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Convergence and Next Generation Networks

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FOREWORD

This paper has been prepared as background for the OECD Ministers' meeting on *The Future of the Internet* Economy (17-18 June 2008, Seoul, Korea). The paper was discussed by the Working Party on Communication Infrastructures and Services Policy in 2007. The Committee on Information, Computer and Communications Policy agreed to declassify the paper in March 2008. The paper is published under the responsibility of the Secretary-General of the OECD.

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CONVERGENCE AND NEXT GENERATION NETWORKS

MAIN POINTS

This paper has been prepared as a background document for the ICCP-organised Ministerial meeting on *The Future of the Internet Economy*.

The communications sector is undergoing significant changes, with the emergence of a number of platforms available to provide a different range of services. Some of these platforms are complementary, others are competitive, or can provide a valid substitute for some of the services provided. Up to now, the most important communications platform in OECD countries has been the public switched telecommunication network (PSTN) which provides access to all households and buildings across most countries. This universality in providing access has also meant that the network has generally been designated as the one for universal service.

This paper focuses on the area where the most significant changes are taking place in the communications sector, rather than providing an overview of all communication platforms, nor is it aimed to assess the relative extent to which different platforms complement or compete with each other. As such, this paper is limited to examining developments in what is commonly referred to as next generation access networks and next generation core networks and their role in convergence. The focus on next generation access and core networks is because they are changing the public switched telecommunication networks (PSTN).

The changes taking place in the PSTN are considerable. For over 100 years copper has been used as the transmission technology in the local loop to connect each home and building to the telecommunication network. Copper is increasingly being replaced by fibre in the local loop while packet-based technology using the Internet Protocol is replacing existing circuit-based switching technologies. These changes require policy makers to review and reassess existing regulations and policy frameworks and ensure that legacy frameworks do not hamper convergence, investment and choice in the market place. New technologies and services can bring significant benefits to end users but care must be exercised to maintain effective competition in telecommunication markets and to prevent the exertion of market power, which would reduce the benefits.

The paper examines developments in a number of areas where policy and regulatory change may be necessary:

- It is expected that significant investment will take place in bringing fibre closer to users as telecommunication operators upgrade the local loop. This will have important benefits in increasing speeds and allowing for the development and transmission of new services. There are concerns, however, that the new fibre networks deployed by incumbent telephone companies may create a challenge to maintain effective competition in markets. Regulators need to examine the options that they can use to ensure competition. This could take place *inter alia* either through access to facilities, access to passive facilities, or through policies promoting inter-modal competition.

- The rollout of fibre networks has increased the importance of rights of way and access to ducts and poles for new entrants. As a large part of the cost of deploying fibre networks is in civil works, appropriate policies should be in place to ensure fair and non-discriminatory access to ducts, poles and rights of way for market players. Policy makers also need to examine how to ensure better access by new entrants to existing resources to promote facilities-based competition.
- The convergence of video, voice and data on next generation networks can lead to more competition in individual markets for each of these services. In addition, increasing competitive pressure on mobile carriers is coming from the IP world. On the other hand, the trend towards horizontal integration of infrastructures, market and services could lead to strengthening of market power as there may be relatively few companies that can package voice, video and data services in a single bundled offer to end users.
- The migration towards Next Generation Networks (NGN) changes the network topology which potentially involves several structural changes, such as a reorganisation of core network nodes and changes in the number of network hierarchy levels. The shift to IP networks also raises questions of whether interconnection frameworks need to be revised, such as a shift to use interconnect frameworks which have been successful in developing Internet markets.
- The roll-out of higher capacity networks, such as through fibre in the local loop, could create asymmetries in access between urban and rural and remote areas. Questions arise as to whether alternative technologies may be used to provide high speed access to rural and remote areas. In addition, the question of whether new network developments should be reflected in universal service obligations also needs reviewing.
- The range of technologies making demands on spectrum, such as HDTV, mobile TV or 3G services, is growing rapidly. This raises the question of the need to change current spectrum allocation and management and to flexibly reassign unused and underused spectrum to users who will use it most efficiently.

1. Introduction

Communication networks have become a key economic and social infrastructure in OECD economies. The network infrastructure supports all economic sectors, is crucial to the national and international exchange of goods and services, and acts as a main catalyst in changing economic interrelationships through rapid technological change and the proliferation of a range of new services. With the development of the Internet the role of communication networks has evolved and their importance increased. The advent of higher access speeds, in many cases symmetric speeds, available to business and to residential subscribers, has also increased the role of communication infrastructures by expanding the available range of services. High speed networks are increasingly helping resolve ongoing societal concerns in areas such as the environment, health care and education, and are increasingly playing a role in social networking. However, for the potential of new network technologies to be realised, the market will require that these networks have universal, or close to universal coverage. The full potential of networks is only likely to be achieved where markets are effectively competitive and solutions have been implemented which ensure adequate coverage to most geographic areas.

The telecommunication market in the OECD area has surpassed USD 1 trillion in revenues and is growing in real terms of around 3% per year resulting in a growing share of telecommunications in GDP presently at 3%, despite the rapidly falling prices that have characterised the sector. The fastest growing item in household consumption is also communication goods and services. Investment in the OECD telecommunication sector has increased in recent years by 24% (from USD 129 billion in 2003 to USD 160 billion in 2005) driven to a large extent by the high demand for broadband data access. Broadband subscriptions across the OECD have increased by 60% per annum over the last 5 years with more than 218 million broadband subscribers in the OECD by mid-2007, up from less than 15 million at the end of 2000. The OECD broadband penetration rate has reached 19 broadband subscribers per 100 inhabitants, much less than the 43 telecommunication channels per 100 inhabitants or the 80 mobile subscribers per 100 inhabitants, but examination of data on penetration rates of different communication technologies indicates that broadband is one of the ICT technologies with the fastest growth in penetration rates.

Technological innovation, stimulated through digitalisation, has been a major factor in driving change in the communications market. This innovation is reducing costs and enhancing the capability of networks to support new services and applications. A key innovation which is expected to bring further significant changes in the communications market is the transformation from circuit-based public switched telecommunication networks to packet-based networks using the Internet Protocol, so-called next generation networks (NGN). NGN is expected to completely reshape the present structure of communication systems and access to the Internet. The present structure of vertically independent, although interconnected, networks may be transformed into a horizontal structure of networks based on Internet Protocol. Investment requirements for NGN are high and, as for any investment, there are risks. Policies need to ensure that risks and uncertain returns are compensated while ensuring competition since, without competition, the benefits of high speed broadband and NGN will not be realised.

The developments in new communication structures and the impetus they are expected to give to the present process of convergence in networks, services and terminals are expected to lead also to new policy challenges. In particular, convergence and the development of the NGN may require a review of a number of elements of the present structure of economic regulation of communication markets, in order to ensure that regulation allows the potential benefits of these technologies to rapidly diffuse in economies and societies. Convergence, by changing service boundaries, service characteristics and stimulating the offer of new services, may require that new markets are regulated differently than existing ones. It remains to be seen to what extent the deployment of NGN and convergence will facilitate the process of creating durable competitive conditions in communication markets or will raise further obstacles to the creation of competition. It is fairly evident, however, that changes taking place as a result of investment in next generation access and core networks and the convergence of technologies, services and markets will require reviews and rethinking of existing policy and regulatory frameworks.

2. Convergence and NGN

Convergence in network technologies, services and in terminal equipment is at the basis of change in innovative offers and new business models in the communications sector (see Box 1). The utilisation of the term “convergence” represents the shift from the traditional “vertical silos” architecture, *i.e.* a situation in which different services were provided through separate networks (mobile, fixed, CATV, IP), to a situation in which communication services will be accessed and used seamlessly across different networks and provided over multiple platforms, in an interactive way. Already in the 1990s, the possible impact of digitalisation and convergence between telecommunications and broadcasting was under examination and proposals made for changes in existing regulation. The growing role of the Internet in the economy and society has enhanced the process of convergence and its rate of change.

Box 1. What is convergence?

The path towards convergence was led mainly by the increasing digitalisation of content, the shift towards IP-based networks, the diffusion of high-speed broadband access, and the availability of multi-media communication and computing devices. Convergence is taking place at different levels:

Network convergence – driven by the shift towards IP-based broadband networks. It includes fixed-mobile convergence and ‘three-screen convergence’ (mobile, TV and computer).

Service convergence – stemming from network convergence and innovative handsets, which allows the access to web-based applications, and the provision of traditional and new value-added services from a multiplicity of devices.

Industry/market convergence – brings together in the same field industries such as information technology, telecommunication, and media, formerly operating in separate markets.

Legislative, institutional and regulatory convergence – or at least co-operation – taking place between broadcasting and telecommunication regulation. Policy makers are considering converged regulation to address content or services independently from the networks over which they are provided (technology neutral regulation).

Device convergence – most devices include today a microprocessor, a screen, storage, input device and some kind of network connection – increasingly they provide multiple communication functions and applications.

Converged user experience: unique interface between end-users and telecommunications, new media, and computer technologies.

The process towards convergence has been based on an evolution of technologies and business models, rather than a revolution. This process has led to:

- Entry of new players into the market.
- Increasing competition among players operating in different markets.
- The necessity for traditional operators to co-operate with companies previously in other fields.

As a result, convergence touches not only the telecommunication sector, but involves a wider range of activities at different levels, including the manufacturer of terminal equipment, software developers, media content providers, ISPs, etc.

Previously distinct communication networks and services are today converging onto one network, thanks to the digitalisation of content, the emergence of IP, and the adoption of high-speed broadband. Traditional services such as voice and video are increasingly delivered over IP networks and the development of new platforms is facilitating the provision of converged services (Table 1). These converged services are appearing in markets as "triple" or "quadruple" play offers which provide data, television, fixed and mobile voice services.

The process of convergence has also been facilitated by the opening up of telecommunication markets to competition. Although large telecommunication operators have played a role in the process of convergence, new market players have moved rapidly, and often in an unpredictable way, adopting different market models from traditional telecommunication firms. Voice over IP is a clear example of such services, disrupting traditional markets, pushing towards adoption of next generation networks and facilitating convergence. Internet service providers started offering VoIP as a cheaper way to communicate over the Internet. Services were offered on a "best-effort" basis by third parties, over any Internet connection. Today the market for VoIP services is varied, with network access operators providing VoIP as a replacement for PSTN voice telephony, often guaranteeing access to emergency services, or a certain QoS. Internet service providers continue to offer access to VoIP services from multiple platforms and from anywhere in the world. Mobile VoIP is also emerging, both as a service provided by the network operator or as an application that can be downloaded on any Wi-Fi enabled handset. Initiatives, such as Google's '*Android*', are likely to put pressure on existing mobile operators to charge flat rates for mobile Internet access, thus eventually increasing the degree of substitutability between mobile and fixed Internet access (in terms of price rather than speed).[1]

On the content side increasing competition is taking place between network access operators, including wireless, cable or satellites, all offering video, music, or other content to their users. A growing number of operators are also focusing on mobile content, in particular on the possibility to download music, or access applications and online services from a mobile device. The possibility to provide video content over IP is often seen as a new way to propose content to users, and as an opportunity for network operators to enlarge the range of services they offer to their customers. Content services, especially those over managed IP networks, have still not exploited their full potential. In most cases, access to content is offered in a form very similar to traditional broadcasting, with defined timetables, geographical distribution, rigid copyright schemes, a very low degree of interactivity, and a traditional billing scheme although a number of operators are now beginning to offer more flexible programming with video on demand and distribution of video content from popular Internet sites. Changes are often taking place as a result of an increasing number of users creating and exchanging their own content on a multiplicity of devices, which imply a shift away from simple passive consumption of broadcasting and other mass distribution models towards more active choosing, interacting, the creation of content, and the emergence of a participatory culture.[2] These developments also increase the need to communicate, and the demand for symmetric communications.

With the growing offers from access platforms, and the different types of video services and applications available – digital terrestrial, IPTV, HDTV, Video on Demand, but also disruptive applications such as Joost[3] or Sling box[4] – the concept of "social value" of terrestrial broadcasting may become weaker, while the impact of these new services remains to be assessed.

Table 1. An IP-based converged environment

Telecommunication environment	Next generation converged environment
Single purpose networks	Multi-purpose networks
PSTN, cellular, broadcast	IP network (providing voice, video and mobile services)
Narrowband	Broadband
Vertical silos	Destroys compartmentalisation Traditional boundaries between industry segments (*e.g.*, telephony, cable TV, broadcasting, wireless) are blurring – Need to re-think market definitions (product definition and geographic boundaries definition)
Network-service link	New services and content developed independently of the network
Operators control services to end users	Increased consumer control

Although the extent and effects of such convergence are yet to be seen, the phenomenon is already challenging the existing remit of many sector–specific domestic regulations. For example, the impact of convergence on competition is likely to be mixed. On the positive side, the move towards next generation networks, able to deliver a wide range of communication services, creates a schism in many traditional market definitions. While in the past telecommunication companies only offered fixed-line voice, and policy makers could easily define the specific market and make regulatory decisions, today the convergence of video, voice and data on next generation broadband networks can lead to more competition in individual markets for each of these services. As a result, convergence touches the telecommunication, cable television and broadcasting sectors, and involves a wider range of activities at different levels, going from manufacturers of terminal equipment, software developers, media content providers, ISPs, etc.

On the other hand, the trend towards horizontal integration of markets and services could lead to strengthening of market power, as there may be relatively few companies in a country that can provide a combined video, voice and data offering. This may lead to a reduction in competition for the communications sector as a whole. In addition, bundling of services may make it more difficult to determine the extent to which prices are cost-oriented, allowing cross-subsidisation between services. Service convergence and the shift towards next generation networks could therefore contribute to the creation of additional bottlenecks and control points, which may need to be addressed by the regulator (see Box 2). On the network infrastructure side investment in fibre local loops may also create new bottleneck positions in the market.

Box 2. Bundled services

Bundling refers to the sale of a number of services combined in a single price package, usually excluding the possibility that customers can obtain a single service without taking or paying for the other services in the bundle.

Bundling of services can help generate economies for the supplier through, for example, reduction in service marketing charges, customer acquisition costs, billing charges, etc. For the client bundling often has the advantage in that prices are lower compared to having to subscribe to each service individually, however customers may not want all the services offered in a bundle. A client who does not want IPTV services may be obliged to pay for these services when subscribing to certain triple play bundles.

At the same time a bundle, while nominally offering a better price than purchasing the same services separately, is also difficult to assess when trying to compare prices across a range of different offers. A service provider may also use a service in the bundle to cross-subsidise other services using this to obtain an unfair market advantage. Bundling may also make it difficult for regulators to define markets, assess market power, and therefore understand whether or not dominance exists in a given market.

In this context, next generation networks (NGN) provide the technical underpinning of convergence, representing a single transport platform on which the carriage of previously distinct service types (video, voice, and data) "converges", together with new and emerging services and applications. While different services converge at the level of digital transmission, the separation of distinct network "layers" (transport, control, service and applications functions – see Figure 1) provides support for competition and innovation at each horizontal level in the NGN structure. At the same time NGNs also create strong commercial incentives for network operators to bundle, and therefore increase vertical and horizontal integration, leveraging their market power across these layers. This may bring about the need for closer regulatory and policy monitoring, in order to prevent the restriction of potential development of competition and innovation in a next generation environment, and therefore the risk of reducing benefits for consumers and the potential of new networks for economic growth.

What is NGN?

Although there is a significant amount of work underway in standardisation forums on NGN, at the policy level, there is a still not complete agreement on a specific definition of "NGNs".The term is generally used to depict the shift to higher network speeds using broadband, the migration from the PSTN to an IP-network, and a greater integration of services on a single network, and often is representative of a vision and a market concept. From a more technical point of view, NGN is defined by the International

Telecommunication Union (ITU) as a "*packet based network able to provide services including telecommunication services and able to make use of multiple broadband, QoS-enabled transport technologies and in which service related functions are independent from underlying transport-related technologies*." NGN offers access by users to different service providers, and supports "*generalized mobility which will allow consistent and ubiquitous provision of services to users.*"[5]

NGN, also defined as "broadband managed IP networks", includes next generation "*core*" networks, which evolve towards a converged IP infrastructure capable of carrying a multitude of services, such as voice, video and data services, and next generation "*access*" networks, *i.e.* the development of high-speed local loop networks that will guarantee the delivery of innovative services.

Next generation access networks

The definition of next generation *access* networks is usually specific to investment in fibre in the local loop, *i.e.* fibre replacing copper local loops, able to deliver next generation access services – *i.e.* an array of innovative services, including those requiring high bandwidth (voice, high-speed data, TV and video). In general, this is the definition used in a number of national initiatives by OECD countries in examining NGN. However, while next generation access networks tend to refer to a specific technological deployment, there are other technologies which can compete in providing some of the services which it is envisaged will be provided by NGNs. There are also other technologies which may not be able to fully compete with NGN access networks in terms of capacity and the plethora of bundled offers which NGNs can provide, but may be perfectly suitable for users who do not have the need for high capacity access. The different technologies available include existing copper networks upgraded to DSL, coaxial cable networks, powerline communications, high speed wireless networks, or hybrid deployments of these technologies. Although fibre, in particular point-to-point fibre development, is often described as the most "future proof" of network technologies to deliver next generation access,[6] there are likely to be a number of alternative and complementary options for deployment of access infrastructures by incumbent telecommunications operators, and new entrants.

Cable

Cable television (CATV) operators have begun to upgrade their infrastructure to hybrid fibre copper (HFC) allowing for bidirectional traffic and using Docsis[7] technology to increase network capacity. These developments are allowing CATV companies to offer voice and Internet access (data services) in competition with telecommunication companies which through their offer of Internet TV have begun to compete with CATV companies. Offering data and voice services, in addition to television, helps cable companies differentiate their product offering from satellite providers.

The bandwidth provided by cable networks, using Docsis 3.0, will allow for 160 Mbit/s downstream and 120 Mbit/s upstream for end-users. This, however, will have to be shared by end-users. Typically there are 500-1 000 subscribers on a single local distribution point,[8] which can be brought down to about 250 on average, thanks to the application of the DocSis standard.[9] This new technology is only just entering the market, with services based on this standard becoming available at the end of 2008.

Broadband Wireless Access (BWA)

BWA technologies aim at providing high speed wireless access over a wide area. Certain early fixed-wireless access technologies, such as Local Multipoint Distribution Service (LMDS) and Multichannel Multipoint Distribution Service (MMDS), never gained widespread market adoption. WiMAX technologies, – the IEEE 802.16 set of standards that are the foundation of WiMAX certification, and similar wireless broadband technologies, are expected to address some of these shortcomings, and fill market gaps left by wired networks, or compete with wired access providers.

The WiMAX Forum has estimated that new WiMAX equipment will be capable of sending high-speed data over long distances (a theoretical 40 Mbit/s over 3 to 10 kilometres, in a line-of-sight fixed environment). When users are connected at the same time, capacity sharing will significantly reduce speeds for individual users sharing the same capacity.[10]

Wi-Fi (or wireless fidelity) refers to wireless local area networks that use one of several standards in the 802.11 family. Wi-Fi allows LANs to be deployed without cabling for client devices, typically reducing the costs of network deployment and expansion. Due to its affordability, scalability and versatility, its popularity has spread to rural and urban area. Wi-Fi range is usually limited to about 45 m indoor and 90 m outdoors, however Wi-Fi technologies can also be configured into point-to-point and point-to-multipoint networks in order to improve their range and provide last mile fixed wireless broadband access. One way to serve remote areas which cannot be reached with the above-mentioned technologies, is with wireless “mesh” solutions. They often include a satellite backhaul connection through Very Small Aperture Terminals, usually coupled with wireless technologies such as Wi-Fi. This combination allows access to telecommunication and data services even to more remote areas, albeit with limited (and expensive) bandwidth.[11]

Terrestrial wireless services offer the opportunity to deploy competing access infrastructure. However, they may offer different service characteristics to fixed-line services in terms of coverage, symmetry and speeds. These networks may be less suitable to deliver sustained high bandwidth connections for larger numbers of users, or for high bandwidth applications, such as High Definition TV on demand. In addition, wireless service deployments are constrained by spectrum availability. At the same time, the economics of their deployment is often relatively scalable, which means that they have lower economic barriers to entry compared to fibre deployments.[12] Therefore while not a complete substitute, they can complement wireline networks and be an alternative provider in certain areas or for specific services.[13]

Broadband over Power Lines (BPL)

Use of the power grid as a communications network, or “power-line communications” appears to provide a series of advantages, offering not only voice, but also broadband services, with the connection speed not dependent on distance from the telephone exchange (as happens with DSL) or number of customers connected (as with cable). With this system a computer (or any other device) would need only to plug a BPL "modem" into any outlet in an equipped building to have high-speed Internet access. Notwithstanding the benefits that the availability of an extensive infrastructure can allow, for the moment the service provision is far from standardised[14], and the capacity of bandwidth provided through BPL is still being questioned.

