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Final Report

The Regulation of Next Generation Networks (NGN): Final Report

for submission to

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Glossary

21 CN	21st Century Network (BT in the U.K.)
3G	3rd Generation
3GPP	3rd Generation Partnership Project
AAA	Authentication, Authentication and Accounting
ADSL	Asynchronous Digital Subscriber Line
AMGW	Access Media Gateway
AMS-IX	Amsterdam Internet Exchange
AOL	American Online
ARPU	Average Revenue per User
ASD	Access Services Division
AssetCo	Asset Corporation; i.e. a company mainly holding network infrastructure as assets
AT&T	American Telephone & Telegraph Corporation
ATM	Asynchronous Transfer Mode
AXH	Access Hub
BB-RAR	Broadband Remote Access Router
BNetzA	Bundesnetzagentur (Regulator in Germany)
BT	British Telecom
CALEA	Communications Assistance for Law Enforcement Act
CAPEX	Capital Expenditure
CATV	Cable Television
CBB/IP	Controlled Broadband IP Network
CDMA	Code Division Multiple Access
CeBIT	Centrum der Büro- und Informationstechnik (annual IT fair in Hanover, Germany)
CGBB	Current Generation Broadband
CHF	Swiss Francs (currency)
CHIP/ISzT	(the organisation to which ENUM has been delegated)
CLECs	Competitive Local Exchange Carriers
CMTS	Cable Modem Termination System
COOP	Electrical Cooperative
CPE	Customer Premises Equipment
CPNP	Calling Party's Network Pays
CPP	Calling Party Pays
CRM	Customer Relationship Management

CRTC	Canadian Radio-Television Commission
CS/CPS	Carrier Selection, Carrier Pre Selection
CSCF	Call State Control Functions
DHCP	Dynamic Host Configuration Protocol
DDoS	Distributed Denial of Service
DE-CIX	German Internet Exchange
DEV/CLEC	Developer/ Competitive Local Exchange Carriers
DiffServ	Differentiated Services
DLE	Digital Local Exchange
DNS	Domain Name System
DNSSEC	Security Enhancement to the Domain Name System
DOCSIS	Data over Cable Service Interface Specification
DSLAM	Digital Subscriber Line Access Multiplexer
DTAG	Deutsche Telekom AG
DVB-C	Digital Video Broadcasting for Cable
DVB-H	Digital Video Broadcasting Handheld
DVR	Digital Video Recorder
DWDM	Dense Wavelength Division Multiplexing
EBC	Element Based Charging
ECS	Electronic Communications Services
EETT	National Telecommunications and Post Commission Greece
EKG	Egységes Kormányzati Gerincháló
ENUM	Telephone Number Mapping
ERG	European Regulators Group
ETSI	European Telecommunications Standardisation Institute
EWSD	Electronic World Switch Digital
FCC	Federal Communications Commission (regulator in the USA)
FL-LRAIC	Forward Looking Long Run Incremental Cost
FMC	Fixed Mobile Convergence
FTTB	Fiber to the Building
FTTC	Fiber to the Curb
FTTH	Fiber to the Home
FTTx	Fiber to the ….
GAN	Generic Access Network
GFP	Generic Framing Procedure
GigE	Gigabyte Ethernet

GPON	Gigabit Passive Optical Network
GPS	Global Positioning System
GSM	Global System for Mobile Communications
HDTV	High Definition Television
HFC	Hybrid Fibre Coaxial
HSPDA	High Speed Downlink Packet Access
HSS	Home Subscriber Server
HTCC	Hungarian carrier
I-BCF	Interconnection Border Control Function
I-BGF	Interconnection Border Gateway Function
IBM	International Business Machines Corporation
ICT	Information and Communications Technology
IETF	Internet Engineering Task Force
IKE	Internet Key Exchange
ILEC	Incumbent Local Exchange Carrier
IMS	IP Multimedia Subsystem
IP	Internet Protocol
IPsec	IP Security Protocol
IPTV	IP Television
IPv4	Internet Protocol Version 4
IPv6	Internet Protocol Version 6
IPX	Internet Public Exchange Point
IRG	Independend Regulators Group
ISA	Integrated Services Architecture
ISDN	Integrated Services Digital Network
ISP	Internet Service Provider
IT	Information Technology
ITSP	Internet Telephony Service Provider
ITU	International Telelecommunication Union
IXC	Interexchange Carrier
KDDI	Kokusai Denshin Denwa (International Telegram and Telephony Corperation)
KPN	Koninklijke Posterijen, Telegrafie en Telefonie Nederland
KT	Korea Telecom
LAN	Lacal Area Network
LCD	Liquid Crystal Display
LER	Label Edge Router

LINX	London Internet Exchange
LLU	Local Loop Unbundling
LNS	Layer 2 tunneling protocol network server
LRE	Long Reach Ethernet
LRIC	Long Run Incremental Costs
LTO	Local Telecom Operator
M/G/1	Specific model of queueing theory
MAP	Media Adapter Point
Mbps	Megabit per Second
MCL	Metro Core Locations
MDF	Main Distibution Frame
MGCF	Media Gateway Controller Function
MGW	Media Gateway
MGWC	Media Gateway Controller
MHz	Megahertz
MIC	Ministry of Internal Affairs and Communications Japan
MPLS	Multiprotocol Label Switching
MSAN	Multi-Service Access Node
MSO	Multiple System Operator
MT	Magyar Telekom
MUNI	Municipality
MVNO	Mobile Virtual Network Operator
NACF	Network Attachment Control Functions
NASS	Network Attachment Subsystem
NAT	Network Address Translation
NCC	Network Charge Control
NDS	Network Domain Security
NEC	Nippon Electric Company
NetCo	Network corporation, i.e. a company mainly operating network infrastructure which they, however, have not necessarily deployed or which is owned by them
NGN	Next Generation Network
NG-SDH	Next Generation Synchronous Digital Hierarchy
NHH	Nemzeti Hirközlési Hatóság
NIAC	Network Infrastructure Advisory Council
NIDP	Network Interface Demarcation Point

NIST	National Institute of Standards and Technology (NIST)
NRA	National Regulatory Agency
NRIC	Network Reliability and Interoperability Council
NTSC	National Television Standards Committee
NTT	Nippon Telegraph and Telephone Corporation
OAM	Operation, Administration and Maintenance
OFCOM	Office of Communications (Regulator in the U.K.)
OLT	Optical Line Termination
OPEX	Operational Expenditure
OPTA	Onafhankelijke Post en Telecommunicatie Autoriteit (regulator in the Netherlands)
OSGI	Open Systems Gateway Initiative
OSI	Open Systems Interconnection
OSS	Operational Support Systems
P2P	Peer to Peer
PAL	Phase Alternation Line (European analogue TV standard)
PATS	Publicly Available Telephone Service
PBX	Private Branch Exchange
PC	Personal Computer
PDH	Plesiochronic Digital Hierarchy
PIS-CSCF	Proxy-, Interrogation-, Serving- Call State Control Functions
POA	Points of Access
POI	Points of Interconnection
PON	Passive Optical Network
PoP	Point of Presence
POTS	Plain Old Telephone Service
PSAP	Public Service Access Point
PSTN	Public Switched Telephony Network
PT	Portugal Telecom
PUD	Public Utility District
PWLAN	Public Wireless Local Area Network
QAM	Quadrature Amplitude Modulation
QoS	Quality of Service
R&D	Research and Development
RACF	Resource Attachment Control Functions
RACS	Resource and Admission Control Subsystem

