant of the impact of these devices in emerging markets is always going to be tied to affordability of these devices. The table below shows the typical price ranges of the devices discussed above.

Category	*Examples*	*Price (USD)*
Desktops	Dell Optiplex, Sony VAIO, Lenovo	300–1200 depending on options
Laptops	Apple MacBook, Dell Inspiron, Sony VAIO	300–1800 depending on brand and options
Netbooks	Asus EEE, HP 2133, Acer Aspire	200–360
Mobile handsets	LG CE110, Sony Ericsson W350	150–200
Smartphones	Nokia N95, Apple iPhone, RIM Blackberry	350–600
Mobile data cards	AT&T 3G data card, XOHM WiMAX card	150–200
Next-gen gaming consoles	XBOX 360, Sony Playstation 3	250–500
Multimedia music devices	Apple iPod Touch, Microsoft Zune	150–400

Figure 4.49: Price ranges for various converged devices [Source: operator websites]

Currently the need in markets is such as Peru is for devices that enable the widest range of usage of Internet enabled services. As such PCs (particularly netbooks), mobile phones and data cards offering general purpose broadband access at an affordable price are likely to play the greatest role in expanding access to advanced services.

4.4 Other key technology issues

There are a number of other related topics that are not specifically categorized using the structure defined previously for converged networks, devices and services, but which are still relevant enough to be discussed in any comprehensive analysis of convergence. We do so in the following paragraphs.

4.4.1 FMC

FMC is achieved through a number of technologies, notably IMS, UMA and femtocells. The main difference of these individual technologies lies in the point where the two different domains (i.e. wireless, wireline) converge. When using UMA, it is the handset, with femtocells it is the access point and with IMS it is the core network that realizes FMC.

IMS

Historically, operators have deployed services in silos, where a separate, dedicated infrastructure was required for the back-office network, the transport network and the control of network. This approach was highly inefficient, and implied dedicated resources to maintain each service. It also made converged – i.e. cross-siloed – services technically, and commercially, impractical.

IMS is a standardized service delivery architecture that offers the opportunity to change this approach and to leverage existing infrastructure by providing a common service architecture for a wide variety of services across many different access network. A typical IMS architecture is illustrated in Figure 4.50.

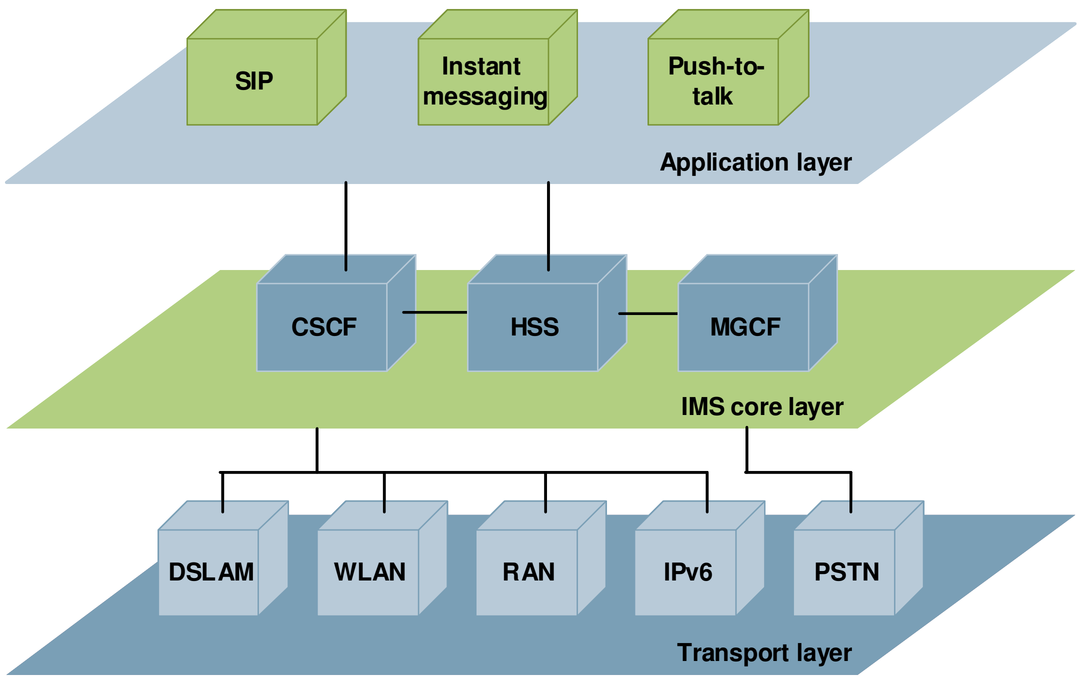

Figure 4.50: IMS architecture [Source: Analysys Mason]

An IMS enables FMC, as it allows both wireless and wireline terminals to access the same network service. To achieve this, it implements a horizontal control layer, which operates independently of the access network from the service layer. The IMS relies on the SIP to control multimedia sessions such as video conferencing, presence based services etc.

The user can connect to an IMS network using standard IP. SIP and IPv6 capable mobile telephones, personal digital assistants (PDAs) and computers (direct IMS terminals) can register directly on an IMS network, even when they are roaming in another network or country.

IMS supports a multitude of access technologies through dedicated interfaces: wireline access (e.g. DSL, cable, Ethernet), wireless access (e.g. 3G, CDMA2000, 2G, GPRS) and wireless access (e.g.

WLAN, WiMAX). Other systems like POTS, H.323 and VoIP systems that are not IMS compatible, are supported through gateways.

As illustrated in Figure 4.32, the IMS can be divided into two different groups of network elements, i.e. IMS core and IMS applications. The IMS core network elements are briefly explained below:

- **Home subscriber server (HSS)** – the central database handling subscription-related information, and performs authentication and authorization of the user. It compares to the AUC and HLR in GSM technology.
- **Call session control function** (**CSCF**) – several SIP servers or proxies are used to process SIP signaling packets in the IMS and are collectively called CSCF.
- **Media gateway controller function** (**MGCF**) – performs control protocol conversion between SIP and ISUP (i.e. circuit switched voice).

As the IMS is a collection of functions, there remains a number of additional functions as shown in Figure 4.50. These functions cater for very specific use cases and do not necessarily require their own hardware and can be integrated into one of the above network elements.

The second group of network elements are the application servers. They host and execute services, and interface with the a specific type of CSCF (i.e. S-CSCF) using SIP. An application server can be located in the home network or in an external third-party network. Standard IMS application servers of an IMS usually are the presence server (i.e. showing whether an IMS user is online) and the push-to-talk server.

IMS offers the following advantages:

- fast deployment and ease of integration
- multimedia support
- global roaming
- interoperability.

These advantages are explained in further detail in the following paragraphs.

► *Fast deployment and ease of integration*

IMS is being standardized in terms of functional blocks, it will therefore enable the fast deployment of new services, and a minimum level of integration, as new applications will be developed with the API standard, i.e. a set of routines, protocols, and tools for building software applications that directly interface with the IMS domain. This will reduce operator opex and capex spend. Multimedia support, one of the many benefits of IMS, is the opportunity to offer multiple, and simultaneous, media streams to the users.

► *Multimedia support*

Although multimedia services have been available in the past, using existing technology, they have always proven difficult to deploy, costly, and inefficient in their use of network resources. IMS offers the unique opportunity to provide a common delivery platform combining legacy applications emulated in SIP with new applications native to SIP.

► *Global roaming*

One of the functions of the IMS domain is to allow seamless roaming between different wireless and wireline access technologies. R6 of the 3GPP standard defines a roaming architecture for IMS that will facilitate mobility between the Wireless LAN domain and cellular access networks. R7 of the 3GPP will take this concept further, by making roaming seamless between Wi-Fi, DSL, 2G, 3G and other access networks. This, of course, will not be limited to a single operator, but will form a stepping-stone to provide true global roaming for users. In this respect, IMS will be a key enabler to provide mobility and services anywhere to the user.

► *Interoperability*

One of the most attractive features of IMS is that it is a standardized technology, and as such will be inter-operable between operators. Initially standardized in Release 5 of the 3GPP wireless architecture, IMS has gained significant interest from the wireline access network community, and the ETSI TISPAN and ITU Study Group 13 (NGN) are now actively collaborating to create a standard technology across both wireline and wireless communities. In the past, operators often developed their own services that could not be made available outside the operator's home network. The implementation of the IP Multi-media Subsystem domain will facilitate inter-operability at different levels, including:

- between applications
- between network vendors
- between network operators, enabling services to be provided to their customers independent of their geographical location
- providing interoperability between different operators is probably the key enabling factor that will ultimately decide of the success of IMS.

IMS will integrate seamless technologies and devices, and will enable new services with a significant improved time to market, and enhanced interoperability between application, vendors and operators. The fact that it been chosen as a common application delivery platform from both wireless and wireline network standardization bodies makes it a key technical enabler for FMC and the delivery of multimedia services.

UMA

UMA refers to the 3GPP standard called generic access network (GAN). The purpose of GAN is to extends telecommunication applications such as mobile voice, data and IMS/SIP over IP access networks. The most common use of UMA is the dual-mode handset service, where users can roam between the cellular GSM/UMTS network and a private wireless unlicensed network such as Bluetooth and Wi-Fi. The UMA Architecture is described in Figure 4.51.

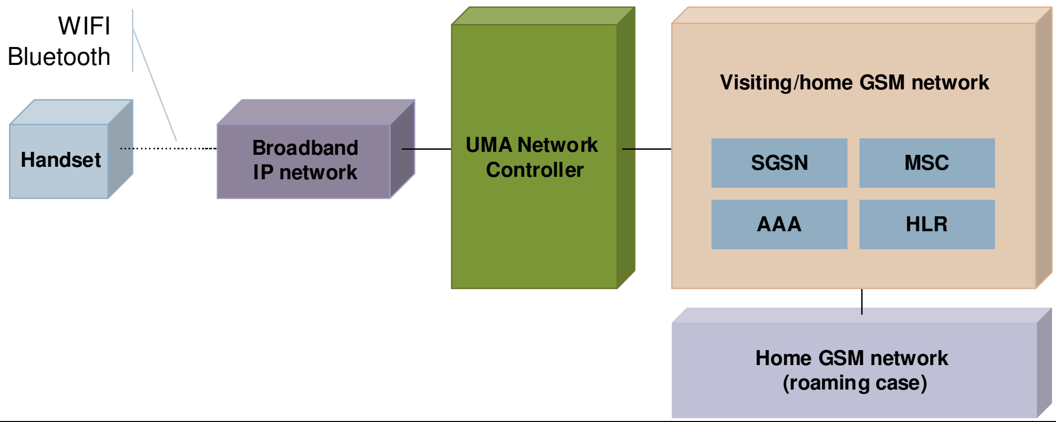

Figure 4.51: UMA architecture [Source: UMA Technology]

Examples of UMA-based services include BT fusion in the UK and Orange Unik dual mode services. BT Fusion, uses UMA to provide seamless roaming between broadband access and the Vodafone cellular network for voice services. France Telecom's MNO subsidiary Orange also implement UMA with their Unik dual mode services being commercially available in 5 countries (Poland, Spain, France, the UK, the Netherlands).

UMA and femtocells are two different means to reach the same end, being FMC. However, UMA needs a new handset and works with existing access points, whereas femtocells work with existing handsets, but require the installation of new access points.

Femtocells

Femtocells are residential indoor base stations that aim to provide satisfactory coverage in a typical home. Femtocells provide access to standard 2G and 3G handsets and act as regular base station using regulated spectrum, albeit with a much smaller capacity in terms of concurrent users. They use established wireline broadband access connections, such as DSL or cable, as backhaul from the home to the cellular network. Femtocells need to be small, inexpensive, easy to install (by consumers themselves) and aesthetically attractive to be successful in this environment.

For MNOs, deploying 3G femtocells can be much less expensive than deploying new macrocells to achieve high-quality home coverage. Customers are likely to pay for at least part of the cost if femtocells give them service and tariff benefits as well as coverage improvements, and backhaul from 3G femtocells to the cellular core network will be achieved through customers' own DSL (or other broadband) services.

As well as cost savings, 3G femtocells will bring MNOs a range of other benefits, including increased voice revenue (by accelerating FMS), an opportunity to bundle DSL with their mobile services, potential revenue from improved 3G data services (such as mobile TV) in the home, opportunities for group tariffs based on the home femtocell, churn reduction, and defense against competition from converged cellular/WLAN services based on UMA.

However, we believe that the impact of this particular technology will be limited in Peru, due to the low levels of current and expected teledensity.

Implications of FMC for the Peruvian market

Due to the significant capital expenditure associated with the introduction of IMS, take-up by telecom operators has still been slow. There are a number of alternative and overlapping technologies for access convergence and the provisioning of fixed-to-mobile services, such as UMA, soft switches and SIP-only servers. It seems that operators find it easier to sell individual services than to market integrated services. Additionally, when taking the initial capex into account, IMS based services are often more expensive than services based on alternative systems which provide that same functionality. Albeit the technical superiority of IP Multimedia Subsystem over a likely patch-work of alternative services, the business case for many operators to introduce this capital intensive and potentially service disruptive technology remains still unproven. We do not expect IMS to be deployed in the Peruvian market in the short to medium term.

UMA is a technology that is currently available, and cost effective to deploy and implement. However, there are potential flaws. In itself, UMA does not provide any new end user services, but just connectivity to legacy services. How operators will persuade customers to pay more for the same service set that are expected to be cheaper under WLAN coverage compared to cellular is still unproven. Also, while UMA is promoted as a relatively inexpensive solution, given it integrates directly within the GSM/UMTS core network, the cost associated in supporting the additional users and bandwidth on the GSM/UMTS core network may be higher than expected. It should also be noted that UMA compliant terminals are still expensive and their range remains limited which represents a major barrier in many markets. Finally, UMA only addresses roaming between WLAN (Wi-Fi or Bluetooth) and the cellular network (GSM/UMTS), and does not provide a roaming solution for other access network technologies.

We also discussed the use of femtocells as another mean to provide FMC for completeness but its business case is still largely unproven and we do not anticipate the deployment of femtocell in the Peruvian market in the short to medium term.

4.4.2 Advanced R&D for converged technologies

With a relatively small wireline access network infrastructure, particularly for consumer access to services it is likely that technologies such as fiber to the home will only be used in niche deployments for example in private deployments of greenfield housing for a small proportion of the population. The candidates for FTTH in such circumstances will be one of GPON or active Ethernet both or which are becoming relatively mature through deployments elsewhere in the world. The final choice will typically be a carrier decision.

Equally, with only low availability of wireline broadband access services, the reality is that femtocell deployment- the subject of considerable debate in advanced markets may be largely irrelevant in Peru.

Instead we believe that there are important areas of base technology development that will be vital to the successful rollout of appropriate solutions in Peru. Key solutions will incorporate one or more of the following for the reasons stated:

- better portable device power sources (long life or cheaper batteries, or altogether new technologies such as reliable low-cost fuel cells)
- low power consumption circuitry – to again assist in providing long standby and usage times where power is difficult to source
- appropriate interface devices for user input – these may be very basic simple or even absent in order to keep usability simple for instance where literacy is low and basic functionality is all that is required

cheap entry-level devices for the masses; expensive terminals are not required – they are not simply not affordable.

Green issues expressed in terms of future waste management and total energy consumption/CO2 production over the expected lifetime of goods intended for mass deployment in fast-growth markets like Peru is likely to feature increasingly in discussion about efficient usage of resources going forward.

5 Competition and convergence

This section focuses on the impact that convergence may have on competition, and how this might affect relevant markets in Peru. The goal is to highlight areas where regulation can help to promote the deployment of converged networks, services, and devices, in order to reap the benefits of competition. The specific regulatory policies that we recommend will be detailed in Section 6.

5.1 General assessment of competition trends in Peruvian telecommunications market

Competition analysis and regulation are customarily based on defining specific markets and analyzing the provision of goods and services within specific boundaries. In the communications sector, this has historically meant that the fixed, mobile, TV and radio industries have been treated as separate markets, as illustrated in Figure 3.1. As discussed in Section 3, and shown in Figure 3.2, convergence removes barriers that formerly separated these networks and services, and thus heightens competition at all levels.

In the context of assessing competition, convergence changes the definition of the relevant markets which are appropriate for determining what modifications and remedies need to be made to existing regulatory frameworks. For instance, many regulatory authorities are now finding that fixed and mobile voice services are being used in many cases as substitutes for each other – in particular, mobile voice services are often being used in preference to fixed voice services (the phenomenon referred to as fixed–mobile substitution, FMS).

In this scenario, where previously fixed voice may have been deemed an essential service subject to monopoly regulation, a wider market of general voice telephony could be judged much more competitive (for example, a voice telephony market with one wireline access provider and multiple wireless access providers) and this could lead to a lessening of the regulation on fixed voice services.

To facilitate the analysis of the impact of convergence, it is helpful to look at competition using two approaches, namely the level of competition in the market and the infrastructure used by an operator to provide services. These are considered below.

Level of competition in the market

Competition analysis can be dimensioned by the level of the delivery chain at which competition is occurring:

- **Retail competition** – the vibrancy of retail competition is the acid test of the performance of a telecommunications market from a consumer perspective. While retail market shares provide a useful but limited indicator of competition reaching consumers, we must bear in mind that ultimately what matters to consumers is the service offering and pricing, rather than the underlying competitive mechanics.

- **Wholesale competition** – Access at the wholesale level is crucial for effective service-based competition, and typically requires close regulation. While this may change in the access part of the network as service-based providers use IP to offer services, it is likely to remain true that service-based and facilities-based operators will benefit from wholesale access to the core network, such as leased lines.

Infrastructure commitment of operator

Competition can also be analyzed in terms of the infrastructure and technology used by an operator to provide services, and can be characterized as follows:

- **Depth of competition** – With **facilities-based competition** the access infrastructure provider is also the retail service provider: i.e. the organization is a vertically integrated operator. Traditionally, **service-based competition** involved the service provider leasing the last-mile infrastructure from an access infrastructure provider on a wholesale basis – this includes service providers relying on local loop unbundling (LLU), bitstream and resale offers. This changes under convergence, as service-based competitors can now provide voice and video services over IP without necessarily accessing the underlying infrastructure.

- **Access technology used** – Section 4 extensively discusses the various access technologies that underlie converged networks. Each access technology has its own advantages and limitations, both from a technical viewpoint and in relation to the historical conditions specific to each country. In this section, we will focus our analysis on how competition in terms of the access infrastructure provided is impacted by convergence.

In a study we carried out for the European Commission in 2006, we assessed the impact of various trends and changes on the telecommunications market using a framework defined by these two characterizations. More specifically, we can visualize the broad Peruvian markets along two key axes defined by the characteristics explained above:

- **Importance of network ownership** – At one extreme, the market is dominated by large, vertically-integrated players, while at the other extreme there is equal network access for service providers and owners of network infrastructure alike – in other words, networks have become a commodity. In the latter case it is likely that consolidation will still drive a trend towards fewer, larger players, but there is more likely to be scope for small, niche players to survive.

- **Multiplicity of access networks –** At one extreme, there is a single access network, while at the other extreme, there are multiple access networks using a variety of technologies. Again, the latter case offers the best prospects for small players to survive.

While this particular study is not focused on specifically defining the relevant markets that would be most appropriate in a converged telecommunications environment in Peru, the analysis of competition under a converged environment is categorized around dimensions that cross some relevant market boundaries which are more appropriate for examining fully the effects of convergence.

In order to provide a coherent and condensed overview of how the sector is likely to develop we simplify matters by considering the impact of convergence on five broadly defined markets. These five broad markets are wireline narrowband services (including dial-up Internet access and long-distance telephony), wireline broadband services, wireless voice services, broadcast TV distribution services, and wireless broadband services. Figure 5.1 below presents our view of where these markets in Peru currently fit against the two axes described above.

The size of the circles is illustrative of the relative size of the markets in revenue terms

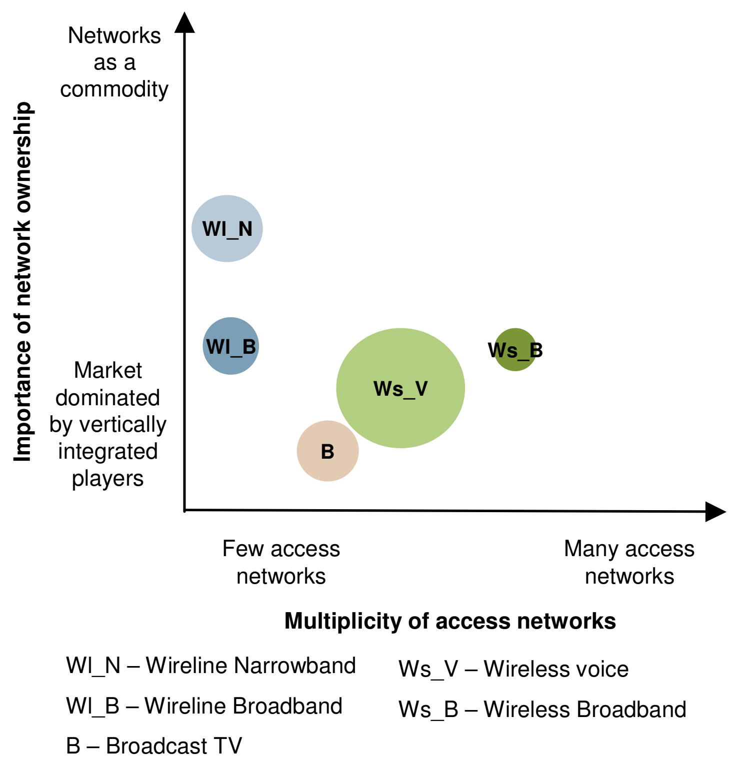

Figure 5.1: The broad Peruvian telecommunications markets [Source: Analysys Mason]

The **wireline narrowband market** is primarily based on Telefónica's network, although Telmex and a number of other cable operators do provide some competing infrastructure. Relatively strong regulation (such as the deregulation of long-distance services in 2007) has opened up the market for competition in basic long-distance telephony services over Telefónica s infrastructure.

The **wireline broadband market** is almost completely dominated by Telefónica , although Telmex indicated that is has rolled out DOCSIS 3.0 in its cable network. Currently, Perusat is the only company offering third-party managed services over broadband connections (VoIP), and with 0.2% of the market, its impact is minor.

The **wireless voice market** has three active MNOs, as well as a number of fixed wireless access networks providing voice services, spanning a range of technologies and frequencies. However, with no MVNOs in the market as of yet, and no alternative providers of other basic services such as long distance or international calling (or even reseller relationships in terms of branding and marketing), the market is dominated by vertically integrated operators.

Terrestrial and cable TV networks as well as satellite distribution mean that the **broadcast TV market** does have a number of alternative networks to Telefónica's incumbent system, and these have made sizable impacts on the market. However in all cases, vertically integrated operators control all aspects of the delivery platform and retail relationships with viewers, to a greater extent than on the other telecommunications networks.

The **wireless broadband market** is at the earliest stage of development. Five WiMAX networks, along with HSPA upgrades to the existing mobile networks, mean that there is no shortage of infrastructures that will be able to offer wireless data services. As with broadband networks in general, it is harder for vertically integrated operators to dominate service provision to the extent possible in the market for basic telephony services, due to the fundamentally agnostic nature of broadband data.

The sections below describe the competitive implications of convergence from the perspective of the infrastructures being deployed (Section 5.2), the services being provided (Section 5.3) and the devices over which these services are used (Section 5.4). Note that most of the commentary will be focused around broadband access and IP-enabled services, as these are the key components of convergence. With respect to Figure 5.1 we note that convergence has two particular impacts, which we explore further below. First, at the network level, as more networks become broadband capable, this effectively increases the number of networks resulting in a beneficial move rightward along the horizontal axis; likewise, the Internet Protocol acts to separate the network from services, thereby effectively mitigating the impact of vertically integrated networks and resulting in a move upward along the vertical axis of this figure. We address this impact below in our final assessment in the Conclusion to this report.

5.2 Competition between converged network operators

The technology mix used to supply telecommunications and media services is dependent upon the historical and current factors that may differ among countries. Given different starting points, it is unsurprising that the process of convergence is leading to different market structures. For example, in developed countries, incumbent wireline telephony operators without wireless offerings (such as BT in the UK) were in danger of losing business due to FMS. These operators, however, have gained a new lease of life by selling data and IPTV services at speeds that mobile networks are as yet unable to match, as well as offering products that combine features of fixed and mobile services (FMC) through wholesale access to mobile networks.

In most developing markets with less extensive and developed wireline access infrastructure, the dominance of wireless access and the onset of new generations of wireless access technologies gives MNOs an opportunity to take a leading role in making advanced data and video services available to consumers, an opportunity not necessarily shared by their counterparts in developed countries.

The USA is a proponent of the prominent school of thought that multiple access infrastructures are the basis for vigorous competition, leading to affordable and innovative services without the need for heavy regulatory oversight.[29] For instance, the USA largely abandoned attempts at promoting service-based technology via unbundled network elements in favor of **facilities-based competition between incumbent telecommunications operators and cable** companies. This reasoning holds that where there are multiple networks to deliver services, as in the USA, operators can compete not just on price but on innovation through upgraded technology standards and equipment. Indeed, in large parts of the USA cable companies took the lead in offering broadband and triple-play services based on DOCSIS 2.0, leading to the deployment of FTTx by the incumbent telecommunications operators, which in turn led to the upgrades to DOCSIS 3.0 that are beginning to be implemented.

However, deploying a network can be a very costly proposition and demands a large amount of upfront investment. Historically, in most countries there was a single incumbent wireline telecommunications infrastructure operator which provided voice telephony services, and was run by the state authorities. Following the wave of privatization and liberalization, the majority of incumbent telecommunications infrastructure operators became commercial. In most European countries, which have generally have less extensive cable networks than in the USA, there were few alternatives for the provision of wireline services, so regulatory remedies focused on ways to introduce service-based competition via bitstream access and unbundled local loops. This has been largely successful, as some of the alternative operators have been quite innovative with higher-speed broadband services and the introduction of IPTV. However, the presence of these alternative operators is now creating difficulties, as the incumbents are planning to move to FTTx networks where wholesale access is not as straightforward as with the current network infrastructures.

With the deployment of wireless networks where there are fewer barriers to deploying competitive networks, regulators in developed and emerging markets focused on ensuring that there were enough operators for effective competition, and on removing barriers to effective competition between well-established operators and new entrants, e.g. the requirements for, and regulation of, interconnection agreements between operators. Most countries have had at least two nationally licensed wireless operators deploying their own physical equipment. Nonetheless, as the plans for

29 See the 2001 speech delivered by FCC commissioner Michael Powell on Digital Broadband Migration which stated that facilities-based competition is the ultimate objective for the FCC, and competition in digital broadband should come from many platforms. (http://www.fcc.gov/Speeches/Powell/2001/spmkp109.pdf)

deploying NGNs are investigated, even MNOs in developed countries such as the UK are exploring ways to share infrastructure costs.

In the case of TV and radio communications, OTA reception meant that multiple TV service providers could be licensed. Satellite and cable TV also offered alternative methods for accessing TV services (particularly premium content) in parallel with the free OTA offerings, and remain largely unregulated in terms of wholesale access and pricing in most of the world. New broadcasting standards (detailed in Section 4.1.6) promise to increase competition in this sector even further.

It is important to note that the deployment of multiple infrastructures does not always guarantee low prices and innovation, and there are several examples where facilities-based competitors have been satisfied to offer the similar services to each other. For example, the mobile network operators in the USA all have similar restrictions in the terms and conditions of access to their networks, restricting usage of services such as VoIP and video downloads even though such services are technically feasible.

Developments in convergence have somewhat blurred the traditional boundaries between core and access networks (e.g. the introduction of femtocells – which we discuss in Section 4.4.1 – as end-user devices), but the distinctions still broadly hold. It is important to keep this in mind as we turn to discuss in greater detail the impact of convergence on competitive dynamics in the access and core networks. We then discuss the role that infrastructure sharing plays in relation to convergence.

We commence by looking at the impact of convergence on telecommunications and media access. We previously noted that most advanced services enabled by convergence (and even an increasing number of basic services) are predicated on the presence of an Internet connection – in later sections of this report we discuss further the various technologies and standards that are used to provide broadband access over a variety of media. Broadband access penetration can thus often be used as a proxy metric for analyzing the process of convergence and understanding its impact on converged networks. The next few paragraphs analyze the take-up of broadband access worldwide.

Worldwide take-up of broadband access

xDSL is still the most common type of fixed broadband access, followed by cable. The remaining connections correspond to other access technologies such as FTTH, fixed wireless broadband (FWA), and satellite-based broadband systems.

Cable broadband access can often provide intense competition in its coverage areas, as evidenced by countries such as the USA, Canada, Singapore and the UK. However, cable broadband competition is absent from many countries and limited in others, making DSL-based (or FTTx) competition that much more important. The extent of cable broadband competition is partially attributable to the extent to which cable was historically a primary option for TV access (such as in the USA, Canada and Singapore).

Of the alternative access technologies, FTTx has made the most inroads in Asian countries such as Japan, Hong Kong and South Korea, although DSL still predominates. Broadband fixed wireless access (FWA) and satellite have begun to have more substantial impact in a number of countries, capturing significant portions of the market in countries such as Japan, South Korea and Sweden.

In contrast, the development of broadband access has been much less pronounced in emerging markets. Figure 5.2 below depicts the number of broadband connections in Latin American markets. In Peru, Telefónica is the principal proponent of broadband Internet services by virtue of both its dominance of the local loop and its presence in the cable TV sector. By December 2008 the company presided over a network of over 697 458 broadband lines (96.3% market share), the bulk of which are DSL lines. DSL services are offered under the 'Speedy' banner, a name which is also extended to the company's Wi-Fi option.

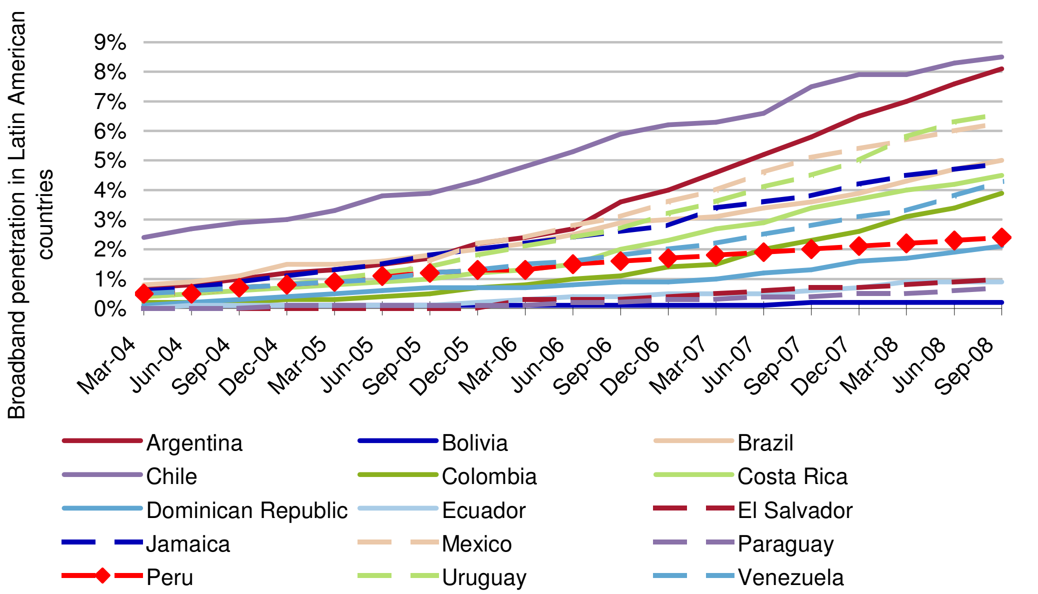

Figure 5.2: Broadband penetration in Latin America countries [Source: Globalcomms]

In addition to reaching far fewer consumers, access speeds offered by these connections have also tended to be limited, trailing the multi-megabit speeds seen in developed markets. In November 2008, for example, Telefónica increased its DSL speeds to a maximum of just 2.5Mbit/s.

Much is made of the potential of wireless access broadband to help bridge the digital divide apparent between developed and developing markets caused by these disparities. In terms of network reach, this is certainly the case, and mobile networks in particular have an opportunity to take advantage of the fact that wireline networks are limited in emerging markets.

However, even in developed markets, wireline operators are facing pressure from wireless access operators. Wireless broadband is now enjoying significant levels of take-up, and the numbers are worrying for DSL and cable players. In several European markets, more than 15% of broadband subscriptions are now for cellular networks – up from almost zero one year ago. The number of net additional subscribers for wireless broadband is currently far in excess of those for DSL, and evidence suggests that 30–50% of wireless broadband subscribers use it as a substitute for wireline broadband.

Partly to combat this trend and partly as a result of continuing innovation, wireline network operators continue to increase the access speeds available over their networks (through the usage of fiber and DOCSIS 3.0, for example) and promote the usage and take-up of advanced services (particularly TV and video) which require these high bandwidths.

As a result, wireline access continues to maintain a healthy lead over wireless access in terms of available bandwidth, but wireless access is beginning to offer bandwidths that enable many converged services. Setting aside the issue of network reach, the challenge facing incumbents and other wireline telecommunications operators in emerging markets is *if, when* and *how* to upgrade and expand the wireline access infrastructure within the country in order to offer these advanced services.

In the following sections we look at next-generation wireline and wireless access, as well as the potential opportunities presented to emerging market operators in the context of convergence.

5.2.1 Next-generation wireline access

In many developed countries, there has been a recent push to upgrade existing networks to FTTx, in order to enjoy the benefits of convergence and keep up with countries that were early adopters of those technologies. Deployment has largely been commercial, although in some countries such as Singapore governments have taken a role to rectify perceived lags in deployment.

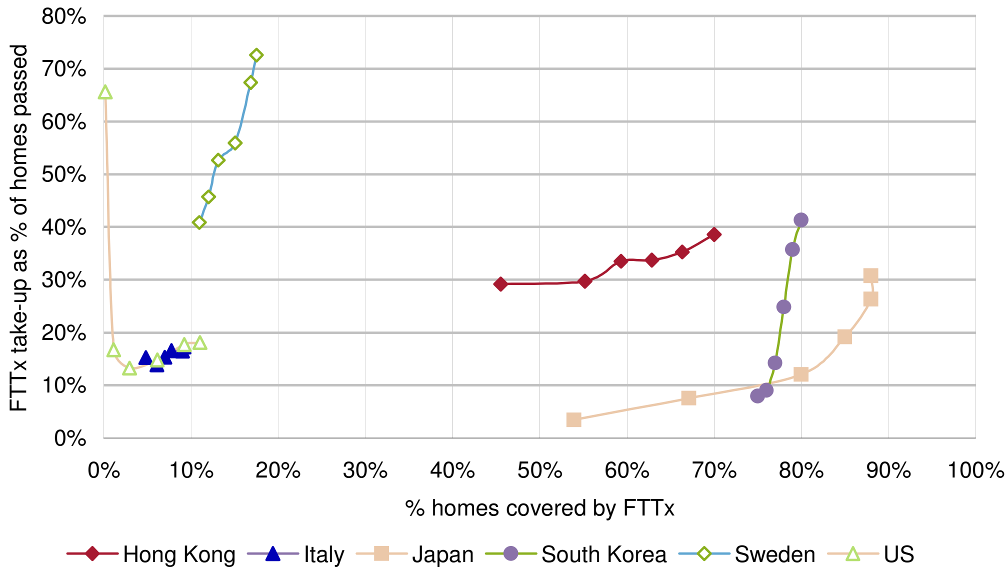

Figure 5.3: FTTx coverage versus take-up as a proportion of homes passed (2003 to June 2008) [Source: Analysys Mason; FTTH Council; OECD]

Figure 5.3 presents data from six leading FTTx deployments worldwide. It shows that at low coverage levels there is wide variation in take-up as a proportion of homes passed, even when services have been available for some time. When FTTx is more widespread, take-up quickly reaches levels in excess of 30% of homes passed. Categorizing the FTTx approaches adopted in each of these six countries provides some insight into how far FTTx deployment can be encouraged, providing a solid base for rapid take-up.

- In the **USA**, coverage has only recently exceeded 10% of homes passed; take-up amongst these homes is still below 20%, and is increasing relatively slowly. The rollout of FTTx is driven by the incumbent and is purely commercial: high-density areas where the business case for next-generation access is clearer have been targeted in response to competition from cable companies.

- In **Italy** and **Hong Kong**, the deployment of FTTx has been driven by new entrants and has been purely commercial as a result of either favorable demographics (Hong Kong) or a desire to invest in infrastructure where LLU is unattractive or unavailable (Italy). The evolution of coverage and take-up in Italy closely matches the USA, while Hong Kong has seen higher take-up, partly explained by the relatively uncommon demographics present in Hong Kong.

- **Sweden** has experienced high levels of take-up due to the open-access nature of the networks deployed. However, FTTx roll-out has been municipality-based and therefore essentially piecemeal in approach. Consequently, high coverage is unlikely in the medium term.

- FTTx networks in **Japan** and **South Korea** have been backed by the government and this support, including tax breaks and other incentives but not capital investment, has led to high coverage (with incumbent involvement) combined with high take-up. A significant factor is that in these countries the high incidence of multi-dwelling units makes the economics of FTTx more favorable than in many other countries.

Outside Hong Kong, there have not been any purely commercial FTTx roll-outs that have reached a near-national scale, although KPN in the **Netherlands** is starting to build a national FTTH network. Meanwhile, the public sector is directly investing in FTTx in a number of countries (e.g. Singapore, Malaysia and Australia) with the precondition that these networks are open access. When conditions are right, we would expect to see these initiatives reach take-up levels of 30–40% of homes passed within 5–7 years.

Emerging markets have very interesting choices available to them when it comes to deploying fiber access networks. While national fiber backbones for core networks are generally agreed to be essential, there is much less consensus over fiber access networks. In particular, there is a large upfront cost in deploying fiber access architectures that can only be balanced out by significant uptake and utilization of such networks. In new deployments there is certainly a better case for using FTTx instead of installing a copper network, but nonetheless the economics of an FTTx network are still less cost effective than those of a wireless network in many cases.

With the ongoing upgrades to wireless access speeds, the subset of services which can only be offered over wireline access connections continues to shrink. Already it is possible to offer general data over wireless connections, and mobile video continues to be seriously investigated, with upcoming deployments such as MediaFlo in the USA or DVB-H in Europe, showing the potential of TV and video over wireless networks.

The problem for wireline access operators in emerging markets is that often (especially in the short to medium term) consumer needs will be met by the speeds being offered over wireless networks, making it hard to persuade these consumers to take up more expensive (though faster) services. Therefore, although there are certainly longer-term issues to be considered in the regulation and possible promotion of FTTx access in emerging markets, we focus predominantly on wireless access networks in Section 6, as a means of meeting OSIPTEL's goal of ensuring a sufficient level of access to enhanced services by the majority of the population.

5.2.2 Next-generation wireless access

In order to be able to offer advanced wireless broadband services (and, looking forward into the future, wireless video services), many operators have had to evaluate their future technology deployment choices for upgrading their networks and select their upgrade paths. We described in Section 4.1.3 how the upgrade paths for 3GPP, 3GPP2 and WiMAX are converging, although this is unlikely to happen in the short to medium term. Therefore, operators still have to make decisions on which next-generation technologies to deploy.

In common with the structure laid out in the technology analysis, we will look in this section at the competitive dynamics of the three relevant wireless access technologies in the context of convergence, and then briefly discuss the competitive implications for Peru.

W-CDMA and CDMA2000 and the path to LTE

The success of wireless access in bringing basic telecommunications services to people around the world (and particularly in emerging markets) has been well documented, and mobile telephony continues to be a significant success story. Figure 5.4 below illustrates growth enormous growth in the number of mobile connections worldwide over the last 15 years.

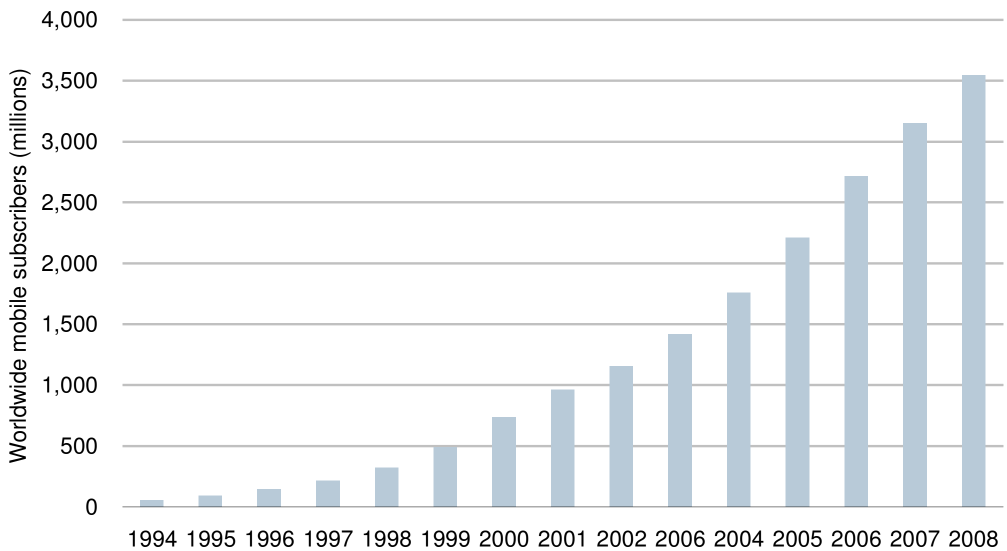

Figure 5.4: Worldwide mobile connections, 1994–2008 [Source: Euromonitor]

On the heels of convergence, the natural question is whether wireless networks can replicate this success with regards to other more advanced services. Of the three classes of converged services that can be delivered over converged networks, wireless broadband access is generating the most discussion by interested stakeholders around the world. Voice telephony is already well established, while mobile TV is still in its infancy (although in developed markets, mobile TV in particular is also beginning to attract a lot of attention).

We previously described the spectrum bandwidth requirements for wireless broadband in order to be able to provide higher access speeds. Competitive spectrum issues are covered in more detail in Section 5.2.3 below.

In developed markets, mobile penetration (measured in terms of number of SIMs per capita) has nearly reached a saturation point, exceeding 100% in many countries. Even in countries such as Canada and the USA where take-up initially lagged, user penetration is now well over 80%. As a result, MNOs are having to look for other ways to grow their business revenues, rather than simply attempting to add more subscribers.

The typical way to do this is to up-sell an operator's existing subscribers additional advanced services, the most prominent of which today is general data access over mobile devices. While initially the usage of data over 3G networks was deemed disappointing, a surprising level of growth has been seen over the last two years. For example, Analysys Mason estimates by the end of 2008, some 18% of new broadband connections in Europe were mobile, bringing the share of wireless broadband as a proportion of total broadband up to 3%.

The evolution paths for CDMA2000 and GSM technology have converged to the extent that the major technology backer of CDMA2000 (Qualcomm) has dropped its support for the next generation of CDMA2000 access (UMB), and instead has thrown its weight behind LTE for next-generation wireless access. While a number of MNOs around the world have committed to deploying LTE, the standard has not yet been ratified, and LTE networks are unlikely to be seen in the short term.

WiMAX

In developed markets, WiMAX has typically been assessed as a competitor to wireline and cellular broadband, and in this context its outlook has generally been judged as bleak. Competition from cellular operators is fierce, given the widespread deployment of HSDPA, falling prices, and the proliferation of flat-rate services in these countries. The threat of future developments in cellular technology, such as HSPA+ and LTE also reduces the incentive to deploy WiMAX. Wireline network operators are turning the screws on WiMAX still further by extending the reach of DSL, deploying fiber networks and bringing prices down.

For emerging markets, however, the case for WiMAX as a last-mile access infrastructure is much more promising. The ease of WiMAX deployment is advantageous in such environments. With a roll-out time defined in months rather than years, and an ability to quickly and cost-effectively cover difficult terrain, WiMAX offers an attractive proposition to communications providers. In particular, new-entrant providers who are unable to get mobile spectrum can bid for concessions in the WiMAX spectrum bands, and thus get an opportunity to compete against MNOs on a facilities basis, allowing for greater differentiation in the services offered. Analysys Mason forecasts that these subscribers in emerging markets will account for up to 92% (90.2 million) of global WiMAX customers by the end of 2015.

Given these developments, it is not surprising that WiMAX is a vibrant and growing market, with over 150 commercial networks currently in service worldwide. Additionally, a number of other uses have been found for the technology which serve to further solidify WiMAX's future prospects, as well as generate economies of scale that lead to more affordable equipment. These other uses range from extending broadband reach through backhaul provision, to various outdoor applications that require high-speed nomadic coverage, such as broadcasting and emergency services. Two of the additional uses that are of most interest to emerging market operators include:

- **WiMAX as a backhaul solution** – As we described in the technology analysis, WiMAX offers an efficient and cost-effective backhaul solution, aggregating the throughput from several base stations onto a single connection for onward transmission. The typical WiMAX cell bandwidth, allied with MIMO technology, can easily accommodate several 10Mbit/s backhaul links. When compared with point-to-point microwave alternatives, this is a cost-effective means of providing backhaul from many WiMAX base stations. The relatively light weight and physically small size of WiMAX units, and WiMAX's ability to operate in license-exempt spectral bands, ease deployment challenges, making WiMAX a particularly attractive backhaul solution in developing countries. Examples of such deployments include MTN Rwandacell and Mobilink in Pakistan.

- **WiMAX as a campus coverage solution** – WiMAX also offers a potential solution for campus area applications, i.e. applications that a specific organization wishes to use internally and which require communication between widely dispersed but geographically adjacent locations. Commercial deployments are wide-ranging, from support for CCTV, through communication between offshore oil rigs and onshore offices, to wireless connectivity for university campuses (see Figure 5.5). In these applications, the main advantage of WiMAX is that it allows the user to move the terminal end of the equipment easily.

Country	*Operator*	*Type of organization*	*WiMAX deployment*
El Salvador	Fiscalía General de la República (FGR)	Government	Connection between FGR's court buildings, located up to 31km apart
Pakistan	City District Government, Karachi (CDGK)	Government	Used for an IP CCTV video-surveillance project in Karachi
Singapore	Qmax Communications Pte Ltd	WISP	Coverage of main harbor and coastal areas in southern Singapore
France	Any-Port.com Ltd	WISP	Yachting community on the French, Italian and Spanish Rivieras
Mexico	PEMEX	Oil company	Connection of 11 oil ring platforms in the Gulf of Mexico (located off Ciudad del Carmen, Campeche) with mainland corporate office
Yemen	Canadian Nexey Petroleum Yemen	Oil company	The East Al Hajr oilfield operations in Yemen
Ecuador	Estacion Cientifica Charles Darwin en Galapagos	Scientific institution	Coverage for various islands in the Galapagos
India	North Eastern Regional Institute of Science and Technology (NERIST)	University	Provision of indoor and outdoor wireless connectivity across the university's mountainous campus area

Figure 5.5: Selected campus area applications of WiMAX [Source: Analysys Mason, 2008]

The most pressing concern for consumer WiMAX is the availability of CPEs. To date, mobile WiMAX handsets are scarce, and fixed WiMAX is only just coming down in price as economies of scale take effect, and chipsets are beginning to be included in more devices such as laptops, which is not surprising given the backing of WiMAX by Intel.

5.2.3 Competitive impact of spectrum assignments and allocations

We previously discussed the various spectrum requirements surrounding usage of basic and advanced services over wireless networks. In particular we noted that in order for wireless networks to deliver on the promise of broadband data access and advances services, it was critical that enough spectrum be allocated to each operator. This requirement clearly is in tension with the desire to be able to license as many service providers and operators as possible in order to ensure the optimal amount of competition in the market.

We have noted in Section 4.1.3 that spectrum at different frequencies has different advantages and disadvantages. Lower band frequencies have better propagation and in-building coverage characteristics, but have more limited bandwidth available for licensing to multiple operators. Higher frequencies have more bandwidth available but suffer from a coverage and signal penetration point of view.

In competitive terms then, operators with frequencies in lower bands will have a cost advantage over operators that are only licensed to operate higher-frequency equipment. In the early years of mobile deployment, when the sole focus of most operators was deploying voice services and bandwidth was less of an issue, there were clear advantages to having spectrum in the 850MHz/ 900MHz bands rather than the 1800MHz/1900MHz bands, and in many countries where multiple operators were licensed, spectrum blocks were often 2×5MHz or 2×10MHz wide in order to accommodate many operators.

With the move to delivery of interactive data and video over wireless links, it has become clear that bigger blocks allow for faster speeds in delivering advanced converged services. 2×15MHz or 2×20MHz of paired spectrum is generally considered the optimum for offering high-speed wireless broadband services. However, where much more targeted services are intended, smaller spectrum blocks are still sufficient for delivery. For example, the MediaFlo mobile TV multicast delivery system pioneered by Qualcomm in the USA is capable of delivering a full one way broadcast user experience over just 5MHz of unpaired spectrum.

Looking specifically at the situation in Peru, the following spectrum assignments apply:

- 850MHz band – Telefónica and América Móvil each have 2×11MHz and 2×1.5MHz for a total of 2×12.5 of paired spectrum
- 1900MHz band – Telefónica has 2×12.5MHz of paired spectrum. America Móvil has 2x15MHz of paired spectrum. Nextel has 2×12.5MHz and 2×5MHz of spectrum, for a total of 2×17.5MHz or paired spectrum

- 2.3GHz band (WiMAX) – 200MHz of spectrum has been distributed between Digital Way and Americatel Peru
- 3.5GHz band (WiMAX) – 200MHz has been distributed between Nextel del Peru, Telefónica , Americatel Peru, Itaca Peru and Telmex Peru.

These spectrum concessions all contain enough capacity to allow deployment of interactive data services, as long as the licensees are permitted to do so by their licenses.

In terms of ongoing Peru license awards, a fourth license of 2×12.5MHz of paired spectrum in the 1900MHz band is currently in the process of being awarded, as is a 25MHz WiMAX license in the 2.6GHz range. Given the prevailing understanding of spectrum requirements for proposed wireless services, the spectrum blocks already awarded, or being awarded, will not at present hinder licensees from launching a wide range of services. However, as 4G networks are deployed, larger frequency blocks will be needed to offer greater access speeds.