3G mobile networks

The term next generation networks frequently encompasses some kind of fixed-mobile convergence (FMC),[15] as it allows the transition from separate network infrastructures into a unified network for electronic communications based on IP, which facilitate affordable multiple play business models, seamlessly integrating voice, data and video. The introduction of 3G technology supports the transmission of high-speed data with speeds theoretically reaching 2/4 Mbit/s, and third-generation handsets give users access to the Internet and multimedia content on the go. In addition, new handsets in countries such as Japan, Korea, Italy or the United States allow users to access innovative, dedicated terrestrial and in some cases satellite television networks. Operators are expanding their 3G networks across the OECD and this will provide higher data speeds to users, who will be able to access innovative networks dedicated to providing mobile video or television programming. In 2005, 11% of all OECD mobile subscribers were on a 3G network, which offered a broader "blanket" data coverage to users. However, existing 3G technologies will need to be upgraded in order to support very high bandwidth or extensive concurrent usage that may be demanded by users in the future. The future evolution of mobile networks for example using LTE technology (Long Term Evolution) – a next generation mobile technology – may significantly increase speeds, enabling high peak data rates of 100Mbit/s downlink and 50Mbit/s uplink. However, deployment of this technology may not begin, at the earliest, before 2010.[16]

Satellite

Satellite services are typically dedicated to direct-to-home television and video services, satellite radio, and specialised mobile telephony uses. More recently technological advances – such as spot beam technology and data compression algorithms – increased technical efficiency in satellite communications, enabling more efficient use of spectrum, and reducing redundancy, thus increasing effective data density and reducing required transmission bandwidth.[17] Satellite broadband is usually provided to the customer via geosynchronous satellite. Ground-based infrastructure includes remote equipment consisting of a small antenna and an indoor unit. Gateways connect the satellite network to the terrestrial network. Except for gateway locations, satellite broadband is independent of terrestrial infrastructure such as conduits and towers, allowing it to provide coverage also to remote areas.

In this context, several operators began to offer broadband satellite service to residential consumers, especially to those in areas not otherwise reached by broadband networks, at affordable prices, and at speeds comparable to those offered by some wired broadband services. For example, Wildblue in the United States offers broadband connectivity (512Kbps downstream and 128Kbps upstream) for about USD 50/month. In Europe, Eutelsat and Viasat jointly launched consumer broadband satellite service, targeting underserved markets in European countries.

While technological developments allowed satellite services to offer significantly higher capacity and improved performance, there are still some challenges to users of satellite connectivity. In particular, limited upstream capacity will restrain the possibility of users to benefit from new Web 2.0 opportunities, while latency issues will continue to limit the usability of satellite for certain broadband services and applications (*e.g.* voice and video conferencing) and speeds are expected to be significantly lower than can be offered by fibre networks.

Competing or complementary networks?

In defining what constitutes next generation access in advance of the emergence of new applications and services that utilise the new infrastructure, most regulators prefer to adopt a more general definition, using a combination of minimum bandwidth and service characteristics, such as symmetry or quality of service, which will enable enable to support of services that cannot be delivered by existing broadband technologies to the majority of customers.

For example, OFCOM in a report on next generation access networks, defines NGA as broadband "*capable of delivering sustained bandwidths significantly in excess of those currently widely available using existing local access infrastructures or technologies*", but OFCOM also recognises that while there are several possible network technologies able to offer higher bandwidth, the extent to which other networks are able to compete with wireline networks is not clear. As noted earlier, the different characteristics of wireless and wireline technologies may make these networks suitable for the provision of services in areas with different densities of users.[18] A study by the European Regulatory Group (ERG) focusing specifically on fibre, affirms that the roll-out of enhanced access networks is considered fundamental to a number of operators as they intend to deliver very high bandwidth services to their subscribers, and considers that all the suitable technologies for enhanced access networks – available or foreseen for the short-medium term – comprise some deployment of optical fibre.[19]

Next generation core networks

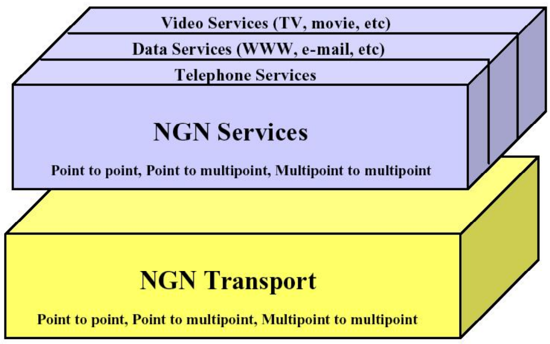
The next generation *core* networks are defined on the basis of their underlying technological "components" that include – as mentioned in the ITU definition – packet-based networks, with the service layer separated by the transport layer, which transforms them into a platform of converged infrastructure for a range of previously distinct networks and related services. These features may have an impact on traditional business models and market structure, as well as on regulation:

- *IP-based network*: "Next generation core networks" generally cover the migration from multiple legacy core networks to IP-based networks for the provision of all services. This means that all information is transmitted via packets. Packets can take different routes to the same destination, and therefore do not require the establishment of an end-to-end dedicated path as is the case for PSTN-based communications.

- *Packet-based, multi-purpose*: While traditionally separate networks are used to provide voice, data and video applications, each requiring separate access devices, with NGN different kinds of applications can be transformed into packets, labelled accordingly and delivered simultaneously over a number of different transport technologies, allowing a shift from single-purpose networks (one network, one service), to multi-purpose networks (one network, many services). Inter-working between the NGN and existing networks such as PSTN, ISDN, cable, and mobile networks can be provided by means of media gateways.

- *Separation of transport and service layer*: This constitutes the key common factor between NGN and convergence, bringing about the radical change in relationship between network "layers" (transport infrastructure, transport services and control, content services and applications). In next generation networks service-related functions are independent from underlying transport-related technologies (Figure 1). The uncoupling of applications and networks allow applications to be defined directly at the service level and provided seamlessly over different platforms, allowing for market entry by multiple service providers on a non-discriminatory basis.

Figure 1. Separation of functional planes



Source: Keith Knightson, Industry Canada, ITU NGN Architecture, presentation at the "ITU-IETF Workshop on NGN", May 2005, Geneva.

These features may foster the development and provision of new services and constitute a new opportunity for innovation, allowing different market players to create value at the separate functional levels of access, transport, control and services.

However, while initially it was a common assumption that this layered structure would lead to a market model where services could be increasingly provided across the value chain, in a more decentralised manner, today it appears that the network provider will decide whether the "horizontal" model will prevail, or whether they will simply (commercially) vertically integrate transport and services across functional levels, offering bundled services.[20]

Currently, bundling of a variety of services is a key trend in the sector, bringing greater competition between formerly distinct sectors. Bundles include all sorts of combinations of fixed and mobile voice calls, Internet access and media/entertainment services (see section 4 below on broadcasting). With services and transport commercially integrated at the vertical level, customers are somehow "locked-in" in a vertical relationship with a single operator. This is not negative in itself, as packages are often more convenient, or easier to use, at the same time it is important to maintain the possibility for users to choose which services they want to purchase, and to have clear information about the cost and characteristics of these. The risk would be to create a situation in which the network provider may limit the possibility of users to access IP-based services and applications provided by third parties.

Considering the economic drivers behind the shift towards next generation networks, there is an incentive for the network provider to also become an integrated market player, in order to maintain/extend their user base or benefit from a privileged relationship with subscribers. This raises questions regarding obligations for access to networks by service providers and issues of traffic prioritisation.[21] In this context access plays an important role for all service providers to be able to provide their content, services and applications to end users.

One essential feature of next generation networks is the capability to support "*generalised mobility which will allow consistent and ubiquitous provision of services to users*".[22] Although core next generation networks tend to be on a fixed infrastructure, the possibility to improve interconnection with mobile networks is being explored, and standardisation organisations as well as operator and manufacturers associations are working to the development of appropriate standards. In addition, the deployment of wireless infrastructures facilitates access to IP networks, and the adoption of increasingly sophisticated devices and handsets will allow an easy access to IP services from anywhere.

The migration process towards IP-NGN potentially entails several structural changes in the core network topology, such as the rearrangement of core network nodes and changes in the number of network hierarchy levels. As a result, an overall reduction in the number of points of interconnection will take place, especially with regard to interconnection points at the lowest level. This could negatively affect alternative operators whose previous interconnection investment may become stranded.[23] For example, BT today has some 1 200 exchanges at which competitors have installed DSLAM's, using local loop unbundling to provide broadband and bundled services. In addition, BT has over 700 exchanges at which competitors can connect their voice services. The number and location of points at which competitors could connect their networks to BT's voice services is expected to reduce substantially to at most 108 Metro-node sites, and probably to a subset of these which could number as few as 29, while the number and location of exchanges at which local loop unbundling is likely to be possible are not expected to be affected by the roll-out of 21CN.[24]

NGN drivers and impact

NGN is an evolutionary process and it can be expected that operators will take different migratory paths, switching to NGN while gradually phasing out existing circuit networks, or building a fully-IP enabled network from the outset.[25] The investment in developing NGN is motivated by several factors (Table 2). Telecommunication operators across the OECD have been faced with a decline in the number of fixed-line telephone subscribers, coupled with a decrease in average revenue per user (ARPU), as a result of competition from mobile and broadband services.[26] Traditional sources of revenue (voice communications) have declined rapidly and fixed-lines operators are subject to an increase in competitive pressure in the market to lower tariffs and offer innovative services. This has generated pressure from the investors' community to decrease the cost and complexity of managing multiple legacy networks, by disinvesting from non-core assets and reducing operational and capital expenses.

Table 2. NGN drivers[27]

Economic Drivers	Technological Drivers	Social Drivers
• Erosion of fixed line voice call revenues. • Competitive pressure from new entrants in high-margin sectors of the market (long-distance, international) and from vertically integrated operators (triple-play bundles). • Saturation of both Fixed and Mobile telephone services • Retain and expand users' base , lower customer churn • Ability to expand into new market segments • Possibility of "ladder of investment", i.e. a phased approach for investment, initially targeting more densely populated areas, and then gradually expanding in other areas	• Obsolescence of legacy networks, plus cost and complexity of managing multiple legacy networks. • Lower capital and operational expenses. Increased centralisation of routing, switching and transmission, lower transmission costs over optical networks. • IP-based networks enable the provision of cheaper VoIP services as a replacement for PSTN voice services. • IP-based networks enable the provision of a wider range of services, and allow bundling of services (triple and quadruple play). • Evolution and convergence of terminal equipment.	• Demand for innovative, high-bandwidth, services (HDTV, VoIP, etc). • Demand for more targeted or personalised content (on demand multimedia services, mobility)., • Demand for increased interactivity: possibility to interact actively with the service, growing interest for user-created content. • Demand for evolved and more flexible forms of communications, including instant messaging, video-conferencing, P2P, etc. • Business demand for integrated services, in particular in case of multi-national structures, which need to link different national branches, guaranteeing a flexible and secure access to centralised resources and intelligence.

In this context, the migration from separate network infrastructures to next generation *core* networks is a logical evolution, allowing operators to open up the development of new offers of innovative content and interactive, integrated services, with the objective to retain the user base, attract new users, and increase ARPU (see Box 3). NGN is therefore often considered essential for network operators to be "more than bit pipes"[28] and to strategically position themselves to compete in the increasingly converged world of services and content, where voice is no longer the main source of revenue, and may become a simple commodity. The investment in next generation access networks – both wired and wireless – will be necessary in order to support the new services enabled by the IP-based environment, and to provide increased quality. At the same time, the important investment necessary to develop next generation infrastructures brings about new economic and regulatory issues, which will be analysed in the following sections.

Box 3. Initiatives on NGN

Some of the major operators in the OECD are already in the process of shifting their networks to NGN. Telecom Italia's complete migration to NGN aims to increase efficiency, resulting from the reduction in ongoing capital expenditure due to network simplification and a reduction in operating expenditure from the reduction in the number of central offices, elimination of traditional switched networks and resolution of obsolescence issues, as well as greater automation of maintenance, provisioning and reliability. It is foreseen that Telecom Italia's plans to implement a "full-IP" network and to introduce fibre in access networks will bring about a reduction in network operational expenditure requirements, estimated to be over EUR 1 billion.[29]

BT's 21 Century Networks project should be fully rolled out across the United Kingdom by 2011, thus phasing out the traditional PSTN. BT has already developed an international IP-based network reaching 160 countries by the end of 2007. The shift to all-IP networks aims to transform the core business processes and the fundamental product propositions of all layers of the network and all elements of the supporting architecture, and should allow the company to save more than EUR 1 billion per year in operational expenses.[30]

In the Netherlands KPN is implementing an all-IP infrastructure, and plans to start installing FTTH in new residential areas by the second quarter of 2007. In its 2006 Annual Report KPN anticipated that main distribution frames should be phased out and that by 2010 a wide range of non IP-based services will be discontinued, which would lead to closing between 1 100 to 1 300 local telephone exchanges and would result in a significant reduction of staff costs. In addition, the reduced technical housing requirements due to the shift to IP, will allow the unlocking the value of non-core assets for an amount estimated to be around USD1 billion.[31] KPN's transition towards next generation networks is driven by the need to take advantage of technological innovation, compete with new entrants in the fibre market – such as Citynet, Versatel, Essent, or Tele2 – and reduce the cost of the company's infrastructure.[32]

In Japan, NTT East and NTT West launched commercial services using NGN in March 2008, which include a high definition TV telephone service and a guaranteed bit rate video service. They plan to extend these services, by March 2011, to all areas where fibre access is currently provided.

In the United states Verizon has deployed a fibre-to-the-premise project passing 9.3 million homes at the end of 2007 in 1 600 cities. The target for homes passed by the end of 2010 is 18 to 20 million. Current offers include a 50 Mbps downstream service and symmetrical offers in some areas.

Although the shift in the migration to all-IP networks is taking place at different paces in different countries, several operators in the OECD area have already updated their transport networks, and are now dealing with NGN at the local access level. Solutions embraced by fixed operators may also increasingly support IP Multimedia Subsystem (IMS), to enable fixed-mobile convergence.[33]

For the moment the most common services provided through the new networks are the provision of PSTN/ISDN emulation services, *i.e.* the provision of PSTN/ISDN service capabilities and interfaces using adaptation to an IP infrastructure, and video on demand (VoDs). At the same time the business world is showing an increasing interest in new NGN-enabled services and applications. Companies are migrating their Time Division Multiplexing switches to IP in order to enable integrated applications for specific industry-based functionalities and purposes.[34]

Progress in the field of mobile (cellular) communications is taking shape with the development of the IMS standard.[35] For the moment two services have been standardised under the IMS protocol, Push to Talk over Cellular (PoC) and Video Sharing.[36] Prominent telecommunication network equipment suppliers are actively supporting the take up of IMS and some of them are implementing IMS strategies and commercial IMS products.[37] IMS is seen as the enabler for the migration to next generation networks of mobile operators and therefore for the implementation of fixed-mobile convergence. No evident killer application has currently emerged, with many operators focusing on one specific service: voice. Facilitating the use of voice applications, enabling users to handle their calls easily between fixed and mobile networks, and to receive calls wherever they are, is fundamental for the take–up of the service. Operating in an IMS environment would allow a seamless handover from WLAN (fixed) to mobile during calls (Voice Call Continuity).

In order for real-time voice calls to be offered seamlessly between the circuit switched domain and the Wireless LAN interworking with IMS architecture, the Third Generation Partnership Project (3GPP)[38] is currently working to develop the appropriate Technical Specifications to define this functionality as a standard 3GPP feature. The study by 3GPP of the standard is underway.[39] In the meanwhile, fixed-mobile converged services have been launched by some mobile operators with access to fixed networks, using a different standard – Unlicensed Mobile Access (UMA)[40] – allowing users to seamlessly switch from fixed to mobile networks (see below, paragraph on Fixed Mobile Convergence).

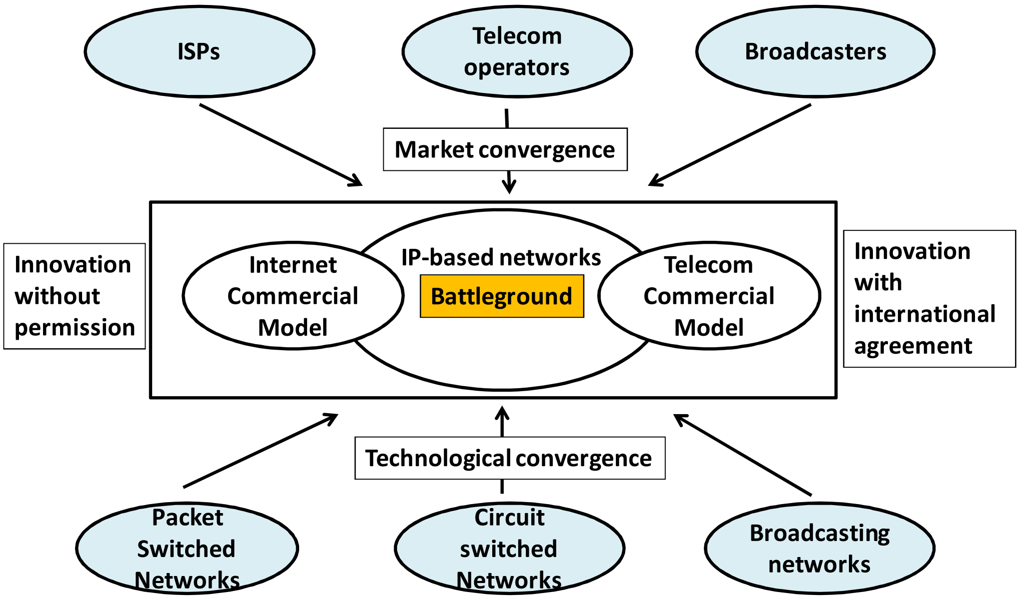
In addition, increasing competitive pressure on mobile carriers is coming from the IP world. Thanks to the availability of dual-use devices and Wi-Fi hotspots, service providers – such as Skype, Google, and others – are able to offer on the market a host of new services for mobile users in a very short period of time. This rapidity constitutes an important comparative advantage, which in some cases provoke the reaction of mobile operators (and manufacturers), tending to limit the services and applications users can access from their mobile handset.

Internet versus NGN

Technological developments associated with next generation networks should help combine the characteristics of the traditional telecommunication model, and of the new Internet model, dissolving the current divisions and moving towards a harmonised and coherent approach across different platforms, gradually bringing to full convergence fixed and mobile networks, voice, data services, and broadcasting sectors. In short, in the future the choice of the technology used for the infrastructure or for access will no longer have an impact on the kinds and variety of services that are delivered.

This however does not reflect the current situation, where the two worlds still have different visions and commercial models (Figure 2).

Figure 2. The convergence model



Source: J. Horrocks, "NGN and Convergence Models, Myths, and Muddle", OECD NGN Foresight Forum, 3 October 2006. See: http://www.oecd.org/document/12/0,3343,en_2649_34223_37392780_1_1_1_1,00.html.

The telecommunications tradition emphasises the benefits of higher capacity local fibre access facilities, and powerful network intelligence. Access in this context should be simple and reliable, with centralised network management and control to guarantee the seamless provision of a wide range of services, bundled network-content-applications offers, and one-stop shop solutions.

On the other hand, the Internet world traditionally focuses on edge innovation and control over network use, user empowerment, freedom to choose and create applications and content, open and unfettered access to networks, content, services and applications. Freedom at the edges is considered more important than superior speed of managed next generation access networks.

Indeed, the "Internet" still represents different things to different people, and next generation networks are seen as both a possibility for improved services or as a way to constrain the Internet into telecommunication boundaries, adding new control layers, capable of discriminating between different content, and "monetise" every single service accessed.