RADIUS	Remote Authentication Dial-In User Service
RAO	Reference Access Offer
RBOCs	Regional Bell Operating Companies
RFCs	Requests for Comments
RFID	Radio Frequency Identification
RIO	Reference Interconnection Offer
ROI	Return on Investment
RPP	Receiving Party Pays
RSVP	Resource Reservation Protocol
RTP	Real-Time Transport Protocol
RTCP	Real Time Control Protocol
RUO	Reference Unbundling Offer
SBC	Southwestern Bell Corporation
SBCGW	Session Border Control Gateway
sBGP	Secure Border Gateway Protocol
SDF	Subloop Distribution Frame
SDH	Synchronous Digital Hierarchy
SDM	Service Deployment Manager
SEG	Secure Gateways
ServCo	Service corporation, i.e. a company mainly providing services, however, not necessarily operating network infrastructure
SIP	Session Initiation Protocol
SLA	Service Level Agreements
SLU	Sub-Loop Unbundling
SMGWC	Session Media Gateway Controller
SMP	Significant Market Power
SOA	Service Oriented Architectures
SPIT	Spam over Internet Telephony
SPS	Service Platform Server
SPT	Saigon Post and Telecommunications
SS7	Signalling System Number 7
TC	Telecommunications
TCP/IP	Transmission Control Protocol/ Internet Protocol
TDM	Time Division Multiplexing
TDMA	Time Division Multiple Access
TELRIC	Total Element Long Run Incremental Costs

TEPCO	Tokyo Electric Power Company
TISPAN	Telecoms and Internet Converged Services and Protocols for Advanced Networks
TKG	Telekommunikationsgesetz (German Telecommunications Act)
TMGW	Trunk Media Gateway
T-OC-DSL	Telekom-Online Connect-Digital Subscriber Line
TV	Television
T-ZISP	Zuführung für Internet Service Provider (Wholesale product of DTAG for ISPs in Germany)
UDP	User Datagram Protocol
UE	User Equipment
UICC	Universal Integrated Circuit Card
UMA	Unlicensed Mobile Access
UMTS	Universal Mobile Telecommunications System
UNI	User Network Interface
USD	Universal Service Directive
VCR	Videocassette Recorder
VDSL	Very High Bitrate Digital Subscriber Line
VoB	Voice over broadband
VoIP	Voice over IP
WACC	Weighted Average Cost of Capital
WBA	Wireless Broadband Access
WiFi	Wireless Fidelity
Wimax	Worldwide Interoperability for Microwave Access
WLAN	Wireless Local Area Network
xDSL	…Digital Subscriber Line

Executive Summary

The migration to Next Generation Networks is a sea change, a fundamental transformation that is "in the air" all over the world. It represents a refinement of the long-standing tendency towards convergence as networks ineluctably evolve from the traditional Public Switched Telephone Network (PSTN) to the same IP protocols that underpin the Internet. The NGN migration will manifest itself in different ways and at different speeds in different countries, but there is little doubt that the key transformation – from PSTN-based to IP-based – will come.

This transformation implies not only changes in technology, but also profound changes in the entire value chain by which services are provided to the public. These changes will transform the regulatory landscape in fundamental ways.

Some might argue that, except in a few leading edge countries, it is a bit early to consider regulation; however, the authors of this study are of a different view. In light of the enormous transformative power of this migration, it is altogether prudent and appropriate for a country like Hungary to begin now to identify the regulatory topics where skill development, tools development, monitoring, and active planning are warranted today or in the near future.

In this executive summary, we consider technological and market aspects of NGN. We then review NGN developments in other countries, notably the UK, Japan, the Netherlands, Germany, and the United States. We then consider at length the regulatory implications of NGNs in a broad, international context. Next, we discuss the specifics of the Hungarian market. Finally, we conclude with suggestions for next steps for the NHH.

This study has been carried out for the Hungarian telecommunications regulator Nemzeti Hirközlési Hatóság (NHH) (Budapest) by a consulting consortium consisting of WIK-Consult GmbH (Bad Honnef, Germany) and Infrapont Kft. (Budapest). We are pleased and honoured to have been chosen to carry out this important and visionary study on behalf of the NHH.

Introduction

Global interest in Next Generation Networks (NGNs) has been driven by a confluence of technological and market factors. Key among these are:

- The overall migration of the network to Internet Protocol (IP),
- The consequent de-coupling of the service from the network, with profound implications for changes in the economic value chain,

- Price-performance improvements driven by Moore's Law for computing and switching equipment, and by digitization and fibre optics (including Dense Wave Division Multiplexing) in the network,

- Widespread deployment and adoption of broadband Internet access, coupled with technological improvements to enable still higher speed and reliability as fibre deploys closer and closer to the consumer,

- Convergence of fixed and mobile services (FMC).

The advent of NGN has profound implications for regulators. Central to many of the challenges of NGN are concerns about market power. Market power has always been a central them for regulators, but NGN poses many of the familiar questions in slightly unfamiliar contexts.

- NGN will decompose the value chain of service and network. Does this mean that market power concerns will be mitigated?

- NGN will make high speed Internet access essential, but it will not necessarily solve last mile bottlenecks. Does this mean that market power concerns will be much as they are today?

- NGN potentially introduces new competitive bottlenecks in the upper layers of the network, closer to the application that is directly visible to the user. Does this mean that market power concerns will be even greater in the world of the NGN than they are today?

Section 2 of this Executive Summary considers technology aspects of the migration to NGN, while Section 3 considers market factors. Section 4 reviews network evolution and regulatory responses in the United Kingdom, Japan, the Netherlands and Germany. Section 5 provides an overall review of regulatory issues as they relate to NGN. Section 6 discusses specifics of the Hungarian environment. Section 7 provides key suggestions and recommendations to the Hungarian NHH.

Technology

The migration to NGN is based first and foremost on the steadily increasing maturity and acceptance of the IP protocols that underpin the Internet. This widespread acceptance generates economic advantages for IP-based protocols, in the form of network effects – the more systems that are able to communicate using IP, the greater the value of IP to all, because the number of destinations increases.

Several closely related developments are also motivating the migration to IP-based protocols generally and to NGN in particular:

- Steady price/performance gains due to Moore's law improvements in semiconductors and due to Dense Wavelength Division Multiplexing (DWDM) in the physical layer,
- The ongoing development of broadband access technologies (including VDSL and Fiber to the Home [FTTH], as well as other fixed, mobile, and fixed-wireless broadband solutions),
- The successful development of protocols to provide packet based real-time bidirectional voice communication (H.323, SIP),
- Steady improvements in terminal equipment,
- The digitalization of media, and the convergence of Information Technology (IT) and telecommunications technology.

Collectively, these changes enable network architectures that are cheaper, more computerized, less centralized, more modular and thus more evolvable than the traditional PSTN.

NGN can be characterized by the logical separation of the transport, control and service layer, differentiated network access, a unique IP transport network in the core, and the application of open protocols. The IP Multimedia Subsystem (IMS) is a set of complementary protocol specifications that addresses session initiation in a way that facilitates mobility. At this point, the standards for NGN and IMS are generally integrated and compatible among the major standards bodies in the field, notably including ITU, ETSI, the IETF, and the 3GPP.

The migration to NGN has different implications for the core of the network in comparison to the access network. The core migration entails replacing central network elements with a standards-based, all-IP network. The IP-based core not only inherently allows the network to carry a much wider range applications, but also potentially enables independent third parties to offer competing applications. This new form of competition is, from the regulator's perspective, a key consumer benefit.

At the access layer, many underlying technologies are possible. It is possible that not all NGN core operators will choose to offer last mile access. For those that do, VDSL and FTTB/FTTH are the choices that are most spoken of, but mobile services also play a major role, and fixed wireless broadband could be important. Some operators might migrate the core without upgrading the access from existing broadband solutions, as BT is apparently doing. Many operators will employ a mix of access strategies, and often will even provide different forms of access to the same customer.

Market aspects

The migration to NGN is largely being driven by (1) incumbent operators, both fixed and mobile, and by (2) manufacturers. (Competitive operators are rarely the first mover.) The incumbents and the manufacturers have somewhat different motivations.

- **The incumbent fixed operator's perspective:** NGN deployment is driven primarily by enhanced cost efficiency, the ability to offer new services and applications, and faster time-to-market. Operator's are under pressure to reduce costs and expand revenues because the established revenue base is eroding. Moreover, pricing structures are evolving towards flat rate regimes – NGN represents an attempt on the part of the operators to regain some pricing power. Intra-modal competition in Europe is increasing. Competitors are becoming stronger vis-à-vis incumbents – they operate with greater efficiency and, based on greenfield approaches, they can often implement the latest technologies more rapidly. As a related trend, voice services and to an increasing degree video services can now be provided by independent service providers. Inter-modal competition is heating up due to the entry of market players from the cable industry. Fixed-mobile substitution is taking place, both a call-by-call basis (where individual traditional PSTN fixed calls are substituted for by mobile calls), and on an overall service basis (where households are becoming mobile-only households that no longer have access to PSTN dial tone). Overall, these trends put pressure on incumbent earnings and motivate incumbents to look for ways to cut costs and to find new sources of revenue.