We should not forget, though, that there are still a number of subscribers who do not have access to even basic voice or data services, particularly rural users in areas with terrain that is difficult to cover. 5MHz unpaired spectrum blocks have been awarded to Telefónica in the 450MHz and 900MHz bands (which have good coverage properties) for the roll-out of fixed wireless connections offering basic access, joining the other concessionaires in the 450MHz band (Telmex Peru and Valtron), and while these will not be sufficient to offer advanced services, concessions in the other bands mean that both Telefónica and Telmex Peru are at no disadvantage, and may in fact benefit from being able to cost-effectively provide basic services to those who do not want more advanced services as of yet.

The question of whether there is enough licensed competition in the spectrum bands is one for a more formal investigation. However we note that in cases where regulators or operators have deemed that the spectrum allocations and assignment are inadequate to deal with the demands of deploying advanced new services, various spectrum re-farming and re-assignment options have been investigated. One prominent example is the various discussions going on in Europe and the USA on reclaiming spectrum which, following the switchover from analogue to digital broadcasting, will become available for more advanced services.

We discuss the implications of convergence and any necessary modifications to the current management of spectrum in Peru in Section 6.2.2. Suffice it to say that the current situation in Peru is such that no current or about to be licensed spectrum concessionaire appears in danger of being significantly disadvantaged compared to its peers or general needs by spectrum assignments.

5.2.4 Next-generation niche access

► *Wi-Fi*

Wi-Fi has been a significant success from a consumer perspective. As a means of sharing a single telecommunications connection, it has proven both reliable and cheap. Wi-Fi equipment has fallen markedly in price, and the market has seen a proliferation of vendors offering various flavors of this type of equipment. It is one of the most ubiquitously deployed standards, and is included in everything from mobile telephones to computers, STBs, gaming systems and radios.

However, despite significant investment in public Wi-Fi hotspots worldwide, a number of issues have arisen with Wi-Fi as a mass-market broadband access medium. In particular, the *coverage* of a Wi-Fi hotspot is severely limited, and hotspots are usually selectively deployed in high traffic areas even within cities.

Figure 5.6 below depicts the public Wi-Fi deployments in developed markets, both in absolute terms and in relation to the number of wireline customers. The USA leads the way in the absolute number of deployments (over 70 000 to date), while the UK leads in terms of hotspots per wireline customer.

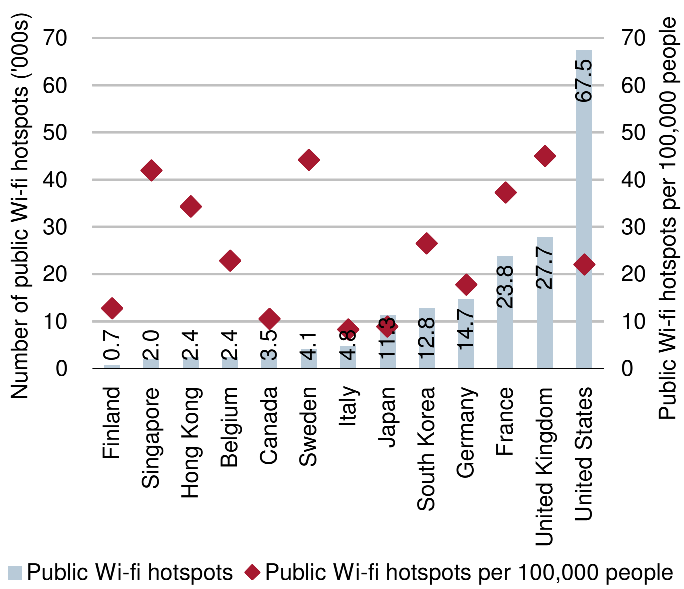

Figure 5.6: Wi-Fi hotspots in developed markets in Q1 2009 [Source: Jwire, Globalcomms]

A number of city governments have undertaken municipal Wi-Fi projects as a means of deploying universal broadband access, with mixed results. For example, delays in service launch and the relatively slow access speeds that are expected have raised some concerns about the long-term viability of municipal Wi-Fi projects in the cities of San Francisco and Philadelphia. Nevertheless, backing by groups such as Google[30] and Earthlink shows that some major entities continue to take the potential of such projects seriously.

In emerging markets, there is certainly potential for Wi-Fi to bridge the access gap between the situation today (limited telecommunications and Internet access) and the roll-out of true mass-

[30] Google reported in August 2007 that its municipal Wi-Fi network covered 12 square miles and catered for 15 000 unique users per month.

market broadband access alternatives such as 3G UMTS, LTE and WiMAX. However, there are currently very few emerging markets with public Wi-Fi deployments in the same numbers as exist in developed markets.

We previously noted that Wi-Fi access points must generally be connected to broadband connections in order to provide any Internet connectivity (excluding the specific cases of mesh Wi-Fi deployments). Thus, the low number of broadband lines in emerging markets is a contributing factor towards the low number of Wi-Fi hotspots seen in these countries. Affordability of access devices (in particular cheap laptops) is also a significant contributing factor. Nonetheless, at a spot where public access is provided, Wi-Fi does offer a low-cost means of distributing access to multiple devices.

► *BPL*

The competitive situation for BPL remains unchanged from our previous analysis two years ago. BPL has been investigated for several years but has never been implemented on a large scale due to a number of concerns, the most significant of which continues to be interference with other transmissions. This is receiving much government regulatory attention around the world. In addition, The costs for utility companies to prepare their grids to support BPL can be high. Although power lines cover many areas not serviced by cable or DSL, BPL service has only been made available in limited areas thus far. The adoption of BPL may be further limited by strong competition from wireless technologies such as WiMAX.

In 2005, consumers in BPL trial deployments paid an average of USD30 per month for services, in line with average costs for DSL and cable modem services. Up-front costs for CPE range between USD30 and USD300, depending on the type of BPL system deployed.

In 2003, the first concentrated efforts to deploy BPL technology commercially were made, and Spain and Portugal developed the largest BPL deployments in the world. Those trials ended in 2006 and 2007 due to economic reasons. Two cities in the Philippines, Roxas City and Bataan, were wired with BPL technology for commercial deployment in 2005 and 2006, but there have not been updates regarding the status of BPL in the Philippines in 2007 and 2008. In the USA, in November 2008 IBM announced a deal with International Broadband Electric Communications to deploy the technology in rural areas. BPL trials have also been carried out in Austria, Scotland, Finland, Spain, Sweden, Russia, Hungary, Hong Kong and Taiwan, and in a few locations in Africa and the Middle East.

In Latin America, in 2007 BPL Global acquired Tyron Technology, a company specializing in the provision of power-line communication products and services to customers in Brazil, potentially setting the stage for potential future deployments.

5.2.5 Overall conclusion and implications for access networks in Peru

We have examined the competitive implications of convergence on broadband access using a range of access technologies. Wireline networks have a completely different fixed/variable cost profile compared to wireless networks. Wireline operators face a significant *variable* cost of extending their networks to reach each additional subscriber, as they have to deploy last-mile loops. Without subsidies, the connection charge would have to be significant for each new subscriber to the wireline network, as incremental revenues are not likely to be sufficient to cover costs, particularly for low-income callers with low call volumes. This is demonstrated by the relatively low number of fixed connections in Peru for both voice and broadband: fixed-line penetration in Peru remained below 10% as of mid-2008, while fixed broadband penetration was much lower, at 2.1%.

As we discuss the impact of convergence and how to prepare for it, it is important not to lose sight of the fact that there is still a significant proportion of the population in Peru without access to even basic telecommunications services, and the universal access plans that have been developed to address this access gap continue to be promoted.

The cost profile for wireless networks is completely different from wireline networks. Given sufficient spectrum, there is a relatively *low* variable cost of adding new mobile subscribers, and operators gain a revenue advantage from both the fees from new users, and the increase in termination rates arising from incoming calls to those subscribers. Additionally, speed upgrades and new service are relatively easier to implement in mobile networks. These cost advantages are reflected in the number of mobile connections in Peru: SIM penetration is much higher than fixed, standing at 66.2% as of December 2008. Figure 5.7 shows a regional comparison of mobile penetration benchmarks.

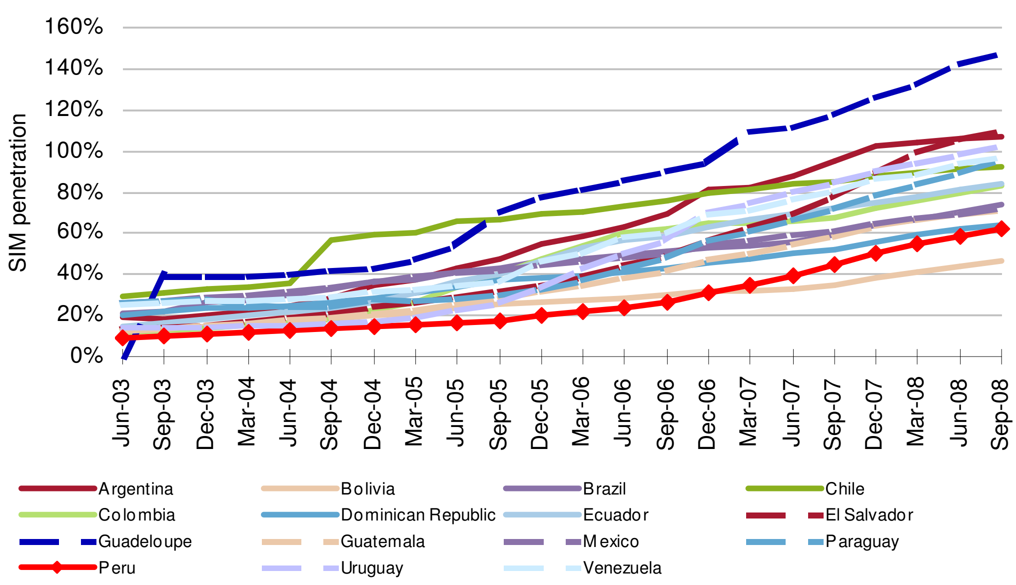

Figure 5.7: Mobile penetration in Latin American countries, 2003–2008 [Source: Globalcomms]

Given the impact of affordability on the take-up of telecommunications services, it is useful to look at the correlation between GDP per capita and total penetration (fixed and mobile) in Peru and other countries in the region, as we did in the previous 2006 study.

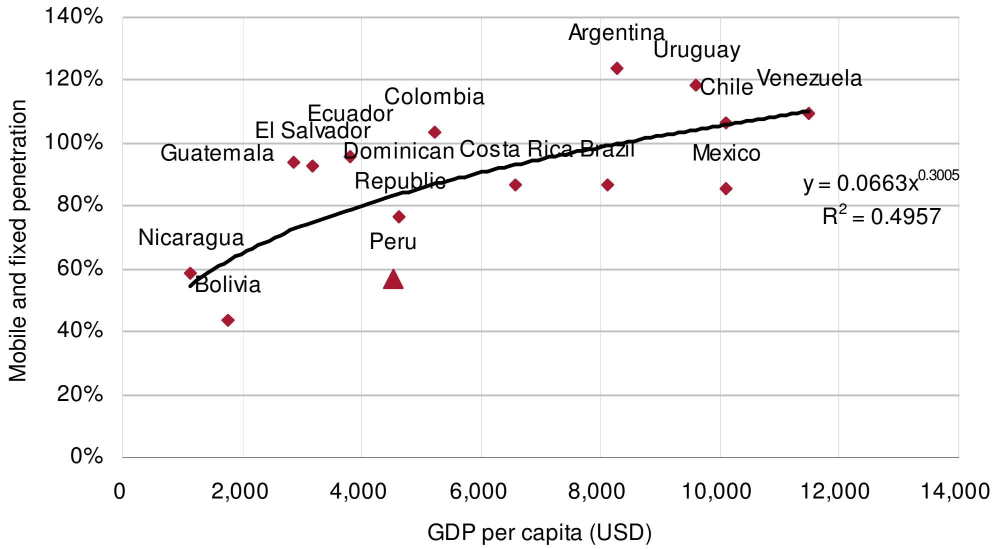

Figure 5.8: *Penetration versus GDP per Capita in Peru compared with benchmark countries by December 2008 [Source: EIU, Globalcomms, Euromonitor]*

We first note that the correlation co-efficient between these measures is not as strong as it was in 2006 (0.5 in 2008 to 0.73 in 2006). This potential weakening can be explained by noting that affordability and penetration are less likely to be tied together as GDP increases given that once a certain level of income is reached that generally makes telecommunications service affordable, other factors begin to play a greater role in determining the level of telecommunications take-up.

Thus on the one hand, the figure supports the theory that the difference in overall wealth level in Peru is not fully responsible for any observed lagging in take-up of services in Peru, and suggests that other avenues (such as increased activity of universal funds and private/public partnerships or greater public education projects in more rural areas) could still have a significant role to play in encouraging greater levels of broadband usage.

On the other hand, it is important to mention that the high levels of shared usage of services in Peru (through telecenters and pay phones for example) imply that while the actual number of subscription may be relatively lower than in other countries, the actual level of people using telecommunications services may be much more comparable. As such, the level of mobile usage in Peru, while at the lower end of the scale in absolute numbers of subscriptions, is likely much more comparable in terms of actual usage of mobile services.

In the next few years, advanced wireless technologies such as LTE and WiMAX (IEEE 802.16m) are likely to converge in terms of their technology (and hence their capability, although this is more likely to happen in the generation of technologies following LTE and WiMAX). This could lead to mergers and acquisitions between vendors as they compete for market share. In turn, various product lines will be dropped or absorbed.

We have already seen some evidence of this kind of convergence. Nortel and Alvarion announced a joint mobile WiMAX solution in June 2008; Nortel indicated that this will allow it to focus its R&D efforts and spend on a version of LTE that will integrate Alvarion's WiMAX technology with Nortel's core networking solutions, backhaul solutions and applications for carriers, such as VoIP and unified communications.

In many ways, this supply-side dynamic will work to WiMAX's advantage. It could be argued that WiMAX has suffered as a result of being positioned by some as a technology in competition with mobile networks and other fixed networks. The development of applications described above has shown that, in the short term, it is not; instead, WiMAX is finding its own areas of application in backhaul, campus coverage and extension or provision of last-mile reach. There is considerable opportunity for growth in these areas as well as in emerging applications such as emergency services and broadcasting. Consolidation between suppliers will, in all likelihood, bring W-CDMA/LTE and WiMAX together as part of vendors' offerings. Vendors will then be able to position the technology appropriately. The future for WiMAX will be less about the viability of the technology, and more about which companies will survive and thrive.

In conclusion, we focus our regulatory recommendations on promoting the deployment of wireless access networks as the most efficient means of providing voice services, as well as increasingly fast broadband services. For wireline networks, in order to maximize their potential, we focus on bitstream access for DSL competition.

5.2.6 Next-generation core networks

After discussing the impact of convergence on competition in the *access* market in the preceding sections, we now consider the effects on *core* networks, both national backbones and international routes. As discussed earlier (Section 4.1.5), many wireline incumbents worldwide have started migrating all their legacy core networks to a single IP-based, NGN. This consolidation involves replacing traditional switches with highly flexible softswitches that can support many more subscribers, and will soon be able to address both wireline and wireless network requirements.

A number of Latin American operators have started deploying NGN technologies in their core networks. Telefónica has also started to implement NGN core upgrades across its Latin American markets, but it does not appear to have firm plans to do so in Peru. Telefónica has implemented an MPLS network, but uses it exclusively to address the demand of its business customers for VPN services.

As briefly outlined in Section 4, there are a whole range of factors that have influenced the changes being made to networks today. We noted that providers are either replacing the core switches in their networks with softswitches, or deploying new softswitches for expansion. Softswitches can support many more subscribers than legacy switches, and this element of the core network is not a significant cost barrier for deployment of new networks – there are examples of small alternative subscribers supporting up to half a million subscribers using a single softswitch.[31]

In addition to softswitches, operators deploying core networks require affordable access to the following facilities:

- Leased lines (for core network connectivity and backhaul capacity)
- infrastructure for international traffic
- Internet exchange points (IXPs).

The deployment of, or affordable access to, these key core network elements is the significant challenge facing operators in emerging markets today. The sections below first discuss in greater detail the competitive implications of convergence for each of these core elements worldwide; we then go on to discuss the specific situation in Peru.

Core networks worldwide

The competitive situation regarding the three elements listed above is usually determined by a host of specific local factors that can introduce significant differences between otherwise similar markets. However, in general, developed markets have more competitive suppliers, more transport capacity and lower prices than emerging markets. The actual levels are often determined by how much of a central hub any particular city is in relation to the transport of capacity around the region and the world.

► *Leased lines (for core network connectivity and backhaul capacity)*

In any market, leased lines are critical to the development of competitive access offerings, both as retail services for large consumers and business users and as wholesale inputs for upstream service providers. The discussion here focuses on leased lines in core networks, where they connect central offices with one another, provide links to interconnection points and to IXPs, and are used to access international infrastructure. Leased-line services can be used by wireless operators to backhaul traffic to their switches, by ISPs to aggregate bitstream traffic from broadband customers, and also by businesses to run data networks between offices. In all but the densest areas, the costs of deploying leased-line infrastructure can be significant, and even in urban areas the civil works costs can be quite high.

In developed countries, the number of options available to infrastructure operators wanting to link together the equipment forming the core of their network is substantial. For example, in the USA there

[31] According to Juniper Networks, MetaSwitch's Class 5 softswitch can support up to half a million subscribers.

are at least nine extensive national fiber backbone operators, as well as a large number of regional and other smaller players offering inter-city and intra-city fiber links. Leased-line costs continue to drop as bandwidth availability grows and as more companies offer leased-line services. In the USA, leased-line prices typically range from USD499 to USD1250 per month for speeds of 1.5Mbit/s to more than 40Mbit/s depending on the specific services sought, performance guarantees required, and the geographical location of the customer. In the UK, prices range from USD250 per month for speeds under 256kbit/s to USD1150 for a connection with speeds of 4Mbit/s or greater. All prices are exclusive of installation charges, which are around USD500–1000.[32]

In most emerging markets, the competitive supply of backhaul links is much more limited. Leased lines must either be bought from the incumbent operator, or self-supplied using microwave or satellite equipment and frequencies. While microwave and satellite links provide sufficient capacity to transport the traffic generated on networks mostly carrying voice traffic, the increasing amount of video and general Internet data transported over converged networks necessitates links with larger capacities. This essentially means that national fiber backbones are a requirement for any market where significant amounts of traffic are expected to be generated and consumed. In emerging markets, the availability of affordable backhaul capacity is often one of the key roadblocks to the deployment of networks with sufficient capacity to encourage and support the provision of converged services. Often geography plays a role in this: a mountainous country such as Peru with a widely distributed rural population makes it more difficult to construct economically viable business models for fiber backbones.

Given the paucity of backhaul options in emerging markets, governments and regulatory authorities have a key role to play, and these authorities are investigating a wide variety of innovative solutions to solve the problem of ensuring sufficient backhaul in rural areas and less developed areas. Infrastructure sharing (discussed further in Section 5.2.7) is one of the most significant options being discussed, and this could play a role in ensuring that affordable backhaul capacity is brought to underserved areas in emerging markets. Public–private partnerships are also being seriously investigated as a means of getting round the ‘chicken-and-egg’ problem of low usage because of inadequate connectivity, which in turn is less likely to be addressed because of a lack of customers. Additionally, there is some investigation into the potential uses of other wireless technologies for backhaul (such as WiMAX). The success of these and other similar initiatives will determine how existing networks are updated and how far access to new services will spread from more urban areas into the rest of the country.

► *International infrastructure*

The ITU defines an international gateway (IGW) as any facility that provides an interface to send and receive electronic communications and traffic between one country’s domestic network facilities and those in another country.[33] Historically, IGWs were primarily used for transporting and switching voice traffic. Convergence and the rise of IP-packaged traffic means that this

[32] Leased-line prices obtained from C-Gate and OneStopClick in the UK and Leased Lines Anywhere in the USA.

[33] *Trends in Telecommunications Reform 2008 – Network sharing*, ITU annual report (2008).

situation has now given way to one in which more general IP traffic (whether voice, video or data) is transported over the same facilities.

Note that, historically, a lot of the content available over the Internet originated in the USA and Europe, and today a significant amount of content is still hosted and sourced from these developed countries. Given that access to this body of content is essential for the success of Internet offerings, in order meet demand for popular content, prices for IP services in emerging markets are intimately tied to the cost of international network capacity leaving and entering the country.

The cost of this international capacity can vary widely. Prices for transit capacity are determined on a local basis, even for global backbones. The factors that determine how much capacity costs are the following:

- **Number of competitive IGW access providers –** The liberalization of the IGW market has provided a major impetus for a fall in international connectivity prices: the greater the number of IGW access providers, the more affordable transit capacity is.
- **Total available capacity of links into a country –** This capacity can be terrestrial (often using submarine cables) or space-based (using satellites). Satellite links are generally more expensive than submarine links, especially where there is sufficient capacity on the submarine cable and a coast with a landing station in the country. According to Telegeography there is generally much more capacity available to developed markets in comparison to emerging markets in Latin America[34]. Unsurprisingly, this situation has led to much cheaper capacity prices in developed markets.
- **Cost of underlying regional facilities** (i.e. transport, landing stations, earth stations, etc.) – In the past, the national incumbent operators often held exclusive authorization to provide IGW services, and owned all the regional facilities. In many cases, the liberalization of IGWs has removed this particular bottleneck, but incumbents may continue to hold a certain advantage in terms of landing/earth stations and transport facilities, making it less feasible economically for competitors to build their own facilities.

Although a lot of the regulatory roadblocks towards cheaper international capacity have been removed (such as liberalization, and cost-based access to incumbent facilities at landing stations), the higher cost of international capacity for emerging markets continues to be a disadvantage. Figure 5.9 shows the median prices for a Gigabit Ethernet (GigE) IP transit port in various cities in Latin America, Europe and the USA. As can be seen, in New York the price of a GigE port in Q2 2008 was USD10 per Mbit/s, compared to USD73 in Buenos Aires.[35]

[34] Global Internet Geography – Pricing, 2008.

[35] Global Internet Geography Pricing 2009, Telegeography.

	DS-3 (USD)	*FastE (USD)*	*GigE (USD)*	*10GigE (USD)*
Europe				
Frankfurt	36	22	12	9
Warsaw	33	20	11	10
North America				
New York	32	20	10	8
Toronto	32	20	11	7
Asia				
Hong Kong	94	53	37	32
Tokyo	89	71	45	30
Latin America				
Sao Paulo	146	102	74	48
Buenos Aires	150	95	73	48

Figure 5.9: Median IP transit prices per Mbit/s in Latin America, Asia, Europe and the USA in 2008 [Source: Telegeography]

One consequence of this disparity is that some carriers in emerging markets may purchase IP transit out-of-region, where transit is significantly cheaper, as long as the cost of transport from the carriers' domestic networks to the out-of-region transit location is reasonable. Telegeography indicates that foreign ISPs using this line of reasoning and purchasing transit capacity in the USA and Europe create large transit markets in major hub cities such as New York, London and Frankfurt. These ISPs have determined that transporting traffic from their domestic hubs to these cities (either using a self-provisioned link or by buying specific capacity for this purpose) and then buying more general transit services in those cities is cheaper than buying transit services in their home countries.

At a basic level, these price differences are simply a function of supply and demand – international capacity providers will only make the considerable upfront investment required to build cables if they see sufficient levels of demand. However, this tends to create a vicious circle as high prices lead to the low levels of demand which discourage investment in capacity in the first place.

In order to stimulate the supply of more international capacity in emerging markets, a number of business models have been discussed. Some governments choose to engage with commercial operators, and other governments to form partnerships that can install additional capacity. Examples include the East African Submarine Cable system (EASSy). In other cases, operators in emerging markets are planning to build cable systems to expand capacity available to them, and as a secondary revenue source. For example, the Indian conglomerate Reliance Communications, which bought the Fiber Link Around the Globe (FLAG) undersea cable network in the early 2000s, is today planning to expand the system to link India to countries in South-East Asia, Africa and the Mediterranean.

Telegeography is currently tracking a large number of undersea cables being planned or under construction (12 in Africa, 3 in Latin America and the Caribbean). However, there is the risk that an abundance of capacity without a rise in usage could leave these new systems facing the same problems that international capacity operators faced in the 1990s, which led to a raft of business failures and bankruptcies. Thus, emerging markets are faced with a dual challenge: to increase the amount of international capacity available to service providers while simultaneously stimulating the usage of advanced services in order to make sure that the international capacity systems are financially viable.

► *IXPs*

Throughout the development of the commercial Internet exchanges – also known as network access points (NAPs) – have played an important role in promoting low-cost interconnection between operators. An IXP is a central location where multiple ISPs can interconnect their networks and exchange IP traffic. This can save on both domestic and international capacity costs, and also reduces latency in the exchange of traffic. Thus, as applications such as IP video services generate more traffic, and as others such as VoIP become more latency-sensitive, having a well-functioning exchange becomes increasingly important to promoting convergence in a country.

While voice traffic has been subject to settlement rates at the terminating network, general Internet data traffic is exchanged under a different settlement framework, which is largely unregulated. Traffic between Internet providers is usually exchanged in one of two ways:

- **Traffic exchange on a peering or settlement-free basis** – In this case the operators are of a similar size and are exchanging similar amounts of traffic. The largest Internet backbones (so-called Tier 1 providers) are the only operators to exchange all their traffic on this basis. Examples include Level 3 or AT&T.
- **Purchase of transit from a larger and more connected backbone service provider** – This option is used by smaller providers to reach regions where their networks do not reach.

As convergence has progressed, this framework which initially governed only Internet services now covers all IP-based traffic (voice and video included).

As mentioned above, most of the early Web content originated in the USA, and all of the early international ISPs had to provide connections to the USA, in spite of the relatively high cost of international capacity at that time. At the same time, local leased lines were often quite expensive because the markets had not yet been liberalized, or competition was not yet vibrant, and as a result, many ISPs chose not to interconnect domestically. Consequently, instead of directly interconnecting locally with one another at high cost, many ISPs chose to exchange traffic in the USA through their existing connections (a process called 'tromboning'). There is evidence that at one point more than 50% of traffic from Europe was passing through MAE-East, a NAP in Virginia near Washington, DC.

Over time, in many countries ISPs realized that they could save significant amounts on international capacity and also avoid the expense of multiple interconnection links between themselves, by banding together and creating a small number of common locations at which to exchange domestic Internet traffic. In the USA, these tend to be located at commercial data centers run by operators such as Equinix, while in Europe they are often non-profit associations that jointly own the infrastructure and operate the exchange. Either way, with such an IXP available, an ISP needs only a single link to this exchange point. In addition, the exchange point can be located near an international gateway, for convenient access to overseas links.

In most emerging markets, the key drivers behind IXP implementation have tended to be individual ISPs or ISP associations. A common approach is that taken by IXP operators such as in Kenya (KIXP) and Argentina (NAP CABASE), which operate as not-for-profit associations set up by ISPs to exchange traffic. One key exception is Brazil, where the government commissioned a project – the Ponto de Troca de Trafego Metro Project (PTTMetro) – aimed at creating IXPs throughout the country.

At an Internet governance forum held by the Internet Society in late 2007, a number of issues concerning IXPs in emerging markets were raised which remain relevant today:

- A key policy of such IXP associations is that membership is often required to be able to exchange traffic at the IXP. This usually requires satisfying requirements such as being a licensed telecommunications provider and having autonomous system numbers (as for membership of NAP CABASE), and therefore a number of potential participants are shut out of doing so. As local multimedia content providers continue to flourish, relaxed participation requirements will be essential in order not to stifle the rise of these entities.
- Peering policies range between encouraging or mandating multi-lateral peering between participating operators at IXPs, thorough to allowing bilateral agreements between any two IXP members. The generally agreed consensus is that encouraging IXPs to adopt flexible peering policies encompassing both multilateral and bilateral agreements is the right approach in order to allow carriers to determine which arrangements best suit their purposes.
- The role of the government in encouraging IXPs and regulating their operation (e.g. the Chilean government has mandated interconnection between all IXPs within the country) remains paramount, and the policies enacted will have a significant role regarding the success or failure of domestic IXPs.
- Other challenges to making a success of IXPs include lack of trust between ISPs, limited local technical expertise, the cost of infrastructure, and the cost of hosting the IXP in a neutral location.

As these issues continue to be addressed, the question of regional exchange of traffic becomes increasingly important. In order to foster closer co-operation between regional IXP operators, associations such as the Latin American and Caribbean Internet Addresses Registry (LACNIC) host annual conferences and cultivate regular contact between such operators. These initiatives serve to help emerging market ISPs to obtain the same benefits enjoyed by ISPs in much more interconnected regions.

The core network in Peru

In Peru, the international access market is fully liberalized, and there is a lot of competitive activity in the supply of these services. Additionally, NAP Peru (the sole IXP in the country) counts as its participants all the major ISPs in the country, fostering domestic exchange of most locally generated content. The key requiring more regulatory attention is the supply of leased lines, which is still limited as Telefónica remains the dominant domestic supplier (although the rates have come down to cost-based values since our last study). We discuss these issues in more detail in the following sections.

► *Backhaul capacity and leased lines*

The amount of fiber laid in Peru increased from 2973km in 2000 to 11 614km by the end of 2007 according to Globalcomms. However, domestic long-distance leased-line supply continues to be dominated by Telefónica , which supplies over 96% of leased-line circuits to other operators (the remainder being offered by América Móvil).

At the time of our previous study, the price of leased lines in Peru were relatively high. During a study carried out in 2007, OSIPTEL determined the price of E1 leased lines in a number of benchmark countries, as shown in Figure 5.10 below.

Country	*50km*	*100km*	*200km*	*300km*	*400km*	*450km*
Spain	2347	2460	4060	5084	5568	5810
Argentina (Telefonica)	3450	5211	9461	12 825	14 940	16 952
Argentina (Telecom)	2257	3497	7569	8814	11 952	13 562
Colombia	1819	1819	1819	1819	1819	1819
Portugal	1739	2356	2975	3593	4211	N/a

Figure 5.10: Monthly rental cost (in USD) of a national E1 leased line over various distances in benchmark countries [Source: OSIPTEL, 2007]

In August 2007, OSIPTEL concluded its regulatory price-cap process by capping the rates that Telefónica could charge for long-distance leased-line services in Peru, and ensuring that these rates were determined on a cost-oriented basis. Figure 5.11 below shows the price caps that were established.

Range	*Price cap (USD per month)*
Under 100km	1166.72
100–450km	2421.51
Over 450km	3166.64

Figure 5.11: Price caps on long-distance E1 leased lines in Peru [Source: OSIPTEL]

It can be seen that these rates are very competitive compared to benchmark countries in the region. While still somewhat higher than prices in some developed markets, this reflects factors that are common to emerging markets such as difficult geography and lack of extensive national fiber backbones, as mentioned previously.

Discussions with stakeholders raised some issues that have not been addressed by the existing leased-line regulations. Specifically:

- Some operators complained that higher-capacity products (which would allow them to be much more cost efficient and would be more useful), are not available. This is consistent with our analysis in the technology section (Section 4) which showed that at higher traffic volumes, transport capacity based on E1s (which have a transmission rate of 2Mbit/s) does not scale well.
- There was also a concern regarding the fact that only long-distance links are regulated and thus offered at cost-based prices. In particular, this means that service providers trying to set up their own networks within a local area find it very expensive to purchase transport capacity from Telefónica to connect their equipment.
- OSIPTEL has been made aware of a requirement for lower capacity leased lines by rural operators who indicate that on particular links, they do not generate enough traffic to utilize a single E1 fully.

These are valid concerns, and combine to hinder the take-up and usage of leased lines over Telefónica's network. This also has an effect downstream: if operators have to deploy their own links this can slow down deployment, and more expensive links eventually mean higher retail prices for consumers.

The other issue for backhaul infrastructure in Peru is the level of deployment, as this is critical to offering basic, as well as advanced, services to unserved and underserved areas. As part of our policy recommendations, we propose some specific infrastructure-sharing policies as a means of lowering the cost of deployment.

International infrastructure in Peru

In Peru, it appears that the international infrastructure market is competitive, with at least four major submarine cables serving the country, as well as several satellite services (which are critical for areas that are more difficult to serve with terrestrial means). In addition, the international gateway has been liberalized, and there are a number of companies providing international services. Perhaps more critically for the development of converged services, international Internet traffic has been growing rapidly, and a significant amount of bandwidth is available. According to Telegeography, the average Internet traffic exchanged over international routes increased by almost 20 times from 2004 to 2008 (see Figure 5.12). During the same period, utilization has actually decreased to just over 22%, implying that significant amounts of bandwidth continue to be made available.

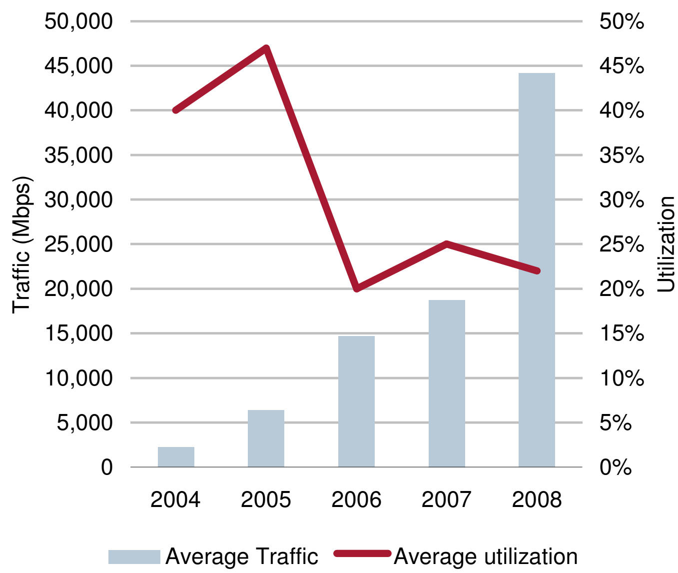

Figure 5.12: Average annual international Internet traffic in Peru, 2004–08 [Source: Global Internet Geography, 2008]

The picture is similar for *peak* international Internet traffic, which has increased by almost 25 times in the last five years in absolute terms, while peak utilization has fallen to a level just under 40% (see Figure 5.13). Again, this implies a significant amount of growth potential in traffic, and does not indicate any bottleneck issues impacting international Internet bandwidth.

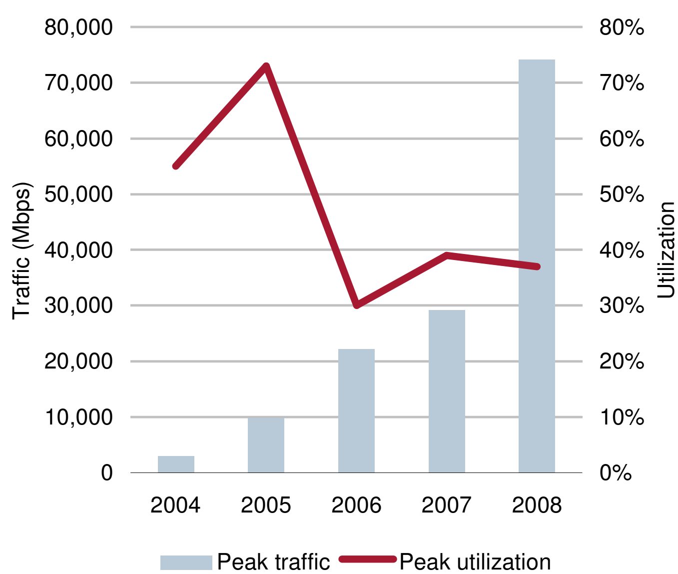

Figure 5.13: Peak international Internet traffic in Peru, 2004–08 [Source: Global Internet Geography, 2008]

A number of other facts point to the competitive supply of international capacity in Peru. In 2008, four out of the twenty highest-capacity international routes for Latin America were connected from

Lima: these were in positions #2 (Lima—Miami), #9 (Lima—Sao Paolo), #15 (Lima—Santiago) and #16 (Lima—Buenos Aires). Lima, along with Sao Paolo, Buenos Aires and Santiago is one of the most interconnected Latin American hubs, facilitating a significant level of regional connectivity. Further, Lima is the third highest-capacity hub in Latin America, with over 200 000Mbit/s connected across international borders.

In sum, there are no bottlenecks in international infrastructure in Peru and therefore we will not propose any regulatory changes with regards to this market in Section 6.

► *IXPs*

NAP Peru is now the only IXP operating in Peru. It has experienced a lot of success in keeping domestically originated traffic within the country: the official website[36] states that 90% of all domestic traffic is supplied and exchanged by its members (with over 95% of the populace served). NAP Peru is a privately set-up IXP (established in 2000) that counts amongst its current members all the major ISPs in the country – Telefónica , América Móvil (Claro), Telefónica Móvil (Telefónica Moviles) and Telmex Peru – as well as a number of other telecommunications service providers – Comsat Peru, Americatel Peru, Global Crossing, Optical IP, Infoductos y Telecomunicaciones del Perú. In common with many other regional IXPs, membership is required in NAP Peru in order to exchange traffic there.

Another IXP, NAP Lima, operated for a time. It was created in 2005 by four small ISPs focused on serving the business segment. However, following the acceptance of Optical IP into NAP Peru, the exchange became defunct in 2007. Given the reach and coverage of NAP Peru, it was always going to be hard for a second IXP to thrive.

Similar to many of the IXPs in Europe, NAP Peru is a non-profit organization set up for the benefit of its members. It works closely with other NAPs in the region through annual regional meetings to share experiences and knowledge on the most cost-effective ways to interconnect and exchange traffic between domestic and regional operators.

5.2.7 Infrastructure sharing

Infrastructure sharing is a theme increasingly prevalent in discussions about network deployment. In developed markets, the primary reasoning behind infrastructure sharing is that it allows operators to save costs in order to maximize their levels of profitability. In emerging markets, while cost saving is also a key driver, there is the additional incentive that infrastructure sharing will help in the development of viable business models for the provision of access to underserved regions. At some level, infrastructure sharing is not a recent phenomenon. In fact, access to international capacity (submarine cable or satellite) is significantly subject to sharing, given the high capital costs involved.

[36] http://www.nap.pe/intro.htm

We discussed in Section 4.1.7 the two main categories of infrastructure sharing – the sharing of *passive* network elements such as ducts and towers, and the sharing of *active* elements. The dynamics of passive network sharing are generally understood by the industry, and pose fewer problems both in terms of regulatory concerns regarding anti-competitive conduct, and an operator's ability to differentiate its own services from its infrastructure-sharing partner. On the other hand, active network sharing is much more problematic and is not actually permitted under the licensing regimes of many countries. This is mainly due to concerns that it may dampen competition, as it is harder to differentiate services when they are offered over the same electronic pathways, which could in turn lead to a uniformity in pricing that belies the intention of having multiple competitors.

Previous discussions on the sharing of facilities have revolved around domestic access networks, and have focused on enforcing access to already existing incumbent facilities. Examples include the unbundling of the wireline incumbent's access network, or regulations governing the licensing of MVNOs. The new worldwide spotlight on infrastructure sharing is often couched much more in terms of joint partnerships for the roll-out of new networks, and comes as a consequence of two developments. Firstly, there has been increased interest by MNOs in minimizing the costs of network expansion and modification: this is a consequence of the fact that in saturated markets upgrades to their current networks are needed to deal with the effects of convergence. Secondly, regulatory and commercial entities have been investigating options to expand access to regions where it would be otherwise uneconomical to deploy a network.

Infrastructure sharing is most often discussed in the context of access networks, because access often represents the most expensive part of a new network – however, new backhaul infrastructure can also be jointly deployed to reduce costs.

Infrastructure-sharing policies will be one of the most powerful tools in OSIPTEL's arsenal to achieve its aims of universal affordable services in a converged environment. Some of the measures that regulators are investigating to encourage network deployments under this policy umbrella include open-access networks, or structural and functional separation. The sections below focus on competitive implications with regards to infrastructure sharing in general, and for Peru in particular. We will discuss regulatory views on, and implications of, infrastructure sharing in much more detail in Section 6.2.4.

Infrastructure sharing of wireline access networks

Regulators worldwide have identified the access network as an 'economic bottleneck' from which vibrant facilities-based competition is unlikely to emerge without regulatory attention. A common method selected by many regulators to achieve competitive and affordable access to communications services is by mandating access to the incumbent's local loop facilities. The two generally used methods to do this are *unbundling* of the local loop and *bitstream access*. These are discussed below.

► *LLU*

In Europe, the obligation imposed on incumbents by the European Commission to publish reference offers for LLU aimed to intensify competition, stimulate innovation in the local access market, and harmonize the conditions under which alternative operators could provide a wide range of communication services. LLU has taken off in recent years, particularly across Europe, and unbundled local loops now account for a significant proportion of broadband lines. However, this initiative has been less successful in other developed countries such as the USA and Canada, where there is a regulatory preference for facilities-based competition and the existence of a viable alternative wireline access infrastructure such as cable.

In emerging markets unbundling has been less prevalent, primarily because of the limited nature of wireline access. In these countries, mandatory access to the incumbents' loops, along with all the regulatory attentions entailed, has not often been deemed a suitable or appropriate regulatory policy.

Even in Europe, the technical limitations of current unbundling services are becoming increasingly acute, particularly in terms of the access speeds that can be offered over the copper loop lengths. Greater speeds will be available as FTTx is deployed, but the question of unbundling FTTx networks is problematic, especially considering the concerns that incumbents state about how they can recover the large upfront investment costs necessary to deploy next-generation wireline access networks. Indeed, some incumbents' plans in developed markets call for the retirement or closure of local exchanges. This could restrict the options for alternative DSL operators to unbundling at the street cabinet, which would limit their ability to differentiate their services. Thus, operators and regulators are struggling to figure out the place of unbundling under next-generation architectures.

► *Bitstream access*

In Section 4.1.7, we briefly described the technical requirements for offering advanced services using bitstream access. Briefly, we noted that while sufficient QoS standards could allow existing bitstream offers to be used to provide advanced services such as video on demand or VoIP; linear TV requires that the network be technically capable of multicasting and able to support multiple operators using multicasting.

In terms of the capabilities offered by these wholesale inputs, current wholesale bitstream services in many countries are not adapted (either technically or economically) to provide these advanced services – the existence of multicast bitstream platforms on a wholesale basis is still in its early days yet.

The actual regulatory treatment of these types of inputs is still uncertain in many countries. As an example, for new bitstream products, which will be essential for future competitiveness, Ofcom's current thinking in the UK is that price regulation may be disproportionate, at least in the early stages of market development. In contrast, the regulator in Belgium is working on ways to ensure that the incumbent's network allows for full replicability of the operator's own bundles (which include IPTV services) using bitstream. Until the regulatory situation clarifies, the full impact of bitstream access on the provision of converged services is uncertain.

Infrastructure sharing of the wireless access network

Given that wireless networks are the most likely means of deploying advanced services in emerging markets, it is not surprising that many of the recent discussions on network sharing have tended to focus on sharing between MNOs. As it is still early days yet, different arrangements are being explored and no single business model has become predominant. The exact nature of the sharing agreements that are put in place is highly dependent on local conditions. Moreover, such agreements can vary by region and even within the same country.

On the one hand, there are sharing arrangements that are originated commercially, although regulators in these cases generally retain the right to evaluate such agreements and adjudicate if necessary. Examples include:

- Vodafone and Orange agreed to share their radio access networks in Spain and the UK. In public statements, Vodafone stated that it expected to reduce its capital and operational expenditures (capex and opex) by 20–30% across its UK networks, and that the agreement in Spain would allow both operators to reduce their number of sites by up to 40%.

- T-Mobile USA and Cingular (prior to the merger of Cingular with AT&T wireless) shared a network in California, Nevada, Northern New Jersey and New York City.

On the other hand, it is more common these days to see some form of regulatory guidelines or policies that either actively encourage infrastructure sharing, or make it a license condition. The following examples can be cited:

- As part of the advanced wireless services auction in Canada in the 2GHz band, the regulator mandated the sharing of antenna towers and sites, as well as setting roaming periods for licensees operating in the new spectrum band.

- The Brazilian government mandated multi-partner sharing agreements between up to four licensed 3G operators as part of the 3G license award process held in 2008, to spur on deployment of wireless broadband coverage to small communities. Although to date the scope of the mandated sharing has not been defined, most observers (including the ITU) believe that both passive and active sharing will be allowed.

- In India, a program to encourage network sharing is being run under the sponsorship of the universal service fund. This will subsidize up to 8000 towers in remote areas as long as up to three operators are sharing the infrastructure. Meanwhile, the Department of Telecommunications has approved the regulator's recommendation to allow sharing of both passive and active infrastructure between operators.

Below we discuss in greater detail a very common method of sharing access to existing mobile infrastructures, namely MVNO arrangements. These may remain one of the most significant forms of providing an avenue for service-based competition in a converged environment.

► *MVNOs*

We discussed in Section 4.1.7 the technology basis that underpins MVNOs. Although not always considered explicitly among the models of infrastructure sharing being discussed today, the existence of MVNOs and their competitive impact have been exhaustively analyzed since the implementation of the first MVNO agreement in 1999 – when in the UK the MVNO Virgin Mobile began offering services over T-Mobile's network. The rationale for MVNOs will generally be an attempt to answer one of the following questions:

- Does the wholesale partner provide access to a customer segment which an operator cannot reach with its own brand (e.g. Tesco on O_2 in the UK)?
- Does the new entrant soak up the operator's excess network capacity (e.g. Boost on Sprint in the USA)?
- Are new customers acquired at a lower cost than if acquired directly by the operator (e.g. Telmore on TDC in Denmark)?
- Is there a value-added revenue uplift from the new proposition (e.g. NRJ on Orange in France)?

Although answers to these questions often provide compelling reasons for operators and new players to enter into a wholesale arrangement, the high-profile failures of a number of MVNOs show how easy it is to get the implementation wrong.

As the services offered by mobile networks continue to evolve, the process of convergence offers both challenges and opportunities for MVNOs. MVNOs have the potential to do well because they already have relationships with MNOs and their brands are trusted by their target customer base, putting them in a good position to offer advanced services and create more customer stickiness with their services, as well as a potentially increased revenue base. Virgin Mobile in the UK is a good example of an MVNO that is taking advantage of the opportunities afforded by convergence, launching wireless broadband services over its partner's (T-Mobile) network.

However, the increased load likely to be placed on mobile networks due to MVNO demands could lead to a degradation of service if the host MNO and the MVNO are not in agreement with regards to traffic control and management issues.

Core network sharing

A key initiative receiving a lot of attention is sharing of backhaul to customer traffic aggregation sites. This matter is particularly pressing in markets where either difficult terrain or a lack of historical wireline infrastructure have meant that it is hard to provide coverage in certain areas. For example, an isolated community could be served using a mobile base station, but the main cost is transporting the resulting traffic back to the core of the network, which is much more expensive.

This problem is only exacerbated by the increasing traffic capacity needs of advanced services, and if underserved communities are to take advantage of the opportunities afforded by advanced services, solutions will need to be found. In many countries, discussions are beginning to center round national fiber networks, many set up via partnerships or agreements between the public and private sectors. For example, the government of South Africa created a state-owned company called Infraco that will operator a national fiber network consisting of assets from the state-owned power and railway utilities. This infrastructure will be leased to the second national operator, Neotel, to run on a limited term basis, and the operator can in turn sell capacity on this backbone to other service providers.

However the challenge faced by authorities in emerging markets trying to spur on investment in backhaul around the country is how to do so without squeezing out private capital for other projects of this type. In the current depressed economic environment, the prospects for private capital are bleaker than previously, but governmental authorities and regulators are still having to take a hard look at the situations in their countries and determine whether more direct governmental action is required to promote or incentivize sharing of backhaul networks as a means of alleviating capacity issues.

Implications for infrastructure sharing in Peru

In 2008, the Ministry of Transport and Communications implemented a new law that mandates sharing of infrastructure between telecommunications service providers. Details provided indicate that the law primarily governs sharing of passive rather than active infrastructure. The current competitive structure, with Telefónica being the predominant wireline operator and MNO, would seem to suggest that Telefónica's network would be targeted, although it will be allowed to charge at cost-based rates for usage of any infrastructure it owns.

In terms of sharing of mobile infrastructure, passive infrastructure sharing is much more common in emerging markets. Nigeria is an example where tower companies are buying up sites from MNOs and then maintaining and selling access to all operators.

MVNOs in emerging markets are still at a nascent stage (if they exist at all). There are currently no operating MVNOs in Peru. Such markets have an opportunity to learn from the experience in other more developed countries. For a new-entrant MVNO, the key to success lies in providing a unique customer experience on the one hand, and careful cost management on the other. Crisp and clean no-frills services have succeeded, and at the other end of the scale converged voice, data and media business models are emerging today, although their long-term prospects are still uncertain.

The competitive implications are such that it is inevitable that regulators such as OSIPTEL will have to retain general oversight of sharing agreements, in order to judge when network sharing is adversely impacting the larger goals of affordable universal access to basic and advanced data services. However, in emerging markets such as Peru, the opportunity afforded by infrastructure sharing to spur deployment of advanced services is probably worth the regulatory burden of managing the implementations. In particular, encouragement of infrastructure sharing between wireless operators will be one of the most significant sharing policies that OSIPTEL can implement to spur on universal provision of converged services.

5.3 Competition in the provision of converged services

In the preceding sections we have discussed the impact that convergence may have on competition between operators of access and core *networks*, and how this might affect relevant markets in Peru. We now move on to consider converged *services*, aiming to identify areas where regulation can help to promote the deployment of such services, in order to reap the benefits of competition.

Before convergence, the assessment of competition focused on separate industries defined in terms of services taken in isolation – fixed telephony, mobile telephony, TV and radio (see Figure 5.14 below). As the process of convergence continues, however, the nature of a network provider is less and less defined by any particular service that it offers over its network. Rather, the type of converged services that can be offered will be determined by the broadband access speeds that can be provided (although service providers may of course choose to offer only a subset of the technologically possible services on their networks).