Services provided over next generation networks allegedly will differ from services currently provided over the public Internet which is based on a "best effort" approach, where the quality of transmission may vary depending on traffic loading and congestion in the network, while with NGN packet delivery is enhanced with Multi Protocol Label Switching (MPLS). This allows operators to ensure a certain degree of Quality of Service – similar to the more constant quality of circuit switched networks – through traffic prioritisation, resource reservation, and other network-based control techniques, as well as to optimise network billing as in circuit-switched transport.[41]

The concept of network-based control seems to be the main difference between the public Internet approach and next generation managed IP networks approach. NGN offers the possibility to provide a detailed service control and security from within the network, so that networks are aware of both the services that they are carrying and the users for whom they are carrying them, and are able to respond in different ways to this information. In contrast, the Internet aims to provide basic transmission, remaining unaware of the packets/services supported. While the Internet model remains therefore completely open to users and new applications and services, in managed IP networks operators are able to control the content going through the network.[42] In turn, this may have negative implications for the content of third party providers if their traffic is discriminated against in relation to that of an integrated operator.

3. Policy challenges

OECD Ministers in 1998 noted that in order to move from a vision to reality in the development of global information infrastructures,[43] a certain number of principles needed to be followed. These included:

- Availability and diffusion of high-speed infrastructure.
- Growth and development of multimedia services.
- Fair access and use of infrastructures for both customers and service providers.
- Interconnection and interoperability of infrastructure and services.

Those principles are still current, and should help orient regulatory and policy actions, supporting technological evolution and the development of next generation services and infrastructures.

The concept of convergence covers a number of issues of which the main one is that it provides the capacity to different communication platforms to transport the same services thus moving away from the present structure where platforms are service specific. Convergence is also occurring because terminals are becoming multifunctional and can thus receive and be used for a range of services instead of being service specific. Services can also be moved with ease from one terminal to another. In turn, next generation core and access networks will provide a platform facilitating convergence, allowing mobility in terms of access (users will be able to access their services remotely), and the merging of diverse services.

These developments imply that the definition of services used in the context of regulatory frameworks are changing and may have implications as to how these services are regulated. Since different services can be provided in an undifferentiated way over different terminals and over different networks, the concept of technological neutrality is also important in terms of regulatory frameworks. In turn, this implies that networks could be regulated in a similar way with no reference to the content carried on them networks. This could also be interpreted as implying that for reasons of coherence the regulation of the communication sector should be undertaken by a single regulatory body.

The question of whether in a converged environment there needs to be better co-ordination between spectrum allocation bodies, broadcast regulators and telecommunication regulators was addressed in the OECD study on "Telecommunication Regulatory Institutional Structures and Responsibilities".[44] The paper concluded that in some cases co-ordination, consistency and technological neutral policies may be more easily accomplished with a single regulatory body organised to examine issues in a horizontal way. Regulatory parity among network technologies which compete against each other is also a more present challenge as networks transition to IP and markets converge.

New technological developments now allow communications services which historically were regulated differently to now appear identical from the consumer point-of view. This underscores the regulator's need to be mindful not only of issues related to companies, but also of the concerns of consumers.

The development of new network structures may also, over time, result in the need for a review of existing regulatory structures and their responsibilities, in addition to a change in the regulations themselves. But many of the changes taking place in networks and applications are evolutionary, even though the changes may be rapid, rather than revolutionary. Developments taking place today might not automatically lead to a fundamental change in regulation, but they bring about the need to analyse the necessity of adjustments in order to preserve a level playing field for competition and promote efficient investment. In this context, the review of policy and regulatory instruments needs to consider whether available tools are still able to effectively achieve relevant policy objectives, and monitor where their impact is weakened and why. In the light of this – and taking into account also industry experience and consumer preferences – policy makers need then to consider how the regulatory framework should be adapted in order to address next generation developments.

Economic regulation: Competition and the development of next generation access

Competition has been viewed as the main tool to develop effective access and foster innovation, investment and consumer benefits in communication markets. All OECD countries view facilities-based competition as the most effective form of competition and the goal of regulatory reform and liberalisation of the sector. In this context it has also been recognised that to attain effectively competitive markets in the transition from monopoly to competitive communication markets requires regulatory intervention. This took place in OECD countries using *ex-ante* regulatory measures to address barriers to entry and the significant market power of established incumbent operators in voice markets. In particular, interconnection policies ensured that all customers of a service provider have contact with all other subscribers. Furthermore, network unbundling policies, including collocation, were employed to stimulate competition in the public switched telecommunications network (PSTN) market by providing entrants with wholesale access to infrastructure that was difficult to economically or technically replicate. This was often undertaken on the assumption that entrants would compete via unbundled facilities as a stepping stone to deploying their own facilities. The above-mentioned access policies have been a fundamental foundation of communication policy in a number of countries and have helped in developing competition in the public switched telecommunication network (PSTN) market. The development of high speed Internet markets (broadband) provided a further incentive to a number of regulators to extend local loop unbundling policies to require bitstream, shared access and full unbundled access as a means to encourage service-based competition in the broadband access market in markets where it was considered that facility-based competition was weak. This helped to stimulate significant growth in broadband subscribers, the development of new services and lower prices, leading in many cases to the emergence of increased facilities-based competition. In other OECD countries, the emphasis has been placed on creating the environment to stimulate facilities-based competition and well established cable operators and other platforms have emerged as a source of facilities-based competition.

The requirements for bandwidth capacity have increased significantly over the last several years. Although robust data is lacking in order to evaluate the future needs of users, the requirements for services such as HDTV, video conferences, peer-to-peer traffic, etc., have led to predictions of bandwidth consumption of at least 50Mbit/s downstream for residential consumers and in the region of 8Mbit/s upstream.[45] Some countries such as Korea, Japan, or more recently France, are developing networks able to deliver services at higher speeds. For example, during 2007 Hanaro in Korea began to offer its 100 Mbp/s service to households. The increasing development of user–generated content also would appear to support higher upstream bandwidth requirements, and in certain cases arguments have been made for symmetric high speed access providing upstream bandwidth at the same speed as downstream bandwidth.

The demand for bandwidth capacity is stimulating the next stage in the development of fixed access networks by bringing optic fibre networks closer to end users in order to increase available capacity.[46] This stage of development, referred to as *next generation access* (NGA) networks, is often taking place independently from the development of NGN core networks, and is aimed at providing the network capacity to support a range of services for the development and diffusion of new online services. As noted below, there are a number of different network topologies for the roll-out of fibre and their implications for the future development of competition in access markets may differ.

Government and regulators need to be cognisant of the economic and technical characteristics of different fibre roll-out strategies and the corresponding consequences for competition. The cost of roll–out of NGA networks has led to some experts arguing that only a single next generation fibre access network to end users will be sustainable from an economic perspective in the future. As next generation access networks develop, the regulatory and policy challenge is to maintain incentives to investment in a competitive environment. If facility-based competitive NGA networks do not develop, the technological and economic characteristics of local fibre networks raise significant new challenges to the continued use of unbundling as discussed below.

Fibre to the…?

Local loops, otherwise known as “Last Mile” or “distribution” networks are those networks which connect end-users to central switching facilities, and through those, to the backbone or transport networks. These last mile networks were traditionally copper, in recent years have also been provided by cable television networks, and in the context of next generation access networks are increasingly fibre. Last mile networks can also be wireless.[47]

As regards fibre networks, there are a number of different variants proposed in the context of next generation access networks.[48]

- *Point-to-point fibre-to-the-home/building* (P2P-FTTH): [49] This is usually viewed as the most future-proof fibre network given its flexibility to handle most new bandwidth intensive applications while allowing for relatively easy upgrading of speeds. While more expensive than other alternatives, such as point to multipoint fibre-to-the-home, some operators believe that in the longer term point-to-point FTTH may be more cost effective. This architecture also has the competitive advantage in that it permits full unbundling, allowing new entrants to connect at the central office (as at present with DSL technology).

- *Passive optical Networks (PON) fibre-to the-home: PON networks differ from P2P-FTTH in that* they use one fibre to connect multiple end customers so that fibre is shared by users. Cheaper than point-to-point FTTH, PON central switches require more logic and encryption to integrate and separate customer streams. There are three successive iterations for PON standards: APON/BPON, GPON and EPON. They differ in terms of downstream/upstream speeds and their maximum reach. In those countries where LLU is mandated, the way PON networks are constructed is important from the policy and regulatory perspective since they influence the extent to which these networks can be made available to other service providers and therefore the development of competition.

At the moment GPON appears to be obtaining the favour of major operators, while P2P is the preferred option in citywide projects.

As shown in Figure 3 there are three basic ways to construct a PON network (although hybrid forms of PON can be envisaged):

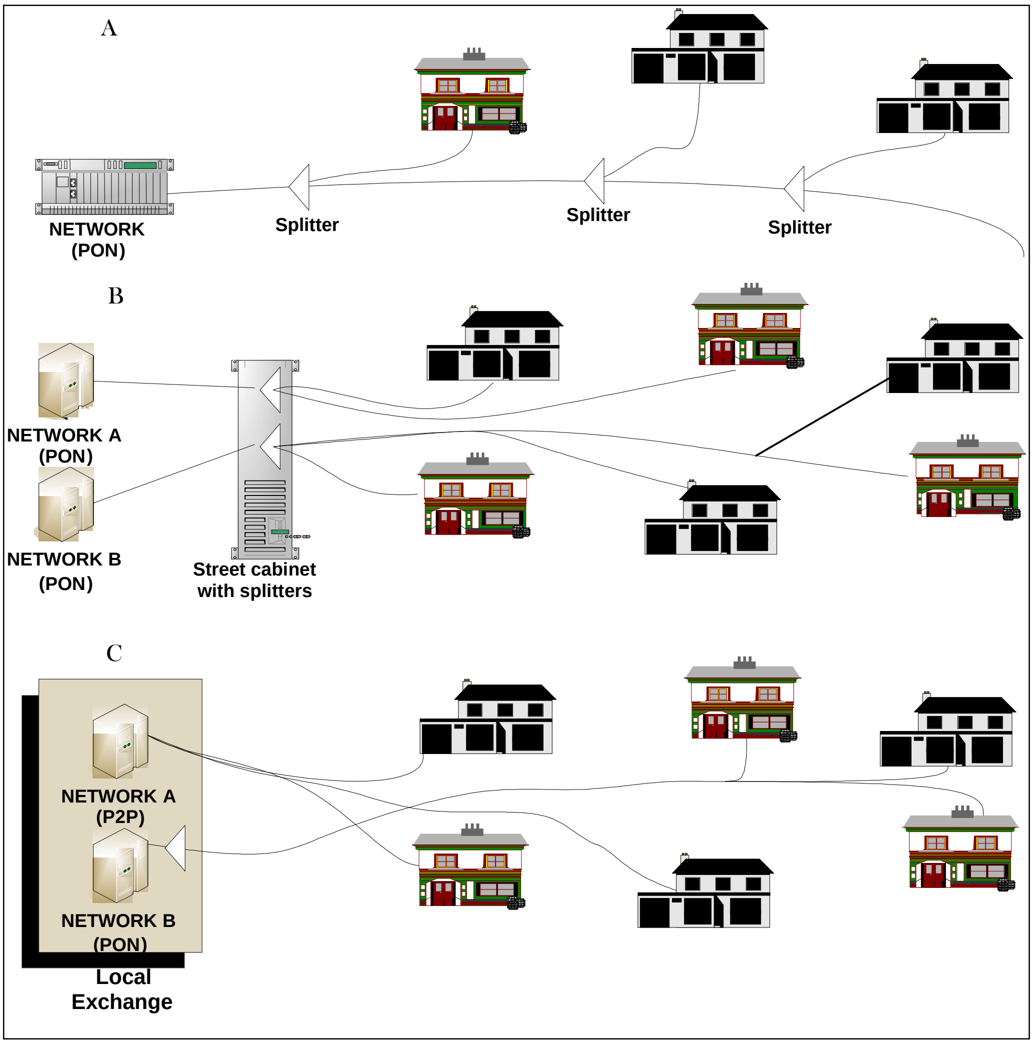
i). Fibre can be split close to the home/building where a splitter is installed to connect the home/building. This architecture makes it difficult for other operators to share infrastructure through local loop unbundling, limiting sharing to wholesale broadband access.

ii). Fibre can be split at a street cabinet and from there individual fibres connect each household/building. Unbundling can take place at the street cabinet for individual houses but would need to take place at the building for apartment blocks.

iii). The network is constructed as a point-to-point network and can be used as a PON or P2P network at the local exchange.

To the extent that a country has determined to rely on unbundling to promote competition, a P2P-FTTH network offers more technological options to implement unbundling than alternative fibre network configurations, some of which can limit the technological options for unbundling as compared to legacy networks. The network topology (B) in Figure 3 requires new entrants to invest up to the street cabinet (for individual homes) or up to the apartment building (unless they can obtain all the residents in a building as customers at the same time. Topology (A) only allows wholesale broadband access for new entrants.

Figure 3. Topologies for PON fibre networks



Source: DSTI/ICCP/CISP(2007)4/FINAL

As an alternative to the FTTH networks described above, some operators are investing in fibre to the node or curb (FTTN). The average local loop length to end users is well above 1km and in most countries less than 10% of the population lives close enough to an exchange to allow for speeds up to 50 Mbit/s.[50] In order to come within reach of the customer and provide adequate speeds the fibre network will need to be brought to street cabinets. From the node VDSL technology is used on the existing copper loop to the house or building. VDSL is being supplanted by VDSL2 which has higher speeds but, nevertheless, requires that the switch is about 450 metres away from the customer in order to deliver around 50 Mbit/s down and 30Mbit/s up.[51] From a distance of 1.5km VDSL2 has a performance equivalent to ADSL2+.

In the Netherlands KPN has estimated that it will need to go from 1 350 local exchanges to its 24-28 000 nodes so that it can come within 450 meters for 8 million of its customers. In the United States AT&T is currently rolling out its U-Verse network based on the same technology but with longer average line distances. A similar initiative is being undertaken by Deutsche Telekom, Swisscom and Belgacom.

There are different available options for high-speed to networks development which private companies need to evaluate in making investment decisions and adopt the approach more in line with existing infrastructures and market conditions.

There are different views regarding the cost effectiveness of investing in VDLS (FTTN). Some operators in OECD countries are upgrading their networks to VDSL (FTTN), as it provides significantly higher capacity – both upstream and downstream – than current ADSL technologies, at the same time allowing for a quicker deployment at a lower cost compared to FTTH networks. Other operators prefer to deploy directly FTTH networks, considering their higher performance and scalability, and therefore their capability to meet future bandwidth demand. In terms of cost, there is still debate as to the most efficient investment strategy for fibre. Arguments have been made that VDSL (FTTN) which in the short term is lower in terms of capital expenditure is not cost-efficient since VDSL has higher operational expenditure than FTTH (PON) technology since FTTH active electronic equipment is managed in the Main Distribution Frame and not dispersed across a number of curb-side boxes. [52] In addition, only some of FTTN investment expenditure can be reused for FTTH so that the eventual upgrading of a VDSL network to a FTTH network in order to attain higher capacity might finally cost more than directly building a FTTH network.[53]. At the same time FTTN is often chosen as the preferred technology since it allows a more rapid network deployment, giving the operator a first-mover advantage, with a lower capital expenditure. This is particularly relevant considering that it may be difficult for operators to justify heavy investment in fibre with their shareholders, as at the same time they are being confronted with higher debt ratios and not necessarily higher revenue streams, at least in the short term.

For regulators FTTN increases complexity in discussions on sharing and unbundling of networks. With fibre rolled out to the node, there is less need for local exchanges in the network. The street cabinet functions as an exchange. For alternative operators who used the unbundled local loop, the business case is often not positive[54] since to access customers using the incumbent's loop they will need to invest up to the node. Furthermore they will possibly need to invest in a street cabinet which has power and air conditioning (creating problems at the municipal level) and it is not clear whether they can unbundle since electrical interference may prevent this. Some incumbents have indicated that they will sell their Main Distribution Frame (MDF) locations in order to finance VDSL roll-outs which could strand the investment of new entrants unless adequate regulation is put in place to ensure that new entrants are given adequate time to invest in alternatives before main distribution frames are dismantled. The viability of sub-loop unbundling has been questioned by some experts in particular because the costs involved for new entrants to roll-out their network to a street cabinet will require that they obtain a relatively high market share in the specific geographic market.

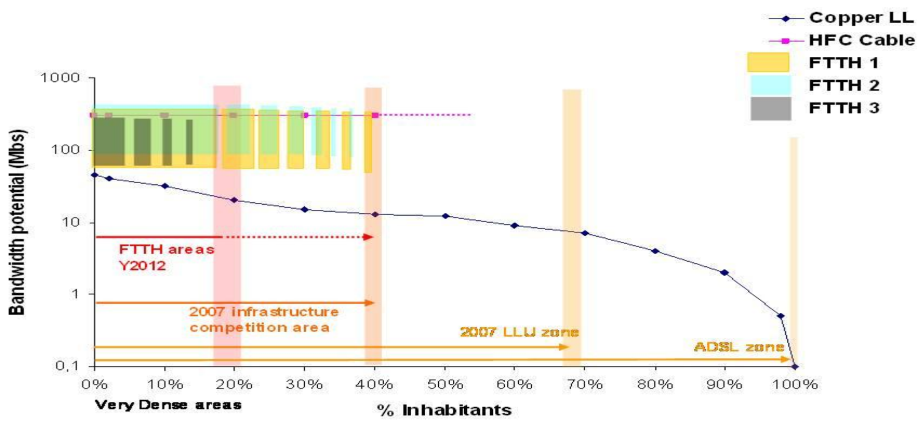
In summary, where adequate facilities-based alternatives are unlikely to develop, the network architecture chosen by incumbent telecommunications operator for their next generation access network will have important implications for access and competition in the communications market. Most of the fibre access solutions are based on a network topology where it is much harder, technically and/or economically, to unbundle loops. Wholesale broadband access, much as bitstream access in xDSL markets, can provide some service competition, but is insufficient in the long run in providing effective competition. The development of fibre networks requires those regulators that have mandated local loop unbundling (LLU) should assess the economic and technical feasibility of continuing LLU policies in their country, taking into account investment plans of the incumbent, the presence of alternative network infrastructures, and the characteristics of particular markets, amongst other things, in order to begin to determine the best regulatory framework to ensure effective competition. In addition, ensuring sub-loop unbundling, where this is feasible, access to rights of way and ducts for new entrants, regulations for backhaul from street cabinets, and regulations for sharing inside wiring of buildings are measures that can reduce barriers to competition, both to promote facilities-based competition and to enable certain unbundling polices as fibre is deployed further into the access network. In those countries that have not mandated LLU, policy makers should examine ways to stimulate inter-modal competition and other barriers to entry.

A next generation access divide?

Other than the competitive conditions which may arise from the deployment of next generation access networks there is a further concern regarding the coverage of these networks. This arises because FTTH networks are likely to only serve relatively dense population areas. It is also in those dense areas that a potential for facilities competition may still remain. Figure 4 illustrates well the challenge facing incumbents and new entrants. France Télécom estimates that very dense populated areas (covering around 40% of inhabitants in France) will over the next five years be subject to competition in FTTH with four companies competing for customers. The next 30% of inhabitants living in the less dense areas will have access to local loop unbundling offers but are unlikely to have fibre access. They may also have the potential for high speed from cable networks, if cable investment takes place, in extending their reach in terms of homes passed by broadband cable (see Figure 4). However, in this example, the last 30% of the population will have access to much lower speeds, declining rapidly according to distance from switches, based on ADSL and probably without a choice between service providers unless access is made available through wireless offers. Telecom Italia envisages coverage of up to 5% in 20 main cities during 2007-2009, moving to 65% in the long term, covering 1 140 cities.[55]

The economics of deploying fibre is such that it would not be cost effective to provide fibre to all communities or geographic areas. The difficulty in extending coverage, shown by the above scenarios, could occur in many OECD countries so that alternative networks need to be encouraged. In some countries cable networks are more widely dispersed and cover smaller (less dense) communities. There may be other alternatives to supplement ADSL coverage in areas with less dense population. Such alternatives include local networks (for example municipal networks[56]) or alternative technologies including fixed wireless technologies.

Figure 4. Infrastructure competition in France



Note: Illustrative graph of infrastructure competition prospects in France from now up to year 2012, based on public information available in September 2007.

Source: France Telecom.

