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NEXT GENERATION NETWORK DEVELOPMENT IN OECD COUNTRIES

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FOREWORD

This paper was presented to the Working Party on Telecommunications and Information Services Policy (TISP) in June 2004 and was declassified by the Committee for Information, Computer and Communications Policy in October 2004.

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NEXT GENERATION NETWORK DEVELOPMENT IN OECD COUNTRIES

Main points

Over the last several years, a number of the major network operators have put in place network upgrade plans to implement next generation networks (NGN). Some market analysts now predict that the entire Public Switched Telephone Network (PSTN) will evolve into an NGN over the next 10 years or so. Technological change is happening very quickly, underscoring the need for policy and regulation to be based on principles that support consumer interests, such as competition policy, not on specific technical aspects of networks. However, in order to develop competition policy that is effective, some knowledge is required about evolving network technology, in particular where there is a potential for anti-competitive activity. Therefore, it is important for policy makers and regulators to be aware of the potential of NGN and what is happening internationally as well as domestically so that they are able to respond in a timely and effective manner.

Even though there is no universal and precise definition of NGN at this early stage of deployment, NGN could be defined as all-IP or packet-based integrated networks. In a NGN environment, applications and services will be separated from the transport network and all kinds of applications and services such as voice, data and video can be organised into packets and delivered on an integrated IP network.

There are several kinds of forces driving the deployment of NGN, including structural changes taking place in ICT (Information and Communication Technology) markets, changes in services and uses, and technical evolution. Among these, the most significant catalyst for the deployment of NGN is the technical and market development in the area of IP, including broadband and VoIP, which present opportunities for new capabilities for users and revenues for service providers. At the same time they pose challenges to incumbents who do not respond to the changing conditions and thus who risk losing some of their market and revenue.

A variety of activities for technological development and standardisation for NGN have been undertaken. In Europe, the GÉANT project and TF-NGN were established for collective investigations and deployment of NGN in early 2001. NGN FOG in Australia, NGN Ventures Conference in the United States, UNF in Japan, and the NGcN Forum in Korea are joint activities related to technology and service development. With regard to standardisation, ITU-T, TOPS Council in the ATIS, TISPAN in ETSI and IETF are actively involved in standardisation issues.

Even though NGN is still in its early stages, the impacts of NGN are expected to be significant to the ICT market, and also to businesses in general and to individual customers. There will be benefits, such as enhancing consumer choice by increasing the number of alternative pipes to the home and improving options for rural and underserved areas. However, a number of challenges remain given the current status of the development of NGN. Economic and business challenges include the financial difficulties of telecommunication operators, the uncertainties about business models, and the openness of services to third party suppliers. On the other hand, technical challenges include end-to-end Quality of Service (QoS), congestion management, network security, interoperability, network reliability and management, and user mobility. An uncertain legal environment also may hinder the further deployment of NGN.

With the advance of NGN, numerous policy issues or challenges for the policy makers and regulators have been raised or are expected to emerge as can be seen in Table 1 below. It could be very tricky for policy makers and regulators to strike a balance between allowing nascent markets to develop without interference and ensuring that competition is able to develop in those new markets. However, they can play an important role in removing barriers to the effective deployment of NGN while encouraging the development of NGN.

Table 1: Policy issues or challenges of NGN

Category of policy	Items
Overall policy challenges	Maintaining the open, fair and competitive market
	Encouraging innovation and long-term investment, and removing barriers to the development of emerging markets
	Ensuring proportionality of regulation including forbearance
	Consumer protection
	Promoting partnerships or strategic alliances
	Different regulatory frameworks of ITC applications/services
Policy issues for open, fair and competitive markets (control points)	Identifying the controls points related to;: - Network capabilities - Elementary services - User access capabilities - Individual user information, etc.
	The scope of competition policy will be expanded from competition among networks to services
	Allowing nascent markets to develop, while ensuring that competition is able to develop
Policy issues for telecommunication services[1] provided over the NGN	Classification of new services over the NGN
	The division into local, long distance and international calls
	Location independence and emergency access
	Interconnection: the openness of services and networks to third party suppliers
	Access to NGN services and systems
	Future definition of Universal Service Obligations (USO)
	Numbering, Naming and Addressing (NNA)
Policy issues for consumer protection, privacy and security	Consumer protection: privacy and content issues
	Security and network resilience
	Lawful intercept
Other policy issues	Possible issues arising from extraterritorial service providers
	Intellectual property rights
	Efficient spectrum management
	Technical development and standardisation

Source: OECD.

1. Introduction

1.1. Emerging NGN: a paradigm shift in telecommunications

A paradigm change in ICT is already underway in many OECD countries and much discussion has taken place in the last several years, especially with regard to ICT technology, standards and business models in the context of so-called NGN. A number of major telecommunication operators, Internet Service Providers (ISPs), and non-traditional communications entities such as cable operators, utilities, and wireless companies have been putting in place plans for NGN and established test-beds for their equipment and services for the future deployment of NGN. Some network operators have already finished their initial tests and started to replace their current Public Switched Telephone Network (PSTN) network with NGN equipment. A number of sector analysts predict that the entire PSTN will be replaced with NGN.

This shift towards the NGN may impact not only the business model of ICT service providers and manufacturers, but also the way a business is carried out in many other sectors and the way private communications are conducted. The NGN is expected to facilitate e-commerce and e-business more effectively than the existing PSTN and make it possible to offer more flexible and customised services for customers.

It is important that policy makers and regulators are fully aware of the potential of NGN and the potential international impacts so that they are able to respond in a timely and effective manner. In an emerging market such as NGN, the role of policy makers and regulators may be critical in that they can play a role in facilitating the technological shifts more smoothly. In addition, policy makers and regulators need to ensure that the market emerging from this evolution is open and competitive.

1.2. Purpose and scope of paper

This paper is aimed at stimulating discussions and identifying issues related to NGN. The paper begins with an overview of NGN, its major components, the differences from the existing PSTN, and the driving forces for deploying NGN. The paper then describes market developments related to NGN in the context of network operators, manufacturers, and technology and standards. Finally, the impacts, challenges, and implications for policy and regulation of NGN are explored. The paper does not aim to provide conclusive regulatory proposals for NGN but to contribute to a discussion of issues. The extent that some issues are relevant for countries will depend on the network environment in their country, including broadband penetration, and the economic or market situation. NGN has been discussed and developed on multi-platforms such as wireline and wireless telecommunications, CATV and powerline. In describing the market situation, this paper has focused on the activities or plans of major telecommunication operators, because they are currently major actors driving NGN, although the Internet business sector as well as cable and wireless network operators are increasingly active in developing their network based on IP.

The development of Voice over Internet Protocol (VoIP) is related to NGN, but has been examined in a separate paper provided to the ICCP in OECD. In addition to VoIP, the ability of operators to use an NGN to deliver a suite of services that formerly each required their own separate network to provide, are presently viewed as the major attractions for NGN development.

2. NGN overview

2.1. What are NGN?

There is no single accepted definition of NGN in this rather early stage of NGN deployment. Usually these definitions are quite broad – this is the case for definitions from organisations such as ETSI[2] and

ITU-T which have stressed the main characteristics of NGN in a broad way. For example, ITU-T described NGN as a packet-based network able to provide services including telecommunication services and able to make use of multiple broadband, quality of service enabled transport technologies and in which service-related functions are independent from the underlying transport-related technologies.[3] In general NGN can be viewed as all IP (Internet Protocol) or packet-based integrated networks with a number of characteristics as shown in Table 2. NGN does not only cover network characteristics but also service characteristics which provide new opportunities to network operators, service providers, communications manufacturers and users.

Table 2: Major characteristics of NGN

All IP or packet-based networks (Migration from circuit based PSTN to packet based NGN)
Separation of application services from the transport networks
Open networks
Converged or integrated broadband networks
Ubiquitous network
Distribution of network intelligence

Source: OECD.

All IP or packet-based network:

Most experts view NGN in general as a multi-service network based on IP technology. NGN, as an integrated IP network for wired and wireless communications, could eventually handle all types of traffic or applications over packet networks. In addition, some market analysts now predict that the entire PSTN will evolve into a NGN over the next 10 years or so.

Separation of application functions from the transport network:

In existing networks, applications are vertically integrated with the transport layer and certain networks are dedicated to a specific application. On the other hand, NGN provide an open architecture by uncoupling applications and networks and allowing them to be offered separately. In this context, the applications can be developed independently regardless of the network platforms being used. With an open architecture, standardisation becomes increasingly important, but this allows network operators to choose the best products available and a new application can be implemented in a much shorter period time than for the PSTN or ISDN. Third parties can also develop applications and services for end users. Service providers may package one or more applications into a service offering or applications may be utilised by users on a peer-to-peer basis. The latter may be facilitated by third parties at the network edge.

Converged or integrated networks:

Traditionally, separate networks have been used to provide voice, data and video applications, each requiring separate access devices. NGN allow different kinds of applications to be transformed into packets and delivered simultaneously. Inter-working between the NGN and existing networks such as PSTN, ISDN, cable and mobile networks can be provided by means of gateways.

Ubiquitous network:

NGN allow for widespread mobility allowing users to seamlessly access all types of applications, at the same level of quality, in any geographic area. IP based global roaming is expected to be facilitated with the deployment of IMT-2000 systems. Navigation and location-aware communications makes it possible to support transport, business and leisure needs at whatever location the user chooses.

