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Telecom Regulatory Authority of India

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On

Issues pertaining to Next Generation Networks (NGN)

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Contents

PREFACE

Presently various telecom services are provided through separate networks. Technological advancements in telecommunications are forcing a trend towards unification of networks & services setting up the stage for the emergence of Next Generation Networks (NGN). In the next generation networks, multiple access networks can connect customers to a core network, which is predominantly based on IP technology. NGN promises to provide number of significant benefits and opportunities both for the service providers and the end-users by providing new innovative services and applications through a common platform.

With the efficient and cheaper IP technology forcing telecommunications networks to migrate to 'Next Generation Networks', triple play (voice, data and video) would become a basic service. Traffic of different services of data, television and subsequently voice would be simply enclosed in Internet protocol packets, transmitted over these networks. These networks can later support any number of additional value-added services and transmit them also as IP packets. As a matter of fact, a number of telecom operators in country are already planning to move to such networks. The deployment of NGN would face a number of challenges and obstacles related to evolution of new technologies and services, emergence of disruptive business models, network security risks and competition and level-playing field issues. Unless license conditions and regulations are properly redefined with a light touch regulatory approach, it would be virtually impossible to regulate the emerging NGN technologies smoothly.

As an early application and driver of NGN, VOIP is proliferating fast and is expected to result in significant penetration in the matured telecom markets. In India, till some time back IP telephony was permitted only in a restrictive manner i.e. PC-to-PC, IP device-to-IP device and PC-to-Phone (abroad). Now with recent guidelines, Govt. has permitted UASPs (telecom access providers) to provide phone-to-phone Internet Telephony viz. unrestricted VOIP and therefore this is likely to proliferate in India also. VOIP is likely to have a big impact on the traditional circuit switched telephony, initially on fixed lines followed by mobile, driving consumer prices and margins down, forcing far-reaching changes in industry and consequently in the regulatory and licensing regimes. Earlier convergence of access networks was dealt with as the demarcation between fixed and mobile services became less distinct and heralded a Unified Access Licensing Regime in the country. Now the convergence trend has moved to core networks also and with the increasing use of NGN in core and access networks associated licensing and regulatory issues are likely to become more complex. The Government and the Regulator need to ensure that the changeover to such regime is smooth.

Regulators in many developing nations are attempting to lay down broad principles for NGN transition well in advance of the transition actually occurring. This is unlike the legacy network where the business model, network and competition were established prior to regulation. Also, operators and regulators around the world are deliberating upon how to overcome technical challenges pertaining to interoperability and interconnection and how to encourage infrastructure investment with least possible risk in an open environment of the NGN.

We, in India, have severe legacy regulatory problem in dealing with the present definitions of services and networks. The definitions and segregation of services based on legacy networks will need modifications and reorientation of the business approach of the existing operators. The regulatory implications for such an eventuality are huge. When one gets into the details of regulatory issues it is found that for promoting such developments, issues like numbering plans will have to be tackled in addition to provision of emergency access and security concerns. It has also been commented that, Number Portability (NP) may become an essential requirement. Broadband penetration is likely to be a key issue as many converged services enabled by NGN can be delivered only through considerable access bandwidth available to the customer, which can be provided through Broadband connectivity. QoS is going to be yet another issue.

Given the stage of fast network and infrastructure development in India, it appears that now is the right time to examine regulatory and licensing approaches in the area of NGN as new competitive networks are just being established and consumer's take-up of IP services and Broadband is at a nascent stage. To start with, it is necessary to ensure that both the industry and regulator appreciate how the new technologies of NGN will interrelate and how the IP based networks will interconnect.

During July 2005, TRAI had released a study paper on Next Generation networks with the objective of initiating the awareness and thought process among various stakeholders on the issues related with NGN. This consultation paper is the next step in that direction wherein various issues related to the technology and regulation of NGNs in addition to the migration issues have been discussed. Some of the international case studies from which useful lessons can be learnt are also included. Its aim is to help build further awareness in the industry as well as to probe initial high-level issues in the area of NGN regulation. It also deliberates upon the various approaches to be considered for adoption by regulator & licensor to facilitate the large-scale penetration of Next Generation Networks for the benefit of customers of telecom services in the country.

A number of issues have been raised in this consultation paper which are organised into four chapters, each addressing the following:

i. *Awareness and relevance*: Is NGN relevant for India? When should the industry migrate? For which category of stakeholders is NGN relevant?

ii. *Regulatory approaches*: Is there need for regulatory initiatives on NGN? Should these be 'light touch' or are there areas needing more detailed regulation? What regulatory incentives could help boost benefit from NGN and reduce risks? Will a move to NGN in rural areas reduce the gap between urban and rural teledensities? If yes, how to push NGN to rural India? What interconnection regime needs to be developed in the NGN context?

iii. *Technical issues*: Is there need for recommendation for NGN specifications or a technology neutral approach be adopted? How can security related concerns be addressed?

iv. *Migration*: Is there a role for Regulator to ensure smooth migration? What are the steps required?

The valuable comments and suggestions from various stakeholders are solicited by TRAI to arrive at the recommendations regarding the appropriate policy and regulatory steps towards NGN migration in the country. Your comments may be sent through e-mail at **trai09@bol.net.in** or through fax at 011-26191998 by ***3rd February 2006***. The paper has also been launched on TRAI's website **(www.trai.gov.in)**. For any clarification, the stakeholders may contact **Mr. S. N. Gupta**, Advisor (Converged Networks), TRAI at Tele: 011-26167914.

(Pradip Baijal)
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GLOSSARY

ADSL	Asymmetric Digital Subscriber Line. A digital technology that allows the use of a copper line to support high bandwidths in one direction and a lesser bandwidth in the other.
ATM	Asynchronous Transfer Mode, a standard for cell-based high speed data communications.
Bottleneck	The part of a network where the economics of building alternative networks are such that effective competition is unlikely to emerge.
Broadband	A data connection defined as 'always-on', and capable of providing a download speed of a minimum of 256kbit/s.
Bundling	Linking the purchase of one product or service to another, either by selling as a package, or through the use of discounts for joint purchasing.
Core network	The centralised part of a network, characterised by a high level of traffic aggregation, high capacity links and a relatively small number of nodes.
CLI	Caller Line Identification
COS	Class of Service e.g. Committed Access Rate (CAR), Waited Random Early Detection (WRED), Waited Fair Queuing (WFQ) in context of MPLS
DEL	Direct Exchange Line
DSL	Digital Subscriber Line.
E.164	E.164 is an ITU-T recommendation which defines the international public telecommunication numbering plan used in the PSTN and some other data networks. It also defines the format of telephone numbers.
ENUM	Electronic Numbering. A suite of protocols to unify the telephone system with the Internet by using E.164 addresses with DNS and IP addressing system.
ERNET	Education and Research Network
Ex ante	Before an event takes place.
Ex post	After an event takes place.
FCC	Federal Communications Commission. The US regulatory body that regulates all inter-state and

	foreign communications by wire, radio and television. Intrastate communications are regulated by state public utilities commissions.
FTTB	Fibre to Building
FTTC	Fibre to Curb
FTTH	Fibre to Home. Refers to a broadband telecommunications system based on fiber-optic cables and associated optical electronics for delivery of multiple advanced services such as the triple-play of telephony broadband Internet and Television Video to homes and businesses.
FMC	Fixed-Mobile Convergence
ICANN	International Cooperation for Assigned Names and Number
IDA	Infocomm Development Authority, Singapore
Interoperability	The technical features of a group of interconnected systems which ensure end-to-end provision of a given service in a consistent and predictable way.
IMS	IP-based Multimedia Sub-system
IP	Internet Protocol. The packet data protocol used for routing and carriage of messages across the internet and similar networks.
IPTV	Internet Protocol TV Video over Internet Protocol
IUC	Interconnect Usage Charge.
LLU	Local Loop Unbundling. A process by which incumbent's direct exchange lines (DELs) are used fully or shared by other operators. This enables other operators to provide various services to customers.
Local loop	The access network connection between the customer's premises and the local exchange or remote switching unit, usually a loop comprising of two copper wires.
LRIC	Long Run Incremental Costs
MDF	Main Distribution Frame. The equipment where local loops terminate and cross connection to competing providers' equipment can be made by flexible jumpers.
MPLS	Multi Protocol Label Switching, an IP technology

	used in many virtual private network (VPN) services.
MSAN	Multi Service Access Node, a common access Point Of Presence (POP) for providing different services.
Narrowband	A service or connection providing data speeds generally below 256 kbit/s, such as via an analogue telephone line, or via ISDN or 2G wireless access etc.
NGN	Next Generation Network
NICC	Network Interoperability Consultative Committee of UK.
NIR	National Internet Registry
NIXI	National Internet Exchange of India
Ofcom	Office of Communications. The converged regulator for the communications industries, created by the Communications Act in UK.
OFTA	Office of the Telecommunications Authority, the Hong Kong Regulatory Body.
PDH	Plesiochronous Digital Hierarchy. A transmission standard historically used for leased line services, now being replaced by SDH.
PLC	Power Line Communication
POTS	Plain Old Telephone Set/ Service
PSTN	Public Switched Telephony Network.
QoS	Quality of Service
RIO	Reference Interconnect Offer
SDH	Synchronous Digital Hierarchy. A transmission standard widely used for leased line services
Service provider	A licensed provider of electronic communication services to third parties whether over its own network or otherwise.
SIP	Session Initiation Protocol, a VOIP protocol.
SHDS	Short Haul Data Services
STM	Synchronous Transport Module, related to SDH.
TDM	Time Division Multiplexing.
USO	Universal Service Obligation
VDSL	VDSL (very high bit-rate DSL) is an xDSL technology

	providing data transmission up to a theoretical limit of 52 Mbit/s downstream and 12 Mbit/s upstream over a single twisted pair of wires.
VOIP	Voice over Internet Protocol. A technology that allows users to send voice calls using Internet Protocol, using either the public internet or private IP networks.
VPN	Virtual Private Network. A technology allowing users to make point-to-point connections over a public telecommunication network to emulate the service offered by a dedicated point-to-point private circuit.
VPT	Village Public Telephone
WiMax	Worldwide Interoperatability of Microwave Access, a Wireless WAN Technology
21CN	21st Century Network, BT's planned next generation core network

BACKGROUND

(i) A Next Generation Network (NGN) is essentially an IP based network that enables any category of customers (residential, corporate or wholesale) to receive a wide range of services (voice, video, data etc.) over the same network. IP access is enabled across a wide range of broadband technologies, both wireless (3G, WiFi, WiMax etc.) and wireline (copper DSL, cable, fibre, power lines etc.). In NGN, the service layer is independent of the underlying network, thus a whole range of 3rd party service providers can offer services to customers and the customer is not bound to take all services from only the access provider.

(ii) The primary change in NGN is that a host of different transport networks (e.g. ATM, Frame Relay, X.25, ISDN etc.), each of which has been historically designed to serve a specific service requirement, are replaced by a single IP transport network. For example, a unified licence operator could use the same transport (IP) network for its fixed voice, mobile telephony, broadband and corporate business services. Thus migration to NGN reduces network and operational complexity resulting in better reliability, better customer provisioning, greater service bundling etc. in addition to lower network procurement, operations and maintenance costs. In addition customers benefit from access to new services, lower prices, better quality of service, choice between service providers without changing networks or customer premises equipment.

(iii) Service providers who do not migrate to NGNs thus face the risk of becoming less competitive as their costs will be higher compared to an operator running a single network and also being unable to commercially exploit new emerging services (IPTV, Messaging, Education, Fixed-Mobile Converged (FMC) Services etc.).

(iv) Migration to NGN could change the operator's business models completely. On one hand, traditional operators would see much greater efficiencies and lower costs as well as possible access to new services, thus boosting revenues and profitability. On the other hand, service independence could create a completely new category of operators i.e. niche service providers who are able to compete effectively with traditional network operators for minimal investment e.g. a IP telephony service providers being able to provide all features of voice service delivered by a traditional fixed operator by investing primarily in only a server. A possible consequence of such new service-only operators directly serving customers is that traditional network operators could become pure access providers where upon all application services (voice, video, broadband and data etc.) are provided by 3rd party service providers. This could change the business model of the existing operator to the extent that if not managed adroitly, it could prove to be disruptive.

(v) Another implication of NGN migration will be that the interconnection regime also would need to change with traditional non-IP interconnection becoming increasingly more expensive and less relevant. It has been commented upon that service providers would need to upgrade to NGN in step with the industry or they may face the risk of lagging behind. Thus the migration to NGNs offers both a huge opportunity to operators as well as poses some serious risks. In this scenario, clear policy direction and enabling regulation could help the industry both reap the benefits of the migration of NGN as well as reduce their investment and commercial risks.

(vi) Compared to many developed telecom markets, India has lesser baggage of legacy products (e.g. lower tele-density of fixed lines (4.6), limited deployment of ATM, ISDN etc.). Various telecom service providers including incumbent are in the process of finalizing their plans for deployment of NGN. This is likely to be implemented in a phased manner starting with core network and then for access network and service provision. The service providers have to evaluate their business plans keeping in view the general NGN migration scenario.

(vii) At this stage, it is considered necessary to initiate a consultation process on various regulatory issues so that service providers get clarity on these issues while planning the deployment of NGN in their networks. The overall approach should be such that the regulatory issues should not come in the way of deployment of new technologies but at the same time new technologies should not be able to exploit the regulatory advantages so as to create uneven level-playing field among service providers. The main regulatory issues involved are related to Interconnection, QOS, Transition, Emergency Access and Security etc., which may need detailed ex-ante regulation. Regulatory clarity on these issues can help reduce investment risk for operators.

(viii) The licensing and interconnection regime may be required to be expanded to also cover service-only operators so that they are able to provide customer services on an equal footing with traditional network operators. A list of 'new' interconnection products will be needed in the all-IP environment for example to include capacity, quality, fixed bit rate, variable bit rate etc. and type of service (voice, video, data etc.) for core network interconnection.

(ix) With facilitating regulation and enabling directions, regulator could help the industry roll out NGNs in rural areas also. Regulatory options to incentivise rural NGN roll-out include possible introduction to Niche NGN operators for rural areas with lighter licensing conditions, access to additional wireless spectrum (e.g. licenced and unlicenced WiMax, UHF bands etc.) to reduce coverage costs, possible access to USO funding for infrastructure and involving other agencies / stakeholders to help drive new services for rural areas (e.g. localised content agencies for television & media, e-Governance agencies etc.). However, each possible option has both benefits as well as risks and need to be evaluated carefully.

(x) The timing of migration to NGN may also be important for different service providers. This interalia would depend upon international developments in this area and also on the plans of other service providers in the country. While some of the regulators in more developed markets are setting up industry interaction bodies to discuss the NGN strategies, it may make more sense only when there is a higher level of common understanding between the various stakeholders. Regulator has a role to play in bringing about awareness about NGN and assisting the industry march in step by suggesting appropriate policy initiatives and enabling regulation.

(xi) This consultation paper is first step to evolve the necessary framework for facilitating policy and enabling regulation pertaining to NGN.

1 INTRODUCTION TO NEXT GENERATION NETWORKS

Historically, incumbent operators typically operated one network i.e. the Public Switched Telephone Network (PSTN), which was designed to carry voice as it was the main communication to be carried. As demand for data communications developed, the incumbents adapted their networks to also carry data traffic. However, rather than replacing the PSTN, operators typically built new networks for data called the overlay network that they ran in parallel,. These new overlay networks were designed specifically to carry data traffic.

As network technology continued to develop, the number of networks multiplied gradually. As a result, today, many operators have typically 5 to 10 different network platforms (ATM, IP, Frame Relay, ISDN, PSTN, X.25 etc.). The problem with this multi-network approach is that it has created a web of complexities resulting in management complexity, operational inefficiencies, smaller economies of scale, maintenance issues, and duplicated capex.

Next Generation Networks aim to go back to the simplicity of one single network and it is all about deploying one network platform capable of supporting all traffic types while facilitating service innovation, simplifying the network and streamlining the support structure.

1.1 Definition

As per ITU a summary definition of Next Generation Networks is given below:

Box 1: Summary definition of NGN from ITU

ITU

- A Next Generation Network is a
  - packet-based network able to provide telecommunication services
  - able to make use of multiple broadband access technologies
  - QoS-enabled transport technologies, and
  - in which service-related functions are independent from underlying transport-related technologies
- It offers unrestricted access by users to different service providers
- It supports generalised mobility which will allow consistent and ubiquitous provision of services to users

NGNs can also be defined in terms of their technical characteristics. The key technical characteristics of NGNs are that they provide:

- A single IP-based core network handling the full range of telecom services.

- A single access platform supporting the full range of access technologies and services (typically referred to as a Multi Service Access Node or MSAN).
- Distributed rather than centralised switching, routing and network intelligence enabling remote access, control and maintenance.

1.2 Benefits of NGN and drivers for migration

NGNs essentially deliver convergence between the traditional world of PSTN and the new world of data networks. From an operators' perspective they provide a means of migrating from the old world to the new world, delivering substantial cost savings due to the economies of scope and efficiencies inherent in a single converged network based on IP.

There are some real world factors that have collectively formed the key drivers for NGN migration. Firstly, across the world, existing network operators are facing fierce competition in the market and they have to remain competitive to survive. In order to achieve this, operators are trying to build cost-effective businesses on the one hand and create new business models and generate new revenue streams on the other hand. The convergence of fixed and mobile networks and integration of voice and non-voice services are becoming their targets because such approach would lower operational cost and allow greater flexibilities for service innovation and increase their revenues.

Secondly, the increasing service requirements from end users call for innovative applications / multimedia services, high flexibility of service access, large access bandwidth, high quality of service etc. Apparently, the operators' need for remaining competitive and the end-users' demand for increased service requirements are together forming a strong driving force pushing the development of NGN globally with characteristics and features that would fulfil the needs of service providers and end-users.

A migration to NGN could bring about a complete change in the existing business models which is a cause of concern for both operators and regulators world over. Hence both regulators and operators need to clearly understand the benefits and risks of a NGN migration and the impact it has on the industry and consumers.

Telecoms operators are moving to NGNs for a number of reasons, including:

- Existing PSTN equipment may be reaching the end of its economical life, e.g. with ongoing maintenance support being harder and more costly to obtain.
- Operational costs can be reduced by running a single converged network rather than multiple legacy networks.
- Innovative services can be developed to improve customer experience.

- New services can be brought to market faster and at lower cost than is possible using traditional technologies.

IP-based networks are likely to be simpler and easier to operate and maintain as compared to the existing legacy networks and provide the scope for operators with sufficient flexibility in their cost base to reduce both Opex and Capex. In addition, all - IP networks allow for innovation in terms of new services and applications, with a truly converged platform to bridge the current distinction between fixed and mobile networks.

NGNs also have important service characteristics, as seen from the perspective of a consumer:

- Continuity – Consumers will be able to continue to use those PSTN services they are used to, with essentially no change.
- Ease of migration – Consumers will be able to migrate seamlessly to new services offered by the same operator.
- Single access to multiple services – Driven by the separation of the service layer from the network layer.
- Innovative new services – New services will have richer functionality (e.g. personalised, location-aware), and reduced time-to-market, since they exploit the distributed intelligence inherent in an NGN.
- Empowerment – Consumers will have an increased capability to configure and manage services to meet their personal requirements.

NGN is as much about easier provision of advanced services such as VoIP, Broadband, Multimedia applications etc. as it is about cost saving through simplification of network.

1.3 Current stage of NGN deployment in India

NGN deployment in India is still in its infancy. While there has been some migration to NGN technologies in the core network by incumbents, the access network is particularly poor and will take many years to be 100% transitioned to NGN.

The transition to NGN access is critically dependent on a number of variables including success of alternate access technologies (Cable TV, Power Line Communication (PLC) and WiMax being the most important), Unbundling (LLU) and market success of triple play services (video, IP voice and data).

In India, take up of broadband services has been low (Broadband penetration of 0.08%) largely due to low PC penetration, insufficient coverage and limitation of suitable access network availability. Further, the knowledge about NGN is not yet wide spread nor are the networks in position to supply these services. Possible applications in rural areas and the business case for rural areas have not yet been studied in any depth.