- **The manufacturing industry perspective:** The communications manufacturing sector has become a global market. The key portfolio of the established players of the PSTN world (the *Bellheads* focusing on switching technology, private branch exchanges and the like) is at the end of the product maturity phase. A new breed of companies focusing on IP technology (the *Netheads* providing routers, bridges, and servers) has entered the market. As everything becomes IP-based, knowledge and expertise regarding IP technology becomes a core asset. So the need arises for the bellheads to re-invent themselves, which they have attempted over the past few years through acquisitions, with varying degrees of success. Meanwhile, network operators are increasingly prone to outsource activities such as network operation and maintenance which were previously part of their core assets. All of these developments are accompanied by a new wave of concentration in the communications manufacturing industry. For manufacturers, the migration to NGN represents a golden opportunity to obsolete most of the installed base and replace it with new equipment – but with the risk that subsequent equipment orders in the long term will represent the lower unit prices associated with IP-based equipment, and that gross earnings in the long term will be lower than today.

A key transformation that is associated with the migration to IP-based networks, and that is being accelerated by the migration to NGN, is the divergence of the *service* from the *network*. Historically, voice ran over the fixed and mobile telephone networks; video operated over the air, over satellite, and over cable; and data operated primarily over the fixed telephone network. Today, voice, video and data all operate simultaneously over the fixed and mobile networks and over the cable television network. All services can run over all networks, but it is no longer necessarily the case that the service provider is the same entity as the network provider.

Developments in other countries

Different operators are approaching the migration to NGN differently, and different countries are approaching NGN regulation differently. These differences are to a significant degree conditioned on a few key factors:

- How rapidly does the incumbent intend to migrate to NGN?
- How rapidly does the incumbent intend to abandon existing infrastructure?
- Will the access network be upgraded, and if so will it be VDSL or FTTB/FTTH?
- What is the underlying style of the NRA – primarily *dirigiste*, or *laissez-faire*?

There are many lessons to be learned from leading edge NGN regulatory experience in other countries, especially other Member States. Exchanging views with other regulators, especially in the context of the ERG/IRG, can be fruitful. Many countries face similar issues in regard to withdrawal of SMP remedies; disappearance of points of access and interconnection; challenges to loop unbundling as the access network migrates to VDSL and to FTTB/FTTH; and consumer welfare obligations (emergency services, lawful intercept) in conjunction with VoIP.

United Kingdom

BT is upgrading its core network to an NGN on a brisk schedule, with the intent of completely replacing the traditional PSTN. Ofcom has already completed a number of public consultations dealing with the transition to NGN. Most notably, Ofcom and BT have agreed to a “structural separation light” approach to BT’s access network, where a separate division will operate the access network and will make it available to BT and to competitors on a nondiscriminatory basis. Ofcom has also considered the implications of changes in the number of points of interconnection, and how to adjust BT’s permissible regulated return so as to deal with the increased risk of deployment for an NGN. In order to address emerging NGN regulatory challenges in a flexible manner, they have placed great emphasis on establishing an improved framework for industry engagement (best embodied by a new NGN industry body, NGN UK (Next Generation Networks in United Kingdom)).

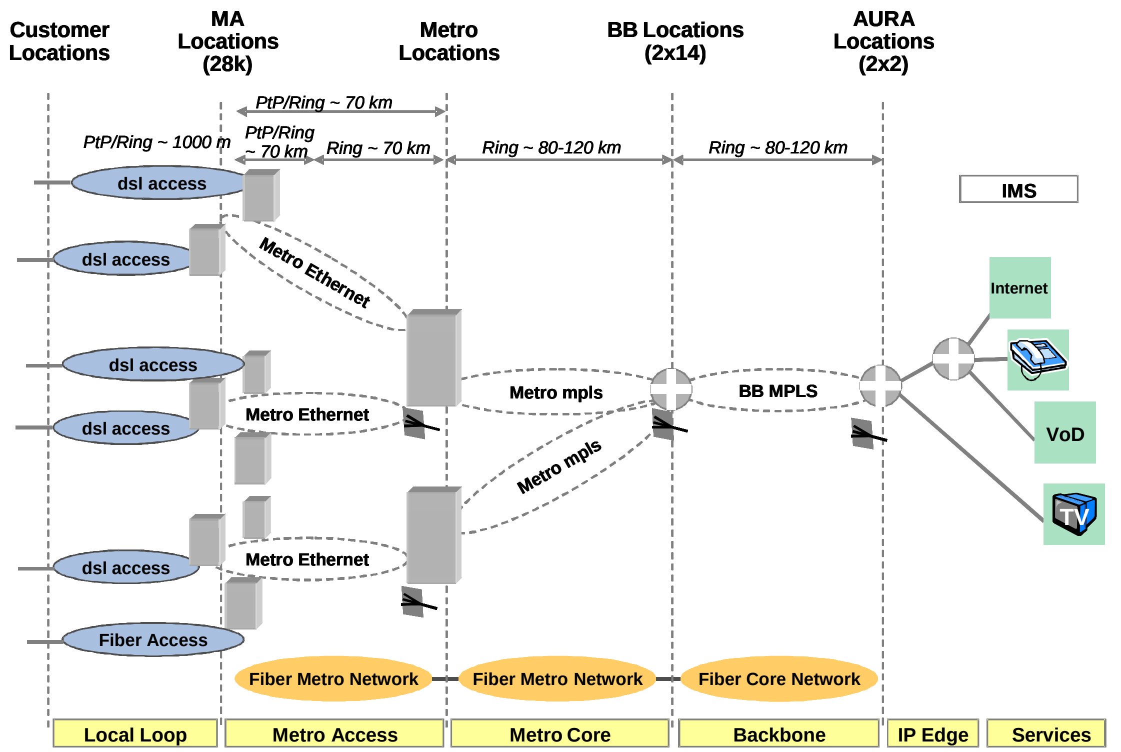
Japan

The Ministry of Internal Affairs and Communications (MIC) set up a “Study Group on a Framework for Competition Rules to Address the Transition to IP-Based Networks” which compiled a final report in September 2006. MIC has formulated the following five basic principles for competition policy in the transition to IP-based networks: (1) Ensuring fair competition at the telecommunications layer (comprising the physical network layer and the telecommunications service layer), (2) ensuring fair competition focusing on the vertical integration business model, (3) ensuring competitive and technological neutrality, (4) protecting consumer interests, and (5) ensuring that competition rules are flexible, transparent and consistent. The study stresses the importance of an appropriate balance between facility-based competition and service-based competition in the communications sector.

The Netherlands

KPN has embarked on an aggressive program to replace its core network with an NGN, and to upgrade its access network through widespread deployment of VDSL, as depicted in Figure 1. The upgrades will be funded primarily through the sale of buildings and land that are no longer needed to operate the simplified network; at the same time, the upgrades will enable the elimination of many jobs, generating substantial operational savings.

Figure 1: KPN's ALL-IP network



Source: OPTA (2006): „KPN's Next Generation Network: All-IP", Positionpaper, OPTA/BO/2006/202771; October 2, 2006 (in Dutch)

OPTA has thoroughly analysed KPN's All-IP strategy. KPN's migration will render unbundling at the MDF impractical; however, OPTA has concluded, based on consultant input, that the obvious alternative (unbundling at the street cabinet) is not economically viable. The migration poses complex regulatory challenges that have not yet been resolved.