Distribution of network intelligence:

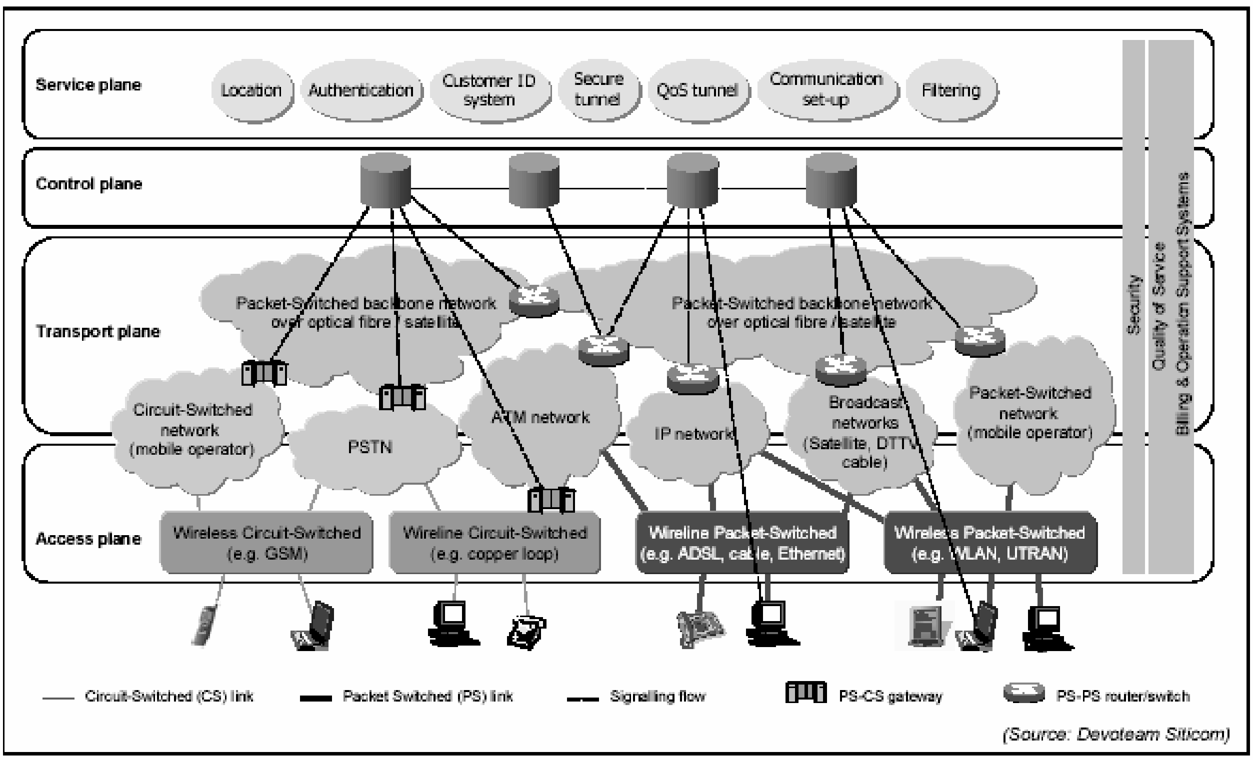
While the current PSTN is based on a smart network and dumb terminals, NGN have intelligence within the network and smart terminals. Within this network environment, it is possible for service providers to easily provide various types of services without the need for cumbersome network equipment.

2.2. Network Architecture and Components of NGN

Architecture of NGN

A depiction of the network architecture of NGN can help clarify its structure and components. Figure 1 shows a concept of NGN architecture. In this figure, both the wireline and wireless terminals are connected with the backbone transport network through an access plane, and all other planes such as service, transport and access networks are controlled by the control plane. As shown in the figure the service plane can be unbundled from the underlying transport and access plane with open and standardised interfaces and the NGN can be connected with other networks, including the PSTN, via gateways which allow all types of data to flow seamlessly through different networks.

Figure 1: The architecture of NGN



Source: Devoteam Siticom.

Major components of a NGN

Along with traditional voice and data equipment, the NGN architecture contains converged network equipment types such as Session/Call Controllers (*e.g*. IP Multimedia Subsystem (IMS) or Call Agent/SIP Server), Media Gateways, Signalling Gateways, Feature Servers, Application Servers, Media Servers and Management Servers, Provisioning and Billing Interfaces. Core technologies include packet transmission technology, traffic engineering control protocol, technology which guarantees quality of service such as MPLS (Multi Protocol Label Switching), multi-party telecommunications technology such as real-time multicasting, session control technology, etc.

Softswitch: The Softswitch, called also a Session/Call Controller, is one of the core components in NGN in that it controls the various types of applications including voice and other value-added features. Softswitch is a software-based control device that provides call control interworking between NGN protocols such as MGCP (Media Gateway Control Protocol), SIP (Session Initiation Protocol), H.323 and traditional telephony protocols such as ISDN, SS7. It also interacts with application servers to supply applications/functions that are not directly hosted on the softswitch. One of the roles of a softswitch is interfacing to the PSTN, which is done by interworking signalling systems.

Gateway: A gateway is a network point that acts as an entrance to another network. For interworking with other networks, there are three types of gateways, that is, Trunking Gateway, Access Gateway and Signaling Gateway, which are located in the service provider's network.[4] The Trunking Gateway provides transcoding from the IP network onto a TDM (Time Division Multiplexing)-based PSTN, while the Access Gateway provides support for PSTN telephones. The Signaling Gateway is acting as a gateway between the call agent signaling and the SS7-based PSTN.

Application Server: The Application Server is located in the service provider's network and provides the service logic and execution for applications or services that are not directly hosted on the softswitches. Typically the softswitch routes calls to the appropriate application server when an application is invoked. In addition, the service broker is located on the edge of the service provider's network and provides the service distribution, co-ordination, and control between application servers and softswitches.

2.3. Major driving forces for deploying NGN

Table 3 highlights the three main reasons underlying the development of NGN.

Table 3: Major driving forces

Structural changes in the telecommunication markets	Decrease in subscribers and revenue from the PSTN
	Increased competition, privatisation
	Market deregulation, *e.g.* local loop deregulation
	Globalisation
Changes in services and user needs	Rapid diffusion of broadband Internet
	VoIP
	Cellular, 3G, WLAN, Wi-Fi
	Digital TV
Technological evolution	Creating innovative, interoperable, scalable solutions under the IP environment
	IPv6
	Digitalisation
	CPU power and memory capacity, mass storage
	Optics

Source: OECD.

Structural changes to the telecom markets

During the last decade the telecommunications market has undergone significant structural and regulatory change. Competition has increased significantly both in traditional PSTN markets and through other services such as cellular mobile services and cable, incumbent telecommunication operators have been privatised, unbundling has been required in member countries to varying degrees and new services have emerged. These developments have resulted in a decline in the traditional sources of revenue in the voice market. The main threat for PSTN operators is the shift of revenue and communications volume to other service providers. On the other hand IP traffic has been growing at 85% annually.[5]

Changes in services and user needs

With the rapid diffusion of broadband Internet services, network service providers have identified customers' growing need for more flexible broadband multi-media services, which cannot be accommodated by the current PSTN network. The increasing problem of the current PSTN network is the limited interworking capacity in an heterogeneous network environment. As an example of the need for IP based network services in the business sectors, a recent European Global Network Strategies survey shows that 91% of manufacturing organisations now have IP-centric networks, and 74% of manufacturers plan to integrate their voice and data network within 2 years.[6]

The innovative developments in VoIP, cellular, wireless and digital TV services added pressures for telecommunication operators to accommodate the increasing needs of customers by embracing the efficiencies of packet-switched multi-service networks, or NGNs. WLAN offers a good mobile solution for outdoor IP access and release 5 of the 3GPP (3rd Generation Partnership Project) specifies that UMTS (WCDMA) is to be based on an all-IP network architecture.

Together with broadband Internet, the widespread use of VoIP has acted as the catalyst to stimulate the development of NGNs. VoIP puts pressure on prices offered by PSTN voice providers. In Italy, for example, the telecommunications operator WIND offers a flat-rate PSTN service for EUR 38 per month, less than FastWeb's equivalent VoIP service for EUR 41 per month.[7] In 2003, a number of incumbents started VoIP and other traditional phone companies are under pressure from VoIP. However, VoIP, which is an application made possible by IP-based networks, should not be confused with NGN itself, which as described in this paper is the IP-based network itself and is capable of supporting numerous IP-based applications of which VoIP is only one.

Technological evolution

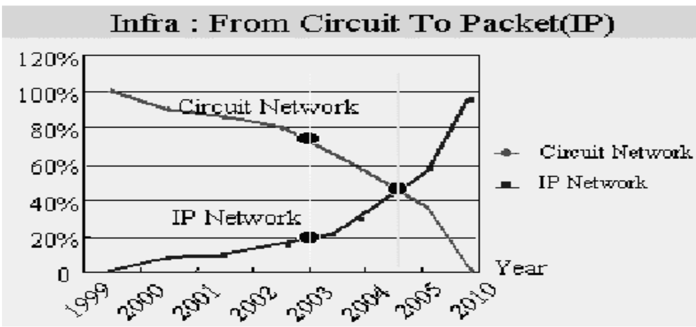
The technological developments in the area of IP including IPv6, digitalisation, increases in computer power and memory, and optics allow for a combination of voice and multimedia traffic over networks. In addition, the quality of service and call control technology for IP such as RSVP, INTServ, DiffServ, MPLS and SIP have improved noticeably. These technological developments have allowed for the provision of Internet access, including e-mail and VoIP using the cable facilities.