In summary, NGN deployment is progressing at the core stage and it is likely to take longer for adoption within the access network. The pace of migration will depend critically on plans of the major operators.

1.4 Regulatory issues concerning regulators around the world

A number of regulators, especially in Europe and the Far East, are evaluating the impact of NGN transition for their sector and for the wider economy. Of these, Ofcom (UK) is by far the most advanced in its thinking followed to some extent by the regulators in Singapore (IDA) and Netherlands. Some other regulators are in the process of concluding their consultations on the subject and are pushing industry led initiatives to regulate the transition to NGNs.

Regulators seem to be alike in their thought process on regulating NGNs and on creating policies to aid its transition. Key thought processes of some of the regulators are summarized below:

- They acknowledge that the transition to NGNs is a fundamental shift and that it offers an opportunity to set in place policies before the transition (as opposed to being ex-post as is the case for legacy networks)
- They also acknowledge that the investment in NGN is risky and clear regulatory policies offer one way to help operators reduce this risk. For example, regulators fear that if NGN investment and decisions are left entirely to the market, it could develop in such a way, which could have adverse impact on the industry.
- One key concern of regulators is that incumbents (state owned TELCOs/Ex-state owned TELCO's) will reap the most advantage from the transition to NGNs as compared to other operators, the competitive advantage being driven from the network depth and control over the transition timetable.
- On the flip side, the other concern is just the opposite viz. the telecom community will lose out to the low capex IT community e.g. voice services losing to VoIP providers, Video loosing to IPTV providers etc. The outcome that is cause of concern is that telecom players may become pure access providers with all application services (voice, messaging, video, gaming etc.) being provided by others.

- They also seem to be increasingly confident of 'delegating' certain aspects of regulation (e.g. basis for charging for interconnection products, details of transition time-table etc.) to the industry. For example, regulators in UK, Netherlands and Singapore are evaluating options to closely involve industry players to evolve some way for industry 'self regulation' on the technical aspects

- Regarding timing, there is a mixed view among regulators. Some regulators (mainly FCC) believe that regulation would make sense once clear network plans and strategies are in place. However, it seems that this is a minority view, with most regulators wanting to evolve policy and regulation in parallel with the technology transition. Thus, for example in the UK, the transition to NGN is expected to take till 2009 but Ofcom has already completed two rounds of consultation, has set forth its views on high level policy issues and has set up an industry body for managing the rules of transition (called NGNCo)

- While there are few public announcements on policies that help make the NGN investment climate favourable, regulators are debating a number of options. These include adjusting the allowed rate of return (used to compute Interconnect usage charge/ wholesale prices) that recognises the additional risk, exploring options for access and service level competition, evaluating additional interconnection products, providing clarity on transition plans with associated incentives and penalties etc.

- They are less sure of need for specifying technical standards for NGN, though they realise that investment risk can be significantly reduced if all operators in the industry follow the same standard. Ofcom has adopted a middle-of-the-road policy of trying to evolve a common set of specifications through industry consultation.

Feedback from the industry suggests that many operators would like clarity on IP telephony as a first step on offering clarity on NGN policy. As per them, this is important, as voice will continue to be the most important service even in the NGN environment.

Regulators across the world have taken cognigance of the fact that IP telephony will happen anyway as the technology provides clear customer benefits and lower prices and it is commented that prohibitive regulation will only drive it to grey route. IP telephony is good for consumers offering benefits of cost, nomadicity and other features and Govt. should generally like to encourage such technologies. IP telephony could help drive innovation in the telephony service market and potentially improve the overall service capability of the industry. There is also a well-established view that IP telephony could drive take-up of Broadband and the transition to NGN technologies. Many regulators believe that this take-up would help drive other national and consumer benefits.

However, at the same time, some regulators are worried that the transition to IP telephony will hurt incumbent voice revenues, especially so in countries where rural teledensity is driven primarily by the Govt. owned incumbents or through USO subsidies contributed by voice operators. Their other concern is that the current numbering scheme (E.164) could be under threat in VOIP environment and this could involve additional investment that does not directly result in an increase in the national penetration levels

From the above, the following key trends are clearly visible from recent regulations across the world on IP telephony:

- Regulators are pushing tiered licencing approaches, with separate regulatory conditions imposed on IP telephony, which is a direct PSTN substitution i.e. phone-to-phone (POTS) VOIP and PC originated i.e. PC-to-PC and PC-to-phone VOIP.

- While all regulators are considering mandate for emergency access and lawful interception and monitoring, many (especially in Europe) are considering giving IP telephony a 'grace period to comply', the reason being that they do not want to put forth conditions that might delay VOIP service roll-out or result in promoting grey routing using VOIP .

- Many regulators are pushing dedicated numbering for IP telephony meaning allocating a separate access code for VOIP provider like any other PSTN/ mobile operator in line with E.164 numbering system. There is also a trend towards increasingly allowing option for geographical/ non-geographical numbers (IN based/ E.num based) for IP telephony (as in US, Canada, UK, France, Japan etc.).

- The general consensus is for forbearance from retail price control (except Canada). The thinking is that IP telephony will need to be cheaper than PSTN voice to be attractive and therefore the tariff for the same should be allowed to be driven by the market.

- Regulators in developed markets are mandating VoIP-PSTN interconnection though usually the commercial agreements are left to mutual negotiations between the parties concerned i.e. the PSTN operator and the VOIP operator. Regulators in less developed markets where competition has not fully evolved normally need to specify the guidelines and terms and conditions of such interconnection agreements between PSTN and VOIP operators.

- QoS obligations on VoIP are becoming an exception i.e. many regulators are going for forbearance on this. The general view is that consumers are best judges of quality. Also, in the long-term, due to technological development in IP, the QOS is not going to remain an issue any more.

Further details on international regulation trends and technical case studies are available in the relevant Annexes (chapter 7) to this paper.

2 RELEVANCE AND TIMING FOR TRANSITION TO NGN

NGN deployment in India is still at an early stage, though the core networks are in the advance process of NGN transition and the market is ready for IP based core network competition. On the other hand, NGN in the access and service layers is in its infancy with majority of operators typically in the commercial and technical evaluation phase.

Globally also, plans on NGN migration are relatively recent. In UK, BT has embarked on its 21CN project to replace all of its core networks, including the PSTN and access network, with an unified NGN. The primary benefit of 21CN will be cost reduction and rationalisation of its network complexity. BT is initially focusing on the core network with migration on access and services layers at later stages. Mass customer migration is planned to start only from end of 2006 to be completed in 2009. Other countries that are considered advanced in the area of NGN viz. Japan, Singapore, Netherlands, Hong Kong etc. are also at a similar stage of migration (though Japan is possibly more advanced on NGN access, primarily through a combination of ADSL2+/FTTH.

Regulators across the world are debating the relevance and timing for policy aimed at facilitating the migration to NGN. They acknowledge that the transition to NGN is a fundamental shift and that it offers an opportunity to set in place policies before the transition (as opposed to being ex-post as is the case for legacy networks). They also acknowledge that the investment in NGN is risky and clear regulatory policies offer one way to help operators reduce this risk.

Consequently, Ofcom (UK regulator) has initiated consultations and issued initial policy statements on NGN, even though BT is expected to complete significant consumer migration to NGNs (PSTN replacement and broadband dial tone) only in 2009. Similarly, IDA (Singapore) has initiated steps on industry involvement today, even though there is no firm deadline from the incumbent and the other operators on mass customer migration.

This chapter discusses the issues related to relevance and time of regulation as to whether there is a need for specific regulation in the area of NGN and whether the time is ripe for the same. Additionally, it is to be discussed as to whether regulator role could be limited to helping create awareness amongst the stakeholders and operators, at this stage.

2.1 NGN relevance for different Service Providers

A migration to NGN has different implications for Fixed line incumbents, Mobile operators, Cable TV operators, Unified Access Service Providers, Internet Service Providers, Software and Hardware vendors etc. NGN can deliver different benefits and risks and each category of player sees a different combination of these benefits and risks.

The implication of the move to NGN is clear from ITU's definition;

"NGN is about multi-platform access and a network where service provisioning is independent of the underlying network".

This definition suggests that there is a role for multiple players within the NGN context. These could potentially include:

- Fixed telecom operators: both incumbents and new entrants
- Mobile telecom operators: especially in the 3G environment (and beyond more as IxEVDO/ 1xEVDV; HSDPA/ HSUPA, EDGE offer ever increasing access bandwidth)
- Internet Service providers
- Cable TV Operators: which have greater household penetration than fixed telephony in India today
- Other value added service providers, operators across multiple access technologies for example Public Mobile Radio Trunking operators, VSAT operators and Other Service Providers (OSP).
- Vendors for both Infrastructure and Customer Premises Equipment.

Fixed telecom incumbents world over are looking towards NGN core as a means of significantly reducing their network complexity & operating costs and improving efficiencies of the transmission network.

Box 2 : Case Study: BT

BT has embarked on its 21CN project to replace all of its core networks, including the PSTN, with a unified NGN. The 21CN project aims to substantially replace all of BT's existing network platforms (PSTN, ISDN, IP, ATM, FR, SHDS (Short Haul Data Service) etc.) with a single unified IP platform. The investment is concentrated in the period 2005 to 2008, and is estimated to be around £3 -£5 billion.

The primary benefit of 21CN will be cost reduction. BT's fragmented network platform is particularly costly to run, but it also supports a hugely complex legacy product portfolio, with many bespoke products - some that only serve one major customer. BT believes that the rationalisation of this product set should yield very significant cost savings and headcount reductions.

New entrants and service providers can easily offer innovative services to users by buying capacity from incumbents. This can increase the competition in the market place by introducing resellers or non-facility based service providers. A core NGN is, in fact, a perfect platform for a reseller. The reseller can buy capacity with much greater ease, flexibility and affordability than is currently the case. This capacity can be repackaged in innovative ways before it is sold on to end users. Services can be monitored and managed much more easily than is the case with legacy network services.

Mobile operators in Asia and Europe are investing heavily in NGN access upgrades. SingTel and 3 HK are offering 3G services to their subscribers with additional revenue streams via advanced services like mobile Broadband, TV over mobile etc. The business case in most markets is based on the concept that providing high-speed data access will create a market for new services.

Box 3 : Case Study: SingTel

Singapore's incumbent operator, SingTel, faces a slowdown in its home market as saturation and growing competition erode its fixed-line and mobile businesses. SingTel hopes, however, that 3G can help deliver a successful broadband strategy at home.

With just 4 million inhabitants and 90% mobile penetration, service differentiation in Singapore's city state is key, and SingTel is turning to a converged approach by combining 3G and video services across mobile, fixed-line and broadband platforms. Its "3loGy" initiative, launched in Singapore in February, is a triple play of 3G and video services across mobile, fixed-line and broadband platforms.

SingTel is also the broadband incumbent, believes the ability to bundle as a strong point of differentiation. SingTel has a single-access plan in which customers pay a fixed subscription fee that gives them mobile and fixed-line access and video telephony.

Over 61 million households in India are today connected by cable TV, being more than fixed line telephony base that stands at about 45 M. Thus, the cable TV sector in India can potentially offer high capacity NGN access if they can upgrade their local networks (through possible digital two-way upgrades, DOCSIS implementation etc.). Coax cable can typically offer spectrum bandwidth of up to 860 MHz and current modulation schemes and DOCSIS implementation offer data speeds of up to 38 Mbps.

The layered architecture in NGN provides a flexible and scalable network, as the core network layer and the service layer are independent of each other. This architecture enables creation of many new services through the service layer without need for any manipulation in other layers, reducing time to market for the implementation of new services. This also allows for easier provision of advanced and innovative services by 3rd party service providers.

Thus, there are wide ranges of possible players within the sector that NGN can potentially impact. There is a need for involving all these very varied players in the consultation process because of following:

- Involving all possible players in the discussion early on will ensure a fully emerged perspective on NGN migration and a greater possibility of innovative and viable competition at all levels
- It will also help develop momentum that will drive the transition forward
- Involving all stakeholders can help develop consumer services which are really needed at the moment and thus generate 'next generation service' revenues early on to the benefit of the entire sector

Issues for consultation in this regard are**:**

2a. Has NGN become relevant for India, at present?

2b. Which are the service providers for whom NGN has relevance?

2.2 Understanding the NGN concepts and implications

Major telecom operators, both internationally as well as in India, consider that their next major network upgrade is much more than just a technology investment. NGN can overturn the existing regulatory framework and alter the competitive landscape, enable radical reductions in operating costs. However, NGN also bring significant risks in the form of a huge upfront investment and due to huge scope and complexity and potential for cost and budget overruns in a core NGN project is very significant. There is also a risk of service disruption for end users, leading to dissatisfaction and possible churn. Hence it becomes important for service providers and regulator to clearly analyse the benefits and risks associated with migration to NGN.

While major telecom operators are known to understand the concept, there may be concerns that the smaller operators and other service providers in the industry are less aware of the implications. Correspondingly, a number of incumbents in developed telecom markets have taken the lead to build awareness, BT, Singtel and KPN (Netherlands) are some examples. BT is probably the leading example where an internal technology programme, 21st Century Networks, has now been embraced by the whole industry and is used inter-changeably as a term with NGN.

Key benefits of awareness include clarity on timelines across the industry that helps reduce capital risk for all operators as interconnection products evolve in step, smaller operators being able to take a well thought 'Build or Buy' decision on network products and consumer interest being build up.

Box 4 : Case Study: BT building awareness in the UK

BT set up Consult21 to create awareness of BTs 21CN project. As a part of the programme BT is talking to regulator, customers, suppliers, and investors. The Consult21 steering board aims to create and manage the framework within which the operators / service providers can agree on interoperability, and consult on the development of next generation products and services (including access and interconnection products with their associated contracts, timeline etc), taking account of Ofcom policy, BT's network capability and industry requirements.

The situation in India appears to be very different. The large operators are known to be embarking on NGN migration projects without involving any other parties. There has been minimal discussion with regards to NGN viz. its benefits and risks among the parties concerned. There seems to have been no discussion on Consumer and National benefits.

In the Indian context, NGN offers scope for meeting an important National objective of rural connectivity. It may be possible that with optimal network planning and innovative applications, NGN access could provide affordable converged services (multimedia including voice, e-education, e-employment, e-health, e-governance) in small towns & rural areas at lower costs.

Building an awareness campaign can align regulatory, business and social objectives and get an increasing number of national stakeholders interested. TRAI initiated the thought process and awareness about NGN by bringing out a general study paper on NGN followed by organizing an international seminar on VOIP and its regulatory implications with participation from majority of stakeholders. This consultation paper has been prepared by taking into account the feedback from major players on important issues. In addition, another study paper focussing on NGN interconnection issues in context of multi-operator environment is also planned to be brought out.

Another possible option is organising workshops on NGN for all relevant stakeholders. For example, NGN awareness in UK has been driven very successfully by workshops and seminars organised by Ofcom (and also by BT); more recently IDA (Singapore) has been organising conferences and workshops on the subject.

Issue for consultation in this respect is**:**

2c. Do you think there is a need to educate and involve all related stakeholders to give additional focus to the issues related to NGN? Is yes, what is the most suitable arrangement for carrying out this task?

2.3 Timing of NGN transition

It is very important to understand the planning and timeframe for NGN migration before deciding when would be a right time for related regulation that could help operators in the potential migration to NGN. From the feedback obtained from the major operators many operators desired the regulator to provide regulatory clarity on key issues before significant capex is sunk in NGN investment by them.

Box 5 : Case Study: BT migration timetable

BT has embarked on its 21CN project to replace all of its core networks, including the PSTN, with a unified NGN. The prime motivation for BT is the cost reduction. BT also set out several key milestones for its programme:

- Trials of the new technology were to be initiated during 2004-05, with next generation voice services being delivered to 1,000 customers . (It is understood that this phase is implemented as planned)
- Broadband services will be available to 99.6% of UK homes and businesses by 2005, with growth in broadband services being met by a new 'Multi-Service Access Node' platform i.e. the single access node to provide multiple services like triple play. (It is understood this has also been achieved)
- The mass migration of PSTN customers is expected to start in 2006, and reach more than 50% by 2008.
- Broadband dial tone i.e. conversion of PSTN local loop to Broadband for multiple services access including VOIP is expected to be available to most customers by 2009

For reference, the following NGN migration strategies in other countries can be analysed:

- *Full steam ahead* – BT's 21CN project is the most prominent example of an early, rapid and inclusive upgrade programme. The test is whether or not an operator has announced plans to retire their Public Switched Telecoms Network. BT, Telekom Austria, NTT and KPN all have plans to switch off some or all of their PSTN over the period to 2009.
- *Gradual with narrower scope* – Operators can take limited steps towards a core NGN upgrade, for example by using IP for transport in the core PSTN. This is a low cost, low risk move, but with few benefits

other than the learning process. In contrast the retirement of the PSTN, which implies the removal of the installed circuit switches, is a much more risky project, but can unlock significant cost savings. Operators in this category are Telecom Italia and TeliaSonera.

- *Wait and watch* – Incumbents may choose to postpone any core NGN programme, waiting to see how other operators succeed with their projects, and avoiding the teething problems of early NGN.

As per the feedback obtained from major operators in the country, they fall into all three categories above.

India is unique compared to many other markets in having far less legacy baggage. There is hardly any ATM core and technologies such as Frame Relay, ISDN and X.25 are limited to very niche segments by only a handful of operators. Most of the major operators are in the advanced stage of making use of IP-based technology in their transmission system. Thus core networks are close to NGN transition and the market is ready for IP based core network competition and wholesale products.

However, it is through service layer migration i.e. operator starting providing NGN based services, that customer realise the benefits of NGN viz. low cost voice with VoIP, multimedia applications, triple play etc. The general view from the initial feedback obtained from major operators is that the service layer should be ripe for transition next year. The service layer requires far less investment compared to other layers and offers scope to roll-out new services viz. voice, messaging, gaming, mobility, IPTV etc., thus offering operators a chance to monetise their NGN investment.

The transition to NGN access takes the most time because of:

- Of all the layers, access migration is most capital intensive.
- With low PC and Broadband penetration, there is limited drive to extend roll-out beyond the metros and major cities.
- Low cost customer premises equipment/ non-PC based IP terminals will be needed to make a viable business case for NGN migration in the access layer.

For additional clarity between the core, service and access layers of NGN, Annexure (chapter 7) may be referred to.

Issue for consultation in this regard is**:**

2d. What could be the likely time frame for the country to achieve complete migration to NGN core? In what time frame the migration in other layers like access and service layer is likely to be achieved? What could be the NGN migration time frames in urban and rural areas?

3 REGULATORY APPROACHES FOR NGN

As per ITU**:-**

"The move to NGNs represents an opportunity to establish in advance ground rules for ensuring the continued passage to effective competition and minimise damage during transition".

This chapter looks at the following major regulatory issues:

- Will NGN benefit from regulation?
- If yes, in which areas is additional regulation needed?

Regulators across the world seem to be similar in their approaches on regulating NGNs and on creating frameworks to facilitate smooth transition. They acknowledge that the investment in NGN is risky and clear regulatory guidelines offer one way to help operators reduce this risk.

Major operators in country have highlighted in their feedback that the main service from NGN they are interested in is VoIP and unless regulatory issues concerning this are tackled first, NGN will be a non-starter.

Most operators insist that the policy should be technology-neutral. Some operators also feel that NGN investment will be limited to urban areas further widening the digital divide.

3.1 Need for a policy framework and regulatory initiatives within the NGN context

The investment to NGN is risky as the costs and benefits are unclear and difficult to quantify accurately. Regulatory clarity can help reduce risks for operators and help make the transition less painful. Most operators believe that the transition to NGN is the single largest investment and business change they will be making.

On the other hand, regulatory intervention in the developing NGN environment has the risk of delaying innovation as services and business models are not yet established in the market. Bodies such as the ICANN an international body, which manages the Internet domain names and addresses believe that regulation could kill innovation in the NGN context. Ofcom, though it has got into a level of details not seen in recent years, has decided to leave detailed management of the transition and specifications to the industry (though it is co-ordinating this through an industry body it has set up called NGNCo).