Access to next generation access fibre networks

There is widespread agreement that infrastructure-based competition provides the most sustainable and effective level of competition in the communications market. In those circumstances where the establishment of networks competing with incumbents' NGA networks is not considered feasible, the pursuit of policies to promote inter-modal or service-based competition is an important goal. There is also general agreement that availability of next generation networks access is a crucial element in the provision of new broadband-based services and applications. Although regulators understand that the policy challenge for NGN access is to strike an appropriate balance between market incentives and ensuring an appropriate level of competition in access network markets, there is much less agreement on how to implement this policy challenge and ensure that such networks are made available with maximum geographic coverage and at affordable prices.

The existing model used by the majority of OECD regulators to promote competition where there is significant market power is through local loop unbundling. This model will be limited in use in a fibre environment. In a PON network local loop unbundling is only possible if this has been taken into account before network roll-out begun by allowing competing splitters to access the network in street cabinets, local exchanges or in buildings. Table 3 summarises unbundling possibilities. While wholesale broadband access may be available on all type of PON networks other issues are raised. These issues are linked to traffic prioritisation practices used by the owners and operators of networks which may limit the quality of service of third party users and which do not provide non-discriminatory access to services and applications of third parties.

In the context of fibre networks policy makers and regulators have, in general, three broad scenarios to choose from. They can:

1. *Allow free rein to the market – no ex ante unbundling requirements*

The market would be allowed to determine the development of fibre networks. This choice would accept arguments that investment in fibre networks by incumbent operators is taking place in a market open to competition as compared to investment in copper networks financed by monopoly rents and cross-subsidisation. In such a scenario such new investment should not be subject to *ex ante* regulation.

There are two possible market scenarios arising where investment in new fibre networks takes place without any *ex ante* regulation. The first is that competition develops as new entrants also invest in fibre or develop alternative network infrastructures capable of delivering NGA functionality. The economics of certain next generation network technologies may make deployment more or less likely in particular geographic areas (see Figure 4 above).

The limitations faced by new entrants are significant, especially with respect to the reach of their existing networks and their ability to obtain access to rights of way and ducts. It is thus difficult for new entrants to replicate an NGN access infrastructure. Incumbents have the financial power to obtain financing for such access networks relative to new entrants. Their market position provides them with much more certainty in obtaining financing since incumbents have much higher revenue streams from existing services than new entrants and they are less likely to go bankrupt. For the same reason they are likely to obtain cheaper loans.[57] In a number of countries the fact that incumbents are partially government owned and may, in the eyes of the financial market, be the designated universal service provider also puts them in a more favourable position. In addition, a large percentage of costs in rolling-out new fibre networks are construction costs related to conduits and rights of way. Construction costs could be significantly higher for operators if they do not already have access to rights of way and ducts. Operators need to be able to replicate a fibre network as efficiently as existing operators. In this case, then, it would be unnecessary to impose any access requirements (at least *ex ante*) on the incumbent's fibre network. The economics of fibre is such that the returns to investment in a fibre to the home network are sensitive to market share, which implies that there could also be a significant first mover advantage.[58]

In countries where there is extensive availability of cable television networks, the upgrading of these networks into hybrid fibre/cable networks would provide competition to NGA fibre networks. However, in duopolies there could be the potential for price collusion and less consumer choice, as well as the danger of tacit or overt co-operation to limit market entry. Where market power is exerted, this could well be mitigated through competition, even if it is limited, from other networks – for example, voice competition and data access (even if speeds are relatively slower) can be achieved through high speed wireless networks. High definition terrestrial television services may be able to compete effectively against IPTV or cable TV services. The high speed broadband access market could well be a natural duopoly market because of large economies of scale and sunk costs. If this were the case and the market does not develop facilities-based competition, then remedies will be required. While a duopoly may have benefits over a *de facto* monopoly market structure, it is far from ideal from the competition perspective.

However, the second scenario is that by allowing free rein to the market the incumbent attaining a dominant position and exerting market power in the next generation access market which would be extremely difficult, *ex post*, to correct through regulatory measures. This is because the configurations of many fibre networks (e.g. see configuration (a) in Figure 1) do not allow for unbundling or allow for unbundling but only at a high cost. In most cases only wholesale broadband access will be feasible and it is not evident that service competition will be sufficient to create effectively competitive markets.

A question which a number of regulators have begun to consider is how to achieve competition in the next generation access market if facilities-based competition does not occur and a single operator becomes dominant in the market. One remedy under consideration, which is viewed as a last resort, and which has many detractors, is the possibility of implementing either structural or functional separation of the fibre local loop from the NGN application and service level. The EC has proposed that the power to implement functional separation should be part of the regulator's toolkit and some European Union countries are actively considering this remedy following the UK's initiative to functionally separate BT (See Box 4 on network separation).

2. Regulators can be proactive and determine where bottlenecks are likely to emerge and take action accordingly

Much of the debate around new network investment has focused on the fact that, since such investment is new, this implies that the incumbent does not have *ipso facto* dominance, whereas the actual issue is whether the existing dominance is transferred to the new network. Many incumbents in the communication market still have market power which arises from their former monopoly position so that, even though investment in fibre networks is "new", incumbents are still leveraging their historical market power and there is a risk that, if exempt from regulation, such investment would result in the creation of new dominant positions.

Under this second scenario regulators would maintain *ex ante* regulation and be proactive by ascertaining potential bottlenecks where regulatory action is required as fibre is brought closer to the consumer. Increasingly, a number of incumbent operators that are subject to asymmetric regulation have argued that with respect to next generation access networks there should be asymmetric geographic regulation, that is, regulatory forbearance should be adopted in geographic areas (usually the more densely populated cities) where facility-based competition is developing.[59] At the same time, it could be possible to explore whether a distinction can be made between the geographic markets approach, where multiple markets are defined, and a single national market approach, with varied remedies by geography. A geographic market approach would require defining a market for access and services at the geographical level and then undertaking market power assessments for each of the designated geographic areas. Asymmetric geographic regulation may also result in geographic price differentiation at the wholesale and retail level – lower prices in competitive cities and higher prices in smaller cities and regions.There would also be an incentive for the dominant operator to try and gain market share in large cities including through cross-subsidisation. In addition, it may be difficult to identify the relevant criteria for the definition of geographic markets, and the segmentation of the market may be excessive, resulting in an overly complex regulatory environment.

The purpose of *ex ante* regulations is to ensure that barriers to market entry are minimised. In this context, the first requirement is to define what *ex ante* regulation means in the context of the roll-out of fibre networks. Maintaining unbundling as the cornerstone of regulation is not helpful if, for technical and/or economic reasons, unbundling is not possible. Therefore, short from mandating that the network topology chosen by a firm with an existing dominant position in the fixed access market should allow for unbundling (see scenario 3 below), the main barriers to market entry in the roll-out of fibre are likely to be construction costs and access to homes/buildings.

Construction costs (civil engineering costs) are estimated at around 60-80% of total costs in rolling out a FTTH network and constitute a large percentage of total network costs. Incumbents have a significant advantage because their historical monopoly position has given them existing rights of way and they usually own the ducts used by copper networks (which often means they do not pay for rights of way). Other utilities, such as electric power companies, also have access to rights of way and ducts. The number of administrative layers (local municipal councils, regional bodies, etc.) often creates difficulties for new entrants in obtaining access to rights of way and ducts. Where municipalities are pro-active in trying to ensure that fibre networks are developed, they often provide access to municipal rights of way and ducts on reasonable terms. For FTTN networks street cabinets and access to them are important. Several authorities in OECD countries are addressing this issue. In the United States the Telecommunications Act of 1996, as well as various FCC orders that implement the statute, set forth numerous requirements that US local carriers must meet in order to provide competitive carriers reasonable and non-discriminatory access to ducts and rights-of-way. In France the ARCEP published at the end of 2007 the results of a consultation on duct sharing, and initiated at the beginning of 2008 technical work with the operators on infrastructure sharing and on the localisation of the adequate points of mutualisation. In Japan a guideline for use of poles, ducts, conduits and similar facilities owned by public utilities was amended in 2007 to add provisions regarding procedures to facilitate the installation of lines in the last mile.[60]

In this context, the main *ex ante* regulations needed to reduce bottlenecks include:

- Ensuring access to rights of way at reasonable prices, and preferably at no charge, for new entrants and incumbents.
- Ensuring access by new entrants to existing ducts/poles of both network operators and utility companies and municipalities.
- Regulations to ensure the sharing of access to the inside wiring of apartment buildings and homes.
- Facilitate access to street cabinets and collocation in street cabinets. Regulators need to work with municipalities to find solutions to avoid excessive duplication of street cabinets and/or restrictions on investing in street cabinets by new entrants.
- Municipal networks can play an important role in enhancing competition in fibre networks. If these develop governments should encourage them to be open networks, that is providing dark fibre to service providers rather than becoming themselves service providers. Nor should the

existence of a municipal network providing dark fibre mean that investment in other fibre networks in that municipality should be prevented.

- Where mandated, ensuring wholesale broadband access is provided on a non-discriminatory basis which must ensure that the quality of service provided to wholesale service providers is the same as that of the owner and operator of the network.
- Where adequate facilities-based alternatives do not exist, consider applying local loop unbundling policies to new fibre networks, in particular sub-loop unbundling since with certain fibre configurations (FTTN) new entrants will need access to street cabinets.

Table 3. Fibre network configurations and unbundling

Type of network / Possibility to unbundle		FTTN	FTTH			
			Point to point (home run)	Wave Division Multiplexing (WDM) PON	Passive Optical Network (PON)	
					Passive optical splitters to distribute the fibre to each customer	PtoP fibre using PON
Characteristics		Single fibre going from the local exchange to the cabinet. From the cabinet users are connected via DSL/VDLS.	Multiple fibre lasers connecting the local exchange (central office) to each user home.	Multiple wavelengths separate Optical Network Units (ONUs) into several virtual PONs co-existing on the same physical infrastructure.	Only a single fibre connecting a number of Customers. Single users cannot be separated on a physical level but only on a logical level.	Network is operated as a PON, but the splitter is moved up to the local exchange level, where alternative operators can connect.
Physical layer unbundling	**Local exchange**	Not possible.	Possible.	Not possible.	Not possible.	Possible at the local exchange.
	Cabinet	Investment intense, limited room at the cabinet level.	No need for street cabinet.		In case the splitter is at the field cabinet level and it is combined with an Optical Distribution Frame (ODF). The cabinet can accommodate a splitter per service provider.	No need for street cabinet.
Logical layer unbundling (Wholesale access)		Wholesale access.	Supports open access.	Supports open access	Wholesale access	Supports open access
Optical layer unbundling				Possible – wholesaler can sell wavelengths.		

3. Picking winners – intrusive regulation

OECD countries have in general been reluctant to pick winning technologies and interfere in the market, as this is not consistent with principles of technology neutrality.[61] However a third scenario can be envisaged, where regulators act to require that the network topology chose by the firm that has the dominant position in the fixed access market is available to third parties technically and economically for full and effective unbundling. Such prescriptive action needs to be carefully weighed, as it would be a significant intervention and would tend to distort the investment decisions of firms.

The way forward for fibre regulation

Investment Incentives

There are a number of factors underlying decisions to invest in the communications sector and investors that have different strategies and time horizons. These differences are evident in the investment strategies followed by incumbents across the OECD both in regard to network investment (fibre to the home, fibre–to–the–curb, VDSL, etc.) as well as in NGN core network investment. From the policy perspective there are two important and interlinked factors that may influence investment: the state of competition in the market and the regulatory framework (including perspectives on how this framework is expected to evolve).

In recent years several incumbent telecommunication operators having tried to forge a direct link between regulation and investment, in particular with respect to protecting investment in fibre networks, ensuring that these would not be subject to open access conditions. Some countries have supported this position, considering that the way forward is thorough the roll–out of high speed networks and platform competition. In other countries LLU has been used as a phased approach to meet the same objectives.[62]

In general, incumbents need to invest in upgrading their existing networks in order to maintain their client base and to regenerate revenue growth. Under present market conditions they are already losing a large number of clients. For example, with the development of VoIP services the main revenue base of incumbents is being whittled away. Although experiences differ by country, competition is building up in broadband markets through the upgrading of CATV networks, through investment by new entrants in infrastructure. Competition from high speed wireless networks may also eventually impact on the client and revenue base of incumbents. Next generation access networks will provide the means for incumbents to compete effectively with new entrants and provide a range of value-added services allowing for new revenue opportunities. At the same time next generation access networks allow for significant cost savings (maintenance, etc.) which, when supplemented by new revenue sources, will be important for revitalising the profitability of incumbent operators. Thus appropriate regulations which help create competition do not necessarily affect the incentive of incumbents to invest. The impact of increased competition, as well, helps to stimulate the rapid take up of new services and thus, even with lower prices, tends to provide a quicker return on investment.

Box 4. Network separation

In 2003, the OECD published a paper on structural separation. At the time, problems faced by new entrants in obtaining access to the PSTN of incumbents led to calls for structural remedies on incumbents, and in particular the separation of the local loop from service provision. The report argued that the costs of structural separation would more than likely outweigh any benefits that it may provide. Lately, with the increase of investment in fibre in the local loop, there has been renewed interest in some OECD countries, and by the European Commission, in functional separation.

The first case of functional separation is the BT Openreach model in the United Kingdom, where the incumbent, BT created an operationally independent unit aimed at ensuring that all the telecommunications industry, including other parts of BT, have fair and equal access to the local and backhaul networks. Openreach offers access to wholesale products (LLU, wholesale line rental, etc.) to new entrants on the same terms as BT offers its own retail entity. BT Openreach signed a number of undertakings with the regulator, OFCOM, and set up an Equality of Access Board aimed at monitoring compliance with undertakings and the code of Practice of Openreach and ensuring that it meets requirement to provide products and services on an "Equivalence of Inputs" basis. The United Kingdom has found that the introduction of functional separation has led to significant new investment from new entrants in that it increased confidence that the regulatory system will address anti-competitive behaviour. The incumbent has also increased investment viewing that functional separation has increased regulatory certainty. In Sweden, TeliaSonera has decided to establish an infrastructure subsidiary selling its products on equal terms to TeliaSonera's wholesaler customers and the company's own operations. In contrast to BT, TeliaSonera separated the whole network – including core and access – from the provision of services. New Zealand's incumbent also is in the process of implementing a separation plan.

The renewed interest in separation by some regulators is the result of slow or non-existent parallel infrastructure development in their countries. In addition, the move to fibre has raised the question of how many fibre access networks a given market can support. The proposal by the European Commission, which is opposed by some EU countries, is that functional separation should be a last resort measure available to the regulator.

The European Regulators Group (ERG) has issued an Opinion[63] in a response to the Consultation on the review of the European regulatory framework that functional separation could be considered as a new remedy in the forthcoming review of the EU's regulatory framework. The ERG adds that regulators would have to judge the costs and benefits of such a remedy and would need to base their decision on completed market reviews covering the full remit of the whole market. ERG believes that functional separation reinforces and complements the existing remedies ensuring that regulators can intervene where particularly non-discrimination behaviour, which cannot be addressed through other remedies, takes place, thus providing a supplementary tool for regulators. ERG points out that the remedy of functional separation has to be solely within the discretion of the national regulatory authority to decide upon its applicability.

Others have argued that the current rules already apply to discriminatory behaviour and that so far, there is no clear proof of benefits of functional separation and its potential efficiency in respect to increasing competition. They also believe that there may be several risks associated with such a decision, such as recreating a monopoly on the local loop and reducing the incentive to invest in future technologies. Those opposed to functional separation also argue that it is very difficult to define the perimeter of the network that would be subject to functional separation, bearing in mind the very quick evolution of technologies and of markets. Opponents also argue that the adoption of functional separation incurs high implementation costs.

Compared to functional separation, there is little support for implementing structural separation which envisages a complete separation, including ownership, between a company providing access (network infrastructure) and the service company. A structurally separate company would resemble some municipal networks (*e.g.* CityNet in Amsterdam which has a minority municipal ownership and only provides dark fibre to the market). Separation, either functional or structural, is viewed by its supporters as limiting regulations aimed at behavioural remedies as it eliminates discriminatory behaviour by network owners/operators; creates more efficient competition; and removes cross-subsidies. Among OECD member countries for the moment there is ongoing discussion on using functional separation as an additional remedy. However, if existing rules do not work well for NGA then functional separation may become a last resort measure. Therefore, it is important, as a first step, that the benefits and costs of such a measure are well documented so that policy makers can take appropriate decisions.

Access to rights of way, ducts and poles[64]

The high costs of civil works to construct ducts will impact on new entrants who, in contrast to incumbents, do not have historical access to rights of way and ducts. In order to try and stimulate the roll-out of fibre by new entrants it is important for policy makers and communication regulators to examine steps that can be taken to reduce these costs. There are a number of steps that can facilitate new entrants including:

- Reducing barriers associated with obtaining municipal authorisation for access to and use of rights of way.
- Ensuring clarification of jurisdiction for both granting rights of way and settling disputes and co-ordination among the public authorities involved.
- Harmonising administrative procedures for access to rights of way and ensuring consistency in the application of these procedures across a country.
- Reducing or eliminating any fees associated with using rights of way.
- Ensuring that operators investing in ducts are subject to a minimum set of obligations for remediation and maintenance.
- Encouraging and/or obliging sharing of ducts and other rights of way both by incumbent communication companies, but also by other municipal utilities that have infrastructure.
- Examining the role of public-private partnerships in the deployment of dark fibre and/or third party infrastructure providers for duct sharing.
- Examining the possibility of regulatory measures to impose the pre-wiring of new residences for sharing of in-house wiring.
- Developing policies to construct joint ducts by new entrants.
- Adding inner ducts (duct dividers) into the ducts and canals for increasing the existing capacity.

Delays in rolling out networks can be costly for operators, and can delay the development of competitive markets, so that by preventing delays in the process of rights of way applications, a system of safeguards which ensures that deadlines for decisions concerning permits are respected. Establishing targeted time frames for various steps of the rights of way process helps in providing predictability to the applicant. In order to facilitate competing fibre local loops, reduce costs and reduce multiple excavation and other civil works in municipalities the sharing of existing ducts, both of telecommunication and cable companies, but also of other utilities, is an important policy requirement. Similarly access to buildings and sharing of wiring is important to ensure effective competition in the market.

Stranded investment

With fibre to the curb there is no need for main distribution frameworks and several incumbents have indicated that they will dismantle these facilities once they have rolled out fibre. Most new entrants are using the MDF facilities to access unbundled local loops. They have also invested in order to reach these facilities and by closing down MDF facilities there is a danger that the investment of new entrants will be stranded. It is therefore important that the process, time frame and details of MDF closure is transparent and made known to new entrants well in advance of any action by incumbents. Regulatory bodies have an important role to play in this context.

Adapting interconnection frameworks

Interconnection is essential in a competitive communications environment since it provides the means to allow the customer of any one communication service provider to connect with the customer of any other communications provider, and any service provider to connect, and provide service, to a customer irrespective of their network carrier. The transition to IP-based next generation networks is likely to raise questions as to how interconnection should be take place, given the significant differences in interconnection practices between the PSTN and IP networks and the fact that there will be interconnection between diverse networks including cable networks and the development of new services such as fixed-mobile converged services.

In the PSTN environment traditionally service providers adhere to wholesale payment arrangements known as Calling Party's Network Pays (CPNP), where the network of the party that places (originates) a phone call makes a wholesale payment to the network of the party that receives (terminates) the call. Differently, Internet interconnection has been based on Peering, Paid Peering, and IP-Transit. With peering, two Internet Service Providers (ISPs) agree to exchange traffic solely among their respective customers, sometimes without payment; with transit, one ISP agrees to carry the traffic of a customer (possibly also an ISP) to third parties, generally for a fee. These arrangements based on commercial agreements result in an interconnected Internet, and have generally not been subject to regulatory obligations. The model that applies is therefore determined, in practice, by the type of interface used to exchange the traffic.

The question is therefore on which model interconnection in a converged NGN environment should be based.