2.4. Who is implementing NGN and the expected time schedule?

A number of ICT service providers including traditional carriers, new entrant operators and ISPs are developing plans for NGN, and some operators such as BT in Spain are already operating their network based on IP. In some OECD countries the most likely market for the development of NGN comes from incumbent PSTN operators. In other OECD countries, like the United States, operators of cable networks, utilities, and wireless are making significant progress with their NGN network development. Many national incumbent carriers have already announced plans to establish their NGN as indicated below. With the development of 3G mobile services, the larger mobile operators are also moving to use an IP-based service.

With regard to the time schedule, some experts groups predict that full scale NGN will take place in the next decade. Figure 2 shows one prediction of the switchover date between IP networks and circuit switched networks.[8] However, other predictions estimate a longer transition period. For example, Forrester Research predicted that it will take until 2020 before a complete transition to NGN is complete.[9] Clearly there are a number of important factors that will play a role in this transition including the intensity of competition for voice calls and access to the broadband market, and regulatory frameworks which may determine the framework in which some services are provided.

Figure 2. Estimated time for switching PSTN with NGN



Source: Ovum.

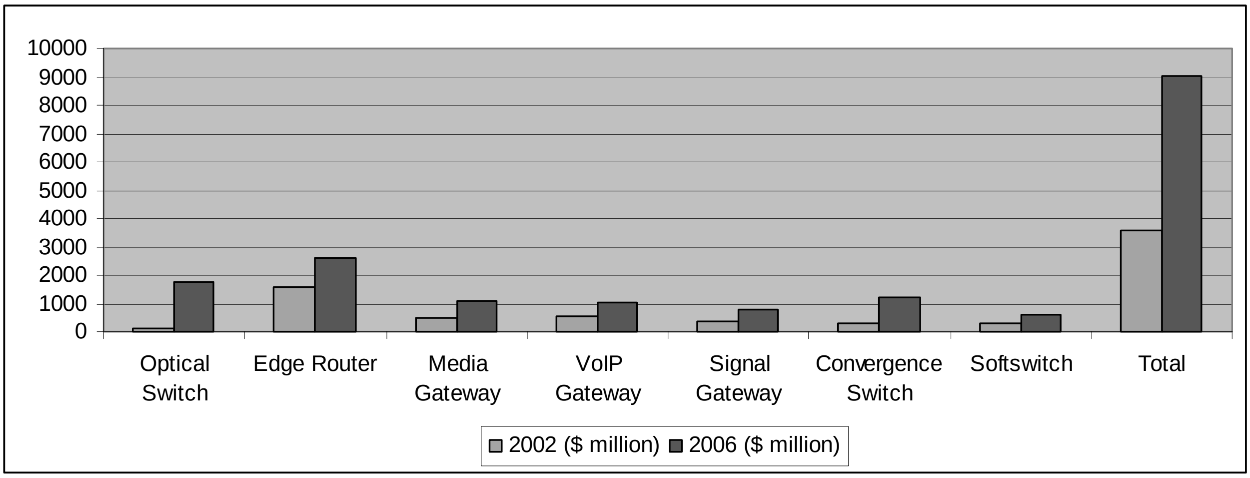
3. The market and NGN

3.1. Market forecast for NGN

NGN are expected to provide new opportunities for a variety of developers such as applications, software components, products and system solutions. Several research companies estimated NGN markets will grow rapidly over the next few years. For example, Pioneer Consulting estimates that the market for NGN equipment will grow globally from USD 3.6 billion in 2002 to USD 9 billion in 2006, a 23% annual growth rate.[10] The optical switch market is expected to grow most rapidly with a growth rate of 84% annually. On the other hand, the market for edge routers will be the largest with USD 2.6 billion in 2006. Figure 3 shows one market estimate related to NGN.

Another market research company, Gartner DataQuest have forecast the average annual growth of the NGN switching market will be 11.9%, growing from USD 6.3 billion in 2002 to USD 10 billion in 2006.[11] Other research companies make similar predictions. Probe Research predicts that the NGN market in the Asia-Pacific region will increase 1 400% from 2002 to 2008.[12]

Figure 3. NGN market estimation



Source: Pioneer Consulting, 2002.

3.2. Telecommunication network operators

Large incumbent telecommunication network operators, in general, are being challenged to shift their network technologies to NGNs in order to increase revenues and reduce the cost by providing multi-media services to their customers. According to the Yankee Group, almost 40% of Europe's operators will also launch major packet voice migration plans within the next two years.[13]

Although the nomenclature "NGN" is not used in all cases by operators, the network architecture is basically that of NGN. For example, in 2001 Deutsche Telekom initiated their IP-based global network, named the TGN or Telekom Global Network which was geared to building an IP-based global network.[14] DT also set up their vision 2010 and strategy for network evolution to make the vision a reality. NTT (Nippon Telegraph and Telephone) refer to their NGN as RENA (Resonant Communication Network Architecture), while KT (Korea Telecom) uses the name BcN (Broadband convergence Network) and British Telecom the 21CN Program. On the other hand, Telus in Canada initially named their project Santa Maria, but it was renamed NGN later.

In November 2002, NTT announced a vision for a new generation of communication. The features which make RENA differ from conventional IP networks include the provision of high security, a high-speed and large-capacity network, and end-to-end connectivity.[15] KT also set up a plan at the end of 2002 to establish NGN as a nationwide network replacing its current PSTN with an all IP network over 10 years. BcN vision for 2010 defined BcN as an IP based integrated network for high quality convergence services through dynamic access. BT launched a five-year plan in June 2004 to transform its network into a backbone of a new generation of converged multimedia communications services.

Other telecommunication network operators that have been very active in implementing NGN include Telekom Austria, Bell Canada, Telecom Italia, Qwest and Sprint. For example, Telekom Austria has tried to be one of the first operators to install NGN in Europe aiming to have the first concrete installations in 2004 and replacing its PSTN network with NGN by 2009. With the deployment of NGN, Telekom Austria expects to replace its 1 240 PSTN switches with 200 total plus some softswitches.[16] Bell Canada put in place its NGN plan in September 2003, aiming to begin its initial commercial services in mid-2004.

In the case of Telecom Italia, 50% of international calls were provided by IP network as of October 2002, and it is expected to complete full network migration in 2004. By 2006, a single national network will handle all the voice, data, and eventually video traffic generated across Telecom Italia's 27 million fixed subscriber lines in Italy and across its pan-European backbone.[17] Qwest in the United States is one of the early starters in implementing NGN and claimed that it became the first network service provider to complete a transcontinental domestic IP network. Since 1998, Qwest has tried to introduce an entire suite of native IP products on its fibre optic network design. In April 1998, Qwest activated the entire transcontinental portion of its fibre network from Los Angeles to San Francisco to New York. Sprint also started its NGN project dubbed Integrated On-demand Network as early as December 1999.

Introducing NGN in incumbent networks requires a large amount of investment and a relatively long period of time since the technical equipment of the entire national network must be renewed at all switching stations, and employees need to be prepared and trained to operate in a new network environment. To recuperate investment costs rapidly, some carriers are looking for 'killer applications'. In this context, several network operators have created and operated test-beds, pilot projects to research, develop and test NGN services and applications. In many cases, they have formed partnerships or strategic alliances with equipment vendors or other related organisations to address compatibility, flexibility, reliability and security issues and to increase the availability of new applications and multi-media services in a new network environment. Table 4 gives some examples of these co-operative efforts. In addition, many telecommunication network operators as well as network equipment vendors have participated actively in standardisation processes either domestically or internationally.

Table 4: Examples of some activities of telecommunication network operators in NGN research, development and testing

Telecommunication Network Operators	Research and Test Activities	Partners
Telekom Austria	- Preliminary tests over last 2 years	
Bell Canada	- Operating 'Innovation Centre' and other R&D laboratories	Nortel
TeliaSonera Finland	- Developed NGN and platforms	Tellabs
Elisa Communications (Finland)	- Researched NGN architecture and protocols, - Launched the 'NGN and new communication service R&D program'	
France Telecom	- Carried out experiments for NGN - Introduced 'QoS monitoring systems' - Developing NGN architecture for mobile/fixed networks interoperability - Developing network architecture for NGN	 Siemens Alcatel
Deutsche Telekom	- Implementing a pilot project	Alcatel, Siemens
Telecom Italia	- Established 'Telecom Italia Lab'	
NTT	- Runs a R&D program focused on RENA	
KT	- Established test-bed for NGN - Launched a softswitch development project - Started to develop an application service test platform	Lucent LG Intel Korea
TP (Telekomunikacia Polska)	- Started NGN R&D project	France Telecom
BT	- Align technology and sales	Cisco
Qwest	- Developing broadband business multimedia services	Cisco

Source: OECD.