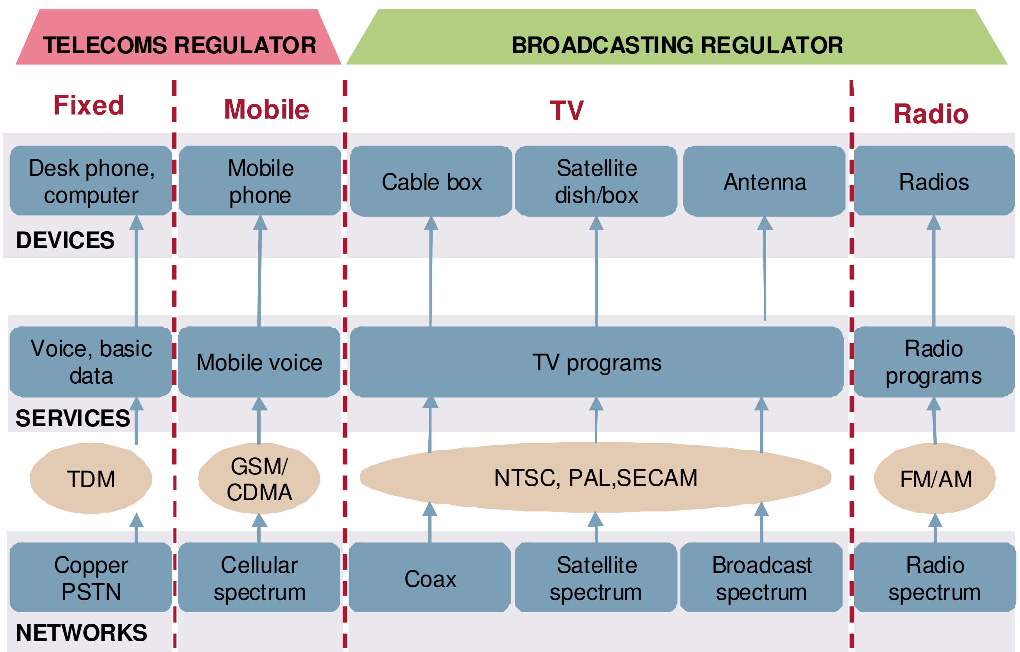

Figure 5.14: Telecommunications, radio-communications and media industries before convergence [Source: Analysys Mason]

As discussed earlier, service-based competition has been a favored by regulators worldwide as a remedy to spur competition to incumbent operators. The main advantages offered by this approach over infrastructure-based competition are faster implementation, less time to market, and reduced upfront costs. With the implementation of new converged networks offering higher broadband speeds, service-based competition will increasingly take place using IP-based services such as Skype or Vudu[37] operating over an end-user's general broadband connection.

[37] A US-based provider of on-demand video services.

In the following, we discuss three main types of converged services: broadband data, VoIP and IP video services. We also briefly consider the importance of a competitive interconnection regime for the success of these services.

5.3.1 Broadband data services

General Internet access is the most basic enabler of convergence and the provision of advanced telecommunications and media services. In fact, many of the advances in voice and video offerings from mainstream service providers have been spurred on by innovative services trialed over general Internet connections. For instance, the wealth of VoIP services available today were developed from, and inspired by, earlier incarnations of free person-to-person instant messaging services that primarily provided text-based chatting, but began to offer person-to-person voice calls between PC clients. While a lot of these early services had reliability and quality issues, they provided sufficient value (especially for no incremental cost) to prove popular with many Internet users and cause established operators to take a look at how to deal with these developments. As will be discussed in Section 6 in the context of net neutrality, some of the reactions were defensive and need to be addressed by regulators, but others have been innovative and have benefited competition and consumers.

As convergence progresses, the key differentiator of a network is increasingly becoming the bandwidth that it makes available on its access connections. In line with this, the two major types of data access networks in the present market – wireline and wireless – can be distinguished simply in terms of the bandwidth they offer. Wireline data access speeds are expected to continue to be much greater than wireless data access speeds, even though 3G and 3G+ wireless networks today provide access speeds greater than those identified as broadband speeds on wireline networks even a few years ago (i.e. in excess of 1Mbit/s) and are set to increase dramatically.

General broadband data usage

Between 2002 and 2008, global Internet capacity increased at an annual rate of 57%. Particularly impressive annual growth occurred on links connected to Latin America, which increased 119% between 2007 and 2008. Traffic can be classified into eight categories, as shown in Figure 5.15. Web and peer-to-peer (P2P) traffic together make up 70% of total traffic. The different types of traffic are described in further detail below.

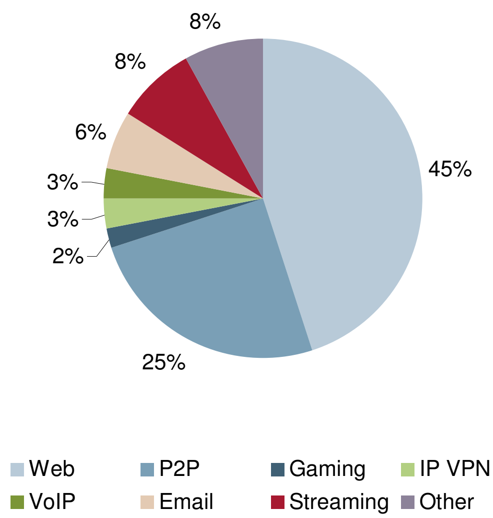

Figure 5.15: Internet traffic by type – worldwide average in mid 2008
[Source: Cisco, 2008]

► *Web*

Web traffic makes up the biggest part of Internet traffic. In the context of a study by Cisco,[38] this not only includes traditional web-page browsing, but also a variety of video content that is streamed via the HTTP stack. The main drivers of growth in this category of traffic are the growing sophistication of websites, for example the increasing use of embedded flash movies and video files. The rapid rise in usage of online video services has caught everyone by surprise. Although the amount of video content on Web sites had been increasing as the take-up of broadband increased, the launch of YouTube in 2005 revolutionized the market. As the consumption of higher-quality and longer online video content increases, consumers are unlikely to remain satisfied with lower-speed broadband connections, driving up demand for higher broadband speeds. This will particularly be the case for users who want to acquire content on a download-to-own basis.

Another factor fueling bandwidth demand is the growing popularity of social networking sites, and other Web 2.0 platforms that allow the sharing of user-generated content. Users can now transfer and share large media files, such as photos and videos they have created themselves.

► *P2P*

During 2008, on average 25% of traffic was P2P, as indicated by a study of Telegeography[39] P2P applications and traffic can be classified into two broad areas, depending on their sensitivity to latency:

[38] Cisco Global IP Traffic Forecast (2008).

[39] Telegeography Traffic Report (2009).

- **file downloading** – the transfer rate of files can vary widely, and may nearly stop for periods of time without the user necessarily realizing it
- **streaming media** – the transfer can only be interrupted up to the amount the media player has cached ahead of the viewing point before the stream is also interrupted for the user.

The vast majority of files shared on P2P networks are pirated content, but a number of companies now use P2P technology for legal uses such as for the distribution of software patches or media contents. Joost, Babelgum, BBC's iPlayer, and SopCast are examples of applications deploying this technology. Unlike standard server-to-client file downloading, streaming P2P caches content on a user's computer while viewing, then discards the content after consumption.

► *Other traffic categories*

Streaming audio and video are high-bandwidth applications that can account for a large share of traffic for the duration of the stream. Podcasts, Real audio and Windows Media Player streams fall into this category of traffic.

Online game traffic is one of the fastest-growing applications, with traffic travelling long distances. The traffic volume that is generated by most online games is small, but for real-time games in particular it is highly sensitive to latency. Gamers are therefore very keen on having short distances to hosting servers in order to reduce latency, and providers of online games place their servers close to end-users. Thus, while game traffic is growing, it is more likely to impact domestic rather than international traffic.

VoIP accounts for a small share of total Internet traffic, but the level is nevertheless impressive since VoIP is an application consuming only limited bandwidth (see Section 4.2.1).

In general, usage patterns indicate a significant shift from the traditional web model of low-volume content downloaded from third-party content owners (such as CNN.com), to high-volume traffic that is increasingly shared directly between end users. This has impacted the nature of Internet traffic exchanged, as increasingly data is being shared between broadband subscribers. For instance, in the USA one estimate is that 40% of traffic is now exchanged between users. As a result, increasingly broadband operators are peering with one another in order to reduce their reliance on paid transit to get access to third-party content providers. This increases the utility of an IXP such as NAP Peru to provide a means for broadband providers to directly exchange traffic.

Wireless broadband data

Wireless broadband sales increased dramatically in many markets across Europe in 2008. Two user segments were responsible: firstly, those users who were previously unconnected, particularly itinerant users such as students. Secondly, tech-savvy early adopters for whom wireless broadband was a complement to their DSL/cable access at home. We can identify these as being the second and third waves of wireless broadband subscribers to arrive in the market, the first being enterprise customers, who have been using mobile connectivity to laptops since pre-3G days. The arrival of the latest two waves of users has been stimulated by the launch of HSDPA, the introduction of low-cost tariffs, and the arrival of user-friendly USB modems.

As wireless broadband markets mature, we can expect a fourth wave of subscribers to enter the market: 'casual' subscribers using wireless broadband as a complement to home DSL/cable, and taking advantage of low-cost devices such as netbooks, on a much more occasional basis than the subscribers who preceded them. Further in the future, we can expect that growth opportunities will be concentrated in two areas: churning customers, and 'cord cutters' who are abandoning DSL/cable and moving to a mobile-only solution. The impact of waves five and six will not be felt for 2–3 years in the future, but the wave of casual users is imminent.

The usage profile of subscribers is set to change the business model, as more casual users usually opt for prepaid subscriptions rather than the commitment of a monthly contract. These subscribers will have different usage profiles from the early adopters and landline-replacement users who have dominated the customer base until now.

Another driver for this rapid take-up was the fact that many MNOs in developed countries began offering wireless broadband services at prices and advertised speeds close to wireline broadband. Despite usage caps that are far lower than those for wireline networks, as prices fell many subscribers opted to cut the cord by abandoning their wireline broadband connection in favor of a wireless connection. However, this strong effect of wireless substitution (up to 50% of substitutive use) is only visible in some markets, such as Austria, and may represent a sudden release of pent-up demand for wireless broadband rather than a long-term trend.

3G+ mobile handsets and laptop data cards and USB dongles will be the platforms driving global mobile traffic. According to a report by Telegeography, a single high-end telephone (iPhone, BlackBerry) generates more data traffic than 30 basic 2G handsets. Due to the different usage, a laptop data card generates even more data traffic, equivalent to around 450 basic handsets. For mobile handsets, video is expected to be responsible for the majority of the traffic growth in the next five years, with value-added services such as navigation, mobile TV, instant messaging, location-based services and social networking adding to this rapid growth in bandwidth requirements. By allowing laptops access to mobile networks, MNOs have to face new degrees of usage of their backhaul and core networks. Despite the relatively small number of laptops with wireless broadband data cards today, P2P traffic from those devices already accounts for 20% of all mobile data traffic globally, according to Telegeography.

Data usage in emerging markets including Peru

The majority of data traffic is generated in developed markets, mainly because that is where most of the high-capacity connections are located and where most of the high-bandwidth services are offered. Although Internet users in many emerging markets are able to access some of the general data services described above, customers and service providers in those countries have also had to find creative ways of using the capabilities that are present locally.

In particular, SMS continues to be an exceptionally profitable and successful data service for wireless networks, and the use of it has expanded well beyond basic person-to-person communications. A very prominent example of this is the rise of m-banking in many emerging markets, for example, the M-PESA mobile payment service in Kenya. Launched in 2006 by Safaricom, the service counted one third of Safaricom's subscriber base as members by Q3 2008, an astounding growth rate. m-payment services have proved successful in many markets for the following reasons:

- for banks, it can give access to customers that do not have bank accounts
- for operators, it can give some incremental revenue and, more importantly, reduce churn

for customers, it provides new financial transaction services via their familiar mobile telephones.

Other examples of SMS usage and interaction with converged networks and advanced services include game show voting, money transfers, etc.

Although there is a drive to encourage the take-up of advanced data services as soon as possible in markets such as Peru, it is important for regulatory authorities not to lose sight of the fact that technology must always be secondary to actual utility of services. Given the basic nature of SMS, its comprehensive availability and the competition in the market, a key aim must be to continue to ensure that there are no barriers to the use of the basic data services available now through Internet cafés and 2G/3G data networks (barriers such as pricing, affordability, interconnection, etc.), while at the same pushing for them to be superseded by more advanced data services.

5.3.2 VoIP

The widespread provision of VoIP services is easily the most disruptive influence in modern communications networks. In particular, the relatively low bandwidth required to provide IP voice only means that any network equipped to transfer IP data can provide voice services. As illustrated in Figure 5.16 below, there are different types of VoIP that can be seen in various markets worldwide.

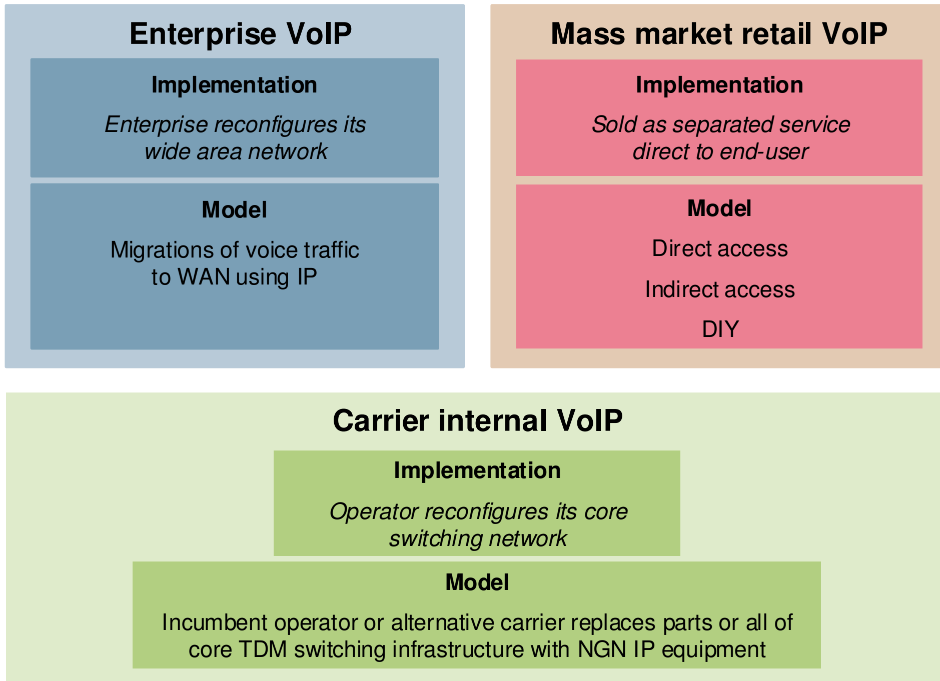

Figure 5.16: VoIP implementations

Mass-market retail VoIP has the greatest effect on the market in terms of the number of end users reached and its impact on operators and regulators, and we will therefore focus our discussions on the competitive impact of solutions in this category. Given the low bandwidth requirements and the multitude of ways available to reach customers, competition in the provision of VoIP services has become fierce in some countries, and the reverberations will continue to echo for a long time. We first describe the different types of mass-market VoIP and then discuss the implications on the provision of VoIP in Peru.

VoIP in general

- **Direct access** – Alternative broadband infrastructure players and local loop unbundlers are usually the most aggressive direct VoIP players. Few unbundlers in Western Europe have a legacy of substantial revenues from wireline telephony: many started as pure-play DSL ISPs. Where they have any wireline voice legacy, this has frequently been low margin and zero growth, and thus there is little risk of cannibalization of existing revenues. These unbundlers have an obvious interest in developing VoIP as a competitive differentiator, or to keep track of competition, even if the margins of VoIP are limited. As for FTTH players, although in most markets they account for a small (and declining) proportion of connections, they have had an obvious interest from the outset in delivering as many services over their networks as possible. None in Europe has a legacy of switched wireline voice to preserve.

- **Indirect access** – These VoIP services continue to grow and have a significant impact, particularly on the pricing of voice services. The introduction of services such as the MagicJack in the USA (which offers unlimited US domestic calls and very cheap international calls for USD20 per year) continues to put pricing pressure on incumbent providers of telephony services.

- **DIY access** – Services such as Skype provide a cheap means of PC-to-PC voice communications, and increasingly offer better quality and value-added services such as three-way calling and video telephony. In countries with high calling rates, the usage of these services can be significant, although such countries also tend to have relatively low Internet penetration.

As an example, in France, both the incumbent wireline operator and local loop unbundlers have seen tremendous consumer take-up of triple-play bundles, and during 2008the decline in PSTN connections was outpaced by the growth in VoIP lines as part of these bundled offers. France thereby appears to go against the prevailing trend in FMS. Heavily discounted VoIP has been used as a tool to gain broadband market share, and so France has a high number of VoIP subscribers, over half of whom use VoIP as a primary line.

VoIP over wireless networks

Wireless operators of 2G and 3G networks have generally been reluctant to offer or allow DIY VoIP services over their networks. The utility placed on mobility, and the clear distinction between fixed and mobile telephony, allowed mobile voice services to command a significant premium, whether as a per-minute rate (in countries such as Europe where there are significant mobile termination charges and high per-minute rates) or in subscription prices (such as in the USA where big buckets of minutes are common). However, as data access over wireless networks has become increasingly prevalent, wireless operators face a dilemma as the per-bit rate that users are accustomed to paying is much less than the per-minute charge for a voice call.

If third-party DIY VoIP services were not controlled, they could threaten MNOs' voice revenues. Therefore, most MNOs choose to restrict DIY VoIP by refusing to transport data encoded using VoIP standards over a general data connection. For example, while third-party VoIP applications, such as Truphone, are already available for the iPhone, and can be downloaded using Apple's App Store, these can operate only via a WLAN and not a via a cellular data connection. There are a few exceptions: in 2005, a German operator (E-Plus) signed a deal with Skype to allow VoIP on its data platform, but charged higher data prices to compensate for it.

However, while end users may be attracted by the potential cost or service benefits of wireless VoIP, consumer sentiment could be a significant barrier to adoption if wireless VoIP is perceived to offer an inferior voice service in terms of quality, ease of use, or choice of handset. In particular, services such as Skype that are designed to allow calls only to other Skype users may not have much utility for mobile users.

Competitive dynamics of VoIP in emerging markets including Peru

In Peru, potential VoIP providers require a license to provide telephony services. However, there is no specific law governing VoIP as all services provided using Internet data are currently categorized as value-added services (VAS) that are covered by a regime of free competition, and thus VoIP tariffs are not regulated by OSIPTEL.

VoIP providers have been in operation since 1996. In 2007, Telefónica and Alcatel-Lucent announced a partnership to deploy advanced VoIP services. Under the deal, Telefónica would be able to offer VoIP, contact center capabilities and XML applications to enterprise customers. Perusat is currently the only operator offering VoIP services using an indirect access model. With just over 5000 active lines, it is still a relatively small operation. However, the company (recently acquired by China Telecom) has plans in place to expand its own wireless access infrastructure offering wireless broadband, which will enable it to move away from the indirect model to a more direct model. Thus, in the short to medium term, indirect VoIP does not appear poised to make a significant impact on telephony in Peru.

In most emerging markets the VoIP opportunity in the wireline residential access market has been mainly limited to Skype-like DIY access, international calling, and models that serve the business market. Lack of competition in the broadband market and the absence of wholesale broadband access regulation in most markets has limited the scope for double-play offers from alternative ISPs. Nonetheless, the limited reach of wireline connections and low PC availability means that the most cost-conscious consumers are less likely to have wireline connections, or the equipment necessary to run these DIY services.

In the short to medium term, DIY or indirect access VoIP over wireless networks is unlikely to have a significant impact, due to the lack of suitable handsets and the absence of large-scale roll-outs of high-bandwidth wireless networks (WiMAX, UMTS). Additionally, LTE will be deployed later in emerging markets earlier than in developed markets, leading to a correspondingly delay in the take-up of DIY and indirect access VoIP services.

The key question is the timescale over which wireless operators will begin to use VoIP as the protocol for communicating with mobile handsets. The key driver will be the need to release capacity for more data-intensive services such as broadband Internet access and mobile TV. The current market situation in Peru seems to indicate that this development is some way off, but these kinds of upgrade decisions are best left to the operators: regulation should focus on removing other barriers to the development of those advanced services, so that the operators have greater incentives to begin taking advantage of the opportunities afforded by converged VoIP.

5.3.3 IP video services

The following sections discuss the impact of convergence on IP video services using the two delivery paradigms presented in Section 4.2.2, namely over-the-top (streamed or downloaded content) and dedicated delivery (IPTV). We then provide an analysis of IP video services in emerging markets.

Over-the-top video – streamed or downloaded content over general data/Internet connections

IP video delivered over general Internet access connections is usually opaque to the ISP or network operators (although operators can determine the nature of IP data packets using techniques such as deep packet inspection.). This kind of IP video is subject to the same constraints regarding quality of service, latency and bandwidth that govern all the other data delivered over the Internet connection. While many of these services are aimed at computers, increasingly there are offerings that connect straight to a TV set and offer high-definition video on demand services.

► *Market structure*

The market for delivery of online video is growing rapidly in most developed countries.

- **USA –** YouTube, Roku Netflix player, Vudu, Joost, Xbox 360, Playstation 3, Amazon Unbox Video, AOL Movies, CinemaNow, Direct2Drive, Hulu, TV.com
- **Europe** – Videoload.de, tf1vision.fr, Dailymotion, Arcor VoD, Filmisnow.it, Filmotech.es
- **Asia Pacific –** Rox, Tudou, Youku, ChinaOnTV, Nicovideo, Pandora.tv, Beedeo.

The market is dominated by video-sharing sites such as YouTube or Dailymotion, and to a lesser extent by national catch-up sites of broadcasters such as CBS in the USA, the BBC in the UK and TF1 in France. The dominance of YouTube in terms of sheer volume of content is likely to continue in the short term, particularly as it combines its own user-generated content with highly sought-after content from the BBC, CBS, Universal and other leading content providers. However, new official catch-up services set up by content rights owners (such as Hulu in the USA) are providing stiff competition. Agreements made between these sites and the content rights owners include stipulations on sharing advertising revenues that are generated in connection with this specific content. YouTube's recent introduction of its 'Content Manager' tool provides rights owners security from pirated content being uploaded to YouTube and allows user-friendly access to viewer statistics. As a result, more deals with content owners will be struck along these lines, as a direct way for partners to generate return on the vast number of visitors to this platform. Online video-on-demand services, however, tend to offer higher-quality content, such as the latest box-office hits and international hit TV series.

► *Business models*

VoD services over the Internet have business models based on transactional revenues (rental and download) as well as subscription revenues. Nevertheless, advertising is expected to become the most significant source of income for Internet video services in the future. This will be driven by the Internet's general tendency to offer free content for immediate consumption, and the advocacy of leading platforms (e.g. YouTube) of this business model. Additionally, there is a proven consumer appetite for watching videos online and the willingness among advertisers to shift budgets to the new medium.

Transactional sales of TV programs through online services represent a new distribution channel and revenue stream for traditional rights owners, but this can potentially have a negative effect on other businesses. An example is the sale of DVD boxes of entire seasons of popular TV series. These have been the strongest-selling DVD genres in recent years both in the USA and Europe, but if consumers are able to download full series through online channels, then this might have a considerable impact on sales of such products. Despite these reservations, this new form of distribution seems to be the only way forward for the content industry, as the demand for such a service is clearly expressed by the already substantial and still rising amount of pirated content in this genre. In the case of one such popular TV series –'Heroes' – the first episode of the latest season was downloaded more than one million times through P2P networks in the first 24 hours after its first airing on NBC. This is in addition to the numerous users that watched the pirated video of this episode on a video-sharing site.

► *Traffic growth*

In Section 4.2.2, we previously discussed two very different business models underlying online video, namely best-effort delivery and managed services. As an example, iTunes from Apple sells individually priced high-quality, full-length TV shows and movies (45 minutes of video is 400–500MB in size). At the other end of the quality spectrum, YouTube streams more than 1 billion low-resolution videos daily to its worldwide audience for free. The latter's sheer volume of videos adds up to a significant amount of bandwidth on the network backbone, and the growth of video distribution on the Internet shows no sign of slowing. Cisco estimates that in 2008 traffic generated by YouTube alone amounted to more than the entire traffic crossing the USA Internet backbone in 2000.

Traffic growth of online video will occur in two phases. During the first phase (now current), viewing of online videos on the PC will grow but not overwhelm networks. During the second phase, online videos will be predominantly consumed on the TV set through Internet-enabled set-top-boxes (this service is not to be confused with IPTV). In this phase, the growth in traffic will be felt primarily in the metro and access networks. Should Internet TV become mainstream, a household that consumed two hours per day of standard-definition TV viewing via the Internet would generate a usage of 54GB per month.

► *Competition*

Competition among sites is strong and the offerings highly fragmented. The main inhibitor to growth of legal online video sites is content rights violations. YouTube is continuously addressing the pressing issues of rights protection, but other players in the market are still reluctant to engage in an industry-wide cooperation. However, even YouTube is not willing to disclose any meaningful statistics about the amount of pirated content on its servers. In this highly competitive market, the attractiveness of a video platform is determined by network effects, i.e. the more interesting content there is on a specific site, the likelier it will be the first address a user types into their browser to consume online videos in the future. Reducing a platform's attractiveness unilaterally by removing pirated content would mean a reduction in competitiveness. To break out of this vicious cycle, YouTube has engaged in partnerships with leading content producers, to slowly phase out pirated content through its proactive rights management tool without losing attractiveness to its audience.

At the same time, online VoD services to TV sets do not suffer from piracy, as the service provider can control what is available and prevent it from being copied. Nonetheless, these sites currently suffer from the reluctance of content owners to make all their content available. This is driven in part by fear of piracy, but also probably by questions about which services to work with or whether to create a self-owned service.

IPTV – content delivered using dedicated broadcasting standards and/or networks

Currently, IPTV operators participate in both the telecommunications and the TV distribution markets which, while converging and blurring, still have distinct characteristics. Thus, the success of an IPTV operator today depends on the dynamics in both markets. Below, we look at what this means in detail in each area.

► *IPTV operators must compete as TV distributors*

Each country's TV market is different, so each IPTV operator has to contend with very different market circumstances and growth prospects. Some of the key country-specific factors include:

- **Take-up of pay TV –** Although lower penetration provides more room for market entry, a high pay-TV penetration rate may still present an opportunity for a new entrant.
- **Take-up of digital TV –** A high adoption rate of digital TV offers poorer growth prospects than where digital penetration is low.
- **Competition –** Free-to-air TV services can also provide strong competition to IPTV services – particularly if they offer a wide variety of channels and high-quality content. Such free offerings can undermine the take-up of pay-TV services.

► *IPTV operators must compete as telecommunications service providers*

Operators will also need to take telecoms industry-related enablers and constraints into account when establishing their IPTV services. Some of the key factors include:

- **Reach of the broadband network –** Operators need to have extensive broadband coverage, and a high proportion of their networks must offer sufficient download speeds to support a basic triple-play offer. Such an offer typically requires a minimum of 4–5Mbit/s, but needs to be much higher to offer HDTV services.
- **Regulation –** The delivery of linear content programming over telecommunications operators' IP networks varies by region; in areas such as the Asia–Pacific region and Latin America operators have been forbidden from launching IPTV services in some countries, while IPTV has been rolled

out extensively in Europe. Access to last-mile infrastructure continues to be a key factor that can enable or constrain the deployment of IPTV services.

- **Customer base and revenue –** The size of an operator's customer base and the amount of revenue it generates will influence negotiations with suppliers, such as content owners and vendors. Large incumbent cable or satellite pay-TV operators are likely to have an advantage over telecommunications operators in their negotiations with content suppliers because IPTV is a comparatively new platform.

► *Key success factors for IPTV operators in emerging markets including Peru*

Currently, the deployments of IPTV services in emerging markets are spotty and limited. While a number of operators are able to offer multi-play services including TV, the majority of these deployments include broadcast TV rather than IPTV services. Although financial constraints play a role in this, in many cases the barriers to offering such services have been regulatory in nature. For example, the Mexican incumbent's license does not allow Telmex to offer TV services, while Anatel (the Brazilian regulator) only gave Telefónica the clearance to purchase the TV assets of a local pay-TV operator in July 2008.

The combination of these factors ensures that there is no universal approach that would be applicable to, and successful for, all IPTV operators. Based on the environment in which they operate, telecommunications operators will have to determine which unique selling propositions they will integrate with their IPTV offer, and then target the market accordingly.

Telefónica has already launched IPTV in several countries in Latin America, and is expected to take similar steps in Peru eventually (although the fact that it is the dominant paid TV provider while using non-IPTV platforms means that there is the potential that Telefonica chooses not to deploy IPTV). However, at present there are no IPTV deployments in Peru: even though there are increasing numbers of multi-play bundles that include TV services, the components of the bundle are still typically delivered over separate networks. For example, all Telefónica's bundles that include pay TV are actually reselling the service of its own multimedia affiliate Telefónica Multimedia.

In February 2009, the South Korean government announced a deal with Peru, exchanging IPTV technology in exchange for Peruvian natural gas. In the short term, low broadband penetration and wireline access are limiting the short-term possibilities for IPTV in Peru, though this new deal and hints of opening up the telecommunications infrastructure seem to be encouraging alternative operators to offer new services such as IPTV by reducing the cost of doing so.[40]

[40] Deal announced by IPTV News.

The importance of content rights

The issue of content rights is not directly related to convergence, but it is nonetheless a very important factor in the spread of video services. Content rights are often sold to channel providers on an exclusive basis. Exclusive agreements are deemed necessary to provide certainty for returns on investment in branding and promotion of premium content. Such agreements are typically pursued by downstream firms (from the perspective of a content rights holders this means channel providers – although their reasons for requesting exclusivity may come from pressures further downstream e.g. from retailers). The main priorities of content owners typically lie in maximizing revenue, and the use of exclusive agreements with channel providers to achieve this aim is often balanced against the potential reach of content, in order to preserve the long-term appeal of such content.

For example, football is often seen as a driver of pay-TV subscription; live football rights are usually sold exclusively at a huge premium. The Union of European Football Associations (UEFA) and the Fédération Internationale de Football Association (FIFA) impose a minimum number of matches that must be made available for FTA broadcast. Exclusive agreements for football content over pay TV have often brought benefits to consumers. Pay-TV operators with exclusive content are able to invest in providing a higher-quality viewing experience, offering with footage from different angles, interactive features, replays and high-quality commentary, which are not always available over FTA broadcast. However, exclusive rights also make it much more difficult for alternative operators to offer a compelling service at an affordable price. As a result, to the extent that content is exclusive to incumbent pay-TV operators, it is very difficult to enter a market with an IPTV service.

5.3.4 Interconnection

Efficient provision of some converged services depends on the availability of any-to-any interconnection at regulated cost-oriented prices. Without this, adequate competition is stumped, and consumers will not receive the full utility of the services they subscribe to, i.e. comprehensive connectivity to service providers and other consumers.

Thus, while the impact of convergence on interconnection is straightforward enough, the details and dynamics of the interconnection regimes actually governing competition in each market can be quite complex and are of much more interest to regulators. We analyze interconnection from a regulatory standpoint later in this document (Section 6.3.1).

5.4 Competitive supply of converged devices

Device convergence is one of the most important determinants of consumer access to advanced services. In Section 4.3 we looked at the range of converged devices that are becoming available, noting that price would be the key determinant of their success. In this section we analyze further what impact the availability of these converged devices will have on the general telecommunications market. Given its importance in allowing consumers to access advanced services, it is ironic to note that device convergence is one of the areas least subject to regulatory control. Thus, the competitive mechanics described here are more often a result of vendor and operator innovation and business decisions than regulatory decisions.

As we have consistently noted throughout this report, broadband data access is the predominant driver of convergence. Historically, access to a PC has been required in order to make use of broadband data. Although this is less true today, given the increasing number of devices connected to the Internet, the number of PCs in a country is still a good measure to understand how many people will be able to take advantage of Internet connectivity if it were made available. Figure 5.17 shows PC penetration in Peru compared to a range of benchmark countries.

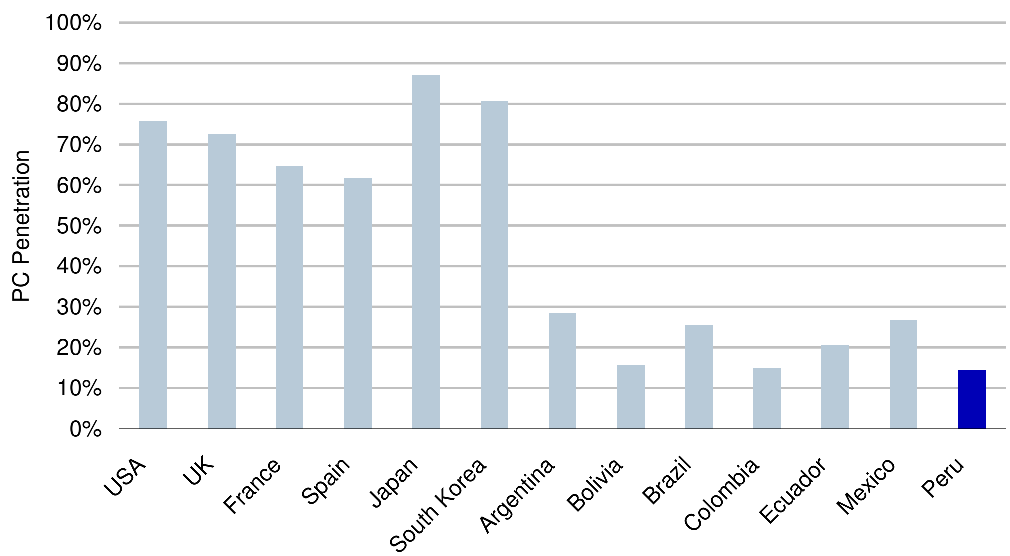

Figure 5.17: PC penetration across a range of benchmark countries in 2007 [Source: Euromonitor]

The increasing availability of cheaper devices is clearly one means to foster the adoption of end-user devices in emerging markets. Although mobile smartphones play an important role in the converged devices revolution, prices of the most capable devices are likely to continue to make these uneconomical for the vast majority of consumers in emerging markets. In the short to medium term, PCs will continue to remain the most promising means of providing access to a large number of consumers; in this context, PCs should be taken to encompass both desktop and laptop computers, and most notably the newly emerging segment of netbooks.

The often-mentioned USD100 laptop has not yet come to pass, and indeed a prominent effort to provide those to schoolchildren – i.e. the One Laptop Per Chile (OLPC) initiative – recently foundered. Nevertheless, the fact that a significant number of netbooks have broken the USD300 barrier – and from commercial operators for use in developed markets – shows that the concept is not that far away from becoming a reality. In Q3 2008, 2 million of the 27.9 million laptops sold in Europe, the Middle East, and Africa were netbooks, and growth in this area is expected to continue. Research firms Gartner and ABI Research have projected that anywhere between respectively 8 million and 39 million netbooks will be sold in 2009; these projections are based on the assumption that low costs of processing will allow prices to plummet to USD200 or less.

However, even at those price ranges, there will still be a significant proportion of subscribers in emerging markets who will not be able to afford these devices. This factor – the number of devices that are uniquely used by individual users – is a key differentiator that often rears its head in comparisons between developed and emerging markets. Whether for reasons of lower income, limited infrastructure or scarcity of suppliers, it is a fact that end-user devices are more often shared between consumers in emerging markets than in developing markets. A proxy metric to see this effect is to look at the ratio of Internet users to Internet subscribers in a given country (Figure 5.18).

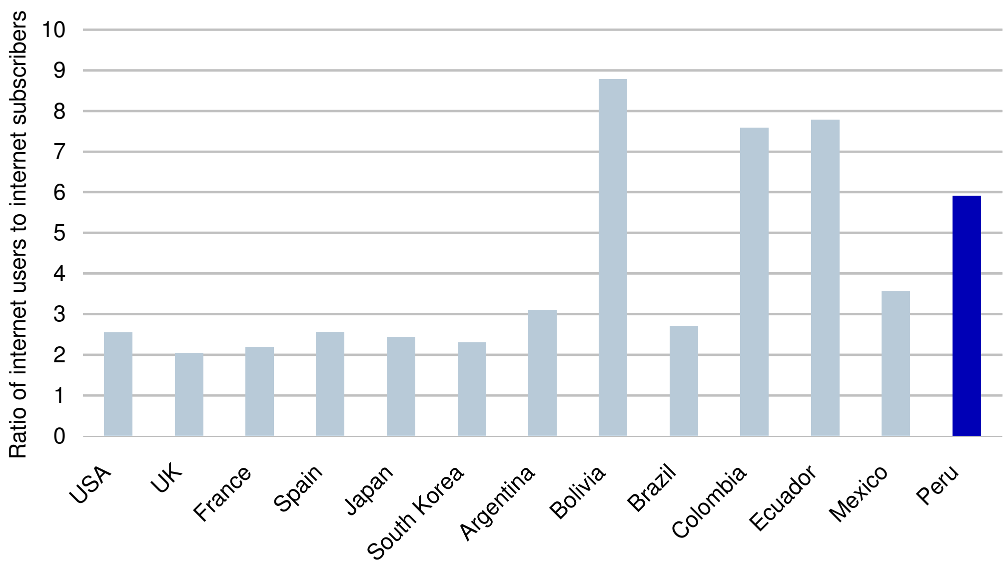

Figure 5.18: *Ratio of Internet users to Internet subscribers across a range of benchmark countries in 2007 [Source: Euromonitor]*

We note that these data may even underestimate the actual usage in practice. For example, the data from a national household survey carried out in Peru by OSIPTEL indicated a ratio of ten users to every Internet subscriber in 2007, reinforcing the conclusions of this chart.

This current dynamic acts as a limiting factor on any forecasts from telecommunications providers of the take-up of converged services. When these providers do these calculations for themselves, the limited number of unique connections and subscribers tends to make viable business models much more difficult to construct. Most regulators and operators in emerging markets are aware of this issue, and this is one area in which regulators can influence the take-up and usage of converged devices and services. A lot of discussions are taking place in order to try and understand the best options.

5.5 Product and market strategies for converged services

In the previous sections we have looked at the practical experience of deploying converged networks, services and devices worldwide. We now turn to an assessment of the strategies that operators are using to sell their services. We first look at bundling and pricing from a theoretical economic point of view, and then look at the practical implementations of such strategies.

5.5.1 Economic treatment of bundling and pricing in a convergent environment

The rise of convergence, with the two related phenomena of separating the provision of services from the ownership of the network while also allowing multiple services to be offered over the same network, has led to a variety of new service offerings from operators as we have stated previously. In economic terms, the responses of operators can be categorized in terms of vertical integration (that is offering services combined with network access) and horizontal integration (that is offering together a variety of services). Further, the resulting offerings from the operators can be considered to be bundles. In economic literature, horizontally or vertically integrated companies can price in three fashions:

- individual pricing, where each service is offered separately
- pure bundling, where the services are only offered together
- mixed bundling, where services are available individually or together in bundles.

As a variation of bundling, where the operator has market power over one element of an offering (such as the network access), bundling choices are considered to a form of tie-in, where an otherwise potentially competitive service is tied to a non-competitive service. In making the decision of whether and how to bundle or tie, the operator must consider both the nature of consumer demand as well as the competitive impact of the bundles chosen. We consider both types of integration in turn.

Vertical integration

The main form of vertical integration that operators undertake is a form of tie-in. Specifically, to only offer network access tied to at least one service, such as fixed telephony and/or DSL service. In this case the economic considerations are relatively easy. Consumers do not demand network access as a service, but rather as a means to access voice and/or internet services, and thus accept or find it convenient that these are sold together. On the other hand, separating network access from service provision would greatly benefit competitors, who could use the network access to compete with the operator to provide services.

As a result, operators with significant market power (SMP) universally choose to bundle the two together to meet consumer demand and prevent competition. Regulators can choose to break this integration by enabling wholesale access to the network, such as through unbundled local loops, to enable competitors to offer their own retail services. This form of vertical integration, and resulting regulatory intervention, preceded the advent of convergence, however, as unbundled local loops were often used to provide traditional circuit-switched telephony.

Convergence simplifies the separation of network access from service provision, at the wholesale level as well as the retail level. At the retail level, as discussed above, VoIP can be offered over a broadband connection, both using direct access (where the two are offered by the same provider) or using indirect access (where the two are offered by different providers). Thus, the decision by an operator to tie broadband access to voice service (that is only to offer broadband to voice subscribers) can have some negative impacts on competition.

First, while it arguably meets consumer demands, to the extent that they do not want to 'cut the cord' and give up fixed voice, or use an alternative provider, it clearly has a negative impact on potential VoIP competitors, as most subscribers do not want to duplicate their fixed subscription with a VoIP subscription. In competitive markets, some operators such as AT&T have taken the decision to offer unbundled DSL (also known as 'standalone DSL') as a commercial decision, but where there is relatively limited competition, regulators have mandated that operators with SMP offer standalone DSL to promote retail voice competition. At the wholesale level, convergence has meant that regulators can supplement mandated unbundled local loop access with bitstream access, which offers competitors the opportunity to offer retail DSL and/or VoIP.

Horizontal integration

The main form of horizontal integration typically is service bundles, sometimes referred to as double or triple play. We already discussed above the relatively common practice of requiring a voice subscription in order to take broadband, which still leaves the question of pricing[41]. Pricing will largely be driven by demand for broadband, as voice is regulated using price caps. The only regulatory consideration here is that the incremental price of the broadband must at least be greater than the incremental cost of providing broadband, in order to avoid a price squeeze on other providers. Similar considerations relate to the triple play of also including pay TV - the benefit to consumers of any discounts must be offset against the potential impact on other operators who may not be able to provide all parts of the triple play.

41 We assume that, if only for regulatory and competition reasons, operators cannot provide only a bundle of broadband and voice without making voice separately available.

A second form of horizontal integration relates to operators with multiple networks as well as multiple services, notably fixed and mobile. The impact of such integration is different depending both on the nature of the competitor (i.e. if it is fixed or mobile), and the impact may also be different inside the region in which fixed services are offered versus outside. Within the area where the fixed-mobile operator offers fixed services, it has an advantage over other operators in being able to offer both services. This advantage arises at multiple levels: at the network level, particularly using an NGN core network, it can achieve significant economies by using one integrated network to offer both services. Likewise, it can use the same retail distribution network to sell both services, again enjoying scale economies. These economies can be passed on in the sale of individual services and therefore impact competition with relevant competitors, and also selling a bundle of those services with an appropriate discount can further impact competition with any individual service provider. The analysis of the impact outside of the fixed region is slightly different. Here the fixed–mobile operator can only offer mobile services, but may still benefit from using the fixed network assets for backhaul, providing a costing advantage over other operators. The regulatory considerations in these cases are to not deny consumers the benefits of scale economies, while not unduly impacting the ability of non-integrated operators to compete. This can be achieved through cost-based access to critical parts of the infrastructure, notably the leased line network as well as bitstream access that can enable competition in fixed services.

5.5.2 Competitive assessment of bundling worldwide

We now turn to a practical assessment of the bundling market worldwide today. Faced with the commoditization of broadband access and the ongoing decline of their wireline voice businesses, telecommunications operators are increasingly focusing on expanding revenue through service bundling and offering triple-play offerings, using the broadband pipe to deliver complementary services such as VoIP and IPTV. In a survey of telecommunications packages in Europe carried out in Q4 2008, Analysys Mason found that 217 of the 978 service offerings examined offer a triple-play package of wireline voice, broadband and TV. However, it is debatable whether these services offer sufficiently attractive margins to justify the investment that telecommunications operators have made.

The bandwidth requirements for a basic triple-play offer remain relatively modest at present. VoIP requires only about 80kbit/s per line, while improvements in video encoding technology mean that a single SDTV stream can be delivered in less than 2Mbit/s downstream bandwidth, although it would be better for operators to plan for 3–4Mbit/s. Thus a 6Mbit/s connection (available on many DSL networks today) can deliver broadband, voice and a single SDTV stream.

However, HDTV is gaining ground in developed markets, and this requires faster broadband connections: a single HD stream typically requires 6–12Mbit/s, using MPEG-4 compression. In North America, pay-TV providers are already competing to offer the greatest proportion of HD content. Research indicates that in the USA around 40% of TV owners have a set that can receive HD content, and that just over 50% of these subscribe to HD packages from their pay-TV provider. Although the HD market is much less developed in Europe, it is starting to gain ground there as well. HD content is also starting to appear on online video services.

Consumer drivers of bundled services

Operators need to cater for the digital lifestyle as more and more consumers are adopting digital substitutes for physical media and storage. The success of online music services, for example, is highlighted by the fact that Apple announced in January 2009 that it had sold over 7 billion songs since the launch of iTunes in 2003. The popular site Photobucket has more than 44 million unique users worldwide, and 7 billion images had been uploaded to the site as of February 2009. We anticipate that the take-up of digital media services, and of complementary services such as online data storage and back-up, will continue to drive up demand for bandwidth, and will have a particularly high impact on upstream speed requirements.

In the course of the present study, we have comprehensively examined all the bundled services being offered in a number of the most advanced markets, to understand the strategies being pursued in converged environments. Countries looked at included Australia, France, Sweden, UK and the USA. Detailed profiles of the bundled offerings in these countries are included in Annex B.

A product bundle is successful if it addresses an important consumer need or want. However the range of wants that are satisfied by product bundles varies, and includes (but is not limited to) the following:

- ease of use
- available functionality
- reliability of service
- one-stop-shop
- cost-effectiveness.

All these factors contribute to the quality of the user experience and/or the quality of service. However, the relative importance of each factor varies: some consumers place a premium on the most functional service, while others are much more influenced by price. Therefore, market intelligence on the nature of the customer in a given service area has become even more important as the number of available choices to consumers increases rapidly. In the paragraphs below we analyze in general how bundling in a converged environment has occurred, and what the implications are for emerging markets.

Service bundling in a converged environment

All of the countries we surveyed with integrated operators have bundles of at least double-play services. It is noteworthy that in those countries with extensive unbundling, such as the UK or especially France, even alternative operators without their own infrastructure can offer triple-play services. In these countries, bundle discounts from alternative operators are also significant, probably because of the margins afforded the alternative operators, which are able to access infrastructure at cost-based rates.

Some operators require a TV service to be taken in conjunction with at least one other service (usually broadband, although there are some dual-play offerings that allow pay TV to be combined with voice services only). For example, Orange in France only sells its IPTV service to existing broadband subscribers. Other operators, such as PCCW in Hong Kong, allow any combination of single- or multi-play services, with greater discounts being applied the more services are added.

The possession of exclusive content rights to premium content is one of the biggest determinants of the success of bundled services that include TV. In particular, access to premium sporting content (such as La Liga in Spain or the English Premier league in the UK) often plays a major role in determining how well a converged service bundle does relative to competing bundles.

Implications for service bundling in Peru

There are a number of reasons why service providers choose to offer bundles. For incumbents, bundling allows the operator to take advantage of cost efficiencies on the supply side, and also to exploit opportunities on the demand side, to enhance customer value by meeting consumer demand for bundles as well as avoid market share loss, or indeed to expand market share. On the other hand, for alternative operators, bundling ensures that their offerings are seen by consumers to be as fully capable as offerings from the incumbent, while also providing avenues for attracting new customers.

In many cases, the regulatory treatment of bundling has been the most influential factor in the market. Bundling by the incumbent is sometimes seen by regulators as potentially leading to anti-competitive conduct by the operator. This is often the case in Latin America, where regulators in many countries prohibit bundling of services including TV and data or voice by incumbent operators. However a lot of those regulatory policies are being modified: for example, in 2008 the Brazilian regulator lifted prohibition on the incumbent offering IPTV services.

In many developed countries, alternative operators which use cost-based unbundled network facilities are able to offer discounts on their service bundles, thus remaining competitive with the incumbent. This makes it clear that, with the right infrastructure access policies in place, regulators can mitigate the potential anti-competitive concerns while still ensuring that consumers get the benefits of bundled service packages, without implementing onerous regulations on service bundles.

In Section 6.3.5 of this report, we look in more detail at specific regulatory implications and responses to bundling in the Peruvian market.

5.6 Other competition issues for emerging markets in the context of convergence

5.6.1 Emerging issues as convergence progresses

The deployment of new networks and services, as well as the availability of new converged devices, is beginning to raise a number of new issues that all stakeholders must consider, as well as increase the profile of others. Below, we highlight briefly four of the most important issues, focusing here on their implications for operators and consumers.

Security and privacy

Although security attacks in networks have existed for years, the convergence of networks raises the profile of security, primarily through two developments:

- New attacks can occur through gaps or interfaces that might occur at the convergence of two, formerly separate, networks.
- Generally, in any given network each application or service represents an entry point for hackers. Where services were delivered over separate networks, compromising one network did not necessarily mean compromising other networks or services. However, in a converged environment, operators and consumers are now worried about the potential risks if a single service out of a suite of converged services is compromised. For example, denial-of-service attacks could take out a user's entire communications access package (voice, video and data) rather than just data access, as before.

The following round-up of commentary from various players in the market shows the impact that security concerns are having, particularly regarding mobile networks:

- McAfee Inc. announced research findings showing that mobile device manufacturers are not only spending more on increasing mobile security, but are also spending more time and money on recovering from security incidents.
- Concern over the security of the various functions of mobile devices is high: 81% of manufacturers are worried about mobile payments; 69% are not convinced by the safety of installing applications; and 66% are concerned about the Wi-Fi and Bluetooth connectivity provided by mobile devices.[42]
- Half of all global manufacturers reported mobile malware infections, voice and spam attacks, third-party application problems, or incidents that caused network capacity issues. They also

[42] McAfee Research and BusinessWire.

stated that the costs related to patching and fixing affected devices had significantly impacted their business.[43]

Related to the question of the security of networks and devices is the question of user expectations regarding data privacy. With the convergence of services, single entities such as ISPs or application providers (such as Google) will possess greater amounts of information on individual users, whether specifically generated by the user or collected through monitoring of the user's activities. This is raising concerns over what the ISP or application provider will do with the data, and also the risk of unauthorized access to these stores of data by third parties who could do harm with the data.

Thus the problem for operators and equipment suppliers is not only one of costs but also of loss of consumer confidence. In a recent survey by McAfee Mobile Security, 36% of manufacturers stated that security and privacy incidents have had a negative impact on their brand or public relations, and 32% said that security and privacy problems have prompted a significant loss in credibility or user satisfaction.

While all parties agree that investment must be made in security and protecting user privacy, there is disagreement over who should bear these costs. Three-quarters of mobile equipment manufacturers believe that the cost of security should be borne by carriers and service providers (44%) or by manufacturers (31%) rather than by the user. Only 12% believe that users should be primarily involved in security measures. Additionally, more than two-thirds of manufacturers believe that device integrated security is the most effective and efficient way to protect devices.[44]

Addressing these questions will continue to become even more important as the process of convergence continues.