Depending on the strategy of companies, there will be a transition phase during which it is likely that both sets of practices will coexist as the proportion of IP traffic increases, and that of circuit-switched traffic decreases. This may imply, as well, a transition in interconnection procedures. In most OECD countries regulators use long–run incremental cost models (LRIC) to determine interconnection costs. There is a need for regulators to assess how the two sets of interconnection arrangements operate in their current milieus to evaluate whether these should be maintained in an NGN environment. The market for exchange of IP traffic, as regards the Internet, has worked well, producing efficient arrangements and lower prices, and allowing for entities of different sizes to exchange traffic.[65]

In terms of physical facilities supporting traditional fixed and mobile switched interconnection, the migration towards NGN changes the network topology which potentially involves several structural changes, such as a re–organization of core network nodes and changes in the number of network hierarchy levels.[66] As an example in Germany Deutsche Telekom has 74 nodes for its IO network compared to 475 nodes for the PSTN.[67] This may lead to a geographical re–arrangement of points of interconnection, and to the reduction in the number of points, especially at the local level. At the same time it can result in new entrants being subject to stranded investment requiring them to invest in new infrastructure in order to reach new points of interconnection. There are different fibre network topologies in a NGN access environment which also may need to be taken into account since the requirements and points of interconnection may differ.[68]

The separation of networks functional planes should allow for the creation of a horizontal platform for the provision of services, separated from the transport layer. For this separation to be effective, interconnection should be possible at all functional levels. However, there is the risk that operators do not consider horizontal separation appropriate, as it is more difficult to guarantee a certain level of quality of service in interconnected networks, or simply because it is not in their best interest. Most incumbent operators still see NGN as a simple continuation of vertically integrated transport and services, as in the case of legacy networks.[69]

Numbering, naming and addressing[70]

Telephone numbers, domain names, IP addresses, and other addresses are crucial resources for communication and access to the market. They provide operators and service providers with the necessary data for locating and identifying customers and network points in order to deliver their services. For end users they provide a presence in the world of communication and a means to communicate with others. For the PSTN, the public switched telephone network, the telephone numbering system[71], is the core mechanism to address end users. Practically all wire line and wireless networks operators base their interconnection, interoperability and service provisioning on the telephone system. With NGN, the existing numbering system is expected to continue, at least in the short to medium term, as the dominant scheme within voice communication to identify and connect subscribers.

Nevertheless, the same developments that characterise the merging communications landscape, such as the migration to IP, are affecting addressing as well, which raises risks in that access for users to competing service providers and/or services of their choice might not be achieved if the resolution between both addressing systems used (telephone numbers in PSTN, and IP addresses, Domain Names and Uniform Resource Identifiers (URIs) in Internet) is not properly addressed with global standardisation.[72]

The IPv4 addressing scheme[73] as used in the Internet has been universally embraced by NGN networks as the core new addressing scheme, in combination with the overarching TCP/IP protocol suite.[74] IP addresses are used 'under the hood' within networks and determinate unique network points; using an IP address will always lead to the exact location of that network point. On top of IP addressing there are translation mechanisms, such as the DNS (Domain Name System) that map or add other identifiers to an IP address. These identifiers, such as domain names, e-mail addresses and SIP addresses,[75] are more comparable to telephone numbers, as they are used at the edges of networks, in the higher layer where services and applications take place in interaction with users.

With the expansion of the public Internet, the use of domain names and e-mail addresses for end users has become common practice worldwide, comparable to the expansion and acceptance of the telephone numbering system. Increasingly the underlying general format used in IP networks is the URI, the Uniform Resource Identifier. The URI is evolving into the main intra-network identifier and basically defines an 'identity – service' combination in a format like scheme:user@host or scheme:identifier@domain.tld. The URI format is versatile and, next to the well known URI for e–mail (mail to:user@domain.tld), the URI for SIP (sip:user@host) is becoming a main identifier to address VoIP subscribers according to the SIP protocol. These types of identifiers are all IP-based and can eventually be traced back to an IP address.

In parallel, other more closed identifier schemes have been introduced, mainly with the emergence of web–based VoIP and instant messaging (IM). Internet-focused companies such as eBay (Skype), Microsoft, Yahoo, Google and AOL have added voice, IM (instant messaging) and video capabilities to their software, serving large communities. They route mostly on the basis of 'end to end point' communication, having the advantage that traffic does not need to be routed through the PSTN's traditional switches, or via SIP gateways as used within VoIP. These highly competitive providers on the voice market manage their subscribers' identities with proprietary schemes[76] and employ telephone numbering only when interoperability is needed with subscribers outside their community (Skype-in).

Although implemented on a provider by provider basis, IP–based schemes follow a standardised format and can be in principle supported across other networks. Interoperability is feasible if there is agreement between providers. The absence of interoperability is sometimes seen as a deliberate customer ‘lock in’, as concluded by some parties on the basis that, *e.g.* Skype, will not map their end users to URIs, and the introduction of IP telephones that cannot be used for anything other than the application provided by the IP telephony provider.

Telephone numbers by which PSTN subscribers are identified may eventually evolve into alternative names and addresses, but generally many new services, such as web–based IM and VoIP services, are used ‘on top’ of the regular voice subscription and this does not lead to the substitution of telephone numbers. The emergence of new addresses, however, does lead to increasing divergence, as users are collecting more numbers and identifiers in different schemes, but there are no real indications that this divergence is posing problems on the end–user side; end–user equipment is becoming more intelligent and capable of handling multiple addresses and managing contact details.

The divergence however, does pose a challenge for providers. Telephone numbers in their standard format are not supported in the core NGN networks based on IP, where generally the URI format or other IP-based identifiers are used. Still, for users as well as for providers, being able to continue to use telephone numbers is considered crucial for the shift from the classic telephone service to VoIP and for the integration of new IP multimedia services. ENUM[77], a standard developed by the IETF[78] was conceived for this purpose; it offers a mechanism for transforming public telephone numbers into unique domain names. While solving the mapping problem, it introduced potential new applications, as a result of the insertion in the Domain Name System.

ENUM comprises a set of standards and mechanisms for transforming public telephone numbers into unique domain names to be used in NGN, enabling providers and users to continue to use telephone numbers which is considered crucial for the shift from the existing public switched telecommunication environment to an Internet Protocol based environment and is thus becoming an essential building block for NGN embedded. Due to ENUM the lifespan of the existing telephone numbering scheme could be prolonged, subsequently maintaining the role of telephone numbers as key identifiers for telecommunication services. Eventually, however, regulators may need to introduce more flexibility in numbering plans by broadening the uses for existing number ranges, and considering portability of numbers between different services. At the same time access to ENUM data will become crucial to set up interconnection.

Universal Service and next generation access

Convergence and the transition to next generation networks could, in the longer term, have an impact on the definition and scope of universal service obligations (USOs). At present USOs focus on the provision of voice services.[79] USOs generally refer to the requirement that a designated USO telecommunications operator provides a minimum set of services (which include voice telephone service) to all users, regardless of their geographical location within the national territory, at an affordable price, even though there may be significant differences in the cost of supply. Differently, the term “universal access” is used to refer to a situation where every person has a reasonable means of access to publicly available network facilities and services.

The communications market has been subject to significant changes both in terms of the means to provide voice services (mobile, VoIP) and the decreasing importance of voice services as a proportion of total telecommunications usage (*e.g.* because of e-mail, SMS, etc.). Countries have stressed the economic and social importance of broadband access which in turn has led to considerations as to whether broadband access should be included as part of USOs. Earlier work by OECD in this area concluded that to do so would be at present premature, although this should not preclude policies aimed at ensuring widespread access to broadband including in rural and remote regions.[80] As the communications market evolves, particularly with regard to next generation networks, policy makers may need to review definitions of universal service to determine whether changes need to be made and, if so, what services and access would be required, and whether funding mechanisms should change.

The goal of universal service obligations generally are to promote the "availability, affordability and accessibility"[81] to telecommunications services. Definitions of universal service across OECD countries are relatively similar although there are differences in the mechanisms used to achieve these goals. Implicit in universal service goals in many countries is national tariff averaging aimed at assisting rural households (on the assumption that service costs are higher in those areas). In many countries part of USOs include, as well, special tariffs for those on low incomes.

Internet access is, to some extent, already included in universal service. For example, in the United States, the federal universal service schools and libraries program provides, among other things, discounts for Internet access for schools and libraries throughout the nation, while the federal universal service rural health care program provides, among other things, discounts to ensure comparability in Internet access rates paid by health care providers in rural areas and urban areas. In addition, the Federal Communications Commission (FCC) has initiated a universal service rural health care pilot program, which seeks to stimulate deployment of the broadband infrastructure necessary to support innovative telehealth and, in particular, telemedicine services to those areas of the United States where the need for those benefits is most acute. The European Universal Service Directive (USD)[82] specifies that connections to the public telephone network at a fixed location should be capable of supporting speech, fax, and data communications at rates sufficient for "functional Internet access." The provision of functional Internet access has been interpreted by the Directive as encompassing simply the provision of a "narrowband connection",[83] and no minimum data rate is mandated in the Directive. Overall, it seems that most EU countries opted for not requiring more than a 28Kbit/s connection.

The definition of universal service is an evolving concept which may change over the years, to reflect advances in technologies and usages. For example, in the United States, universal service specifically is defined as "an evolving level of telecommunications service that the [FCC] shall establish periodically . . . taking into account advances in telecommunications and information technologies and services."[84] In the EU, to ensure that the changes in USO designations justify the important associated policy interventions, the Universal Service Directive established a number of criteria for modification. These usually include the popularity of the service, the diffusion of the technologies, and the likeliness that the unavailability of the service causes social exclusion. They also include considerations regarding "technological feasibility", the possibility to find "practical and efficient implementation mechanisms", and the balance between the cost of the measure and the benefits it will brings to society, always seeking to minimise market distortions.[85]

New opportunities and new challenges: Do USOs definitions need to change?

Technological innovations associated with next generation networks will be able to offer end-users access to content and services through a variety of networks and platforms, including fixed networks, cable, terrestrial wireless (mobile and fixed), satellite, or mesh networks. In addition, being IP-based, NGN may rely on cheaper connectivity, to make available a wider range of services more easily. However, the transition from legacy networks to converged next generation networks may not take place evenly across different customer groups or geographic areas. In this context, the realisation of the potential of NGN to provide more, better and cheaper services may be limited to only certain geographic areas or population groups, at least in the short to medium term.

In the context of NGN three main issues should be addressed:

- Do we still need Universal Service Obligations?
- If so, which services should be included in the definition of universal service in the new NGN environment?
- Should new approaches be developed for funding universal service programmes?

Do we still need Universal Service Obligations?

Arguably, given the increased importance of communications in everyday economic and social relations, the need to safeguard universal service has become more important. Today, there are more opportunities than ever before to access networks and services, including through growth in mobile and broadband penetration. This may make it easier to ensure that universal service is available. However, including these services in discussions of universal service could require re-examination of universal service policies, including requiring that definitions change in order to allow voice services to be provided by other than fixed networks. This, however, could require that other technologies providing voice also provide the other elements included in universal service, such as carrier of last resort obligations, facilities for the disabled, location technologies for use in emergencies and a predetermined quality of service.

Which services should be included?

As stated above, universal service represents an evolving level of service. The question of which services to include in the definition of universal service thus changes over time. Increasingly today, this question focuses mainly on whether broadband should be included. Broadband is relatively widely available in all geographic areas of OECD countries, although speeds may differ and there are countries where in rural and more remote areas no access is available. A particular concern of some countries is that, as fibre is deployed in local loops in urban areas, the service gap between urban and rural areas will widen. Recently, the EU Commission launched a review of the Scope of Universal Service, with the exact purpose of finding out if Universal Service should include 'other' basic services, rather than a fixed phone line, that are able to provide effective access to the Internet. The review, published in 2006, concludes there is a lack of necessary conditions and requirements to proceed to a modification of the Universal Service definition to include mobile communications or broadband Internet access. At the same time, however, in the medium and long-term, the EU Commission recognises that the policy debate on Universal Service should evolve in a converging and competitive communications environment.[86] The Universal Service Directive, together with the general framework for electronic communications, is due for review in 2008, which may bring about further discussion on the need to revise USO terms. For the moment, however, it appears it is still unclear whether USO will be extended to cover broadband or mobile connectivity.

Another option being examined in some countries is whether to require policies to ensure universal access to broadband at the national level. Such policies may focus on minimising the gap in services (speed) between urban and rural areas in terms of the availability of capacity. Some OECD countries are actively promoting national coverage of high-speed broadband networks These policies are often separate from universal service obligations although to some extent they have a similar purpose, *i.e.* to make available an infrastructure and access to a service on a national basis. In addition, in some instances, prices to access broadband have been set by the market such that there has been little need to provide price subsidies. (Remote areas such as the Canadian North or remote areas of Australia are notable exceptions). Therefore, it is not clear that subsidies are needed to support the provision of the broadband Internet access service. In Europe, the first country specifying a minimum bandwidth requirement for Internet access is Switzerland. The country just finished the revision of its Universal Service definition in September 2006, and decided to introduce the obligation for the Universal Service operator, Swisscom, to offer Internet access at a minimum rate of 600Kbit/s (uplink) and 100Kbit/s (downlink), at the maximum price of CHF 69 (about EUR 50). The provision of this service will be undertaken without any universal service funding. In New Zealand the government is inviting public comments on whether the Kiwi agreement should be expanded to provide a public right to broadband. Surveys conducted by the Economic Development Ministry suggest that a basic 256 Kbit/s per second broadband connection may be one of the outcomes of the discussion.

Some countries consider it important that efforts are made to ensure that next generation networks and the services they make available are provided to the extent possible equally across the country. However, many countries have recognised that it may not be possible to provide equivalence for all elements of services on a nationwide basis, although their initiatives to provide nationwide connectivity have as a goal the maximisation of nationwide connectivity.

Funding

Changes in technologies and markets may also have an impact on the funding of universal service. It may be important to ensure a more equitable sharing of the costs of providing universal service. Current funding arrangements for USO may, in general, be unsuitable for broadband and a NGN environment. Traditional operators may need to be cushioned against the effect of unpredictable revenues resulting from the transition to NGN which may require that governments consider funding USO from a wider economic base. This could include, for example, funding from general taxation revenues. Solutions should consider that the digital divide is a multifaceted problem, and policy makers should work to develop a multi-level approach to bridging it, especially in the new converged environment. Such problems range from scarcity of physical infrastructure and telecommunications investment and difficult topography, to low population densities.

Technological innovations have already started to transform the way universal access is being extended to rural and remote areas. In some countries, mobile technologies have been instrumental in extending access to communication services to disadvantaged parts of the population. In developing and least developed countries, the rapid expansion of mobile networks increased the availability of services, allowing regions access to basic phone services not previously reached by the PSTN. In many cases, the extension of mobile networks did not have to be supported by subsidies. Mobile technologies may offer access to data services at speeds that – though not similar to fixed broadband technologies – provide a wide national coverage. However, high prices for data access and bit caps, which are, at times, quite restrictive, has meant that mobile broadband access technologies are still far from being a substitute for fixed broadband access technologies, although some operators are now offering flat rate data pricing. New technologies, such as WiMAX, have the potential to complement fixed broadband access technologies and provide access in rural and remote areas where it is not economically feasible to invest in fibre networks. The need for subsidies to support these technologies is likely to depend on the specificities within each country. A technology–neutral approach to universal service allows the flexibility necessary for the most competitive and effective technology available to address the challenge of universal service, as well as allowing for the different relative costs of different technologies to be taken into account.

An example of providing connectivity to a small community in a remote area not reached by DSL, cable or fibre networks is shown in Box 5.

Box 5. Broadband in the Alps: the project in the town of Chamois

In 2005, the Italian national association of smaller towns ("Associazione Nazionale Piccoli Comuni") launched a project addressing the digital divide in smaller or remote areas not reached by ADSL or other broadband technologies. To this end, the Association signed an agreement with an Italian network solutions provider, which will provide access through broadband using satellite and Wi-Fi technologies, at relatively low prices. The pilot project was launched in Chamois, a small town of about 90 inhabitants, which has hundreds of visitors during holiday seasons. Satellite connectivity is ensured through Eutelsat, which provides a 2Mbit/s connection for EUR5,000 a year. Users access the service using Wi-Fi. Two options are available to end-users: flat access (for about EUR30/month), or by paying an hourly tariff. The company is providing the services without public subsidies, and provides access to applications for public administration, telemedicine, video-surveillance, etc.[87] However, the intrinsic characteristics of satellite technologies, in particular the delay of communications (about 1.5 seconds), make it impossible to use time-sensitive services such as VoIP, while the scarcity of backhaul is likely to act as a bottleneck to the delivery of high consumption applications, such as videoconferencing and IPTV.

Source: Associazione Nazionale Piccoli Comuni d'Italia, online at http://www.anpci.it/gest/AssociazioniEuDettaglio.asp?r=c&idV=17.

Emergency calling

Access to emergency call services is often included in the definition of universal service. Operators are required to ensure that users can access emergency services, free of charge, from any telephone, including public pay telephones.[88] However, with the migration to NGN, wireless and IP services are increasingly proposed as a replacement for fixed-line services. These services offer substantial advantages in terms of affordability and allow a larger choice of applications and services for users but they do not always provide features and guarantees that were taken for granted with the PSTN services. For example, reliable call localisation for emergency services, continuous operation during a power failure, etc.[89] Problems in providing access to emergency services by some VoIP providers stem from the nomadic nature of their services. In addition, with Voice over IP services increasingly adopting the look and feel of traditional telephones, there is an increased risk of confusion as to whether or not users have access to emergency call services. This requires action on two fronts:

- Proper education of service users

Even though traditional voice telephony is being supplemented, and eventually replaced, with new IP-based communication methods, consumers do not always realise the change of technology behind the new services, and expect they will function like the regular telephone service, including for emergency calls.[90] As a first step to address this problem, some regulators have developed provisions requiring service providers to inform users about the possibility of making emergency calls. In March 2007, Ofcom put in place a code of practice that requires all VoIP providers to make it clear to consumers whether or not their service includes access to emergency services. In addition, in July 2007 Ofcom launched a consultation on a proposal to require certain VoIP providers to offer access to emergency services.[91] The FCC has required interconnected VoIP providers to provide 911/E911 service for non-nomadic customers.

- Regulation and technological issues

Traditional phone services (provided through PSTN) have been configured to recognise a specified number for calls to emergency services (such as 112 in Europe, or 911 in the United States). Emergency calls are delivered to special call centres equipped to manage emergency response. Successful delivery of a call within those systems requires both an association of the physical location of the originator with an appropriate emergency service centre, and call routing to deliver the call to the centre. The emergence of IP as a means of transmitting voice will eventually require specific provisions requiring (interconnected) VoIP providers to enable their subscribers to access emergency services.[92] Taking into account technical difficulties, regulators are often allowing providers a more or less extended timeframe to implement provisions, and limit among the scope of the legislation to those services/applications which are most likely to engender confusion in users (mostly services that are viewed as a replacement for PSTN services).

Dealing with nomadic VoIP services in the context of emergency services is clearly more difficult in particular in obtaining caller location information.[93] In the United States, the Department of Transportation launched the Next Generation 911 initiative to address the challenges posed by new technologies to circuit-switched emergency systems. NG911 services should allow multimedia emergency calls (including, for example, emergency e–mail, instant messaging or SMS), to address the problem of nomadic and mobile IP features, and ensure a secure environment for emergency calls.

The Internet Engineering Task Force (IETF) Working Group on Emergency Context Resolution with Internet Technologies (ECRIT)[94] is elaborating a new standard to allow direct routing from VoIP devices to the emergency call centre, using a globally compatible and consistent system. The standard should show how the availability of location data and call routing information would enable communication between a user and a relevant emergency response centre. With technological evolution, access to emergency services over IP in the future may become even more efficient in comparison to the current system, as it would be global in its scope, and could be easily accessible from anywhere on any kind of network or device.

In the future, with appropriate architecture development and technical standards, it seems that the public safety community will be able to take advantage of modern technology to increase the flexibility and functionality in existing emergency systems, at the same time maintaining and improving existing performance levels. In the meanwhile, as interconnected VoIP services are threatening to compromise public safety, several governments are considering the need to react, imposing the provision of emergency services also to certain types of VoIP providers. These measures, however, should always consider current technical constraints, and while measures should aim to guarantee the safety of users, they should not constitute an unfair burden for providers, and stifle the evolution and development of VoIP.

NGN lawful interception

Subject to national legislation, all kinds of telecommunications may be subject to interception and/or data searches in relation to enquiries. Lawful Interception (LI), also called "wiretapping", consists in the interception of communications by law enforcement agencies (LEAs) and intelligence services. The requests are directed to public telecommunication networks and services, in accordance with national legislation and on the basis of the authorisation from competent authorities. With technological evolution it has become more difficult to intercept all communications of a targeted user. In the public switched telephone network (PSTN) environment interception was carried out by connecting to the line of the user at the local switch. With the advent of mobile phones, it became more difficult to implement lawful intercept since users could be at any location served by the operator and its roaming partners. The mobile signalling networks need to be monitored to detect the presence, identity and location of callers. On the technical side standards organisations have played a role in formulating standards which allow for lawful interception.