A number of network operators have recently started to provide VoIP and other multi-media services especially for business customers. These include Telus in Canada, Bell South and MCI in United States. For example, Telus established the NGN plan as early as November 2002 and launched its VoIP service to business in November 2003. BellSouth and MCI have also proceeded with their deployment of NGN together with starting VoIP service with business customers first. In addition, the initial commercial service of Bell Canada is scheduled for mid-2004 and will include hosted VoIP and multimedia services for businesses with private or managed networks. In March 2004, AT&T announced that it would integrate VoIP into all its data services, roll out new voice applications and offer VoIP services throughout its local markets.[18] That acceleration covers three dimensions: VoIP networking, application development and equipment interoperability. AT&T also is planning to roll out IP Centrex and VoIP services throughout its local markets this year.

Not only fixed network operators but also several mobile network operators have started to plan their migration to NGN or convert their networks to an IP based network. For example, Telia Mobile in Sweden designed its GSM network as early as 2001 to bring data, Internet, mobile and IP telephony together under the same network.

It is worth noting that several network operators are trying to expand their service markets to the international market using NGN deployment. For example, Deutsche Telekom plans to expand their NGN services to around 40 countries. British Telecom also aims to expand its services to Germany, Spain, Netherlands, and Ireland.

It is also noteworthy that some telecommunication network operators in non-OECD countries, where the PSTN is still being developed, are actively planning to deploy NGN solutions in their networks. For example, in China, Shanghai Telecom, a subsidiary of CT (China Telecom) introduced its deployment of NGN solutions for the future network since July 2003. In November 2003, Chunghwa Telecom selected NGN solutions from Nortel Networks to transform its network to a packet-based infrastructure, expecting full network deployment to be completed by September 2004. In Russia, Combellga announced in November 2003 that it will enhance its existing voice network by using a next-generation IP-based infrastructure to interconnect its local services areas. In the Czech Republic, the largest carrier Ceský Telecom started to introduce NGN solutions in October 2002.[19]

3.3. Cable network industry

In line with developments in the telecommunication service sector, the cable network industry is also investing in IP-based networks. Cable companies have invested in upgrading their networks to provide Internet telephone service and VoD. While many cable operators are currently offering IP-based voice services using their digital networks to interconnect with the PSTN, their networks are expected to provide a variety type of packet based services in incoming years.

In North America, several companies such as Time Warner, Portland and ME launched VoIP service, and a number of companies such as Comcast, Charter Communications, Time Warner and Liberty Cablevision are undertaking technical trials for commercial deployment during 2004. In Australia, Neighbourhood Cable is offering its subscribers packet based IP technology over the cable modem's shared data connection.[20] In Europe, Essent Kablecom in Netherlands was expected to commercialise rollout in the 1st quarter 2004. In Switzerland, Cablecom expects country-wide deployment by the end of 2004 and in Denmark, TDC Kabel TV is also expect to provide services in the 3rd quarter 2004. FT Cable in France is focusing on multimedia services exploiting broadband access.[21]

The main operators in Europe grouped together in 2002 to establish ECCA (European Cable Communications Association) with the aim of increasing interoperability. EECA led an initiative to establish a certification process for PacketCable in Europe.[22] PacketCable project aimed at developing interoperable interface specifications for delivering advanced, real-time multimedia services and an open architecture to manage delivery of IP services over cable networks. Major European operators also developed a Certification Program among operators and vendors. In addition, a working group of IPCDN (IP over Cable Data Network) in IETF was established to develop a standard for IP-capable data over cable systems.

3.4. Network equipment vendors

NGN solution providers currently offer a variety of solutions and support flexible and different approaches to migration. The major solution providers are switch manufacturers such as Nortel, CoSine, Lucent, Alcatel and Ericsson providing total solutions from softswitch to various types of gateways. NGN will also increase the demand for fibre optic transmission systems such as all-optical packet switches and servers which are able to deal with various types of applications.

According to a study published in November 2003 by Dittberner Associates Inc. traditional telephone switches seems to be obsolete, and sales have declined rapidly.[23] The withdrawal of technical support for some older switches by the large equipment vendors has also forced telecommunication network operators to consider deployment of NGN-based solutions. Table 5 shows the ranking of the top suppliers by digital ports installed worldwide.

Table 5: Major suppliers installed base, worldwide market share

(October 2003, Wireline Digital Port Count in millions)

Rank	Manufacturer	Ports	% Market share
1	Alcatel	314.6	18 %
2	Siemens	258.1	14 %
3	Lucent	232.6	13 %
4	Nortel	227.4	13 %
5	Ericsson	178.5	10 %
6	Hauwei	121.6	7 %
	All others	455.8	25 %
	World total	1,788.6	100 %

Source: Dittberner Associates Inc.

4. Activities for technology development and standardisation

Technologies and standards related with NGN are wide ranging.[24] Some of the major efforts are mentioned below.

4.1. Technology development activities

In Europe, a co-ordinated effort was launched for the deployment of advanced communication technologies for the research and education community. For example, the *GÉANT project*, supported by the European Commission, was established in January 2001 for a duration of 4 years to provide the research community with an advanced infrastructure for communication and collaboration.[25] Project participants included all National Research and Education Networks in Europe. The GÉANT infrastructure has been successfully operating a full-scale NGN (more than 200 Gbps of aggregated IP transmission capacity). By now GÉANT is recognised as a leader in this field with numerous know-how transfer activities to other regions. Around the same time as GÉANT started to operate, a major push for the deployment of IPv6, the new Internet Protocol, was launched by the European Commission. As a result of these concerted activities related to IPv6, first commercial offers are appearing on the market. Again the scientific community spearheaded this trend by deploying IPv6 on their networks.

The Task Force on Next Generation Networking (TF-NGN) was established in November 2000 to investigate the suitability of advanced networking technologies for future implementation in research and education networks in Europe.[26] The task force's aim is to exchange experiences and knowledge, to promote development and testing of new networking technologies, and to develop and test new networking services. The activities also include the piloting of new services on the GÉANT backbone as part of the project. TF-NGN facilitated the deployment of the following services on GÈANT:

- Less-than-Best-Efforts Premium IP Service Specification.
- Improvement of current multicast services.
- IPv6.
- Tools for network monitoring and flow measurement.
- MPLS (Multi Protocol Label Switching) testing, etc.

Current investigation areas of TF-NGN are:

- Close integration of optical and IP networking (*i.e.* hybrid networking).
- New pilot services as defined in the GÉANT Technical Roadmap.
- AAA (Authentication, Authorisation and Accounting) development.
- Support from GÉANT and national research and education networks for special projects, etc.

In Australia, the *Australian Communications Industry Forum (ACIF)* set up a national NGN task force at a NGN seminar in May 2002 to examine service quality and delivery issues posed by the emergence of NGN.[27] The ACIF Board agreed to support an NGN project to look at the technical, user and policy impacts of the move to packet-based networks, working through the ACIF *NGN Framework Options Group (NGN FOG).* The main task of the NGN FOG has been to assist in enhancing the understanding of the transition to NGN equipment. The NGN FOG has been working on several issues including technical standards, end-user issues, end-to-end services, interconnection across networks and regulatory issues. A series of meetings and working groups have been held and the project results were presented at an industry seminar in August 2003. The ACIF view is that NGN will be packet based networks and the predominant packet technology will be IP.[28] The major role for ATM will be to support IP, not as the prime packet medium. The ACIF NGN Project was closed as of July 2004 when NGN FOG provided policy and regulatory considerations for new and emerging services at its 8th meeting. Newly established Future Applications, Networks and Services (FANS) Group will continue to examine the NGN issues.[29]

In Japan, the *Ubiquitous Networking Forum (UNF),* established in June 2002, has been working on R&D and standardisation of ubiquitous network technology, co-ordination with other organisations, and the promotion of the concept of an ubiquitous network.[30] In Korea, the *NGcN Forum* was established in June 2003 made up of experts from industries, universities and research institutions, to develop the roadmap for networks and technology development and standardisation.

The *Multiservice Switching Forum* (MSF), an international consortium of carriers and vendors including switch manufacturers, tested interoperability between US, Japan and UK members in November 2002 to promote interoperability and accelerate the commercial availability of next-generation technology.[31] A second multi vendor interoperability event, GMI (Global MSF Interoperability 2004) was held across four carrier test labs, *i.e.* Qwest in the United States, BT in the United Kingdom, NTT in Japan and KT in Korea in October 2004.

4.2. Standardisation activities

The openness of networks and services requires the use of standardised and interoperable solutions and interfaces. Further NGN deployment will result in a variety of architectures and protocols, which creates interoperability issues. In this context, international standardisation bodies such as ITU, ATIS, ETSI and IETF play an important role by setting the specifications of protocols, establishing a common general architecture and technological blocks of NGN.[32] Telecommunication network operators also prefer an open, standard-based approach, in that it will relieve them from the dependence on a single vendor.

ITU-T (International Telecommunication Union)

The ITU-T has become more active in developing NGN standards and is planning a reorganised structure to focus on NGN and related matters. *ITU-T SG (Study Group) 13* has been involved in standardisation research of NGN. During its January 2002 meeting, SG 13 decided to undertake the preparation of a new ITU-T Project entitled *'NGN 2004 Project'*. At the November 2002 SG 13 meeting, a preliminary description of the Project, which includes characteristics and capabilities of NGN, the objectives of NGN and seven study areas requiring standardisation of NGN, was endorsed by SG 13.[33] A major goal of the NGN Project is to facilitate convergence of networks and services. The role of the *NGN 2004 Project* is to organise and to co-ordinate ITU-T activities on NGN. Its target is to produce a first set of recommendations on NGN in mid-2004. The major task of the *NGN 2004 Project* is to describe all elements required for interoperability and network capabilities to support applications globally across NGN.