It is believed that both operators and regulators must understand clearly the risks and the benefits involved with NGN regulation. However they cannot make informed choices based only on a theoretical understanding of the technology and economic conditions in which the new networks, applications and service-packages will operate.

Issue for consultation in this regard is**:**

3a.Is there a need for regulatory initiatives within the NGN context? If yes, why? If no, why not?

3.2 Relevance of 'light touch' regulation in the NGN context

Regulators across the world are looking to move away from detailed ex-ante regulation to 'light-touch' that focuses on the main principles and leaves specific compliance to 'ex-post' activities and general law relevant to the sector. As the telecom industry in India becomes more established move to 'light-touch' regulation, may be considered as an option.

However, internationally as well as in India, views are split on the issue of 'light touch' regulation. One view, mainly expressed by operators in Europe and Far East Asia is that the transition to NGN is a complete shift in the business model for telecom industry moving away from a well established practice of charging by time and distance (miles & minutes) to charging by capacity and quality of service. Telecom operators are becoming media companies and vice-versa. Third party service providers are being able to provide services to customers connected by telecom operators without much revenue flowing to the main operator who has provided the infrastructure.

In the above scenario, one may like the regulator to get into details of regulation, so that they can make commercial and technical decisions with minimal risk. For example, from the feedback from major operators, about a third of operators have suggested that regulator should get involved with technical specifications. Their natural concern is that if they invest in a technical specification that is not supported by the incumbent operators, they will need to invest further for interface/ translation equipment that would make their products both more expensive as well as of lower quality. Another area of detailed regulation that is popular is the transition plan wherein operators in some European markets have demanded that regulators also mandate a common transition calendar so that no one is left with stranded non-compatible assets.

As a converse view number of operators do not want any agency to mandate technology and want the present technology neutral regime to be extended to NGN also.

Issue for consultation in this regard is:

3b. Does a 'light touch' regulation regime makes sense within the NGN environment? What benefits and risks do you see with a 'light-touch' approach? Alternatively, do you prefer tighter and more detailed regulation from the beginning? If so, what extent of details would you want the regulator to go into and why?

3.3 Establishing viable competition and a level-playing field within the NGN context

There are two related but contrary competition positions that can develop within the NGN context:

***(i) Service level competition**:* Open services access can result in the situation where 3rd party service providers are able to ride on a telecom operator's network to directly serve customers. This can result in intense service level competition (e.g. customer being able to buy services from many IP telephony providers or TV/ Education/ Gaming providers that are independent of the network operator). There is a possibility that in this scenario, network operators see themselves becoming pure connectivity providers and thus suffering a huge erosion of revenues. Network operators are basing their NGN business plans on some estimation of service revenues and cost and such an open service scenario could well make their business unviable.

(ii) Network level competition: NGN offers the most benefits to those with the largest scale, for example, BT estimates annual Opex benefits of £1b on a Capex spend of £3b-£4b; benefits to competitive operators estimated to be about 20% of BT's. Incumbents (ex-PTTs) also gain immense advantage in being able to dictate the transition plan for the entire industry; other operators have to march in step with the incumbent, as typically upwards of 50% termination occurs on the incumbent's network. The incumbent has the maximum clout in terms of deciding the network specifications; functions within the service layer and on the nature of interconnection products to be offered in the NGN context. Thus it is not surprising that, world over, regulators are worried that the transition to NGN could make the market less competitive unless the transition is properly regulated.

The transition to NGN could potentially offer incumbents a means to further strengthen its competitive position through far higher cost advantages compared to their smaller competitors coupled by their huge access reach. The incumbent operators because of their large network sizes are in a position to extract maximum price advantage from vendors due to economies of scale and volume. In this scenario, a number of the newer operators may want regulator to ensure viable competition across the various layers of NGN.

On the other hand, the maximum risk for an NGN investment is also with the incumbent. Provided relevant interconnection products are available, competitive operator and resellers can buy capacity with much greater ease, flexibility and affordability than is currently the case. This capacity can be repackaged in innovative ways before it is sold on to end users. Incumbent bears all of the costs and disruption of a major network upgrade, but also provides its competitors with a significant boost to their effectiveness.

Another area to consider is the possible actions that a regulator could take in the current environment when there is no Local Loop Unbundling (LLU). It is understood that in the non-LLU environment, access level competition will prove to be the most difficult. One way to get over this problem is to offer incentives to alternate access paths (Cable TV, WiMax, Powerline). Offering regulatory incentives to alternate access can generate competition e.g. providing additional spectrum in both un-licenced and licenced WiMax bands within the NGN access layer. In a developing economy like India, there is a need for capital to be invested in pushing rural penetration i.e. in rural access rather than capital invested in duplicating access paths in urban areas.

Issues for consultation in this regard are:

3c. Is there a need to encourage service-based competition in core and access networks or both?

3d. If yes, how it should be done?

3.4 Regulatory incentives at the initial stage of the migration to NGN

Regulators across the world are evaluating various options for regulation within the NGN context. This sub-section aims to discuss some of these options to get the views of stakeholders.

(i) Standardisation: Given that, some regulators are helping industry evolve certain technical standards, so that operators are not left with 'non compatible assets' in the eventuality that they have embraced the wrong standard, Ofcom (UK) has taken the step of helping set up a cross-industry body (NGNCo) to help finalise some of the broad specifications for NGN.

ii) Transition Time-table: Given that the industry would need to follow incumbent's NGN plans to ensure customers get the full benefits of NGN (given around 50% of termination will happen on incumbents networks), some regulators are debating a schedule of incentives and penalties to ensure the industry agrees and then follows a transition time-plan.

(iii) NGN and legacy interconnection product lists: Given that, there is a need for operators to be able to continue serving their customers with legacy as well as new NGN products, it is to be ensured they are given fair and sufficient notice of any change to the interconnection product list by NGN based incumbents.

(iv) <u>Competition</u>: Given that NGN requires significant investment and is risky in terms of service revenues, there is a minority view that regulators should examine ways to limit competition within certain layers of the NGN to enable network operators to recoup their investment. This is because of fact that only few NGN services are well established apart from voice, which can be provided as VOIP by 3rd party service providers with little revenue flowing back to the NGN operator.

(v) <u>Rate of return</u>: Given that NGN investment is risky, for the calculation of interconnection prices, some regulators are debating if they should set the required rates of return on the basis of which cost based interconnection is calculated, recognising the much higher risk in NGN investment.

(vi) <u>Alternate access paths</u>: Given that local loop unbundling is still non-existent in India, operators may want additional resources for reducing the cost of wireless access e.g. through additional allocations for both licenced and un-licenced WiMax and WiFi spectrum.

While there have been examples from across the world of investment incentives through limited facility-based competition (e.g. infrastructure and network sharing for mobile in rural areas), there are obvious risks with exclusivity. For example, if a single operator given exclusivity in a rural area does not perform satisfactorily, it can lead to reduced customer service take-up as well as innovations in absence of service layer competition.

Issue for consultation in this regard is**:**

3e. What possible regulatory actions could TRAI consider at this initial stage of the migration to NGN to help the industry in general and to reduce risks associated with migration?

3.5 Regulatory facilitation for encouraging NGN migration to rural areas

NGN benefits should reach out to whole of India, specially covering the rural and remote areas. However, it is possible that the economics of NGN in rural areas will vary depending on the technologies used and the specific enabling regulations, if any. This sub-section aims to solicit industry's views on how the benefits of migration to NGNs can benefit rural areas as well and whether any additional regulatory incentives are needed to achieve the same.

In its recommendations on growth of rural telecom in India, TRAI has recommended sharing of infrastructure, delicensing of certain frequency bands and the USO funding for rural infrastructure etc. to promote rural services. Also, the Authority has further suggested possible sharing of frequency in UHF Band IV & V that are not being used for Broadcasting in small towns and rural locations (ref. 'Recommendations on Private Terrestrial TV Broadcast Services' on TRAI website). In case such resources be judiciously used, the rural business case for NGN access could possibly become comparatively stronger.

The present network in the rural areas comprises of approximate 25,000 small exchanges providing 14 Million DELs. Today all the exchanges are connected by optical fibre media mostly with CCS 7 signalling. With Village Public Telephones (VPTs) in place in 530,000 villages (86%) out of total 600,000 villages, basic infrastructure for connectivity appears to be available. The scenario could improve further as more private operators, move towards villages but the time frame for such a move is uncertain at the moment.

Between 1998-2005, whilst urban tele-density has increased from 5.8% to 32% in India, rural tele-density has just grown from 0.43% to 1.94%, signifying the digital divide. Overall, the country has a tele-density of just over 11% and population coverage of around 35%. Hence there appears to be need to balance between the commercial interests and social interests i.e. the objectives of increasing tele-density and provision of basic services to the masses versus upgrading networks to provide more advanced services.

As per the feedback obtained from major operators in India there is a concern that NGN will be limited to only urban India. On the other hand, there is a strong view that the lack of potential for rural is a misconception as seen by recent growth in consumer goods (shampoo, soft drinks etc.) and durables (two-wheelers, televisions) is being driven to a large extent by rural markets and this experience can well be duplicated in telecoms and NGN based services.

Some operators have suggested that access to incumbent's network is critical for rural migration. This will avoid duplication of investment, which is considered hugely wasteful, and allow operators to push tele-density by concentrating on serving new unconnected areas.

The increasing gap between urban and rural tele-density is a major concern for govt. and regulator. To address this issue TRAI has submitted its recommendations on growth of telecom services in rural areas on 3rd October 2005. One apprehension is that if NGN migration takes place only in urban areas then it may widen the gap between urban and rural instead of bridging it. On the other hand, with the technological developments in NGN era and with the kind of regulatory and policy decisions recommended in TRAI's recommendations referred above, NGN migration could be viable case in rural areas. Infrastructure sharing by various operators particularly in rural areas could be a key to success of cost-effective NGN services.

Issues for consultation in this regard are**:**

3f. What are your views on the effect of NGN migration on the gap between urban and rural tele-densities?

3g. Should TRAI propose incentives for NGN roll-out in rural areas? If yes what regulatory incentives beyond the ones already recommended can help push benefits of NGN to rural India?

3.6 Delivering QOS in NGN environment

NGN is all about service layer independence from main network. Third party service providers can provide customers access to a range of IP based application services without revenues necessarily flowing to the network provider. In this scenario, some network operators may resort to degrading the quality of service provided by these non facility based service providers so that customers switch back to procuring application services from the network provider.

These issues are already evident in the area of IP telephony today. A key case has been fought in the US. Madison River, which is also the fixed line operator in Virginia, was fined by the FCC for blocking VoIP calls of Vonage and Nuvio in an attempt to protect its own voice revenues.

On the other hand, non-facility based service providers may argue that such service degradation goes against the spirit of NGN and would hurt customers and the industry in the long run. They may also argue that network operators have an edge over 3rd party service providers anyway (greater QoS control, single bill, CRM etc.) and this should be sufficient to allow them to compete against 3rd party service providers.

Issue for consultation in this regard is:

3h. Should TRAI set in place a QOS regulation for the minimum level of quality to be provided by the facility based operators to their competitors?

3.7 Development of interconnection regime in the NGN context

The existing interconnection regime prevailing in country is as per various regulations/ determinations / directives issued by TRAI from time to time. This interalia includes level of interconnection between various networks, cost-based IUC charges, RIO regulation and regulation on mandatory registration of interconnect agreements etc. Licensing conditions also stipulate that interconnection among various operators is mandatory. It is to be examined to what extent these regulations/ determinations / directives would be able to accommodate various interconnection issues in NGN environment.

Some regulators believe that incumbents will not offer their NGN products to competitors unless they are compelled by the regulator. This is at the crux of the struggle between BT and Ofcom around the subject of “full functional equivalence”, where BT’s 21CN initiative features in many of the key areas of dispute.

Some tactical options that a dominant operator generally employs can be:-

- Refusal of access to the NGN on economically viable terms so that competitors have to make do with legacy arrangements, which disadvantage them in several respects.
- Elimination of legacy services, at short notice and without workable fall-back alternatives forcing competitors to have legacy networks that depend on legacy products purchased from the incumbent.

Regulators and Operators both in India and globally are concerned that the present well established interconnection principles for legacy networks may not be appropriate and sufficient in the NGN context.

A number of interconnection related issues arise in the NGN context, some of them include:

- **Interconnection parties**: classic interconnection is mandated between telecom operators, but in the NGN world, a software led service provider (e.g. an ISP or an IPTV operator) may want to terminate calls or other services on a telecom operator network. Hence, existing policy may need to be expanded to include non-telecom operators as well in the interconnection domain.
- **Interconnection products**: Various types of interconnection products in NGN domain will be based on capacity, quality of service and class of service as well as the layer at which it is done. It is to be decided which of the interconnection products should be allowed to ensure that society and industry gets the full benefit of NGN. In addition it is to be discussed which layers should the interconnection regime cover viz. only Core, Core and Access or all three layers including Service?
- **Types of Interconnection**: should interconnection in the NGN context still be priced by ‘time and distance’ or will it immediately need to evolve to interconnection priced by ‘capacity, quality and class of service’? Should regulators look to mandate interconnection products such as ‘fixed rate voice’, ‘variable bit rate voice’, ‘fixed rate video’, ‘subscriber’s presence’ etc.?

- **Legacy products**: should the incumbent be mandated to offer legacy interconnection products like distance and time based (minutes and miles) consisting of the transit and termination charges? Or should the incumbents be allowed to 'switch off' legacy products provided sufficient and fair notice is given? If legacy products are mandated, how should the cost be computed? If in future, the interconnection usage charge is determined on a LRIC/ cost-plus mechanism, would falling units of use and ever increasing costs to maintain a legacy network any way make legacy interconnection more expensive and hence unviable?

- **Basis for charging for interconnection**: one radical view is that incumbents have finalised their transition plans to NGN for the internal cost control and revenue enhancement reasons and hence this is an internal cost that competing operators connecting to the incumbent network should not be called upon to pay for.

  As interconnection is a vast subject and is more complex in NGN domain, there may be a need to have a separate dedicated and detailed consultation on this issue.

Issues for consultation in this regard are:

3i. Is there a need to have a detailed consultation on the various interconnection issues in NGN context?

3j. What interconnection issues do you think should be discussed in such consultation process ?

3k. How should TRAI regulate existing interconnection regime while facilitating the transition towards NGN?

3.8 Timing of evaluation of regulatory approaches on NGN

Most regulators are looking to clarify principles for NGN transition well in advance of the transition actually occurring. For example, Ofcom is pushing NGN policy since early 2005, despite BT targeting only end-2009 for 'complete' NGN migration. Ofcom wants to ensure that there is clarity as to the regulatory policy requirements necessary to support effective competition. By providing clarity as to those regulatory policies Ofcom wishes to help BT and others be clear about the constraints within which they should design their networks. IDA in Singapore evaluating NGN migration today, though only Singtel has made some transition in the core network

In comparison to BT, some operators in India are farther ahead in some ways and some of them seem to be already transitioning to NGN in the core layer. From the feedback obtained from major operators, it was evident that operators would like the regulator to set forth relevant policies on NGN at the earliest to reduce their investment risk.

However, at the same time, it is equally possible that with the exception of major telecom operators, there is little awareness of the opportunity (and risks) that NGN offers.

There are a number of possible approaches to be considered for the issue of NGN regulation. One possible route is a multi-stage process that builds on previous stages. For example, one could start by building national awareness between the stakeholders say through formal consultation like this one. The next stage could possibly be for the regulator taking a lead in building industry consensus on what policy (timetable, competition, interconnection principles etc.) the industry would like to best meet their objectives and reduce risk. Regulators across the world believe that this step is best taken after sufficient momentum is built and should not be hurried through. The final stage could be specific regulation. It is given to understand that detailed regulation is desirable, but it can be implemented in steps e.g. specific interconnection products, QOS regulation, cost based access charges etc.

Issues for consultation in this regard are:

3l. Is time ripe for TRAI to start formulating regulatory approaches on NGN?

3m. What issues should be focused on to start with?

3n. By when detailed regulations on NGN interconnection products, QOS and Access pricing in NGN domain should be brought out?

4 TECHNICAL ISSUES PERTAINING TO NGN

It is generally accepted that Next Generation Networks do not represent a specific technology but rather a system and a market concept enabled by combination of different advance technologies.

The basic features of NGN are range of access platforms, independence and range of service architecture, different migration paths and timing. Given this complexity, it is natural that a whole list of technology related issues arise, covering product development, wholesale service provisioning, transport protocols, quality of service, security, numbering etc.

The drivers for migrating to NGN are different for different players viz. reducing their network infrastructure and maintenance costs, enabling faster service deployment for the provisioning of enhanced services and therefore creating new sources of revenue. The high flexibility, low cost and wide support throughout the world for the Internet Protocol makes it the best option for building NGNs, even though it has some limitations that need to be overcome as for instance the lack of guaranteed QoS and security requirements.

Network operators will potentially choose a different migration path depending on their existing assets. Each path may therefore involve different technologies and happen at different pace.

For circuit-switched network operators, a multi-service network for converged services and more revenues represents the main driver for the migration to NGNs. However, a migration also imposes various direct and indirect costs including network upgrades, staff retraining costs, organisation process changes, etc. Moreover, some circuit-switched networks specially the cellular mobile systems are still in a very good state and provide quality telephony services, which are currently difficult to replicate on a large-scale in IP based networks.

Packet-switched data networks rely on several technologies and a number of protocol stacks are used depending on the service delivered and the functionality offered by each protocol, e.g. “IP over SDH over DWDM”, or “IP over ATM over SDH over DWDM”, or “IP over Ethernet over SDH over DWDM”. The migration towards NGN for these types of networks means a simplification of the network and more flexibility. Building an NGN network also means that the network needs to support converged services including voice and real-time applications. The migration of packet-based networks towards NGN can follow several strategies that could possibly be combined. A migration to NGN could also involve a move towards the next version of the Internet Protocol, IPv6, though it may not be a must.

NGN concept also implies many different types of “Convergence”;

- PSTN/ISDN convergence with IP based networks.
- Fixed – Mobile convergence (FMC).
- Broadcast (Cable) – Telecommunications convergence.
- Web based services convergence.

Each has different addressing structures, not to mention terminology.

The issues related to convergence of broadcast and telecom network are therefore being deliberated through a separate consultation paper on Convergence and Competition issues, which has already been released.

The convergence towards Next Generation Networks also requires that customers of different market players, using different network technologies, can communicate with each other and access resources on another market player's network. This requires the interworking of different Naming, Addressing and Numbering systems.

Two main standardised numbering solutions being discussed for NGN are ENUM and TIPHON led by the IETF (Internet Engineering Task Force) and TIPHON (Telecommunications and Internet Protocol Harmonisation Over Networks) respectively. (Please refer the annexure in Chapter 7 for details).

Another key area of concern is the security monitoring and emergency access. These issues are under hot debate in the context of IP telephony, with the main discussions occurring in the US (please refer to Annexure at chapter 7). The issue is of equal concern in our country as well.

A number of different international bodies are separately pursuing specifications and standards for NGN across the world. Some of the main bodies are shown in box below.

Box 6: Some of the NGN Industry standards forum

1. ITU – ITU-T and NGN GSI (Global Standards Initiative), Focus group on NGN
2. IETF
3. 3GPP
4. 3GPP – 2
5. TISPAN
6. DSL Forum
7. WiMax Forum
8. IPv6 Forum

ITU is one of the leading bodies developing standards for NGN. Its activities in this regard are summarised in the box below. (Please refer both the annexure at chapter 7 and the ITU website (www.itu.int/ITU-T/worksem/ngn) for details of technical specifications.

Box 7: Case Study: Technical standardization initiatives by ITU-T

At the World Telecommunications Standardisation Assembly (October 2004), ITU-T was given the task to lead the standardisation work on NGN. The activities are being carried out on a project basis involving other study groups, other sectors of the ITU and other standardisation organisations (IETF and ETSI).