Germany

Deutsche Telekom is gradually migrating its core network to an NGN, and has begun deployment of VDSL in the access network. Two main regulatory issues have been considered to date: (1) IP-based network interconnection, and (2) a deregulatory Amendment to the German Telecommunications Law as regards "new markets" such as VDSL. The German regulatory agency (BNetzA) established a working group to study interconnection in IP-based networks in 2005. The working group commissioned a number of expert studies, and took a keen interest in so-called Bill and Keep wholesale interconnection arrangements, but reached only tentative conclusions. The new German Telecommunications Law which took effect in February 2007 could lead to far reaching deregulation for DTAG's new investments in VDSL technology. This, however, has led to severe tensions between Germany and the European Commission, which views VDSL as part of the broadband market and thus subject in principle to the same regulatory obligations. The matter is likely to ultimately wind up before the European Court of Justice. Meanwhile, BNetzA recently decided to require DTAG to grant competitors access to ducts between the MDFs and the street cabinets.

Regulatory considerations

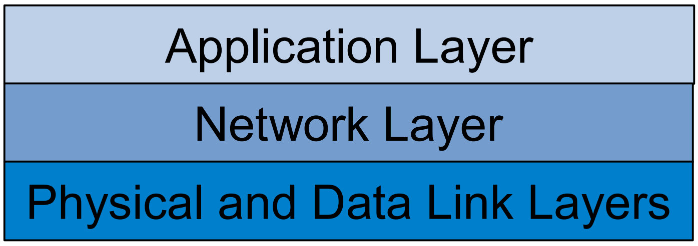
A number of key themes underpin regulatory reasoning. Inasmuch as these are driven by fundamental economics, NGN does not change the fundamentals; however, NGN often raises old questions in new forms.

A few key considerations:

- In a market economy, the state should not "regulate technical progress"; rather, it should employ a technologically neutral approach to policy and regulation. Intervention always carries the risk of "betting on the wrong horse". The market is usually more capable than the regulator of determining which innovations have real value.
- Where new and emerging markets exhibit higher than normal risk, investors require a higher than normal return on their capital in order to make the investments. A regulatory environment that is, insofar as possible, predictable is also essential for investment.
- Consumer welfare is most effectively fostered through real, meaningful competition. Given the choice, the regulator should prefer competition to regulation. Regulation may, however, be appropriate to deal with market defects, notably with market power.
- Market power is a central theme in communications regulation. For reasons noted in the introduction to this Executive Summary, it is not yet clear whether market power concerns will be less than, similar to, or greater than those in current networks.

With that said, we review regulatory issues and NGN, starting at the lowest layers of the communications protocol (those closest to the physical transmission medium) and ending with the highest layers (those closest to the application and the user). To organize this discussion, we can use a simplified and stylized version of the layered protocol model that underlies the Internet (see Figure 2 below): The lowest layers are associated with data transmission over the local network, and are often referred to as the *Physical Layer* and the *Data Link Layer*. The middle layer is concerned with the forwarding of data from one system to another, and can be referred to as the *Network Layer*. The upper layers provide services directly to the end-user, and can be viewed as the *Application Layer*.

Figure 2: Simplified layered protocol reference model of the Internet



Source: WIK (based on IETF RFC 791)[1]

Access and Interconnection are central themes for regulation. Access and interconnection are related, but they are not the same thing. For our purposes, *interconnection* enables an operator to establish communications with the customers of another operator, while *access* enables an operator to utilize the facilities of another operator in the furtherance of its own business and in the service of its own customers. Network access is primarily associated with the lower layers, the Physical and Data Link Layers. Network interconnection in an NGN context is based on the Internet Protocol (IP) and takes place at the Network Layer.

Access

As long as the access network remains with traditional broadband and narrowband media, the migration to NGN raises no new regulatory challenges at the Access level.

Where an operator migrates to VDSL, the DSLAM will normally be deployed to the street cabinet, not to the Main Distribution Frame (MDF). This implies that unbundling must move to the street cabinet, if it is to be supported at all. Street cabinets are far more numerous than MDFs, and much closer to the user. It is not practical, in general, for competitors to establish their own, competing street cabinets, and it is not yet clear whether it is practical for a competitor to share a street cabinet – there would potentially be issues of space, manageability, and perhaps heat dissipation. (Bitstream access is, however, presumably workable.)

Where an operator migrates to FTTB/FTTH infrastructure, a different set of regulatory challenges must be addressed. First, it is inconceivable that owners/renters in a multiple dwelling unit would permit more than one set of fibre in a single building, so the last 100 meters becomes the ultimate competitive bottlenecks. First mover advantages are im-

1 IETF, *Internet Protocol : DARPA Internet Program Protocol Specification*, RFC 791, September 1981.

mense. Secondly, there are substantial unresolved regulatory challenges as regards unbundled access to Passive Optical Network (PON) infrastructure used to simultaneously carry multiple video channels.

As cable operators migrate to NGN, the NHH might conceivably consider the regulatory imposition of wholesale access to cable operators' broadband capabilities. There would, however, be a concomitant risk of slowing the deployment of broadband over cable. Overall, we view the rationality and viability of this option in Europe as questionable; moreover, experience from the U.S. and Canada is not encouraging. At the same time, the issue would need to be considered in terms of the specifics of a particular Member State. In the case of Hungary, cable penetration is unusually high. There is a basic trade-off: slowing deployment of broadband over cable infrastructure versus enabling service-based competition. Nonetheless, it might be considered if the Hungarian market tilts strongly toward cable.

Interconnection

Interconnection in the world of the PSTN is usually effected using wholesale arrangements in one of two forms: Calling Party's Network Pays (CPNP), where the originating user's network makes a per-minute payment to the terminating party's network; or alternatively "Coasian" voluntarily negotiated arrangements. In the latter case, and under suitable preconditions, the network operators often agree to waive charges, a system known as Bill and Keep.

In the Internet, two forms of wholesale arrangements are common. In one, a transit customer pays a transit provider for access to the whole Internet. In the other, two peers agree to exchange traffic, but usually only among their respective customers. Peering is accomplished according to Coasian negotiated arrangements, where again the network operators often agree to peer without charge.

There is an extensive literature on the economics of both systems. CPNP generally leads to faster take-up of mobile services, but also leads to higher retail prices, lower utilization of the network, and economic distortions between fixed and mobile networks. It also necessitates regulation indefinitely.

Since the NGN incorporates elements both of the PSTN and the NGN, it is not altogether clear how interconnection should be addressed at an economic level. It is, however, clear that CPNP in its present form is probably unsustainable in the NGN in the long term. There are a number of reasons: (1) In CPNP, payment based on the service compensates for the cost of the network. If these are provided by different entities, the system cannot work correctly. (2) Minutes of use correlate only weakly to marginal cost in an NGN. (3) In an NGN world, the non-cost-based fees invite massive arbitrage from independent service providers. (4) The notion that the caller is solely responsible for the cost of the call is dubious in the current network, and doubly so in an NGN.

Coasian negotiated arrangements are likely to be viable, since they already seem to be viable in the Internet. CPNP with very low termination rates might be a useful interim solution.

Differentiated Quality of Service is intended to be a key differentiating capability of the NGN. There is considerable doubt that consumers are willing to pay as much for QoS as incumbents seem to assume. Experience in the US supports what engineering tells us: Most users will be unable to perceive a difference most of the time, and therefore are unlikely to be willing to pay much of a premium for better-than-best-efforts QoS between networks. Within a single network, and especially near the edge of the network, QoS will be useful and will be deployed – but this is already the case in the Internet, it is not a new NGN phenomenon.