In July 2003, the NGN workshop hosted by SG13 and SSG (Special Study Group) was held in Geneva, main topics were interconnection between mobile and fixed networks, interworking with existing networks, and convergence. As a result of this workshop, *JRG (Joint Rapporteur Group) on NGN* under the ITU-T SG13 was established to provide basic frameworks of recommendations on NGN standardisation in the following areas in 2004:

- General reference model of the NGN.
- Business model, service architecture and scenarios for NGN.
- Functional requirements and architecture of the NGN.
- Identification requirements for the NGN.
- Mobility requirements and mobility management architecture.
- QoS requirements and end-to-end QoS architecture of the NGN.
- Reference service model for MPLS based reliable and manageable IP network.
- Migration of networks (including TDM networks) to NGN.
- Technical issues and layer models useful for 'regulatory' considerations.

At the ITU-T's 2004 World Telecommunications Standardisation Assembly (WTSA-04), held in October 2004, WTSA decided to create a new SG for NGN (NGN-SG). In addition to taking over the tasks foreseen for the former SG13, the new SG will deal with all questions relating to architecture and frameworks for NGN, provide the requirements of Recommendations developed by other SGs and promote the co-ordination of NGN-related activities across SGs. The NGN Focus Group that had been established in June 2004 prior to WTSA-04 to ensure continuity of ITU-T's efforts on NGN following the final SG meetings in the 2001-2004 period will also feed into this new NGN SG. The new SG will be assisted by a joint coordination mechanism set up to co-ordinate core NGN studies in the areas of mobility, signalling, naming, numbering, addressing and routing.

ATIS (Alliance for Telecommunications Industry Solutions)

In the United States., the Technical and OPerationS (TOPS) Council of the ATIS initiated a programme in 2002 to identify and assess industry's technical and operational initiatives of strategic importance, including its technical and operational priorities. It initially established Focus Groups to investigate the important NGN topics of VoIP, Network Security, Wide Area Ethernet, Mobility and Data Interchange. ATIS will be holding special industry forum to progress several key issues and will be co-operating and collaborating with other groups such as the IETF and IEEE to address industry standards needs on a timely basis. Additional ATIS TOPS Council Focus Groups are expected to be formed to investigate other priorities, *e.g.* optical networking and wide area storage.

ETSI (European Telecommunications Standards Institute)

NGN standardisation has been part of the ETSI Strategic Guidelines since November 2000. ETSI started its discussion on NGN in a workshop held in April 2001, in which the establishment of a *NGN-SG (Starter Group)* was decided. *NGN-SG* defines NGN as a concept for defining and deploying networks, which, due to their formal separation into different layers and planes and use of open interfaces, offers service providers and operators a platform which can evolve in a step-by-step manner to create, deploy and manage innovative services.[34] In addition, *NGN-SG* considered NGN as the general concept of new network architectures using any kind of transport and distributed call control using a variety of different access and core technologies covering wired, wireless and mobile domains. This includes issues such as end-to-end service enabling capabilities, interoperability and QoS, security, network management and network architecture along with the use of protocols such as MEGACO (Media Gateway Controller), SIP (The Session Initiation Protocol) H.323 (Packet-based multimedia communications systems), BICC (Bearer Independent Call Control), Parlay, IP, ATM, etc.[35]

To strengthen the role of ETSI in the provision of standards for NGN technologies, the new technical committee, *TISPAN (Telecommunications Internet converged Service protocols for Advanced Networks)* was created in September 2003 combining the work of the former ETSI bodies *SPAN*, on fixed network standardisation and *TIPHON*, on VoIP based networks. TISPAN is responsible in ETSI for all aspects of standardisation for NGN, which will enable the emergence of pan-European multi-media networks. There are eight working groups under the TISPAN; Services / Architecture / Protocols / Numbering, Addressing & Routing / Quality of Service / Testing / Security / Network Management. The TISPAN is now working to define an implementable *European MultiMedia Network (eMM-Net).*

In addition, TISPAN held a workshop together with 3GPP in June 2004 to discuss the globalisation of IMS to make it applicable as a core network component of Fixed and Mobile NGN. ETSI is currently working on the proposed objective of the release1, such as real time conversational services, messaging, content delivery, etc., expecting to finish it in mid 2005.

IETF (Internet Engineering Task Force)

The IETF is not working on NGN as an individual topic, but its Working Groups have responsibility for developing or extending existing protocols to meet requirements such as those agreed for NGN in other standardisation bodies. Among the standardisation activities undertaken in IETF related to NGN, MMUSIC (Multiparty Multimedia Session Control), SIP, MEGACO and NSIS (Next Steps in Signaling) are the core protocols. Other related protocols include SIPPING (Application of SIP), IPv6, MOBILEIP (IP Routing for Wireless/Mobile Hosts), IEPREP (Internet Emergency Preparedness), MPLS, GMPLS (Generalized MPLS), etc. The IETF also developed the ENUM specification to enable an E.164 (telecom) number to be used to access the Internet DNS system. ENUM might be used to facilitate interworking between telephony (and other carrier services) and IP services (including IP telephony and multimedia).

3GPP (Third Generation Partnership Project)

Many of the NGN principles have already been standardised in the 3GPP work on Third Generation Mobile and the 3GPP2 group which have adopted a common IP Multimedia Subsystem or IMS as the core of their network architectures for later versions of 3G.

GSC (Global Standards Collaboration)

NGN standardisation work is co-ordinated in that the above-mentioned standard bodies meet regularly in the GSC to discuss their work and to minimise overlap and increase co-operation and collaboration. NGN work was discussed at GSC7 (hosted by ACIF in 2001), GSC8 (Ottawa, Canada, 2003) and GSC9 (Seoul, Korea, 2004). These meetings have identified principal areas for NGN standardisation work such as architecture and protocols, end-to-end QoS, service platforms, network management for NGN, lawful/legal interception, security, the interworking of services supported by both current networks and NGNs, and the transition of these services from legacy networks to NGNs.

5. The impact and challenges for NGN

NGN is still in its infancy, but it is expected to have a significant impact. NGN will not be a single unit network or service, but a multiplicity of different components requiring seamless interconnection and full service interoperability. It needs to be noted that the impacts identified here are based on current knowledge and are probable rather than definitive.

5.1. Overall impact of NGN

The sunk cost of incumbent telecommunication operators in existing networks and the budget for investment in NGN is so large that the transition from PSTN to NGN will be evolutionary rather than revolutionary.

First of all, for consumers, businesses and economy, NGN will help in enhancing access to communication services and more innovative and personalised services and applications. NGN would be a basis for the UNS (Ubiquitous Network Society), where easy-to-use network is connected at anytime, anywhere, with anything and for anyone. In addition, it can be expected that by facilitating more competition NGN will help lower prices for users.

NGN will provide the technology that could lead to full convergence between telecommunications, cable TV and broadcasting services markets. In this regard, the market and regulatory boundary in the current telecommunication and broadcasting business regime may not be so clear and relevant in this new environment. It is also expected that competition will increase significantly between service providers in an integrated market.

In the network equipment and contents market, investment in NGN is expected to help bolster the market for communications equipment which has been lagging in recent years, as well as the market for customer premises equipment. In addition, because NGN can support new multimedia services, it can be expected that content markets will grow.

5.2. Challenges and limitations in the development of the NGN

Economic and business challenges

Financial difficulties of telecommunication operators

Given the significant investment funds needed to transform existing networks to an NGN, and the financial problems a number of companies have faced in the industry, a number of telecommunication companies may hesitate to undertake large scale investments in new equipment.

Uncertainties about the business model

Even though many infrastructure options and business models are now being deployed in many different markets, development of NGN is still at an early stage. The direction of the development of NGN is not so clear and some network operators are hesitating in investing. These operators need some assurance that NGN applications and services will be sufficient to provide a return to investment and, at present, they are not sure which killer application will develop to provide a new revenue stream sufficiently.

Openness of service to the third party suppliers

In the open network environment of NGN, access by third party suppliers to the network also raises some operational and economic concerns as well as technical concerns. For example, the redistribution of revenues among players can be a challenge. In addition, suitable ways for pricing new content and billing methods in an environment of converging voice and data need to be developed.