Open-source technology

Open source as a methodology is an approach to design, development and distribution that offers practical accessibility to the technical underpinnings of various technologies. Open-source inputs can be a critical strategic element of operations or design approaches. Open-source technologies allow for concurrent input of different agendas, approaches and priorities, an approach that differs from the more closed, centralized models of development that have historically been predominant in the deployment of networks and services.

Open-source technologies have already had a significant impact in network deployment and the provision of telecommunications and media services around the world. For example, most of the key servers that are responsible for maintaining the World Wide Web are based on Linux. Another example is the Android mobile platform, introduced by Google in 2008 as an open-source

[43] McAfee Research and BusinessWire.

[44] McAfee Research and BusinessWire

operating system for mobile phones. This promises the same functionality found in more expensive closed systems such as Windows Mobile or the iPhone OS. Recent announcements indicating the introduction of netbooks with Android by the end of 2009 promise to reduce the costs of these devices even further, bringing the goal of very cheap PCs even nearer.

Of course, the key advantage of open-source technologies is the fact that because they are free, they reduce the cost basis for any service that they are included in. This makes open source a very attractive option for emerging markets, and there is clearly a lot of ongoing investigation into the best ways to include open-source technologies in the plans to bring services to market.

Green IT

Green IT and computing can mean different things to different people. In some cases it means the use of technology that is as energy-efficient as possible. In other cases, it is about reducing the impact of telecommunications operators on the general environment, for example by reducing power usage. In yet other cases, it means making sure that all resources and equipment are made using environmentally friendly products, and ensuring that waste items are disposed of properly. There are two primary concerns that are driving the increasingly louder discussions on Green IT:

Social concerns – Corporate social responsibility has become one of the key metrics on which companies are judged as studies on the negative impact of a rapidly increasing and industrializing world population on the environment are popularized and more widely dispersed. More and more telecommunications companies are investigating and announcing initiatives which show that they are taking these matters seriously. One example of this is Vodafone's announcement in April 2008 about halving its CO_2 emissions by 2020.

Cost concerns – As the size of network deployments and the infrastructure used to support advanced services has increased, the cost of maintaining such installations has become a key issue. Data centers housing the servers that host the world's content and applications are generating more and more heat and waste, requiring ever greater amounts of power to maintain and house. Thus there is intense interest in technologies that reduce these costs (and almost as a secondary consideration, reduce the impact on the environment).

When these two concerns are in alignment, for example the desire to (such as in reducing the power requirements at data centers) it is easy for companies to allocate investment to investigations and research. However when they are in tension (such as obtaining the cheapest equipment from a country, such as China, that generates a lot of pollution in the production of that equipment), the outcomes are harder to predict. In the context emerging markets, there are a number of Green IT developments that fit perfectly into the need for affordable services:

- painting cabinets white to reduce the need for cooling
- adopting energy-efficient data-center technologies which with the reduced power requirements are even more cost effective in emerging markets

- introducing equipment with operating temperatures better suited to the prevalent conditions e.g. mobile equipment introduced by Vodafone Portugal that works perfectly at 35ºC, making it very suitable for deployment in hot countries
- for MNOs, rolling out no-frills base stations that consume less power and are cheaper to purchase.

For many of these initiatives, discussions are still at their early stages and, while the regulators must be involved in these discussions as interested stakeholders, it is less clear what roles government authorities should actually play. Governments wish to avoid unnecessarily distorting the competitive mechanics of the market, but they also wish to manage the general impact of companies on the environment, a responsibility that is increasingly accepted as a key governmental role today.

5.6.2 Competition and commercialization strategies of operators in a converged environment

In the previous 2006 study for OSIPTEL we discussed the strategies of multi-market operators in Latin America. We briefly revisit that discussion here.

Telmex and Telefonica continue to be the largest multinational players in the region as of December 2008; Telmex and Telefonica had 24.2 million and 25.1 million fixed lines (representing 51 % of fixed lines in Latin America, up from 45% as of December 2005) and their mobile divisions had 136.6 million and 107 million lines respectively (representing over 56 % of the mobile lines in Latin America, down from over 70% as of December 2005). In Peru, Telefonica owns the incumbent fixed and mobile operator, and Telmex owns the second largest mobile operator (America Movil) as well as a fixed-line cable competitor.

Although there are other international operators in Latin America in general, and Peru in particular, the trends point towards consolidation of the Telmex / Telefonica ownership and away from other international operators entering the market with significant investment. In the last report, we pointed out two trends of potential interest to OSIPTEL:

- the first trend is that each of the main operators in Peru operates in a number of different countries around the region
- the second is that both of these operators compete against each other in most of those markets, in fixed and/or mobile markets, with the incumbent operator or an entrant.

We revisit those trends and examine the potential impact of each trend in the light of convergence.

The ownership of operators in Peru by companies with ownership stakes in similar companies around the region likely provides significant benefits (significantly enhanced in a convergent environment) in Peru. First of all, these companies can leverage their experience with similar investments in terms of increasing the efficiency of the company, upgrading the technology, providing new services, and even improving their marketing approach. Second, the economies of scale derived from these ownerships, in terms of negotiating volume discounts on equipment and handset purchases are bolstered by the process of convergence which allows for more harmonization of service portfolios; these savings could be passed on to consumers in lower prices. Finally, multinational companies with headquarters or subsidiaries in Peru may benefit from purchasing international network services from a single company, although we have not analyzed whether such demand (or supply) exists today.

The fact that the two largest operators in Peru also compete against one another in a number of other countries may not be so beneficial in the long-run. We have previously referenced the large amount of economic literature about duopoly interactions between companies, stemming from advances in game theory[45], and this literature suggests that it is easier to sustain collusion in one market if there is multi-market interaction between the companies. In other words, either of the companies in Peru may fear that if they begin a price war in Peru, the other company will not just retaliate in Peru, but also in the other markets in which they jointly operate. On the other hand, related theory would suggest that such behavior is unlikely in growing markets, where the companies are seeking to build up market share by attracting new customers, but rather in saturated markets, where the only means to grow market share is to win customers from competitors.

The process of convergence opens up new avenues for Peruvian operators to increase coverage and deploy new advanced services in Peru, thus realizing new revenue opportunities.

Accordingly, given the steady growth rates across the region in telecommunications services, it is unlikely that Peru will see any downside from the joint presence of Telefonica and Telmex in the near future.

5.6.3 Mergers and acquisitions, and their impact on market structure

Mergers, acquisitions and fusions of operators within a particular industry always have the effect of reducing the number of competitors in the industry, while vertical integrations can compromise the effectiveness of the delivery chains supplying that industry. Collectively we will refer to such activities as M&A activity. In general, any developments that reduce competition in an industry are frowned upon by regulators. Where there is the potential for the combined entities to obtain monopoly power, an anti-trust investigation is usually carried out.

There are many reasons that companies may choose to integrate with others in one form or another. Synergy between the combined operations of the separate companies usually plays a significant role in determining whether or not the combination is a good idea, be it synergy in business models, in retail propositions, or in delivery chains. There are a number of multi-sector conglomerates that own or acquire operations in significantly different spheres of operation, but

45 See for example: “Multimarket Contact and collusive Behavior,” Bernheim, B. Douglas, and Michael D. Whinston, RAND journal of Economics, 21, 1,1-26 (1990); “Collusive Conduct in Duopolies: Multimarket Contact and Cross-Ownership in the Mobile Telephony Industry,” Parker P. M. and L. roller, Rand Journal of Economics, 28, 304-322 (1997).

M&A activity of this type goes in and out of fashion, and today this type of activity is not well looked upon by most investors or economic commentators.

In this context, the primary effect of convergence is to open up the potential pool of companies that used to be in distinct markets with seemingly significantly different operation, but which may now find themselves with operations that complement each other, thus making the combination of their organizations attractive. A number of forms of M&A activity become increasingly attractive (and potentially even critical to stay competitive) in a converged environment:

- the combination of a satellite TV provider with a telephony and broadband access provider (e.g. the acquisition of easynet by Sky in the UK)
- the combination of a broadband access provider with an Internet content provider or portal (e.g. the acquisition of AOL by Time Warner Cable in the USA)
- the combination of access providers with content owners.

However, it is clear that the potential effects of these possible combinations will still be judged using the same standards of competition and anti-trust law as is present in all countries around the world. What will change are some of the definitions and standards used to decide on the competitive results of such mergers. These are the kinds of issues that regulators will have to concern themselves with in relation to convergence and M&A activity.

For instance, where market definitions are required in order to determine whether or not a company has significant market power, the definitions of the relevant markets will certainly be impacted by the process of convergence, and governmental authorities in each country will likely need to initiate processes (if they have not already done so) to update these definitions, unless such definitions are not part of local competition law.

The recently signed free-trade agreement between the USA and Peru comes with the obligation for OSIPTEL to perform significant market power analysis on the telecommunications and media markets in Peru. The determination of relevant markets is therefore a primary focus for OSIPTEL currently, and we discuss the key elements that go into relevant market analysis in further detail in the following section as part of our regulatory recommendations and proposals.

6 Policy recommendations under convergence in Peru

The previous two sections focused on understanding the technologies that are facilitating the advance of convergence, as well as understanding the domestic and international competitive implications of convergence as it has progressed to date. With these analyses in mind, we can now turn to determining specific policy recommendations that are needed in Peru to ensure that the full benefits of convergence are realized.

The process of IP-based convergence has resulted in a shift in regulatory focus for most regulatory agencies, including OSIPTEL. Broadly, there have been three phases of regulation over time, as follows:

- **Regulation of integrated operators –** Prior to the introduction of competition, *ex ante* regulation was imposed on the incumbent telecoms operators, and, to the extent relevant, on the incumbent cable TV operators. As shown in Figure 4.1, the network and services were linked, and thus regulation could separately regulate each sector. Regulation predominantly focused on retail prices, in the absence of competition to determine those prices.
- **Introduction of competition –** As new technologies were introduced, relevant markets were liberalized and it became possible to contemplate both *facilities-based competition* and *service-based competition*. As shown in Figure 6.1 below, facilities-based competition arises when the incumbent produces service A, while an alternative network may produce service C in competition with A. On the other hand, for regulatory or commercial reasons, the incumbent, and possibly alternative networks, may provide wholesale access to a competitor that can produce service B as a service-based offering with significantly less capex.

  Differences arose in how competition developed in the markets for fixed and mobile services, as follows:

  – *Fixed services:* In most countries, following liberalization a decision was taken to focus on fostering service-based competition by providing for wholesale access to the incumbent's infrastructure, at cost-based rates. Different options for this access include resale, bitstream access for broadband, and unbundling the local loops. As competitors began to use these wholesale services, regulation of retail prices has been relaxed accordingly. This process has worked most successfully across Europe.

  – *Mobile services*: Given the lower cost of deploying wireless networks, in most countries there was a focus on developing facilities-based competition quickly by licensing two or more MNOs, which typically were not regulated at the retail or wholesale level. In some countries, however, in order to stimulate competition, dominant MNOs were required to provide wholesale access to MVNOs who could then offer service-based competition.[46]

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[46] For instance, in Norway and Denmark MNOs had obligations to provide national roaming to smaller MNOs, or to offer MVNO arrangements, in an attempt to rapidly increase retail competition.

- **IP convergence –** Primarily due to the introduction of IP, it is now possible to have separation between network and services. This process started with voice services and is now extending to video, which has increased the possibilities for competition at all levels:
  - *Wireline networks*: First, companies such as Vonage in the USA began to offer VoIP service over broadband connections, with no interaction with the broadband provider. Further, in countries with cable networks, these networks have now begun to offer the triple play of voice, video and data, forcing the incumbent telecommunications operator to respond by deploying IPTV in order to offer a competing triple-play package. Finally, as broadband speeds increase, companies such as Vudu are offering paid VoD services to the TV using a broadband connection, in a fashion similar to how Vonage provides voice.

  - *Wireless networks:* First, there is an increasing amount of FMS, whereby subscribers 'cut the cord' and rely solely on their mobile telephones, and thus generate further competition in voice. Now MNOs are also providing higher-speed data connections, either to the telephone or to a laptop, which can substitute for a fixed connection.

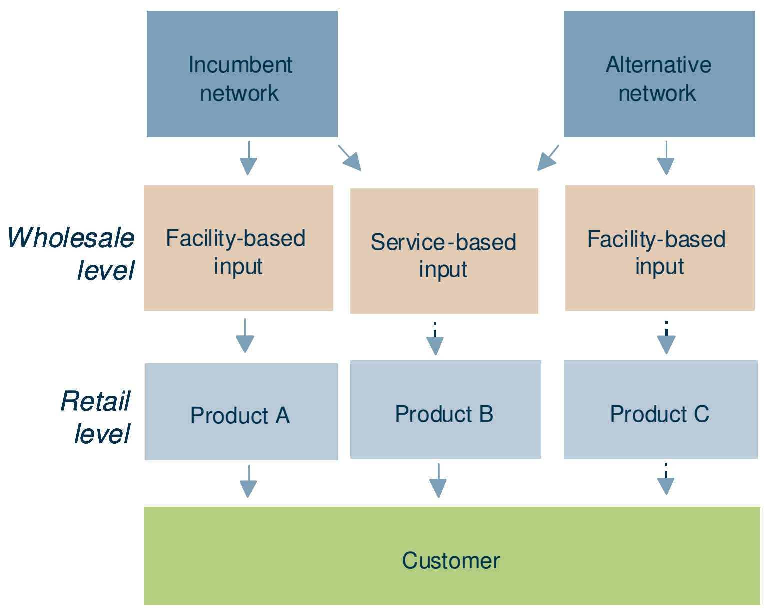

Figure 6.1: Modes of competition [Source: Analysys Mason]

With this in mind, the main principles that our regulatory recommendations for the regulatory framework in Peru will adhere to are:

- Promote network deployment. We focus on two types of facilities-based competition
  - *Indirect competition*: deployment in under- or un-served areas to facilitate access
  - *Direct competition*: deployment in served areas to create innovation and choice.

- Promote converged services. Service-based competition can be made easier with converged services that can be offered over broadband platforms.

- Work to ensure the availability and affordability of the wide range of converged devices that are able to access broadband networks to promote fixed-mobile convergence.

This section is organized as follows:

- Section 5.1 provides a brief discussion on the process of relevant market definition, offering some international best practice and key principles
- Section 5.2 presents a number of policy recommendations with regards to the deployment of converged networks (core and access), as well as a discussion on spectrum management and infrastructure sharing
- Section 5.3 discusses policy recommendations governing the provision of converged services in a convergent environment
- Section 5.4 discusses recommendations on the supply of converged devices in Peru
- Section 5.5 discusses recommendations with regards to specific regulatory issues including the licensing framework, universal access and service (UAS), QoS requirements in a converged environment, and in-building wiring access.

6.1 Relevant market analysis

The free-trade agreement signed between Peru and the USA has given rise to discussion about the possibility for OSIPTEL to carry out SMP analysis on the various relevant telecommunications markets in order to determine which firms are dominant and thus decide where remedies are appropriate in a structured manner.

This study is not focused on specifically defining the relevant markets that would be most appropriate in a converged telecommunications environment in Peru – a full relevant market analysis would have to be carried out by OSIPTEL in order to do this. Rather, this section aims to provide a brief overview of international best practice in defining relevant markets, and then discussing the implications of convergence on this process.

Market definition represents an essential element within the overall assessment of the degree of competition or the extent of market power held by operator(s). It provides the foundations for the subsequent analytical process, which involves the identification of market participants and the measurement of market concentration, as well as the assessment of competitive dynamics (e.g. market entry and exit, price competition and service differentiation). The main risks in defining market boundaries are:

- defining an overly narrow market, within which competition might appear to be more limited than it really is
- identifying overly broad market boundaries that lead to a conclusion of high levels of competition when operators are, in reality, offering distinct rather than substitute services.

The market definition process needs to address two main issues: identifying the relevant service or services which fall into the market in question, and defining the relevant geographical area over which the market extends.

6.1.1 Relevant services within a defined market

In order to correctly identify the boundaries of a market for a given service it is necessary to identify the competitive constraints on the price-setting behavior of the firms supplying that relevant service. There are two sources of competitive constraints on the price-setting behavior of firms, namely demand-side and supply-side substitutability:

- **Demand-side substitutability** – represents the ability and the will of consumers to substitute the relevant service in question with other available services. Suitable services will be substitutes to the extent that they can provide similar functionalities, or can satisfy consumer needs to the same extent as the relevant service. The key issue is to determine whether or not the price of a potential substitute service effectively constrains the price of the relevant service.
- **Supply-side substitutability** – refers to the ability of a firm to easily switch its production from its current services to the relevant service in question (or a substitute service of this).[47] Supply-side substitution is a different concept from market entry (or potential competition). Substitution can happen in a short time period and requires only limited costs for switching the production from the current service to the relevant one. For this reason, the search for supply-side substitutes tends to focus on producers of related services that have the expertise and market knowledge to produce the relevant service. On the other hand, market entry is likely to involve significant investments and sunk costs, as well as longer lead times before the entrant can supply the relevant service.

For the purposes of market definition, demand-side substitution analysis is the primary tool, while supply-side analysis is more relevant for the identification of participants within that market.

Using this methodology, it is not the technology which defines which products compete with each other, but rather an analysis of the usage to which these services are put which determines the relevant market boundaries. For example, fixed and mobile telephony are still generally considered by most regulators to be in separate markets (even though wireless networks can offer both fixed and mobile telephony) because the uses afforded by mobility are such that fixed telephony services are not considered direct or effective substitutes for mobile telephony services.

In order to identify constraints on price-setting behavior arising from demand-side and supply-side substitution, it is common practice to apply the 'hypothetical monopolist test'. According to this principle – at least as a theoretical framework – a market should be defined as a service (or a group

47 Supply-side substitution can occur in the form of production substitution, when a firm shifts the use of existing assets from the production of a given product to the production of the relevant one, or production extension, when the existing production facilities are used both for the supply of the current products and the relevant one. See DOJ/FTC *Horizontal Merger Guidelines*, 1997.

of services) such that a hypothetical, profit-maximizing firm, not subject to price regulation, which was the only present and future seller of that service (or group of services) could profitably impose a small but significant non-transitory increase in price (SSNIP)[48] above prevailing or likely future levels for at least two years.

The analysis of demand-side substitution will therefore initially consider a narrowly defined service that is representative of the relevant market. Subsequently, it would extend the market boundaries, including demand-side substitutes, by assessing whether or not a hypothetical monopolist supplier of those services would be able to profitably introduce a small but significant non-transitory increase in price, assuming that the terms of sale of all other services are held constant. To the extent that the price increase is not profitable, it is because consumers switch to buying alternative services in response to the price increase, and thus alternative services should be considered substitutes for the original service (or group of services) and the market definition should be broadened to include them.

In practice, it is often difficult to have practical evidence (available from the market) of consumer and/or supplier responses to non-transitory relative price movements of different services. International best practice usually involves a qualitative and technical analysis of the services in question, sometimes supported by a quantitative analysis of relative prices.[49] No regulators, however, have used a quantitative approach in applying this framework.[50] As recently stated by the Hong Kong regulator, because the small but significant non-transitory increase in price test is by definition a hypothetical test, the necessary evidence is rarely, if ever, available to allow the test to be applied. [51]

In these circumstances, the use of qualitative data is the best means to draw robust conclusions about market definition.

The main difficulty in applying the hypothetical monopolist test is that – in theory – it is effective only in those environments in which the price of the relevant services is freely set by market forces in an effectively competitive market. In non-effectively competitive markets, where one or more firms hold market power, the SSNIP test might be applied to a market price which is already set at a monopoly

48 It is common practice to assume a price increase in the order of 5–10%.

49 Another possible way of implementing the SSNIP test is to adopt a quantitative approach – by using econometric analytical tools – in order to estimate the demand elasticity as well as cross-price elasticities and profit margins for groups of telecommunications services, which would be needed to determine the profitability of a price increase. A rigorous implementation of a quantitative analysis would require the availability of data on sales and price evolution of each service over a sufficiently long period of time and/or consumer surveys on consumption patterns and behaviors. However, in line with the approach generally followed worldwide, we chose to use the qualitative approach.

50 The European Commission, in defining the list of relevant markets under the New Regulatory Framework, has not provided any quantitative evidence (e.g., econometric analysis or estimates of demand elasticities/cross elasticities) supporting its definition of market boundaries. Ofcom, for example, has relied on qualitative analysis, consumer surveys and analyses of current pricing levels to determine substitutability possibilities and, hence, market boundaries.

51 *"…the importance of the small, but significant, non-transitory increase in price test is that it imposes a disciplined objective framework on the analysis of market definition in which the inquiries are focused upon …."* Draft Merger Guidelines for Hong Kong Telecoms Markets, Consultation Paper issued by the Office of the Telecoms Authority, 4 August 2003.

level (or has been set at regulated conditions), such that any further increase will be unprofitable (because profits peak at the monopoly price level and a further price increase will reduce profits).

In such circumstances, which might frequently occur in a liberalizing market environment, such as that of the telecommunications industry, the application of the small, but significant, non-transitory increase in price test will lead to a broader market definition that will also include inappropriate demand-side substitutes, which would not have been considered if the correct price basis was considered. Such distortion, which in the literature is known as the 'cellophane fallacy',[52] will potentially lead to a conclusion of high degree of market competition and will fail to identify operators with market power.

Thus, in the Peruvian context and with respect to existing operators, it will be critical to ensure that the relevant market analysis process properly assesses the existing state of market prices.

6.1.2 The geographical market

After identifying the relevant service market, it is necessary to define the geographical scope of the market. The relevant geographical market comprises those areas where the relevant firms are currently supplying the services in question; however, it should also include other areas where consumers could practically turn to purchase the relevant services in reaction to a small, but significant, non-transitory increase in price. If the price increase of the relevant service introduced by a hypothetical monopolist supplier in a given area would be unprofitable because customers would turn to other areas where the terms of sale of the relevant service are attractive and the purchase can be practically made, then these other areas should be included in the relevant market (which should therefore be broadened).

However, for the telecommunications industry, the substitutability test is only of limited relevance in determining the relevant geographical scope of the market. In fact, at least theoretically, each single location could be considered a relevant market. By means of an example, it is clear that a customer buying a fixed-line service at its own premise will not consider switching to buy a fixed-line service at any other location. It might be possible therefore – at least theoretically – to identify separate markets on a line-by-line basis (or user-by-user).

However, such an approach would be very impractical, and its implementation almost impossible. It is therefore appropriate to group together those geographical areas in which the relevant services are supplied and demanded, and in which the supply and demand competitive conditions are similar. In the telecommunications sectors the geographical scope of a market is generally defined by the coverage of

52 U.S. v. E.I. DuPont de Nemours & Co., 351 U.S. 377 (1956). See William Landes and Richard Posner, Market Power in Antitrust Cases, 94 Harv. L. Rev. 937 (1981). In this case DuPont presented evidence that the relevant market was "flexible wrapping materials," including such products as wax paper and aluminum foil. The U.S. Supreme Court agreed, failing to realize that it was precisely DuPont's non-competitive price on cellophane that allowed these products to compete. The criticism of this decision has centered on the allegation that the prevailing prices were above competitive levels. At (lower) competitive prices for cellophane, there may have been no substitutes for cellophane, and thus DuPont would have had market power. See Margaret Sanderson and Ralph A. Winter, "Profits" Versus "Rents" in Antitrust Analysis: an Application to the Canadian Waste Services Merger.

networks and by regulatory or legislative requirements. The geographical scope of a market may therefore be defined by grouping together those areas which are covered by a similar number of alternative networks, because in this case the supply conditions (the number of competing suppliers) will be similar and consumers will face the same range of alternative purchase options.

In order to group together different geographical areas, it is sufficient that the competitive conditions are similar or sufficiently homogeneous, and can be distinguished from neighboring areas where the competitive conditions are appreciably different. Thus, in Peru, it is possible that a market definition exercise could classify urban areas (particularly Lima) as a separate relevant market from the rest of the country for a number of services given the greater supply of, and demand for, services in these urban areas relative to the rest of the country.

6.1.3 Other issues in market definition

Customer type

It is important to ensure the market definition is appropriate to the customer type. The most common reason for segmenting a market is that business and residential customers are identified as in separate markets. To the extent that firms can identify and price-discriminate between different groups of consumers in such a manner that they cannot defeat a hypothetical monopolist imposing a small but significant non-transitory increase in price for a particular service, these different consumer groups (such as business and residential customers) could form different sub-markets of the broader market. Similarly, it may be necessary to segment a market by customer type for other reasons, such as regulatory mandate or different cost bases. Consequently, the market definition will need to be aware of potential effective sub-markets (or market segments) for those consumers groups.

Functional markets

The definition of market boundaries also involves the identification of the relevant vertical stage of production. In the telecommunications industry, it is common to observe operators that are vertically integrated over several production levels competing with other operators that are not vertically integrated, or are only integrated over a limited number of levels. In such case, it must be determined whether the different production levels are all part of the same economic market or in fact each of them represents a separate market.

Where the efficiencies and the economies of scope arising from vertical integration over two (or more) adjacent production levels are such that they outweigh the transaction costs that an operator faces in separately provisioning each production level output on the market, these production levels should form part of the same economic market. On the contrary, when transaction costs are low or marginal, such that the different production levels can be separated from an economic perspective without prejudice to the efficiency of the overall production process, the different levels can be separated and identified as separate economic markets.

This leads to the most common functional segmentation, between retail and wholesale. A retail product is one available to the end consumer. A wholesale product is one that is available from a firm higher in the value chain to a firm below them in the value chain. The lower firm will add value and either sell directly to the end consumer or sell as a wholesale product to another firm below them in the value chain.

Wholesale products are an effective way to introduce service-based competition into a market without the potentially economically sub-optimal construction of competing infrastructure. Regulated wholesale markets are often necessary to permit competition in those areas where it is economically beneficial (e.g. retail markets), but not possible or appropriate to achieve competition higher in the value chain. In these cases, the firm higher in the value chain has an economic incentive to charge high wholesale prices and thus destroy retail competition; this can be countered by effective regulation.

6.1.4 Market definition approach in the context of convergence

Based on the methodology described in the previous section, the diagram below illustrates a representative logical flow of the market definition process that should be adopted in identifying specific relevant markets for the purpose of assessing dominance.

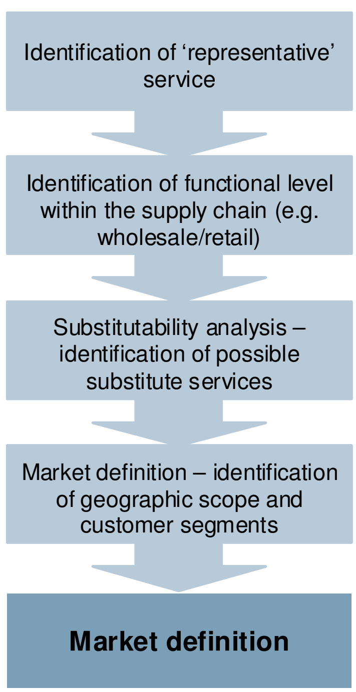

Figure 6.2: Market definition process [Source: Analysys Mason]

The process of convergence does not change this approach, but might give rise to either slightly enlarged market boundaries when compared to traditional relevant markets or changed findings when specific relevant markets are analyzed. For example, if there were sufficient evidence showing that VoIP, where available, is being used as a substitute for fixed telephony (for instance, indirect or direct VoIP services with sufficient quality metrics), this could lead to a market definition for fixed voice services that included fixed VoIP services. On the other hand, DIY VoIP services have generally been found to not be part of the same market given reliability, quality, availability and service delivery differences to other fixed telephony options.

In our discussions with OSIPTEL, questions concerning the role of technology in the definition of relevant markets arose. Consistent with a technology-neutral policy (which we discuss in more detail below) there should not be a need to *a priori* specify which technologies are competing with each other. Rather, the relevant market process should define markets (such as fixed basic telephony) in which the nature of the service being provided is the key characteristic, irrespective of what technology is used.

The five broad markets defined at the start of Section 5, (wireline narrowband, wireline broadband, wireless voice, wireless broadband, and broadcast TV) are not official relevant market descriptions, but rather a categorization deemed useful for analyzing the impact of convergence on the industry; legally applicable relevant markets are likely to be more narrowly defined.

The approach to market definition described in the figure above is the more appropriate and rigorous mechanism that OSIPTEL should follow in determining the appropriate relevant markets for SMP analysis.

6.2 Policy recommendations at the network level

Having discussed the impact of convergence on the determination of relevant markets, in this section we discuss more specific policy recommendations arising from convergence.

At the network level, we distinguish between policies aimed at the access network and those aimed at the core network:

- Within the access network, competition is more feasible for wireless networks; this depends on effective spectrum management and removal of roadblocks to tower-siting and deployment of equipment where such roadblocks exist (Section 6.2.1).
- Within the core network, the key objective is also to identify and remove roadblocks to deployment and efficient running of core network functionality and equipment, as well as ensuring wholesale access to existing infrastructure, most notably leased lines (Section 6.2.3)

We also review the existing spectrum management framework in Peru (Section 6.2.2) and note that infrastructure-sharing policies will have a significant impact on the deployment of both access and core networks (Section 6.2.4).

6.2.1 Access network policies

In terms of deploying access networks in Peru, the over-riding issue highlighted by this study was the burden placed on operators by municipal access policies. All the operators interviewed noted that negotiations with municipal authorities were time consuming, varied from place to place, and could be costly depending on the size and number of fees charged for permits.

Discussions with both OSIPTEL and the MTC acknowledged this problem with municipalities, but noted a significant difficulty with enforcement. There is currently a focus on starting a new law which will focus on defining and limiting the authority of municipalities to permit access, but enforcement will still be a key issue.

Analysys Mason carried out a study on broadband deployment in the USA;[53] among other things, the study looked at the role played by municipal access policies in relation to broadband deployment in the various states. The findings concluded that the state of Michigan had the most effective framework in place of the states surveyed, with comprehensive policies that also covered municipal access issues in relation to network deployment. Thus, an analysis of the approach taken in Michigan can thus shed light onto how best to deal with municipal access barriers.

Michigan policymakers determined that one of the main impediments to infrastructure investment in cities and towns was the inconsistent and burdensome rights-of-way procedures and fees being imposed by municipalities. A review of just the telecommunications fees charged by the municipalities in Southeastern Michigan showed a tremendous range in these fees. Municipalities charged both application fees, ranging from USD500 to USD10 000, as well as annual fees that were either fixed (ranging from nothing to USD500), a percentage of gross revenues (up to 5%), or a fee per lineal foot of wires (ranging from USD0.15 to USD1.25 per foot).

To deal with this issue, the Metropolitan Extension Telecommunications Rights-of-Way Oversight Act (METRO Act) was passed.[54] The METRO Act eliminated the disparities in rights-of-way access charges, and in the process ensured that the access fees are relatively low and based on cost; it also set a maximum permissible permit delay for municipalities in Michigan. In addition, it created the METRO Authority to administer the new system, thus anticipating any enforcement problems.

In light of this, we see three areas that any successful policy in Peru must cover in order to remove municipal roadblocks:

- **Process** – Legislation that requires municipal action on requests for access to public rights-of-way within a specific, reasonable time frame (such as 30 to 45 days) is essential for effective network deployment (as opposed to the multiple months that it can take now). Other effective

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53 *The State Broadband Index,* Analysys Consulting report for Technet. 2003.

54 Michigan's P.A. 48 (2002), also known as the Metropolitan Telecommunications Rights-of-Way Oversight Act ("METRO Act"), effective as of November 1, 2002, (www.michiganlegislature.org/documents/2001-2002/publicact/pdf/2002-PA-0048.pdf).

policies include: offering streamlined resolution of rights-of-way disputes; standardizing the permit application in larger regions; and prohibiting local regulations that set requirements on providers that are unrelated to rights-of-way usage. Although there are already some rules in place meant to streamline the process of municipal access, it is important to review these to ensure that the provisions are specific and harmonized enough to be effective.

Recommendation: Adopt (or review existing) policies that standardize and expedite rights-of-way permissions to ensure cost- and time-effective site deployments, and provide operators with clear visibility of timescales for efficient network planning.

- **Prices –** The government should impose limitations on the fees that municipalities may charge for rights-of-way access. Such policies enable municipalities to be compensated for rights-of-way access, while at the same time ensuring that rights-of-way fees do not create a disincentive for deployment. This can be done in a number of ways, including:

  – setting specific limits on the fees that can be charged by a municipality; these limits can include a set monthly fee, a certain percentage of revenues of the provider, or a fixed fee per lineal foot of infrastructure utilizing the public rights-of-way

  – limiting fees to the 'reasonable costs' incurred by the municipality in managing the rights-of-way access; this, of course, leaves the exact fee open to interpretation by the municipality, but may result in lower fees than those that are currently specified.

  The exact pricing mechanism will be left to a more detailed treatment; however, the general principle of ensuring that prices are viewed as enablers of local economy growth rather than revenue sources by the municipality still holds.

Recommendation: Ensure that the fees imposed for rights-of-way access are determined on a reasonable cost basis to provide cost certainty for operator network planning processes.

- **Enforcement** – This has been identified as one of the key inadequacies of the current system. In particular, the multitude of different local laws and processes makes it difficult to transfer knowledge from previous experiences or locations and streamline the process of rapid deployment.

As was done in Michigan, a very practical solution is to consolidate the coordination of municipal rights-of-way issues (such as with a particular government agency or authority). This authority would, for example, be responsible for coordinating with the municipalities, and assessing and distributing any applicable fees. The authority would also be responsible for providing standardized permit applications to operators.

Recommendation: Centralize the process of obtaining municipal rights-of-way, which provides operators with a much more streamlined and effective method of obtaining permits.

6.2.2 Spectrum management

One of the most critical issues facing regulators worldwide is the allocation (the choice of which service is used in each frequency band) and assignment (the choice of which supplier has access to a particular frequency band) of spectrum. In the communications sector, radio frequency spectrum is probably at once both the scarcest and the most critical resource for efficient deployment of communications access networks. Around the world, regulatory and policy authorities have implemented a wide range of options in the drive to find the most efficient and beneficial way to distribute and use spectrum:

- **Allocation** – Generally, the majority of countries have chosen to follow international standard allocations defined by the ITU (such as putting WiMAX in the 2.4GHz and 3.5GHz bands). This has the benefit of lowering the cost of equipment due to economies of scale, as well as facilitating the build-up of expertise in any given technology. There are differences (many of a historical nature) between frequency bands used for a particular technology between countries, but these differences are likely to shrink or disappear as newer **standards** established with greater international co-operation are implemented (e.g. IMT-2000 WCDMA).

- **Assignment** – Assignment of spectrum has proved a more difficult procedure than allocation in general. In almost all cases, spectrum charges are assessed, which can help ensure the efficient use of spectrum. However, very high charges can reduce the ability to deploy networks efficiently and handicap future development. As an example, the very high concessions paid for 3G licenses in the UK have arguably hampered the deployment of even newer technologies, given the fact that anticipated take-up and usage of 3G services has not yet matched the projections at the time the auction was held.

  At this juncture, we note that the spectrum assignments in Peru are currently directly administered by the MTC. Internationally, it is more often the case that the national regulator is authorized to have primary jurisdiction over spectrum assignment issues because of the close relationship between spectrum assignment and ongoing market assessment obligations of sectoral regulators. In particular, such authority is important in regards to the ability to apply spectrum caps across rapidly changing technologies.

Recommendation: The assignment of spectrum and the assessment of competitive impact and obligations should be harmonized under the primary aegis of OSIPTEL in order to improve the effectiveness of spectrum management in Peru.

In addition to choosing the right bands for allocations, it is important that the assignments are large enough to support wireless broadband services under current and future technologies. We have discussed the issues involved in this process in more detail in both the technology and competition analyses, noting that it is generally agreed that 15–20MHz of spectrum will likely be the minimum required for delivery of full interactive advanced services over wireless broadband.

To illustrate some of the intricacies of spectrum management, we discuss in a bit more detail the process of spectrum management in the USA.

The Federal Communications Commission (FCC) and the National Telecommunications and Information Administration (NTIA) share responsibility for the management of spectrum in the USA. The Telecommunications Act authorizes the FCC to promote development and deployment of new technologies and services through the use of market-oriented allocation and assignment policies (typically auctions), as well as promulgate licensing policies that encourage the efficient use of spectrum.

In 2002, a task-force assigned to advise the FCC on future best-practice spectrum assignment policies came up with a number of recommendations. Among other things, it advocated a migration from a traditional command-and-control model to a market-oriented exclusive rights model and unlicensed device/commons model, as well as the implementation of ways to increase access to spectrum in all dimensions for users of both unlicensed devices and licensed spectrum.

A key step in maximizing the benefits of spectrum usage in the USA was the 2003 decision by the FCC that authorized licensees with exclusive rights to their assigned spectrum to enter into spectrum leasing arrangements with minimal conditions attached, mainly in ensuring that geographical scope, length and bandwidth do not exceed the boundaries established in the original license.

Auctions and secondary markets are only effective in countries where demand for spectrum outstrips supply. Otherwise, in countries where this is not the case, auctions could be inefficient, if not ineffective, at assigning spectrum.

Another means of promoting efficient spectrum usage is re-farming spectrum that has already been allocated and assigned, and putting the spectrum to more efficient use. This can be done by a regulator, or it could be done by the market if existing spectrum owners are allowed to sell their spectrum to the highest bidder. The market will likely be more efficient at this task, but this may create inequitable situations where historical spectrum owners reap large rewards for selling their spectrum. Finding the most effective means to ensure efficient spectrum usage presents an ongoing challenge for regulatory authorities around the world.

Spectrum management in Peru

Our analysis in this section is targeted at ensuring that the spectrum management policies in Peru are appropriate for taking full advantage of the specific benefits that convergence brings. A full and more extensive treatment of the entire spectrum auctioning, licensing and management framework is best left for a more directed study.

With regards to spectrum requirements, the specific benefits of convergence (bringing an increasingly wider range of basic and advanced services to the entire population) in Peru will be best realized when operators have access to large-enough spectrum assignments, harmonized technology standards (subject to standardized allocation bands in line with ITU standards), and freedom from onerous fees on usage. In more detail, the situation in Peru is as follows:

- **Standardized frequency allocations** – Allocations in Peru are in line with the suggested ITU frequency allocation recommendations, and as such operators in Peru are fully able to take advantage of the economies of scale that come with using equipment that is consistent with multiple operators around the world.

- **Adequately sized frequency assignments** – We have previously noted that 2×15MHz to 2×20MHz of spectrum is emerging as the optimal block size for deployment of high-speed advanced services over 3GPP wireless networks; on the other hand, mobile WiMAX networks need a minimum of 20MHz of unpaired spectrum (30–40MHz being optimal). At present, the major MNOs have either 2×12.5MHz in two different bands (Telefónica and América Móvil) or 2×17.5MHz (Nextel), while the fourth licensee will have 2×12.5MHz at 1900MHz. Additionally, 400MHz of spectrum is shared between the three existing MNOs and four additional WiMAX-only operators at the 2.5GHz and 3.5GHz bands, with a new license soon to be awarded in the 2.6GHz band.

  It is our general opinion that the total holdings of each operator are sufficient at this time to allow for deployment of converged services. In particular, the fact that all assignments have large contiguous blocks (and in many cases they are a single contiguous block in fact) is also a key characteristic that makes the current assignment framework conducive to delivery of advanced services. However we note that for historical reasons, Emax has access to more than double the amount of spectrum capacity of any other operator in the 2.5GHz band. This could potentially be a competitive disadvantage for other operators, but currently does not constitute a barrier to introduction of advanced services for any operator because each operator has enough spectrum to efficiently offer the advances services considered in this study. This imbalance can be reviewed in a full study of spectrum management in Peru, which is one of the key recommendations made below.

- **Harmonized technology standards** – The fact that operators are free to choose to deploy any technologies that they wish within the family of network standards applied to specific frequency allocations is a key current policy that facilitates convergence. As a specific illustration, while LTE has not yet been standardized, there are moves to do so at the 2.5GHz band. If this becomes the case, Telefónica and América Móvil will then have the option to deploy LTE services using their concessions in this band, giving them even more flexibility on how best to optimize their networks for delivery of advanced services.

- **Undemanding spectrum fees** – There is a potential concern about the fact that the revenue collected from recurring spectrum fees currently goes beyond servicing just spectrum management costs, and is used for general operating costs of the ministry and FITEL (Portal del Fondo de Inversión en Telecomunicaciones). The ITU recommends setting spectrum fees using rules that recover only the costs associated with actually administering the spectrum.[55]

Recommendation: Ensure that the structure in place for charging spectrum fees is such that fees are set to recover costs associated with administering spectrum, assuring a more equitable economic treatment for concession holders and lowering the cost of offering services.

A spectrum cap of 60MHz is currently applied to all operators by the MTC; in the interviews conducted, these operators noted that, at present, there was not any serious agitation for more spectrum by existing operators. While not specifically related to convergence, we note that a spectrum cap at this stage of market development is essential to prevent operators from hoarding spectrum and also as a control against mergers and acquisitions which could reduce competition.

There may be some scope for modifying which bands the spectrum cap is applicable to and adjusting the actual level of the spectrum cap in future as the demand for higher-speed wireless services increases. For instance, as WiMAX goes mobile, it may be appropriate to include WiMAX spectrum in the spectrum cap and also consider changing the level of the cap at that time. At present, however, the spectrum cap does not hinder operators from expanding the coverage and functionality of the services they provide, while reducing the risks of spectrum hoarding or reduction in competition in particularly competitive bands.

Digital migration in Peru

All around the world there is an ongoing movement to switch over from analogue to digital broadcasting in the part of the spectrum usually used for TV broadcasting (490–860MHz). Switching the existing analogue channels to digital frees up significant capacity, called the digital dividend in many developed markets. For example, in a country with five analogue TV channels broadcast over five multiplexes, these could theoretically be broadcast over just one digital multiplex, freeing up significant spectrum.

In many emerging markets, this issue is actually less complex for the simple reason that there are not a lot of analogue broadcast channels as most multiple-channel TV customers are served by satellite signals or, to a lesser extent, cable signals – many countries may have only two or three national broadcast channels. Nonetheless, digital transmission is more efficient, and the digital migration is being recommended by the ITU.

Thus, regulators are faced with a very complex question, the answer to which is likely to have a profound impact on the future of the communications and broadcasting industries – specifically the question on the best way to perform the digital transition.

[55] ICT regulation toolkit Module 5: Radio Spectrum Management

The ITU has recommended that digital migration take place before 2015. In order to minimize the cost and disruption of the migration to both broadcasters and consumers, it is important for regulatory authorities in Peru to start investigating the issue. In particular, issues that will need to be discussed include:

- technology choice issues
- the question of when broadcasters should begin to purchase digital broadcasting equipment by weighing any falling costs of such equipment against the need to encourage consumers to begin to purchase digital receivers when they buy new or replacement televisions or radios
- the timeframe over which analog services will be terminated
- how this digital dividend spectrum is to be assigned (e.g. it could be assigned to existing operators auctioned off freely to anyone, reserved for new entrants, or any combination of the previous options).

The process of choosing the digital mobile TV standard in Peru has already been undertaken, with the ISDB-T standard selected in early 2009. The conclusions from that process should be part of this discussion as services based on these new standards will be prime candidates for deployment in this band.

Additionally, the digital migration process provides an opportunity to consider in depth the optimal spectrum management procedures going forward with regards to the distribution of this entire resource. For example, there may be issues to discuss with regards to the most effective way to assign spectrum between existing and new operators, and harmonize some of the existing assignments (e.g. Telefónica obtaining 450MHz spectrum within Lima, while another company is given the spectrum everywhere else).

Recommendation: ·Commission a wide-ranging study to investigate the reform of the spectrum management process, paying particular attention to the process of digital migration and how best to free up and assign additional spectrum for deployment of advanced services. This would allow OSIPTEL to keep pace with other digital dividend transition and migration processes going on worldwide and meet ITU deadlines, while also fully modifying the spectrum management process to take advantage of all promising possibilities in an effective manner.

The responsibilities of both MTC and OSIPTEL in the assignment and administration of spectrum in Peru suggest that any spectrum management reform study should be carried out in collaboration between these organizations.

6.2.3 Core network

In the core networks the critical pieces consist of international infrastructure, Internet exchange gateways, and backhaul and leased lines. These are not just important for carrying voice traffic, but also for carrying data traffic and traffic from any other advanced services based on IP. Where competition has developed, no *ex ante* regulation is required, but where there is no competition, then *ex ante* regulation is required in order to ensure cost-based access to these critical facilities.

Appropriate policies concerning the core network in Peru can be categorized according to those concerning existing facilities and those concerned with new deployments.

Existing facilities

► *International infrastructure*

In Peru there are a variety of sources of international infrastructure, both terrestrial and satellite-based. Specifically, there seems to be sufficient international Internet bandwidth to accommodate increased adoption and usage of convergent services without the need for any regulatory intervention at this time. We consider this area to be successful and do not propose any specific policy remedies targeted towards international infrastructure and services.

► *Connectivity and backhaul – leased lines*

We noted previously in Section 5.2.6 that although there is cost-based access to E1-based long-distance leased lines in Peru (which cover point-to-point delivery between specific locations), the unavailability of cost-effective higher-capacity units such as STM-1s is a major stumbling block for alternative operators looking to obtain leased lines from Telefónica . In particular, our analysis in the technology section of this report (see Section 4) illustrated how expensive capacity links based on E1s are as traffic increases relative to larger Ethernet-based products. We also note that OSIPTEL has been made aware of demand for smaller leased-line capacities by operators in rural regions which may not actually want to pay for a full E1 given the low levels of demand.

Additionally, the fact that the regulated leased-line prices are for point-to-point connections *between* different cites means that alternative operators looking to connect their own PoPs in any given city are forced to choose between self deployment or paying unregulated (and likely expensive) charges for leased lines.

Thus, although OSIPTEL has already moved to address the supply of leased lines in Peru in a cost-effective manner by mandating cost-based E1 long-distance leased lines (in 2007), there is a need to implement further policies to promote competitive usage of leased lines from Telefónica .

To illustrate the necessary principles, we will analyze the leased-line regulations implemented by Ofcom in the UK. The range of wholesale leased lines that BT must make available are categorized in a number of ways:

- traditional interface (TI)[56] circuits and alternative interface (AI) circuits[57]

56 2TI circuits include analogue circuits and digital circuits that use synchronous digital hierarchy (SDH) or pleisynchronous digital hierarchy (PDH) transmission.

57 AI circuits are digital circuits which use other forms of transmission, generally Ethernet.

- trunk and terminating segments (the former are the long-distance component of the circuit and the latter are the segments at each end of the circuit which connect to the customer site).

Ofcom defines and implements price controls on a suite of leased-line products, as shown in Figure 6.3 below:

Wholesale product markets	*Bandwidth breaks*			
TI symmetric broadband origination (terminating segment)	Low Up to and including 8Mbit/s (including analogue and SDSL services)	High Above 8Mbit/s up to and including 45Mbit/s	Very high – 155 Above 45Mbit/s up to and including 155Mbit/s	Very high – 622 Above 155Mbit/s
AI symmetric broadband origination (terminating segment)	Low Up to and including 1Gbit/s		High Above 1Gbit/s	
Trunk segments (SDH/PDH)	All bandwidths			

Figure 6.3: Summary of Ofcom's proposed wholesale product market definitions for leased lines in the UK [Source: Ofcom Business Connectivity Review 2008]

While it is unlikely that the suite of services offered by Telefónica will be categorized in such a complex manner as done by Ofcom, there is scope for OSIPTEL to implement policy changes such that alternative operators have cost-effective access to leased-line capacity for a wide variety of purposes. These policy changes could range from low-capacity connections (E1s) connecting two PoPs within a city, to high-capacity connections (STM-1s or higher) connecting very distant locations, with services based on Ethernet access also available.

> **Recommendation:** Mandate a wider suite of higher and lower capacity leased-line services (in consultation with industry) that should be provided by Telefónica , offering cost-based options for both local and long-distance connectivity, as well as multiple capacities to provide operators with more cost-effective options to deploy their networks.

The determination of the actual suite of products that will be needed must be done in consultation with the industry for two reasons:

- to ensure that it is the products that are actually in demand (or likely to be in demand) by competitors are provided
- to ensure that unnecessary obligations are not placed on Telefónica for products which are not needed, which could distort or delay the final cost calculations.

► *Internet exchanges*

As discussed in Section 5.2.6, information provided by OSIPTEL indicates that NAP Peru is running well and thus there is no need for immediate regulatory attention. Interviews with all the major operators indicated a good level of satisfaction with the exchange services offered in NAP Peru.[58]

NAP Peru should continue to run unregulated, as is the case for most IXPs around the world, and OSIPTEL should continue to monitor the amount of domestic traffic exchanged within the country.

Some operators in our interviews expressed a slight concern that all domestic traffic needed to be transported to Lima for exchange since NAP Peru only has a presence in the capital. This process has not been a hindrance to service deployment to date. In the event that there is an opportunity to do so, OSIPTEL could consider encouraging multiple IXP locations (as the Brazilian regulator did where the government-commissioned, multi-stakeholder Brazilian Internet Steering Committee (CGI.Br) initiated the Ponto de Troca de Tráfego Metro project (PTTMetro), aimed at creating IXPs in cities throughout Brazil).

In carrying out a monitoring process, it would be useful for OSIPTEL to know the total amount of traffic exchanged in the NAP, and compare that with the total Internet traffic generated in Peru, in order to determine the extent to which the NAP is serving its needs, and whether a second or third NAP in other geographies would be cost efficient.

Recommendation: Promote secondary domestic IXPs outside Lima potentially by using universal service funds in partnership with private organizations or using tax breaks for interested organizations. This will help to ameliorate the need to transport all domestic traffic to Lima for exchange.

Nonetheless, unless a significant market failure is observed (such as barriers to entry for new entrant ISPs), this policy is not critical.

► *NGN upgrades*

As described in Section 5.2.6, NGNs are more efficient to operate while also providing IP-based services. Our interviews did not uncover any regulatory roadblocks to upgrading existing core networks in Peru, and so at this juncture there is no need for any specific change to existing regulatory policies.