In order to accelerate the work on NGN standardisation a Focus Group was set up in June 2004 under the auspices of Study Group 13. Study Group 13 (Study Group NGN) is one of thirteen study groups in the telecommunication standardisation sector of the ITU.

ITU-T has been working to prepare Release 1 specifications for NGN with meetings every two / three months and the final meeting (the 9th) will be held in the beginning of 2006. Draft Release 1 specifications are already available on the ITU website.

ETSI is the another body that is pursuing technical standardisation for NGN.

Box 8: Case Study: ETS1 initiatives for technical standardization for NGN

ETSI established an ad-hoc group on Electronic Communications Networks and Services (OCG ECN&S) to provide a horizontal co-ordination for issues related to the ETSI support for the implementation of the European Directives; to co-ordinate ETSI contributions to the definition of the Framework Directive Article 17 “List of Standards” and to share views and understanding between regulators and ETSI technical bodies experts on regulation and standardisation issues.

In addition, OCG ECN&S is also a meeting place for coordination between regulators and ETSI technical bodies experts on regulation and standardisation issues.

4.1 Regulation of technical aspects of NGN.

Operators and regulators around the world are divided on whether regulators should involve themselves with technical aspects of NGN. Those in favour of regulatory intervention on technology claim that it can help reduce technology risk. These operators fear that if various operators pursue different technical standards, there will be potential issues with interconnection and quality of service. For example, if some operators pursue IPv4 with MPLS implementation and others pursue IPv6 transport, additional investment will need to be made at the edge of networks for tunnelling between the standards. Another area where there may be issues could be on Class of Service (COS), which could be based on packet classification like CAR, Congestion Avoidance like WRED and Congestion Management like WFQ in MPLS context. For example one operator may support 5 classes of services on MPLS while others may support say only 3 classes. However, the biggest fear that smaller and new operators have is if their technology does not match the capabilities of incumbent networks, this could further strengthen the incumbent and make their operations unviable.

However, some operators are equally concerned about the risks in regulators getting involved in technical specifications. The two main issues of concern are:

- Regulator taking too long to specify technology thus holding up the migration process.
- Regulator specifying the sub-optimal technology or specifying a theoretical 'gold standard' that is not commercially viable.

This dichotomy in views was also evident in the feedback from major operators. While all operators would like that policy should be technology-neutral, a couple of large private sector operators suggested regulator specifying a 'recommended list of technologies'.

Ofcom, the UK regulator, has decided to stay clear of detailed management of the transition to NGNs and specification of new products. However Ofcom recognises that many of the issues raised by 21CN project are technical in nature, for example new interconnect products may depend on the development of appropriate technical standards. In order to provide adequate focus on 21CN and ensure issues are addressed in a timely manner, Ofcom proposed restructuring the Network Interoperability Consultative Committee (NICC) and providing an increased level of resource commitment from industry.

Recently, ITU's focus group on NGN now named NGN GSI (Global Standards Initiative) has come out with broad requirements of various aspects of NGN, which are to be made available on their website (www.itu.int/ITU-T). The above group will also be coming out with requisite standards for NGN. It may be advisable for the operators to make use of such specifications for the purpose of global standardization.

Issue for consultation in this regard is:

4a. What role should the regulator play in technical specifications for NGN?

4.2 Timing for investigation on technical aspects of NGN

There could be a view that it may be too early for regulator to analyse NGNs technical specifications and related issues due to:

- There are far too many specifications and standards under consideration by various technology bodies for regulatory bodies (TRAI, TEC etc.) to actively follow, evaluate & recommend.
- In addition, regulation at this level may become counter productive and block innovation.
- Detailed specifications are best left to the industry, though it will be helpful if common standards are followed.

On the other hand to minimise interconnection issues and costs in the longer term, it may be essential that operators are provided a list of recommended technologies that they would be encouraged to follow. Operators may want this list to be specified at the earliest, before they invest capital in NGN transition.

Issue for consultation in this regard is:

4b. At what stage should the regulator investigate the technical aspects of NGN, if at all?

4.3 Network architecture for NGN

From a high-level perspective, Next Generation Networks are implemented in such a way that the functions performed by the network are separated into functional planes or layers. The layers include Access, Core/ transport and Service. Layers are independent in the sense that they can be modified or upgraded regardless of other functional layers. Sometime Control layer is also indicated separately though this layer/ plane is supposed to provide the intelligence for management of all the layers. This layered architecture provides a flexible and scalable network, reducing time to market for the new services, which can be provided through manipulation in service layer alone.

It is understood that the core networks of all major operators are already moving towards NGN transition and the country's market is ready for IP based long distance services and therefore there appears to be a case to focus attention on core NGN transition.

Core NGN migration is mainly about cost advantages to the operator because of efficiency of IP based transmission. However, it is through service layer migration that customer realise the real benefits of NGN. The feedback obtained from major operators through a TRAI's survey suggests that they are in the final stages of core NGN migration and looking to move into service migration some time in 2006.

The access network in country is particularly weak and insufficient and will take many years to be 100% transitioned to NGN. Huge capital investment needed for this and low PC/Broadband penetration could delay NGN access migration. Low cost customer equipment/ non-PC based IP terminals will be needed to make a viable business case for NGN migration in the access layer.

At the same time, there could be a case to accelerate access level migration in the non-unbundled situation. WiMax and HFC cable offer alternatives as does Power-Line Communication (PLC), proprietary wireless access etc. Each of these technologies while offering potential has inherent issues (state of network and organisational issues for cable operators, cost and specifications for WiMax and other wireless options, nascency for PLC etc.).

Issue for consultation in this regard is:

4c. How can TRAI encourage access migration in the situation of non-unbundling of local loop?

4.4 Agency for technical standardisation in the NGN context

Work on technical standardisation for telecom in India is currently carried out by the Telecom Engg. Centre (TEC) under the DoT. TEC is supposed to have technical personnel, experience and testing facilities that few other technical bodies in country have, except may be for Centre for Development of Telematics (C-DOT).

Possible options for the agency that can drive the standardization initiatives forward may include:

- Govt. standardisation and developmental bodies such as TEC, CDOT
- Industry led groups

In UK, in order to provide adequate focus on 21CN and ensure that issues are addressed in a timely manner, Ofcom proposed restructuring the Network Interoperability Consultative Committee (NICC) and providing an increased level of resource commitment from industry. This is happening through participation of the industry through a body created by regulator called NGNCo and through inputs from a body created by BT, the incumbent called Consult21.

Issues for consultation in this regard are:

4d. Which Agency/Entity is best positioned to analyse the technical standards and related issues of NGN?

4e. Should a joint consultative committee of C-DOT, TEC and Industry be created to do this job?

4.5 Relevance of IPv6 for NGN transport

TRAI on 9th January 2006 has issued recommendations on various issues related to Migration from IPv4 to IPv6 for consideration of the Government. In these recommendations, though TRAI has not recommended that migration to IPv6 should be mandatory, but has suggested that it should be facilitated through following:

- Enabling amendment in ISP license conditions.
- Setting up of test beds for IPv6 trials through govts' technical agencies and academic institutions in addition to augmentation of existing ERNET test bed.
- Upgradation for NIXI as a national test bed for IPv6 and interconnection among its various nodes.
- Creation of National Internet Registry (NIR) in the country.
- The usage of IPv6 in e-governance programmes and other govts' projects and networks.
- Workshops and training programmes by govt. agencies to bring out awareness about IPv6.

The main concern in this regard is the linkage between IPv6 and NGN. Some stakeholders feel that since capacity of switches may fall after upgradation from IPv4 to IPv6, this in turn may increase the processing cost. As far as the necessity of upgrading the backbone to IPv6 for implementation of NGN is concerned, some stakeholders feel that NGN's full benefits will be provided even without updating to IPv6, while others feel that IPv6 is essential for providing all benefits of NGN, specially, those related to security, quality of service for real time applications and mobility.

Issue for consultation in this regard is:

4f. Is IPv6 an essential feature of IP transport for the migration to NGN? Does it have cost implications on the migration to NGN?

4.6 Security aspects of NGN

The main issues of security related to NGN have emerged within the IP telephony sphere. There are two aspects viz. emergency calling and wiretapping (legal intercept and monitoring).

In the US, the FCC mandates all providers of PSTN-interconnected IP telephony services to provide access to emergency services. However in the UK, Ofcom is of the view that access to emergency service is not essential. The IP telephony operator must inform the users that such access is not available. (Please refer the Annexure in chapter 7 for details).

Wiretap is a more serious national security issue. VoIP softphone services can be provided from anywhere in the world and hence monitoring and enforcing compliance could be very difficult.

The figure below describes some of the technical requirements pertaining to this issue:

Fig. 10: Security related technical issues

Possible NGN regulatory requirements

National security / infrastructure protection

- Network attack mitigation
- Public safety emergency and law enforcement/national security assistance
- Priority access during or after disasters
- Priority service provisioning and restoration
- Analysis and reporting of network metrics and outages

Legal system requirements

- Cybercrime mitigation
- Digital rights management
- Fraud detection and management
- Juridical evidentiary and forensics

Source: ITU, EC consultations, FCC, Spectrum Strategy Consultants

Issues for consultation in this regard are:

4g. Should regulatory bodies specify technical specifications on security related issues for NGN or is it too early?

4h. Should the access to emergency services be made mandatory for an NGN based operator?

5 MIGRATION TO NGN

Migration to NGN can be a cause of major disruption for operators in terms of the network, business models, operations etc. Regulators need to step in to ensure the transition is as smooth as possible with early education and awareness, clear interconnect regulation and adequate industry involvement.

This chapter discusses the possible issues involved with NGN migration viz:

- Is there a regulatory role in the transition to NGN?
- How should the industry participate interactively in the migration to NGN?

In UK, Ofcom has created an independent industry body called NGNCo to manage key aspects of transition to NGN. The NGNCo is responsible for specifying a transition plan setting out the detailed process for managing the transition from existing networks to NGN.

The Infocomm Development Authority of Singapore (IDA) has also taken steps on involving industry in evolving a common migration plan. This includes the development of next-generation networking technologies, the development of skilled infocomm network professionals and the establishment of a Singapore Solutions Centre to help local enterprises bring their products and solutions to market.

During the feedback process it was suggested by most of major operators that regulator should encourage setting up of a cross-industry body comprising of all the major players to manage the transition. The purview of such body should cover technology, interconnection, timeframe etc.

5.1 Inter-operator aspect of migration to NGN

In India, major operators have embarked on NGN migration projects without involving and interacting with any other parties. This situation is very different from some of the more developed markets where the incumbent and the rest of the industry have taken a number of steps to get all players involved together. Despite much greater industry and incumbent led initiatives in these developed markets, operators have been pushing the regulators to help on certain inter-operator aspects during migration, as can be seen from examples from UK and Singapore.

One possible role for regulator could be to help industry evolve a common universally accepted timetable. This timetable would need to be led by high-level goals as opposed to being a micro-managed plan. A common timetable will help reduce risk of non-compatible assets. Also a goal led timetable could potentially offer individual operators the independence they need without getting micro-regulated.

Regulators across the world are also considering offering incentives to operators for sticking to the goals e.g. USO payouts, Interconnection product availability etc. Such incentives could help and encourage compliance. Both financial e.g. USO and service-led e.g. access to interconnection products incentives could be considered for this.

Regarding penalties, it may be felt by operators that at this stage, regulator should not consider any penalties to be levied on the operator's who fail to meet the migration goals as it may unnecessarily lead the transition in controversy. Such penalties make sense in well-established environments and NGN is different, at least for present.

Issues for consultation in this regard are:

5a. Is there a role for regulator to help the industry evolve a common universally acceptable timetable for NGN transition?

5b. If yes, should regulator offer incentives to operators to stick to the timetable? And if yes, what incentives should be offered?

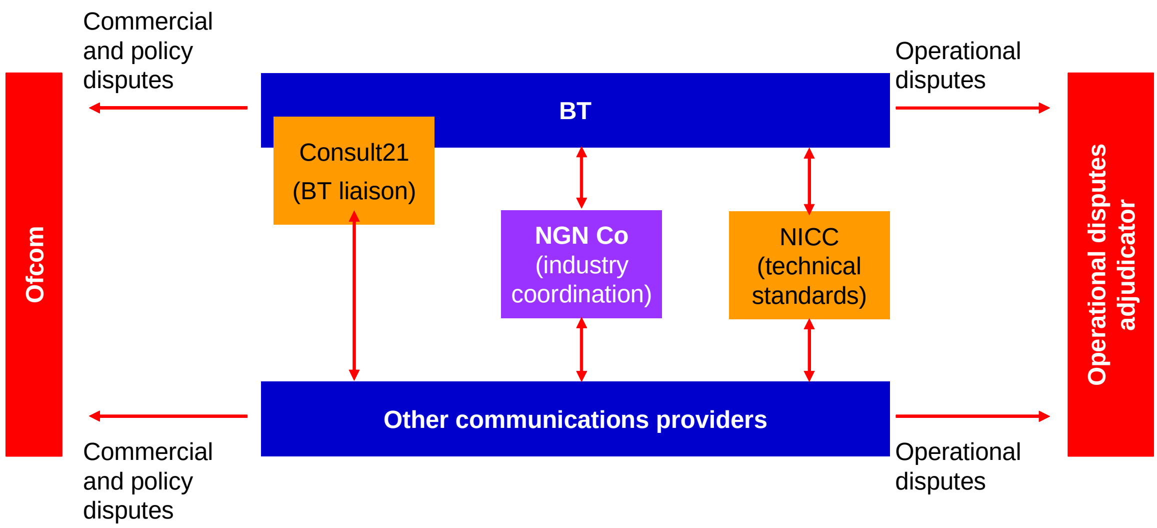
5c. Should regulator consider levying penalties for operators who do not stick to the timetable?

5.2 Options for industry involvement in migration

Industry and other stakeholder interaction are essential to evolving regulation that benefits operators, consumers and the society as a whole. Benefits of such an interaction include education and awareness, services evolution and innovation, regulated competition, reduced technology risk, reduced non-compatible assets etc.

Ofcom (UK) has taken the lead in evolving organisations and processes to facilitate industry interaction. This is done through three bodies of which one, NGNCo, has been established mainly for helping manage the transition. In addition, Network Interoperability Consultative Committee (NICC) is currently responsible for technical standardisations of interconnect interfaces within the UK.

Fig. 11: Industry interaction as managed by Ofcom (UK) on NGN migration



The responsibilities for NGNCo are summarised in the box below.

Box 12: Case Study: NGNCo

Ofcom is setting up an Industry body called NGNCo for managing the key aspects of transition to NGN. NGNCo will have the following responsibilities –

- Produce a reference interconnection architecture, setting out the manner in which NGNs are expected to interconnect with each other
- Produce a transition plan setting out the detailed process for managing the transition from existing to NGN networks (including BT and other providers' NGNs), including the process for migrating PSTN interconnection to NGN interconnection.
- Produce a communications plan setting out how this transition will be communicated to consumers.
- Oversee the actual transition, taking any such action as may be necessary in order to ensure that the above plans are achieved

In Singapore, IDA has also taken the first step on formal industry consultation. While this is financed by a vendor it is in many ways similar to the steps being taken in the UK.

Box 13: Case Study: IDA

In October 2005, the Infocomm Development Authority of Singapore (IDA) and Cisco Systems have signed an $18 million three-year Memorandum of Intent (MOI) to advance Internet Protocol (IP) networking in Singapore.

The investments will focus on three areas: the development of next-generation networking technologies; the development of skilled infocomm network professionals; and the establishment of a Singapore Solutions Centre in Singapore to help local enterprises bring their products and solutions to market.

One potential area in this collaboration is to **study the feasibility of deploying next-generation integrated voice**, video and data networks that will provide the country with seamless, ubiquitous wired and wireless connectivity.

The second focus area is to **develop and upgrade the skills and competency level of network professionals** and students in Singapore through training and certification, local and overseas industry attachments and scholarships, and enhancing the resources of the more than 20 educational institutions under the Cisco Networking Academy. The objective is to train more than 600 infocomm professionals and students over three years.

The third area covered by the agreement is the **establishment of a Singapore Solutions Centre** that will help Singapore-based enterprises to develop, test, showcase and market their products and solutions. The ultimate aim of the centre is to help turn Singapore into a key developer of advanced IP networking technologies.

Industry involvement could be particularly desirable in India as the incumbent has taken a low profile approach compared to most other markets (e.g. BT in UK, KPN in Netherlands, TI in Italy and Singtel in Singapore etc.)

Operators may want industry involvement to be built up slowly, starting from awareness programmes and discussions to consultations and then possibly through formal bodies, but they may want that the process not be rushed. Momentum and interest are critical if the industry forum is to succeed, especially in the initial phases.

Issues for consultation in this respect are:

5d. How should regulator involve the industry in NGN migration?

5e. Should a cross-industry body be set-up to plan and oversee transition? What should be its form?

6 SUMMARY OF ISSUES FOR CONSULTATION

The chapter wise issues for consultation are summarised below:

2. Relevance and timing for transition to NGN

2a. Has NGN become relevant for India, at present?

2b. Which are the service providers for whom NGN has relevance?

2c. Do you think there is a need to educate and involve all related stakeholders to give additional focus to the issues related to NGN? If yes, what is the most suitable arrangement for carrying out this task?

2d. What could be the likely time frame for the country to achieve complete migration to NGN core? In what time frame the migration in other layers like access and service layer is likely to be achieved? What could be the NGN migration time frames in urban and rural areas?

3. Regulatory approaches for NGN

3a.Is there a need for regulatory initiatives within the NGN context? If yes, why? If no, why not?

3b. Does a 'light touch' regulation regime makes sense within the NGN environment? What benefits and risks do you see with a 'light touch' approach? Alternatively, do you prefer tighter and more detailed regulation from the beginning? If so, what extent of details would you want the regulator to go into and why?

3c. Is there a need to encourage service based competition in core and access networks or both?

3d. If yes, how it should be done?

3e. What possible regulatory actions could TRAI consider at this initial stage of the migration to NGN to help the industry in general and to reduce risks associated with migration?

3f. What are your views on the effect of NGN migration on the gap between urban and rural tele-densities?

3g. Should TRAI propose incentives for NGN roll-out in rural areas? If yes what regulatory incentives beyond the ones already recommended can help push benefits of NGN to rural India?

3h. Should TRAI set in place a QOS regulation for the minimum level of quality to be provided by the facility based operators to their competitors?

3i. Is there a need to have a detailed consultation on the various interconnection issues in NGN context?

3j. What interconnection issues do you think should be discussed in such consultation process?

3k. How should TRAI regulate existing interconnection regime while facilitating the transition towards NGN?

3l. Is time ripe for TRAI to start formulating regulatory approaches on NGN?

3m. What issues should be focused on to start with?

3n. By when detailed regulations on NGN interconnection products, QOS and Access pricing in NGN domain should be brought out?

4. Technical issues pertaining to NGN

4a. What role should the regulator play in technical specifications for NGN?

4b. At what stage should the regulator investigate the technical aspects of NGN, if at all?

4c. How can TRAI encourage access migration in the situation of non-unbundling of local loop?

4d. Which Agency/Entity is best positioned to analyse the technical standards and related issues of NGN?

4e. Should a joint consultative committee of C-DOT, TEC and industry be created to do this job?

4f. Is IPv6 an essential feature of IP transport for the migration to NGN? Does it have cost implications on the migration to NGN?

4g. Should regulatory bodies specify technical specifications on security related issues for NGN or is it too early?

4h. Should the access to emergency services be made mandatory for an NGN based operator?

5. Migration to NGN

5a. Is there a role for regulator to help the industry evolve a common universally acceptable timetable for NGN transition?

5b. If yes, should regulator offer incentives to operators to stick to the timetable? And if yes, what incentives should be offered?

5c. Should regulator consider levying penalties for operators who do not stick to the timetable?

5d. How should regulator involve the industry in NGN migration?

5e. Should a cross-industry body be set-up to plan and oversee transition? What should be its form?

7. ANNEXURE A: TECHNICAL DISCUSSION ON NGN

This annexure aims to provide a general technical and functional overview of NGNs.