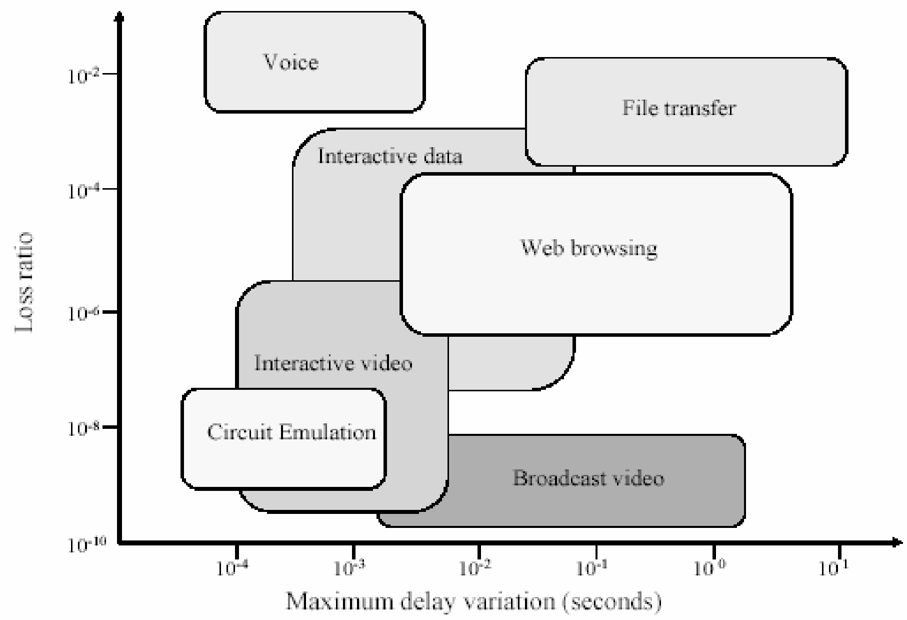
Technical challenges

End-to-end QoS

There have been concerns as to whether current IP networks are able to deliver an acceptable grade of service to meet the expectations of customers. Some current IP networks are not able to guarantee secure delivery especially during periods of congestion. Many current IP networks are essentially ‘best efforts’, without any guarantee of QoS. To transform the current PSTN network to an all IP network, NGN need to ensure that the network will work reliably all the time.

When addressing QoS issues, one thing which needs to be remembered is that there will be a broad range of services that can be provided over the NGN, making different demands on QoS parameters as well as on bandwidth. Figure 4 shows approximate ranges for datagram loss and time-to-arrive, for different types of end-use services. In this regard, ITU-T adopted Recommendation Y1541 in 2001 which provides objectives for performance parameters for various QoS classes.

Figure 4: Application specific loss and delay variation in QoS requirements



Source: WIK Consult[36].

In a NGN environment where many different networks will be connected with each other and different types of services delivered, limitations in the interoperability between different vendor equipments can deteriorate end-to-end QoS. Moreover, service level agreements (SLAs) offered by transit providers are all different. Therefore, it is important to reach agreement among different systems on end-to-end QoS suited for each different type of data stream, and to set the parameters with upper layer protocol to control the lower layer, transport and access level QoS mechanisms. In addition, there is insufficient information at end-user interfaces to enable them to select among connections with different QoS parameters. The quality of the access for some end-users is also insufficient to support satisfactorily the full range of applications. Greater availability of high-speed broadband access and other capabilities will help address this.

There is a wide range of techniques to provide QoS connections, including over-dimensioning, providing underlying connections, either actual separated physical routes or virtual premium circuits, and various QoS protocols. However, these techniques need to be implemented where necessary to meet the end-to-end requirements. NGN will need international standards for signaling/control mechanisms to achieve the desired guaranteed end-to-end QoS.

Congestion management

Congestion management is another challenge. To address this, economic solutions as well as technological developments are required. With current unmetered services, or flat-rate pricing, increasing the capacity is required to ensure there is adequate performance. An economic mechanism for congestion management is more important in a NGN environment in which larger and more variable bandwidth applications are to be supported. In some countries, flat-rate pricing may bring about a potential commercial barrier to access other networks such as mobile networks which have limited network capacity, although in other countries this may not be a concern. So, especially in the former case the introduction of demand management mechanism, through the provision of several grades of services with different QoS and pricing according to customers' choices, needs to be considered.

Security

In terms of security, NGN needs security mechanisms to protect them from service denial and virus attacks, and protect customers' sensitive information from malicious hacking. The security features of the current IP network raise a quite different set of issues from those of the current PSTN network.

Interoperability

It is possible that the transition to NGN will take place over more than a decade so that during the transition period the telecom network operators need to support both NGN and PSTN in parallel. Therefore, interoperability among new products and technologies is important to ensure that legacy network services are not interrupted. In addition, continuing support for POTS telephone lines is necessary. In the backbone network, interconnection with SS7 signaling and TDM trunks, emergency and operator services, databases for free-phone services and local number portability and lawful Intercept are all important, where applicable. In this regard, telecommunication network operators need to plan NGN migration strategies so that they include both introducing new services and support for legacy interfaces.

Interoperability between vendors is another major issue in any environment where open interfaces are available, including NGN. In the case of SIP, interoperability concerns has been one of the major inhibitors to large scale SIP deployments.[37] To enable the heterogeneous networks to interoperate, the number of elements/interfaces/protocols involved in the support and delivery of services need to be standardised. To guarantee seamless interoperability between different operators, roaming and media handover are also important.

Reliability, sustainability and network integrity

Applications on the IP network can only be satisfactorily provided if the packet loss, latency and jitter are all low as required for that application. In many cases, competition and market forces are primary drivers in establishing IP network performance levels. National regulation is not used to impose conditions relating to the performance levels of the networks for IP service providers, as is done for the PSTN. A significant issue is whether market forces and competition among the NGN operators will evolve to meet user needs. If a service provider's network assets are based abroad, it will not be easy to ensure continued network and service availability.

Network management

One of the major challenges in developing NGN is network management and the need for sufficient automated management tools to address the complexity. NGN will need to interoperate with existing networks and different types of services. In addition, IP networks have fuzzy boundaries. Network server functions are moving to the edge of the network and in some cases it may be difficult to distinguish between network components and user terminal equipment. There is no difference between network components and terminal equipment in terms of addressing or transmission protocols.

User mobility

Introducing mobility in the fixed network is also one of the major challenges for NGN. Enabling more transparent fixed-wireless broadband communications and mobility across various access technologies seem to be major issues. Today, there are no well developed service control standards to support mobility for users or roaming over different types of networks. However, fixed network operators have tried to introduce mobility management in their fixed telephones. The mobile operators are also planning more on a mobile network scenario that will take charge of all the services by using the fixed network. Co-operation between fixed and mobile operators and a relevant set of standards could help to overcome this challenge.

6. Policy implications and issues

Before the concept of NGN was introduced, deciding which service providers are under what kind of regulation was rather clear. However, with the advance of NGN, numerous policy issues or challenges for the regulator have been raised due to the tricky fact that the large telecom network operators, which have been regulated rather heavily so far, are trying to transform their entire network based on IP and to provide IP services which have not been regulated or much less regulated in general. The regulatory environment of upcoming NGN, where major incumbents transform their PSTN network to an all IP network, is quite different from the past where some ISPs provide VoIPs and PSTN is still available as a substitute. In this respect, one big challenge for policy makers and regulators is whether they will maintain current regulatory regimes where different platforms are regulated differently, or not regulated, with similar types of applications, *e.g*. voice over PSTN and IP network, broadcasting over IP and CATV network. In addition, the uncertainty of market outcomes makes it more difficult to address policy issues.

The uncertainty of regulatory frameworks towards NGN may undermine the development of NGN as mentioned before. Therefore, the policy makers or regulators need to revise those regulations and evaluate their relevancy for the new environment of NGN according to the state of deployment of NGN in each country. In addition, it is necessary for policy makers or regulators to evaluate the focal point of significant market power to make a market open and competitive, and consider carefully consumer needs, protection and other policy issues related to the deployment of NGN. This paper tries to set out a number of important policy issues which policy makers or regulators will face over the next decade.

6.1. Overall policy challenges

First of all, the market situation, migration strategy and technology development may be somewhat different in each member country. Therefore, the policy makers or regulators need to identify the migration plans, roadmaps and strategies, business models, major players, opportunities and challenges and potential issues of NGN in their market. And then, the role of policy makers or regulators is to create the regulatory environment which is able to accommodate innovative business needs and facilitate increasing consumer benefits and choices by reviewing their policy and regulation in a timely manner. The overall important challenges identified for the policy makers and regulators are:

- Dealing with significant market power and promoting fair competition.
- Maintaining the open and competitive market both in infrastructure and services.
- Encouraging innovation and long-term investment, and removing barriers to the development of emerging markets.
- Ensuring proportionality of regulation including forbearance.
- Ensuring a technologically neutral regulatory framework, allowing the players freedom of choice.
- Finding the optimal balance in spectrum management.
- Consumer protection.

To achieve real progress and avoid duplication of work, partnerships or strategic alliances among network service providers, broadcasters, network solution providers and electronics manufacturers, application service or contents providers, research institutions, academia and standard organisations either domestically or internationally will be very useful, especially in this early stage. They need to co-operate to develop strategy, road map and business models, to test and prove the functions of new equipments, and to share their experiences. This is also necessary in order to develop an appropriate architectural framework, standards and implementation agreements to ensure adequate interoperability of individual components. Therefore, another important role of policy makers and regulators will be promoting these activities in the market while maintaining fair competition among the players.

In addition, the current regulatory framework of dividing telecom service providers into several categories based on the separated networks, such as wireless/wireline, Internet/broadcasting/ telecommunications, will be challenged as NGN deploy further. Different regulatory frameworks need to be reconsidered in an integrated environment of NGN. With regard to this issue, refer to a recent paper on convergence in OECD for a more detailed discussion [DSTI/ICCP/TISP(2003)5/FINAL].