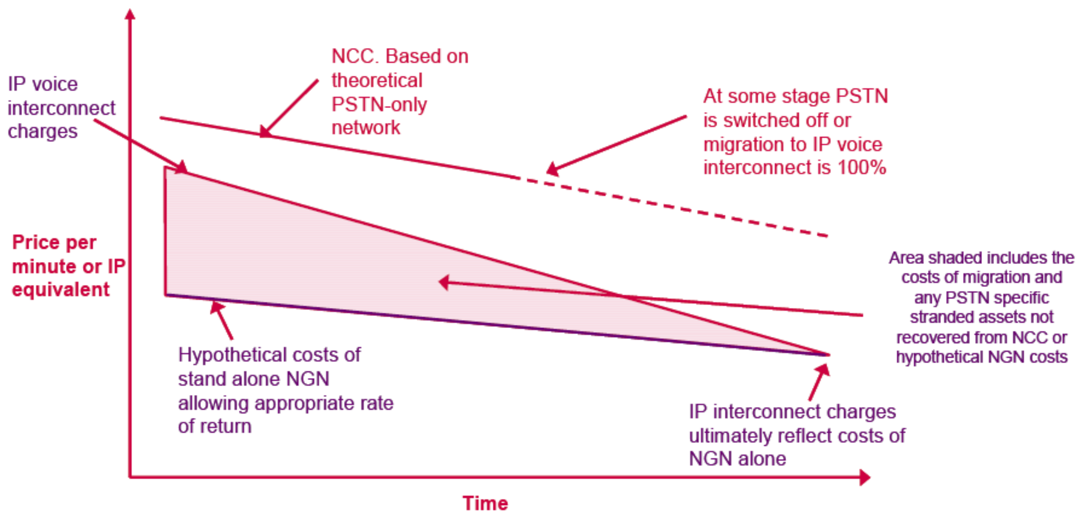
It is conceivable that some network operators might be disinclined to interconnect, or might intentionally degrade the quality of interconnection. Based on experience with the Internet, we know that a technically and economically efficient can emerge through a mix of peering and transit, even though an operator declines to peer with some other operators. The economic basis for these risks has been extensively researched. Nonetheless, there is some risk that incumbents who control access to a large number of end-users might intentionally offer poor or degraded interconnection. NRAs should monitor for this possibility – NRAs have a range of potential remedies, not just SMP-based remedies.

Cost Modeling

Cost modeling will not necessarily be needed for interconnection in a Coasian world, but it will certainly be needed for access.

Cost models will have to be revised to reflect differences in network structure. Depending on the intended use, it may be necessary to update both core and access models. Cost models will also need to somehow address the reality that costs are likely to be higher during migration due to the parallel operation of two networks, PSTN and NGN, even though they will ultimately be lower in the long run. As shown in Figure 3, Ofcom hopes to address this problem (in the case of regulated charges for narrowband access) by establishing a gentle glide path toward true marginal cost, and keeping the regulated charges somewhat in excess of true marginal NGN cost until the migration is substantially complete.

Figure 3: Ofcom's approach to narrowband voice interconnect cost recovery



Source: Ofcom (2005b), Figure 5, page 14.

Applications

The layered IP-based NGN architecture enables competition at every level of the network. At the same time, it is not clear that network operators will permit such competition. NGN, and especially IMS-NGN, makes it possible either to permit or deny third party access at the application layer. For exactly the same reasons that some operators might choose to impact IP interconnection at the network layer, they might choose to impact interoperability at the application layer. They could do so by intentionally undermining interoperability, or equivalently by intentionally choosing incompatible versions of network standards. Whether this is a regulatory concern is not yet clear – if interoperability at the IP-based Network Layer were good, it might not be essential to also have interoperability at the application layer.

Transitional Issues

Incumbent network operators will typically be subject to a number of regulatory remedies designed to address their SMP. As their networks change, those remedies might no longer be relevant. Regulators will need to somehow strike a balance: enabling the incumbent to migrate their networks without undue hindrance, but at the same time ensuring reasonable notice and transition times for competitors.

Analogous concerns relate to the number of Points of Interconnection used for access and for interconnection, which are likely to be far fewer in an NGN than in the PSTN. There is a legitimate concern with stranded investment on the part of competitors. Again, regulators seem to be striking a balance that in most cases implies reasonable notice, but not compensation to competitors. The incumbent clearly should not be burdened with the cost of no-longer-needed facilities for an unreasonably long period of time.

The European Regulatory Framework

The regulatory framework put in place in 2003 is in our view the regulatory system most capable of dealing with technological and market evolution and convergence. It is a model of best practice. Nonetheless, the transition to NGN poses substantial challenges, not only in the primary mechanisms of the framework (which deal with significant market power, or SMP) but also in regard to obligations that are not linked to SMP.

Market definition, SMP, and remedies

The European regulatory framework comprises three key elements: market definition, determination of market power (SMP), and imposition of remedies on operators that have SMP. In principle, this system is fully applicable to NGNs. At the detailed level, NGNs raise new issues.

First, in an NGN world, there is a potential for competitive bottlenecks at the IP network layer and at the applications layer. The mechanisms of the framework are still applicable, but it may be necessary to use the *three criteria test* to identify new markets that are susceptible to *ex ante* regulation. Second, there are potentially new forms of market power associated with network externalities – these manifest somewhat differently than the traditional market power with which the European regulatory framework concerns itself. Finally, existing remedies may need to be adapted to new situations (for example, unbundling at the street cabinet).

Non-SMP-based obligations

Many of the obligations in the European framework, especially those that appear in the *Universal Service Directive*, are not specifically conditioned on the presence of SMP. Voice over IP (VoIP) access to emergency services is already a regulatory challenge, and it is just as relevant to an NGN. Analogously, lawful intercept (wiretapping), which is a national rather than a European competence, poses special challenges in an IP-based world.

The Hungarian perspective

In this section, we consider the Hungarian market in terms of the services that are available and used, the state of competition, and the plans of major operators.

Services that are available and used in Hungary

The fixed market in Hungary may pose special difficulties as regards market entry. The largest incumbent, Magyar Telekom, provides about 80% of all lines, but four smaller incumbent operators (LTOs) provide the rest. This complicates the situation for new entrants inasmuch as they require interconnection agreement with five operators if they are to reach all households in Hungary.

Cable television penetration, at some 52%, is well above the EU27 average (36%). UPC and MT's subsidiary T-Kábel together have roughly half of the cable television subscribers. They have generally modernized their infrastructure; however, some 400 firms comprise the remainder of the cable television market, and they operate for the most part with obsolescent infrastructure that has not been modernized for increased channel capacity or two way data transmission. Cable operators will not be effective NGN competitors until and unless they modernize their infrastructure.

As with many of the newer Member States, mobile penetration is effectively higher than fixed in Hungary. Fixed penetration is some 38%, and dropping year over year, while mobile penetration is in excess of 92% and growing year over year. One must, however, be cautious in comparing these figures, inasmuch as the fixed phone generally serves the *household*, while the mobile phone serves the *individual*. About two-thirds of Hungarian households have fixed telephone service.

Overall Internet penetration in Hungary lags somewhat behind the European average, apparently due to lack of consumer interest and, to a lesser degree, because penetration is effectively constrained by the number of personal computers, which also lags somewhat. At the same time, the fraction of Hungarian Internet subscribers who use broadband (as distinct from dial-up) is high. While in 2004 the share of Internet access through DSL and cable was less then 50%, by the end of 2006 DSL and cable accounted for more than 75% percent of all access lines. Broadband penetration increased partly due to lower prices (especially if increased bandwidth is taken into account), and partly due to availability to a steadily increasing number of households. At the end of 2004, DSL technology passed 70% of residential users, while broadband capable cable passed 52% of the residences.

The status of competition in Hungary

Competition has been a bit slow to develop in the Hungarian fixed market, but now corresponds to some 10% of usage. This competition reflects (1) carrier select / carrier pre-select services provided to business customers, (2) a range of services offered to consumers, notably be Tele2, (3) triple play services offered over cable by UPC (this last representing about 2% of residential lines), and (4) Vodafone's Otthon, which is a mobile service that effectively competes with fixed line offerings.

For broadband, competition between cable and DSL has resulted in both lower prices and higher bandwidth. Cable operators provide roughly one-third of broadband lines. Service-based competition using IP-based bitstream access is effective, and represents about a fourth of Hungarian DSL broadband. At the end of 2006, the NHH implemented new rules that should greatly facilitate the ability of competitors to use shared access and full unbundled local loops (ULL), but it is too soon to judge the effect that this ruling will have in practice.

Migration to NGN in Hungary

Magyar Telekom (MT) is the only Hungarian service provider that has a more or less well established NGN strategy. Even so, it is clear that NGN related issues at MT are still in the phase of planning and discussion. They are indeed concerned with these issues, but in many cases they have no clear answers, and developments up to now are rather tentative, looking for the most appropriate solutions. In the near future (1-2 years), strategic deployments similar to those of BT or KPN are not expected. NGN development and later the implementation of migration itself will presumably occur gradually over a more extended time frame, and will depend heavily on initial experiences.