7A. 1 Summary

NGN is about the network infrastructure that will enable the provision of the existing telecommunications services and innovative applications of the next generation. The term NGN refers to a converged network capable of carrying both voice and data over the same physical network, with all traffic (voice and data) carried as IP.

IP networks are likely to be simpler and easier to run and maintain as compared to the existing legacy networks and provide the operators with sufficient flexibility in their cost base to reduce both opex and capex. In addition, all IP networks allow for innovation in terms of new services and applications, with a truly converged product offering that bridges the current distinction between fixed and mobile networks.

The process of realization of NGN will lead to a revolution in the design and build-up of telecommunications network architecture, which will result in a change in the way service providers offer their services and the way people communicate. Ultimately, NGN would phase out the existing legacy networks at a point of time in the future.

There are some practical factors that have collectively formed the key drivers for NGN migration. Firstly, the existing network operators are facing fierce competition in the market and they have to remain competitive to survive. In order to achieve this, operators are trying to build cost-effective businesses on the one hand and create new business models and generate new revenue streams on the other hand. The convergence of fixed and mobile networks and integration of voice and non-voice services are becoming their targets because such approach would lower operational cost and allow greater flexibilities for service innovation and shorter time-to-market.

Secondly, the increasing service requirements from end users call for innovative applications / multimedia services, high flexibility of service access, high bandwidth, high quality of service and etc. Apparently, the operators' need for remaining competitive and the end-users' demand for increased service requirements are together forming a strong driving force pushing the development of NGN all over the world with characteristics and features that would fulfil the needs of network operators, service providers and end-users.

NGN is as much about easier provision of advanced services such as VoIP, Broadband, multimedia applications etc. as it is about cost saving through simplification of network.

A migration to NGN will bring about a complete change in the existing business models which is a source of concern for both operators and regulators world over.

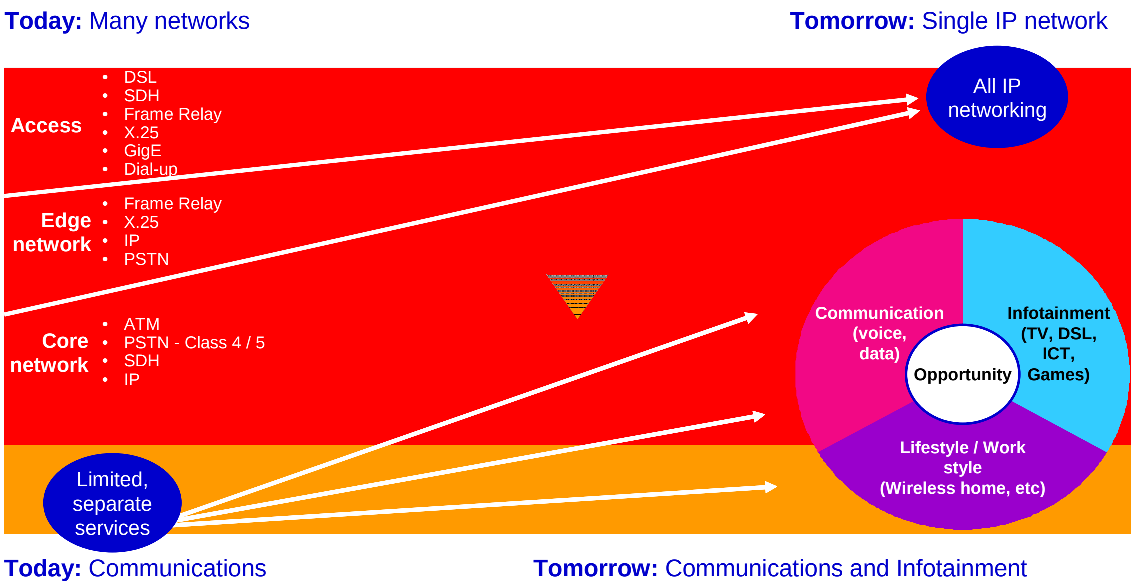
7A.2 Introduction to the NGN concept

Historically, incumbent operators typically ran one network — the Public Switched Telephone Network (PSTN). The PSTN was designed to carry voice when voice was the only communication carried. As demand for data communications developed the incumbents adapted their networks to also carry data traffic. However, typically, rather than replacing the PSTN operators typically built new networks that they ran in parallel – which is called the overlay network. These new overlay networks were designed specifically to carry data traffic.

As network technology continued to develop, the number of networks multiplied in step. As a result, today, many operators run typically 5-10 different network platforms (ATM, IP, Frame Relay, ISDN, PSTN, X.25 etc.). The problem with this multi-network approach is that it has created a web of complexity resulting in management complexity, operational inefficiencies, smaller economise of scale, maintenance issues, and duplicating capex.

Next Generation Networks aim to reverse the clock and go back to the simplicity of one single network. NGN is all about deploying one network platform capable of supporting all traffic types while facilitating service innovation (Fig. 14).

Fig 14: NGN is about simplifying networks



7A.3 NGN Definition

ITU defines Next Generation Network (NGN) as “a packet-based network able to provide 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.

It enables unfettered access for users to networks and to competing service providers and/or services of their choice. It supports generalized mobility which will allow consistent and ubiquitous provision of services to users”.

7A.4 Convergence between Telecom and Internet

It is believed that the rapid and widespread growth in the use of the Internet has become the catalyst to the fostering of such a concept of NGN. With Broadband access service becoming increasingly popular, easily accessible and more affordable to any corporate entity and individuals, more and more applications and services have been developed and evolved based on the IP technology of Internet, varying from narrow-band voice telephony services (i.e. VoIP) to broadband applications such as high-speed Internet access, video conferencing, multi-casting of TV programmes and etc. The increasing proliferation of IP-based services has in turn driven the rapid development of packet-based networks in the access, transport and core layers of the telecommunications infrastructure in order to cater for the drastic increase in the volume of IP traffic. Such a change in telecommunications services brought about by the Internet has paved the path and laid a foundation for the development of IP-based NGN.

7A.5 NGN Principles

From a high-level perspective, Next Generation Networks rely on three main principles. First of all, NGNs are implemented in such a way that the functions performed by the network are separated into functional planes. These functional planes include access, transport, control & intelligence, and service layers. Layers are independent in the sense that they can be modified or upgraded regardless of other functional layers.

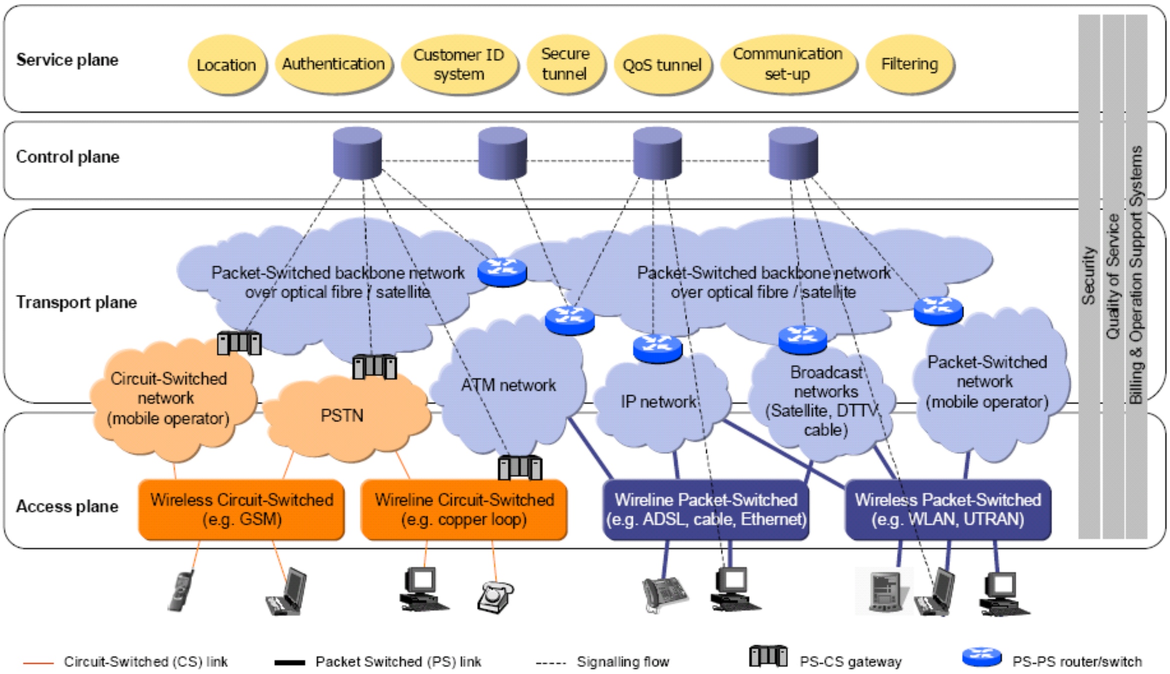
This layered architecture provides a flexible and scalable network, reducing time to market for the implementation of new services. Moreover, the functional planes are separated by open interfaces in order to facilitate the interconnection to other operators’ networks but also the integration of third-parties’ services and applications. Provided that commercial agreement is reached between the different parties, such a principle can widen the operator’s coverage and service scope and can also provide end-users with an access to a greater number of services.

Last but not least, NGN is a multi-service network meaning that an NGN can be used to provide many services, as opposed to legacy networks that are only used for specific services. This multi-service network enables operators to implement converged and new services in addition to POTS. From the users' perspective, the convergence of services will enable the emergence of the seamless service concepts, where users can access their "desired" services from any type of access network.

7A.6 NGN Architectural Concepts

The NGN architecture can be illustrated as shown in the figure below.

Fig 15: Typical representation of NGN architecture



Source: EU study, 2003

The architecture is composed of functional planes that perform tasks at different levels.

Some other technologies not mentioned in the above figure will also play a role in NGNs whereas some of the technologies mentioned in the figure might disappear or not have the predicted impact. Operations Support Systems (OSS) and Billing systems (BSS), Quality of Service (QoS) management systems and security systems are used in all of the four planes described below.

- The **access plane** provides the infrastructure, i.e. the access network, between the end-user and the transport network. The access plane may be wireless or wireline, and it can be based on different transmission media e.g. copper wires, cable TV and fibre optic.

Technologies in the access plane can be circuit-switched or packet-switched. The access network is connected to network nodes at the edge of the backbone (core) network.

- The **transport plane** provides transport between network nodes to which the access networks are connected. The transport plane consists of one or several backbone networks based on packet or cell switched network nodes. Links are mainly based on optical fibre links but can also be satellite or terrestrial radio links. The transport plane is capable of handling different kinds of traffic, e.g. voice conversation, streaming video, interactive data, and batch data. Gateways at the edge of the transport network converts traffic to and from legacy networks, e.g. telephony, Internet and real-time data applications.
- The **control plane** includes both service control and network control elements. As such, the control plane controls all other planes shown in the figure above: access, network, and services. The control plane can for instance be responsible for the control of communication sessions, e.g. establishing or disconnecting voice calls or multimedia sessions, intelligent service provisioning or resources provisioning depending on the service requested. A core principle of the NGN architecture is to separate the control logic from the underlying switching hardware.
- The **service plane** offers elementary service functions that can be used by service providers to build more complex or comprehensive services. The service plane also provides interfaces towards service providers who want to use these elementary service functions to access the underlying infrastructure. Such access will depend on commercial agreements between service providers/third parties and network operators. The interfaces may be implemented in different ways, e.g. in the form of APIs for service specific software to be run on servers within the network, or in the form of open standardised interfaces between the network and application servers. Such interfaces will enable the unbundling of services and underlying technologies.

7A.7 Factors affecting incumbents NGN decision

NGNs can deliver several different benefits, and bring a range of costs and risks for the incumbent. Every incumbent sees a different combination of these benefits, costs and risks, so one can expect the timing and nature of their NGN decisions to vary significantly.

The figure below, lists the various categories of benefit, cost and risk that incumbents need to take into account when formulating their NGN strategy, subdivided between access NGN and core NGN.

Fig 16: Generic benefits, costs and risks for incumbents considering NGN investments

	Access NGN Investment	Core NGN Investment
Benefits	• Improved competitiveness against triple-play cable TV operators (although an incremental ADSL2+ based approach can bring many of the benefits of more capital intensive access NGN moves) • Opportunity to disrupt the business models of DSL resellers and unbundlers (if the regulator doesn't act to prevent this disruption)	• Opportunity for very significant cost reductions, through the rationalisation of legacy products, networks and back-office activities • Opportunity to disrupt the business models of competitors (CPS players, altnets, ISPs etc. (if the regulator doesn't act to prevent this disruption) • Anticipation of the technical obsolescence of the PSTN (as switches and concentrators reach the end of their engineering lifetime).
Costs	• Significant capital investments ahead of any benefits to revenue and profit • Triple play may increase costs without leading to intended ARPU rises. • Regulator may insist on wholesaling • Potential cannibalisation of legacy access svcs (private ccts, FR, ATM etc.)	• Project risk due to huge scope and complexity • Cannibalisation of higher margin legacy services • Risk of failure to realise identified cost savings • Project reveals reality of costs to the regulator, leading to cuts in interconnect and other prices • Regulator forces reselling of core NGN services in forms that are highly beneficial to competitors.

Source: Spectrum, New Street

7A.7.1 Factors affecting decision on NGN access

The primary benefit of an investment in a next generation access network is that it provides a better platform for competing with the 'triple play' offers of cable TV providers. However, a great deal of this benefit can be gained without the cost and risk of an NGN investment, by using ADSL2+ as an incremental improvement to the existing ADSL1 platform.

Another benefit of NGN access investment is the opportunity to make life difficult for competitors that are currently reselling DSL or using unbundled lines for DSL. It is much harder for an unbundler to offer its own VDSL service, compared to ADSL, and an incumbent may resist offering a bitstream version of its VDSL product for resellers.

In the US it is clear that SBC is benefiting from this outcome, with no obligation to offer its VDSL service on a wholesale basis to resellers, and, in addition, regulatory forbearance on key forms of unbundling. In Europe, Belgacom also expects to avoid facing VDSL competitors, either resellers or unbundlers. However the European operators are reluctant to invest in VSDL as they expect to be forced to offer a bitstream VDSL service (BT, KPN and Telekom Austria). This partly explains why seven

European incumbents have chosen ADSL2+ as their next move in access networking.

It's highly likely that no European incumbent will be able to make a case for a major VDSL investment unless it is confident that it will not be forced by the regulator to resell VDSL (affordably) to its competitors. Resale will eradicate most of the competitive rationale for VDSL.

7A.7.2 Factors affecting NGN core network decision

(i) Benefits

The prime motivation for moving to a core NGN is cost reduction. The entire cost structure of a wireline incumbent is based around its legacy networks and the legacy products that these networks support. These legacy structures have, in most cases, become fragmented and inefficient, but these problems are too deep-rooted to be adequately addressed by piecemeal management interventions.

To make progress a completely new core network platform is needed, enabling the migration of customers from legacy products onto a set of rational new services. These new services can have a much lower cost base than the legacy products as they will be less fragmented (with less duplication of costs) and they will also be state-of-the-art with respect to the integration of functions (such as provisioning, activation, rating, billing, interconnection, fault monitoring, diagnosis and repair, moves and changes, etc.), the sources of much inefficiency in current operations.

The complete migration from legacy networks to NGN will enable radical transformation of the incumbent's cost base. The impact should be at least as great as the previous generational change in core networks viz. the migration from analogue switching to digital switching in the 1980s. Incumbent headcounts were cut by more than half, and some key unit cost fell by a factor of ten (such as switching cost per voice minute).

Incumbents are giving much more modest estimate for the impact of core NGNs, but still expect striking savings. For example, KPN is projecting the elimination of 8,000 of its 23,000 wireline employees by 2009 (35%), based on its 'all IP' NGN project.

The first operators to move on core NGNs should therefore be those that are:

- Under the maximum pressure to cut costs (probably due to competitive pressures on prices and from the loss of volume through share loss);
- Suffering from the greatest fragmentation and complexity in their current cost base (i.e. with the greatest potential savings from network and product rationalisation).

As we have noted in past coverage, BT has a particularly fragmented and complex operations, for a variety of historical reasons. It is also under huge competitive pressure in key markets such as retail Broadband. On this basis, it is not a surprise that BT was a first mover on core NGNs.

(ii) Risks

The risks associated with this cost saving opportunity are substantial and can potentially wipe out most of the benefits for the incumbent:

- **Project risks due to huge scope and complexity** – the potential for cost and budget overruns in a core NGN project is very significant, particularly for the pioneers. There is also a risk of service disruption for end users, leading to dissatisfaction and churn.
- **Cannibalisation** of higher margin legacy services. Customers should be able to use NGN services to obtain much better value for money than the equivalent legacy products, such as voice calling, private circuits, frame relay, ATM and even IP-VPNs. Incumbents' NGN investment cases will assume a significant cannibalisation of legacy services as the NGN is deployed, hurting the top line.
- **NGN as a trigger for churn**. During the period of migration, customers may be chose to change their supplier / provider as they are expecting a period of change and uncertainty. It is conceivable that incumbents will try to reduce the risk of cannibalisation and extra churn by ensuring that the NGN can emulate key legacy services. Such a move is likely to increase the cost and risk of the NGN project and may also shut off many of the cost saving opportunities, as many of these legacy services must, in large part, continue to be supported, despite all of their current inefficiencies.
- Risk of **failure to realise identified cost savings**. As mentioned earlier, prime motivation for NGN migration is cost savings. So even if operations and networks are simplified and rationalised, the incumbent still needs to be able to actually cut the underlying costs .If the operator is unable to reduce the headcount due to any reason then the benefits will be reduced. It is reported that KPN has tied its core NGN programme to explicit headcount reductions of the order of 35% of wireline headcount over 5 years. BT has been much more reserved about the implications of its 21CN programme for its 100,000 workforce.
- Project **reveals reality of costs to the regulator**, leading to cuts in interconnect and other prices. Any moves that draw regulators' attention to incumbent cost structures, RoCEs and wholesale pricing are inherently dangerous.
- **Regulator forces reselling** of core NGN services in forms that are highly beneficial to competitors. A core NGN is, in theory, a perfect

platform for a reseller. The reseller can buy capacity with much greater ease, flexibility and affordability than is currently the case. This capacity can be repackaged in innovative ways before it is sold on to end users. Configuration changes can be implemented almost in real time, with greater confidence and at low cost. Services can be monitored and managed much more easily than is the case with legacy network services.

Incumbents will not offer their core NGN in this form to resellers unless they are compelled by the regulator. This is at the crux of the struggle between BT and Ofcom around the subject of "full functional equivalence", where BT's 21CN features in many of the key areas of dispute. Incumbents will fight hard to prevent full functional equivalence with respect to their core NGN, and some will postpone the investment if they are nervous about the outcome. If the incumbent loses this fight with the regulator the outcome could be referred as 'NGN Hell', where the incumbent incurs all of the costs and disruption of a major network upgrade, but also provides its competitors with a significant boost to their effectiveness.

These risks add up to a fairly strong argument for an incumbent for moving slowly on core NGN investments unless there are pressing reasons to proceed.

7A.8 Migration paths to NGNs

The drivers for migrating to NGN are different for all the players viz. rationalisation of networks to reduce maintenance costs, enabling faster service deployment for the provisioning of enhanced services, creating new revenue streams. The high flexibility, low cost and wide support throughout the world for the Internet Protocol makes it as the best option for building NGNs, even though it has some limitations that need to be overcome, as for instance the lack of guaranteed QoS.

Depending on the present state of their networks each network operator will potentially choose a different migration path. This path will therefore involve different technologies and happen at different speeds.

7A.8.1 Circuit switched network migration

a) Current Situation

The Public Switched Telecommunications Network (PSTN), based on circuit-switched technology and built by incumbents and competitive operators, provides telephony services with high QoS, enhanced with services provided by the associated Intelligent Network (IN) (e.g. call back on no answer service). Over the years these operators may have also implemented packet-switched data networks and services on top of their circuit-switched voice network, relying on different technologies such as

b) Migration Strategies

Frame Relay, ATM or IP. Therefore, they currently have a layered architecture implemented, using different technologies for the delivery of different services. Internet traffic originated on the PSTN can for instance be routed to the IP network as early as possible.