6.2. Policy issues for open and fair competitive markets

In general, NGN are expected to lower barriers to entry in the ICT markets, thereby increasing competition. Paradoxically, this potential may also lead to additional and different sources of market power. Maintaining open and competitive markets is critical for the further development of NGN. Therefore, it is necessary for policy makers and regulators to understand where new sources of market power with the potential to inhibit the development of competition may occur in the NGN environment. This will require an understanding of new technologies and how they interrelate.

In the traditional telecommunication market, regulatory policy has focused on opening up the existing networks of incumbents to competitors. The focus of competition in the NGN environment will be slightly different, in that the challenge in terms of competitive policy is to create a competitive environment for new products and services to develop. In addition, the emphasis of competition will shift from the lower transport and network layers to the higher layers of services and applications in the NGN environment.

A list of potential control points for market power has been identified in an EU consultant's paper, which is shown as an example in Box 1.[38] Although it is very useful to understand where the potential for dominance will occur, it is premature to assume that all of these will emerge with NGN in a sense that regulatory action may be required.

Box 1. Potential control points

- Control points could relate to *Network capabilities* which are potentially enabling dominant operators to limit access to certain infrastructure capabilities by competitors. Examples include: Network Address Translators and firewalls, routing tables, quality of service capabilities and interconnect,on, network coverage, termination capabilities.
- Control points could relate to *Elementary services* which potentially enable dominant operators to limit competitive ability to create certain types of services. Examples include: Call set-up capabilities, proprietary standards, non-proprietary standards, interoperability, Application Programming Interfaces.
- Control points could relate to *User access capabilities* which are potentially enabling dominant operators to limit or restrain access to certain service providers. Examples include: unnecessary software and service bundles, walled gardens, tunneling, filter mechanisms and digital rights, end-user devices and content..
- Control points could relate to *Individual user information* which potentially enable certain operators to decide who could construct services based on this information. Examples include: authentication, single logon and profile management, customer billing information, access to customer information systems, resolution of names and numbers through customer identity systems, functions for determining location.

Source: Devoteam Siticom & Cullen International.

There is no consensus in the market that such control points will emerge with NGN. However, policy makers and regulators need to keep paying attention to those control points as the NGN deploy, and this will be a challenge for them given the complexity of the NGN environment.

Some of the potential control points in Box 1 arise from the fact that the NGN is an all IP network. This allows operators of access networks to easily block access to specific services or applications by blocking specific IP addresses or TCP/UDP port numbers. Other examples are the points related with QoS among service providers. It is important because QoS is a major important interface parameter with the end-user for the services/applications. It is also interesting to note that the open service environment of NGN creates potential control points, such as access to user information and location, which are more critical than in the present network environment. In addition, some control points arise because of the importance of interoperability between existing networks and NGN.

6.3. Policy issues for telecommunication services provided over the NGN

Classification of new services over the NGN

One of the important challenges facing policy makers or regulators is how they classify new emerging applications. This becomes important in that regulatory frameworks and legal obligations are often dependent on how applications are classified. The importance of these classifications is evident in the upcoming debate on VoIP and decisions as to whether VoIP should be treated as an application, a public telephone service or a value-added capability.

Decisions made too early in the development stage of services may hamper development of new innovative integrated applications, but at the same time there is a growing need for legal certainty. So, it is necessary for policy makers or regulators to develop certain criteria or principle which can be used to promote new innovative capabilities as well as provide legal certainty. As an example, the principle of technology-neutrality with respect to user choice or functional equivalence across the full-range of features is being adopted and used by regulators when considering regulation on new services. The ACA in Australia uses matrices with which they can check whether current regulatory requirements are applicable against a range of new services over NGN.[39]

Division into local, long and international calls

In a NGN environment, it is possible for users to make any call (from a geographical perspective: local, long distance or even international) at a monthly fixed charge. On the Instant Messenger software applications for the Internet users can make a video telephone call without incurring further charges. If these kinds of services are widely used in the NGN environment, the current practice to segment the call market on the basis of local, long distance and international calls is less meaningful.

Location independence and emergency access

The PSTN has a direct mapping between the access link and a user's address. This is not the case for IP access, which can make the issue of how emergency services are delivered critically important in a NGN environment. Although currently this issue is mainly related to VoIP, in the future the issue might not be limited to VoIP as the use of integrated applications is increasing.

Interconnection: The openness of services and networks to third part suppliers

Interconnection will probably be increasingly important to the further deployment of NGN. In addition, while the NGN develops and legacy networks remain in operation, interconnection between NGN and legacy networks will be required. In this environment, maintaining any-to-any connectivity for voice telephony and developing any-to-any connectivity for other new multi-media services would require interworking arrangements between legacy systems and the NGN, and between NGN systems as well. Furthermore, current per minute based interconnection pricing may no longer be suitable for services in the NGN environment, because IP resources are not dedicated for the entire period to an application as in the case of the PSTN.

Although cost-based interconnection prices need to be reviewed as the NGN develop, the focal point of the issue may need to move from a price debate to emphasis on the quality of service in a IP network which may not be as good as that of PSTN. This raises the challenge of whether there is a need for interconnection agreements to include service level agreements. It will also be a challenge for policy makers or regulators to set up the interconnection framework suitable for a NGN environment which can encompass PSTN, mobile, Internet and cable TV traffic. So, it will be necessary for them to establish an interconnection framework which allows different types of network interconnection agreements for different categories of services in the NGN environment. Over time, as the NGN develop further, interoperability between services and applications will become important due to the characteristics of openness of NGN. In a NGN environment, intelligence and functionality can be distributed in many different locations among many different operators. This will add to the complexity for policy makers and regulators when setting up interoperability requirements. Additionally, this makes the standardised open interface more significant.

Selective access to NGN services and systems: preferential routing

Related to the openness of NGN, another potential issue is whether consumers should be allowed to connect any equipment, provide service or content that they desire. Although this is related with the interoperability issue mentioned above to some degree, it differs in that even though the two systems are interoperable, service providers may have the ability to block access to selected destinations.

This kind of preferential routing by service providers could be used for several possible reasons, such as capacity limits, quality of service, user's agreement or preference, unaffiliated content or application providers, and discrimination against rivals. However, policy makers and regulators need to monitor this issue in case significant competitive problems arise with the deployment of NGN.

Future definition of Universal Service Obligation (USO)

The deployment of next generation networks may have several implications for future USO. Eventually choices may need to be made as to whether the coverage of USOs should expand beyond voice services to cover other multimedia. This choice becomes complex in the NGN environment where voice services are provided together with data, and video which will require more bandwidth and quality than current PSTN voice service. Another issue is to what extent USO contributions should be imposed, and what type of companies should be required to contribute to any USO financing.

Numbering, Naming and Addressing (NNA)

NGN require regulators as well as technology experts to be aware of numbering, naming and addressing issues. It is necessary for all stakeholders to discuss how these resources will evolve and the management mechanisms for numbering, naming and addressing on NGN networks.

First of all, a universal numbering plan or scheme needs to be considered. Currently, The PSTN uses numbers only based on the E164 scheme which is, in general, controlled by national regulators, while Internet can be accessed using an IP address, URI (Uniform Resource Identifier) such as e-mail address, and domain names which are allocated by registries, operating under the co-ordination of ICANN (Internet Corporation for Assigned Names and Numbers) and oversight of national governments. As the NGN advance further, a mutual recognition system between circuit-switched and packet-switched networks is increasingly necessary. IETF have already introduced ENUM (Electronic NUMbering) as an integrated numbering scheme, which is a protocol that facilitates mapping traditional telephone numbers with IP addresses and other identifiers, *e.g.* SIP addresses.

However, there is no consensus yet on what numbers within national numbering plans should be used for NGN services, especially for VoIP, even though the Internet Architecture Board (IAB) and ITU-T Study Group 2 have discussed collaboration on the operational, administration and delegation issues related to deployment of ENUM protocol-based services. This requires extensive consultation between the above and the other key stakeholders including administrators of resources derived from the international E.164 numbering plan as well as national and integrated numbering plan administrators.

Another important issue in NNA is privacy concerns which mostly relate to the operation of the ENUM database. These concerns are about the security and privacy of the personal information in the ENUM database, authentication processes for access to the database, and how ENUM should be operated. These concerns arise from the fact that, unlike information contained in the signalling system of the PSTN, ENUM could be accessed over the Internet and may potentially be accessed illegally.

As the NGN develop, there may not be enough E. 164 numbers within the numbering plans of some countries to allow access to certain types of numbers for a large number of new service providers and for new services. On the other hand, increasing the number allocation may result in a significant cost increase for telecommunication network operators if they need to modify or upgrade switches to cope with the additional size of the relevant routing tables. These could mean that existing national numbering plans may become inadequate if NGN services, increase the need for E.164 numbers, especially in the case of VoIP, So, policy makers or regulators need to consider the implication of NGN development with respect to naming, numbering and addressing and also to consider whether additional numbering ranges should be allocated for use by new services in the NGN environment.

6.4. Policy issues for consumer protection, privacy and security

Consumer protection: privacy and content issues

NGN as an ubiquitous network will provide at the application level geographical location information, which makes user privacy more important. The need for sharing users' information due to the integration of NNA and the interoperability of networks and services will also increasingly raise the importance of privacy in the NGN environment.

NGN may pose significant challenges for the regulation of content. Development of NGN will blur the boundaries between broadcast and unicast content, in which the user specifically requests a certain type of content which is transmitted individually to them. However, the distinction between the two may not be evident to the user or regulators. So, the challenge for policy makers or regulators will be to devise an appropriate approach to promote innovation while meeting user needs.