New facilities

The deployment of new infrastructure in the core network will be critical in order to achieve a number of results:

- expanding access to un- or under-served areas

58 The point was raised that all operators have to have the same capacity entering and leaving the IXP, which could force some operators to have over or under supply of capacity to the exchange. However, this was not considered a significant problem.

- increasing capacity in response to an increase in access and usage
- efficiently facilitating competition.

This new infrastructure will be useful for all types of access, fixed and wireless, and can also be used for broadcasting services. While international best practice focuses on wholesale access to existing leased lines, it is not efficient to impose wholesale access on new infrastructure, because it reduces the incentives for any operator to invest in capacity if it must be made available to competitors at cost.

First, any roadblocks to the deployment of the new infrastructure should be cleared in order to facilitate investment. The same municipal roadblocks that exist for the deployment of access networks as we discussed previously will also complicate the deployment of core network infrastructure. As we have discussed, many municipalities object to infrastructure deployment for both aesthetic and (perceived) health reasons; at the same time, it may impose unrealistic charges on the deployment of network equipment owing to the civil engineering costs. Thus, our recommendations on municipal access policy proposal put forward in Section 6.2.1 in the context of deploying access networks holds for all deployment of network infrastructure, including core network deployments.

A consensus is forming that infrastructure sharing may be the best way to promote investment. We discuss infrastructure-sharing policies in detail in the next section.

In Peru, there is already provision in the rules for all major civil works (such as road building) to ensure that infrastructure providers are given opportunities to lay cabling and gain access to ducts in order to deploy access and core networks in a cost-effective manner. Maintaining this policy going forward will continue to be essential as a means of reducing the costs of deploying networks.

6.2.4 Infrastructure-sharing policies

Having discussed the technical aspects of infrastructure sharing in Section 4.1.7 and its competitive considerations in Section 5.2.7, we now turn to a more detailed regulatory analysis of this issue. Regulators around the world have continued to turn to infrastructure sharing as a key regulatory tool for encouraging effective and efficient deployment of networks. Figure 6.4 below shows the percentage of countries in which some form of infrastructure sharing is mandated according to the ITU.

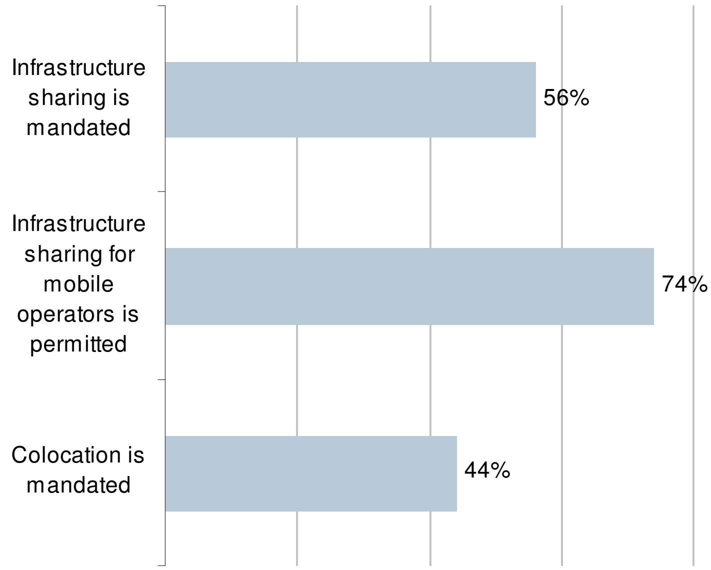

Figure 6.4: Percentage of countries mandating or permitting infrastructure sharing, worldwide, 2007 [Source: ITU world telecommunications regulatory database, 2008]

There are a variety of ways to promote infrastructure sharing. For instance, it would be important to stipulate that all infrastructure deployed on government property should be jointly deployed or shared (as is already done for new major civil projects in Peru such as roads). Alternatively, the government could investigate how to facilitate sharing of infrastructure through a non-profit entity that would raise capital, deploy infrastructure, and operate the infrastructure. Finally, infrastructure could be deployed and shared via the universal service fund, as described below.

However, it is important to note that infrastructure sharing is not just restricted to telecommunications infrastructure. For instance, other network industries, notably water, electricity, gas and trains, all offer rights-of-way that can be used for telecommunications infrastructure. The government should facilitate access to existing infrastructure at cost-based rates, and also encourage efforts to jointly deploy new infrastructure as needed.

In the following paragraphs, we determine the most optimal infrastructure-sharing policies for the Peruvian market, again making a distinction between existing networks and new networks (either core or access networks).

Existing networks

There are well-established means by which access to existing wireline and wireless networks are shared. We note that as a result of the relatively low coverage of the fixed network in Peru, the benefit from regulatory interventions will be relatively limited in terms of wider service deployment compared with the potential advantage of applying new regulations to the wireless sector.

► *Wholesale access over incumbent wireline access networks*

In general, wholesale access regulation has been mainly focused on wireline networks (and specifically the incumbent telephony network), whereas alternative wireline networks or wireless networks in general have received much less regulatory attention.

To understand this issue we will discuss in depth the experience in Europe, which has one of the most developed wholesale access frameworks in the world.

Wholesale access to access networks is mandated across all EU countries, with significant success in creating competition. The European New Regulatory Framework (NRF) aims to address convergence and all its challenges. The NRF is composed of six Directives that address the convergence of telecommunications, media, and information technology, but does not specifically address any content regulation**.** This framework is built on the following principles:[59]

- technology- and provider-neutral
- focus on services, not technology
- informed by legal principles drawn from general competition law
- focus on enduring bottlenecks
- light-touch regulation
- foster innovation and investment
- provide legal and investment certainty
- avoid fragmentation of markets
- balance harmonization and innovation
- address the question of cross-border services.

Of particular interest is the fourth principle, namely ‘focus on enduring bottlenecks’. This reflects the general *ex-ante* approach taken to regulation. The NRF states that *ex-ante* regulatory obligations (notably wholesale access) should only be imposed where there is not effective competition, i.e. in markets where there are one or more providers with SMP. As soon as wholesale competition creates significant retail competition, then any retail obligations are removed, and to the extent that wholesale competition becomes sustainable without regulatory obligations, then those obligations will be removed as well.

As part of the wholesale regulatory regime for broadband, regulators in Europe generally have tried to establish a ladder of investment for new entrants offering data services (Figure 6.5). The ladder starts with resale, which requires the least investment by the entrant while providing the lowest wholesale discount, which in turn provides the least means for the entrant to differentiate its retail service, as it is essentially the service of the incumbent.

As soon as the entrant has enough customers it has an incentive to move up the ladder, to a form of bitstream access (differentiated by where in the network the entrant picks up traffic); this requires more investment by the entrant, but in return has a larger discount and provides more means for the entrant to differentiate its service. Again, when the entrant builds up a customer base, it has an

59 Source: European Telecommunications Platform, (06) 01, 17 January 2006.

incentive to take unbundled local loops, which requires yet more investment in return for more flexibility. The culmination of the ladder is infrastructure investment, where there is likely to be an appropriate return.

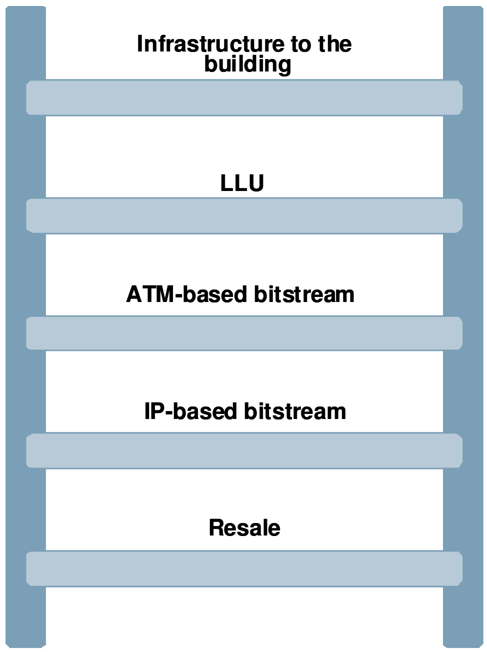

Figure 6.5: Ladder of investment for wireline broadband services [Source: Analysys Mason]

The most prevalent form of access in Europe is unbundled local loops, which provide the highest degree of flexibility for competitors – notably, a number of them used unbundled loops to offer IPTV services even before incumbent operators, creating a significant amount of competitive pressure in the process.

However, for reasons discussed in our earlier study for OSIPTEL in 2006 (mainly relating to the cost and complexity of implementing unbundling regulations, the costs incurred by entrants in using the service, and the relatively low likelihood of widespread take-up), we do not recommend this course of action for Peru.

On the other hand, bitstream access is also common in Europe, and we believe it affords a great deal of flexibility for entrants in Peru. Bitstream services are all slightly different, and vary in particular along two key dimensions:

- **ATM-based versus IP-based** – ATM-based offers allow for more control over backhaul bandwidth, contention and quality of services, but tend to be more expensive than IP-based bitstream. Countries with bitstream offers often have both variants.

ATM-based bitstream	IP-based bitstream
Allows for significantly different technical characteristics to incumbent, with potential competitive advantage	Cheaper and quicker to provision
Directly alter QoS parameters such as contention ratio for end-user access connections	Fewer connection/handover points required
Quality of service to end-user can be guaranteed by alternative operator	

Figure 6.6: Comparative advantages of ATM-based bitstream and IP-based bitstream [Source: European Regulatory Group]

- **Parent versus distant access** – ATM-based offers may involve either handover to the service provider at each ATM switch closest to the DSLAMs in the central office (parent access) or handover at a smaller number of ATM switches to which the traffic is backhauled and aggregated from several locations by the incumbent before handover (distant access).

With specific regards to Peru, we note that the following types of wholesale access to the incumbent's network will be most effective in spurring competition:

Cost-based resale using wholesale line rental (WLR)

WLR is the resale of the incumbent's access service (using cost-based wholesale inputs) to end users. The incumbent provides the telephone service and all facilities, while the reseller takes responsibility for marketing, customer care, and billing. Wholesale prices are generally determined using a retail-minus methodology in order to ensure that there is always a sufficient margin to allow resellers to be able to offer the service to end-users at reasonable cost.

This option requires extremely low investments on the part of resellers, and as a result, this is a good way to enter the market at low risk and build up customers.

The main benefit for the reseller is that wholesale line rental may improve customer retention because the same operator is providing both access and call services. As such, in Peru this will allow alternative operators using bitstream to compete with Telefónica for those customer who want a single bill.

Recommendations: Mandate WLR for competitive operators using a retail-minus methodology to set prices, which enables the option of offering single billing to consumers.

Bitstream access

We note that cost-based ATM-based bitstream offers over Telefónica's network were implemented in Peru in March 2007.[60] However, there are

60 RESOLUCIÓN DE CONSEJO DIRECTIVO Nº 010-2007-CD/OSIPTEL (March 2007).

indications that the current bitstream offerings are not having a significant effect on the market place, i.e. only one rural operator has chosen to use this input to offer its own service-based products. There are a number of specific issues that have arisen with regards to the existing offer. We go through these issues in turn, and make recommendations that address these potential obstacles to further take-up of bitstream access.

The first of these issues has to do with the possibilities for margin squeezes. A margin squeeze occurs when the wholesale price that a vertically integrated company such as Telefónica charges to its competitors for wholesale services is so close to (or greater than) its retail price that the competitor is unable to compete effectively with the integrated company.

Additionally, OSIPTEL has noted that in some cases, even with the existing regulatory process determining cost-based bitstream prices, Telefónica increases the functionality of its retail service (for instance, through a higher downstream bandwidth speed) while keeping the retail price constant; in doing so, the incumbent makes its services much more attractive than its competitors based on a wholesale input that offers services at the old functionality level. This practice makes it difficult for alternative operators to offer comparable services to Telefónica .

The most direct method of dealing with this type of issue is to prohibit the incumbent from offering any regulated retail services for which the equivalent wholesale input is not also made available to competitors. Two regulatory examples of this methodology are:

- *'Equivalence of Inputs'*[61] *(EoI) in the UK:* as part of the regulatory conditions imposed on BT, Ofcom requires BT's own downstream operations use the same products, processes, and prices as those used by their retail rivals.
- *The imputation test by the FCC:*[62] succinctly, incumbent operators are not allowed to provide to themselves or to affiliates any wholesale

61 OFCOM telecommunications statement on BT undertakings *http://www.ofcom.org.uk/consult/condocs/telecoms_p2/statement/*

62 'FCC Telecommunications Act 1996 Section 272 – *(e) FULFILLMENT OF CERTAIN REQUESTS- A Bell operating company and an affiliate that is subject to the requirements of section 251(c).*

'(1) shall fulfill any requests from an unaffiliated entity for telephone exchange service and exchange access within a period no longer than the period in which it provides such telephone exchange service and exchange access to itself or to its affiliates;

2) shall not provide any facilities, services, or information concerning its provision of exchange access to the affiliate described in subsection (a) unless such facilities, services, or information are made available to other providers of interLATA services in that market on the same terms and conditions;

`(3) shall charge the affiliate described in subsection (a), or impute to itself (if using the access for its provision of its own services), an amount for access to its telephone exchange service and exchange access that is no less than the amount charged to any unaffiliated interexchange carriers for such service; and

service related to access unless these wholesale facilities and services are also made available to alternative operators.

In both cases, the effect of these policies is to ensure that alternative operators are not at a disadvantage with respect to the incumbent when using wholesale inputs or services.

Recommendation: Require that Telefónica make available the equivalent wholesale input (in terms of functionality and quality of service) for every regulated retail service that it offers, at the same time that the retail service is made available to consumers.

Construct tests to check and ensure that there is enough of a margin between retail services and wholesale services such that an efficient entrant can make a reasonable return on investment.

Another issue concerns the ability to deliver advanced video services using bitstream inputs. The nature of the requirements is dependent on the type of video service being delivered:

- Linear TV requires one of two things: either the incumbent operator is already deploying a TV service using IP – and as such has implemented multicasting capabilities in its network – or the alternative operator has set up (or has the ability to set up) its own linear TV distribution system with servers close to end users so that it can efficiently deliver linear TV. As neither of these conditions is currently present in Peru, no bitstream offers will be able to support the delivery of IPTV.

- VoD can be delivered using existing bitstream inputs as long as the products have the appropriate QoS parameters attached to them. In Section 6.5.3 below we discuss in more detail the QoS requirements for bitstream inputs in a converged environment.

As consistently noted throughout this document, we expect that the predominant benefit of convergence in Peru will be increased access to advanced services over wireless networks; these do not have the same regulated investment ladder as wireline networks in any countries, but also are in a much more competitive situation than incumbent fixed networks. As such, the infrastructure-sharing policies and other wireless access policies are likely to have a greater effect in achieving OSIPTEL's goals than wireline-specific access policies.

(4) may provide any interLATA or intraLATA facilities or services to its interLATA affiliate if such services or facilities are made available to all carriers at the same rates and on the same terms and conditions, and so long as the costs are appropriately allocated.

Wholesale access over existing cable networks has generally not been considered a regulatory matter as the providers typically are not considered dominant for the telecommunications services that they provide, namely telephony and/or broadband. Additionally, wholesale access to cable networks is technically challenging given the shared nature of the last mile access. We know of several cases in the US and Singapore in which cable operators were required to provide cable open access (essentially bitstream), as a condition for merger, but in both countries there was no detailed wholesale price regulation and the resulting commercial negotiations did not lead to significant service-based competition. As such, we do not make any particular recommendations on access to cable networks in Peru, and instead suggest to focus on bitstream access to Telefonica's larger PSTN network

Wholesale access over fiber access networks is a question that is still under heavy investigation in Europe where these networks are being rolled out, and it appears that the answer will be dependent on the architecture of the fiber network. With no firm fiber access plans from Telefonica currently announced, we suggest waiting to learn from the European approach. Once Telefonica begins to make definite plans on the rollout of fiber networks, it will be important at that time to engage with the operator and look at then current international best practices in order to decide the most appropriate regulatory policies for the network being deployed by Telefonica.

► *Structural and functional separation*

In countries where the incumbent telecommunications network covers the majority of the population and is also a monopoly provider of many fixed telecommunications services, a lot of work has been done by governmental and regulatory authorities on the best way to stimulate competition. Also, significant work has focused on the best form to provide alternative operators wholesale access to bottleneck facilities controlled by the incumbent, such as those described in the previous section. One approach that has been investigated in detail is the separation of incumbent networks into network, wholesale and retail arms.

The aim of this kind of separation is to reduce the incentives of incumbents to engage in discriminatory supply of bottleneck facilities. The most well-known example of this is the separation of BT in the UK into BT Openreach (the network arm), BT Wholesale, and BT Retail. Other examples include the separation of incumbent networks in Italy, New Zealand, Sweden, and Ireland (where full structural separation is being discussed), among others.

Given that the wireline network in most emerging markets is not as extensively deployed, separation as a remedy is much less appropriate as a tool to bring affordable communications and media services to the majority of the population. For this reason, there have been very few instances of regulators in emerging countries seriously investigating separation of networks (the structural separation of the incumbent network in Mongolia being an exception). The ITU recommends a very cautious approach to network separation in emerging markets as the cost and regulatory burden can significantly outweigh any potential benefits.

As a regulatory measure, we concur with the ITU in that we do not believe this policy is appropriate for use in Peru because the complexities involved in imposing any kind of separation on Telefónica's network significantly outweigh any potential benefits to the country as a whole, given the limited coverage of the network.

► *MVNO access*

In many countries, it is common for MVNOs to re-sell the network services of MNOs. As we discussed in Section 4.1.7, there are a variety of MVNO arrangements depending on the extent to which the MVNO invests in network infrastructure, but there are two common features:

- at the operational level, the MVNO does not have a license to operate spectrum
- at the retail level, the MVNO has the primary customer relationship.

An MVNO's relationship with its host MNO is crucial in defining its ability to compete in the market. The involvement of national regulatory authorities in MVNO agreements can be quite significant. Although in most cases the two parties are left to reach a commercial agreement even where regulators mandate that terms must be offered (such as in Denmark), the authorities may still make the provision that they will intervene if anti-competitive practices on the part of the MNO prevent an agreement being reached. The approach taken by the regulator can have a significant impact on the MVNO's prospects.

It is notable that in many countries MVNOs have arisen purely from commercial negotiations between a network operator and the MVNO, and not from any regulatory mandate. This is common in competitive markets, as network operators seek to expand their reach through arrangements with other companies, typically those with a strong customer base. For instance, one common example is T-Mobile UK, which had a very strong business base, resulting in significant spare capacity at nights and week-ends, and thus reached an early MVNO deal with Virgin Mobile to access Virgin's younger clientele focused more on personal use outside business hours.

In some European markets, including Denmark, Norway, Slovenia and Spain, MNOs were required by regulation to negotiate with MVNOs. This requirement often followed the regulator finding that one or more operators had SMP. According to this requirement, the MNO is obliged to allow the MVNO access to its network, usually using a cost-plus methodology: the price the MVNO pays is dependent not on the MNO's retail prices, but on the costs incurred by the MNO that are attributable to the MVNO's usage of its facilities. Cost-plus pricing gives the MVNO more freedom to set its own tariffs, as it is not tied to following any upward movement in the MNO's retail prices, and it generally allows higher profit margins for the MVNO. This situation makes it easier for MVNOs to prosper in the market and leads to more intense competition for the MNOs.

In some growth markets, it has been necessary to implement regulation to enable the introduction of MVNOs. In Oman, the Telecommunications Regulatory Authority cited lower prices and greater variety of services on offer as key reasons for the introduction of mobile service resellers into the market. The Indian regulator, TRAI, made similar points, referring to more competitive pricing, a better choice of services and service providers, and more efficient use of infrastructure as its main reasons to introduce MVNOs. Even in these cases, the regulation has focused on ensuring that prospective MVNOs were legally able to offer services – the actual arrangements between the MVNO and host MNO were left to commercial negotiation.

The variable impact of MVNOs suggests that no typical outcome can be predicted for the effect of MVNOs in emerging markets. Much depends on the level of regulatory intervention in the market, which can range from simply not forbidding the entry of MVNOs, through facilitating their entry, to forcing MNOs to accept cost-based access to their networks by MVNOs. For example, in the case of Denmark, cost-based access early in the market's development led to price falls, but also resulted in market consolidation later as some operators exited the market, leading to less competition[63].

The entrance of MVNOs could be beneficial in promoting competition in the market, but could also be detrimental to the concurrent aim of expanding mobile network infrastructure in the country. In the case of Peru, there are currently three nationally licensed MNOs, with a fourth on the way. The entrance of a fourth licensed MNO in 2009 is more useful for satisfying the double aims of competition and network expansion than MVNO entry, given the focus and requirement for deploying infrastructure. For emerging market in general, forcing MVNO obligations on existing MNOs could have the harmful effect of reducing incentives for investment or expansion of network and services of existing MVNOs by compromising existing revenue streams.

Thus OSIPTEL's short-term focus should be on fostering greater competition from Nextel and the new fourth entrant to Telefónica and América Móvil. Methods of doing this are discussed in the next section which covers national roaming.

As is currently the case in the USA, OSIPTELs current aim with regards to MVNOs should be to ensure that there are no regulatory barriers to any prospective MVNOs being able to offer service after entering into commercial agreements with host MNOs. The widely varying success of MVNOs in many markets has shown that MVNOs should not be relied upon as a primary means to provide competitive pressures to existing operators, and thus achieve specific market aims.

In terms of regulations that MVNO operators should be governed by, in Section 6.5.1 we discuss a new licensing framework that separates licensing of services from licensing of scarce resources. Under such a framework, MVNOs should be subject to the same license conditions as any other provider of licensed mobile voice services. More specifically, the licensing regime should make it straightforward for an MVNO to apply for and receive a license to offer applicable services (and not a spectrum license) as soon as agreements are concluded with a host MNO.

[63] The regulator mandated cost-based access to MNO infrastructure in 2000, and MVNO's had captured about 29% of all subscribers by 2005. Retail revenue per minute in Denmark was significantly lower than the rest of Western Europe in 2004/2005. However by 2006 the market structure had changed radically. Several acquisitions in 2004/2005 reduced the number of MNOs from four to three, and two of the largest MVNOs were bought out by two existing MNOs. Additionally, the regulatory removed all obligations on facilitating MVNO access in 2006, with the result that much of the competitive pressure introduced by MVNOs in 2000 was gone. By 2008, retail revenue per minute in Denmark was in line with the rest of Western Europe.

In terms of specific recommendations outside the licensing recommendations made below, there are no specific steps that OSIPTEL needs to currently take with regards to MVNOs. Essentially, any entity that wishes to provide MVNO services should be able to apply for and receive the general license to offer telecommunications services,; any operator with a license to offer telecommunications services should not need a separate authorization to offer MVNO services.

If in the future, a market review makes it clear that MVNOs are necessary and desirable to achieve further market goals, more proactive steps can be taken. This process will be facilitated by the ongoing relevant market and dominance review. For example, if any of the current MNOs are determined to have SMP, one potential remedy could be imposing cost-based access to the network for MVNOs.

► *National roaming*

National roaming is also a way to facilitate entry by a licensed MNO. Under national roaming, an existing MNO must offer roaming onto its network in areas of the country where the entrant does not yet have coverage. This enables the entrant to provide full coverage immediately, while still providing an incentive to further deploy their network in order to reduce the reliance on the existing network. National roaming might be only required for a limited period of time until new networks are more extensively built-out.

India provides an illustrative case. Mobile licenses were auctioned on a regional basis (called circles) and national roaming is crucial for customers traveling outside of their providers' licensed area. Note, however, that there was a worry that high roaming call charges could suppress network usage outside coverage areas, and strong regulatory oversight was needed to ensure that charges remained reasonable as well as enforcing coverage obligations.

In several other countries, such as Austria and Australia, national roaming was used to support market entry by a 3G network operator that had no 2G network. Regulators mandated that the 3G network operator had the right to negotiate temporary national roaming agreements covering access to the 2G networks of the network operators that had both 2G and 3G networks. Without such agreements, the 3G network operator would have very limited coverage in the early years of launch, which could prove a significant disadvantage. With these types of agreements, the 3G network operator can have national coverage but can be motivated to enlarge its own coverage by the potential economies of scale.

We note that in Europe, a decision from the European court agreed that temporary roaming agreements between operators could actually allow small network operators to compete with larger network operators, thus affirming the potential for national roaming as a pro-competitive policy.[64]

[64] In the case of roaming agreements between O2 and T-Mobile brought before the European Court of first instance – Commission Decision on German 3G Mobile Network Sharing Agreements Partially Annulled (Bird & Bird, May 2006), Judgment (European Court of First Instance (Fourth Chamber), May 2006.

Another example of mandated national roaming is found in Canada, where as part of the auction of new spectrum, the regulator required the incumbent to provide 'in-territory' roaming for five years to new entrants. This timeframe was intended to insure that new licenses will be able to offer effective competition with the incumbents from launch.

In Peru, it is hoped that the entrance of a new mobile network in the 1900MHz band, as well as the expected expansion of Nextel's network for deploying mobile services, will provide significant competition to the current duopoly of América Móvil and Telefónica . However, in the initial stages of launch and expansion, it is clear that Telefónica and América Móvil will have a significant advantage over the other networks. In this case, mandated access to national roaming over the existing mobile networks for a limited period of time (usually five to ten years) will likely allow the new networks to compete on a more equal basis in the short term, while also encouraging them to deploy their own networks and realize economies of scale before the roaming timeframes expire.

Recommendation: Require existing MNOs (namely Telefónica and América Móvil) to offer national roaming for specific time periods to new licensees (particularly the fourth mobile entrant) in order to encourage effective competition from launch.

► *Third-party ownership of mobile network infrastructure*

Where communications service providers also own the infrastructure over which services are provided, there is the in-built incentive to prevent competitors from sharing their sites to maintain an advantage. Where such infrastructure (towers, sites or masts) is deemed non-replicable or critical to achieve some regulatory goals, authorities could consider encouraging the separation of ownership of such resources from service provision. These third-party infrastructure providers would then have non-discriminatory obligations to provide access to any requesting operators.

Such third-party providers would have responsibility for offering a variety of services to requesting service providers including (but not limited to):

- radio and transmission planning
- site acquisition
- site construction
- equipment installation
- site maintenance
- site security.

The USA is one example of a country where third-party ownership of mobile network sites has been successful (without regulatory intervention). Companies such as Crown Castle and American Tower (both privately owned) own thousands of sites, and are able to provide very efficient services to multiple MNOs as they are not affiliated with any of them.

In the specific case of Peru, there are a number of potential advantages of such an organization for all parties:

- for *service providers*, they would be freed from dealing with a multitude of potentially different local ordinances, and can focus on their core competency of providing telecommunications and media services
- for *municipal authorities*, there would only be one organization to deal with, which would make it easier to address problems such as health concerns or multiple tower sites
- for *regulatory authorities*, the monitoring burden would be reduced; for example there would be less of a need to look out for potentially anti-competitive arrangements between municipal authorities and particular service providers against other service providers
- for the *infrastructure company*, economies of scale would be reached more quickly, providing it with both a stronger bargaining position and operational efficiencies as multiple sites are obtained.

One of the operators indicated that American Tower (which operates sites in the USA, Brazil and México) was at one point thought to be in talks to take over a number of Telefónica's sites and begin to run a network of mobile sites in Peru. However, this does not currently appear to be the case, and we are unaware of any particular indications in this arena.

OSIPTEL cannot compel any of the existing operators to allow a third-party infrastructure provider to take over their sites or use those third-party sites. Additionally, it is unlikely that such a venture will succeed without some sort of arrangement with either América Móvil or Telefónica to take control of existing sites that they control, given that Telefónica and América Móvil currently own most of the existing sites in Peru, and would be the largest customers. Even if the government were to set up an entity using its own funds (either solely or in partnership with a private organization), success would still depend on obtaining access to the existing sites of the dominant MNOs.

However, many operators in emerging markets are finding that in order to fulfill coverage obligations and provide continuous and effective service, they are having to take on responsibilities (such as security, or power generation) that are not part of their core service portfolio. Thus, there is a potential incentive to relinquish this responsibility to another party that is better able to focus on such issues.

Initiatives on OSIPTEL's part to encourage operators that this could be a beneficial idea, coupled with proactive moves to ensure that a third-party provider is established, could prove successful very quickly. An example of a regulator in an emerging market doing this is the NCC in Nigeria, which licensed nine independent companies to provide infrastructure sharing and collocations facilities in 2008.[65] Some of the licensees had already been operating these sites through commercial agreements with the existing operators. The NCC formalized the arrangement as well

65 NCC List of licensed telecommunications service providers, official website.

as taking on an officially regulatory role of such companies by providing guidelines on the expected standards and process details that these companies have to offer to service providers.[66]

Recommendation: Facilitate entry of third-party companies (potentially through formal licensing or other means such as government-initiated public–private partnerships) which can own and operate mobile network infrastructure such as towers, masts and sites to encourage mobile network sharing.

New networks

Given the different role for wireline and wireless networks described above, we recommend a slightly different approach for each. For wireline networks, we would focus on promoting efficient network upgrades where needed, and NGNs where new networks are to be built. For wireless networks, on the other hand, it is worth exploring network sharing to lower deployment costs, both where there are no networks today and also where operators plan to deploy NGNs. We cover several important aspects of infrastructure sharing here that are most relevant to Peru.

► *Open access*

According to the ITU, open access means the creation of competition in all layers of the network, allowing a wide variety of physical networks and applications to interact in an open architecture.[67] The reason that open access is increasingly being discussed as a solution towards offering affordable converged services is that it provides an equal platform on which service providers can innovate, which is what leads to the creation of the new services which are driving convergence.

The attractiveness of open access as a policy for regulators is that it solves the problem of unequal access to network elements encountered by opening up the vertically integrated networks of incumbents to competing providers. Having a truly open access network should encourage a whole host of service providers to being competing in the provision of converged services. Thus, it is typically considered to be optimal, if not essential, to not allow the network operator to provide downstream retail services. Otherwise, the elaboration of non-discrimination policies must be put in place, including, but not necessarily limited to, structural separation between the network operator and its affiliated retail service provider.

For instance, municipal open access projects are a representative example of the idea of open access networks – there is an infrastructure provider that sells its network services to any suitable service provider without preference. One such model that is often referenced is the municipal fiber network deployed in the city of Stockholm in Sweden, known as the Stokab system. Launched in 1994, the core

66 Guidelines on collocations and infrastructure sharing, NCC regulations.

67 Trends in Telecommunications Reform 2008, Chapter 3.

aims of the network are to build, operate and maintain the fiber networks in Stockholm and lease out fiber connections on a neutral, non-discriminatory basis to all service providers.

On the other hand, the concern with open access networks (particularly in emerging markets) is always whether the network operator will be able to recover its investments, especially in the case where it is only an upstream wholesale provider of network access. Thus, often the government sponsors the project and builds the infrastructure, while potentially setting up an entity to run the network, or letting another private entity run the network as a commercial operation. Such open access networks could possibly be funded through the universal service contributions.

The specific open access policies that are appropriate for any given country will be highly dependent on the exact local conditions present. In the case of Peru, it is unlikely that rural locales will be able to fund open access networks in their areas. The high deployment costs associated with wireline networks means that it is uneconomical to have multiple wireline infrastructures, making these networks most suitable for open access conditions.

There is potential for multiple wireless networks to compete with each other in underserved areas; however, the lower revenue potential dissuades wireless operators from rapidly deploying networks in these areas. In many cases, operators may apply for universal service subsidies to deploy networks to such areas.

Regulators in many countries where this has been the case implemented policies in the universal service subsidy competitions. According to the ITU, *"Access network extensions, under a UASF subsidy tender typically have some limited backbone extension associated with them. It is normal for UAS tenders to include open access requirements on access backbone links so that service providers, other than the initial subsidy recipient, have use of the facilities. This has been for example the case in Nigeria, Uganda and Mongolia"*[67]. Thus, there is scope for OSIPTEL to implement similar policies in order to promote competition even in areas with limited infrastructure.

> **Recommendation:** Mandate open-access requirements where possible for networks (or parts of networks) funded using FITEL as a means of spurring competitive provision of services.

► *National fiber networks and backbones*

Telefónica owns the only major national fiber infrastructure in the country. However, Telmex is currently building a coastal fiber network to run from the northern border of the country all the way to the southern border, which promises to provide another alternative national fiber network that may serve to spur competition in the provision of transport capacity, and alternative operators such as ISA Internexa are also building fiber infrastructure.

One policy gaining increasing attention in many emerging markets is the establishment of a national fiber network or backbone which can then be made available to service providers on an equal access basis. We have previously referenced the South African example of a national fiber network commissioned through a public–private partnership with a company called Infraco.

Another instructive example is the case of Alberta SuperNet in Canada, which was designed to provide a high-speed, high-capacity broadband network linking government offices, schools, health-care facilities and libraries, as well as residences.

The SuperNet network consists of approximately 13 000 kilometers of fiber-optic and wireless connections covering 429 communities in the region of Alberta, many with populations of less than 100. Fiber-optic cable amounts to roughly 84% of the network, while fixed wireless point-to-point links cover the remaining 16%. Approximately 340 fixed wireless links are used in the SuperNet network. The typical range of broadband access links is 10 to 40 kilometers, at speeds of 6.5–26Mbit/s.[68]

The incumbent operator Bell and Axia SuperNet were awarded contracts by the Government of Alberta to build (Bell), and manage and operate Alberta SuperNet (Axia). The Government invested CDN193 million in the construction of Alberta SuperNet, while the incumbent Bell invested over USD102 million in the network. Bandwidth is sold to any requesting service providers at standard prices. Axia SuperNet does not offer retail services for end users and has an open-access model.

These two examples illustrated an increasingly common arrangement for deploying national fiber networks and backbones. The development of an alternative national fiber network is not currently one of the main policy objectives in Peru. However, OSIPTEL has noted a concern about the potential for an increasing divide between rural and urban areas as new services are introduced at a more rapid rate in urban areas. Convergence can exacerbate the situation by making it easier to deploy innovative services more quickly in urban areas.

> **Recommendation:** Consider commissioning a national fiber backbone covering underserved areas to be funded either fully by government (using FITEL funds), or in partnership with private enterprises or existing operators as a means to alleviate transport capacity supply issues.

A potential alternative or complementary solutions often mooted to national fiber backbones could be a national communications satellite. While attractive from a standpoint of coverage over difficult terrain, there are a number of reasons why national fiber backbones are often considered of greater utility. Some of these are

- Upfront costs – The costs of launching and putting into use a communications satellite are very large and risky, and the pay back period can stretch out well over a decade., in contrast with a national fiber network that can be rolled out more gradually and see returns more quickly.

68 Official Alberta SuperNet website

- Technology constraints – current fiber networks can carry a greater capacity with less latency than satellites for a smaller cost.

More often, satellite solutions are seen as complementary to other access solutions, and primary as a means of filling in coverage gaps using existing satellites. In such a scenario, the significant cost of launching a new communications satellite is likely to far outweigh any potential realized benefits. A full cost-benefit study can be carried out if necessary to more specifically quantify the feasibility of a national communications satellite.

While we have already extensively discussed the potential for wireless technologies to deal with the issue of last-mile access, the transport requirements of core networks mean that the key limiting factor in bringing the benefits of convergence to many un- or underserved areas could be the availability of fiber transport capacity.

A policy that extends the current site sharing rules from new public infrastructure to existing public infrastructure will go a long way in addressing the problems of deploying core network equipment and backhaul. For example, the ability to deploy fiber alongside railroad tracks going from the coast to the interior could be a cost-effective means for telecommunications operators to obtain much needed capacity to the hinterlands.

> **Recommendation:** Extend site sharing rules on new public infrastructure to existing public infrastructure to facilitate deployment of core network equipment and backhaul.

► *RAN sharing*

We noted previously in Section 4.1.7 that RAN sharing is increasingly being considered by operators in developed countries as a way to lower the cost of deploying new generations of mobile services. We also discussed the different types of RAN sharing arrangements possible, which differ in complexity and cost savings. Analysys Mason has done a significant amount of work on this area for operators, and can attest that the savings can be significant. For reference, in the technology section we provide a sample list of various RAN sharing agreements being discussed around the world (see Section 4).

From a regulatory standpoint, the main risk associated with RAN sharing is that it facilitates a tacit or explicit form of collusion as the operators may be able to acquire confidential data about their partner's operations, conspire against other operators in the market, or stop competing against each other to provide better-quality services. This has led some regulators to explicitly ban active mobile infrastructure sharing, e.g. the NCC in Nigeria actively discourages sharing of complete networks, switching centers, radio network controllers and base stations.[69]

Nonetheless, these concerns can be overcome through careful procedures that limit the ability of the operators to share information and collude. For example, in reviewing a potential 3G network-

[69] Guidelines on Collocations and Infrastructure Sharing , Section 5(1).

sharing arrangement in 2002, the Dutch regulator explicitly required the operators to retain independent control of all parameters that determine the quality of the network such as coverage, speed and handover parameter.[70] After initially prohibiting active mobile network sharing in the MNOs' original license conditions, the regulator in India reversed course, and decided to allow MNOs to implement active network sharing.

All of the currently existing RAN sharing agreements have arisen from commercial discussions between operators. Given the complexities involved in RAN sharing, agreements initiated by operators have a greater chance of success than forced agreements. In our discussions with the operators and service providers in Peru, although all operators with the exception of Telefónica indicated an interest in sharing the cost of deploying sites and towers, the process of negotiation was seen as so onerous and time-consuming that all the operators expressed the eventual preference for self deployment. This experience applied in general to all attempts to implement infrastructure sharing. The experience of RAN sharing in other countries (such as between Vodafone and Orange in the UK) has shown that these kind of agreements are much harder to implement than passive sharing implementations, and thus we see it as unlikely that the Peruvian operators will implement RAN sharing of their own volition.

From OSIPTEL's point of view, the key advantage of RAN sharing would be to promote more rapid deployment of advanced wireless networks in underserved and rural areas given the cost savings (discussed in Section 4.1.7*)* that can be seen from RAN sharing. However, given the issues discussed with respect to forcing operators to share their networks, OSIPTEL's actions with regards to passive sharing policies such as third-party ownership of towers and sites will be much more critical in the short term in promoting widespread access.

With specific regards to RAN sharing policies, OSIPTEL's optimal role will be to help to facilitate discussion between operators investigating active network sharing deals; the chances of these deals being implemented could be boosted by the presence of a neutral third party helping with certain aspects of the discussions.

Recommendation: Setup an independent organization that will act as a third party mediator and facilitator for operators that wish to investigate active mobile network sharing, which will also help to prevent collusion.

6.2.5 Access procedures

There is a need to ensure transparent procedures for accessing the wholesale services that Telefónica (or any other operator deemed dominant) is mandated to offer by OSIPTEL.

In our previous study undertaken for OSIPTEL in 2006 we discussed the fact that in many countries the incumbent is required to issue reference offers (RO) – variously referred to as reference interconnection

[70] NMa Decision of 11 October 2002, Case No. 2816/35.

offers (RIO) or reference unbundled offers (RUO), which provide transparent terms and conditions for access to the incumbent's network. As we noted then, because these terms and conditions must be made available to all qualified entrants, ROs can reduce negotiation times for obtaining relevant access or interconnection, and provide certainty on terms and conditions.

ROs can be used for the following wholesale services:

- indirect access
- direct access
- leased lines
- interconnection.

Any reference offers should address the following at a minimum (among other things):

- **Conditions for access** – For all access and interconnection it must be specified where access takes place, how it takes place (e.g. modem configuration for data services), and what are the ordering and provisioning procedures.
- **Co-location services** – For direct access where co-location is required it must be specified where it is available and what can be co-located.
- **Information systems** – For all access and interconnection, access to the notified operator's operational support system is required for provisioning and repairs.
- **Supply conditions** – For all access and interconnection the quality of service and other conditions must be specified.

In setting ROs, the common practice in Europe is for the regulator to specify the outlines of what should be contained in the ROs. Incumbents are then given the option to set their own ROs or to negotiate them with entrants. In any case, interested parties such as alternative operators are then given the option to provide comments on their proposed offers to the regulator, who then rules on the contents of the final ROs.

In our previous study in 2006, we recommended as a tertiary priority that procedures such as ROs should be introduced to allow for easier negotiation of wholesale agreements between operators. As such, we repeat the recommendation here, noting that it remains a useful but not necessarily time critical step in reforming regulatory processes.

Recommendation: Require Telefónica to offer a comprehensive RO with details of all wholesale access services available in order to streamline and improve the process of obtaining wholesale access products.

6.3 Policy recommendations at the service level

At the service level it is important to note, as discussed above, that converged services can in principle operate over any IP-based infrastructure. Nonetheless, a number of issues are likely to arise as some service-based providers begin to compete with the legacy services offered by the operator of the infrastructure over which their services are provided. Thus, for instance, there has been significant attention in the USA and Europe as to how emergency calls must be provided for, depending on the type of VoIP. Similar issues are now arising as cable companies in the USA are beginning to set limits on downloads over their broadband connections, which could impact IP video service providers that may be competing with the video services provided by cable companies.

In the following subsections we first suggest a general set of regulatory principles that could be adopted to facilitate the general deployment of IP-based services in Peru (Section 6.3.1). We then examine in more detail some specific regulations that help to promote both the deployment and adoption of broadband services (Section 6.3.2), VoIP (6.3.3) and IP video services (Section 6.3.4). We also include a discussion on regulatory approaches to bundling of these services (6.3.5).

6.3.1 Regulatory principles

There are three particular areas around which a number of regulatory principles could be adopted in Peru to facilitate the general deployment of IP-based services. These areas are:

- technology neutrality
- net neutrality
- IP interconnection.

The above principles help to remove potential roadblocks to the adoption of IP-based services that could be put in the way by existing vertically integrated broadband providers offering traditional services.

Technological neutrality

The general principle is that regulation should not incentivize or discriminate based on the platform being used. For example, technology neutrality suggests that voice services should be regulated consistently if they are provided over a fixed line, wireless, or broadband network, and that ‘new media’ services, like IPTV, should be regulated in the same manner as conventional broadcasting.

The principle of technology neutrality, however, is not absolute. In some cases, extending burdensome or unnecessary regulation may not be feasible or desirable. For example, it would not be feasible to apply conventional voice telephony regulation to PC-based VoIP services such as Skype, which differ quite significantly. In other cases, convergence may reduce the need for regulation because it creates additional competition. For example, while radio frequency scarcity was a primary justification for broadcast regulation, the ability to transmit content over the Internet may substantially reduce the need for such regulation.

Finally, significant consideration must be given to the application of any existing content regulations to new media. With the deployment of broadband technology, the Internet can be used to stream audio and video content to users. Although the principle of technology neutrality is important, this should not provide a basis for mechanically implementing regulations historically applied to users of a scarce resource (i.e., radio spectrum) to new entrants.

Net neutrality

The concept of net neutrality is a general one that applies to the actions that a broadband provider may, or may not take, with respect to content and applications run over its network. The origins of this concept are based on two related points:

- Broadband networks all involved some aspect of shared capacity. While telephony networks are in a 'star' configuration that involves a unique line to each home, the backhaul is always shared, and for cost efficiency reasons there is less backhaul than the sum of all of the broadband lines served by that backhaul, which may result in congestion at peak times.[71] On the other hand, cable networks are in a 'tree and branch' configuration (see Section 4) in which the last mile is also shared between all the households served by a particular node, and thus there is potential for congestion even in the last mile.

- The Internet in general delivers traffic on a 'best efforts' basis, with no guaranteed QoS. Thus, the quality of some applications that are sensitive to latency, such as voice or video telephony, and others with high bandwidth, may vary depending on general usage levels, both in the core of the network and also in the shared parts of the broadband network, as described in the previous bullet.

The result is a general incentive for the broadband provider to manage the network in order to optimize the performance of users and prevent one or two heavy users from degrading the quality enjoyed by the other users. The net neutrality debate arose and was fueled in the USA in response to three specific sets of actions:

- **Differentiation** – First, several large providers such as AT&T proposed to provide for differentiated tiers of broadband, such that a content provider could pay to guarantee a certain level of QoS for the delivery of traffic over the new NGNs being built by AT&T and others.

- **Discrimination –** Second, at least one local exchange carrier, Madison River, was caught by the FCC blocking traffic from a VoIP provider, presumably to favor its own traditional voice service. Likewise, a number of MNOs set conditions that disallow the usage of VoIP services over wireless broadband connections, which again could be perceived to favor their mobile voice services. Other

71 This concept is summarized in what is known as a 'contention ratio', which describes the amount of last-mile capacity in relation to the amount of backhaul. A common residential contention ratio is 50:1, meaning that if 50 households are served with a 1Mbit/s DSL connection, one Mbps of backhaul capacity is allocated – the calculation is that usage is variable, both in terms of time of day and the amount of traffic generated, so that this should efficiently minimize contention.

companies have been accused of blocking emails and SMS messages that carry potentially objectionable content.

- **Network management** – Finally, a number of cable companies have imposed conditions to limit excessive usage of their networks to prevent degraded service for their other customers, either by 'throttling' the usage of those high-traffic users, or selling them additional capacity after a threshold is reached, or even by discontinuing service to them.

In our view, it can be beneficial to allow differentiation of capacity on a broadband network, as this can help the provider to increase revenues and thereby provide incentives to build new networks. However, particularly for a broadband provider with market power, there should be non-discrimination rules such that all independent content providers can access the tiers on the same terms and conditions. Likewise, it is important to prevent a vertically integrated broadband provider from blocking or degrading traffic to benefit its own services.

Network management is a more difficult concept for a regulator, however. On the one hand, all broadband networks are managed to increase service quality and protect consumers from spam and malware. On the other hand, network management can disguise discrimination, if for instance a cable company targets certain streams, such as IP video, for degradation.

Currently, advanced services such as IP video and VoIP are not specifically classified under the existing regulatory framework in Peru, and are thus not specifically addressed. However, there are existing rules that specifically forbid discrimination of third-party services over current broadband networks, and thus OSIPTEL's focus should be on adequately monitoring and enforcing the rules currently in place. The supervision and enforcement of QoS rules will also play a role in ensuring non-discrimination. For a more in-depth treatment of this issue, see the discussion on QoS requirements in later sections.

IP interconnection

The final principle is that interconnection is critical to the adoption of many of these new services – in particular, interconnection between incumbents and new service providers. We note first that regulatory intervention should be asymmetric, in that regulation should be mainly imposed on operators with market power, who have the ability and incentive to deny interconnection or provide unfavorable terms and conditions. This is in contrast to competitive operators, who have the incentive to interconnect with one another and typically are able to commercially negotiate terms and conditions. Thus, for instance, in many countries MNOs are able to negotiate interconnection agreements with one another and regulators only have had to intervene in countries with a calling-party-pays (CPP)[72] regime where it was felt that the resulting mobile termination rate was uncompetitive.

72 Under typical CPP regimes, the originating operator is responsible for paying a per minute charge to the terminating operator for traffic exchanged between the networks

However, as services migrate from traditional voice networks to converged IP-based networks there is a potential clash between interconnection regimes. The current traditional voice model is one that is regulated, typically charged per minute, and is complicated by the direction of the call, the distance of the call, and the type of call made (such as free business numbers). On the other hand, Internet interconnection is based on commercial negotiations, and involves an unpaid exchange of traffic known as peering. Even paid Internet interconnection, known as transit, is charged based on the capacity of the connection, or less frequently by volume.

Thus, as more traffic moves to converged networks there may be different approaches to interconnection. For instance, VoIP providers may reflect the way that they procure IP capacity by using a form of peering for exchanging traffic among themselves, i.e., without interconnection fees, and likewise may not charge termination rates to their own customers. This can put pressure on interconnection and termination rates for traditional services, particularly mobile services for which termination rates are higher than those for voice services. For instance, to the extent that users can install Skype on their mobile devices, they can receive calls using their data plans, and thus the cost of terminating calls may be much lower than the mobile termination rates. This in part has led to some efforts to block VoIP on handsets, and will put pressure on traditional mobile termination models.

To our knowledge, no regulator has taken any specific action with respect to the regulatory issues that may arise from a movement towards all-IP traffic, although we do note that the European Commission has proposed new regulations that would significantly lower the mobile termination rate, which could potentially start a movement towards a bill-and-keep[73] regime. The potential regulatory response differs in one crucial respect between those countries such as the USA, which have mobile-party-pays (MPP)[74] regimes for mobiles, and those such as European countries, which have CPP regimes. In MPP countries there is no mobile termination rate, and thus a movement towards bill-and-keep for all calls may be relatively easy.[75] In CPP countries, on the other hand, where MNOs depend more on mobile termination rates as a part of income (and to promote rural deployment), the clash may be more severe. There is relatively little clash, on the other hand, with fixed termination. The reason for this is that in most developed countries the fixed termination rate is already very low, while in developing countries there is relatively little fixed termination.

The current interconnection regime in Peru is CPP, with asymmetric interconnection rates between operators, i.e. there is a different interconnection rate for each network. Additionally, operators are

73 – Under bill and keep, there are no per-minute charges (or per-capacity charges) levied between interconnected operators for the exchange of traffic, and no payments are exchanged. Operators can recover the cost of carrying and terminating any traffic originated on other networks from their own consumers in whatever way they choose.

74 Consumers are charged a per-minute airtime rate for all outgoing and incoming calls that they make.

75 This is not necessarily true in the USA, where the fixed termination rate for rural termination is still relatively high, and there is a long-distance access charge for terminating long-distance calls. On the other hand, Singapore is an example of an MPP country with very low fixed termination rates and thus will face little disruption if all termination rates begin to migrate towards bill-and-keep. In fact, Analysys Mason was engaged to advise the regulator in Singapore on whether to move to CPP, and we cited the potential change in interconnection as a reason not to make this move, a suggestion which they adopted.

required to interconnect with each other using the SS7 interconnection standard. As such, while we make no specific recommendations requiring wholesale changes to the currently existing interconnection framework in Peru, we do encourage increasingly allowing commercial interactions to guide termination rates, particularly when no operator with market power is included in the discussion. In particular, not mandating SS7 interconnection where two interconnecting operators agree commercially to interconnect with a different standard will provide more flexibility for operators going forward, while still providing a safety net in the cases where regulatory intervention is required.

Recommendation: Remove the mandatory SS7 interconnection requirement in the cases where two interconnecting operators agree commercially to other alternative interconnection arrangement in order to provide greater flexibility to operators going forward, although it will be important to maintain the current standards and framework for any regulated agreements.