For circuit-switched network operators, a multi-service network for converged services and more revenues represents the main driver for the migration to NGNs. However, a migration also incurs various direct and indirect costs including network upgrades, engineer retraining costs, organisation processes changes, disruption of existing business models etc. Moreover, some circuit-switched networks are still in a very good condition and provide top quality telephony services, which is currently difficult to replicate on large-scale IP networks.

Some operators claim that the cost per line of TDM (Circuit Switched) equipment in the access network is less than that of IP, while still providing greater quality, which could be a further reason for delaying the migration to a packet-switched IP network. In addition, a circuit switched access network would seem to provide better conditions for control over the customer by the network operator. Notwithstanding these points, as packet-switched technologies mature and enable the integration of telephony services and other multimedia services, one will likely observe a gradual migration from circuit-switched to packet-switched technology but with a long period of co-existence to allow network operators to phase out circuit switched equipment. This implies that issues such as call set-up, QoS and billing across networks are solved. Two types of migration scenarios could be foreseen based either on a replacement or on an overlay strategy:

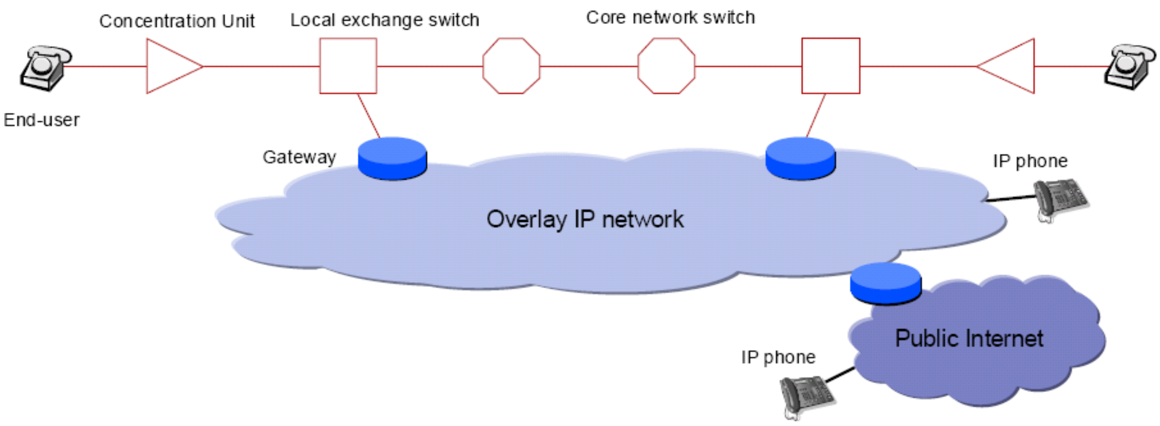
(i) The **replacement strategy** consists of replacing traditional PSTN equipment by next generation equipment. This can be done either in the core of the network in order to provide further capacity and to enable a better utilisation of the network resources, or at the edges of the network, in order to provide advanced services to the customer.

The **overlay strategy** is described in greater details below.

(ii) Overlay Strategy

With an overlay strategy, the NGN network will integrate current circuit-switched and packet-switched technologies. The modern packet-based overlay network will provide advanced services whilst the circuit switched PSTN network will continue to provide basic telephony services. Both networks are interconnected via gateways as required by specific types of services (e.g. VoIP call originated from an IP phone and terminated on the PSTN, or Internet data traffic originated from the PSTN). When the overlay network eventually becomes capable of providing sufficient QoS, all traffic could be diverted from the circuit switched PSTN to the packet-switched overlay network as shown in the figure below.

Fig 17: Overlay scenario



Source: EU study 2003

The overlay backbone in such a migration would be based on IP from the start, possibly used with other technologies in order to provide sufficient QoS for some specific applications (e.g. IP over ATM). Session Initiation Protocol (SIP) has grown to be the most popular signalling protocol for implementing call control on IP networks as it can be integrated easily with other Internet protocols, as compared to H.323. However, due to the early availability of H.323 products compared to SIP, some operators have already implemented H.323 solutions and therefore may not migrate to SIP in the short term. The replacement and overlay strategies are not exclusive and some operators actually transport voice traffic on packet-switched trunks in the core network while also building overlay networks.

7A.8.2 Packet-switched networks migration

a) Current Situation

Packet-switched data networks rely on several technologies and a number of protocol stacks are used depending on the service delivered and the functionality offered by each protocol e.g. “IP over SDH over DWDM”, or “IP over ATM over SDH over DWDM”, or “IP over Ethernet over SDH over DWDM”. The migration towards NGN for these types of networks means a simplification of the network and more flexibility. Building an NGN network also means that the network needs to support converged services such as voice or real-time applications. This implies that certain necessary features are implemented. The migration of packet-based networks towards NGN can follow several strategies that could possibly be combined. A migration could also involve a move towards the next version of the Internet Protocol, IPv6, which is described in the next section.

b) Migration to IPv6

IPv6 is the upgraded version of the current Internet Protocol version, IPv4. It has already been fully specified by the IETF but has not been widely implemented yet.

The key drivers towards IPv6 are the additional address space provided and the mobility features inherently implemented in IPv6. Address fields contained in IPv6 headers are coded on 128 bits instead of 32 bits in IPv4 addresses, which could solve the address scarcity problem that is currently being encountered. Some mechanisms like Network Address Translation (NAT) are currently being used in order to solve the problem of address scarcity, but these add complexity in the implementation of peer-to-peer applications and are pointed out as a mechanism used by network operators to retain control over end-users. Some solution providers have however indicated that certain software developments could overcome the NAT limitations in peer-to-peer applications and therefore limit the need for operators to deploy IPv6 on their networks.

Moreover, as opposed to an IPv4-only enabled host, an IPv6-enabled host can automatically create its own address when connecting to a network, based on a network identifier acquired from a local router and its own specific identifier. This facilitates auto configuration processes and mobility applications.

IPv6 packets can also have extensive headers, which provides further advantages like the possibility of avoiding tunnelling in mobility applications.

On the other hand, the implementation of IPv6 requires hardware and software upgrades, in the operator's network as well as in the applications and programs used at the user's side. It is unlikely that operators will implement IPv6 in the core network as long as the "edge", that is the end-user equipment, is not IPv6-enabled. Enabling the edge involves an upgrade of commonly used operating systems and software into IPv6-enabled software, but also the deployment of the all-IP architecture based on IPv6. Operators would thus wait until there is a clear demand and business model for implementing IPv6.

The migration towards IPv6 could take a long time and it has been predicted that IPv4 networks will not have completely disappeared before 2020, hence the need for coexistence mechanisms in the mean time.

Three mechanisms can be used during the IPv4 / IPv6 coexistence period which are not exclusive and can be used together as follows:

- The dual stack mechanism is based on the principle that a piece of equipment is enabled with both the IPv4 and the IPv6 protocols. It can therefore use the most suitable protocol depending on the capabilities of the correspondent device and of the transporting network. As an example, UMTS (3G) terminals will be dual stack.

- The tunnelling mechanism enables the hosts of clouds running a specific version of the IP protocol to communicate with each other through a network running the other version by the means of a tunnel. With this approach, IPv6 clouds could communicate through an IPv4 network (as it will most likely happen in the first stage of IPv6 deployment) or IPv4 clouds could communicate through an IPv6 network (later stage of IPv6 deployment). Tunnelling can occur between hosts, or between routers, or between host and router. For instance, in the case of tunnelling between two routers, the packets are encapsulated by an edge router at the edge of a network cloud and then de-capsulated by the border router of the receiving cloud.
- The translation mechanism enables the communication between IPv6 and IPv4 hosts when the dual stack mechanism has not been implemented. The translation between IPv4 and IPv6 is performed by a dual-stack border gateway.

7A.9 Recent Developments in access technologies

Some of the recent developments of access technologies are important drivers for the development of NGN and will impact the development of broadband services and content. This section provides an insight into the technologies under development today or technologies that are representative of recent market trends but does not provide an exhaustive list of all access technologies.

Access network technologies usually refer to networking technologies providing connectivity between the end-user and the transport plane, what is usually called “the last mile” or the “local loop”. Most recent of these are described below:

7A.9.1 ADSL2+

ADSL2+ is the most popular next step for upgrading a copper access network. Many incumbents have deployed ADSL1 which can be upgraded relatively cheaply to ADSL2+ to provide higher speeds up to a range of about 3km. ADSL2+ does not constitute a generational change due to its low upfront costs and the low level of disturbance to existing industry structures.

The upgrade from ADSL1 to ADSL2+ requires the existing exchange equipment and the customers’ premises equipment to be replaced, and may also need additional backhaul capacity from the exchange to the core network. An ADSL2+ upgrade could cost upto USD 50 for each existing ADSL1 customer. The cost for incremental customers is only a few tens of USD more than for ADSL1 additions.

An ADSL2+ connection should, under ideal conditions, be able to provide a downstream speed of 26 Mbps up to 3km from the exchange. In practice the maximum speeds tend to be rather less than this and over shorter ranges. However, ADSL2+ is generally able to carry multiple TV streams and high speed internet traffic simultaneously for homes that are up to 1.5km from the exchange.

An upgrade to ADSL2+ does not disrupt the existing market structure of unbundlers, resellers and ISPs. However, it is best practice for the approval of ADSL2+ to be coordinated between DSL operators that share the copper network, as ADSL2+ frequencies and modulation are not the same as for ADSL1. This coordination process can be used by incumbents to delay ADSL2+ deployment by unbundlers, citing the risk of interference with other access services (private circuits, frame relay etc.).

7A.9.2 VDSL

VDSL (Very high speed DSL, often referred to as fibre-to-the-node, FTTN). is a short range service that is aimed at the last section of the local loop, from the street cabinet to the home or office. The street cabinet must then be linked back to the exchange with a new connection, generally new fibre, instead of the existing copper links. There are two versions of VDSL at present – VDSL1 is relatively well developed and standardised, whereas the faster VDSL2 is still under development.

A fibre-to-the-node VDSL upgrade could cost USD 100 – USD 500 per home served – a very wide range that depends on the density of customers and the layout of the existing network. These costs are incurred upfront, before penetration and ARPUs are known. A VDSL upgrade is therefore a major investment decision for an incumbent, and the expected benefits must be significant if they are to match the costs and risks. A further key benefit of VDSL for incumbents is the disruption that it can bring to DSL resellers, in terms of technology issues.

Several major VDSL upgrades are underway in Asia (KT, PCCW, NTT) and in North America (SBC using VDSL2, Qwest, Bell Canada). However, the only European incumbent with clear VDSL plans is Belgacom, which launched services in November 2004, and has said that it will invest €300m on VDSL1 deployment to cover 46% of the population by the end of 2006. Several European incumbents have indicated that they will continue to experiment with VDSL, but this does not signal any intent to make an early investment.

It is possible to offer VDSL without a fibre-to-the-node investment, if it is restricted to homes or businesses that are less than about 1 to 1.5 km from the exchange. In this case all that is required is a VDSL DSLAM and VDSL CPE – very similar to an ADSL2+ upgrade. It is likely that any incumbents will not deploy VDSL in this way, given the problems of marketing the service to a minority of their customer base. However, non-incumbent DSL players may choose to use VDSL in this way if they are permitted to operate with VDSL frequencies on unbundled loops.

It is very difficult, and often impossible, for unbundlers to offer VDSL from the street cabinet to the end user. Even where 'sub-loop' unbundling is available, there is rarely any space within incumbent cabinets for competitors' equipment, and backhaul from the cabinet is also problematic. With no practical unbundling solution, competitors may look to the incumbent to provide a bitstream VDSL product that they can resell as retail VDSL. Incumbents will, in general, resist such pressure to provide wholesale VDSL.

7A.9.3 Fibre-to-the-premises (FTTP)

Fibre-to-the-premises is the most extreme option for NGN access network upgrade. Fibre can provide a multi-Gigabit per second connection – more than any residential applications, ever likely to require. FTTP requires new fibre to be installed to replace the copper connections that currently link homes and businesses to the nearest switching unit ('the local exchange' in common parlance).

The cost of FTTP is highly dependent on local conditions – new fibre can be deployed to modern urban apartment blocks for a few hundred USD per customer, but in less dense areas the cost can run to thousands of USD per home. Costs are lowered if aerial fibre can use existing poles, or where buried fibre can be pulled through existing ducts, but will always be significantly higher than the costs for a VDSL upgrade in the same circumstances (by a factor of at least two or three). The only exception is for new housing estates or apartment blocks, where the cost of FTTP need not be materially higher than the cost of installing a new copper access network.

FTTP can be mixed with VDSL using copper connections where the higher cost of FTTP is deemed to be uneconomic. (NTT uses FTTP and VDSL).

Not many European incumbents have announced plans for major FTTP deployment, although all have some sites connected using fibre. This contrasts with the multi-billion dollar FTTP programmes announced by Verizon in the US and NTT in Japan. European incumbents believe that they can achieve their access network goals without incurring the expense of FTTP.

A major FTTP programme is likely to recast the entire telecoms landscape in the affected market. Verizon's FTTP investment is part of a significant shift in US telecoms policy and regulation, in return for commitments to invest in NGNs, US incumbents are no longer obliged to offer various unbundled services to resellers, as a result, the US market is becoming a head-to-head duopoly of local operators vs. cable TV players.

The following figure indicates the combinations of consumer services that should be supported by different access networks at 1.5km from the exchange. (Distance from the exchange is a constraint for ADSL services. VDSL services are constrained by the distance from the street cabinet to the home, not the distance to the exchange. FTTP services are not constrained by distance, although the cost of installing the connection is a function of the distance to the exchange).

Fig 18: Expected performance of various access technologies

Technology	ADSL1	ADSL2+	VDSL1	FTTP
Headline Speed	8Mbps	26Mbps	52Mbps	Multi-Gbps
Expected performance in real networks within 1.5Km of exchange	6Mbps	12Mbps	20Mbps	Multi-Gbps
Internet and one TV	✓	✓	✓	✓
Internet and two TVs	✗	✓	✓	✓
Internet and one HD TV	✗✗	✓	✓	✓
Internet and two HD TVs	✗✗	✗✗	✓	✓
Internet and more than two HD TVs	✗✗	✗✗	✗	✓

Note: ✗ = probably inadequate. ✗✗ = inadequate
Source: New Street Research

Operators need to have a bullish view on customer requirements before there is a simple case for VDSL rather than ADSL2+. We see no demand-based case for consumer FTTP rather than VDSL in the next few years. This implies that operators that have embarked on FTTP are doing so for other reasons (regulatory relief, anti-competitive manoeuvring, especially dense consumer concentrations etc.). Even where a major FTTP programme has been announced it is possible that relatively few areas will actually have FTTP deployed, and most areas will be served with VDSL instead.

There can be a very strong case for FTTP to serve enterprise sites and community sites such as schools and hospitals. Such sites can benefit from fibre speed connections to interconnect their Ethernet LANs and to support the multiple simultaneous video streams that will, in many cases, be required. However, a programme of FTTP deployment for business sites does not materially improve the economics of residential FTTP in most circumstances.

7A.10 Quality of service

One of the key challenges in the fixed line world has been how to accommodate data and voice traffic in one network environment. The challenge is a result of a fundamental difference in transport requirements:

- ***Voice is real time information and hence delay sensitive.*** The best practical example of the impact of delay on the quality of a voice call is an international call made via a satellite link (a common occurrence a few years ago). The round trip delay introduced by the satellite hop makes it very difficult to hold a normal conversation, creating the impression of long silences followed by both parties talking simultaneously.
- ***Data tends to come in bursts but is generally non-delay sensitive.*** As such data networks tend to use contention ratios viz. the level of demand exceeding the capacity of the network. The network uses queuing/buffering mechanisms to accommodate the excess demand. The use of queues in the data world and the need for minimal and predictable delays in the voice world represent a fundamental incompatibility. Technology has been trying to marry together the two conflicting characteristics for many years. However it is only in recent times that the conundrum has been cracked.

The advent of Multi Protocol Label Switching (MPLS) enables data centric networks to efficiently priorities information packets based on the type of information contained within the packet. It is MPLS that lies at the heart of NGN deployment. MPLS uses a system of 'labels'. A label allows performance guarantees to be set, and congestion to be managed. It holds the promise of delayering the network technology stack, enabling IP to be carried in its native form. This in turn improves network utilisation by eliminating the overhead associated with technologies such as ATM (i.e. ATM uses fixed 53 byte cells of which 5 bytes are taken up by the cell header i.e. 10% of overhead) and cost, as more the components the greater will be the capital cost and the greater will be the cost of managing complexity.

7A.11 NGN naming and addressing system

7A.11.1 Naming and addressing issues

NGN concept implies many different types of "Convergence" –

- PSTN/ISDN convergence with IP based networks.
- Fixed – Mobile convergence (FMC).
- Broadcast (Cable) – Telecommunications convergence.

- Web based services convergence.

Each network mentioned above has a different addressing structure – not to mention terminology. The challenge is to find a consistent, comprehensive scheme and not repeat mistakes of the past.

The convergence towards Next Generation Networks also requires that customers of different market players, using different network technologies, can communicate with each other and access resources on another market player's network. This requires the interworking of naming, addressing and numbering systems across networks.

Before we delve into the issues further it is important to first understand the two different concepts of "name" and "address" –

- An **address** identifies the specific termination points of a connection and is used for routing purposes. It carries information on the network topology in order to identify the location of the resource within the network.
- A **name** is a combination of characters that is only used to identify end-users and does not carry any network-related information. It thus needs to be translated into an address for routing purposes. A name can be ported between service providers whereas the address associated with the name will change to reflect the change towards a different location within the network. Examples of names are Internet names such as john.doe@abc.com, public telephony numbers or instant messaging users identities.

7A.11.2 Overview of addressing and naming schemes

a) IP Address

IP addresses represent the fundamental addressing scheme for all applications running on the Internet. An IP address is a unique number that devices use in order to identify and communicate with each other on a network utilizing the Internet Protocol standard. The numbers currently used in IP addresses range from *0.0.0.0* to *255.255.255.255*, though some of these values are reserved for specific purposes. The format of IP addresses can differ depending on the IP protocol implemented: IPv4 or IPv6.

b) Public telephony numbering scheme (E.164)

Public telephony numbers follow the ITU-T Recommendation E.164. This recommendation specifies the international public telecommunication numbering plan and the structure of public telephony numbers, referred to as "E.164 numbers". This numbering plan was initially an addressing scheme but has become a naming scheme due to services such as number portability and non-geographic numbers. In the PSTN environment, the routing is thus done by associating a routing number, containing the required network information, to E.164 “names”.

c) Internet names

Internet names represent a very commonly used naming scheme in an IP environment. They are based on the concept of domain name and are usually of the form user@domain where domain represents the user’s home network or host. The same Internet name (e.g. john.doe@abc.com) may be used for different services, e.g. email and SIP voice call.

d) Mobile identifiers

Although mobile phone numbers are part of the E.164 numbering plan, mobile phone users can also be identified through the mean of their International Mobile Subscriber Identity (IMSI). The IMSI number is coded in the SIM (Subscriber Identity Module) card. It is unique for each specific subscriber and does not vary as long as the subscriber keeps the same SIM card. The number provides all the information necessary to find a subscriber’s record within a specific mobile network.

7A.11.3 Mapping methods

The main standardised solutions for mapping are results of initiatives led by the IETF (Internet Engineering Task Force) and TIPHON (Telecommunications and Internet Protocol Harmonisation Over Networks). These are described below:

a) DNS

Internet users more often than not use internet names rather than IP addresses to find resources (either people or documents) on the Internet, hence a mapping system had to be created to map these names into addresses and thus obtain information on the user’s or resource’s location within the Internet.