Security and network resilience

As in case of the PSTN, another important role of policy makers or regulators is to deal with the issue of investment in the network to ensure its resilience. Therefore, policy makers, regulators and the private sector companies which provide NGN services and technologies need to ensure that appropriate measures are being taken to keep NGN from disruptive shocks such as technical failure, physical or cyber attack, or accidental damage.

Lawful intercept

Lawful intercept can be more challenging in the NGN environment, in that data or some important call processing information does not necessarily pass through the IP network service provider's facilities. In addition, users are able to encrypt their data with relative ease. It will be necessary for regulators or law enforcement agencies to evaluate this issue in the NGN environment and to review whether, where and how to intercept IP traffic of various types, while ensuring practical solutions and costs for service providers and ensuring the authorised privacy of users.

6.5. Other policy issues

Possible issues arising from extraterritorial service providers

In the NGN environment based on IP, service creation may be geographically independent and it may be difficult to pinpoint a geographic locationfor a service provided. That is to say, certain network facilities, such as the domain name system (DNS), presence management DB (Databases), or the resolution of names can be provided from a different country. As a result, it may be difficult for regulators to apply their national law to companies that are in another jurisdiction. Furthermore, this may possibly make it more difficult to protect consumers and ensure continued network and service availability. Therefore, policy makers or regulators need to consider how the extraterritorial provision of domestic services or components within these services could be treated. Policy makers and regulators also need to consider that attempts to develop and implement regulatory solutions before any indication of a real problem exists or before market-based solutions which can adapt to meet changing needs could inhibit the introduction of many innovative applications or limit their utility. In addition, international co-operation will be needed to effectively address these issues.

Intellectual property rights

Another increasingly important issue for the NGN is the intellectual property rights of content providers. Illegal file sharing or unauthorised copying threatens the economic interest of content providers. The best way is to develop technical solutions to secure the intellectual property rights of content without inconveniencing consumers. Even though technical solutions such as DRM (Digital Rights Management) and watermarking have been used, those efforts are still evolving. Policy makers and regulators need to continuously monitor and act to secure intellectual property rights, as appropriate.

Efficient spectrum management

As an integrated and ubiquitous network, a variety of services of NGN require more efficient spectrum management. In this regard there have recently been discussions about more efficient spectrum management in member countries. Several proposals for more efficient uses of the spectrum have been made, such as adopting technology development, *i.e.* smart radios, or promoting the development of secondary markets by allowing primary licensees or spectrum brokers to lease spectrum rights to secondary users. [40] In addition, to prevent overrun capacity in a license-exempt spectrum environment such as WiFi networks, it has been proposed that a registration system or the use of a ‘public interest band manager’ should be considered. Other discussions include that the spectrum, held by users such as government who have less incentive for efficient use of spectrum, needs to be used more efficiently by, for example, charging fees or providing them flexibility to sell or lease their frequencies to other users.

In Europe, with the EU Regulatory Package for Electronic Communications of March 2002, which made the trading of spectrum licenses possible, EU Member countries are now considering allowing licensees to sell their licenses, or change the services or the technology deployed, as well as partitioning their licenses. The spectrum policy debate is gaining significant momentum. A study for the European Commission on the secondary trading of spectrum rights was released in May 2004, after the discussions in two public workshops and a public consultation. The final report identified increased competition and innovation as the main benefits of spectrum trading and liberalisation as well as potential drawbacks, such as difficulties in co-ordinating spectrum bands internationally, the potential increase in interference and fragmentation. The Radio Spectrum Policy Group (RSPG), a high level policy group, where representatives of the Member States have the possibility to provide the Commission with co-ordinated opinions on EU-wide spectrum policy initiatives, is expected to deliver opinions on the possible introduction of spectrum trading in Europe, spectrum policy options in view of the digital switchover of broadcasting and a co-ordinated policy approach for regulation of spectrum bands for wireless electronic communications application platforms. At the same time, as these pan-EU policy discussions move forward, several Member States continue their national debates and reform activities.

In the United States, the FCC Spectrum Policy Task Force was established in June 2002 to identify and evaluate changes in spectrum policy that will increase the public benefits derived from the use of the radio spectrum. The task force has examined its spectrum policy to ensure that its policies evolve with the consumer-driven evolution of new wireless technologies and services. In addition, the White House took a spectrum policy initiative to develop recommendations for improving spectrum management policies in June 2003. Accordingly, the Department of Commerce has developed a US spectrum policy for the 21st century, streamlining the deployment of new and expanded services and technologies, while ensuring national security and public safety. One year later, in June 2004, the US government released two reports providing a set of recommendations to manage spectrum more efficiently.

Technical development and standardisation

As opposed to the traditional telecommunications network which has been developed mainly by large monopolistic network operators with internationally agreed technical standards, the IP network is a collection of heterogeneous networks that are connected to each other through a variety of solutions. To ensure ubiquity, interoperability and a competitive marketplace, NGN services and applications must be based on accepted open, voluntary, consensus-based international standards as mentioned previously. Technical development and standardisation is not the job of the policy makers or regulators. However, they need to understand the importance and trends of technical development and standardisation in order to facilitate friendly environments for technical development and standardization, to promote the relevant activities both domestically and internationally and to support their use in promoting open markets and trade. In addition, policies must be set based on the technical reality of the services and underlying networks that can be supplied economically. For this reason, the policy makers and regulators need to have technological experts groups actively involved in the development of NGN policy.

7. Conclusions

As noted in this paper, the transition from circuit switched PSTN to packet based or IP based networks has already commenced. Policy makers and regulators need to pay attention to this transition is that quite a number of major incumbent telecommunication network operators, as well as ISPs have established their plans and strategies and recently started to invest in NGN equipment. These trends are spreading not only in member countries but also in other regions of the world.

NGN will provide a number of potential benefits and opportunities both for users and network operators. The use of IP to carry voice and other converged services is of great significance for all users as well as policy makers and regulators in that it will change the environment in which we define, use and regulate electronic networks. At the same time, new players will enter communications markets, changing the current status of those markets, hence changing the role of the regulator.

On the other hand, the development of NGN will also face a range of challenges and obstacles: it will be dependent on a number of variables as well, such as the evolution in the equipment for networks, the attractiveness of the new services and applications, the establishment of effective business models, network security, competitive and predictable regulatory frameworks, etc.

In the process of this transition towards NGN, there are considerable challenges for policy makers and regulators, and their role will be significant especially in this early stage of NGN deployment. Most of all, in this early stage, a primary interest for policy makers and regulators will be to track carefully the technological and market developments taking place. They also need to assess new networks, applications and services, and to review the regulatory regime to ensure that policy is not an impediment to new applications, services, demands, innovative investments and network developments while safeguarding the long-term interests of users. It is also necessary for policy makers or regulators to track market signals carefully, and then tailor the regulatory approach accordingly in order to encourage both infrastructure deployment and service competition. The regulatory structure needs to be stable as well, since it is not possible to run a business and create long term investment plans if the business needs to react to unexpected regulatory changes.

NOTES

1 . The term ‘service’ has many meanings and occasionally, in some regimes, implies a need for regulation. In this paper, the use of the term ‘service’ does not necessarily imply that regulation should be required.

2 . Graham Rose, ‘ETSI reviews work on NGN Standards’, 8. 2001, http://webzine.kt.co.kr/s-trends/200108/html/0201.html

NGN SG defined NGN as follows:

- The main characteristic of NGN is the uncoupling of services and networks, allowing them to be offered separately and to evolve independently (clear separation between functions for services and functions for transport).
- NGN will have to provide the capabilities (infrastructure, protocols, etc.) to make the creation, deployment and management of all kinds of services possible using service related APIs (Application Programming Interfaces). This comprises services (known or yet unknown) using all kinds of media, audio, visual, audiovisual, with all kinds of encoding schemes and data services.
- In NGN, functional entities controlling policy, sessions, media, resources, service delivery, security, etc. may be distributed over the infrastructure, including both existing and new networks. Interworking between the NGN and existing networks such as PSTN, ISDN and GSM will be provided by means of Gateways.
- NGN will support both existing and "NGN aware" End Terminal Devices.
- Quality of Service for real time voice services (bandwidth guarantees, delay guarantees, packet loss guarantees, etc.) is a key issue to be solved.
- NGN will need security mechanisms to protect sensitive information and to protect against the fraudulent use of the services.

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    Some of the key technologies for NGNs would have to include:

    - middleware and distributed systems to enable service provider – network provider separation
    - IP: IPv6, broadband, QoS, security, mobile and wireless
    - multi-domain network management for seamless roaming and QoS support
    - seamless interworking between core and access networks

- micro and opto-electronics
- cross-media content
- multi-modal and adaptive interfaces
- multi-lingual dialogue mode
- embedded intelligence
- facilities for mobile transitioning between networks owned by different providers mid-session and the corresponding charging issue

25. www.geant.net

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    In the fields of service; Parlay, JAIN.

    In the fields of network management; TMF (Telecommunications Management Forum), T1, 3GPP in wireless network Etc.; IETF (Internet Engineering Task Force), TISPAN, MPLS Forum, ETSI BRAN (Broadband Radio Access Netwoks).

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