MT's strategic direction is (1) to increase broadband access penetration, (2) to use the broadband to introduce and improve NGN-based VoIP service, and (3) to introduce IPTV service.

In the access network, an upgrade to ADSL2 or ADSL2+ is anticipated, which is sufficient to support triple play with IPTV at SD quality; however, more bandwidth would be needed to offer multiple HD channels. It is unclear whether MT's direction in the intermediate term will reflect VDSL versus FTTB/FTTH. In the longer term, the preference for FTTH is clear.

MT is implementing IMS NGN in both its fixed and its mobile operations, but it is using two different vendors, and there is no application for which IMS is indispensable.

Pantel, the largest competitive operator and a subsidiary of the LTO HTCC, has been IP-based from the first in the access network; however, their voice services were initially developed on a PSTN model. They are gradually incorporating VoIP softswitches, but do not envision a near term migration to IMS.

GTS-Datanet, a large competitor, apparently will stay with more traditional network for at least the next year or two.

Actel, a flexible IP-based competitor, currently offers voice and data services and expects to offer IPTV shortly.

All three of these telecommunications competitor depend in some degree on availability of underlying services from the incumbents, and all are anxious for regulatory certainty as incumbents migrate to NGN.

UPC envisions a different migration path, but one that includes triple play, higher speeds, and full competition with NGN-based telecommunications providers.

Summary of recommendations

Inasmuch as migration to NGN is not yet advanced in Hungary, relatively little is yet required in the way of actual regulation. Nonetheless, there is much that can be done to prepare for the transition, in terms of research and education, fact-finding, internal training, and the establishment of consultative mechanisms with industry and other stakeholders. We have not made specific recommendations as regards continuing to enhance the competence of staff, or continuing to strengthen industry consultation processes, but we emphasize that both are potentially valuable in addressing the changes that are to come.

With that in mind, we recommend the following concrete actions.

Specific immediate regulatory steps

There are a few areas where immediate regulatory initiatives, consistent with European practice and with the emerging 2006 Review of the European regulatory framework, should be considered.

1. NHH should internally review decree No. 345 as it relates to access to emergency services to ensure that it requires VoIP service providers to provide location information to the extent technically feasible (taking account of difficulties with nomadic services). In doing so, NHH should be sensitive to the need to balance the need for consumer safety against the potential harm of impacting competitive entry by needlessly strict rules. Also, NHH should bear in mind the ongoing need for consumer education as regards VoIP. Finally, NHH should respect Commission and ERG/IRG guidelines in this area. In our view, Ofcom's 2006

ruling in this regard represents a good example of best practice. If the internal review concludes that rule changes merit serious consideration, NHH should launch a public consultation.

2. NHH should internally review decree No. 345 as it relates to access to quality of service requirements to determine the degree to which the requirements are reasonably achievable for IP-based services. In doing so, NHH should be sensitive to the need to balance the need for consumer safety against the potential harm of impacting competitive entry by needlessly strict rules. If the internal review concludes that rule changes merit serious consideration, NHH should launch a public consultation.

3. NHH should internally review current requirements for lawful intercept to determine whether they adequately address law enforcement and national security requirements in connection with IP-based services, including VoIP, but keeping in mind challenges to technical feasibility. In doing so, NHH should be sensitive to the need to balance the need for consumer safety against the potential harm of impacting competitive entry by needlessly strict rules. If the internal review concludes that rule changes merit serious consideration, NHH should launch a public consultation.

4. Once incumbent VoIP services emerge, NHH should reflect the services in subsequent market analysis. In this regard, recent French practice is instructive: they treat VoIP delivered over the incumbent's own broadband facilities as being in the same market as other incumbent voice services, but voice over the public Internet as being in a distinct market. This is an appropriate way to respect technological neutrality.

5. Termination fees have been moving downward in Hungary as in other Member States. NHH should maintain downward pressure on termination fees, moving them progressively closer to true marginal usage-based costs. Doing so tends to foster lower retail usage-based prices, and thus serves to encourage use of the network (and thus provides immediate consumer benefits), but the NGN aspect is that it reduces the shock to industry should the termination fees prove unsustainable in the longer term.

6. As new forms of access appear, notably VDSL and/or FTTB/FTTH, the NHH should reflect them appropriately in market reviews, adhering to Commission and ERG/IRG guidance.

Topics that the NHH should study

There are a number of areas where more detailed preparatory work could make sense, such that NHH is well prepared as the transition unfolds.

7. To the extent that incumbents upgrade the access network to reflect new technologies such as VDSL or FTTB/FTTH, or that core networks are upgraded to NGN, the NHH's cost models will need to be updated to reflect the changed characteristics of the network. (Even in the event that network *interconnection* fees were to entirely disappear in a Bill and Keep world, it is likely that there will still be a need for SMP operators to provide *access* at rates that reflect cost.)

8. NHH may wish to develop a more detailed understanding of conditions in the Hungarian market that are likely to affect access competition in a VDSL and/or FTTB/FTTH world. Understanding the geographic distribution across Hungary of the number of MDFs, the number of street cabinets (and thus the number per MDF), the length of loops from the MDF and from the street cabinet, and possibly the availability of ducts and rights of way from parties other than the incumbent could all be useful in understanding the likely evolution of competition, and in responding to future market challenges.

9. NHH may want a more detailed understanding of the relative geographic distribution across the national territory of wired telephony services and of cable television services. What areas have access to zero, one, two, or three or more full facilities-based alternatives? This is relevant both to universal service and to competition.

Topics that the NHH should monitor

There is a great deal that can be learned by observing best practice in other countries. In many cases, Hungary can benefit by studying developments in Member States that confront these issues before Hungary must.

10. The NHH should be aware as Hungarian operators begin to deploy NGN in the core network, or VDSL and/or FTTB/FTTH in the access network.

11. The NHH must, of course, monitor the 2006 review process, which will interact with a number of these recommendations in ways that cannot be fully predicted today.

12. The lightweight structural separation agreements that Ofcom and BT have reached represents an interesting and promising but still largely unproven regulatory model. NHH should track developments with Openreach, and with any similar systems that evolve in other countries.

13. NHH should track the evolution of interconnection arrangements in other Member States (and globally) to see if a trend away from CPNP wholesale interconnection payments is emerging, and particularly to see if the movement that some have predicted toward negotiated "Coasian" arrangements (and/or Bill and Keep) is developing. Also, RIOs will presumably evolve if and as IP-based interconnection becomes the norm. The ERG/IRG will likely be a good source of ongoing information.

14. NHH should continue to monitor the take-up of LLU and of other competitive options to ensure an ongoing balance between facilities-based and service-based competition, and the ongoing overall effectiveness of the Ladder of Investment. More generally, the NHH should continue to monitor the state of competition in the markets identified by the Commission as being susceptible to ex ante regulation, and should be generally vigilant as regards the state of electronic communication markets overall.

15. As cable television operators in Hungary gain traction with triple play services (an evolution closely related to that of the NGN), they increasingly become effective competitors to the traditional SMP operators of telephony services. NHH should monitor this evolution and its impact on competition.

16. NHH should monitor the evolution of regulatory arrangements as regards unbundled access to newer fiber-based technologies. For sub-loop unbundling in conjunction with VDSL, developments in the Netherlands and in Germany bear watching. The recent German decision to mandate *competitive access to incumbent ducts* is particularly interesting – access to ducts is a critical factor in the cost of fibre deployment. The work that the French have undertaken in regard to unbundling of FTTB/FTTH bears watching. Again, the ERG/IRG will likely be a good source of ongoing information.

17. It is likely that many Member States will apply bitstream access obligations to the VDSL and FTTB/FTTH offerings of SMP operators. These arrangements are likely to prove to be effective. Given the relatively high use of IP bitstream in Hungary, the NHH should pay particular attention to the emergence and effectiveness of bitstream in connection with VDSL or FTTB/FTTH.

18. The migration to NGN could raise market power concerns either at the Network Layer (IP) or at the Application Layer of the NGN, or both. NHH should monitor experience in other Member States to see the degree to which this in fact develops, and should also be alert, especially during the transition to NGN, to the possibility that it might develop in Hungary.