The Domain Name System (DNS) provides this function and translates domain names into IP addresses. It was first described in 1983 in IETF RFCs 1034 and 1035 and has been enhanced and modified in several RFCs since then.

b) ENUM

The ENUM protocol has been described by the IETF ENUM Working Group. The purpose of ENUM is to use the already existing DNS and expand its functionality to provide a mapping between E.164 numbers and a number of other addresses/names such as email address, fax number, mobile number and website address. These addresses can then be used to contact a resource associated with that E.164 number.

The ENUM protocol specifies –

- how E.164 numbers can be mapped into domain names and inserted into the DNS;
- how E.164 numbers can then be mapped into “preferred” identifiers (email addresses, voice over IP, SIP addresses, voice mail servers, fax machines, etc).

c) THIPON

TIPHON aims at supporting the public telephony service on IP technology. As a result, interworking between the PSTN and the Internet is possible only if the Internet telephony user has also been allocated an E.164 number. In this situation, the Internet name is not sufficient to provide public telephony services, although it can still be used on its own for VoIP services. At a certain stage though, the E.164 number has to be mapped into an Internet name that will be resolved by the Internet Telephony provider.

The TIPHON approach implies that public telephony over IP is provided by a specific service provider to its customers and that communication with the customers of another service provider requires interconnection between the service providers.

7A.12 Signalling systems

One of the big challenges of NGN is to enable circuit-switched services, mainly telephony, to be migrated onto packet-switched technology. Signalling System 7 is being used extensively in PSTN voice networks, as it not only ensures the initiation and termination of voice communications, but also the provision of further advanced services in the case of Intelligent Networks.

A number of signalling protocols have been developed by different standardisation bodies and consortia in order to enable voice and multimedia services on packet-switched networks. Although they are regularly being upgraded in order to overcome the limitations of their previous releases, each of them has been developed within a specific context (telecoms, Internet, etc) and for this reason does not fit all technologies or strategies equally well.

The BICC (Bearer Independent Call Control) protocol has been created by the ITU and is biased towards ATM backbones. This protocol suits for instance operators who want to carry telephony services originated and terminated on the PSTN on a packet-based network (“trunking”) but still provide PSTN-like quality of service.

For many reasons, the IETF SIP protocol will most likely be the most popular protocol for providing voice and multimedia services over IP. SIP has been chosen by the Third Generation Partnership Project (3GPP) as the call control protocol in 3G networks. However, the alternative protocol from the ITU, H.323, was released before SIP and has already been widely implemented and deployed, thus slowing down the deployment of SIP.

Networks are likely to remain highly heterogeneous in the foreseeable future, using different signalling protocols and a different approach in terms of architecture (distributed or centralised). This requires the use of interworking mechanisms between the different signalling protocols involved, including the PSTN signalling system, SS7.

This section describes the different signalling protocols that have been developed over different types of technologies.

7A.12.1 Signalling System No. 7 (SS7)

SS7, defined by the ITU, is the signalling system used in the Intelligent Network (IN) architecture in the PSTN voice network. In this architecture, signalling and voice are transmitted over two physically separated channels also referred to as "out-of-band" signalling. The transport network only carries voice traffic whereas the overlay control networks carries the signalling traffic. This enables simpler and more efficient network management and the provisioning of further advanced services, such as interacting with databases for non-geographic numbers and billing.

The SS7 network is made of packet switches, called Signal Transfer Points (STP), that route the SS7 messages over the network, and of databases, called Service Control Points (SCP), containing information used in services such as non-geographic numbers and number portability. The SS7 network is linked to the SCN through Service Switching Points (SSP). The SS7 network can be divided into several layers, with a number of protocols performing the functions of the application-oriented layers of the OSI model (higher layers).

7A.12.2 H.323

H.323 is an umbrella recommendation from the ITU-T, that defines the protocols to provide audio-visual (multimedia) communication sessions on any packet network. It is currently implemented by various Internet real-time applications such as NetMeeting and GnomeMeeting (the latter using the OpenH323 implementation). It is a part of the H.32x series of protocols which also address communications over ISDN, PSTN or SS7. H.323 is commonly used in Voice over IP (VoIP, Internet Telephony, or IP Telephony) and IP-based videoconferencing.

H.323 was originally created to provide a mechanism for transporting multimedia applications over LANs but it has rapidly evolved to address the growing needs of VoIP networks.

One strength of H.323 was the relatively early availability of a set of standards, not only defining the basic call model, but in addition the supplementary services, needed to address business communication expectations. H.323 was the first VoIP standard to adopt the IETF standard RTP to transport audio and video over IP networks.

H.323 is based on the ISDN Q.931 protocol and is suited for interworking scenarios between IP and ISDN, respectively between IP and QSIG. A call model, similar to the ISDN call model, eases the introduction of IP Telephony into existing networks of ISDN based PBX systems. A smooth migration towards IP based PBX systems becomes possible to plan.

However, the H.323 standard also presents several drawbacks, in particular the fact that it was derived from ISDN signalling. It is not especially suited to IP networks and it involves a great number of protocols which makes its implementation heavy and expensive.

7A.12.3 Session Initiation Protocol (SIP)

SIP is a protocol developed by the IETF MMUSIC Working Group and proposed standard for initiating, modifying, and terminating an interactive user session that involves multimedia elements such as video, voice, instant messaging, online games, and virtual reality. In November 2000, SIP was accepted as a 3GPP signalling protocol and permanent element of the IMS architecture. It is one of the leading signalling protocols for Voice over IP, along with H.323.

A goal for SIP was to provide a superset of the call processing functions and features present in the public switched telephone network (PSTN). As such, features that permit familiar telephone-like operations are present: dialing a number, causing a phone to ring, hearing ringback tones or a busy signal. Implementation and terminology are different.

SIP also implements many of the more advanced call processing features present in Signalling System 7 (SS7), though the two protocols themselves could hardly be more different. SS7 is a highly centralized protocol, characterized by highly complex central network architecture and dumb endpoints (traditional telephone handsets). SIP is a peer-to-peer protocol. As such it requires only a very simple (and thus highly scalable) core network with intelligence distributed to the network edge, embedded in endpoints (terminating devices built in either hardware or software). Many SIP features are implemented in the communicating endpoints as opposed to traditional SS7 features, which are implemented in the network. . Although many other VoIP signaling protocols exist, SIP is characterized by its proponents as having roots in the IP community rather than the telecom industry. SIP has been standardized and governed primarily by the IETF while the H.323 VoIP protocol has been traditionally more associated with the ITU. However, the two organizations have endorsed both protocols in some fashion.

SIP is similar to HTTP and shares some of its design principles: It is human readable and request-response structured. SIP proponents also claim it to be simpler than H.323. However, some would counter that while SIP originally had a goal of simplicity, in its current state it has become as complex as H.323. SIP shares many HTTP status codes, such as the familiar '404 not found'. The promoters of SIP have said that the rapid innovation and application development that has characterized the Web will now mark the telephony industry, too. SIP and H.323 are not limited to voice communication but can mediate any kind of communication session from voice to video or future, unrealized applications.

7 ANNEXURE B: INTERNATIONAL CASE STUDIES

This annexure aims to provide a review of technical implementation and regulatory trends pertaining to NGN from some advanced countries.

7B. 1 Summary of international trends

A number of other regulators, especially in Europe and the Far East, are evaluating the impact of NGN transition for their telecom sectors and for the wider economy. Of these, Ofcom (UK) is by far the most advanced in its thinking followed to some extent by the regulators in Singapore and Netherlands. The other regulators are in the process of concluding their consultations on the subject and are pushing industry led initiatives to regulate the transition to NGNs. Regulators seem to be similar in their thought process on regulating NGNs and on creating policies to aid its transition.

The prevailing situation in some of the developed countries is described in following sections:

7B. 2 UK

The UK is one of the most competitive Broadband markets in Europe. Incumbent BT faces tough competition from both cablecos and alternative ADSL ISPs. BT holds just 24% of the retail market; the two largest cablecos NTL and Telewest hold 22% and 12% of the market. At the moment, most alternative xDSL ISPs resell BT's wholesale product, which makes differentiation on price or speed difficult to achieve.

Prices have dropped over the past year, and consequently, Forrester expects residential broadband penetration to more than double from 2004 to 2010, eventually reaching 42% of all UK households.

It is likely that it will wait out the storm in anticipation of a favourable repositioning once 21CN is rolled out. It is plausible that BT could also use 21CN to disrupt, disadvantage or inconvenience its UK competitors. We do not expect this to happen to a significant degree, primarily because the regulator is devoting significant attention to 21CN and its impact on competitors. It is likely that BT will be forced to give access to 21CN in ways that actually improve the lives of its competitors.

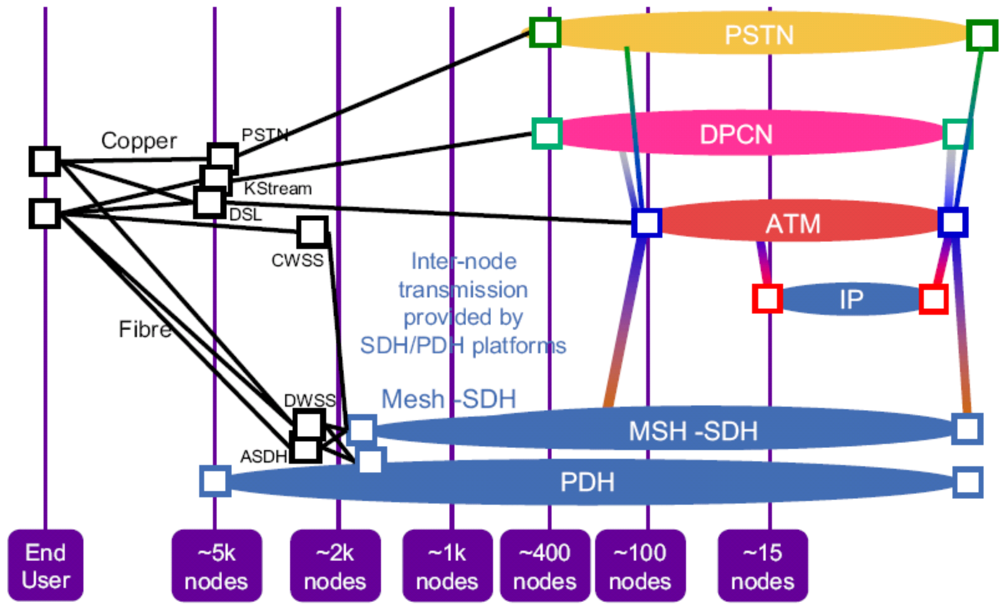
7B. 2.1 Technology trends

BT has embarked on its 21CN project to replace all of its core networks, including the PSTN, with a unified NGN. The 21CN project aims to substantially replace all of BT's existing network platforms (PSTN, ISDN, IP, ATM, FR, SHDS etc.) with a single unified IP platform. The investment is concentrated in the period 2005 to 2008, and is estimated to be around £3 -£5 billion. After 2008 it will still take several more years to migrate a long tail of customers onto the new platform. The most rural areas of the

UK will most likely not be upgraded as part of 21CN - solutions for these areas will probably be worked out at a later date.

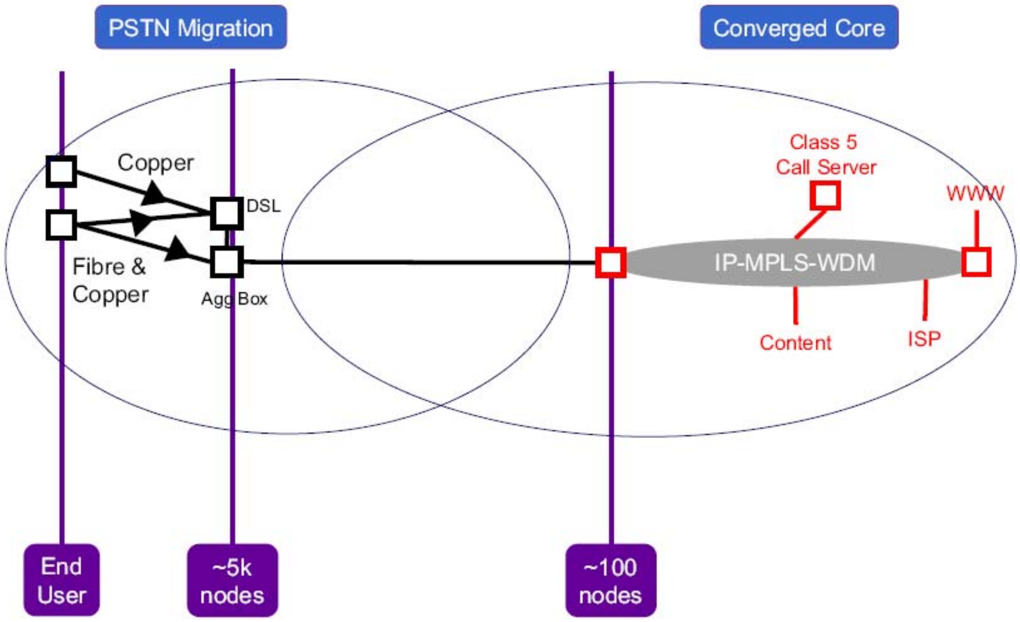
The primary benefit of 21CN will be cost reduction. BT's fragmented network platform is particularly costly to run, but it also supports a hugely complex legacy product portfolio, with many bespoke products - some that only serve one major customer. The rationalisation of this product set should yield very significant cost savings and headcount reductions.

Fig 19: Current BT network



Source: Morgan Stanley

Fig 20: Single IP Architecture



Source: Morgan Stanley

The BT case illustrates the independence of core network upgrade decisions from access network decisions. BT is at the leading edge of core network development, and at the trailing edge of access network upgrades (with significant resistance to even ADSL2 introduction). Conversely, operators such as Belgacom are at the leading edge of access network upgrades, but have no announced plans for retiring their PSTNs. In broad terms, all access network upgrades can be made to work with existing or new core networks situations, and all core network upgrades can be made to work with existing or new access networks.

British Telecom's (BT) has selected Huawei Technologies as one of next generation network (NGN) equipment suppliers. Once the contracts are finalized, Huawei will manufacture, supply and install multi-service network access (MSAN) components and transmission equipment. Huawei is the only Chinese firm among a total of eight companies that were selected to supply equipment out of more than 300 candidates after two years of discussions and negotiation. Other companies selected by BT include Fujitsu, Alcatel, Ericsson, Cisco, Lucent, Siemens, and Ciena.

7B. 2.2 Regulatory trends

21CN represents the most significant change in BT's network. In this case it creates the first ever opportunity to ensure that the network of an incumbent operator accommodates competition from the outset.

Ofcom's role is to ensure that there is clarity as to the regulatory policy requirements necessary to support effective competition. Ofcom does not wish to become involved in the detailed design of BT's network. However Ofcom intends to ensure that BT is able to provide access to its network in a manner that supports the further development of competitive markets. By providing clarity as to those regulatory policies that flow from this access obligation, Ofcom wants to help BT and others be clear about the constraints within which they should design their networks.

Ofcom has proposed key regulatory principles in the Telecoms Review. They are that Ofcom should:

1. promote competition at the deepest levels of infrastructure where it will be effective and sustainable;

2. focus regulation to deliver equality of access beyond those levels;

3. as soon as competitive conditions allow, withdraw from regulation at other levels;

4. promote a favourable climate for efficient and timely investment and stimulate innovation, in particular by ensuring a consistent and transparent regulatory approach;

5. accommodate varying regulatory solutions for different products and where appropriate, different geographies;

6. create scope for market entry that could, over time, remove economic bottlenecks; and

7. in the wider communications value chain, unless there are enduring bottlenecks, adopt light-touch economic regulation based on competition law and the promotion of interoperability.

Application of regulatory principles –

- **Principle 1: Competition at greatest depth.**

– Geographic depth within the topology of 21CN, i.e. how close to the customer is access provided. There are three geographic levels within 21CN at which it might be possible to provide access: the local loop (MDF/MSAN sites), the metro node and the core node. It is likely that a combination of access remedies will be required, focusing on access at MDF/MSAN sites in those geographies where this is likely to result in sustainable competition, and providing metro node access elsewhere.

– Service level depth. There is likely to be a choice between end-to-end services (e.g. wholesale calls), service-specific interconnection services (e.g. voice call origination), a generic interconnection service (e.g. bitstream interconnection) or physical unbundling (e.g. LLU).

Consistent with its regulatory principles, Ofcom believes regulation should be focussed as deep in this service stack as possible, recognising that this might vary with different geographies. If, for example, some form of access is made available at the MSAN, then there would be a preference for this to be at the physical or bitstream level rather than service specific.

- **Principle 2: Equality of access**

– The design of key regulated access and interconnection products must support equality of access. In particular, new regulated 21CN access and interconnect products will need to support 'equivalence of inputs', so that BT uses the same products, at the same price, managed using the same systems and processes as alternative providers.

– Reduced time to market is expected to be one of the key benefits of 21CN, so an effective process for the introduction of new regulated products will also be important. Even where existing regulated products currently support equivalence of access, they may have to evolve in light of new capabilities introduced by 21CN. For example, the requirement to support equivalence of access to the local access network might require changes to the existing LLU service, and may require consideration of some form of bitstream access at the MSAN.

- **Principle 3: Regulatory withdrawal**

21CN might allow for regulatory withdrawal because:

– 21CN may be the vehicle for the delivery of improved equivalence in relation to BT's wholesale services. This should allow other providers to compete in downstream markets and create the conditions where BT's downstream services, particularly at the retail level, could be deregulated.

– At the wholesale or network level a key theme of 21CN is convergence. If convergence is effective, this should allow a reduction in service specific wholesale regulation, and a greater focus on generic access and interconnection remedies (LLU, bitstream interconnection).

- **Principle 4: Favourable climate for investment**

– An important general principle is that regulation of NGNs should not simply be seen as a 'zero-sum' game, where Ofcom's primary concern is to decide how the benefits of BTs investment in 21CN should be divided between BT and the rest of industry. Instead, the aim should be to promote a favourable investment climate for industry as a whole, in order to deliver the greatest possible benefit to consumers of an industry wide migration to NGN.

– There are a number of ways in which Ofcom can influence the investment climate:

1. Providing regulatory clarity and predictability
2. Ensuring alternative providers have confidence in BT's regulated products
3. Setting appropriate regulated returns for BT's regulated products, that take account of the commercial and technical risks associated with its investment in 21CN
4. Ensuring the migration to 21CN minimises the impact on existing investments (and thereby also minimises the perceived risk associated with new investments) whilst enabling BT to close its existing networks as soon as reasonable

Application of principles to key forms of access and interconnection –

Ofcom is considering the application of these principles in four key areas:

1. Access and interconnection at the level of the local access network (MDF sites / MSAN nodes)
2. Access and interconnection at the level of the core network (Metro nodes)
3. Access to the intelligence and applications layers of 21CN
4. Systems and processes

The focus at this stage is on generic access and interconnection remedies, such as physical unbundling and bit-stream interconnection, which can be used to deliver a broad range of downstream services.

- Access at the local access network level (MDF/ MSAN site) – At the MDF/ MSAN site there are two main alternatives for the provision of access to the local access network, i.e. local loop unbundling (LLU), and some form of interconnection with the MSAN. Applying the first regulatory principle, Ofcom favours the deeper option, i.e. LLU, where this can lead to effective and sustainable competition. However, two factors suggest that an alternative to LLU, i.e. some form of interconnect with the MSAN, should be considered, at least in some areas, as a more effective means of promoting competition at this level.

– BT's deployment of 'broadband dial-tone' to its narrowband customers could create a major challenge for LLU-based operators. BT will be able to migrate customers to broadband almost immediately whilst the manual LLU process is likely to take several days at best.

– LLU is unlikely to be viable in all geographies, particular in those areas (e.g. rural areas) where there is a lower number of households connected to each MDF site.

- Access at the core network level (Metro node) – The current level of interconnection with BT's existing core network suggests that conveyance between metro nodes is potentially competitive. However, in moving to 21CN there may be differences in the location and topology of metro nodes compared to existing networks which might, albeit temporarily, lessen competition at this level.