Convergence of networks and services, with users transmitting information through IP-based, mobile or fixed networks interchangeably, is exacerbating the problem of lawful intercept. To preserve the ability of law enforcement agencies to conduct electronic interception, network operators and application service providers, as well as manufacturers of telecommunications equipment, are required to modify and design their equipment, facilities, and services to ensure that they have the necessary capabilities to intercept. Governments extended the obligation to provide lawful interception from network operators to include also Internet service providers.[95] However, considering that often the reference is not anymore the connection, but the service used over the connection, questions arise as to whether the coverage of lawful intercept is adequate and whether this requires retention of data by, for example, Internet Service Providers. Communications using instant messaging or e-mail, as an example, do not necessarily have to be 'home-based', but can use web-based mail where servers are located outside a country so that cross-border enforcement also becomes important.

In this context, it is essential for law enforcement authorities to co-operate with network and service providers,[96] as well as with application service providers, and to continue to work at the international level to build effective co-operation networks among authorities in different countries.

Fixed-Mobile convergence

In the future network technology such as IMS (IP Multimedia Subsystem), should provide a standardised next generation architecture based on Internet Protocol (IP) for operators, and allow for the provision of mobile and fixed services using converged handsets embedding a radio interface such as cellular/Wi-Fi or cellular/Bluetooth dual-mode handsets. Currently, the main factor promoting FMC is the trend towards VoIP-enabled wireless telephony (VoWi-Fi), *i.e.* devices that use Wi-Fi to connect to a VoIP service such as Skype or roam between cellular and wireless LAN systems. Some of the VoWi-Fi operators are at present providing Wi-Fi based only services, but some are starting to offer FMC services by combining cellular services with VoWi-Fi. Challenges to mobile telecommunications operators are also coming from Wi-Fi hotspot operators, such as Boingo, allied with Skype. Some mobile operators are linking or considering linking their cellular networks with Wi-Fi hotspots and using VoWi-Fi to improve indoor coverage and offer low-cost calling in Wi-Fi locations.

At present there various ways being used to provide FMC services, some of which are more technologically integrated than others. Dual-mode cellular/Wi-Fi handsets and using Wi-Fi modems in the home environment to access VoIP through ADSL connections can be found in some countries. There are less evolved forms of FMC using cellular/Wi-Fi dual-mode handsets that do not have a handover function or have a handover function but do not utilise a fixed voice or broadband network in the home. Services also exist linking both fixed and mobile networks which are not technologically converged, such as those offering a single voice mailbox over both fixed and mobile networks.

The deployment of NGN is expected to accelerate the offer of FMC services which are seamless to the user and use least cost routing. In turn, this may require that regulators review existing frameworks to ensure that they are not a disincentive to the development of new services, and that existing frameworks treat new services in a technologically neutral way. Numbering policies also have to accommodate FMC services and, if existing geographic numbers are used, then, in a calling party pays system, it may be necessary to devise ways to inform the call originator if different charges will be assessed based on the called party's location. It may also be important for regulators to develop adequate market tests given that the incumbents already have market power and often their mobile operators are also the market leaders; the development of FMC can augment this market power.

Efficient spectrum management

Wireless technologies, including those using unlicensed spectrum, are becoming an important part of the telecommunications landscape. The range of technologies making demands on spectrum is growing rapidly (HDTV, mobile TV, mobile broadband like 3G and Long term evolution technologies (LTE), WiMAX, unlicensed spectrum technologies, etc). Ensuring effective spectrum management is thus becoming a key policy issue. Since most "prime" spectrum has been assigned, it is becoming increasingly difficult to find spectrum for expansion of existing uses or for innovative new businesses spawned by technological developments and market convergence. In turn, this has led to concerns on the traditional "command and control" approach in current spectrum allocation policies and management - in which key aspects of the allocation of spectrum usage rights are controlled, including exactly which frequencies can be used, for precisely what purpose, and with what technologies.

Not only is access to more spectrum required in many countries, there is a pressing need to flexibly reassign unused and underused spectrum to users who will use it most efficiently. Greater flexibility in usage/market solutions (tradability) is increasingly viewed as a way to better take into account the expected competing demands. In particular, the introduction of secondary markets for spectrum is considered as important to improve economic efficiency in spectrum markets. Secondary markets may enable spectrum resources to shift from low-value uses to higher value uses.

Spectrum trading and liberalisation are separate developments. Even without liberalisation of spectrum use, spectrum trading has some benefits. However, liberalisation allows the required flexibility giving spectrum users freedom to adopt new technologies and offer new services. Combining spectrum trading with liberalisation may help the market to decide how much spectrum should be allocated to different uses; enable faster flexible access to spectrum, including unused and underused spectrum; help to promote the development of new, spectrum–efficient technologies; and boost innovation in the use of the spectrum and spectrum-based products and services.

Even though spectrum trading is not applicable to all frequencies, it allows the opportunity cost of frequencies allocated by traditional command-and-control or the ‘commons’ approach to be imputed from those that are traded. National security, public safety, health, media pluralism and other legitimate public interest objectives need not be compromised under a spectrum trading regime. But where governments intervene in spectrum management decisions, this intervention should be clearly defined, transparent and limited in scope wherever possible. Given the importance of wireless in rural and remote areas, and the difficulties in replicating some fibre networks, changes in spectrum markets are important. It needs to be stressed that the use of secondary markets for spectrum does not apply, and indeed cannot apply, to unlicensed bands since these bands are not allocated to any specific user or service. It is also important that such unlicensed bands continue to be set aside for unlicensed use.

Countries have an important opportunity to introduce reforms in spectrum markets over the next few years with the shift to digital transmission from analogue in TV markets which will free a significant amount of spectrum bandwidth making it potentially available for other applications. Taking into account the expected competing demands to use the spectrum dividend and the uncertainty of technology development and convergence of services, a market-based property rights approach (exclusive usage rights + tradability) coupled with flexible spectrum use (in broader terms), subject to public interest objectives (cultural diversity and pluralism of information, international agreement, interference protection, etc.) may be considered.

4. Broadcasting convergence into IP-based networks: competition or consolidation?

The digitalisation of content, added to the shift towards IP-based networks, the diffusion of high-speed broadband access, and the availability of multi-media devices, allowed an increasing convergence of broadcasting and telecommunication sectors. The production and diffusion of audio-visual content does not seem to be limited to traditional broadcasters anymore. Telecommunication operators are providing content along with Internet access, newly emerging providers are offering access to content over IP, and traditional broadcasters are crossing over to other platforms, transmitting their programmes also over IP networks (see Table 5).

Furthermore, the development of next generation mobile services – using 3G and 4G networks, or mobile broadcasting systems – enables the delivery of high quality audiovisual (AV) content to portable devices and mobile phones. Convergence is nowadays a reality, with different types of content and communication services delivered through the same pipes and consumed over a variety of platforms and user devices.

Convergence over multiple access platforms has not only affected the distribution market, but also created new forms of usage, providing consumers with greater choice and control over content. Multimedia, interactive audiovisual services are increasingly transforming users from passive watchers of TV programmes to active players able to decide what they want to see, when and on which device. Video on Demand, Personal Video Recorder (PVR) services, peer to peer (P2P), or user–created video, therefore, herald an important change in the traditional broadcast model to exchange audiovisual content among large audiences. Media consumption, tastes and preferences may become more fragmented, the importance of social networks as a means to participate in content creation will probably continue to grow, and there will be an increasing demand for new types of content, able to fully capture the new capacity of the Internet for interactivity, non-linear consumption and participation.[97]

Table 4. Different examples of ways to access content in a converged environment

	Provider	Content	Business model	Upload of user created content	Geographic restrictions
Managed IP networks	France Telecom	DTT + VoD (DSL)	Commercial + subscription channels	No	Yes
	BT Vision	DTT + VoD (DSL)	Commercial + subscription channels	No	Yes
New Internet service/applicat ion providers – IPTV model	Joost	Streaming Independent / private content producers	Ad-supported	No	Yes – geographical blocking, depending on content rights
	Babelgum	Streaming Independent / Private content producers	Ad-supported	No	Yes – geographical blocking, depending on content rights
Broadcast operators	Hulu (BETA) NBC/News Corp.	Premium content from NBC/Fox + content from 15 other cable channels. Streaming from the main site or distribution partners (AOL, Yahoo, Comcast, MSN, MySpace	Ad-supported, banners alongside the video, text along the bottom of the picture or clips	No	Yes: cannot access the service from outside the US
	BBC	On demand 7 day catch-up of BBC TV and radio programming	-	No	-
	YouTube	User Created Content, short professional video/trailers, promotional material	Ad-supported, targeted adverts, banners, etc	Yes	No
	iTunes	Download of movies, music, and podcasts. Distribution agreements with major content producers	Pay per download. Free content is also available (podcasts)	Through podcasts	Yes, cannot download movies outside the US

What has changed?[98]

The evolution of technology does not necessarily change many of the social and cultural broadcasting policy objectives, but technology may change the way that they are presently implemented and may allow for increased market liberalisation than that which has been common in the sector while allowing the core policies to be maintained. The digitalisation of transmission, for example, enables a more efficient use of spectrum than analogue transmission, increasing significantly the number of terrestrial broadcasting channels which can be made available. When analogue TV signals are switched off (which in OECD countries is expected between 2006 and 2015), a significant amount of spectrum bandwidth will be freed up, and will be available potentially for other applications, such as mobile television, high-definition television, mobile broadband networks and WiMax networks.[99]

Audio-visual content providers may include – in addition to traditional broadcasters – network operators, which are usually providing digital television and content over IP networks (such as Video on Demand) as part of their "triple play" bundles, or new service providers, such as Joost,[100] using P2P technologies to stream content over the Internet, or YouTube, based *inter alia* on user created content. Broadcasters are also entering the IP market, launching new content platforms, such as Hulu – a NBC/NewsCorp venture (see Table 3).

As the market for audiovisual services becomes more dynamic, content producers will be able to offer services directly to all new markets without intermediaries or gatekeepers. With content available on new platforms and networks, there should be lower entry barriers, and the sector could become more open and competitive over the next years. At the same time this will bring up the issue of the need for network neutral policy approaches, for both fixed and mobile networks, in order to avoid the creation of barriers to access for independent service providers.[101]

In addition, existing government instruments to control broadcasting content – such as quotas for protection of language and culture, pluralism requirements, or must carry obligations – are challenged by the new multiplatform environment, and may need to be adjusted in order to continue to fulfil their goals.

Convergence not only leads to a larger and more competitive market, but also a more international market. A globally structured market – in terms of ownership, investment, and distribution and marketing strategies – offers an enormous potential to the media industries, but also poses new challenges to national regulation, which may not always be compatible across borders, therefore risking to be less effective, not enforceable, or – if excessively restrictive – to slow down growth of media players in an international content market.

A converged approach to content

While convergence may contribute to plurality and diversity, as it lowers market entry barriers, it creates new issues and challenges to existing policy. The telecommunication and broadcasting policy traditions may need to adjust in order to cope with the changing markets and to continue to achievie common policy objectives.

- Scope of regulation

Audiovisual content is increasingly distributed via a broad range of digital technologies that transmit to television, computers, as well as mobile and portable devices, blurring boundaries between "video" and "broadcasting services". The scope of the definition of broadcasting services[102] is relevant considering the detailed regulation which is usually imposed on broadcasters and usually aimed at addressing a number of social and economic interests, such as the need to maintain plurality and cultural diversity, develop national identity, and implement certain standards of decency. Policy makers need to determine whether and to what extent existing broadcast regulations should apply or be adapted to a wider range of content packagers and suppliers, and to what extent existing broadcast regulation may be reduced.

In order to address technological evolution, the Council of the European Union and the European Parliament in their work differentiated between television broadcasting ("linear" audiovisual service), where the broadcaster establishes the programme schedule; and "non-linear" content, *i.e.* on-demand audiovisual services. They also separated "television-like" on-demand services, which refers to content comparable to television broadcasting, from other content available on IP-based platforms – such as user created content.[103]

The scope of the Audiovisual Media Services Directive[104] adopted on 11 December 2007 covers the first two types of services (television broadcasting and "television-like" services), to which the directive's provisions are applicable, and special provisions are dedicated to on-demand services only. In Canada, the independent regulator, CRTC, exempted from licensing or other requirements of the Broadcasting Act all broadcasting services and mobile television service over the public Internet but not television broadcasts over managed IP-based networks.[105] The EU proposals specifically note that they are not aimed at user created content. However, depending on the definition of "editorial responsibility" and "effective control"[106] adopted by EC countries, the dividing line between regulated and unregulated services may shift. It is important to stress that new technological developments do not imply that existing regulations need to extend their coverage over other platforms of services,[107] as, if they were implemented without appropriate adjustments to the nature of these platforms, they could stifle the take up of innovative services.

- Ensuring effective competition

Convergence is helping to intensify competition in broadcast markets by impacting on delivery networks and services. Convergence can help reduce access bottlenecks by allowing services to be delivered on a number of different platforms, and by creating market entry opportunities by new providers stimulates innovative services. The entry into the audio-visual market by new players, such as telecommunication network operators and larger Internet-based companies, can reduce market power in broadcasting. However, access to content is important for new entrants so that if larger companies or joint ventures (horizontal integration) control media rights for the most interesting premium content, it may be difficult for new entrants to provide competitive offers.[108]

In addition, the development of some of the new technologies and services depends on the spectrum which is made available. With the shift to digital television more spectrum will be freed up and will be available for other services. The allocation of the so–called "digital dividend" can therefore have an impact on the development of new services in the content market.[109] Currently it seems that the request for spectrum will be driven by mobile television (see Box 6), high-definition television and wireless services, such as WiMax.

As it is currently difficult to foresee how a converged audio-visual sector will evolve in the next years, most policy makers in the OECD are taking a "light touch" regulatory approach. This approach may also need to be complemented by instruments addressing specific bottlenecks and helping the competition process, for example to ensure consumers are properly informed, reduce switching costs for users, and remove possible barriers to entry for competitors (including spectrum). [110]

The increasing globalisation of the audio-visual service market is raising additional issues regarding competition, questions on whether there is a need for increased harmonisation of regulation relating to advertisement, quotas, and the like. In addition, a number of rules exist at the national and at the European Union level that aim at promoting cultural and linguistic diversity of audio-visual contents by setting up limits or rules applicable to the international trade of audio-visual services. These rules are conforming notably to the UNESCO Convention on the protection and promotion of the diversity of cultural expressions adopted in October 2005 and since then ratified by more than 75 Member States, according to which governments are able to protect their national content. Finally, difficulties are posed by the application of different copyright schemes for content at local/regional levels.

At the level of the broadcasting market itself few countries have moved in undertaking significant reforms to try and enhance competition in these markets, while taking into account public interest mandates. These mandates have often been used to slow down market entry and limit competition. Technological and market change provide an opportunity for broadcast regulators to undertake fundamental reviews of regulatory frameworks.

Box 6. Mobile video content

The limitations and the cost of offering television on 3G networks using Multimedia Broadcast Multicast Service (MBMS) have encouraged operators to try to obtain separate allocations of spectrum for mobile television using a number of technologies. In addition, the interest for the allocation of new spectrum bandwidth may also be a means of pre-empting competition from broadcasters offering mobile television, and push convergence from the network into the handset.

The mobile television market does not seem to have deployed its full potential yet and innovation has been lagging behind, with sometimes restrictive platforms adopted by the wireless carriers and phone manufacturers. The EC estimated that the market for mobile TV would reach EUR20 billion by 2011, however it seems that mobile operators still have difficulties in identifying the appropriate business model for the service. Currently, revenues for mobile TV mainly come from subscriptions, as advertising is not expected to be significant because of low usage.[111] However, in order for the service to be profitable, a 2006 OECD study noted that penetration needs to reach a level of about 10% – as is already the case in Korea or Japan; while in other OECD countries it is still below 1%.[112]

In November 2007, Google announced the launch of a new mobile operating system called Android. Based on Linux, Android provides an open platform for developers to create their own applications for a wide range of mobile devices, and will be available for free to cell phone manufacturers. Mobile-tailored content with targeted advertisement could therefore be one of the future models for mobile television. Another model for mobile television could be Qualcomm's one-way, multicast video programming network, MediaFLO. The MediaFLO service is currently offered by one mobile operator in the United States in approximately 40 US markets.

Regulation can play an important role in the successful take-up of mobile TV, ensuring effective and transparent spectrum management and allocation procedures, promoting competition of platforms and networks, interoperability, and the development of common standards.[113]

- Spectrum allocation

The switch off of analogue TV signals and the shift to digital transmission will make available a significant amount of spectrum bandwidth (the so-called "digital dividend") which could be used for the provision of enhanced TV services, more TV channels, or some advanced wireless communication services.[114] Discussion is currently ongoing in many OECD countries on the allocation of the "digital dividend". In particular, the availability of spectrum to develop new wireless networks could help new entrants to create alternative access infrastructures and deliver directly their services to users, competing with incumbent operators. At the same time, mobile carriers are looking at the new available spectrum as an occasion to increase their bandwidth capacity and provide their customers with improved audiovisual services.

- Public interest objectives for content

The rationale for special regulation of broadcast content is changing along with digitisation and increasing access to on-demand audio-visual services: there is more choice, an increasing proportion of consumers can control the time of consumption of content, and the amount of programming and information have increased significantly in recent years. It is important, in view of the changes in the supply of information and programming, to reconsider how public interest objectives can be achieved in the digitalised IP world.

Some have argued that in a dynamic and diverse on-demand world, a scenario relying only on mandatory rules could be ineffective and undesirable. In particular it has been argued that in a converged audiovisual environment content control should partly move from institutional supervision to a system based also on individual responsibility of users (for protecting themselves and their children), plus voluntary regulation of content standards by commercial content providers. [115] There are growing instances of the development of codes of conduct and self-regulation,[116] and overall of increasing co-operation between governments and private companies. As an example, the recent Recommendation of the Council of Europe on "*promoting freedom of expression and information in the new information and communications environment*" encourages dialogue between Member States and the private sector in order to clearly define respective roles and responsibilities, and to ensure that complementary regulatory systems – such as new forms of co-regulation and self-regulation – respond adequately to the changes in technological development.[117] While the objective of the Recommendation is to protect users, it also raises issues regarding the possible abuse of such measures and their lack of transparency vis-à-vis end-users.

Audiovisual service offered by Internet providers that simply host the content uploaded directly by users, cannot be included in a possible definition of broadcasting service. The service provider often is not exerting editorial control, and therefore does not have the responsibility for the content available on line. This does not exclude, however, the application of general Internet regulation.[118]

- Advertising

Advertising quotas and time frames were developed to limit commercial communications in traditional linear, point to multipoint broadcast transmissions. In a more interactive environment, and with VOD and PVR providing some possibility to skip frames, the traditional advertising model has become less effective, while at the same time regulations constrain the development of different models. A controlled liberalisation of some rules for television advertising, such as product placement, interactive online selling and banners during certain programmes, could help the development of new business models, allowing broadcasters to compete with innovative Internet-based video services, at the same time protecting the interests of users.[119]

- Quotas

A number of OECD countries have content quotas, usually for language (minority languages) or specific categories of content (such as religious or cultural programmes, or independent productions). In many cases quotas are combined with timeframe requirements for the transmission of the content. Quotas have been established when users had a limited choice of TV channels, and the exclusion from this transmission platform meant the impossibility to address large audiences.

With technological development, TV viewing habits have changed, and more choice is available to users. This does not mean that stimulating or ensuring the availability of specific types of content should be discontinued. It is still important to guarantee access to certain kinds of programmes; however quotas are becoming less important and may not be adapted – without appropriate modifications – to new platforms. New instruments should be considered by policy makers, including for example the possibility of offering non-linear services for specific types of production, which interested users will be able to access – for free – at the time they prefer.[120]

- Must carry

Most OECD countries enforce some form of "must-carry" regulation. These rules were devised during a period of scarcity of distribution networks, and usually imposed on what the public considers as "primary networks". In the European regulatory framework on electronic commerce, for example, article 3(1) of the Universal service directive permits member states to impose proportionate and transparent “must carry” obligations on cable television network operators. These obligations may also be imposed on terrestrial and satellite networks.