To the extent possible, rapid reductions in mobile termination rates also will help to promote the adoption of converged services, although we recognize that this will reduce monies for promoting rural deployment of mobile services. Additionally, if any operators seek to move to a bill-and-keep system with other operators through commercial negotiations, they should be encouraged to do so.

Currently, there is also a particular exception with regards to interconnection in the Peruvian regulations with regards to fixed–mobile calls. In particular, the current situation is that mobile operators set the fixed–mobile retail rate while also paying a low fixed origination charge to the fixed network. As a result the fixed-mobile calling rate is set higher than the mobile-mobile calling rate, which is unusual. Additionally, fixed operators receive less for origination than for other calls.

While this policy was useful in the early days of mobile network expansion, the current relative importance and sizes of the networks and the traffic they carry mean that this policy is now imbalanced in favor of the mobile network and needs to be modified.

Recommendation: Remove the exception governing fixed–mobile calls such that fixed operators should now be allowed to set the retail rate on this type of calls while paying the mobile termination charge to the terminating mobile network. In practice, for a dominant operator such as Telefónica , the fixed–mobile rate could be set as a sum of the mobile termination rate and the current origination charge on fixed to fixed calls (i.e. the fixed retail price minus the fixed termination rate).

This recommendation is particularly relevant because the fixed–mobile policy exception was initially set up to provide an incentive for MNOs to expand their networks. The question arises now about whether similar incentives are need to promote expansion of the fixed network. However, as we have consistently discussed in this document, wireless networks provide a much more cost-effective means of reaching a larger population of people than wireline networks. As such, any distortions in interconnection policies used to incentivize network expansion are unlikely to be effective in a scenario where the majority of users are on wireless networks.

Therefore, the better policy is to have a consistent framework that facilitates easy exchange of traffic between all the operators and removes competitive distortions. Lower fixed-mobile calling rates will also promote greater usage.

In the following sections we examine in more detail some specific regulations that help to promote both the deployment and adoption of broadband services, VoIP and IP video services. We also include a discussion on regulatory approaches to bundling of these services.

6.3.2 Regulation of broadband services

Broadband is essential for promoting convergence, as it is the foundation for the converged services discussed below (as well as consumer access to the global information society). The key regulatory principle for broadband is to promote competition, both facilities-based and service-based. This can come from a variety of sources:

- **Wireless broadband –** As discussed elsewhere in this report, wireless broadband services will increasingly offer access speeds that will enable key converged services to operate. Thus, actions that promote mobile deployment, such as increasing the amount of backhaul available and promoting RAN sharing, will promote wireless broadband deployment and increase general broadband competition.

- **Fixed divestiture –** One of the quickest paths to next-generation wireline access is to upgrade cable networks to DOCSIS 3.0, while there are also ways to increase the xDSL speeds. It appears unlikely that both the PSTN or cable networks owned by Telefonica will be upgraded as long as they are owned by the same company.

  One proposal made in our previous study for OSIPTEL in 2006 was the divestiture of the cable network by Telefónica to a company with the resources and willingness to update that network (to the extent that such a company can be found in the current climate). We acknowledge that the current arrangements made with Telefónica make it unlikely that fixed divestiture will be feasible in the near term. However, it is still important to note here that objectively this will be one of the quickest paths to getting competition in NGA upgrades and competition.

Wholesale access – As discussed above, where facilities-based competition is not likely, bitstream can create broadband competition on the PSTN, and likewise an MVNO can create more competition in wireless broadband.

Other access technologies – As discussed above, there are a number of technologies that can provide broadband, including powerline, and OSIPTEL should apply technological neutrality principles to ensure that any company wishing to trial or offer such services should not face any roadblocks.

To the extent that broadband competition cannot be facilitated to a sufficient degree nationally, or in any particular region of Peru, it is important to intervene in the retail market with price caps or some form of retail rate regulation to ensure that the operators cannot exert market power and raise rates above those that would exist in a competitive market.

In Peru, at the moment we do not see a need to exert any retail price regulation on broadband services because the market is still at an early state, and the number of broadband lines are growing steadily (up from 1% of all lines in 2004 to 8% by the end of 2009). Additionally, retail price regulation should not be implemented in competitive markets according to regulatory best practice, so such remedies will only be appropriate upon SMP determination in the relevant markets.

6.3.3 Regulation of VoIP services

The growth in VoIP usage raises a number of regulatory issues. The list below represents main areas that need careful consideration in regards to VoIP:

- whether and how emergency service access is provided, including the nature of the information provided to the emergency services on caller location
- network availability (e.g. whether terminals still function in a power cut)
- lawful intercept of calls (for national security purposes)
- numbering issues (e.g. whether the numbers are fixed geographical, mobile, non-geographical, VoIP specific)
- interconnection issues related to VoIP (e.g. termination payments, especially as regards international calls, interfaces between VoIP and public telephone networks)
- whether VoIP providers are licensed, especially if they claim to be resident in other countries
- payment of fees to the regulator and any telecommunications-specific taxation.

We believe that one appropriate formulation of VoIP regulation is that, in the case that a service such as cable telephony or a Vonage-type service is marketed and widely understood to be a substitute for traditional telephony, it should be supplied in a similar manner (e.g. with respect to emergency access). However, other forms of VoIP such as Skype and mobile VoIP services should not be subject to regulations that may unnecessarily retard their availability or adoption.

These principles are codified in the recommendations we make in the context of QoS and licensing discussed later in this section.

In addition, requiring number portability, allowing subscribers to take their fixed numbers to their VoIP telephone, and then move their numbers if they switch VoIP operators, is very important to reduce the switching costs for customers in order to adopt VoIP, and also to provide reassurance that they do not need to feel tied to their VoIP provider. However, this again needs to be in the context of equal treatment between operators providing substitutable services.

As an example, Perusat (a VoIP provider using indirect access in Peru to compete with existing providers of telephony) has been licensed to provide fixed telephony services and has been assigned a range of numbers in the national numbering plan. It is also under similar obligations as other providers of fixed telephony services (e.g. user terms and conditions and quality of service requirements). Thus although the principle of equal treatment has not been codified specifically in Peru, in this case, the VoIP operator is being treated the same as the operators that it is competing with. There are not other VoIP operators that we are currently aware of that are deploying public telephony services.

Recommendation: All operators in Peru offering telephony services in direct competition with each other and with similar functionality should have access to national numbers to enable them to compete fairly; any operators that are not offering services with the same features or functionality should not be given the same access to national numbers, again to ensure fair competition.

6.3.4 Regulation of IP video services

As discussed above, there are a variety of forms of IP video, ranking from those like YouTube that go to the computer, and others, including IPTV, that serve TV sets. While IPTV is a managed service that requires direct access to segmented bandwidth, most forms of IP video can operate independent of the broadband provider. Thus, the main regulatory framework to promote IP video is the application of the principles described above, notably technological neutrality and rules preventing operators from unduly blocking IP video streams. Furthermore, bitstream access could facilitate competitive IPTV offerings when sufficient bandwidth, functionality and QoS inputs are made available.

Finally, it should be noted that the main difference between telephony and video is that video involves content as opposed to speech. As a result, mass-market IP video (as opposed to user-generated content) will not succeed without protection of intellectual property rights that will encourage content owners to make their content available while prohibiting the distribution of content that infringes on their rights. Further, there are potential issues relating to content restrictions or censorship that must be considered by rights owners. To our knowledge, however, these issues are outside the jurisdiction of OSIPTEL and thus beyond the scope of this report.

6.3.5 Service bundling

It must first be recognized that service bundles can deliver significant value to both customers and operators; operators achieve economies of scope from offering multiple services together, along with an increase in revenue, and can pass these savings on to consumers who then benefit from the convenience of a single service provider and bill. As the process of convergence gathers pace, bundles begin to look even more attractive to consumers, and the provision of such bundles becomes easier.

In general, bundling should be treated with light-touch regulation. As the ITU notes, regulation is intended as a substitute for competition and where competition itself exists or is emerging, the justification for continuing to regulate retail prices becomes less relevant. Thus, for example, a number of regulators respond by exempting multiple-play offerings from price-cap regulations. The traditional voice telephony service is still available to be purchased at a regulated price, but the regulator opts to allow the market to determine the price for the bundled offerings. Very few European regulators, for example, have specifically looked at detailed regulation of bundles including services under price-cap regulation.

As this is an emerging area and the policy questions are evolving rapidly, there is yet to be a full consensus on best-practice policies in this area, and the optimal policies will be significantly dependent on local conditions. One regulator that looked at this issue extensively is the telecommunications regulator in Ireland, ComReg.[76] In the context of this process, ComReg noted that although it gave a few examples of what constituted unreasonable bundling by an incumbent, it would assess on an ex-post case-by-case basis whether any bundle had anti-competitive effects.

In general, we would expect that this approach is suitable for treating the issue of bundling in Peru. Until any specific anti-competitive practices are identified, it is best to refrain from overly regulating potentially beneficial new developments such as quadruple play services. Rather, the general principles promulgated in this document (such as equality of inputs and non-discrimination) should serve to deter most anti-competitive developments. Such a general policy is already present in Peru but there is scope for improvement in the monitoring instruments and procedures focused regulated operators. Additionally, a number of the recommendations in this report are targeted at improving these areas.

In particular, it is important to prevent different Telefónica subsidiaries from benefiting from each others services at the expense of competitors. Thus we encourage and recommend a general non-discriminatory policy.

We now discuss a number of specific anti-competitive issues that are currently a concern arising from such service bundles in Peru under the following categories, namely: bundling of regulated and unregulated services; competition between single supplier and integrated operators; and bundling of free minutes between fixed and mobile networks of integrated providers.

► *Bundling of regulated and unregulated services*

A dominant operator effectively can link the offering of an uncompetitive service (such as local fixed telephony) with that of a more competitive service (such as basic broadband) in order to leverage market power into the otherwise competitive market. In the case of fixed telephony and DSL, requiring consumers to obtain fixed telephony with Internet access makes it less cost effective to choose VoIP services from an alternative operator.

Such tying should typically not be allowed through *ex ante* rules, as it is clear that this will have a negative impact on competition, and by extension on consumers. Currently in Peru, subscribers are

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76 *Treatment of Regulated Services within Bundled Retail Offerings*, ComReg January 2008.

unable to purchase broadband services from an alternative operator over Telefónica's network (using bitstream) without having to purchase local telephony services from Telefónica .

Recommendation: Require Telefónica to offer standalone DSL, which will enable consumers to have the choice of obtaining broadband access together with voice services (VoIP) from an alternative operator, thereby increasing competition.

A very specific issue has arisen in Peru with regards to bundling of regulated and unregulated services:

- Telefónica has 43 different fixed local telephony plans. These 43 plans are regulated under a price-cap regime which determines whether the required price reductions or maximums have been met in formula using tariff information from all 43 plans.
- Three of these regulated plans are offered as components in a bundle with Internet and pay-TV services, which are unregulated. OSIPTEL believes these three plans are likely subject to different competitive pressures than the other 40 because discounts are only ever offered in conjunction with the bundles (although it is not clear how the bundle discounts are apportioned to the various services within the bundle, and the incumbent has no obligations to report this information).
- When the price caps are re-calculated, the incumbent formula co-efficients are calculated using the prices and subscription numbers of the plans that are in the bundles.
- As a result, the price-cap calculations show a distorted result. This indicates that the required price reduction has been met or exceeded (even though it is unlikely that the full amount of the required reductions came from the regulated services sold as part of the bundles, given that the unregulated services are more likely to be subject to competitive pressures on pricing and discounting). Further, if the calculation shows that the requirement has been exceeded, Telefónica is given credit for a reduction below the existing price cap, which means that no reductions on any plans are required for the following price-cap period.

This issue of bundling regulated and un-regulated services is one that other regulators have had to face. For instance, the Irish regulatory authority noted that *"… bundles can have anti-competitive effects on the market. In particular, when some of the services in the bundle are subject to ex ante price regulation (of the retail-minus variety), it can be difficult for the regulator to assess whether or not there are margin squeeze problems arising as a result. Recently, it has become increasingly difficult for ComReg to fulfill its regulatory obligations in relation to the standalone wholesale product offerings included within these bundled offerings"*.[77]

Given that bundles offer real benefits to consumers, prohibiting the incumbent from offering this type of services is not a viable solution. In deed, in the aforementioned Irish consultation, the regulator noted that regulating the retail price of bundles or preventing innovative bundles from being offered would be unwise.

77 *Treatment of Regulated Services within Bundled Retail Offerings*, ComReg January 2008.

To address this issue, any regulated services that are included in bundles must have standalone offerings, and only the standalone prices and subscription volumes (subscription numbers and traffic) should be considered in the price-cap regulatory regime. Thus, the prior price cap policies on those regulated services will continue to apply as normal on the standalone offerings, while the inputs included in the bundles are excluded from the price-cap calculation process.

Recommendation: Only the standalone prices and subscription volumes (subscription numbers and traffic) for standalone plans for each of the regulated telephony plans used in bundles should be used when performing the price-cap calculations.

► *Competition between single supplier and integrated operators*

The second bundling issue arises when one or more operators offer services either on an unbundled basis or as part of a bundle with a discount. This situation is typical and, as discussed above, should have benefits for consumers who enjoy the discounted prices. The issue is that, as these bundles become more popular, it can be difficult for non-integrated operators, such as those that only provide mobile services, to compete. The addressable market for operators that only offer a single service will begin to shrink as more and more consumers opt for the convenience of the bundle.

In this case, we believe that the general solution is not to prohibit the discounts, but rather to create the conditions under which non-integrated operators begin to compete in the same bundles. This can be most easily done by creating wholesale access to relevant networks at cost-based prices, which enable entrants to create the bundle of services on their own.

For instance, as noted above, in Europe ISPs were very aggressive in unbundling loops, and then installing equipment that actually enabled them to offer higher-speed xDSL and IPTV in advance of the incumbent operator providing the underlying wholesale access. However, as discussed previously, bitstream access (which was enacted in Peru in 2007) is easier to implement than unbundling (which we have determined is not appropriate for Peru at this time), and can still enable the offering of bundles of services that include data access by competitive service providers. Thus in the context of Peru, the most appropriate policy is already in place.

In the case of multi-play offerings that include a TV service, international channel providers in Peru are already required to ensure that their content is available on a non-discriminatory basis. However, it is currently the case that domestic content providers are not under the same obligations. As such, TdP is able to offer bundles including TV from Telefónica subsidiary Telefónica Multimedia which other providers cannot. While Telefónica Multimedia is not legally considered the same company as TdP (in effect, TdP is only allowed to resell the TV services), it has an exclusive arrangement to provide content only to TdP.

In this case, we propose that OSIPTEL impose a non-discrimination rule on sales between subsidiaries. In other words, any offer that Telefonica Multimedia makes to TdP should be available to any other operator to offer in its own bundle. This is particularly important between these two subsidiaries as they effectively each wield market power in their own sector; TdP with the fixed network in its footprint, and Telefónica Multimedia with its own network plus proprietary content. Imposing such a non-discrimination clause does not prohibit attractive bundles of service offered by TdP, but also enables competitors, notably bitstream operators in Telefónica's footprint, to be able to bundle Multimedia services and compete on an even playing field.

> **Recommendation:** Investigate arrangements such as the resale agreement between Telefónica's fixed retail subsidiary (TdP) and the paid-TV subsidiary Telefonica Multimedia for anti-competitive subsidiary practices and impose or enforce non-discriminatory rules.

► *Bundling of free minutes between fixed and mobile networks of integrated providers or on-net on fixed networks*

OSIPTEL has noted a specific issue in Peru whereby a number of wireless plans offered by Telefónica Moviles (specifically plans on the fixed wireless network) offer free minutes to customers on TdP's wireline network. There is also a concern that the reverse situation may soon arise i.e. a number of fixed plans could offer free minutes to customers on the affiliated mobile or fixed wireless network.

An international example of this situation is seen in Ireland. The fixed incumbent Eircom launched a series of promotional bundles in 2008 that included free calls to Meteor, its mobile affiliate. As Eircom has been designated as having SMP in the fixed market, ComReg investigated and determined that the bundles were being sold below cost with potentially negative impact on competition, which ran counter to Eircom's obligations (set out in the SMP determination and decision process) not to unreasonably bundle.

The situation presented by Telefónica has more nuances than the one in Ireland; currently Telefónica is offering customers of its wireless fixed network (grouped under Telefónica Moviles, the mobile affiliate) free minutes to the entire fixed network (wireline and wireless) on certain plans. There is a concern by OSIPTEL that Telefónica could eventually begin offering free calls from all mobile customers to the fixed network, as well as free calls from fixed customers to the mobile network.

These plans act to strengthen both the mobile and fixed arms of Telefónica:

- Mobile subscribers wishing to call fixed numbers will find these offers attractive as TdP is the largest fixed network in Peru by a distance.
- Fixed subscribers are less likely to switch to alternative fixed operators if they have free calls to or can receive free calls from a large number of mobile subscribers (for instance, a family will stay with Telefónica for both fixed and mobile services if they can ensure that everyone can call or be called for free between the home fixed line and personal mobile phones).

Thus, these all appear to be cases of leveraging from a dominant service (fixed) into a more competitive service (mobile).

There are two general explanations for how these services are provided.

- First, there may be a case of predatory pricing, whereby a service is provided below cost in order to weaken rivals.
- Second, the various Telefónica networks may be offering affiliates services (such as free interconnection or lower retail prices to reach its network) that they don't offer other operators.

There are two potential remedies that could result from any regulatory investigations into such propositions:

- First, if there is evidence of anti-competitive practices, such practices should be stopped outright – this could arise if either arm of Telefónica (fixed or mobile) is charging an interconnection fee which the other affiliate is absorbing (thus pricing below cost for these calls).
- Second, if any of Telefónica's networks is waiving interconnection to an affiliate, it should be required to provide the same interconnection conditions to all operators (i.e. charge everyone the same interconnection fee).

Recommendation: OSIPTEL should decree that Telefónica cannot offer discriminatory access between its networks, and investigate the conditions of Telefónica's existing offer giving Telefónica's wireless fixed network subscribers free calls to the wireline network to ensure that this bundle is not contravening the non-discriminatory policy, and at the same time that Telefónica is not engaging in anti-competitive pricing.

Another issue concerns the practice of offering free on-net minutes over TdP's fixed network, which raises regulatory concerns because of network effects. TdP can offer the largest on-net subscriber base, which provides a significant advantage with regards to other operators.

Recommendation: TdP (and in a generalized framework any fixed operators deemed dominant) should be prohibited from offering free or unlimited on-net minutes given the anti-competitive considerations with regards to its position as the overwhelmingly dominant provider of fixed telephony.

6.4 Policy recommendations at the device level

One of the first targets of telecommunications liberalization in many countries has been CPEs, recognizing that there are few, if any, competition concerns relating to the manufacture and distribution of CPE. Indeed, this liberalization has arguably led to significant innovation. In the USA, the Bell System strenuously defended its rights to protect its monopoly over all parts of the telephone network, including device manufacture, before losing several decisions that enabled customers to purchase their own equipment. This led to significant innovations in handsets, as well as answering machines, fax machines, and dial-up modems that became the gateway to the Internet.

For fixed CPE, the key regulation is that the network owner uses a standard interface, such as the RJ11 that is common for telephones, and that the devices cannot harm the network. For wireless networks, the requirements may be a bit more rigorous as it is important that devices adhere to power limits and do not cause interference.

Otherwise, the key policy issues relating to devices are to reduce any barriers to deployment and purchase of devices. This can include ensuring a simplified type-approval so that devices can be brought quickly and cheaply to market, and reducing any taxes on their purchase to make them as affordable as possible. Particular attention may be paid to promoting the introduction of new converged devices that may be able to access multiple networks.

A policy that removes import taxes from mobile telephones has already been implemented in Peru in order to make them more affordable for end users, which has resulted in a very competitive market with wide availability of a whole range of devices from basic handsets to smartphones. As convergence progresses apace, the importance of other devices in the context of expanding access will increase. Removing taxes on devices such as netbooks with broadband capacity and on other online devices below a certain price (e.g. USD300) could serve to target the most affordable devices and make them even more available to Peruvian consumers.

Recommendation: Remove duties on imports of netbooks and PCs, and explore reduced import taxes on other communications devices and equipment in order to make converged devices more affordable for consumers.

6.5 Other specific policy recommendations in relation to convergence

Having looked at policy options and principles at the various levels of the converged telecommunications and media stack, we will look in more detail at other regulatory processes that will be critical to address in the context of convergence but which do not fit neatly into any of the previously discussed categories.

6.5.1 Licensing

Regulators are taking a variety of approaches to licensing in recognition of the changes brought on by convergence and competition. There are three approaches to licensing, which can be used in conjunction with one another: individual licenses, general authorizations, and open access (without licenses). Following the general principle of 'light-touch' regulation, it is increasingly popular to abstain from licensing services or require only general authorizations that lower the burden on operators. This can be done for value-added services, including the offering of Internet services such a VoIP that replace traditional services but do not require infrastructure.

In Europe, for example, operators are required to do little more than notify the regulator before launching. However, despite reference in the European Directive to 'an authorization system covering all comparable services in a similar way regardless of the technologies used', in most cases there is still a firm distinction between fixed and MNOs, and mobile licenses are usually closely tied to specific technologies and spectrum. Similarly, countries that offer a 'second national license' to end a fixed incumbent's monopoly (for example, in Senegal), while often describing the license as converged, are actually offering a set of fixed and mobile licenses bundled together.

Pioneered by Mauritius in 2003, and subsequently adopted in several countries including Tanzania, Nigeria and India, a more comprehensive type of converged licensing framework (CLF) typically aims to:

- separate the licensing process from the allocation of scarce resources (such as spectrum, rights of way and numbering ranges)
- be technology neutral (in particular, fixed and MNOs are not distinguished)
- be service neutral (voice, data or broadcast services are all permitted).

Tanzania is an example that demonstrates the dramatic effects that a CLF can have on the market. A 2005 review of interconnection regulation conducted by Analysys Mason for the Tanzanian Communications Regulatory Authority (TCRA) counted four operators, all using GSM. The latest review, conducted at the end of 2007 and the first to be carried out under the CLF, found seven operators licensed and with access to spectrum, including two CDMA operators and two operators that were formerly 'fixed-only'.

Legislators and regulators support converged licensing because it can simplify some of the issues they face; for example, the Indian regulator, TRAI, has found that restricting the scope of licenses (such as limiting mobility) has led to an artificial segregation of markets and consequently to disputes and litigation when operators stretch the mandate of their licenses. The flip side of a CLF is that in order to achieve the three aims listed above, the regulator may have limited power to influence how the allocated resources are used – for example, which numbering ranges are associated with which access technologies, or how spectrum is allocated between end users.

Yet, at the same time, obligations remain on the regulator to ensure that the correct investment incentives are preserved. In this context, moving to a CLF requires the regulator to carefully consider how to adapt its economic regulation.

For illustrative purposes, let us examine current interconnection policies. In cases where price caps have been imposed on termination rates, fundamental questions must be asked anew:

- What is the efficient technology to deliver voice services: copper, GSM, fiber or WiMAX? Standalone or combined?
- In a market with an unpredictable number of telecommunications operators, what is the scale of an efficient, competitive operator?

These questions are particularly relevant in countries where the traditional fixed operator does not (and possibly cannot) make a profit out of fixed-line telephony services, and where low cellular penetration presents opportunities for new entrants. Thus, the distinct categorization and licensing of operators based on technology is called into question.

Hence, it is unsurprising that the future of converged licensing is being explored in many emerging markets.

As discussed above, convergence will increase the ability of network owners to offer a variety of services over the same platform, and likewise enable service-based competitors to enter the market without facilities investment. In order to promote such pro-competitive offerings, it is important that the licensing regime does not impose any undue barriers. Many countries are finding that, while traditional licensing regimes were appropriate when significant investment was required to be able to offer a particular service, convergence significantly decreases the time needed to offer new services, which is being reflected in the licensing regimes as described above.

We understand that public telecommunications services have four classifications in Peru:

- transport services
- end-user services
- broadcast services
- value-added services.

Further, under the current system, providers of value-added services must only register, while others must apply to the MTC for a single concession. In order to provide further services, the applicant notifies the MTC to amend the concession, with approval usually granted in most cases relatively quickly.

The current single concession licensing framework in Peru is analogue to a unified license that allows the provision of all telecommunications and broadcast services that are currently covered by the concessions. This is the appropriate policy for a convergent environment, with at most notification required when a licensee begins to offer a service in order to provide flexibility for operators to effectively leverage the opportunities afforded by convergence.

Such a licensing regime maximizes the flexibility of licensees to enter markets as service-based providers, or use their next-generation facilities to offer a wide variety of services, thereby taking advantage of convergence.

In order to increase flexibility and reduce regulatory burdens, we make the following primary recommendation.

Recommendation: Separate the license for access to scarce resources, such as spectrum and numbers, from the license to offer services. This will ensure that providers have the rights to access those scarce resources as needed, with reasonable and necessary responsibilities relating to their usage. Any needed legislation governing service provision should be established in regulation and not in the license itself.

6.5.2 Universal access and service (UAS)

There is a difference between universal access and universal service. Universal service refers to service at the individual or household level, e.g., typically a telephone in each home, while universal access more broadly refers to the ability of all potential consumers to use telecommunications services, whether through individually owned facilities or shared facilities (such as telecenters).

The primary impact of convergence on the existing UAS mechanisms in most developing countries will be to change the focus of UAS projects. Historically, these projects were often significantly (if not solely) focused on specific basic telephony services, however, general Internet broadband and even broadcasting will begin to take a more prominent role.

There has been a lot of work done in Peru already on universal access to telecommunications services by Fondo de Inversión en Telecomunicaciones (FITEL). Its agenda to reduce the gap in the market includes tariff plans for low-income sectors, prepaid fixed telephones, development of cells, extension of mobile telephony, and micropayment options in mobile telephony. FITEL's implementation processes include the participation of private companies, both national and international, with transparent bidding handled by ProInversion. The projects currently handled by FITEL already include telephony and broadband services. As such, the process of convergence in Peru is unlikely to require a significant overhaul of the definition of what services can be covered by UAS funds.

At this juncture, broadcasting or video services are not specifically referenced or included in documents describing FITEL's aims or projects. We are not aware of any universal service funds in any other country that have addressed this issue; universal service funding primarily focuses on services defined as essential, and TV access is yet to be classified as an essential service by regulatory authorities.

In general, there are two important issues with relation to universal access: how the money is raised and how it is disbursed. We will treat these two issues in succession in the paragraphs below.

UAS funding in a converged environment

One current means of promoting universal access is an asymmetric interconnection rate that can be used to reflect the higher cost of providing service in rural areas, and thereby serves to attract investment into the area in order to attract these higher termination rates. Currently in Peru, each operator has a single national interconnection rate covering both urban and rural areas. This policy does not require a universal service fund, and thus is relatively simple to implement.

We note, however, a potential drawback of this policy in the context of convergence. In many countries, there is a growing discussion of a move towards bill-and-keep for interconnection, which is common for IP interconnection (see Section 6.3.1 for a more detailed discussion on this issue). In such an environment, maintaining asymmetric interconnection charges will be problematic. However, this movement is primarily gathering steam in developed countries with universally deployed services, and in emerging markets such as Peru it is unlikely to be a significant factor in the short to medium term.

Other options include raising funds from other charges or levies on telecommunications revenues. Either way, universal service obligations (USO) add to the cost of services or devices, thereby depressing adoption and/or demand for relevant services. We note that the imposition of obligations on specific converged services may have a negative impact on the goals of this study, and thus other targets may be more appropriate.

FITEL is currently funded by 1% of gross revenues from all service operators and end carriers, as well as a minimum of 20% of Canon Electrico Radio's annual revenues. We do not recommend any particular changes to the current structure of levying based on gross revenues on all service operators and end carriers.

UAS funds disbursement

Currently, FITEL has a limited geographical scope; it is not involved in urban areas, and focuses on locations where fixed teledensity is less than 2%. Telecommunications projects and pilot projects focus on investment into infrastructure, activities such as studies, acquisition of transmission equipment, civil works, testing, content and training, and legal technical assistance to regional and local governments.

FITEL currently has five primary programs in the pipeline: rural Internet, rural broadband, broadband for isolated locations, the San Gaban-Puerto Maldonado Rural Broadband project, and improving ICT in low-income areas. Given these primary focuses, it is clear that the current universal service scheme at a high level already takes into account the increasing importance of broadband as a primary ICT access mechanism.

In terms of disbursing universal service funds, there are a number of ways to promote convergence with UAS funding:

- focus more funding beyond basic wireline or wireless access into broadband access, increasingly seen as a basic telecommunications need, and also can be technology neutral to cover wireless as well as wireline access
- co-ordinate with other governmental agencies or programs (covering health, education, commerce, etc.) to ensure that funds are deployed as effectively as possible to meet actual end-user needs

- create or supplement the infrastructure sharing discussed in prior paragraphs; in particular, the funds can be used to create core network infrastructure such as towers and lines which all operators can access at cost-based rates under open access.

Given the still growing penetration rates (fixed and mobile telephony as well as broadband) in Peru, UAS policies will be better served in the short term focusing on broadening universal access, while focusing on universal service goals in the mid term.

However, determining primary areas of focus for UAS funds based on fixed teledensity as is currently done is unnecessarily limiting. The range of services that can be covered under UAS in a converged environment necessitate broader requirements that include both wireline and wireless broadband (as opposed to just telephony). Also, they require acknowledgement of the fact that there are increasingly a multitude of technologies for offering UAS services, particularly as wireless technologies will be a primary avenue for addressing market gaps. The Rural Guidelines issued by MTC in August 2008 indicate a broader definition of universal access which does take into account more than just fixed teledensity, and this progress should continue to be built on.

> **Recommendation:** The conditions and requirements that determine where UAS funds are targeted should include broadband and wireless alternative infrastructures to the existing fixed infrastructure. Specifically investigate disbursement of funds towards wireless access-related projects and potentially a national fiber network to be shared by all operators.

Under the current UAS structure, OSIPTEL noted a real concern about whether the current scheme disadvantaged rural operators who take a lot of risk in initially deploying network with the help of UAS funds, but who then may be at risk of being unable to recoup some running and deployment costs if the demand is such that existing operators (such as MNOs) rapidly extend their coverage to such areas and attract a lot of the available revenue.

However, in such a scenario, if the existing operators are really able to extend their networks to such areas relatively easily, then such areas should not necessarily continue to have access concerns addressed using rural operators. The solution is to make existing operators eligible for UAS funds in these areas, as long as some open-access conditions are placed on the networks that they build in these areas, as recommended earlier in this section. As MNOs in Peru are already currently eligible to receive FITEL funds, the existing framework does not need to be modified.

In the specific case of the rural operators which find previously determined business plans to no longer be viable, the key focus for OSIPTEL is to ensure that all areas of the country continue to receive telecommunications service, and not specifically the survival of any particular companies. As such, if OSIPTEL determines that there are now areas served by these rural operators that qualify for more intensive FITEL funding or project attention as a result of a changed business environment, new projects can be initiated to address those regions.

As the mobile network spreads into areas formerly served only by FITEL projects, FITEL may wish to consider operators' requests to move their FITEL project equipment to more rural areas with no commercial coverage. At the same time, FITEL could also entertain applications from the MNOs to share that infrastructure (instead of moving it), in order to reduce costs and increase competition in these formerly underserved areas. The particular details, including potentially compensating the existing operator for sharing access, would have to be examined on a case-by-case basis.

Recommendation: For previously underserved or rural areas now being partially served by existing MNOs on a commercial basis, investigate the most appropriate usage of FITEL funds to ensure that universal access objectives are being met, including promoting infrastructure sharing between rural operators and MNOs. Additionally, commission a study to investigate compensation for existing rural operators who have to move to new unserved areas.

6.5.3 Quality of service and quality of experience requirements in a converged environment

We have previously mentioned that bitstream can support delivery of advanced services if two components are in place – the right technology and appropriate QoS requirements. Various voice, video and data services require different QoS standards depending on their specific application. Thus, video telephony (real-time service) has different requirements from VoD (streaming service). The issue is that in Peru (as in many European countries) bitstream offers have typically been optimized for data services with minimum QoS requirements unsuited for other service types.

The issues we look to understand in this section is what QoS and quality of experience (QoE) policies are necessary in a converged environment. To answer those questions, we can categorize QoS requirements as follows:

- **Requirements for retail products** –these measures are focused on the end-user experience; they revolve around service uptime, fault incidences and operator response times. QoE is purely end-user based as it is often a qualitative measure that tries to quantify user satisfaction with their service in a manner that cannot be measured directly through the service provision infrastructure.
- **Requirements for wholesale products** – these measures are often more detailed than consumer-focused indicators; this is because service-based providers need very specific assurances on wholesale products to ensure that they are able to offer the best services to end users that they can without worrying about reliability issues from their wholesale suppliers.

The officially defined QoS policies[78] in Peru currently specify the following indicators which apply to retail public telecommunications services:

78 *RCD Nº 040-2005-CD/OSIPTEL Reglamento de Calidad de los Servicios Públicos de Telecomunicaciones* and *Modificación de la Resolución Nº 040-2005-CD/OSIPTEL.*

- fault incidence rates
- fault repair rates
- operator response
- call completion rates
- failed call rates
- dropped call rates
- text message delivery times
- radio coverage (measuring minimum acceptable signal strength)
- voice quality (speech intelligibility during call)
- link utilization rates (for Internet access products)
- average connection bandwidth in Mbit/s (for Internet access products).

Additionally, the following indicators are specifically for wholesale Internet access products:

- link utilization and bandwidth
- packet loss rate
- latency.

We note that these QoS indicators do not cover the more detailed and specific measures that service providers require when purchasing wholesale products from Telefónica . In particular, with respect to the bitstream access product, a more detailed set of indicators are defined in the regulations establishing bitstream access which include measures such as peak cell rate (PCR), sustainable cell rate (SCR), and maximum burst size (MBS); [79] these are defined for specific products (differentiated by headline speed). Updates to the regulations have introduced new indicators: the parameters concurrency factor and 'objective_value' for example.

In terms of QoS/QoE requirements and indicators from a retail perspective, the current Peruvian regulations are well set-up to measure the key indicators such as service downtime or repair rates. A converged environment does not change the need or ability to keep the existing measures or processes of measuring these indicators. Rather, as new services are deployed, the regulations should be updated (as was done once in 2005) to include any new indicators that are necessary to measure the quality of service on new advanced services.

Just as importantly, the regulations should be updated to ensure that any new services that are enabled by convergence are subject to QoS standards that the service provider can control. To illustrate this issue, we take the example of Perusat. As a public provider of voice services using indirect VoIP with national numbering allocations, Perusat has no control over the quality of the broadband services over which its services are provided, and as such will not be able to remedy issues such as poor voice quality when the network is congested. Thus, it may be more appropriate to subject such providers to lower standards of voice quality, while subjecting the underling broadband access provider to separate standards.

79 Revisión de Tarifas de Prestaciones de Transmisión de Datos Mediante Circuitos Virtuales ATM con Acceso ADSL, Nº 008-GPR/2007.

However, if such providers are marketing and selling their services as direct substitutes to existing traditional or direct VoIP providers, then one could argue that they should be subject to the same kind of quality controls. The question of treatment of VoIP providers continues to be a significant issue for many operators, and the same will be the case when over-the-top video and IPTV providers begin to be seen as direct competitors of traditional and direct TV services. Making specific recommendations at this juncture on what QoS indicators should be applied to each type of officially licensed service would be premature, subject to a modification of the licensing framework.

Recommendation: Ensure that providers of officially licensed services are subject to retail quality indicators over which they actually have control, and that the service providers make clear to any potential customers the quality they can expect on this service.

At the wholesale level, the only access product that currently has QoS conditions attached to it is the ADSL bitstream offer from Telefónica . At the time the offer was set-up, QoS requirements for this offer were determined with respect to its use as a downstream input for Internet services, which is a best-efforts proposition. As convergence progresses, the ability to offer more advanced services using bitstream inputs necessitates a review of the appropriateness of the current QoS requirements.

The particular question that needs to be asked is if there are new wholesale QoS indicators that need to be defined in a converged environment. The answer to this questions depends on the nature of the services that can be offered. Figure 5.6 and Figure 5.7 below (reproduced from our technology analysis earlier in this document) shows the ITU defined QoS definitions and objectives, illustrating the four main dimensions along which QoS class of service is defined: ·

- time sensitivity (real time versus non-real time)
- jitter sensitivity
- service interactivity
- packet loss sensitivity.

QoS class	*Applications (examples)*
0	Real-time, jitter sensitive, high interaction (VoIP, VTC)
1	Real-time, jitter sensitive, interactive (VoIP, VTC)
2	Transaction data, highly interactive (Signaling)
3	Transaction data, interactive
4	Low loss only (short transaction, bulk data, video streaming)
5	Traditional applications of default IP networks

Figure 6.7: IP QoS classes definition [Source: ITU-T, Y.1541]

Network performance parameter	*Nature of network performance objective*	*QoS Classes*					
		Class 0	*Class 1*	*Class 2*	*Class 3*	*Class 4*	*Class 5 unspecified*
Transfer delay	Upper bound on the TD	100 ms	400 ms	100 ms	400 ms	1 s	U
Delay variation	Upper bound on the 1-10-3 quartile of IPTD minus the minimum IPTD	50 ms	50 ms	U	U	U	U
Loss rate	Upper bound on the packet loss probability	$1x\ 10^{-3}$	$1x\ 10^{-3}$	$1x\ 10^{-3}$	$1x\ 10^{-3}$	$11x\ 10^{-3}$	U
Error rate	Upper bound	$1x\ 10^{-4}$	$1x\ 10^{-4}$	$1x\ 10^{-4}$	$1x\ 10^{-4}$	$1x\ 10^{-4}$	U

Figure 6.8: IP Network QoS class definitions and network performance objectives [Source: ITU-T Y.1541]

A classification of services done in a study for the Irish regulator proposed that all applications could be grouped into four service categories based on requirements using existing QoS indicators, as shown below.

Service category	*Delay, packet loss and jitter*	*Bandwidth*
Real time service	Must be limited	Average bandwidth must be guaranteed
Streaming service	Higher delay possible, but jitter and packet loss must be limited	Average bandwidth must be guaranteed
Data services	Not critical	Average bandwidth must be guaranteed
Best efforts services	Not critical	Not critical

Figure 6.9: Classification of services by QoS requirements [Source: Next generation Bitstream access, WIK consulting for COMREG, Analysys Mason]

The point of these tables is that QoS requirements (at a wholesale level) currently envisaged for the advanced services that are enabled by convergence (such as IPTV or VoIP) can be defined using existing indicators. As such, there is no need at this juncture to define new network indicators for implementation

If the technology basis is not in place for the delivery of advanced services over bitstream (such as multicasting or localized content storage by the alternative operator), then the QoS requirements alone are not sufficient for service-based providers to offer services such as IPTV. However, if the technology basis is in place, then defining the appropriate classes of QoS requirements will enable alternative operators to remain competitive with the incumbent in offering the full suite of converged services.

Given that in Peru Telefónica does not currently offer IPTV services, it is unlikely (though possible) that its network is set-up to support linear TV delivery using bitstream. However, the current bitstream offer can be modified to allow for a number (potentially up to five) of QoS service classes at various functional levels (which are currently differentiated by speeds ranging from 128kbit/s up to 155Mbit/s). This would allow alternative operators to better tailor retail offerings to provide a suite of voice, data or video (VoD) services. For example, offering standard-definition video services would require a product with 2–5Mbit/s bandwidth with QoS parameters that support video delivery, while offering just broadband at the same speed level would require less onerous QoS standards (with a correspondingly lower rate).

Recommendation: Establish different classes of QoS standards for Telefónica's wholesale bitstream product. This would ensure that service-based providers are able to select the most appropriate and cost-effective inputs for any voice, video or data products that they wish to offer.

6.5.4 Consumer protection and user terms and conditions

The regulatory framework in Peru makes provision for a set of consumer protection terms and conditions[80] (user conditions). In our interviews, a number of service providers indicated that they found these terms and conditions onerous and disruptive, and that they considered these as hindrances to their deployment of more advanced services and networks.

In summary, the main obligations placed on service providers in interacting with their customers are as follows:

- provision of information services and assistance, for 12 hours and 6 days a week at least, through a toll-free number for inquiries
- free access to emergency and police numbers
- implementation of systems to prevent fraudulent charges to customers
- provision of information on any restrictions on connectivity to other operators
- ensure uninterrupted service; if service is interrupted for more than one hour due to no fault of the subscriber (or force majeure conditions), then the user should not be charged for this period
- toll-free directory access of all fixed telephony numbers
- for fixed telephony providers, obligation to lock or unlock, when requested by subscribers, the domestic long-distance services, the international services offered through the 808 number, and calls to mobile services.

Many countries have enacted consumer provisions in telecommunications legislation. These regulations have been passed by both developed market regulators such in the UK and the USA, and emerging market regulators such as in India and Nigeria.

[80] Condiciones de Uso de los Servicios Públicos de Telecomunicaciones en Perú (Summary, March 2009)

In the UK, Ofcom has stated the following obligations: providers must have a proper and effective functioning network at all times; customers must be able to reach operator assistance and emergency numbers at all time; contracts must have a minimum amount of detail such as the actual services provided, detail of maintenance, particulars of price and tariffs, duration of the contract, and payment and refund arrangements. Ofcom further dictates that there must be a complaint department set up; it also addresses number portability and sets a level for accessibility for the disabled.

In the USA, the FCC has left consumer protection as a state issue, and current legislation deals primarily with landline providers. For instance, in Missouri, landline telephone providers must:

- place 911 calls
- block caller IDs when requested
- provide a toll-free telephone number for customer complaints and inquiries
- clearly label charges, fees, and dates on bills
- cap consumer deposits
- cannot charge consumers for operator services.

Other states, including Vermont and Ohio, have additional regulations that include :

- incumbent local exchange carriers must have an average monthly speed of 90 seconds in answering calls placed to business and repair offices
- incumbent carriers must supply customers with directory information
- local telephone companies must install new local service within five days of receiving an order.

A few states in the USA, namely New York, California and Arizona, attempted to introduce legislation in 2004 and 2005 that would provide a wireless consumer bill of rights, but were struck down by lobbyist groups including CTIA and the International Association for the Wireless Telecommunications Industry. According to the ITU, consumer issues and the degree of regulatory oversight can be influenced by the maturity of the national market and the degree of competition in the sector. Reliance in these countries is placed on industry self-regulation through voluntary codes of practice. As such, CTIA provided a consumer code for wireless service signed by over 22 providers. The code required that providers:

- disclose rates and terms of service to consumers
- make maps available showing where service is generally available
- provide contract terms to customers and confirm changes in service
- allow a trial period for new services
- provide specific disclosures in advertising
- separately identify carrier charges from taxes on billing statements
- provide customers the right to terminate service for changes to contract terms
- provide ready access to customer service
- promptly respond to consumer inquiries and complaints received from government agencies
- abide by policies for protection of customer privacy.

Legislation regarding consumer protection appears to be more comprehensive in developing countries, covering both landline and mobile telephones. This can be attributed to, in part, the increasing reliance on mobile telephones and the lack of landline telephones in these countries.

In Nigeria, providers are required to :

- give consumers information about their service and any changes to the service
- allow customers to report faults 24 hours a day
- give customers free operator assistance and emergency access and cancel unsolicited telemarketing
- correctly itemize charges on each bill.

Similarly, India's TRAI states that providers must give customers:

- protection against tariff hikes
- timely refunds of security deposits
- consumer transparency in billing
- a complaint department
- three-day repair guarantee
- benchmarks for QoS in basic and cellular mobile service regulation.

There is also a "Common Charter of Telecoms Service" that all service providers have agreed to, but is that is non-enforceable.

The nature of consumer protections across these countries are similar in tone to those in Peru, though different in specific implementations. The advent of convergence makes it more essential that user conditions are in place as they complexity of offerings that are available increase and there is even more scope for customer confusion with regards to the services that they are provided with. Thus we do not believe that the user conditions in Peru are unduly onerous or disruptive.

6.5.5 Access to in-building wiring

There is also a specific issue that has come to attention with regards to access to Telefónica's infrastructure. Telmex is Telefónica's main competitor in the market for bundled telecommunications services, but only operates in 18 districts in Lima. According to OSIPTEL, even within these districts, a new user is unable to have Telmex services installed if they live in a building with more than three floors (referred to as multi-dwelling units (MDU)) due to 'technical issues'. At the time of writing this report, detailed information on what these technical issues are was not available from the operators.

The conditions of access to in-building wiring continue to be a significant issue in many countries. For example, in Germany they are owned by the building landlord, while in the UK BT claims ownership of the cables and their housing (e.g. duct). It is possible for these issues to be either technical or non-technical in nature.

France is one country that has placed significant regulatory attention on the issue of in-building wiring. The regulator believes there is no reason why there should be multiple operators wiring within a building. It would not be efficient, and cause inconvenience for people who live in the building. Therefore, the vertical network should be shared. The first operator to get the tenants' agreement to lay fiber in the building should be the only one covering the building. Other operators will be able to provide service within a covered building on the condition they are connected at the aggregation point. This aggregation point can cover one single building (typically in the densest zones) or several buildings.

Furthermore, operators have argued over deploying one single fiber per dwelling versus several fibers per dwelling. The benefit of having several fibers is that each operator can have its own fiber to each home and, therefore, no manual 'switch' is necessary at the concentration point to change an end user's provider (the end user only needs to connect the optical CPE to the new operator's 'fiber wall plug'). On the other hand, deploying multiple fibers to each dwelling (as from the concentration point) has a cost. Thus, ARCEP came to the preliminary conclusion in early 2009 that in the densest zones (defined as zones where it is economically viable to see two or more providers rolling out a fiber infrastructure), every service operator will have the option of requesting a dedicated fiber line for their own use in each building (which will be financed by the operator) being built.

We can also look at the example of the USA, where most communities have local ordinances that restrict tenants from putting up their own antennas; as a result, telecommunications companies typically seek to make their connection to an MDU in the basement or on the roof (for wireless). That process is relatively straightforward assuming they can get the requisite permits they need to bring their cables to the building.

Once inside the building, operators need access to the risers or ducts (which are the spaces between the walls which carry telephone, electric, etc.). In some cases there really is limited space in the risers and/or the landlord is reluctant to allow access in the risers and in the telephone closets on each floor. There were several instances where an alternative operator was installing its cables and severed the existing cables, leaving entire buildings without telephone services and Internet access.

However, in most cases, there is room but the landlord is otherwise unwilling potentially because of a deal with the incumbent. In the case of older buildings in large cities, the building owner may have actually entered into a contract in perpetuity with the incumbent to maintain the riser for the building.

Nevertheless, building access was an issue that the CLECs took head on in the USA. The FCC finally tackled these issues in 2000. In its decision, the FCC took several actions:

- it prohibited exclusive contracts between telecommunications carriers and commercial office buildings
- it changed the demarcation point for inside wire in buildings

- it ruled that the pole attachment provisions in Section 224 of the Telecom Act require utilities to provide non-discriminatory access to all telecommunications carriers, and
- it decided that Section 207, which prohibits restrictions on the use of antennas, applies to fixed wireless services.

At the same time, the real-estate industry took positive steps to facilitate tenant choice of telecommunications providers by working towards the development of best practices and model agreements, the commission noted.

In particular, a coalition of 11 trade associations representing more than one million owners and operators, committed to a best-practices implementation plan regarding these issues. Such support came from organizations such as the Building Owners and Managers Association International (BOMA,) and the Real Access Alliance.

The commission also noted at the time that it would closely monitor these industry efforts. Moreover, it stated that, if such efforts ultimately did not resolve concerns regarding the ability of property owners to unreasonably deny competing service providers access to customers in MTEs, the FCC was prepared to consider taking additional action. Potential actions included:

- the adoption of rules to ensure that competing service providers receive access to MTE premises, or
- extending cable inside wiring rules to facilitate the use of home run wiring by service providers.

At the time of this report, OSIPTEL specific details on the nature of the access problems in multi dwelling units were not yet available. Thus while we refrain from making any specific recommendations on this issue, we note the following general recommendation:

Recommendation: Multi-tenant dwelling units (especially new builds) should not be allowed to have exclusive agreements with any single telecommunications operators, but should provide non-discriminatory access to all operators in order to provide a more level-playing field and provide consumers in these buildings the benefits of competition.

We do note that there are two general approaches to addressing these kinds of access issues:

- If the issue is determined to be technical in nature, and there is simply no room for further infrastructure deployment, then effective bitstream access policies are the most generally applicable solution to provide alternative operators access to customers in these buildings.

- If the issues are non-technical in nature and are due to anti-competitive behavior by Telefónica, then a more detailed process will need to be started in order to put in an official framework for building access that is non-discriminatory towards alternative operators such as Telmex. This framework would potentially include the measures referenced above as prohibiting exclusive contracts between building owners and Telefónica.

6.5.6 Regulatory authority and market control

Regulatory convergence and scope of responsibility

We note that in Peru there already appears to be some convergence at the regulatory authority level. There are not completely separate telecommunications and media regulators. Rather, there is a structure in which the MTC (responsible for both some telecommunications and all media matters) and OSIPTEL (telecommunications matters only) share overall responsibility. (Another agency, ProInversion, is specifically responsible for running award processes such as auctions, but does not have any specific regulatory authority over service provision.) OSIPTEL is already primarily responsible for regulation of (and implementation in) the entire telecommunications and media industry, while the MTC is in charge of passing telecommunications laws, spectrum and licensing, among other things.

However, as the process of convergence continues, a need for clarifying the areas of responsibility for the different regulatory entities has become clearer. One specific example is the recommendation to harmonize the active regulation of spectrum, both assignment and monitoring, under OSIPTEL (in the discussion of spectrum management in Section 6.2.2).

Another issue raised in the context of this study is the issue of merger control. Conversations with OSIPTEL and the Ministry indicate that there are not currently any controls on mergers and acquisitions within the telecommunications industry. As such, a dominant operator such as Telefónica is able to purchase potential competitors (such as cable operators) in what is clearly an anti-competitive development with little impediments to such developments. As a specific example, in Aug/Sept 2008, Telefonica acquired Star Global Com (which operates cable and broadband services in Arequipa and Tacna) for USD12 million, and increased its pay TV market share from 66% to 85% in Arequipa and from 21% to 91% in Tacna. Telefonica also increased its broadband Internet from 87% and 81% respectively in both departments to almost 100%.