- Intelligence and application layers – Ofcom believe that it is possible that 21CN will create new access bottlenecks at the intelligence and application layers. For example, an alternative provider may be able to deliver a voice service based on the use of bitstream access at the MSAN, but they may need access to additional functionality at the application layer (e.g. customer location data, session control functionality) in order to be able to compete effectively. Some of these functions may be needed on a reciprocal basis, others may relate solely to BT, whilst others could be developed on a commercial basis.

- Systems and processes – The operational processes and systems associated with key products must support equality of access, so that alternative providers are able to order and manage key products using the same processes and systems as BT's retail activities. A key enabler of this is likely to be BT's Next Generation OSS, a distributed OSS architecture based on off-the-shelf commercial systems linked by standard industry interfaces. This is expected to replace the vertically integrated OSS systems currently in use.

7B.2.3 Effective Industry led process

Ofcom is trying to develop an effective industry led process to ensure that the transition to NGNs is successful. It has highlighted the following areas which require industry involvement –

- Development of the obligatory products to be offered on 21CN, both migrated existing products and new SMP access and interconnect products

- Development of the commercial terms for the migration and new SMP products

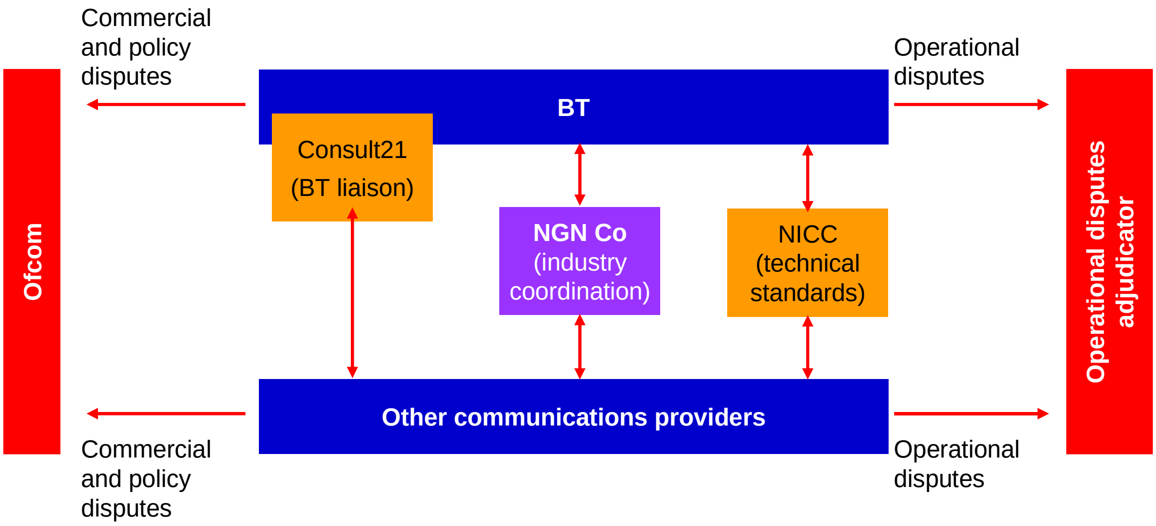
- Technical standardisation to support next generation access and interconnect products

- Planning and management of the migration to NGNs

- Addressing consumer protection issues

- Addressing other cross industry NGN issues

Fig 21: How Ofcom is involving the industry



7B. 3 China

7B. 3.1 Technology trends

The China Netcom fixed telecom service provider has chosen Alcatel's Chinese unit Alcatel Shanghai Bell to implement a full-scale, nationwide network evolution to Next Generation Network (NGN). Under the agreement, Alcatel will deploy a nationwide long-distance NGN trial network covering all 31 provinces of China, and also roll-out tandem and local NGN networks in two provinces.

Alcatel will provide its IP multimedia subsystem (IMS)-compliant NGN solution including Alcatel 5020 Soft switch, Alcatel 7500 family of media gateways and Alcatel multi-service access gateways linking voice and broadband. Upon completion of the deployment, China Netcom customers will be able to enjoy a host of next generation voice over IP and enhanced communication services.

As part of the deal, Alcatel will also support Chine Netcom in transforming its existing fixed network in Heilongjiang Province to intelligence network with NGN technology. The transformation will enable the operator to provide new fixed services with improved intelligence and enhanced mobility.

Alcatel will also deploy a new NGN network in Tianjin city for delivery of converged voice and broadband services.

7B. 4 Japan

Japan has a strong competitive Broadband market with a penetration of 16%. It leads technology deployment, in terms of NGN access network such as VDSL, VoIP, and Fibre to the Home (FTTH). FTTH is popular in Japan, with over a million homes currently connected and 80,000 to

90,000 more customers connected every month according to Japanese government data.

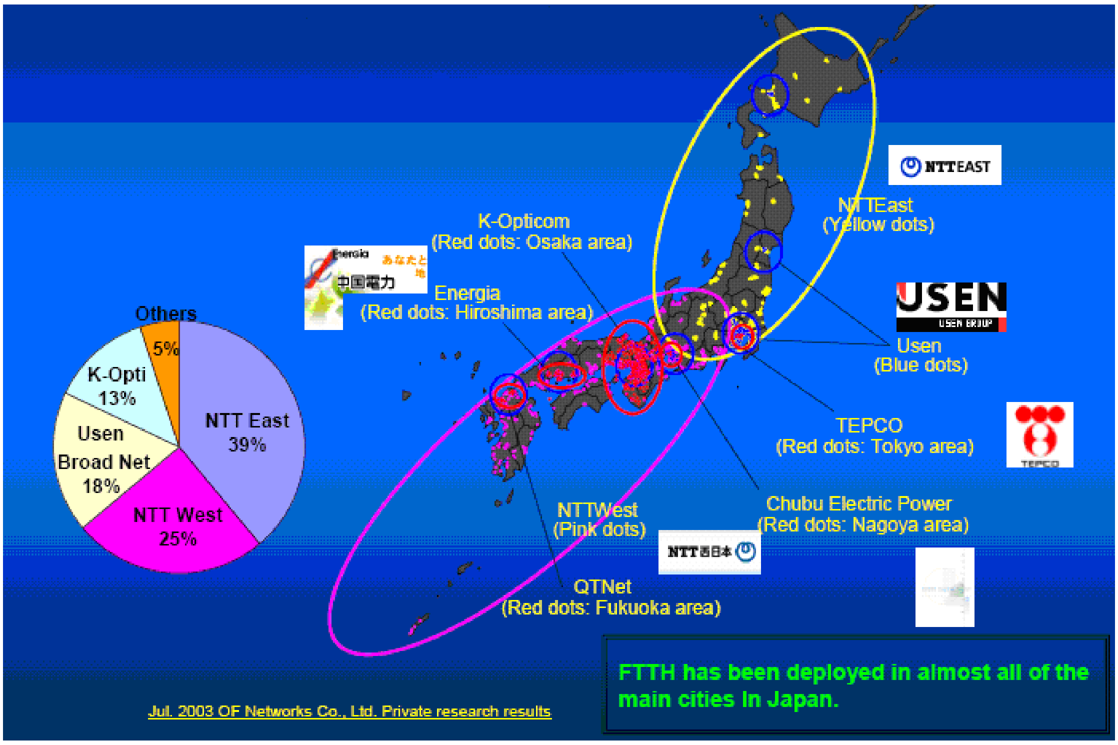
The incumbent telephone companies, NTT-East and NTT-West, are by far the dominant FTTH suppliers in Japan. There is more competition in the DSL market, where Yahoo! Broadband (Yahoo! BB) has gained significant market share and several smaller providers have made inroads. Yahoo! BB is unique in that it serves as an access provider, ISP, and content provider all in one place. Hence NTT is aggressively rolling out FTTH to compete with ADSL

The Japanese consumer has become accustomed to very high speed data services. DSL download rates of 40Mbps are common. FTTH services are offered at 100Mbps bidirectional as a way to distinguish them from the DSL offerings. Drivers for higher speeds include voice over IP (VoIP), peer-to-peer file transfer (P2P), Internet education and remote e-training, on-line gaming, large file emails (e.g. photographs), IP virtual private networks (IP VPNs) for teleworking, and streaming video over IP.

In Japan, FTTH is viewed primarily as a replacement for DSL high speed data – as opposed to the US where FTTH is viewed primarily as a vehicle for triple play (voice, video, and data) service delivery. DSL is viewed by many in Japan as an “unfair” delivery technology since only those closest to the central office (CO) can achieve the highest speeds. As distances between CO and home increase, the available DSL bandwidth decreases. This is not the case with FTTH, which can offer 100Mbps speeds to all customers.

The business case of the incumbent FTTH provider in Japan is based on the concept that providing high speed data will create a market for services. Therefore, the network provider does not always have to be the service provider. The network provider bases its business model on selling bandwidth to the end customer as well as to the service providers. The Internet market in Japan can be segmented into access providers who supply the FTTH (and DSL) infrastructure, the Internet Service Providers (ISPs) who provide access to the Internet over that high speed data infrastructure, and the Content Providers who provide services on top of the data network.

Fig 22: Japans regional FTTH deployment



7B. 4.1 Technology trends

The Japanese FTTH market is dominated by the incumbent telephone companies NTT-East and NTT-West. When NTT decided upon the ITU-T G.983 B-PON standards as their technology of choice for FTTH deployment, they instructed a select set of equipment suppliers to build the equipment necessary to deploy that technology. B-PON OLTs and ONTs were contracted, as well as the surrounding support equipment (switches, routers, etc.).

Since NTT had significant experience in high speed data to the home from their DSL business, they recognized the value of an IP-based network beyond the OLT (for IP-based video and voice services, IP-based handoffs to ISPs, less expensive IP-based switches, etc.). Therefore, NTT is deploying a set of BPON standard equipment that looks like E-PON in that it has Ethernet1-based network interfaces. This interesting combination of standards (Ethernet and B-PON) has resulted in a very cost-effective and flexible network.

NTT has decided to place the ONT (home user device) inside the home. Some network operators in other countries typically require the ONTs to be outdoor mounted to avoid entering the end-users' homes. This adds cost to the ONT due to hardening and security requirements, but allows much simpler access for installation and maintenance. Outside mounting also allows the network operator to avoid running optical cable into the home, although this advantage is dubious, as power cables and data cables must usually be run into the home anyway.

The Japanese model for FTTH ONTs is more like a DSL model, where the end-user equipment is located inside the home or office. This significantly reduces the cost of the ONT since hardening and security measures are not required. An internal ONT does require that the installer enter the home.

NTT has selected EPON for their FTTH deployment. EPON provides variable length packets designed for data transmission. APON was initially set up for TDM voice and it sends voice and video data as separate packets which are not always efficiently filled.

With an EPON deployment NTT can’t broadcast video but can provide VOD. But consumer demand is for data so EPON satisfies the requirements.

1Gbps4A single fibre is shared by multiple users for capital efficiency

- PON (Passive Optical Network) for Household customers (Fig 23) – A Passive Optical Network (PON) is a fibre to the premises configuration in which unpowered optical splitters are used to enable a single optical fibre to serve multiple premises, typically 32. A PON consists of an Optical Line Termination (OLT) at the communication company's office and a number of Optical Network Units (ONUs) near end users. It is, in other words, a point-to-multipoint configuration, which reduces the amount of fibre required compared with point to point.
- FTTB (Building) with VDSL, LAN Switches for Apartment customers (Fig 24)

Fig 23: Several customers share a fibre with a fibre splitter installed outside the plant

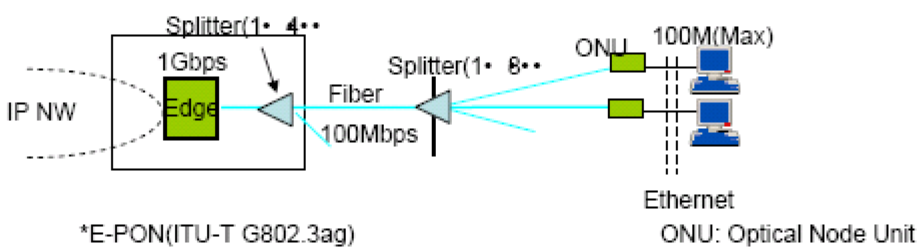
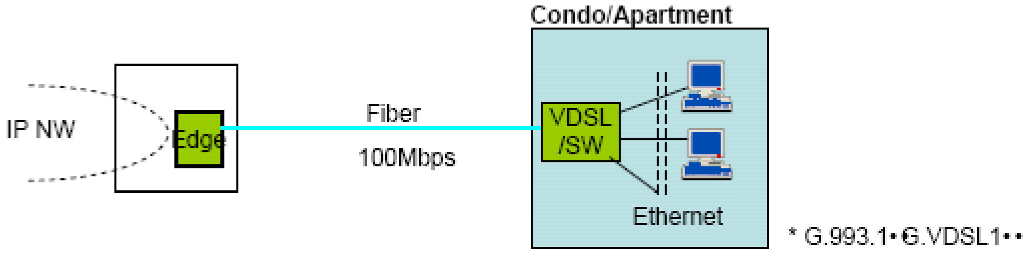


Fig 24: Sharing a fibre, with a LAN SW / VDSL installed in customers' premises



7B. 5 Singapore

Singapore was the first country in the world to deploy ADSL commercially when SingTel launched its Magix service in November 1997. Presently, all its households have copper installed and by end-2005, the Government predicts broadband access will be pervasive across the country.

The Singaporean Government is committed to making Singapore one of the most connected cities in the world. Its Singapore ONE project is a broadband network launched in June 1998, using fibre backbones and a combination of fibre, DSL and cable for last mile access. Singapore has a high level of awareness of broadband technology and some surveys report that up to 99% of the population is covered by broadband networks.

7B. 5.1 Technology trends

SingTel has implemented a global IP network backbone using Juniper Networks routing platforms. SingTel's ConnectPlus IP backbone is comprised of an IP core and edge routing platforms offering advanced IP services including Secure Remote Access, Virtual Private Networks (VPNs), Voice over IP (VoIP), Multicast and the highest levels of Quality of Service (QoS).

SingTel believes that the market is ready for a next-generation global IP network that can meet the current and emerging business data communication needs. SingTel has chosen an infrastructure that is designed to provide the highest level of reliability and performance for our IP network and can support a full range of advanced IP services.

ConnectPlus was built with Juniper Networks T320, M20, and M10i platforms. These support the creation of Multiprotocol Label Switching (MPLS) networks and utilize the fault-tolerant, modular JUNOS operating system to provide a rich set of reliable network features. The Juniper Networks T320 is a 10 Gigabit-per-second core routing platform with scalability and extensive ultra-dense aggregation support including ATM, Frame Relay, SONET/SDH and Metro Ethernet. The Juniper Networks

M20 and M10i edge routing platforms provide ASIC-based network routing.

7B. 5.2 Regulatory trends

In February 2005, IDA unveiled its latest initiative called Next Generation I-Hub, a secured, high-speed and ubiquitous network to drive next generation connectivity. By leveraging on the country's strengths in terms of its pervasive communication infrastructure, pro-business policy environment and plentiful ICT skilled manpower, the SupraHub envisages the creation of an island wide ubiquitous network in the period running up to 2009.

IDA intends to support the provision of a multi-channel platform that achieves convergence between Wired & Wireless, Data & Voice and Broadcasting & Telecommunication services. It is considering plans that include developing a favourable IP licensing regime, encouraging IPv6 adoption and investing in fibre to the home (FTTH).

IDA will play an active role in promoting the formation of industry-led alliances, exchanges and marketplaces while collaborating with industry to deploy infrastructure for ubiquitous offerings. Potential industry alliances can be forged in the areas of inter-roaming, interoperability and interworking in a multi-operator, multiplatform environment

In October 2005, the Infocomm Development Authority of Singapore (IDA) and Cisco Systems have signed an $18 million three-year Memorandum of Intent (MOI) to advance Internet Protocol (IP) networking in Singapore.

The investments will focus on three areas: the development of next-generation networking technologies; the development of skilled infocomm network professionals; and the establishment of a Singapore Solutions Centre in Singapore to help local enterprises bring their products and solutions to market.

One potential area in this collaboration is to study the feasibility of deploying next-generation integrated voice, video and data networks that will provide the country with seamless, ubiquitous wired and wireless connectivity.

The second focus area is to develop and upgrade the skills and competency level of network professionals and students in Singapore through training and certification, local and overseas industry attachments and scholarships, and enhancing the resources of the more than 20 educational institutions under the Cisco Networking Academy. The objective is to train more than 600 infocomm professionals and students over three years.

The third area covered by the agreement is the establishment of a Singapore Solutions Centre that will help Singapore-based enterprises to develop, test, showcase and market their products and solutions. The ultimate aim of the centre is to help turn Singapore into a key developer of advanced IP networking technologies.

7B. 6 Hong Kong

Although NGN has not yet come into play in Hong Kong in a widespread scale, some pre-NGN installation and IP-based services such as VoIP services, broadband Internet access, broadband pay-TV service and etc. are already available for the general public while Centrex IP and IP-VPN has become part of some private / corporate networks.

Some fixed telecoms network services (FTNS) operators have already launched some sort of NGN service to its corporate clients based on MPLS / IP technology while some others are planning their NGN programs and implementation schedules. It can be reasonably expected that NGN and the relevant services will become popular in the foreseeable future in Hong Kong. OFTA, the telecom regulator, believes the pace at which NGN is evolved quite depends on the business initiative of the carriers and the demand of the market.

7B. 6.1 Technology trends

Hong Kong Broadband Network Limited (HKBN) is a wholly-owned subsidiary of City Telecom (H.K.) Limited and a Broadband telecommunication enterprise in Hong Kong. In June 2002, HKBN built the largest Metro Ethernet IP network in the world, covering 1.2 million homes. Earlier this year (2005), HKBN announced the official launch of its bb1000 service, a symmetric 1Gbps for the Residential market. HKBN believes that Hong Kong is the first market in the World whereby 1/3rd of the total households, approximately 800,000 households out of a total of 2.2 million households, can now enjoy World Leading FTTH (Fibre-to-the-Home) symmetric 1Gbps Internet access service.

bb1000 is the fastest Internet access service in Hong Kong, being up to 166x faster downstream and 1,950x faster upstream than the advertised bandwidth by the leading Asymmetric Digital Subscriber Line (ADSL) deployment in Hong Kong. bb1000 targets premium residential users, such as Home Office or Remote Office access applications.

HKBN is expanding its coverage and capacity with a Cisco IP Next Generation Network (IP NGN), using Cisco ROADM (Reconfigurable Optical Add/Drop Multiplexer) technology together with HKBN's existing ONS 15454 Multiservice Transport Platform (MSTP) optical core, providing total network capacity approaching 2 Terabits per second.

With an IP-centric network, HKBN aims to increase the scope of its service offerings and expand its network coverage to 80% of homes in Hong Kong. This will increase their ability to deliver innovative new services, improve their operational and capital expenditure efficiencies, and advance the network and service control that they and their customers need for long-term business success.

HKBN was seeking a flexible and highly scalable DWDM (Dense Wavelength Division Multiplexing) solution to help reduce maintenance and support costs. HKBN believes that a completely integrated optical network will deliver ongoing CapEx and OpEx savings. With the deployment of the Cisco solution, HKBN aims to achieve an 80% throughput for the 10 Mbps and 100 Mbps high-speed broadband service.

The implementation of the ROADM solution on HKBN's network infrastructure will start at the end of August and finish by early October. Upon completion, HKBN's optical core will consist of multiple rings spanning the territory of Hong Kong. The new network capacity will be about 2 Terabits. This will allow faster and more flexible service deployment and maintain smooth operation as the number of customers increases.

7B. 6.2 Regulatory trends

OFTA recently released a paper on a general overview of Next Generation Networks (NGN). At present, OFTA has not prescribed any HKTA specifications for NGN as it believes that there are no internationally accepted standard on NGN yet. It plans to keep monitoring the standards development on NGN and its deployment and consult with the industry on how to adopt any specifications for NGN in the future.

OFTA has invited its members to offer supplementary information and comments on the paper about the standards development and deployment trend of NGN over the world. It has also asked the members to advise on the need and timing for the adoption of technical specifications for NGN in Hong Kong.