As a result of technological and market developments, there is less dependence on a single infrastructure, and more channels and platforms for distribution of content are now available. Must carry rules should therefore be limited to a reasonable number of channels, including especially public service channels. Instead of “must carry”, consideration could be given to a framework whereby terrestrial broadcast channels should be subject to “must offer” requirements, *i.e.* certain broadcasters are obliged to offer their content to other platforms if they ask for it (so that content will not be “locked-in” on a single platform, but can be made available through different devices).[121]

5. The institutional environment

In a number of OECD countries there has traditionally been a distinction between broadcast regulators and telecommunication regulators. In some countries, even though there may be a single regulatory body, there are distinct legal frameworks for broadcasting, cable television and telecommunications. Significant regulatory changes have already affected the telecommunication sector, and while changes have been made in broadcast regulation they have not been in the amplitude of those in telecommunications. Broadcast regulators have, in general, been more cautious in opening up the market to increased competition even though this competition has emerged from telecommunication networks and the Internet.

The implications of convergence on regulatory institutions has focused on whether separate bodies should merge into one, and whether there should be two regulators, one for content and one for carriage. There are a number of issues that need to be taken into account to determine the appropriate regulatory structures. It is important for industry to have coherence which is easier to achieve through a single regulator. Content and carriage are not independent and with convergence it is necessary to take into account a much broader view of the market, market entry possibilities and how these developments impact on plurality in the content market. Minimising the number of regulators that an enterprise needs to deal with is also important in order to minimise regulatory costs, and reduce the potential for uncertainty and inconsistency.

The area of spectrum allocation is one of particular importance to the broadcasting and telecommunication sector – a single regulator is better placed to assess the cost and benefits of different allocation proposals across the industry rather than separate regulatory bodies who often are more concerned in ‘protecting’ their part of the industry than they are with the wider question of increasing overall spectrum efficiency. In some countries broadcasters need two licences, one to operate the carriage network including spectrum and one to operate a broadcasting content service. Concern has been expressed that with a single regulatory body, issues of culture would come secondary to arguments on efficient market mechanisms and competition. The UK experience is helpful here where a Content Board with a wide membership was created which works within OFCOM, but is to some extent separate from OFCOM.

Regulators in broadcasting and telecommunication have had an important role in regulating dominant market positions. Convergence is changing the definition of the market which has implication for decisions on dominance depending on how broadly the market is defined. Convergence is also leading to the creation of new and emerging markets which produces another set of difficulties in defining the market. Convergence may also lead to more vertical integration, for example, through mergers and commercial agreements between owners of delivery platforms and content providers which will mean that some decisions concerning the regulation of carriage will have an impact on the provision of content and vice versa. Network operators able to deny access to competitors (or impose delays or unreasonable conditions) can create substantial barriers to entry and reduce competition. When the network operator is a vertically integrated enterprise with interests in the provision of content services, the concern about the potential for anticompetitive behaviour is heightened.

Convergence driven by NGN is clearly increasing the need for better horizontal co-ordination in regulation of the communications sector widely defined. It is especially important in the field of spectrum management and carriage regulation to establish efficient resource management, to avoid market distortion and to improve competition between infrastructures. A single regulatory authority would be best placed to bring about the necessary market efficiencies which could be achieved through convergence.

6. NGN and network security

The convergence of networks towards all-IP architecture provides operators with great opportunities to reduce their costs, and develop integrated services across fixed and mobile access increasing subscriber welfare. Network convergence needs to be complemented by convergence in the underlying security of policies, measures and practices to avoid NGN is subject to the attacks experienced today by IP networks carrying Internet, e-mail and presence applications.[122] As operators move from trials to wide commercial roll-out, questions regarding how to guarantee security across multiple networks are becoming more urgent.

IP-based next generation networks and the traditional circuit switched networks operate in different environments and are therefore exposed to different types of threats and attacks, both from within or externally. With converged networks, operators are migrating from a stand-alone “closed” environment, such as the PSTN, to an open environment. The PSTN infrastructure is controlled by operators, and users have a lesser amount of information on its structure and functioning, as well as fewer possibilities to misuse the network. This situation, sometimes labelled as “security by obscurity”,[123] stands in contrast with the design of the IP infrastructure, based on open protocols, which were not originally designed for security implementation.[124] IP networks enable the provision of services – such as voice, data, and multimedia – provided by multiple access and service providers, and are connected with a growing number of devices, which are moving to open platforms, becoming increasingly powerful, and providing users with the possibility to actively interact with the network.

Security in a converging environment is not only a technical, but also an economic and social issue. On the economic side, networks are an integral part of the global information infrastructure, defined as an essential, indispensable facility for society, whose disruption would rapidly bring about a state of emergency or could have adverse societal effects in the longer term, and as such they need to be protected.[125] Governments and businesses alike are eager to adopt innovative services and applications; however, in order to be able to rely on them, they require appropriate levels of assurance to protect their information and transactions. Security is essential for the industry to be reliable and competitive in the global market.

The social dimension of security is also important: consumers are becoming increasingly dependent on information systems, and convergence of networks and services will expand opportunities to be connected anytime, anywhere. While the growing empowerment of users enables them to benefit more from ICTs, it also entails less positive consequences, such as increasing security and vulnerability risks, which threaten users’ transactions, privacy, and personal data. At the same time, with advanced and always-connected devices at their disposal, users may unwittingly become a vehicle for security attacks.[126] New and advanced solutions to security issues are being discussed at national and international levels, and several initiatives are currently underway.

The borderless nature of IP networks means that security threats affecting the converged infrastructure can arise from anywhere. The main challenges across borders include the necessity to improve co–operation of law enforcement activities against security offences, with particular attention to consistency of cybercrime legislation and regulations. In addition, international co–ordination and exchange of information is essential to create a global understanding of security risks and solutions linked to converged networks.

Although security is a priority in the future networks, it is also important to ensure an appropriate balance between civil liberties and security solutions – at the technical, policy or regulatory levels – in order to avoid excesses leading to violation of users' privacy, or illegitimately limiting individuals' rights to anonymity and freedom of expression.[127] It is also important to take into account the direct and indirect costs which may be incurred from securing networks. These costs also reduce the openness of networks and may impact on innovation.

At the regulatory level, greater emphasis is put on regulatory oversight in the implementation of security measures. Already in 2002, the *OECD Guidelines for the Security of Information Systems and Networks* recognised the need to tackle a growing number and a wider variety of threats and vulnerabilities in information networks, and called all participants, which include "governments, businesses, other organisations and individual users who develop, own, provide, manage service and use information systems and networks" to "focus on security in the development of information systems and networks".[128] On the same note, the 2002 EU Directive on Data Protection specifies, in its article 4, that "the provider of a publicly available electronic communications service must take appropriate technical and organisational measures to safeguard the security of its services".[129]

International standard development organisations (SDOs) such as ITU, ETSI, ISO, IETF, and 2GPP/3GPP2, are currently working to integrate security into the definition of NGN standards and protocols, in order to appropriately address security in the design phase of the new generation of networks. A set of specifications for IMS standards has been included in IMS Release 7, while TISPAN, in the preparation of its NGN Release 1, has been working on an equivalent set of specifications for broadband fixed access. TISPAN aligned its security approach with 3GPP where convergence was identified, adding TISPAN-tailored security specifications in areas where there are differences between fixed and mobile architecture. For example, pure wireline solutions do not have the same vulnerability as the mobile interface, which allows for the introduction of simplified security scenarios; on the other hand, fixed networks have to support inter-working with many sets of more or less secure protocol stacks, and with a wider variety of access technologies compared to mobile operators. In addition, user equipment vulnerability is more pronounced in fixed than in mobile networks, as users can modify their equipment without prior notice to the provider.

In general, ITU Resolution X.805 on "security architecture for systems providing end-to-end communications" identified five possible threats menacing a networked environment:[130]

- Destruction – destruction of information and/or network (an attack on availability).
- Corruption – unauthorised tampering with an asset (an attack on integrity).
- Removal – theft, removal or loss of information and/or other resources (an attack on availability).
- Disclosure – unauthorised access to an asset (an attack on confidentiality).
- Interruption – network becomes unavailable or unusable (an attack on availability).

The risks and vulnerabilities attract ting the attention and concerns of NGN operators at the moment seem to be mostly identity theft[131] and Denial of Service (DoS) attacks. The former directly threatens revenues, while the latter endangers service delivery and quality, thus impinging on the reputation of the provider.

In a layered architecture, such as that of NGN, where services are separated from transport and access is enabled from multiple devices, security has to be considered at different points in the NGN architecture. In its NGN Release 1, ITU stressed the need to provide security of end-users communications across multiple-network administrative domains,[132] and identified three security layers: Infrastructure security, service security and application security.[133]

NGN solutions vendors also address the problem of security at different layers. These include access security, addressing direct or indirect connectivity of networks to user equipment (UE); Intra-domain security, which is under the responsibility of the operator of the domain in question; and inter-domain security, *i.e.* security risks and threats associated with interconnection with untrusted and trusted[134] networks. In the latter case, security policies[135] from the originating network are usually enforced towards the destination network domain thanks to the utilisation of "Security Gateways" (SEGs), situated at the borders of different domains and communicating during interconnection.[136]

A specific example of possible security issues in an NGN environment can be provided by Voice over IP services. Voice is a critical service which in the past has benefited from separate PSTN and mobile networks, and had a certain degree of reliability. Shifting from PSTN to IP, the existing redundancy may be lost due to network convergence, and VoIP may inherit many of the problems already experienced by TCP/IP protocol data communications, such as attacks on confidentiality, integrity, availability and authenticity. Some of the current threats include transmission of viruses and malware, eavesdropping, Denial of Service (DoS) attacks, but also power failures (see Table 6). Although operators are currently working on secure solutions for VoIP, service providers believe that it may be difficult to implement security while maintaining an appropriate level of Quality of Service, because of the burden of extra processing and the possible delay in communication transmission it may cause.[137]

Table 5. Threats and risks for VoIP

Threat	Risk Issues
Eavesdropping through interception and/or duplication	Access can be gained through any access point to the voice network (particularly if there are wireless access points in the same network that supports the VoIP service). Once access has been gained, network sniffer tools are commonly available to intercept IP–based traffic.
Loss, alteration or deletion of content	Exposure to programmed attack *e.g.* programmed substitution of Dual-Tone Multi-Frequency (DTMF) or Interactive Voice Response (IVR).
Caller ID/location may not be identified in an emergency	Complex numbering schemes, combined with incorrect PSTN access point routing, may provide wrong location information to emergency services. There is a greater risk of this happening when calls from remote offices are routed over a Wide Area Network (WAN) before reaching the PSTN.
Lack of capacity/system management	Other network traffic can impact on VoIP traffic.
Denial of service attack	Swamping of network traffic resulting in no capacity to support voice. Can be targeted from within the enterprise or externally.
Viruses and other malware	Swamping of network traffic resulting in no capacity to support voice. Can be targeted from within the enterprise or externally. Viruses can also target specific VoIP protocols.
Power failure	VoIP is different to traditional telephony in that voice services are potentially vulnerable to a number of power failure points within the data network, *e.g.* local router and switches. In contrast, traditional telephony handsets are powered from one centralised point, usually with a backup battery bank.

Source: Trusted Information Sharing Network (TISN) "Security of Voice over Internet Protocol: Advice for Chief Information Officers", September 2005. Online at :http://www.dcita.gov.au/communications_for_business/security/critical_infrastructure_security (last accessed April 2007).

An issue which may need to be specifically addressed in the context of NGN security, is Identity Management, which in the NGN field has been technically described (at the working level) as the "management by NGN providers of trusted attributes of an entity such as: a subscriber, a device or a provider".[138] In a converged environment users could be able to use a single authentication mechanism (sign-in) on any access point to the NGN. The development and implementation of an authentication mechanism allowing a single and secure identification while protecting users' privacy, however, meets complex technical challenges.[139] In an environment with multiple providers, a common authentication process is difficult to achieve, and crucial in order to maintain a relationship between users, devices, and service and access providers. In addition, interoperable Identity Management is an issue which spans all layers from infrastructure to applications, and requires both technical and regulatory approaches harmonised at the international level.[140]

GLOSSARY

3GPP:	3rd Generation Partnership Project
3GPP2:	3rd Generation Partnership Project 2
AUTH:	Authentication
AV:	Authentication VectorAudio-Visual
CAPEX:	CApitale Expenditure
DoS:	Denial of Service Attack
DVB-H:	Digital Video Broadcasting - Handheld
ESP:	Encapsulating Security Payload
ETSI:	European Telecommunication Standardisation Institute
FTTH:	Fibre to the Home
FTTN/C:	Fibre to the Node or to Curb
HDTV:	High Definition Television
HSS:	Home Subscriber Server
I-CSCF:	Interrogating Call Session Control Function
IETF:	Internet Engineering Task Force
IDM:	Identity Management
IETF:	Internet Engineering Task Force
IMS:	IP Multimedia Subsystem
ITU:	International Telecommunication Union
LLU:	Local Loop Unbundling
MDF:	Main Division Frame
MPLS:	Multi Protocol Label Switching
NGN:	Next Generation Networks
OPEX:	Operational Expenditure
P-CSCF:	Proxy Call Session Control Function
P2P:	Peer to Peer
PoC:	Push to Talk over Cellular
PON:	Passive Optical Networks
PVR:	Personal Video Recorder
SDOs:	Standard Development organisations
SIP:	Session Initiation Protocol (IETF)
SIP:	Session Initiation Protocol
TISPAN:	Telecommunication and Internet Converged Services and Protocols for Advanced Networks
UCC:	User Created Content
UE:	User Equipment
UMA:	Unlicensed Mobile Access
VCC:	Voice Call Continuity

NOTES

1 See http://www.openhandsetalliance.com/index.html.

2 See OECD "Participative Web: User Created Content", online at http://www.oecd.org/sti/internet-economy.

3 http://www.joost.com/.

4 http://www.slingbox.com.

5 ITU-T Recommendation Y.2001, approved in December 2004, available at http://www.itu.int/rec/T-REC-Y.2001-200412-I/en.

6 See for example: Viviane Reding, European Commissioner for Information Society and Media, "The Access Revolution: an evolution of regulation for competition", address to the annual KPN event, Brussels, 14 January 2008.

7 DOCSIS refers to "Data Over Cable Service Interface Specifications".

8 See Netwerkstructuur Hoofdnet, picture of the Essent @ Home network http://www.corp.home.nl/NR/rdonlyres/CD94491F-9967-411A-81DF-717747D4F116/0/hoofdnetekc.gif.

9 Data Over Cable Service Interface Specifications, Docsis 3.0, Cable Television Laboratories Inc. http://www.cablemodem.com/downloads/specs/CM-SP-PHYv3.0-I02-061222.pdf.

10 *OECD Communications Outlook 2007*; OECD, The Implications of WiMAX for competition and regulation", 2006; OECD "Universal Access and NGN", 2006.

11 OECD, "The implications of WiMAX for competition and regulation", online at http://www.oecd.org/LongAbstract/0,3425,en_2649_34223_36218740_1_1_1_1,00.html.

12 OFCOM, Regulatory challenges posed by next generation access networks, 23 November 2006. Online at http://www.ofcom.org.uk/research/telecoms/reports/nga/nga.pdf.

13 European Telecommunication platform (ETP); OFCOM Public Discussion Document: "Regulatory challenges posed by next generation access networks" (hereinafter "OFCOM NGA"), 23 November 2006, online at http://www.ofcom.org.uk/research/telecoms/reports/nga/nga.pdf (last accessed February 2007). See Telecom Italia Project NGN2, Presentation at the meeting with the financial community, March 2007, online at http://www.telecomitalia.it/TIPortale/docs/investor/ID_Pileri_NT_OK_noNote.pdf .

14 The IEEE P1901 Work Group for Broadband over Powerline is aiming to develop an international standard and permit interoperability between competing specifications.

15 See OECD paper on "Fixed-Mobile Convergence: Market Developments and Policy Issues" online at http://www.oecd.org/sti/ict.

16 Standardisation of this technology has stabilised during 2007 and field trials and pre-commercial trials are taking place in 2008-2009.

17 See FCC Annual Report and Analysis of Competitive Market Conditions with Respect to Domestic and International Satellite Communications Services, March 2007.

18 For an example of upstream and downstream speeds needed to deliver advanced, converged services and application, see "Broadband Availability and Adoption in California, Final Report of the California

Broadband Task Force", p. 12, January 2008. Online at:http://www.calink.ca.gov/pdf/CBTF_FINAL_Report.pdf.

19 See ERG Opinion on Regulatory Principles of NGA, online at: http://erg.ec.europa.eu/doc/publications/erg07_16rev2_opinion_on_nga.pdf

20 Ernst Langmantel, "NGN as Multimedia Implementation of Legacy Telco Model?", Presentation at the ITU NGN Workshop, Geneva, May 2006; and ERG Report on IP Interconnection (hereinafter "ERG Interconnection Report" [ERG(07)09], February 2007, online at http://erg.eu.int/documents/cons/index_en.htm.

21 See OECD, "Internet Traffic Prioritisation", DSTI/ICCP/TISP(2006)4/FINAL, Paris, April 2007.

22 ITU Rec. Y.2001 (2004).

23 ERG Interconnection Report (2007).

24 Scott J. Marcus, "Interconnection on an IP-based NGN environment", discussion paper for the ITU Global Symposium for Regulators, Dubai, February 2007, online at http://www.itu.int/ITU-D/treg/Events/Seminars/GSR/GSR07/agenda-documents.html.

25 F. Fuentes, presentation, European Telecommunication Platform. Online at http://www.etp-online.org.

26 See OECD "Fixed-Mobile Convergence: Market Developments and Policy Issues" (2007), page 8, Figure 1. Online at http://www.oecd.org/dataoecd/20/26/38309911.pdf (last accessed April 2007).

27 Source: OECD, adapted from OECD study on "Participative Web and User Created Content" (2007); ERG Workshop on Next Generation Networks: "NGN Regulation and Investment", Turin, 17 April 2007.

28 Quoted in G. Bertrand, "The IP Multimedia Subsystem – An overview" (2006), from A. Cuevas, J. Moreno, P Vidales, and H Einsiedler, "The IMS Service Platform: A Solution for Next Generation Network Operators to be More than Bit Pipes", *IEEE Communication Magazine*, August 2006.

29 Telecom Italia, Meeting with the Financial Community 2007, presentation by Riccardo Ruggiero, TI CEO, available online at http://www.telecomitalia.com/analystmeeting2007/eng/index.html.

30 See BT Global Telecom News, online at http://www.btgtm.com/BTGlobalTelecomNewsFixed/Article.asp?ArticleCode=79681832&EditionCode=68857552 (12 April 2007); Zdnet "BT to offer 21CN experience overseas", 6 December 2006, online at http://news.zdnet.co.uk/communications/0,1000000085,39285012,00.htm.

31 KPN presentation on "All-IP", Turin ERG Workshop on Next Generation Networks: "NGN Regulation and Investment", 17 April 2007; http://erg.eu.int/doc/whatsnew/kpn_van_den_beukel_erg_17_apr_07.pdf.

32 KPN Annual Report, 2006, online at http://www.kpn.com/upload/1786687_9475_1173767749534-KPN_Annual_Report_and_Form_20-F_2006.pdf.

33 IMS is an architectural framework for delivering *Internet protocol (IP) multimedia services to mobile users, aiding the access of multimedia and voice applications across wireless and wireline terminals, and therefore foster fixed mobile convergence (FMC). Initially developed in the framework of the Third Generation Partnership Project (3GPP), IMS Release 7 was developed in co–operation with ETSI TISPAN, in order to support fixed networks. See http://www.etsi.org/tispan/. S. Pileri, Telecom Italia, presentation at the meeting with the financial community (2007); British Telecom, with its 21st Century Network project; France Telecom announced its plans to introduce IMS in its networks starting from 2007, etc.

34 Alessandro Rossi, Italtel, phone interview, March 2007. "Technical progress, market evolution and the regulation of the electronic communications sector in the EU", Paul Richards, BT.

35 The IP Multimedia Subsystem (IMS) was originally developed for 3rd generation networks and is now considered the standard for fixed and mobile IP-based communication by mobile operators.

36 Alessandro Rossi, Italtel, telephone interview, March 2007.

37 See for example Ericsson IMS products description at http://www.ericsson.com/products, or Nokia IMS at http://www.nokia.com/A4126030.

38 The 3rd Generation Partnership Project (3GPP) brings together a number of telecommunications standards bodies which include ARIB, CCSA, ETSI, ATIS, TTA, and TTC. See the 3GPP website online at http://www.3gpp.org.