19. As soon as some incumbent announces a migration to NGN, NHH will have to address questions relating to (1) how long existing SMP obligations should be maintained, and (2) how to deal with stranded investment as the number of POIs is reduced. NHH should monitor developments in other Member States, including the UK, the Netherlands, and Germany.

20. The NHH should continue to monitor developments regarding fixed-mobile convergence (FMC). For many operators, FMC is a driver of the migration to NGN.

21. NHH must of course continue to monitor Hungarian markets as players merge or consolidate.

22. As operators in other Member States migrate to NGN, many will attempt to commercialize the ability to offer different grades of Quality of Service (QoS). Differentiated QoS could be relevant to interconnection and to competition. NHH should monitor developments.

23. During the transition period to NGN, other Member States will have to deal with cost-based prices in a context where prices are first increased due to the need for parallel operation, then presumably decreased due to the benefits of NGN technology. NHH should monitor the approaches taken by other NRAs, including Ofcom, to cost modelling and price-setting in this transitional context.

24. NHH should monitor the ways in which other countries, in Europe and around the world, adapt their universal access and universal service policies as NGN and other IP-based services become increasingly prevalent.

Preface

This report is delivered pursuant to a contract executed on January 15, 2007 between the Hungarian telecommunications regulator Nemzeti Hirközlési Hatóság (NHH) (Budapest) and a consulting consortium consisting of WIK-Consult GmbH (Bad Honnef, Germany) and Infrapont Kft. (Budapest).

The kick-off meeting with the NHH took place in Budapest on January 17, 2007. Two Interim Reports have been submitted and presented to NHH in the beginning and at the end of March 2007. The consulting team also met with the NHH on five separate occasions to conduct workshops in the interest of knowledge transfer.

The present document is the Final Report. The structure of the Final Report reflects the original Terms of Reference, with minor modifications as agreed in the course of the many discussions between the WIK-Infrapont team and the NHH.

The main authors of this report are Dieter Elixmann, Antonio Portilla Figueras, Klaus Hackbarth, Scott Marcus, Péter Nagy, Zoltán Pápai and Mark Scanlan. We also express our deep appreciation for assistance and support from colleagues too numerous to name at WIK-Consult and at Infrapont.

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We greatly appreciate the many helpful questions, suggestions and comments that the NHH provided, but the authors take responsibility for any errors or omissions.

1 Introduction

Next Generation Networks (NGN), broadly speaking, denote current developments in the communications service provision industry to migrate the network infrastructure to new technical standards. Migrating to NGN in practice can have several different meanings and many market players – e.g. fully integrated traditional fixed-link carriers, mobile carriers, Internet Service Providers - are involved in this migration process.

In this very general sense the term NGN comprises elements of a new technology, it is a concept for the future provision of electronic communications services and it is also related to standardization. All of these different facets will be addressed in this study.

Technical progress and its implementation is not a new phenomenon in the communications services industry – think of the migration from manual "switching" to Strowger automated electromechanical switches, the transition from traditional PSTN to ISDN, the transition from analogue to digital, the transition from Plesiochronic Digital Hierarchy (PDH) to Synchronous Digital Hierarchy (SDH), the establishment of different data transmission networks (like Frame relay, ATM), the use of fibre as physical infrastructure, to name a few. All of these developments have to some extent changed the architecture of networks, service portfolios, costs, and the inherent economics of service provision. However, none of these technical developments ever had such a wide-ranging impact on the industry as the migration towards NGN will have.

Inherent in the deployment of NGN technology is the final objective of having a unique network platform on the basis of which *all* communications services and applications can be provided.

NGNs will not only change the underlying technological basis of communications services provision, rather they are going to change more or less disruptively value chains, business models, and competition and regulatory policy in the communications service sector.

NGN not only has a fundamental importance for communications carriers, but will also have substantial impacts on the business processes within companies. Indeed, VoIP, unified communications, fix-mobile convergence, Service Oriented Architectures (SOA) etc. are crucial factors shaping the competitiveness of IT infrastructures of the business sector, and thus also of the companies in the market. Viewed from a (macroeconomic) investment and productivity perspective migration to corporate NGNs presumably will be very important. Yet, even though there might be also regulatory impacts brought about by such a migration they are not that clear so far and they have not been mentioned in the current NGN regulatory discussion. Thus, the present report is exclusively confined to relevant NGN aspects regarding public networks and carriers.

To shed light both into the technical developments and into the implications for the communications services markets at large as well as the players in these markets is the central topic of the present study. The main objective is to analyse the implications for competition and regulatory policy.

The academic and policy discussion of issues surrounding Next Generation Networks (NGN) is not new. Indeed, aspects regarding VoIP have been a key theme for several years.[2] On both sides of the Atlantic, competition policy aspects of an IP world played a vital role in the treatment of the mergers of Worldcom and MCI as well as of Worldcom and Sprint.[3] Institutions like the ITU have analysed in detail aspects of interconnection in an IP world.[4] As early as 2003, the European Commission had commissioned studies concerning NGN topics.[5] Many National Regulatory Agencies (NRAs) in Europe have dealt in one way or another with NGN topics. Examples are OFCOM in the U.K., OPTA in the Netherlands and BNetzA in Germany. This study will in particular anyalse the stance towards NGN of these and other regulatory institutions. Moreover, it is worth noting that not only in Europe but also in many countries outside of Europe, NRAs have already focused on NGN issues. Examples are Japan[6], Australia[7] , and India.[8]

NGN and related technologies are also on the agenda of several standardization organizations, like e.g. ITU, ETSI (TISPAN), and 3GPP. The main contributions of these bodies regarding NGN are addressed in section 2.3.

As required in the terms of reference, the key objectives of the study are to thoroughly

- examine the drivers and consequences of the paradigm shift,
- highlight alternatives of the development of NGNs,
- analyse the issues of the NGN technology components relevant to regulation,
- determine the instruments of regulation and outline possible regulatory alternatives.

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2 See, for example, the European Commission (2004); the European Regulators Group (2005); FCC (2005a); Ofcom (2006); Marcus (2006a), and IEEE Communications Magazine, August, available at http://www.comsoc.org/livepubs/ci1/public/2006/aug/cireg.html.

3 See *"Justice Department Sues to Block Worldcom's Acquisition of Sprint"* at http://www.usdoj.gov/atr/public/press_releases/2000/5049.pdf. The complaint is available at http://www.usdoj.gov/atr/cases/f5000/5051.pdf. For a deeper theoretical discussion see Cremer, Rey, and Tirole (1999) and Malueg and Schwartz (2001).

4 See Marcus (2006c).

5 See Cullen International and Devoteam Siticom (2003) and Political Intelligence (2003).

6 The NGN policy of the Japanese regulator will be outlined in more detail in section 2.4.2. of this study.

7 Reference is made to the work undertaken by the Australian Communications Industry Forum (ACIF) in their 2002-2004 Next Generation Networks Project, see www.acif.org.au/projects/previous/ngn; and also to the work of the National Broadband Strategy Implementation Group Working Party on NGN, see www.dcita.gov.au/communications_for_business/broadband_and_internet/national_broadband_strategy/.

8 See Telecom Regulatory Authority of India (2006). The study focuses on the following topics: background relevance and impact of NGN, the need for awareness building, enabling policy and licensing framework, facilitation of regulatory initiatives, technical and standardisation issues, and the need for cross-industry and regulatory collaboration.

The main issues to be addressed in this study include:

- Empirical evidence: What is actually going on in the markets with regard to deployment of NGN and related technologies?
- Technology: What are the main technological developments regarding NGN and and related technologies where the particular focus is on those features which are (or might become) relevant for regulation?
- Market power: the degree to which it is relevant to NGNs, the risk of the emergence of new forms of market power, and the implications for regulation going forward.
- The regulatory implications of fundamental changes in the value chain.

From a methodological perspective, the approach in this study rests on results of a wide range of national and international studies and information sources as well as several interviews with experts from market participants.