The system put in place in many countries to deal with such an issue is for a separate authority (such as the Department of Justice (DoJ) in the USA) to have the authority to conduct *ex-ante* review of any potentially problematic mergers, particularly on competitive grounds. In such a scenario, telecommunications regulatory authorities (such as OSIPTEL) are usually solicited for their input on such cases. In the US for instance, the FCC ensures that the merger is “in the public interest” and submits its analysis to the DoJ process.

We are aware that there is a competition agency in Peru (Indecopi) with a purview that is limited to other industries (such as the electric power utilities). An agency of similar make-up but with authority over the communications industry (or expanded authority for the existing agency) is a potential means for implementing the necessary merger controls. While it is possible that OSIPTEL could be granted additional powers in order to assume this role, as we discussed in the previous paragraph, a separate agency to the official telecommunications regulator is the typical structure. Reasons for this typically are that one agency can develop the capacity for all competition issues across the economy, including telecoms. Should it not be feasible to develop such an independent agency, then we feel it would be better to invest OSIPTEL with this authority, rather than the current status quo

Recommendation: We recommend the creation of an agency (or agencies) with *ex-ante* authority to review all mergers and acquisitions in the telecommunications and media industries in order to determine and prevent any potential anti-competitive developments.

Regulatory accounting and convergence

Simply put, the question of regulatory accounting in a converged environment is a consideration of how (under the current regulatory reporting requirements) to accommodate the impact of moving from clearly dedicated networks to networks that provide all kinds of services. For example, in a PSTN network offering, it is generally clear what costs are driven by basic telephony (but even in such a scenario, there is a lengthy debate on how copper loop costs are allocated between voice and broadband services where these are offered).

For illustrative purposes and to place our discussion in context, we consider the most recent principles governing regulatory accounting in Europe, which are contained in the European Commission Recommendation on Cost Accounting and Accounting Separation of September 2005.[81] At the time this was enacted, the effects of convergence were already beginning to become apparent in Europe, particularly in the widespread delivery of broadband and telephony over copper access networks.

Briefly, accounting separation and cost accounting are primarily important to help regulatory authorities ensure compliance of regulated entities with non-discrimination obligations and cost-orientation obligations for regulated services, as well as an absence of anti-competitive cross-subsidies.[82]

The problem of cost causality and allocations to particular services and products is similar and related to the problems that regulators have in determining distribution of bundle costs between service components, or the more recent debate in Europe about allocations of costs in mobile termination on a marginal basis versus the previously preferred long-run incremental costing standards.

81 Recommendation 2005/698/EC replacing Recommendation 98/960/EC on Accounting Separation and Cost Accounting of April 1998.

82 In September 2005, the European Regulator's Group (ERG) published a Common Position containing "Guidelines on implementing the EC Recommendation 2005/698/EC", cf. document ERG (05) 29. As defined in the document, "*An accounting separation system is a comprehensive set of accounting policies, procedures and techniques that can be applied to the preparation of financial information that demonstrates compliance with non-discrimination obligations and the absence of anticompetitive cross-subsidies … Accounting separation provides a systematic disaggregation of costs, revenues and capital employed between disaggregated regulatory entities and services of a vertically integrated undertaking. It should also ensure that each financial report includes only costs, revenues and capital employed that are relevant to the regulatory entities and services*"

While a full discussion of the appropriate regulatory accounting requirements on regulated entities and services in Peru is the subject for a more targeted study, any revision processes should consider the following in determining the appropriate regulatory accounting requirements going forward:

- **Focus of regulatory reporting requirements –** Historically, much importance has been attached to the part of the regulatory accounting system that calculates network unit costs (for example, the cost per line of fully unbundled local loops in Europe). However regulatory authorities are increasingly finding that in a converged environment, such network unit costs are necessary, but not sufficient, inputs for the setting of appropriate wholesale prices on regulated services. In particular, there may be issues in specific cases where the cost-based network unit costs (under particular standards) create a price squeeze with existing bundles from incumbent or SMP operators.

  In such scenarios, a potentially preferable solution to even more complex cost accounting investigations is to set up a parallel set of investigations into bundled offers using margin squeeze analysis techniques (e.g. as mentioned by the European Commission).[83] Thus, the particular utility of the regulatory accounting system shifts from a focus on cataloguing network costs to a focus on retailing costs (i.e. all other costs). Such retailing costs are key inputs to any margin squeeze methodologies. At this moment, there is not a consensus approach to margin squeeze tests on multi-play service bundles, and so any specific implementations for Peru on this issue will require more detailed investigations and consultations with the industry.

- **Methodologies and indicators for regulatory reports and accounts –** A key problem posed by convergence to existing regulatory accounting systems is the increasing proportion of intra-service common costs. This development makes it more difficult to unequivocally allocate certain cost items to specific services, and requires more interpretative judgment calls on the appropriate allocations and service categories by regulators and regulated entities. Such determinations are quite complex and can be contentious between regulators and regulated entities. The particular indicators and systems chosen by a regulatory authority are very specific to that country and regulated entity. For example, recent determinations by Ofcom in the UK regarding reporting requirements for BT included specific requirements for regulatory reports to determine what new network components are included in BT's 21CN and disclose the costs of these elements.[84]

While the general principles of regulatory accounting systems remain the same (for example, as promulgated by the ERG " *Review and justify the relevance of each item of cost, capital employed and revenue; Establish and quantify the factor or "driver" that caused each item to arise; and Use the driver to allocate each item to individual businesses/activities/network components or services*")[82] the

83 See for reference, the ERG document "Report on the Discussion on the application of margin squeeze tests to bundles" March 2009.

84 The document "*Changes to BT's 2007/08 regulatory financial statements"* contains a list of detailed and specific modifications to the reporting requirements placed on BT as a result of ongoing changes in the nature of services provided by BT, both at retail and wholesale levels.

practical details underlying the reporting requirements in Peru should be reviewed and updated on a regularly basis. It is important to note that this process must be targeted to obtain information that is both specific to the regulated entity in question and required by existing regulatory processes (either for monitoring or to determine new policies or regulations). As such, appropriate specific regulatory reporting requirements are not generally determined in advance of the processes they are meant to serve, but in response to observed developments in the regulated entity.

The previous recommendations in this report concerning access to Telefónica's networks (such as the recommendations concerning leased-line products, standalone DSL, bundled products and bitstream) will all require detailed disclosures from Telefónica regarding the operation of its current network and future service deployment plans. The detailed understanding that comes as part of these processes provides an opportunity to design and implement updated regulatory accounting requirements that will enable OSIPTEL to ensure Telefónica's compliance with the recommendations arising from this and any other regulatory study.

Recommendation: Commission a specific study that identifies the key inputs required in the process of implementing existing and recommended policies on access to Telefónica's networks (and any other regulated entities) and detail these in an updated set of reporting requirements.

7 Conclusion

7.1 Policy recommendations and impact on the Peruvian market

The process of convergence brings many benefits to consumers including new applications and cheaper prices due to greater competition. However there can also be some negative side effects if the process is not managed smoothly by regulatory authorities. The previous sections present an in depth analysis of the implications of convergence from a technology, regulatory and competition standpoint, and then a determination of the recommendations that will best facilitate the realization of the benefits of convergence in Peru, while minimizing any potential disruptions.

In 2006, Analysys Mason conducted an in-depth study for OSIPTEL reviewing the regulatory framework and determining the most optimal policies to govern the Peruvian telecommunications market over the next decade. Figure 7.1 presents the summary of the outcome from that process.

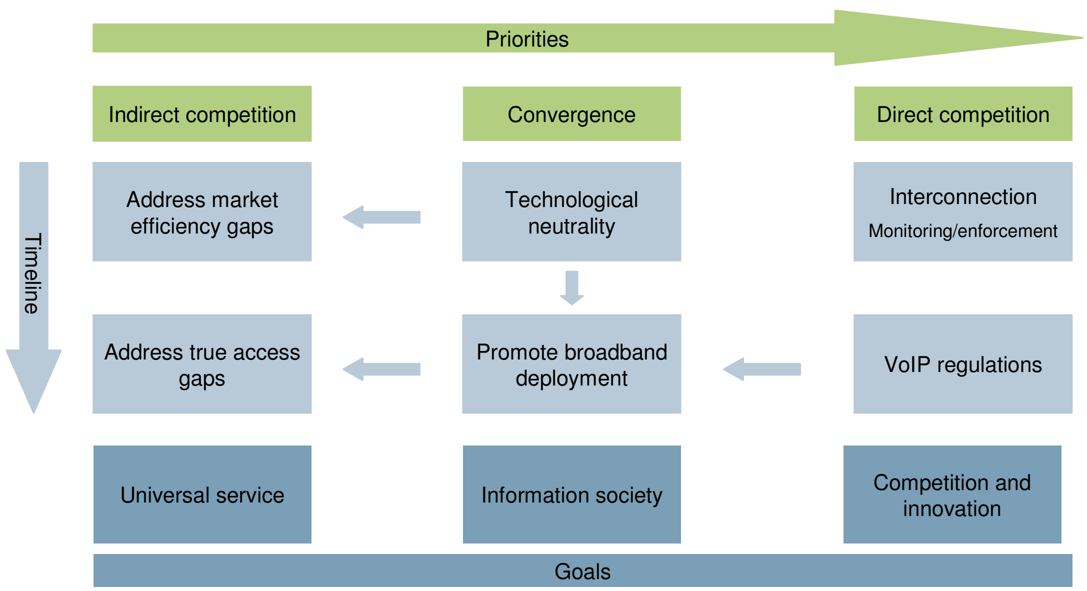

Figure 7.1: Priorities and policy goals for OSIPTEL at the time of the 2006 review of the regulatory framework [Source: Analysys Mason]

In the intervening years, OSIPTEL has made a lot of progress in implementing a number of the short term policy goals identified, particularly in the context of the primary priority which was indirect access. Such policies have included implementation of cost-based access to long-distance leased lines and implementation of bitstream access. Some recommendations are still in the process of being implemented in their recommended time frame and others (such as increasing PC penetration, etc.) are not solely within the scope of OSIPTEL functions and responsibilities.

In the same study, convergence was identified as a secondary priority with both short term and long term goals, specifically

- eliminate distinctions between network types
- eliminate differences in treatment of voice and Internet services regardless of the underlying network technology
- ensure that there is clear jurisdiction over the converged services and networks
- take steps to promote network neutrality
- increase PC penetration with low cost PCs or public access to computers
- create competition via divestiture or cable open access.

Additionally, a number of direct competition policy goals (a tertiary priority) were identified which included a requirement for stand-alone DSL and number portability between PSTN and VoIP users.

This study takes a more detailed look at convergence in order to define some more specific regulations as part of the preparation for convergence.

Figure 7.2 summarizes the key areas of regulatory focus for OSIPTEL with regards to convergence.

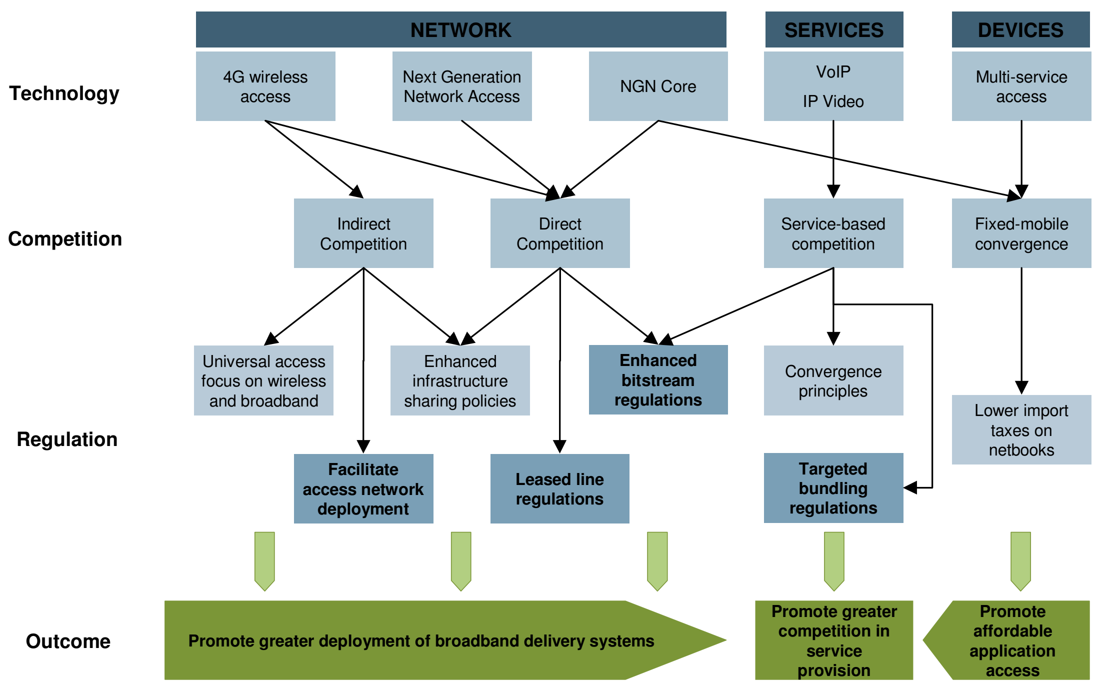

Figure 7.2: Implications and regulatory areas of focus for OSIPTEL with regards to convergence [Source: Analysys Mason]

As illustrated in the diagram, we consider three aspects of convergence – at the network level, services, and devices – across the three phases of this study – technology, competition, and regulation. Our regulatory recommendations are targeted towards three main objectives in respect of competition:

- **Promote network deployment**. We focus on two types of facilities-based competition
  - *Indirect competition*: deployment in under- or un-served areas to facilitate access
  - *Direct competition*: deployment in served areas to create innovation and choice.

- **Promote converged services**. Service-based competition can be made easier with converged services that can be offered over broadband platforms .

- Work to ensure the **availability and affordability** of the wide range of converged devices that are able to access broadband networks to promote fixed-mobile convergence

The order of implementation or detailed timescales for specific recommendations is a function of the available capacity and time possessed by the regulatory authorities including OSIPTEL. If sufficient resources are available, it is possible to implement the majority of these recommendations in parallel or in rapid succession. However, this situation is unlikely, and as such the diagram above also provides a relative indication of the priorities for each recommendation – policies related to the boxes in the darker shades of blue are of immediate priority.

In Section 5.1, we assessed the current status of the broad telecommunications markets in Peru as a prelude to discussing the dynamics of convergence and the optimal policies in a converged environment in Peru. Following on from these discussions, we can look to assess at a broad level the impact of the recommendations and the general process of convergence in Peru.

In relation to Figure 5.1 that summarized the current Peruvian market environment, we now examine the impact of convergence. As discussed above, broadly speaking convergence will have two impacts in the context of this figure: increase the number of access networks that are broadband capable, and also commoditize the networks by facilitating the offering of converged services over broadband. We examine the specific impacts in relation to the original five markets that we reviewed below.

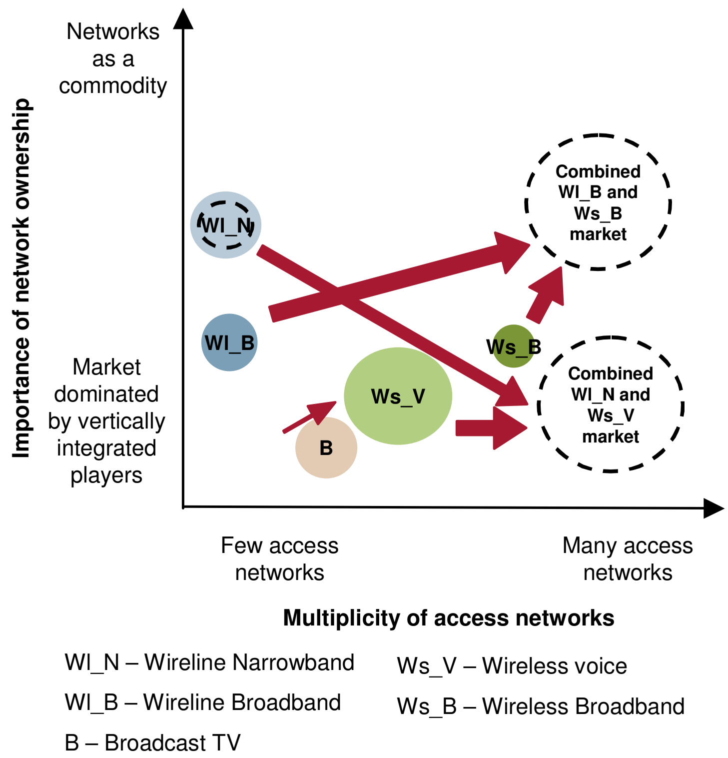

Figure 7.3: The broad Peruvian telecommunications markets in a converged environment [Source: Analysys Mason]

Convergence may have the following specific impacts on markets in Peru, in conjunction with the recommendations of this study:

- The boundaries between wireline and wireless broadband service markets will blur in the short to medium term as commercial developments in the functionality of wireless broadband services, and policies to promote wireless broadband as a universal means of access to Internet connectivity combine to minimize the differences between services offered over the two platform types.
- Similarly, the differences between wireless and wireline voice services may diminish, either through the predominance of wireless voice access, or the merging of solutions that offer a single service over both types of platforms (FMC).
- The dynamics and business models associated with the broadcast TV market indicate that there may be scope in the long term for an increase in the number of access networks available, although significant power will remain in the hands of the vertically integrated players.
- The dynamics of competition and existing business models associated with offering the various telecommunications and media services indicate that, in the short term, there will continue to be key distinctions between broadband, voice and broadcast video services.
- Over the longer term, further merging between these markets is possible and certainly likely (such as a single product being used to offer broadcast TV, data and voice), although the actual timescales will depend on specific operator commercial plans and other external factors such

as an increase in disposable income for customers and more widespread awareness of the potential of connectivity in the populace.

Figure 7.4 presents a summary of the recommendations we have made in the course of this study in terms of prioritization and timescales. In detail we see four categories of recommendations:

- Higher priority, shorter timescale: Recommendations in this category should be addressed with some urgency, and can be done using targeted policies under the current framework
- Higher priority, longer timescale: Recommendations in this category should be addressed with some urgency, but will either require more time consuming changes, or can be done in a longer time frame
- Lower priority, shorter timescale: Recommendations in this category can be addressed with less urgency than the higher categories, but can also be implemented relatively quickly under the current framework and thus may be relatively straightforward to implement
- Lower priority, longer timescale: Recommendations in this category do not take precedence over recommendations in any of the other categories. Their implementation while beneficial for the process of convergence, is either not quite as critical to its progression as the other recommendations, or is not quite as effort-effective as the other recommendations.

IMPLEMENTATION TIMESCALES

PRIORITY	SHORTER	LONGER
HIGHER	• Enact municipal deployment regulations • Mandate broader portfolio of price-regulated leased lines from TdP • Mandate equivalence of inputs with regards to wholesale and retail products on TdP's network • Mandate national roaming for new entrant operator • Mandate additional wholesale products from TdP (standalone DSL and wholesale line rental) • Enact regulations concerning anti-competitive practices in bundled services • Modify wholesale bitstream product to provide for multiple QoS classes	• Commission study on digital migration and general spectrum management reform • Facilitate entry of third party ownership of mobile network infrastructure • Require reference offer from TdP • Implement policy recommendations on new licensing framework
LOWER	• Enact regulations on anti-competitive supply of bundled products • Broaden UAS definition and project selection standards beyond the fixed infrastructure • Mandate open access requirements on UAS funded networks and ensure that existing operators qualify for UAS funding • Ensure QoS standards are appropriate to each type of operator • Remove duties on import of netbooks and PCs and other online devices	• Modify spectrum charging fee structure • Promote internet exchanges outside Lima • Commission national fibre backbone network covering underserved areas • Setup independent organization to facilitate active mobile network sharing

Figure 7.4: Priorities and timescales of key recommendations [Source: Analysys Mason]

A final note relates to the crucial role of competition policy in terms of realizing the full benefits of convergence – both ex ante and ex post authority will be critical.

- *Ex ante* merger review. Mergers of competing networks, such as acquisition of the cable company by Telefónica, effectively reduce the number of access networks, representing a move to the left in the Figure above. Vesting an agency with the authority to investigate and thwart such mergers is important to prevent network consolidation.

- *Ex post* competition review. Actions by vertically integrated players to impede the offering of third-party converged services such as VoIP, in order to protect their own service revenue, will effectively extend the domination of markets by vertically integrated players, resulting in a downward movement in the Figure above. Ensuring that OSIPTEL and/or another specialist agency has the ability to enforce competition rules such as net neutrality are important to prevent vertical domination.

7.2 Policy recommendations in OSIPTEL's regulatory framework

We present details of our regulatory recommendations in the sections below, using the same regulatory implementation framework upon which OSIPTEL is built. In detail, the framework is setup as follows:

- **objectives** of regulation must first be defined
- **specific polices** should then be defined which address the objective identified
- **specific tools** can then be created to implement the defined policies.

7.2.1 Objectives

The process of convergence does not change the particular aims and objectives currently specified in OSIPTEL's regulatory process:

- expansion of access and coverage to telecommunications services
- ensure good quality of services delivered
- ensure that cost of deployment and service pricing are brought down to the most efficient levels.

Our technology analysis highlights the fact that given the difficulties covering the terrain in Peru, and the relative cost of deploying various types of access networks, wireless networks are likely to be the primary means of widespread deployment of converged services in Peru on a nationwide basis, while wireline networks will provide more competition and diversity of services in urban areas. This is true even for broadband, for which wireless offers ever increasing speeds.

For wireless networks, the relatively large number of infrastructure operators (three MNOs and four other WiMAX operators, with additional operators being licensed) indicates that policies encouraging effective competition between these operators will be most effective. Looking forward, means to lower deployment costs will be critical to ensure widespread deployment of the latest technologies.

The dominance of Telefónica's fixed wireline network continues to imply that specific regulations will be needed to open up access to essential facilities needed by alternative operators (whether service based or facilities based) such as leased lines. This again will lower the cost of the deployment and usage of new technologies.

7.2.2 Policies

The specific recommendations to achieve the objectives highlighted in the previous section are presented in the following paragraphs. These are distributed according to the OSIPTEL regulatory implementation framework categories, showing which divisions are responsible for each regulation, although we note that some policies may cross boundaries.

Entrance policies

Licensing	Separate the license for access to scarce resources, such as spectrum and numbers, from the license to offer services. This will ensure that providers have the rights to access those scarce resources as needed, with reasonable and necessary responsibilities relating to their usage. Any needed regulations governing service provision should be established in regulation and not in the license itself.
Spectrum	The assignment of spectrum and assessment of competitive impact and obligations should be harmonized under the primary aegis of OSIPTEL in order to improve the effectiveness of spectrum management in Peru.
	Ensure that the structure in place for charging spectrum fees is such that fees are set to recover only costs associated with administering spectrum, assuring a more equitable economic treatment for concession holders and lowering the cost of offering services.
	Commission a wide-ranging study to investigate reform of the spectrum management process, paying particular attention to the process of digital migration and how best to free up and assign additional spectrum for deployment of advanced services. This would allow OSIPTEL to keep pace with other digital dividend transition and migration processes going on worldwide and meet ITU deadlines, while also fully modifying the spectrum management process to take advantage of all promising possibilities in an effective manner.
Numbering	All operators in Peru offering telephony services in direct competition with each other and with similar minimum functionality should have access to national numbers to enable them to compete fairly; any operators that are not offering services with the same features or functionality should not be given the same access to national numbers, again to ensure fair competition.

Pricing regulation

Price cap	Only the standalone prices and subscription numbers for standalone plans

regulations for each of the regulated telephony plans used in bundles should be included when performing price-cap calculations.

Essential facilities

Termination No specific policy changes are required.

Transport Consider commissioning a national fiber backbone covering underserved areas to be funded either fully by governmental funds (using FITEL funds), or in partnership with private enterprises or existing operators as a means to alleviate transport capacity supply issues.

Leased lines Mandate a wider suite of higher and lower capacity leased-line services (in consultation with industry) that should be provided by Telefónica. These should offer cost-based options for both local and long-distance connectivity, as well as multiple capacities to provide operators with more cost-effective options to deploy their networks.

Bitstream Require that Telefónica make available the equivalent wholesale input (in terms of functionality and quality of service) for every regulated retail service that it offers at the same time that the retail service is made available to consumers.

Additional recommendations Mandate WLR on Telefónica's network using retail-minus methodology to set prices, which enables competitive service providers to offer single billing to customers.

Promote secondary domestic Internet exchanges outside Lima, potentially by using universal service funds in partnership with private organizations or using tax breaks for interested organizations. This will help to ameliorate the current requirements to transport all domestic traffic to Lima for exchange.

Interconnection

Relax mandatory interconnection standards	Remove the mandatory SS7 interconnection requirement in the cases where two interconnecting operators agree commercially to another alternative interconnection arrangement, in order to provide greater flexibility to operators going forward. However, it is important to maintain the current standards and framework for any regulated agreements.
Harmonize fixed-mobile interconnection	Remove the exception governing fixed–mobile calls such that fixed operators should now be allowed to set the retail rate on fixed–mobile calls while paying the mobile termination charge to the terminating mobile network. In practice, for a dominant operator such as Telefónica, the fixed–mobile rate could be set as a sum of the mobile termination rate and the current origination charge on fixed-fixed calls (i.e. the current fixed retail price minus the fixed termination rate).

Competition

In this section, we provide a listing of the recommendations that are primarily focused on addressing competitive issues.

Streamline municipal deployment processes	Adopt (or review existing) policies that standardize and expedite rights-of-way permissions to ensure cost- and time-effective site deployments, and provide operators with clear visibility of timescales for efficient network planning.
	Ensure that the fees imposed for rights-of-way access are determined on a reasonable cost basis to provide cost certainty for operator network planning processes.
	Centralize the process of obtaining municipal rights-of-way, which provides operators with a much more streamlined and effective method of obtaining permits.
Encourage infrastructure sharing	Require existing MNOs (namely Telefónica and América Móvil) to offer national roaming for specific time periods to new licensees (particularly the fourth mobile entrant) in order to encourage effective competition from launch.
	Facilitate entry of third-party companies (potentially through formal licensing or other means) which can own and operate mobile network infrastructure such as towers, masts and sites to encourage mobile network sharing.
	Extend site sharing rules on new public infrastructure to existing public

infrastructure to facilitate deployment of core network equipment and backhaul.

Setup an independent organization that will act as a third party mediator and facilitator for operators that wish to investigate active mobile network sharing, which will also help to prevent collusion.

Extend site-sharing rules on new public infrastructure to existing public infrastructure to facilitate the deployment of core network equipment and backhaul.

Prevent anti-competitive bundling

Require Telefónica to offer standalone DSL, which will enable consumers to have the choice of obtaining broadband access together with voice services (VoIP) from an alternative operator, thereby increasing competition.

Investigate arrangements such as the resale agreement between Telefónica's fixed retail operations and the paid-TV subsidiary Telefonica Multimedia for anti-competitive subsidiary practices, and impose or enforce non-discriminatory rules.

OSIPTEL should decree that Telefónica cannot offer discriminatory access between its networks, and investigate the conditions of Telefónica's existing offer giving Telefónica's wireless fixed network subscribers free calls to the wireline network to ensure that this bundle is not contravening the non-discriminatory policy, and at the same time that Telefónica is not engaging in anti-competitive pricing.

Telefónica (and in a generalized framework any fixed operators deemed dominant) should be prohibited from offering free or unlimited on-net minutes given the anti-competitive considerations with regards to its position as the overwhelmingly dominant provider of fixed telephony.

Multi-tenant dwelling units (especially new builds) should not be allowed to have exclusive agreements with any single telecommunications operators but should provide non-discriminatory access to all operators in order to provide a more level-playing field and provide consumers in these buildings with the benefits of competition.

User conditions

The need to continue to ensure that consumers remain adequately informed and treated appropriately by their service providers is only strengthened by the process of convergence. The current policies in place are suitably detailed (for example, requirements for the provision of information on any restrictions on connectivity to other operators and ensuring uninterrupted service). Going forward, OSIPTEL should continue to be on the look-out for any developments which are detrimental to user's expectations of good service.

Supervision

Retail QoS requirements	Ensure that providers of officially licensed services are subject to retail quality indicators over which they actually have control, and that the service providers make clear to any potential customers the quality they can expect on provided services.
Wholesale QoS requirements	Establish different classes of QoS standards for Telefónica's wholesale bitstream product. This would ensure that service-based providers are able to select the most appropriate and cost-effective inputs for any voice, video or data products that they wish to offer.

Universal service

Fund definition	The conditions and requirements that determine where FITEL funds are to be targeted should include wireless and alternative fixed infrastructures (focused on broadband) to the existing fixed infrastructure. Specifically investigate disbursement of funds towards wireless access related projects and potentially a national fiber network to be shared by all operators.
Fund disbursement	Mandate open-access requirements for networks (or parts of networks) funded using FITEL funds as a means of spurring competitive provision of services. For previously underserved or rural areas now being partially served by existing MNOs on a commercial basis, investigate the most appropriate usage of FITEL funds to ensure that universal access objectives are being met, including promoting infrastructure sharing between rural operators and MNOs.

7.2.3 Tools

Mandate a reference offer from Telefónica	Require Telefónica to offer a comprehensive reference offer with details of all wholesale access services available in order to streamline and improve the process of obtaining wholesale access products.
Margin squeeze test for bitstream	After imposing equivalence of inputs regulation on wholesale offers, construct tests to check and ensure that there is enough of a margin between retail services and wholesale services such that an efficient entrant can make a reasonable return on investment.

Reduced duties on telecommunication, media and technology devices	Remove duties on imports of netbooks and PCs, and explore reduced import taxes on other communications devices and equipment in order to make converged devices more affordable for consumers.
Creation of agency with authority of M&A	Create an agency (or agencies) with ex-ante authority to review all mergers and acquisitions in the telecommunications and media industries in order to determine and prevent any potential anti-competitive developments.
Updated regulatory reporting requirements	Commission a study that identifies the key inputs required in order to implement existing and recommended policies on access to Telefónica's networks (and any other regulated entities) and detail these in an updated set of reporting requirements.

Annex A: Case studies on service bundling worldwide

A.1 Multi-play offering in developed markets

A.1.1 Australia

Multi-play bundles including pay-TV subscriptions are available from FOXTEL (through Telstra), Austar and other retailers.

FOXTEL

FOXTEL itself does not sell pay TV as part of bundles. Instead Telstra, a shareholder in FOXTEL[85], who are pursuing a bundling strategy offering dual-, triple- and quadruple-play packages, include FOXTEL pay TV branded as 'FOXTEL from Telstra'. As of June 2008, Telstra had 419 000 subscribers on such FOXTEL from Telstra bundled services, thus constituting 31% of FOXTEL's total retail sales, as shown in Figure A.1 below. These bundles give subscribers free call minutes and SMS as well as a single bill for all services.

Previously Telstra also sold Austar pay TV in a similar way but ceased doing so on 30 June 2008. By 2006 the marketing of the service was limited and hence it reached its maximum number of subscribers, 55 000, at the end of June 2005. FOXTEL from Telstra was launched by Telstra in December 2002 while Austar from Telstra was launched in October 2003.[86]

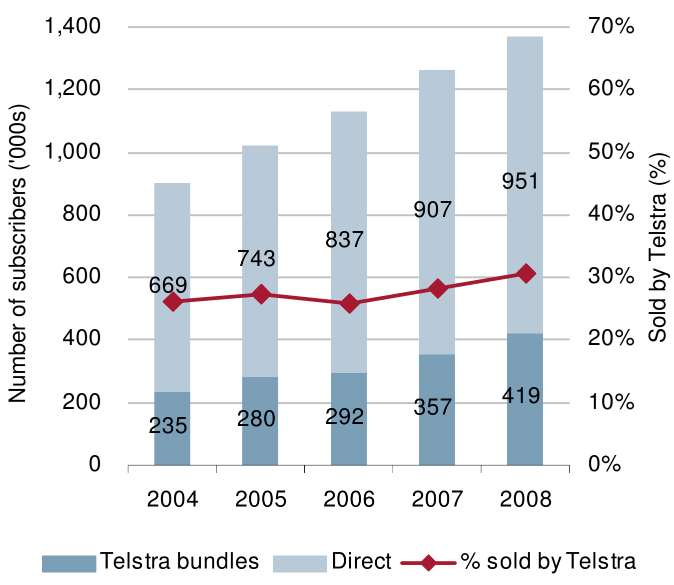

Figure A.1: FOXTEL retail subscribers through directly and through Telstra as of 30 June each year [Source: Telstra]

85 Telstra owns 50% of FOXTEL Partnership and FOXTEL Television Partnership as well as 80% of FOXTEL Cable Television Pty Ltd

86 Telstra Annual Reports, www.telstra.com.au

Telstra and FOXTEL have also launched the 'FOXTEL by Mobile' service, a mobile television service sold by Telstra with content from FOXTEL, supplying up to 31 channels, including:

- news channels such as Sky News and CNN
- entertainment channels such as Fox8, bio and E!
- sports channels such as Fox Sports, Union and Eurosport News
- kids channels such as Disney and Cartoon Network
- music channels such as Max and MTV.

Telstra mobile customers can subscribe to the service, with prices ranging from USD9 to USD12 per month. In June 2007, Telstra announced that it had signed up 50 000 customers to the service, that was launched with 12 channels in October 2006, and that FOXTEL by Mobile had contributed to raising Telstra's mobile data usage and thus mobile ARPU. It is unclear whether such positive development has continued further.[87]

Austar

Austar has launched an MVNO and markets its mobile services under their own brand name. It does not, however, offer this service in bundles with its pay-TV offers. Instead, it offers bundling with its dial-up Internet access services, where customers are offered discounts of approximately 50% on their monthly Internet access fee.[88]

Others

Optus offers the possibility for customers to bundle pay TV with broadband, home phone and mobile phone services providing discounts of approximately 10% on the monthly fee. Further, Optus offers a mobile TV service with 35 channels including several music, lifestyle and news channels. Access to these is charged at USD0.66 or USD2.33 per month per channel, with certain premium channels charged USD1.34 per day or USD3.33-4 per month.[89]

Regional pay-TV retailers Neighbourhood Cable and TransAct extensively bundle pay TV with other services. Neighbourhood Cable offers triple-play bundles of pay TV, broadband and fixed telephony while TransAct offers triple- and quadruple-play bundles of pay TV, broadband, fixed and mobile telephony. Its subscribers can also bundle ISP services, electricity, natural gas and green energy from affiliates Grapevine and ActewAGL. [90]

87 www.telstra.com.au, Telstra annual reports

88 www.austar.com.au

89 www.optus.com.au

90 www.ncable.net.au, www.transact.com.au

A.1.2 France

Bundling pay TV into multi-play offerings is frequently available in the French market; it is offered by cable company Noos Numericable as well as by all IPTV providers. Mobile TV is also a prominent feature in France, with Canal Plus and Orange offering content on mobile TV.

CanalSat

CanalSat does not offer any multi-play bundles, but has launched a mobile TV network in collaboration with mobile network operator (MNO) SFR. It offers 50 channels including: [91]

- general channels such as TF1, Canal+ En Clair
- youth channels such as TiJi and Nickelodeon
- music channels such as MCM Top and MTV
- news channels such as Tele1, BFM TV
- foreign channels such as BBC Worlds News
- sports channels such as Eurosport and l'Equipe
- documentary channels such as Planete and Discovery Channel.

Separately, a Canal+ Mobile[92] offering exists that is accessible for SFR and Bouygues Telecom mobile subscribers (contracts are however signed with Canal+ directly). The Canal+ Mobile offering consists of five channels:

- *Sport TV*, which broadcasts e.g. the UEFA Champions League and the English Football Association Premier League (FAPL)
- *Canal+ TV En Clair*, a general channel that is also included in the CanalSat Mobile offering
- *Humour TV*, a comedy channel
- *Cinema TV Serie*, which offers series such as Desperate Housewives
- *Charme TV*, an adult channel.

Noos Numericable

Noos Numericable offers dual- and triple-play combinations of television, 100Mbit/s broadband access and fixed telephony over both cable and ADSL. In such packages, pay TV is used as the basic component.[93] A discount of 50% is given when Internet and fixed telephony access are bought with the pay-TV service instead of buying them separately. Notably the bundling discounts are much higher in this example than those in Singapore; this is often true in countries with a good local loop unbundling

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91 Television Business International, 01/04/2007, www.canalsat.fr

92 Canal+ and CanalSat are both part of the Canal Plus Group but the Canal+ channels are required to be sold separately,

93 www.numericable.fr

(LLU) product with strong take-up. Noos Numericable also sells mobile services acting as an MVNO on Bouygues Telecom's network. These services are not sold as part of bundles but a fixed line Noos Numericable telephony subscriber will get free calls to that number.

Orange

Orange only sells its IPTV service as part of bundles (to those who are already broadband subscribers). This is currently subject to an investigation in France.

Orange offers several bundles in dual- and triple-play (Internet, IPTV and fixed telephony). In 2009 it intends to also launch services over satellite to allow triple-play customers who are not capable of receiving TV by DSL to instead receive TV over satellite through a single DSL/satellite hybrid STB[94]. Orange is also an MNO but it does not at the moment offer any quadruple-play bundles.

Orange has also launched a mobile TV service through which 60 channels are available, which it includes in its unlimited data package. The service was launched in April 2005 and reached 1 million subscribers at end of 2007 as can be seen in Figure A.2 below. Orange is thus the leading mobile TV operator in France, having four times as many subscribers as SFR and Bouygues Telecom combined.

	Launch	*Channels available (November 2008)*	*Subscribers (December 2007)*
Orange	Apr 2005	60	1,000,000
SFR	Jun 2005	60*	200,000
Bouygues	Oct 2005	18*	50,000

Figure A.2: *Channels and subscribers for French mobile TV retailers * In addition Canal+ Mobile's five channels can be accessed [Sources: Analysys Mason, Orange, SFR, Bouygues Telekom]*

A.1.3 Hong Kong

Inclusion of pay-TV services in multi-play bundles is quite common practice in the Hong Kong market with the pay-TV services from all four pay-TV retailers available in such bundles.

i-Cable

Leading cable operator i-Cable, offers dual- and triple-play services combining pay TV with broadband and voice services. It launched a broadband service in 1999 but only began bundling it with pay TV in 2004 after several competitors had launched triple-play packages. It therefore

94 TeleGeography, 07/01/2009, Orange and Canal+ ink deal to broadcast content via Astra satellite

began marketing dual-play bundles and, in the same year, also launched a triple-play offer by adding a voice service. The company acknowledges that pay TV is its main customer retention and acquisition tool. In fact, as can be seen in Figure A.3 below, it actually lost 22 000 broadband subscribers in 2007 whilst gaining 96 000 pay-TV subscribers.

To enhance the attraction of its broadband products i-Cable has launched an IPTV service on which it offers four free channels and a learning portal, eLearning, catering to children. Subscribers who add other services to their pay-TV subscription are given discounts based on promotions and total spend with the company, although these are administered on request and not published as part of a price list.[95]

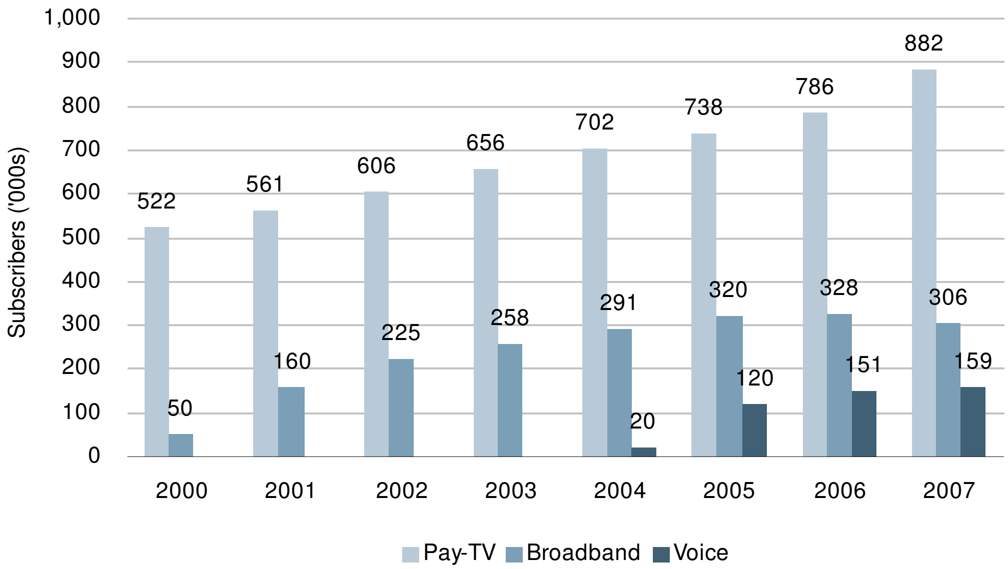

Figure A.3: Subscribers for i-Cable pay TV, broadband and voice services [Source: HKCTV]

PCCW

PCCW offers several triple- and quadruple-play packages, combining its IPTV pay-TV service with broadband, fixed telephony and mobile (voice and mobile broadband). Additionally, it offers access to more than 4000 Wi-Fi hotspots in Hong Kong. Fixed broadband is offered over VDSL and FTTH, with bandwidths of up to 1000Mbit/s while mobile broadband is offered over the company's 7.2 Mbit/s HSDPA network.

95 HKCTV annual reports

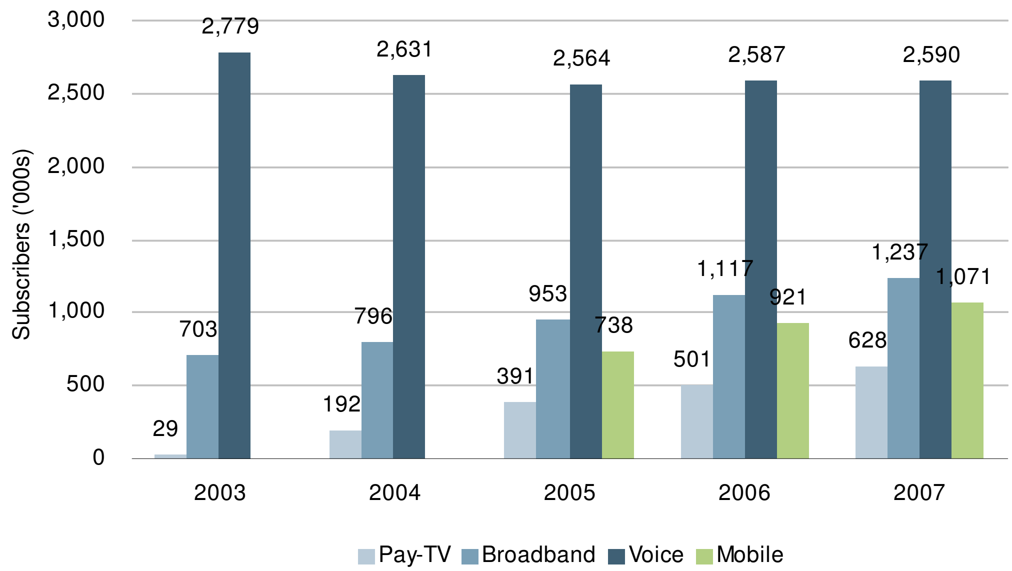

Figure A.4: Subscribers for PCCW's pay TV, broadband, voice and mobile services [Source: PCCW]

PCCW's service is constructed as a dual-play bundle as broadband subscribers are given free STBs and can access some content free of charge. Pay-TV-only subscribers are asked to pay a monthly rental fee for their STBs and a line rental that is waived for broadband subscribers. It is thus highly beneficial for broadband subscribers to sign up for pay TV and disadvantageous for pay-TV subscribers not to sign up for broadband services.

PCCW also runs a mobile TV service on which it offers services such as Now Sports, with sports content such as the EURO2008 football championships, and Now TV, which provides 13 local and international channels of which 4 in HD. PCCW also offers a mobile music platform with a library containing songs and music videos from 40 local and international music labels.

Others

TVB Pay Vision does not retail its service in any bundles but broadband provider HGC does offer a dual-play package in which it combines its own broadband service with TVB Pay Visions pay-TV service.[96]

Broadband operator HKBN also offers a broadband TV service, which is sold in triple-play packages in which pay TV is combined with broadband access and VoIP .[97]

96 www.hgcbroadband.com

97 www.hkbn.net

A.1.4 Spain

The Spanish authorities did not allow bundling of TV, Internet and telephony services until 2005. Since then bundling has become very common in the Spanish market with all major operators offering multi-play bundles. [98]

Digital Plus

Digital Plus, Sogecable's pay-TV service, is available in bundles offered in partnership with MNO's Telefónica, Orange (through its Internet service provider Ya.com) and Vodafone (yet to launch). Interestingly this is done on a non-exclusive basis with three different mobile operators:

Telefónica and Digital Plus offer the bundle Trio+, which combines a 6Mbit/s ADSL connection and fixed telephony with unlimited national calls from Telefónica with the pay-TV service from Digital Plus. Sogecable launched these bundles in 2008 after previously being constrained from doing so by remedies imposed on it by the competition authorities following the merger between Canal Satellite and Via. This bundle is priced at USD86.68/month with the first three months at USD25.34/month and the following three months at USD75.35/month.[99]

Orange and Digital Plus offer the triple-play bundle Yacom+, which consists of a 10Mbit/s Internet connection and fixed telephony with unlimited national calls from Ya.com as well as the pay-TV package PLUS from Digital Plus. Price: USD67.35/month, and the first two months are offered at USD75.34/month.[100]

Vodafone and Digital Plus announced on 21 November 2008 that they will also launch dual-play bundles of ADSL and pay TV. These bundles will see Vodafone combining its ADSL services with the pay-TV operations of Digital Plus. The bundles will be sold for USD40.67 per month and existing Digital Plus customers will be offered a 15% discount for six months on Vodafone's ADSL services.[101]

In addition, Digital Plus offers a mobile TV service with 30 channels called Digital+ Movil that is available to subscribers of MNOs Vodafone and Orange. Channels on the service include: Canal+ Futbol Movil (a mobile football channel), CNN+ and Cartoon Network. The service is priced at USD8/month.[102]

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98 Ofcom, Pay-TV market investigation consultation, 18 December 2007

99 trio.plus.es

100 yacom.plus.es

101 TeleGeography's CommsUpdate 21 November 2008

102 Analysys Mason

ONO

ONO offers dual-play combinations of telephony, Internet access and pay TV as well as a triple-play package combining all three:

- Esencial (basic) television and unlimited phone calls for USD38/month
- Esencial (basic) television and 6Mbit/s Internet access for USD54/month
- Esencial (basic) television, unlimited phone calls and 3Mbit/s bandwidth Internet access for USD67.35/month
- Esencial (basic) television, unlimited phone calls and 6Mbit/s bandwidth Internet access for USD76.68/month
- Extra television, unlimited phone calls and 6Mbit/s bandwidth Internet access for USD90.02/month
- Extra television, unlimited phone calls and 12Mbit/s bandwidth Internet access for USD104.02/month
- Esencial (basic) television, unlimited phone calls and 50Mbit/s bandwidth Internet access for USD88.02/month.

ONO has been quite successful in bundling its services, selling on average more than two services per customer and having succeeded in selling triple-play services to almost a third of its customers. The uptake of triple-play grew strongly between 2004 and 2006 but stabilized in 2007 indicating that there is a limit to the number of customers that are interested in triple-play, as shown in Figure A.5 below.

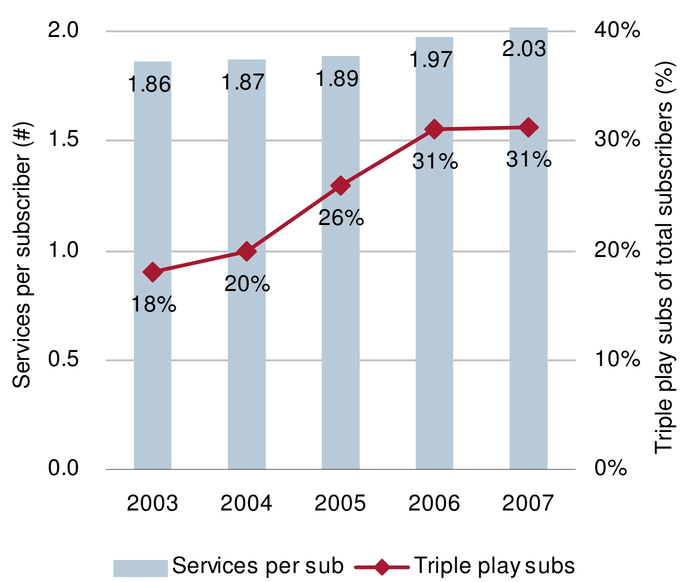

Figure A.5: Percentage of triple-play subscribers and services per customer for ONO [Source: ONO]

Imagenio

Telefonica's Imagenio IPTV service is available only as part of the triple-play bundle Trios (voice, 6Mbit/s ADSL and IPTV). Trios is priced at a monthly fee of USD59.63 with the basic TV package Conexion and USD72.36 with the premium package Familiar. The company was banned from bundling products until 2005 but has aggressively been pursuing a bundling strategy since this ban was lifted.[103]

A.1.5 Sweden

Dominant cable operator Com Hem is pursuing a multi-play bundling strategy, as are the IPTV operators and Tele2. The satellite operators are however not offering any multi-play bundles.

Com Hem

In addition to pay TV, Com Hem also provides broadband Internet access and fixed telephony services. Com Hem launched broadband services in 1999 and subsequently added telephony in 2004. These can be bundled in a variety of combinations by the user, with Com Hem pushing for triple-play uptake by providing three services for the price of two in a scheme where users don't pay for the cheapest of chosen pay TV, Internet and fixed telephony offerings. Com Hem has been using this scheme, which it calls'com.bo', since it first launched triple-play services in 2004.[104] The scheme has been successful with substantial take-up of triple-play services, as shown in Figure A.6 below.