39 See 3GPP Active Work Programme, Voice call continuity (VCC) between CS and IMS (incl. I-WLAN), online at http://www.3gpp.org/ftp/Specs/html-info/FeatureOrStudyItemFile-32091.htm.

40 Unlicensed Mobile Access (UMA), is the 3rd Generation Partnership Project (3GPP) global standard for subscriber access to mobile circuit, packet and IMS-based services over any IP-based access network, including the Internet. UMA allows seamless roaming and handover between local area networks and wide area networks using a dual-mode mobile phone. See http://www.umatoday.com/umaOverview.php.

41 Summary report of the OECD Foresight Forum "Next generation networks: evolution and policy considerations", Budapest, 3 October. Online at www.oecd.org/sti/ict.

42 See ECC/CEPT, "Next Generation Network Developments and their Implications for the New Regulatory Regime", 2003.

43 OECD, "Global Information Infrastructure - Global Information Society" (GII-GIS), online at http://www.oecd.org/document/18/0,3343,en_2649_33757_1912210_1_1_1_1,00.html.

44 Telecommunication Regulatory Institutional Structures and Responsibilities, DSTI/ICCP/TISP(2005)6/FINAL, 11 January 2006.

45 See Arthur D. Little for Liberty Global, 2006 at http://www.vecai.nl/downloads/docs/ADL_report.pdf, in Dutch.

46 The speeds available for xDSL connections are dependent on the distance between the switch and the customer with speeds deteriorating rapidly with distance.

47 This paper deals mainly from the perspective of fixed networks. Wireless technologies are in general considered to be less competitive than fixed networks given technological limitations and the shared nature of wireless networks which reduces bandwidth availability with the increase in the number of simultaneous users logged onto the network. This is not to imply that wireless networks do not play a useful role in complementing fixed networks, as part of a converged offer, or in providing service, albeit of less quality than fixed networks, to areas which are difficult to reach with fixed networks.

48 See DSTI/ICCP/CISP(2007)4/FINAL, "Developments in Fibre Technologies and Investment", OECD, Paris, 2007.

49 Terminology with respect to fibre delivery is not always consistent. FTTH (fibre to the home) implies fibre to the living/office; FTTB when signal reaches building but then depends on copper to reach end user; FTTC or FTTK (Fiber to the Curb or to the Kerb), which is placed near the curb and servers a limited number of customers; FTTN (Fibre to the node), also called FTTCab (Fibre to the Cabinet), where the fibre reach the "node", which can serve several hundred customers.

50 UK's Broadband Local Loop Lengths, http://www.ispreview.co.uk/cgi-bin/news/viewnews.cgi?id=EEFplFyZEkrNkluWdw, and Loop Lengths and Architecture presentation at IEEE EFM, Raleigh, NC, 14-16 January 2002, http://www.ieee802.org/3/efm/public/jan02/mickelsson_1_0102.pdf.

51 The exact distances will vary based upon various factors, like age and quality of the line, shielding, amount of lines in a bundle and other things that can influence the quality of the line.

52 Shorter local loop lengths in some countries provide a greater incentive to investment in VDSL than in FTTH.

53 See, for example, *The Reality of FTTH in the United States*, Michael Kunigonis, Corning, at http://www.corning.com/docs/opticalfiber/cm9570.pdf and *From FTTH Pilot to Pre-rollout in France*,

Paul-Francois Fourinier, France Telecom, at http://www.francetelecom.com/en_EN/finance/invest-analysts/meetings-conferences/att00003205/20070920-FTTHpresentation.pdf.

54 "The business case for sub-loop unbundling in The Netherlands", Anaylys, 2006, report written for OPTA. "http://www.opta.nl/download/Analysys+Final+Report%2Epdf.

55 See Telecom Italia, http://www.telecomitalia.it/analystmeeting2007/ita/index.html.

56 These can be owned, sponsored by municipalities or based on public-private partnerships.

57 Cable companies that are beginning to triple play would not be faced with these difficulties in that they already have a business case, access to networks, and a existing revenue stream.

58 DSTI/ICCP/CISP(2007)4/FINAL, Developments op. cit.

59 Giovanni Amendola and Lorenzo Pupillo "The Economics of Next Generation Access Networks and Regulatory Governance in Europe: One Size Does not Fit All", paper presented at 35th TPRC Conference in Washington DC, 28-30 September 2007.

60 The Guidelines for Use of Poles, Ducts, conduits and Similar Facilities Owned by Public Utilities, which is based on the Telecommunications Business Law, was formulated in 2001.

61 There are however other example of situations in which regulation is not fully technology neutral. These include not requiring cable networks to unbundle, limiting universal service to fixed telephone networks, and limiting emergency calling requirements to fixed networks.

62 There is little evidence that LLU policies have been a disincentive to invest in new fibre networks. On the contrary, LLU has stimulated investment by incumbents in upgrading their networks.

63 See http://www.erg.eu.int/doc/publications/erg07_44_cp_on_functional_separation.pdf.

64 See DSTI/ICCP/CISP(2007)5/FINAL, "Public rights of way for fibre deployment to the home".

65 See, OECD, "Internet Traffic Exchange: Market Developments and Measurement of Growth", Paris, April 2006, at http://www.oecd.org/document/27/0,3343,en_2649_34225_25496027_1_1_1_1,00.html.

66 ARCEP study.

67 See, RegTP, Competition in the Internet Access Market: Current Regulatory Issues, http://www.regtp.de/en/aktuelles/reden/02713/03/index.html.

68 ERG Final Report on IP Interconnection http://erg.eu.int/doc/publications/erg_07_09_rept_on_ip_interconn..pdf

69 See *supra*.

70 This section is drawn from OECD, DSTI/ICCP/CISP(2007)14, Secretariat working document.

71 ITU-T recommendation E.164.

72 See, OECD Foresight Forum "Next Generation Networks: Evolution and policy considerations", held in Budapest, 3 October, 2006 (http://www.oecd.org/dataoecd/24/5/38079155.pdf), presentation by Mr. Stastny, Senior Analyst, OeFEG, Telekom Austria.

73 In the following years IP networks will have to adapt to the successor of IPv4; IPv6. The expectation is that IPv4 addressing will long co–exist with the new IPv6 addresses.

74 The TCP/IP protocol suite is named after two of the most important protocols used in the Internet: the Transmission Control Protocol (TCP) and the Internet Protocol (IP).

75 SIP (Session Initiated Protocol) is a signaling protocol defined by the IETF to locate users and establish interactive communications with them. It is similar to setting up a call on the telephone network, with two crucial differences: *i)*. It is Internet native, giving the versatility to interoperate with other protocols used in IP environment. *ii)* It separates 'session establishment' from 'session description', so specifying who or what you would like to connect to is independent of how you would like to communicate. SIP is considered the glue for a variety of applications beyond VoIP, for which it is now widely used, such as multimedia, mobility, IM and presence, e-commerce and web services.

76 While these schemes often use the e–mail address or a self chosen ID as an entrance for users, the underlying numbering schemes are self chosen and proprietary.

77 The origin of the word ENUM remains unclear. Both 'tElephone NUmber Mapping' or 'Electronic NUmber Mapping' are found in literature sources, but it is also suggested it is not even an acronym.

78 The Internet Engineering Task Force (IETF) is one of the leading standardisation bodies of the (core technologies of the) Internet. It is formed by a large open international community of network designers, operators, vendors, and researchers concerned with the evolution of the Internet architecture and the smooth operation of the Internet. IETF produces RFC documents.

79 See OECD, "Rethinking Universal Service for a Next Generation Network Environment" (DSTI/ICCP/TISP(2005)5/FINAL).

80 Ibid.

81 Availability means that the level, price and quality of service is the same where a person lives or works, so that residing in a high–cost rural area does not affect a person's ability to access communication services. Affordability refers to the need that maintaining and using the service does not place an unreasonable burden on consumers, particularly those more vulnerable or disadvantaged. Persons with physical or mental disabilities should not be precluded to access communication services (accessibility requirement).

82 Directive 2002/22/EC of the European Parliament and of the Council of 7 March 2002 on universal service and users' rights relating to electronic communications networks and services [Universal Service Directive], Official Journal L 108 of 24 April 2002.

83 For example, OFCOM consider that the obligation of BT and Kingston [designated undertakings] to provide a connection upon reasonable request encompasses the provision of a narrowband connection capable of 'functional Internet access' (FIA). See OFCOM Universal Service Review, online at http://www.ofcom.org.uk/consult/condocs/uso/main/.

84 47 U.S.C. § 254(c)(1).

85 DSTI/ICCP/TISP(2005/FINAL, op. cit.

86 Communication from the commission to the council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions: "Report regarding the outcome of the Review of the Scope of Universal Service in accordance with article 15(2) of Directive 2002/22/EC", COM(2006)163 Final, 24 May 2005, and European Commission, Directive of the European Parliament and Council of 7 March 2002 on Universal Service and users Rights relating to Electronic Communications Networks and Services, (O.J. No L 108, 24.4.2002).

87 See ANPCI-WiFi Company agreement online at http://www.anpci.it/gest/AssociazioniEuDettaglio.asp?r=c&idV=17 (Italian only) and http://www.wifi-company-podcast.com/ (podcasts in English and Italian).

88 Directive 2002/22/EC of the European Parliament and of the Council of 7 March 2002 on universal service and users' rights relating to electronic communications networks and services (Universal Service Directive), Official Journal L 108 , 24/04/2002.

89 It should be noted that DECT telephones using the PSTN also fail during power outages.

90 See FCC Report and Order and Notice of Proposed Rulemaking In the Matters of IP-Enabled Services E911 Requirements for IP-Enabled Service Providers (2005), online at: http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-05-116A1.doc

91 See Ofcom Consultation "Regulation of VoIP Services: Access to the Emergency Services", online at http://www.ofcom.org.uk/consult/condocs/voip/voip.pdf .

92 Obligations on emergency calling have been imposed in many countries on mobile operators - technological developments have allowed for more precise user localisation information.

93 R. Stastny, "Emergency Services Obligations and Responsibilities", online at http://enum.nic.at/documents/AETP/Presentations/Austria/0053-2005-05_VON_Europe/200505_VON_Europe_Emergency_Services_R. Stastny.ppt.

94 ECRIT charter and documents: http://www.ietf.org/html.charters/ecrit-charter.html.

95 In the US, Communications Assistance for Law Enforcement Act (CALEA) applies to facilities-based broadband Internet access providers and providers of Voice-over-Internet-Protocol (VoIP) services interconnected with the PSTN network. See http://www.fcc.gov/calea/. See also EU Council Resolution on law enforcement operational needs with respect to public telecommunication networks and services, online at http://cryptome.org/eu-intercept.htm.

96 For example, the Italian Anti-terrorism legislation (Legge 31 luglio 2005, n. 155) among its provisions include the obligation for owners of Internet cafés to require customers to present their ID card in order to use public Internet access points or to connect to a wireless network. See http://www.parlamento.it/leggi/05155l.htm (Italian only).

97 Robin Foster, "Future Broadcasting Regulation", report commissioned by the UK Department for Culture, Media and Sport [hereinafter, R. Foster, 2007].

98 See OECD, "Policy considerations for audio-visual content distribution in a multiplatform environment", DSTI/ICCP/TISP(2006)3/FINAL, online at http://www.oecd.org/dataoecd/21/41/37868139.pdf.

99 OECD, "The Spectrum dividend: Spectrum Management Issues", DSTI/ICCP/TISP(2006)2/FINAL.

100 See the online platform at: www.joost.com.

101 R. Foster, 2007, op.cit.

102 See for example the EU Directive on Television Without Frontiers (TVWF), which in its Article 1(a) establishes that " television broadcasting' means the initial transmission by wire or over the air, including that by satellite, in unencoded or encoded form, of television programmes intended for reception by the public.". This definition is being re-modernised by the proposed Directive on Audiovisual Media Services, which defines television broadcasting as an "audiovisual media service provided by a media service provides for simultaneous viewing of programmes on the basis of a programme schedule" (article 1 c).

103 See Proposal for a Directive of the European Parliament and of the Council amending Council Directive 89/552/EEC on the co–ordination of certain provisions laid down by law, regulation or administrative Action in Member States concerning the pursuit of television broadcasting activities, Permanent Representatives Committee of the Council of the European Union, 31 October 2006 (preparatory work), online at http://ec.europa.eu/avpolicy/index_en.htm.

104 Communication from the Commission to the European Parliament concerning the Common Position of the Council (18 October 2007). For the latest developments of the Co-Decision procedure, see http://ec.europa.eu/avpolicy/reg/tvwf/modernisation/proposal_2005/index_en.htm.

105 See OECD "IPTV: market developments and regulatory treatment ", DSTI/ICCP/CISP(2006)5/FINAL.

106 See EC proposal for an Audiovisual Media Services Directive, online at http://ec.europa.eu/avpolicy/reg/tvwf/modernisation/proposal_2005/index_en.htm.

107 The implications of convergence for regulation of electronic communications, DSTI/ICCP/TISP(2003)5/FINAL.

108 R. Foster, 2007, op.cit.

109 OECD, "The spectrum dividend: spectrum management issues", DSTI/ICCP/TISP(2006)2/FINAL..

110 R. Foster, 2007, op. cit.

111 OECD "Mobile TV and Video: New Value Chains and Business Models", DSTI/ICCP/IE(2006)3, Secretariat working paper

112 See European Commission "Television on the move", online at http://ec.europa.eu/information_society/industry/broadcasting/mobile/index_en.htm

113 See "Google enters mobile phone market", 6 November 2007, *Reuters*, online at http://www.reuters.com/article/ousivMolt/idUSN0262823920071106; "Google, Bidding For Phone Ads, Lures Partners", WSJ, 6 November 2007, http://online.wsj.com/article/SB119427874851482602.html?mod=hpp_us_whats_news; "Google alliance may stop wireless firms' gouging of users", 7 November 2007, *MercuryNews*, online at http://origin.mercurynews.com/deantakahashi/ci_7382833?nclick_check=1.

114 DSTI/ICCP/TISP(2006)2/FINAL, op. cit..

115 R. Foster, 2007, op. cit.

116 E. Filkin, Regulatory Forbearance in Operation, Chair, ATVOD http://www.oecd.org/dataoecd/14/47/34985339.pdf.

117 See Recommendation CM/Rec(2007)11 of the Committee of Ministers to member states on promoting freedom of expression and information in the new information and communications environment, online at https://wcd.coe.int/ViewDoc.jsp?id=1188541&Site=CM&BackColorInternet=9999CC&BackColorIntranet=FFBB55&BackColorLogged=FFAC75.

118 Such as safe harbour for ISPs, but also notice and takedown procedures for illegal content. See for example the UK Defamation Act, online at http://www.opsi.gov.uk/acts.htm, article 1(3), or articles 12-15 of the EU Electronic Commerce Directive, 2000/31/EC.

119 See for example the EC proposal for an Audiovisual Media Services Directive, which in its article 3(f) admits product placement for some kinds of audiovisual products. Online at http://ec.europa.eu/avpolicy/reg/tvwf/modernisation/proposal_2005/index_en.htm.

120 EC Green Paper on convergence: *Regulatory requirements with regard to the production of European audiovisual content,* 1999, online at: http://europa.eu.int/ISPO/convergencegp/com(99)108/com(99)108enfinal.html.

121 See OECD, "Policy considerations for audio-visual content distribution in a multiplatform environment", DSTI/ICCP/TISP(2006)3/FINAL, online at http://www.oecd.org/dataoecd/21/41/37868139.pdf

122 Graham Ingram, AusCert, presentation at the OECD NGN Technical Foresight Forum "NGN Security", online at http://www.oecd.org/document/12/0,2340,en_2649_33703_37392780_1_1_1_1,00.html (last accessed April 2007).

123 The concept of security through obscurity is a controversial concept used in the context of computer security or cryptography. It is based on the idea that the use of secrecy in the development of a technology can provide security, *i.e.* although a product may have flaws, those are not known, and are unlikely to be find out by potential attackers. See Wikipedia, "Security through obscurity", online at http://en.wikipedia.org/wiki/Security_through_obscurity (last accessed April 2007).

124 Except for redundancy. During the OECD Workshop "Social and economic factors shaping the future of the Internet", David Clark stated that currently we have a "*security lumberyard, rather then a security architecture*". Several protocols exist for significantly improving communication security but uptake is very limited and fragmented. See OECD Workshop "Social and economic factors shaping the future of the Internet" Proceedings, online at www.oecd.org/sti/ict.

125 See OECD, "The development of policies for the protection of critical information infrastructures (CII)", (forthcoming).

126 OECD "Analytical Report on Malicious Software", DSTI/ICCP/TISP(2004)4/FINAL.

127 G. Galler, European Commission, DG Information Society and Media, Presentation at the ETSI meeting: "A strategy for a secure Information Society: Dialogue, Partnership and empowerment", 17 January 2007.

128 The OECD *Guidelines for the Security of Information Systems and Networks: Towards a Culture of Security* (2002) calls "participants", which include "governments, businesses, other organisations and individual users who develop, own, provide, manage service and use information systems and networks" to "focus on security in the development of information systems and networks", in order to tackle "a growing number and a wider variety of threats and vulnerabilities". Online at http://www.oecd.org/document/42/0,2340,en_21571361_36139259_15582250_1_1_1_1,00.html (last accessed Aprile 2007).

129 See Directive 2002/58/EC of the European Parliament and of the Council of 12 July 2002 concerning the processing of personal data and the protection of privacy in the electronic communications sector (Directive on privacy and electronic communications), ondine at http://europa.eu.int/eur-lex/pri/en/oj/dat/2002/l_201/l_20120020731en00370047.pdf. See also the European Commission document: "New Strategy for a Secure Information Society", COM(2006)251 of May 2006. Security is one of the main priorities of the European Commission strategic initiative i2010. More information is available online at http://ec.europa.eu/information_society/eeurope/i2010/index_en.htm. Regarding regulatory initiatives touching upon IT security in the United States, see the Sarbanes Oxley Act, ondine at http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=107_cong_bills&docid=f:h3763enr.tst.pdf.

130 See ITU-T Recommendation X.805 "Security architecture for systems providing end-to-end communications".

131 OECD "Scoping Study on Identity Theft" DSTI/CP(2007)3/FINAL.

132 ITU-T Study Group 13, Report 24 "Draft ITU-T Recommendation Y.2701, Security requirements for NGN Release 1". November 2006.

133 See ITU-T Recommendation Y.2201 "NGN Release 1 requirements", and ITU-T Recommendation Y.2012 "Functional requirements and architecture of the NGN".

134 Trusted zone: a domain where a NGN provider's network elements and systems reside and neer communicate directly with customer equipment. Un-trusted zone: a zone that includes all networks elements of customer networks or possibly peer networks, which are connected to the NGN provider's border elements. See Study Group 13, Report 24 "Draft ITU-T recommendation Y.2701, Security requirements for NGN Release 1".

135 Security policy is a set of rules established by the security authority governing the use and provision of security service and facilities. NGN providers are in charge of preparing such policies and of implementing it to all network elements and devices under their control. ITU-T Draft Recommendation Y.2701 (op. cit).

136 Alcatel-Lucent paper: "Security 3GPP IMS to TISPAN NGN", last quarter 2005, online at http://www1.alcatel-lucent.com/com/en/appcontent/apl/S0512-TISPAN_NGN-EN_tcm172-521381635.pdf (last accessed April 2007).

137 Graham Ingram, AusCert, presentation at the OECD NGN Technical Foresight Forum "NGN Security", online at http://www.oecd.org/document/12/0,2340,en_2649_33703_37392780_1_1_1_1,00.html (last accessed April 2007).

138 ITU Draft Recommendation Y.2701.

139 See OECD, Working Party on Security and Privacy, IDM resources online at www.oecd.org/sti/security-privacy/idm.

140 At the technical level the ITU-T, in liaison with other standardisation groups, such as IETF, ETSI/TISPAN, liberty alliance, OMA, etc, is working on the harmonisation of technical approaches to IdM, with particular

attention to the security aspects of Identity Management. On the policy side, the OECD hold a workshop on Digital Identity Management on 8-9 May 2007, exploring the main information security and privacy issues surrounding digital identity management, as well as possible responses to those challenges. More information about the OECD work on IdM is available online at www.oecd.org/sti/security-privacy/idm. See also OECD Workshop proceedings "Social and Economic Factors Shaping the Future of the Internet", forthcoming (May 2007).