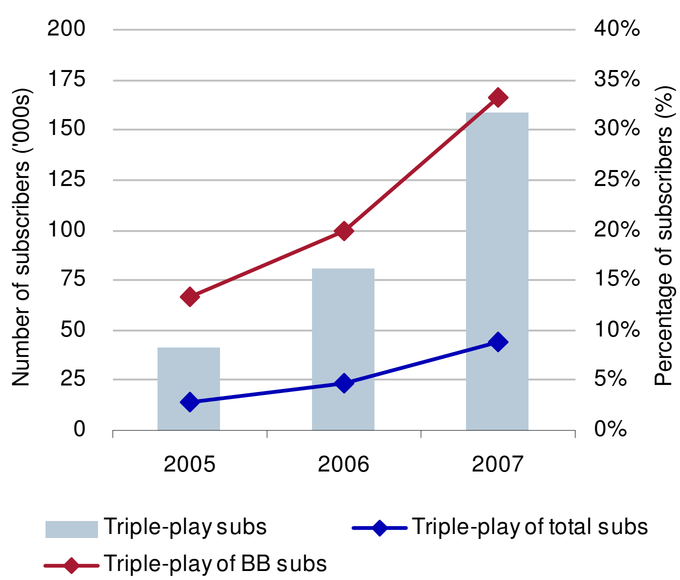

Figure A.6: Figure A.6: Triple-play uptake for Com Hem since launch of such bundles. [Source: Com Hem]

103 TeleGeography, www.telefonicaonline.com

104 www.comhem.se, Analysys Mason

Canal Digital

Canal Digital has only recently started to offer dual-play by launching a broadband service that is offered to existing customers only. Three bandwidths are offered:

- 2Mbit/s, price: USD32.16/month
- 8Mbit/s, price USD33.50/month
  24Mbit/s, price USD37.52/month

The broadband service is delivered as a separate service, with a modem that is not integrated with the company's STB.[105]

Viasat

Viasat does not offer any dual- or triple-play packages. It does however offer a mobile TV service, Viasattogo, which is currently only available to subscribers with MNO Tele2.[106] In total 34 channels are offered in four different basic packages – entertainment, news, music, children; and 3 premium packages – sports, EA Games and adult; and a bonus package. The basic packages are priced at USD6.03/month for one package, USD8.04/month for two, USD10.05/month for three and USD11.39 for all four packages. The premium packages are priced at USD4.02/month for EA Games, USD4.69/month for the adult package and USD6.03/month for the sports package. The bonus package is supplied free of charge.[107]

Others

IPTV providers Bredbandsbolaget (a subsidiary of Telenor) and Telia use their background and widely offer triple-play bundles of broadband, fixed telephony and TV. Cable company Tele2 also offer triple-play bundles in which is gives discounts on packages of thematic pay-TV channels and on broadband connections. Smaller independent provider FastTV also offers a similar triple-play package, despite not owning any infrastructure, taking advantage of access to the many city owned networks that exist in Sweden. DTT retailer Boxer does not offer any bundled services.[108]

105 www.canaldigital.se

106 Tele2 and MTG/Viasat belong to the same sphere of companies, the Kinnevik group

107 www.viasat.se

108 www.bredbandsbolaget.se, www.fasttv.se, www.telita.se, www.boxer.se, www.tele2.se

A.1.6 United Kingdom

Sky

Sky began to offer broadband and telephony services in 2006. To any Sky TV package, customers can add either broadband, fixed telephony or both. Sky offers three different broadband packages[109]:

- *Sky Broadband Max*, for USD13.40 per month, a 16Mbit/s broadband connection with unlimited downloads
- *Sky Broadband Mid*, for USD6.70 per month, an 8Mbit/s broadband connection with a 40GB monthly download limit

Sky Broadband Base, this is free of charge and consists of a 2Mbit/s broadband connection with a 2GB monthly download limit.

The price of these broadband packages has increased by USD6.70 per month if customers do not also subscribe to Sky Talk, which consists of either:

- a carrier pre-select service with no monthly fee, but charges for calls
- a carrier pre-select service with a USD6.70 monthly fee, allowing unlimited national evening and weekend calls.

Line rental can be added to either product for USD13.40 per month, which is similar to that charged by the incumbent BT.

In June 2008, 11% of Sky's customers were on triple-play bundles, in June 2008 this had increased to 12% and is expected to continue to increase. Furthermore, Sky offers three mobile TV services.

- *Anytime on Mobile*: a mobile phone application that allows access to certain mobile content on a compatible mobile handset, it is provided free of charge to Sky pay-TV customers.

- *Sky Mobile TV*: a service with 25 channels that is accessible through the mobile networks of Vodafone (UK and Ireland), Orange and T-Mobile. Service characteristics and charges depend on the mobile operator.

- *24-7 Football*: that allows any customer on a UK mobile network with a compatible handset to watch football clips, either for a monthly subscription fee of USD6.70 or by paying USD0.67 per clip.

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[109] www.sky.com, Sky Annual Reports, Ofcom Communications Market Report 2008

Virgin Media

Virgin Media offers several dual-play, triple-play and quadruple-play bundles including pay-TV, broadband, fixed voice and mobile voice (that it offers as an MVNO):

- Dual-play bundles:
  - *TV + phone M*: TV with approximately 40 channels, access to VoD and BBC iPlayer, and unlimited fixed weekend calls to UK land lines is offered for USD15.41/month.
  - *TV + phone L*: TV with approximately 90 channels, access to VoD and BBC iPlayer, and unlimited fixed weekend calls to UK land lines is offered for USD28.14/month.
  - *TV + phone XL*: TV with approximately 145 channels, access to VoD and BBC iPlayer, and unlimited fixed weekend calls to UK land lines is offered for USD41.51/month.
  - *Broadband + TV*: TV with approximately 90 channels, access to VoD and BBC iPlayer, and a 2Mbit/s broadband connection is offered for USD34.84/month.
  - *V+ bundle*: TV with approximately 40 channels , access to VoD and BBC iPlayer, fixed voice with unlimited fixed weekend calls to UK land lines and a USD69.68 discount on a V+ STB (see below, regular price USD209.71) is offered for USD6.70/month.

- Triple-play bundles:
  - *Broadband triple deal*: TV with approximately 40 channels, access to VoD and BBC iPlayer, fixed voice with unlimited fixed weekend calls to UK land lines and a 10Mbit/s broadband connection is offered for USD37.52/month.
  - *TV triple deal*: TV with approximately 90 channels, access to VoD and BBC iPlayer, fixed voice with unlimited fixed weekend calls to UK land lines and a 2Mbit/s broadband connection is offered for USD42.21/month.
  - *XL triple deal*: TV with approximately 145 channels, access to VoD and BBC iPlayer, fixed voice with unlimited fixed calls to UK land lines and a 20Mbit/s broadband connection is offered for USD68.34/month.
  - *Very Impressive Package*: TV with approximately 145 channels, access to VoD and BBC iPlayer, Sky Sports and Movies premium channels, free V+ STB, fixed voice with unlimited fixed calls to UK land lines and a 20Mbit/s broadband connection is offered for USD120.60/month.

- Quadruple-play bundles:
  - *All 4 services*: TV with approximately 90 channels, access to VoD and BBC iPlayer, fixed voice with unlimited weekend fixed calls to UK land lines, a 2Mbit/s broadband connection and mobile subscription with either 300 free minutes and 500 free SMS per month or 100 free minutes and 100 free SMS per month but a phone is offered for USD58.96/month.
  - *Very Impressive Package – Complete*: TV with approximately 145 channels, access to VoD and BBC iPlayer, Sky Sports and Movies premium channels, free V+ STB, fixed voice with unlimited fixed calls to UK land lines, a 20Mbit/s broadband connection and a mobile subscription with a free phone plus 750 free minutes and 750 free SMS per month is offered for USD176.21/month.

Furthermore, certain Virgin Media subscribers, can also add a mobile broadband service with a 1GB monthly allowance for USD6.70/month

Virgin Media has continued to increase the penetration of its triple-play customers and the number of services sold per customer and now has almost 50% of its customers on triple-play bundles, as shown in Figure A.7 below.

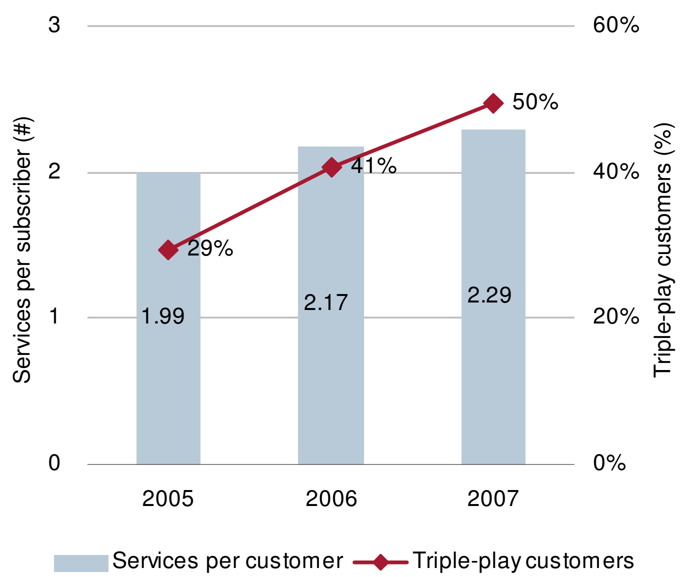

Figure A.7: Services per customer and percentage of customers that are triple-play customers for Virgin Media [Source: Virgin Media]

Others

IPTV providers Tiscali and BT only include their pay-TV services in triple-play bundles. Top Up TV and Setanta however do not offer any multi-play bundles.[110]

A.1.7 United States

Comcast

Comcast started offering triple-play bundles of TV, Internet and fixed telephony that it markets with a discount, in 2005. Broadband access is available with bandwidths of up to 16 Mbit/s, which Comcast markets as "way faster than DSL". Telephony is offered as a digital service with unlimited local and long-distance calls and additional features such as included voice mail, caller ID, call waiting, call screening, call forwarding, three-way calling, etc. The standard triple-play package includes these three services for a monthly charge of USD99.[111]

110 www.btvision.bt.com, www.tiscali.co.uk, www.setanta.com, www.topuptv.com

111 www.comcast.com, Comcast Annual reports

DirecTV

DirecTV markets dual-play bundles where its pay-TV service is combined with broadband Internet access that is offered through partnerships with local ADSL providers. DirecTV also offers a satellite Internet access service, with bandwidths of up to 1.5Mbit/s, through a collaboration with provider WildBlue. Prices for this service start from USD39.99/month. DirecTV pay-TV is also included in triple-play and quadruple-play bundles sold by operators such as Qwest and Verizon.[112]

Dish

Dish offers its DISH satellite pay-TV service in triple-play bundles with fixed telephony and ADSL Internet access as well as with satellite Internet access from provider WildBlue (for rural areas).[113] ADSL and telephony is supplied from:

- AT&T
- Verizon
- Qwest
- Embarq
- Windstream
- Cincinnati Bell
- Frontier
- CenturyTel
- Clearwire
- Hawaiian Telcom.

Time Warner Cable

Time Warner Cable offers a triple-play service, All The Best, which combines a pay-TV service with HD (Digital Cable plus HD) with digital phone service (with unlimited calls to the US, Canada and Puerto Rico) and broadband Internet access (Road Runner High Speed Online). The digital phone service includes extra features such as caller ID and call forwarding, in addition, a bundle of minutes, International OnePrice, (1000 minutes/month to 100 countries) for international calls can be added to subscriptions for a monthly fee of USD19.95. Choices, prices and discounts vary depending on the region in which a subscriber lives.[114]

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112 www.directv.com, www.qwest.com, www22.verizon.com

113 www.dishnetwork.com

114 www.timewarnercable.com

Others

AT&T and Verizon are both pursuing bundling strategies for marketing their IPTV platforms but are also offering bundles including pay-TV from other retailers.

AT&T

AT&T offers triple-play bundles combining DISH's satellite pay TV (DishDVR Advantage with America's Top 100) with its own High Speed Internet Pro broadband access and All Distance fixed telephony packages. The triple-play is priced at USD99/month. Users who sign up for the bundle get a USD150 cash back offer and the bundle includes a USD10/month discount compared to buying the services separately.

Its U-Verse IPTV service is available in dual-play bundles of pay TV and Internet access for users connected to the company's U-Verse FTTC network. These bundles are based on pay-TV packages to which broadband Internet access can be included for USD25 per month; examples include:

- *U-family* which includes 70 channels and an HD-ready STB with recording functionality, single play price USD44 per month, price in bundle with broadband USD69 per month
- *U200* which includes 220 channels and an HD-ready STB with recording functionality, single play price USD59 per month, price in bundle with broadband USD84 per month
- *U400* which includes 340 channels and an HD-ready STB with recording functionality, single play price USD99 per month, price in bundle with broadband USD124 per month

Triple-play bundles are also available, terms and conditions for these vary depending on the region the subscriber resides in.[115]

Verizon

Verizon offers the possibility to include either its IPTV solution FiOS TV (FiOS TV is available only for user connected to Verizon's FiOS FTTH network) or pay TV from satellite provider DirecTV in dual-play, triple-play and quadruple-play bundles with:

- broadband access over either ADSL or Verizon's FiOS fiber network with speeds up to 30Mbit/s (50Mbit/s in some areas)
- fixed telephony, with unlimited local and long-distance calls to US, Canada and Puerto Rico and features such as voice mail, caller ID and call waiting.
- mobile telephony.

Triple-play plans are offered from USD79.[116]

115 www.att.com

Verizon's mobile subsidiary, Verizon Wireless of which it owns 55% with Vodafone owning the remaining 45%, also offers a mobile TV service – V CAST Mobile TV, which was launched in March 2007. It offers broadcasts from ten channels, including CNN, Fox, MTV, NBC and Nickelodeon. The service is available in three packages:[117]

- *Limited,* with four channels, is available for a monthly fee of USD13
- *Basic,* with ten channels, is available for a monthly fee of USD15
- *Select,* with ten channels and unlimited access to video clips and mobile web, is available for a monthly fee of USD25.

A.2 Brief summary on status of multi-play offerings in Latin America

A.2.1 Brazil

Multi-play bundles are abundant in Brazil, especially after regulations that stifled convergence were overturned in April 2008.

Net Servicios

Net Servicios is the largest CATV operator in Brazil by subscribers and is trying to gain a foothold in the local and domestic long-distance telephony services market by offering triple-play in partnership with its sister company Embratel. Both owned by Telmex, the pair signed an agreement to jointly develop telecoms service in November 2005.

Net Servicios operates a broadband Internet service that passes 6.7 million homes and operates in Brazil's four largest cities. They began VoIP and high-speed data services in March 2008, though their Internet connection is only 100kbit/s and therefore the standard definition of broadband.

Global Village Telecom

Operating in 62 cities, Global Village Telecom (GVT) has become ideally placed to enter the triple-play arena given that 58% of its subscriber base already takes broadband as well as telephony services. Furthermore, GVT's network is capable of delivering broadband connectivity of up go 15Mbit/s. GVT is currently awaiting an amendment from the government that would allow telcos to broadcast TV content on their networks to launch their IPTV services.

116、 www22.verizon.com, Verizon annual reports, TeleGeography

117、 www22.verizon.com, Verizon annual reports, TeleGeography

Oi (Telemar)

Oi recently agreed to acquire rival telecoms operator Brasil Telecom (BrT) that now creates a broadband power with 3.2 million subscribers. Oi was able to offer Brazil's first quadruple-play offer in April 2008 when regulations barring companies from providing telephony and cable TV in the same geographic area was overturned. There is currently an agreement in place with US-based VoIP specialist Net2Phone to launch residential VoIP services for broadband customers and is currently waiting to hear about VoIP regulations from the Brazilian regulator Anatel, but in light of lack of guidance has opted to go ahead with VoIP rollout in some areas.

Telefonica Brasil

Telefonica Brasil offers triple-play with through Speedy broadband services with connection speeds of up to 30Mbit/s via fiber-optics, the fastest connection in Brazil and can claim 2.07 million ADSL connections.

A.2.2 Argentina

Current legislation bans telcos from offering pay-TV, but the law permits cable TV operators to offer telephony. As far back as 2003, Telefonica del Argentina (TdA) had filed a lawsuit seeking USD2.83 billion attempting to change the regulation, but has continually been stifled. In July 2008, the Supreme Court took the case and upheld the ban that stopped telcos from offering pay-TV. TdA, among other telcos, had wanted to offer television services over their DSL broadband lines to help boost revenues, but the Argentine Cable Television Association filed a case to prevent the telco from doing so.

Due to current regulation, local TV provider Telecontro launched the first triple-play package in Buenos Aires in the 2Q 2008. Cable TV operators Multicanal and Cablevision, owned by Grupo Clarin, are deploying fiber-optic infrastructure in preparation to offer triple-play services in major cities.

There is a bill currently being debated by Argentina's federal broadcasting committee that is expected to pass, allowing cooperatives to launch their own TV services but prevent mainstream telcos from offering triple play. If this proves to be the case, it will be a major blow to TdA and other telcos who have prepared their networks for IPTV in anticipation of one day being allowed to offer triple play.

A.2.3 Chile

Four companies in Chile offer triple-play services, although some are achieved through partnerships with other companies.

Telmex Chile

Telmex Chile entered the residential market in 2007 offering bundled telephony, broadband and satellite TV. Its acquisition of satellite TV operator ZAP TV allows it to offer broadcast services, and their telephony and broadband services are offered over its WiMAX-based network. At the end of 2007, Telmex Chile claimed to serve 67,000 residential television customers, equivalent to around 6% of the pay-TV market.

Telefonica Chile

As part of its strategy to become a triple-play provider of services, Telefonica Chile recently launched a satellite delivered DTH pay-TV service. Their service, called Telefonica TV Digital, carries a selection of channels including Disney, ESPN, and FOX. The service is available nationally and customers have the opportunity to purchase additional premium channels and services including PPV. Their dual-play bundle combines TV with fixed line telephony while the triple-play adds high-speed broadband Internet access.

By the end of 2007, Telefonica Chile had over 219,000 pay TV customers, giving t a 17% market share and making it the second largest pay-TV operator in Chile. 26% of their customers subscribed to the dual-play package and 70% subscribed to triple-play, which was further augmented in 2007 when IPTV was launched.

Others

VTR is the second largest player in the broadband market with 39.7% of subscribers, while leader Telefonica claims 49.3%. In June 2008, their cable market network passed over 2.5 million households and they have 870,000 TV subscribers, 564,000 Internet and 578,000 telephony customers. They were recently granted a license for wireless broadband services and a WiMAX pilot is in the works.

Grupo GTD provides broadband Internet, local and long-distance telephony services to residential and business customers in Santiago and southern Chile. In September 2006, they launched their digital TV service via fiber-optic networks, and also offer pay-TV services in partnership with DirecTV and triple-play provider VTR.

A.2.4 Colombia

Three providers dominate the converged services market and the government maintains a large financial interest in each company, owning one outright.

Telmex Colombia

Telmex entered Colombia in 2004 after purchasing AT&T Latin America and has proceeded to enhance their converged services by purchasing small network operators in Colombia offering cable television and broadband Internet access. In September 2007, Telmex announced plans to invest USD340 million to expand the telecoms infrastructure in Colombia. At the end of 2007, Telmex had coverage of more than 2.5 million households and launched telephony services in Bogota, Medellin and Cali.

Empresas Municipales de Cali (EmCali)

Empresas Municipales de Cali (EmCali) was originally established in 1961 to provide utilities in Cali but split in June 2008 into three standalone companies responsible for electricity, telecoms and water. They were split to attempting to attract strategic partners to inject needed resources of USD845 million over the next ten years. EmCali is wholly owned by the state but is considering forming a strategic partnership with either Telmex or Telefonica as significant funds are required to expand its telecoms business.

EmCali offers a full portfolio of telephony services, including local and public telephony, Internet access and data services. In 2006, EmCali launched a triple-play voice, video and data package on a ZTE-built USD10.9 million IP/MPLS network and integrated services platform.

Telefonica Telecom

Telefonica Telecom has been offering broadband services since early 2005 with ADSL and at the end of 2005 had service in 37 cities across the country. In November 2005, Telefonica Telecom unveiled a new package bundling fixed line and broadband services, offering unlimited calling plans and broadband at speeds of 300kbit/s to 2Mbit/s. In July 2007 they launched a new broadband service to Bogota residents offering broadband speeds of up to 16Mbit/s as part of a triple-play package including unlimited local fixed line calls and satellite TV services for USD185 per month.

A.2.5 Dominican Republic

Converged services in the Dominican Republic appear to still be in its infancy but providers are committing resources towards upgrading infrastructure.

Triple Play

Triple Play, owned by Espinal Technology Group, began in October 2007 by revealing plans to launch triple-play services, including IPTV, in poor communities across the country. Delivered via WiMAX and supplemented by WiFi, converged services were introduced in the Restauracion municipality and there are plans to roll out services to 500 rural communities in 16 provinces without broadband Internet access.

Codetel

Codetel has currently invested USD4.57 million to upgrade its entire fiber infrastructure to a next-generation-network enabling data and video services in addition to increased capacity. There are plans to launch a converged triple-play voice, data and video services package but this has not begun. Codetel hopes to provide up to 190 channels in conjunction with existing voice and broadband Internet services over its fiber-to-the-home network covering parts of Santo Domingo and Santiago. A VoIP IP Centrex Service is offered with bundled broadband Internet packages, provided by Verlink Corporation, which was contracted to roll out VoIP services in 2006.

A.2.6 El Salvador

El Salvador is dominated by Telefonica and though converged services exist though are marketed separately.

Telefonica Multiservicios

Telefonica Multiservicios (TM), a subsidiary of Spanish incumbent Telefonica, offers triple-play Internet access, cable TV and telephony services nationwide. Formed in 2000, TM provides triple-play voice, video and data services over a single network, although the three services are marketed separately. TM is a joint venture between Telefonica Moviles El Salvador and Amnet, a US-based cableco.

Amnet provides cable TV under its own brand and also offers fixed line telephony on its network, while Telefonica offers fixed-wireless telephony using sister cell phone provider Telefonica Moviles' CDMA network. A cable-based triple-play is offered to residential and corporate subscribers under the Integra brand name with a cable backbone that stretches a total of 1,200 miles – 935 of which is hybrid fiber-coaxial and the remaining 265 being fiber-optic.

A.2.7 Jamaica

While Cable and Wireless Jamaica is the dominant service provider, intense competition from providers and a recent growth in converged services has weakened its subscriber base .

Flow

Flow is a triple-play provider of voice, Internet and television services. In August 2007, Flow paid USD412,000 for a national TV license and has since invested more than USD180 million to build out its fiber-optic cable system. Their talk packages include voicemail, call waiting, call forwarding, and also includes free “on net” calls that are bundled with television and broadband options. The premium package, Flow Absolute, offers 250 TV channels, unlimited voice minutes and a 15Mbit/s broadband connection for JMD6,900 per month.

Cable and Wireless Jamaica

Cable and Wireless Jamaica uses ADSL technology to provide Internet access over a telephone line for a double-play package. Started in 1987 as the Telecommunication of Jamaica and awarded a monopoly until March 2003, competition from fixed line alternative providers has almost halved its subscriber base from its March 2000 high of 513,000 subscribers. In November 2005, VoIP services were launched, addressing an area where ISP rivals had been stealing ground.

A.2.8 Mexico

Up until mid-2007, Mexican law prohibited cable TV providers from launching voice services over their own cable infrastructure, which hindered the growth of converged services, but providers have either been pursuing partnerships to skirt the rule and since the law has passed, numerous companies are investing in building and upgrading infrastructure to offer their own converged services.

In April 2006, Mexican regulators issued a “triple-play”, or “convergence” bill that allowed for the direct provision of voice telephony by cablecos. An amendment was added allowing wireline telcos to also enter the TV business in return, and the bill received the approval of the federal regulatory review body. The bill was passed in May 2007 after a federal court overturned a temporary suspension of triple-play convergence agreements.

Megacable

In June 2006, cable companies Megacable and Bestphone formed a partnership to offer TV, Internet and voice services. Due to delays in implementing the aforementioned triple-play regulations, several companies sidestepped restrictions by offering triple-play via cableco-telco joint venture initiatives, and Megacable was no different, striking agreements with telcos Maxcom and MCM Telecom to provide triple-play in certain regions.

Megacable is Mexico’s largest provider of cable broadband Internet services by subscribers and also offers local and long-distance telephony. They have more than 1.44 million CATV customers and 227,000 telephony customers, with approximately 600,000 subscribers taking more than one service. Megacable has invested more than USD20 million in building infrastructure and expected to sign more than 450,000 triple-play customers at the end of 2008.

Cablevision

Cablevision is Mexico City's largest cable network operator by subscribers, and has an all-digital network passing more than 1.62 million homes, 81% of which are broadband-capable. They had a resale agreement in 2006 with Bestphone to launch telephony, Internet and TV bundles in 2006 before receiving their own fixed line telephony license in May 2007.

One month later, Cablevision launched triple-play bundles, including VoIP, on its own cable infrastructure and has plans to invest between USD250-500 million in its triple-play offerings over a three year period beginning in 2007, and all signs indicate that they intend to honor that commitment.

Telmex

For the year 2008, Telmex earmarked USD1.1 billion, focused on launching triple-play bundles that included telephony, Internet and IPTV. As Telmex is arguably the largest provider of voice and internet services in Mexico, their plans for launching IPTV services have been hindered by regulators due to having substantial market power and could eventually see price controls before being beginning IPTV services. A partnership with satellite TV provider MVS Communications, which would provide TV services as part of a triple-play with Telmex's telephone and internet services, is currently being debated.

Others

Maxcom, forming a regional partnership with Cablenet, launched triple-play services in November 2007 and also added mobile services as part of a different triple-play offering with Telefonica's Telefónica Moviles.

Cablemas partnered with Axtel in 2007, receiving licenses to provide fixed telephony and thus allowing it to launch triple-play telephony, TV and Internet services over their own cable networks. Cablemas is one of Mexico's largest CATV operators and a growing force in the Internet access market.

A.2.9 Venezuela

Three providers dominate the telecoms market and each have only recently established converged services.

CANTV

CANTV is the dominant provider of local, domestic long-distance and international fixed telephony services. They ended 2007 with 754,600 broadband subscribers, up 61.5% from 2006. CANTV has been increasing performance speeds and lowering cost of their broadband connections to respond to threats posed by cable companies, and who are able to offer triple-play VoIP telephony, high speed access, and digital pay-TV service including video-on-demand.

CANTV has spent USD300 million to expand their networks, and has recently launched a commercial IPTV service at the end of 2008, giving users a choice of 100 channels, including VoD alongside voice and broadband services. In April 2008, CANTV received a concession for TV broadcasting allowing it to install and operate TV transmission systems of any type, fixed or wireless.

Intercable

Intercable is Venezuela's largest cable TV provider, offering pay-TV, Internet and local telephony, covering more than 70 cities and passing 1.2 million homes. At the end of 2007, Intercable claimed more than 450,000 TV subscribers, good for 28% of the market and second only to DirecTV. Significant expansion of their service coverage in 2007 allowed the launch of triple-play services under the Triple Hogar banner beginning in August 2008.

NetUno

NetUno is a cable TV network that covers roughly 70% of the country's population. They also offer residential broadband Internet and dial-up Internet access in all cities within its TV footprint with a maximum download speed of 1Mbit/s, up from 384kbit/s in 2007. Residential cable broadband Internet is offered over a hybrid fiber-coaxial network that covers over 500,000 homes and businesses.

A.2.10 Uruguay

BNamericas reported in February 2009 that the Uruguay government planned only to allow state-owned telecoms operator Antel and national pay-TV operators to allow triple-play packages. Cancelling the license for Mexico's Telmex to provide satellite TV services, the government is concerned that Telmex would use its satellite TV license to introduce services such as IPTV and fixed line telephony, creating further competition for state-owned telecom companies.

A.2.11 Countries where triple-play is currently unavailable

Triple-play offerings are currently not available in the Bahamas, Costa Rica, Cuba, Ecuador, Guatemala, Guyana, Haiti, Nicaragua, Paraguay, Belize and Bermuda.

Annex B: Transcripts of interviews with industry stakeholders

Below we summarize the response of the various stakeholders interviewed during the course of this project with respect to the process of convergence, and do not necessarily reflect Analysys Mason's views. These responses have been noted in direct form as they would be articulated by the stakeholders themselves.

B.1 Telefónica

Current network and service and future plans

Broadband – An important consideration is increasing broadband penetration over both fixed and mobile networks. The available speeds over current offerings are about the same as those available over the mobile network, and are aware of the need to respond to this issue by differentiating services more. Also, mobile broadband is seen as a complement to fixed. Telefónica has been studying all wireless access services – it sees WiMAX as a good opportunity to expand services in new areas. Mobile broadband is bigger than WiMAX.

Service tariffs and bundling – a response to increasing mobile penetration in order to create more loyal Telefónica customers. Regulated fixed and mobile tariffs restrict flexibility in marketing and the introduction of new services. For example, long-distance rates have both price floors and ceilings while competitors can and do price below the price floor.

Network status – The mobile and fixed networks continue to be operated separately, and while operational synergies are being investigated, there is no real practical effect yet. Digitalization of cable network is an important issue for them now. They view mobile as competition to them, not to Telefónica's network. So, they worry about competition and monitor what MNOs are doing. There is a big problem with theft of copper wiring. In general, when copper is stolen, connection is replaced using wireless not fiber.

NGN upgrades – offers IP Centrex (centralized PBX function) services to businesses which requires softswitches. NGN with VoIP has been implemented on a limited number of bases in a small portion of the network and it seems to be working well. No urgent desire to implement this service more widely in the near future. There are also no active plans to upgrade the PSTN generally to NGN using softswitches; the migration will be gradual and on a case-by-case basis. Mobile TV is being investigated and trialed.

Wholesale services – A single rural operator is the only operator currently using bitstream services to provide connectivity to the local community. Trying to restructure offer terms to encourage more use.

It appears that bitstream is often used to connect telecenters (where the traffic volume is very high as it accommodates several users). The bitstream offer was not designed for this type of usage. However, Telefónica noted difficulty in determining which lines were being used to service telecenters, and which were being used by individual customers. Telefónica was unsure as to whether a different bitstream service aimed at businesses would see any take-up given the likely higher prices. New contracts are more flexible to charge for volume or provide services to migrate to telecenter tariff, but existing contracts cannot be changed. More flexibility is required to be able to rescind a contract when bad usage occurs.

Telefónica also has a resale broadband service – called Speedy. Usage of local loops for voice with Telefónica is still required (i.e. no standalone DSL).

Infrastructure sharing – At the moment, Telefónica is not sharing any of its existing duct or wireline access infrastructure with other operators. Cable companies are using some of Telefonica's physical plant such as towers and poles.

Rural broadband – Telefónica requires more transmission facilities in underserved areas to provide broadband.

Roadblocks and remedies

Municipal barriers to site deployment – High taxes on use of sites/areas which service contract with government already gives then rights. In other areas, municipal barriers to big civil works continue to be a problem, and make expansion expensive over time. Should coordinate deployment. Reduce the cost of deployment. Government should facilitate access to land for operators, and this has not been a problem.

Rural services – Rural installations need security.

Service bundling – Prohibited from converged billing of multiple services. The different entities of Telefónica cannot do joint billing because of rules – must buy and resell services from each other. It is important for the user to receive only one bill.

General regulations – Regulation should be ex-post instead of ex-ante for new services. Markets with competition should be deregulated. Regulation should be uniform because the market should be more independent with respect to the network – technology neutrality. New policies should wait until a particular issue is identified that requires a particular policy.

Service regulations – Fixed voice should be deregulated because tariff flexibility is an issue. Clarification needed on VoIP rules to promote take-up – universal access, emergency service, numbering, etc.

Consumer protection –'User conditions' contract terms tied to traditional services definitions and need to be made more flexible. Quality of service should not be so strongly regulated – just measure and let users decide which service to take.

Infrastructure sharing – Private/public agreements are a good way to promote infrastructure, even with other operators in new areas. Infrastructure sharing should be used more extensively – for example, when new roads are built ducts should be used – one company could operate those ducts. Existing rules are not efficient because they only apply to new infrastructure (not existing public infrastructure) and big civil projects initiated by the government do not take good advantage of the infrastructure sharing principles mandated by law.

Other issues – Telefónica wants to be able to recuperate costs – now recover costs from voice, not data – so no requirement for standalone DSL. Need more investment in network deployment (which is what the country needs), which will be hindered by requirements to open up the incumbent's network. Policies should focus on expanding take-up and usage of government services using broadband (health care, education, etc.) and deal with other more general problems such as no electricity, PC take-up, etc.

B.2 América Móvil

Current network and service, and future plans

Spectrum and mobile services – 90% of network is GSM and 10% is 3G. Does not have any WiMAX spectrum. Competes vigorously with Telmex Peru, although both are owned by the same parent company. Its core network uses softswitches (3GPP R4 standards, which includes a media gateway and MSC-Server in the circuit-switched domain). Transmission is all based on TDM (SDH). It is using one carrier for HSDPA in some cities. It does not have enough spectrum for a second HSPA carrier, which will be required if usage of mobile broadband continues to increase. Also, it has interference in the 850MHz spectrum with Nextel's 800MHz services. As result, América Móvil are forced to reduce the advertising of its mobile broadband offer as the interference problems have an impact on the number of end users that can be efficiently supported.

Leased line and backhaul – América Móvil only deploys backhaul and switch connectivity in E1 units because no other form of leased line is available from Telefónica. No opportunities are currently available to migrate to IP Ethernet transport, which would represent major savings.

> The leased lines available are poor and of bad quality, and they are the most expensive lines in Latin America. In highlands their prices is USD10 000 for satellite links; E1 is USD5000–6000 for long distance. For comparison purposes, in Chile, an E1 for 1000km would cost USD500, whilst in Peru it would go up to USD3500. It prefers microwave, but in some cases it has no choice other than buying satellite.

Infrastructure sharing – Tried infrastructure sharing (even when known as TIM). Serious limitation to this, both from a technology point of view (GSM versus IDEN) because sites may not be useful, and Telefónica is not so open to sharing. Tried infrastructure sharing with BellSouth in

2002/3; subsequently it tried it with Telefónica but was not successful. Not used to waiting for coordination with other operators. Just want to go ahead and install equipment by themselves.

Roadblocks and remedies

Municipal barriers – it is not easy to obtain planning permission from local authorities; the process is lengthy and difficult. In some instances, it has been asked to remove some installed base stations. América Móvil wishes local government would make this process easier as it currently represents a major barrier. The company does not believe that infrastructure sharing would help alleviate these issues with the local authorities.

Spectrum – América Móvil has problems in the 850MHz band with interference with Nextel (similar to the USA) – the Ministry has not yet provided a solution.

Spectrum fees need to be revised. The Government struck a deal on spectrum with both América Móvil and Telefónica a few years ago. Instead of the usual regime of charging per customer for the spectrum (USD3 per user/year), América Móvil signed a five-year flat-fee agreement with some minimum expansion obligations. There is the concern that the deal is coming to an end and that the standard per user regime is going to be imposed again. The company believes that such policy is unfair as it penalizes increasing penetration, thus the company does not want to go back to per-user fees (it should be up to the company to manage its own spectrum, irrespective of the number of customers).

New standards and services – Mobile TV is a governmental decision on the standard chosen. Need this to take advantage of economies of scale. Otherwise no roadblocks.

Infrastructure sharing – Roadblocks include high prices, and time involved being too long. Even where it is theoretically possible to share, there are costing issues. Would not make sense also for Telefónica to ask for sharing to non-dominant – this does not seem right but seems to be under consideration. There are infrastructure sharing rules that were revised due to free trade agreement with the US but still don't expect much.

In greenfield deployments there is a major problem with getting electricity, which increases maintenance costs.

Other issues – In 2007, the government stated that no custom taxes would be charged on mobile telephones – important to extend this to other elements of the network to lower the cost of imports. Retail store was the one that drove elimination of custom duties. Still have duties on netbooks.

B.3 Nextel del Peru

Current offerings and future plans

General – Part of NII holdings, operating in many LA countries. Provide ESMR (enhanced special mobile services) service in all markets. In Peru these are considered same as other mobile services so no special license conditions. All strategic approaches and decisions come from US HQ. Noted that Peru is technology neutral which is positive.

IDEN network – Has 16.4MHz in the 800MHz band over which the company provides ESMR services. With iDEN it covers 80% of GDP covered in business corridors, which is radio and mobile system. Equates to about 285 000 users. Continue to provide spectrum with the iDEN technology for future years.

UMTS network – In 2007 participated in an auction and won a license to provide PCS service. Have 35MHz in the 1900MHz band. PCS will complement main business offerings buy targeting other segments such as university students (in particular by offering broadband using HSPA). Does not have overall corporate strategy for UMTS yet given that appropriate spectrum is only owned in Peru currently.

WiMAX network – have 50MHz of WiMAX spectrum in 3.5GHz (as part of broadband service provider company acquired), WiMAX service is offered using TDD as there is freedom to use spectrum as wished, and is collocated with iDEN service where possible.

Backhaul – In terms of backhaul, have carrier licenses with authorization for microwave links, and have own network (particularly in the North). Covers most of the areas in the North, but in order to extend its coverage to the south had to use Telefónica's network for redundancy. After the reduction in leased-line prices in 2007, this has not been a major issue for Nextel. As Nextel moves into 3G and begins to understand the costs of providing service, it may see that leased lines are a problem, but does not see that yet. Currently its network is based on E1. Does not need Ethernet transport yet. E1s have been the common way to deal – but recently leased dark fiber so this is possible.

Roadblocks and remedies

Municipal barriers – Dispersed municipal regulations on zoning, tower licensing, with more than 1800 local governments with different requirements and licensing fees. (Luis indicates at this point that there is a law to promote deployment and limit municipal interference). After implementation of law, the situation has gotten a bit better, but municipalities still disregard limitations. The law is fine if enforced. significant education would be required with local governments (to make them aware of the law and its implications) before the situation improves.

Infrastructure sharing – Collocating most of UMTS and WiMAX network with iDEN network; for new sites, facing problems with deployment, and also meeting license obligations. Site collocation among operators is not very common yet. This has started and would be open to it. Were deploying network in north of Peru, where other two operators in place and wanted to share electricity – operators quite open to do this at first but negotiations took so long, so did it themselves. This is why this is not common. Have had some positive experiences but very limited. Not so likely with third party infrastructure provider. There was some thought that American Towers would come into market to take sites from Telefónica.

Internet access – looking forward has not been an issue yet. Lima is only international access point so far. Could be better to have more POPs around the country.

Spectrum – Main issues is interference issues at 800MHz. Nextel has experienced interference but it is very focused and caused by pirates and Ministry has addressed this issue. Claro has complained about Nextel and filed a procedure in Ministry. Long procedure, including sanctions, and Ministry found that Nextel operating within limits, and new entrant (Claro) should be responsible for avoiding interference.

Classification of services – With convergence of fixed and mobile services will have to review interconnection charges, particularly mobile. Now is very service focused, so hard to converge. Ask follow up.

B.4 Americatel

Current offerings and future plans

Network – Use fiber optic up to base station for 6 BTS and microwave in 38Ghz.

Core network and connectivity – No leased lines from Telefónica. Relationship with Telefónica is not good, so prefer to use own network. International access from a number of providers – LAN Nautilus (TI) and Global Crossing and TWIS (Telefonica Wholesale International Service). Have five STM1's internationally. Seems to be at reasonable prices.

Access network – have partnered with Alvarion and have a Pre 802.16d WiMAX network in the 3.5GHz (with future expansion planned into 2.3GHz band) offering VoIP and Internet. However, Alvarion equipment is quite expensive and limited in features. As a consequence, are considering Huawei as alternative provide. Do not experience of transformation from 16d to 16e.

Voice services – Use VoIP for transporting voice on network and then convert to TDM for termination. Cannot currently do local bypass (using a local line) so need to interconnect to terminate on other networks such as Telefónica fixed network.

Devices – Not possible to offer full advanced data services (including TV) with current Alvarion equipment, but will plan to do so in future

Roadblocks and remedies

Municipal barriers – takes 3-4 months to install fixed wireless tower.

Spectrum – Have 50MHz in 3.5 GHz band and 54MHz in 2.3 GHz band (FDD) but need more spectrum to offer voice, video and data services.

Licensing – In order to offer new service must apply for authorization as opposed to simple notification.. Okay with current system for applying for numbers and spectrum, but simplification of licensing.

Interconnection – Currently defined only for voice. For data services there are no rules. For wholesale services no QoS qualifications are applied. There is net neutrality rule over bitstream but QoS is still bad.

Wholesale services – With bitstream access, there is not sufficient margin and no QoS provisions so actual quality is bad. Telefónica has a 30 day deadline to provide the input and uses this to do a form of win-back i.e. uses wholesale information for capturing retail customers.

Other issues – Have market in long distance calls but only for fixed. Ministry currently trying to extend call-by-call to mobiles to foster fixed-mobile convergence, which will help.

B.5 Telmex Peru

Current offerings and future plans

Wireline access network – Have HFC network to offer triple play (using broadcast) over DOCSIS 3.0.

Wireless access network – Offer fixed WiMAX services (broadband and voice) using 802.16d standard over Alvarion equipment. Also use 450 CDMA for fixed wireless voice services.

Core network, backhaul and leased lines – all self-provided for all networks. In some cases, use Claro and Telefonica backhaul for more rural areas. Have fiber backhaul along entire coast but not completely finished.

For international connectivity, have access to submarine cable capacity from Nautilus and Global Crossing and use own fiber to connect with Chile and Ecuador to form ring of terrestrial connectivity.

Use NAP Peru for domestic Internet exchange. Current NAP Peru rules state that all members must maintain same capacity connected to NAP and so must increase capacity simultaneously. Also has multilateral peering obligations. Setup has been working well.

Upgrades – Should not have to install new networks to offer new services but rather use existing networks. The main issue is to replace existing technology with IP-based while being required to keep current QoS requirements. High expectations for WiMAX (e) but still not ready. Also looking to obtain 2100 MHz to offer new services over new technologies.

Roadblocks and remedies

Municipal barriers – Difficult to upgrade network in Peru due to the municipal authorities. Problem extends to backhaul and towers as well as other physical siting issues. Telefónica has aerial backhaul, but Telmex required to do terrestrial deployment in ducts which is more expensive. So focusing now on HFC network. Accused Telefónica buying local governments to prevent Telmex deploying their networks on their territories. This represents a major barrier for them

Infrastructure sharing – Not working in Peru. Even working with Claro on towers, the process does not work quite right for Telmex.

Spectrum – In 2500MHz, will participate in planned auction in a few months, but there is not enough spectrum to really operate, particularly to offer video services.

Consumer protection issues – user conditions are too stringent to give them enough flexibility to provide their services. Some relaxation of the rules would benefit the overall provision of services.

B.6 Ministry of Transport and Communications (MTC)

Infrastructure sharing

There are laws and rules on this but the rules are not complete and there is a need to set up the rules and processes on a case-by-case basis in terms of cost of sharing, etc.

> Municipalities are acknowledges as a problem, but a difficult one to solve given enforcement issues. Starting to work on new law which will have a focus on defining and limiting the authority of municipalities to permit access but enforcement will still be key.
>
> Ministry is also responsible for roads and other big civil transport projects as well. These projects have a policy in place for making sure that ducts are put in place that can carry fiber which will be accessible to all operators. However it is still unclear who will put in investment for these ducts – could be FITEL, or the construction companies or some other third party.
>
> FITEL has provision for a number of small projects which use the electricity network to install fiber. FITEL will be the owner of these fiber installations on electric networks which reach small villages.

Classification and licensing of services

Under current framework, there are four categories of services (carrier, diffusion, value-added, final) that can be offered. Operators apply for a single concession license granted by the Ministry, but each service to offered must be registered. The general process is to apply for each service with a standard form, and then the ministry determines (usually in 3 days) whether to authorize the offering of the service (usually given although process allows Ministry to retain the right to refuse service authorization). Main reason for this framework is to address the problem of informality present in many regions around the country where service providers avoid legal obligations or laws by not notifying the authorities of services they provide.

The main problem is that it is not clear though for new services such as Mobile TV what this will be. Peruvian market is not mature enough yet for general authorization – idea is to introduce formality to prevent piracy or illegal operation. Next step is general authorization.

Other problem is how to deal with services that don’t fit current classifications.

Issue relating to 850Mhz interference?

Proceedings not yet complete. 1st judgment goes in favor of Nextel, but 2nd judgment not done yet. Solution still being sought which will determine a medium point between the operator’s positions.

Spectrum assignments – e.g. 2100mhz.

Want to get a new operator in 1900 band. 2100 MHz is currently reserved – not decided what the usage will be. Believe that operators have enough spectrum. They have not officially asked for more at this point. Can improve networks in same spectrum that they have – technology neutral licenses. There is a spectrum cap on mobile service of 60Mhz. Leads to more efficient use.

Priority now is to have a new operator in market. Don’t want to limit expansion of existing operators – will consider raising spectrum cap.

Have 2.5 GHz auction for WiMAX scheduled for end of April (either fixed or mobile). This is 24Mhz – operator can decide what to do – and will be TDD. There are coverage obligations (still pending) after which operators can offer other services. Licenses in the 3.5GHz band are allowed to offer mobile services, but have to apply for concession, and will likely have coverage obligations. This spectrum does not come under spectrum cap for mobile services.

Spectrum will be auctioned end April – now designing criteria for evaluating auction – monetary with coverage obligations.

Numbering issues

Numbers can be used nomadically – has not been done yet. Companies such as PeruSat are doing this informally at this point (offering VoIP over cable modem connections). All numbering can be identified by prefix (fixed and mobile). Studying ENUM procedures to see what modifications are necessary.

Signaling

Now requirements are for SS7 and TDM. Studying need for specifying protocols at IP level or whether to let the market address this.

Spectrum taxes

New scheme for MNOs to reach goals in mobile services – operators pay flat fee and in return deploy infrastructure in new places. Considering similar offer to fixed wireless access.

Annex C: Glossary of terms

2G	Second generation
3G	Third generation
3GPP	Third Generation Partnership Project
AAA	Authentication, authorization and accounting
ADSL	Asymmetric digital subscriber line
AI	Alternative interface
ANSI	American National Standards Institute
ARPU	Average revenue per user
ASN	Access service network
ATSC	Advanced Television Systems Committee
AuC	Authentication centre
BSC	Base station controller
BSS	Base station system
BTS	Base transceiver station
CDMA	Code division multiple access
CGI.Br	Brazilian Internet Steering Committee
CN-CS	Core network – circuit switched
CPE	Customer premises equipment
CPP	Calling party pays
CS	Circuit switched
CSCF	Call session control function
CSN	Core service network
DAB	Digital audio broadcasting
DIY	Do-It-Yourself
DOCSIS	Data over Cable Service Interface Specification
DSL	Digital subscriber line
DSLAM	Digital subscriber line access multiplexer
DVB-H	Digital video broadcasting – handheld
DVB-T	Digital video broadcasting – terrestrial
EDGE	Enhanced data rates for GSM evolution
EFM	Eight-to-Fourteen Modulation
EP2P	Ethernet point-to-point
EPC	Evolved packet core
EPON	Ethernet passive optical network
FCC	Federal Communications Commission
FDM	Frequency division multiplexing
FIFA	Fédération Internationale de Football Association
FITEL	Portal del Fondo de Inversión en Telecomunicaciones
FLAG	Fiber Link Around the Globe

FMC	Fixed–mobile convergent
FMS	Fixed–mobile substitution
FTA	Free to air
FTTC	Fiber to the curb
FTTH	Fiber to the home
FTTx	Fiber to the *x*
FWB	Fixed wireless broadband
GAN	Generic access network
GERAN	GSM EDGE radio access network
GGSN	Gateway GPRS support node
GigE	Gigabit Ethernet
GMSC	Gateway mobile switching center
GPON	Gigabit-capable passive optical network
GPRS	General packet radio service
GSM	Global system for mobile communications
HDTV	High definition digital television
HFC	Hybrid fiber coaxial
HLR	Home location register
HMNO	Home mobile network operator
HSDPA	High-speed downlink packet access
HSPA	High-speed packet access
HSS	Home subscriber server
HSUPA	High-speed uplink packet access
iDEN	Integrated digital enhanced network
IEEE	Institute of Electrical and Electronics Engineers
IGW	International gateway
IMS	IP multimedia system
IP	Internet Protocol
IPTV	Internet Protocol television
ISDB-T	Integrated services digital broadcasting
ITU-T	International Telecommunication Union
IXP	Internet exchange point
KPI	Key performance indicator
LACNIC	Latin American and Caribbean Internet Addresses Registry
LLU	Local loop unbundling
LOS	Line of sight
LTE	Long Term Evolution
LV	Low voltage
M2M	Machine to machine
METRO Act	Metropolitan Extension Telecommunications Rights-of-Way Oversight Act
MGCF	Media gateway controller function
MIMO	Multiple input multiple output
MNC	Mobile network code

MNO	Mobile network operator
MOA	MNO Association
MPLS	Multiprotocol label switching
MPP	Mobile party pays
MSAN	Multiservice access node
MSC	Mobile switching centre
MTC	Ministry of Transport and Communications
MV	Medium voltage
MVNO	Mobile virtual network operator
NAP	Network access points
NGA	Next-generation access
NGN	Next-generation network
NTIA	National Telecommunications and Information Administration
OLT	Optical line termination
ONU	Optical network units
PDA	Personal digital assistant
PDSN	Packet data serving node
PON	Passive optical network
PS	Packet switched
PSDN	Packet switched data network
PSTN	Public switched telephone network
PTTMetro	Ponto de Troca de Tráfego Metro project
PVR	Personal video recorders
PWE	Pseudo wire edge
QoS	Quality of service
RfoG	Radio Frequency over Glass
RIO	Reference interconnection offers
RNC	Radio network controller
RNC	Radio network controller
RO	Reference offer
RUO	Reference unbundled offer
SDTV	Standard definition digital television
SDV	Switched digital video
SGSN	Serving GPRS support node
SIP	Session Initiation Protocol
SMP	Significant market power
SSNIP	Significant non-transitory increase in price
STB	Set top box
STP	Shielded twisted pair
TDM	Time division multiplexing
TDMA	Time division multiple access
TI	Traditional interface
UAS	Universal access and service

UEFA	Union of European Football Associations
UMA	Unlicensed mobile access
UMTS	Universal mobile telecommunications system
UTRAN	UMTS radio access network
VAS	Value added services
VDSL	Very high bit-rate digital subscriber line
VLR	Visitor location register
VoD	Video on demand
VPN	Virtual private network
W-CDMA	Wideband code division multiple access
WES	Wholesale extension service
WiMAX	Worldwide interoperability for microwave access
WLR	Wholesale line rental