The study is organized in five chapters. Chapter 2 focuses on general developments in the communications sector and stresses facets of the paradigm shift under way, different NGN architecture models, basic characteristics of the so called IP Multimedia Subsystem, and international examples regarding NGN regulation. Chapter 3 is devoted to a detailed analysis of the technological basis of NGN. In this chapter, we address both the likely changes regarding the architecture of the NGN core network and the NGN access network as well as elements of NGN service control. Issues addressed with regard to the latter are flexibility and mobility of services, nomadicity, network security, billing, Quality of Service, and presence and location. Chapter 4 is concentrating on regulatory tasks and instruments, thereby analyzing (among others) the basic regulatory implications of the paradigm shift under way, NGN and security, NGN and network access, NGN and network interconnection, NGN and network interoperability, NGN and "network neutrality, universal service issues, and NGN and the present EU regulatory framework. Chapter 5 deals with possible regulatory alternatives. The analysis in this chapter will be based on the findings in the previous chapters and will contain the most valuable results and suggestions. This chapter will address both theoretical issues of NGN regulation (in particular regulation of new and emerging markets, regulation in view of different migration strategies towards NGN and different (competitive) market structures) and the management of the transition period. The final chapter 6 considers the specific Hungarian perspective regarding NGN. This chapter discusses the implications for domestic regulation in view of the current and foreseeable market structure, different NGN migration strategies of market players, and different phases of NGN presence in the Hungarian communications markets. Moreover, the relationship between NGN regulation at the domestic and the EU level is addressed.

2 General developments in the communications sector

This chapter highlights the most important basic and general issues relating to NGN. It iis devoted to current and foreseeable developments shaping the paradigm shift underway in the communications markets. The chapter is mainly based on the evaluation of actual trends regarding the positionining of stakeholders in the communications market (in particular telecommunications carriers, other carriers, service providers, manufacturing industry, regulatory agencies) vis-à-vis migration towards future networks. It, thus, lays the foundation for the subsequent chapters where particular technological issues are addressed in more detail as well as the upcoming regulatory issues and options for regulatory policy.

In particular this chapter will address the relationship between NGN and IMS.

2.1 The paradigm shift under way

In this section we highlight different technological, economic and market, as well as regulatory facets of the paradigm shift.

2.1.1 Technological drivers of the paradigm shift

This section addresses technological drivers of changes in the communicatons industry. In this respect carriers and manufacturing industry alike are involved in this process.

Several developments, sometimes more than two decades old, have had an influence on the current shift towards NGN and ALL-IP:

- Success of the Internet (TCP/IP),
- Development of suitable protocols to provide packet based voice communication (H.323, SIP),
- Development of broadband access technologies (fix, mobile, fixed-wireless),
- Development of MPLS (Multiprotocol Label Switching; level “2.5”), Dense Wavelength Division Multiplexing (DWDM) in the physical layer,
- Development of Ethernet technologies beyond the LAN,
- Developments in terminal equipment,
- Digitalization of media,

- Convergence of IT and TC: not only infrastructures/technologies for voice and data converge, rather, ntegrated applications emerge supporting the business processes in companies (to make workflows more efficient and productive).

In keeping with these driving forces the communications services sector has experienced already since several years some deep-rooted changes:

- Substitution of traditional PSTN class 5 and class 4 switches, implementation of softswitch technology or Media Gateway Controler and Access and Trunk Media gateways, resulting from the ITU NGN concept,
- Migration of core networks to ALL-IP/MPLS (Multiprotocol Label Switching) often in conjunction with implementing Dense Wavelength Division Multiplexing (DWDM) in the physical layer); this migration is carried out both by fixed-link carriers and by mobile carriers,
- Implementation of Pre-IMS (Internet Multimedia Subsystem) technology, under a hierarchy of proxies named Call State Control Functions (CSCF) resulting from the standards defined in the 3GPP,
- Deployment of “deep fiber solutions” in the local loop (Fiber to the cabinet, curb, premise, building, home etc.),
- Deployment of Giga- and Metro-Ethernet as the layer 2 transport technology in the aggregation and backhaul network (i.e. those parts of the network between the end-points of the local loop and the PoP from the IP-core),
- Provision of VoIP, IPTV Broadcast services via Ethermet or IP DSLAM,
- Fix-mobile convergence,
- Implementation of universal access wireless (WiFI, WIMAX ; GSM, UMTS-HSPDA) and wired (xDSL, Cable modem, PON) solutions against the backdrop of fixed-mobile convergence.

To cut a long story short: Many communications carriers - incumbents and competitors alike - all over the world are currently investing in NGN technology. In a recent report submitted to the German Ministy of Economics and Technology the authors point out that there are basically two different approaches to migrate from the current network world to a unique next generation multi-service network[9]:

9 See Pohler, Beckert and Schefczyk (2006).

- On the one hand carriers can follow a piecemeal approach to migrate to a NGN. To this end hybrid network elements are implemented containing upgrade options for broadband data technologies. Thus, a system technology is used which is called „best of both worlds“. Otherwise stated, conventional PSTN technologies are utilized in parallel to modern IP components. These systems often are NG-SDH-(Next Generation Synchronous Digital Hierarchy) based, i.e. the network elements are linked over SDH technology and they work internally with virtual containers provided by the so called “Generic Framing Procedure GFP”[10]. Within the SDH-framings unique virtual containers are reserved either for voice services or for packet oriented data services. In this case the operator can rely on already existing and paid-for network technology. Some of these systems are even capable of offering a multitude of new services like Voice over DSL or Voice over to be clarified.

- The second migration variant rests on the establishment of an end-to-end IP infrastructure. This variant is used in particular in greenfield situations, e.g. if new living areas are constructed and it rests on real next generation broadband systems. The sytem technology underlying this variant is called Multi-Service Access Node (MSAN) or Access Hub (AXH). Conventional wisdom tells that this solution is better, faster, and more cost efficient than the piecemeal migration. In the final stage of such an NGN access network the traditional narrow band world only plays a minor role and it is utilized only for some exotic services.

Usually the first step of the migration towards an end-to-end IP based network is the transition of the backbone (core) network. Indeed, many carriers in the world have already finalized this transfer. However, the network technology in the access networks often rests heavily on the traditional PSTN technology. Nonetheless, in many countries of the world carriers are underway to deploy fiber optic technology “nearer” to the end user. Moreover, a new breed of services is evolving combining fixed-link services with mobile services e.g. by offering handsets and respective services for the end user which function as Wifi-based VoIP where Fixed Wireless Acess technology is available and as usual GSM-based mobile service otherwise.

2.1.2 Market drivers of the paradigm shift

This section addresses the main driving forces in the telecommunications services markets regarding the paradigm shift. Thereby we focus both on the carrier (i.e. service provision) and the manufacturing industry.

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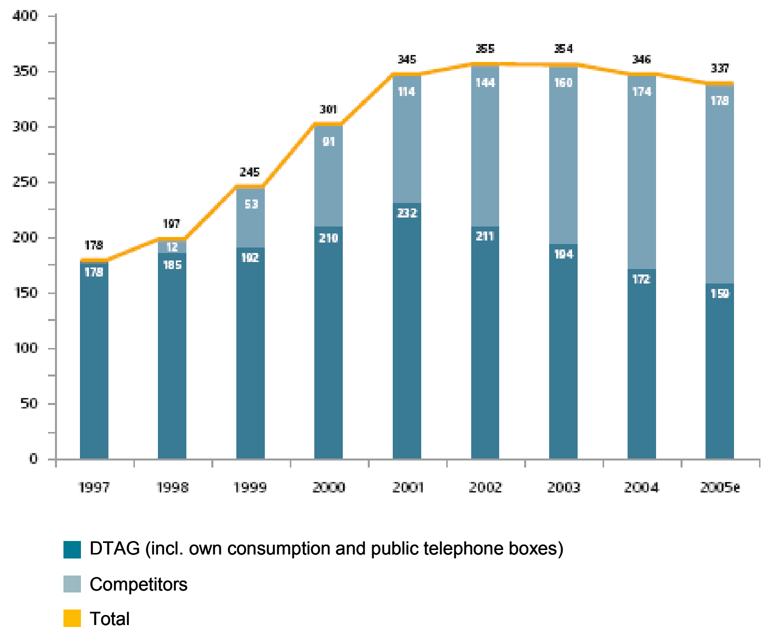
10 For an introduction into the concept of NG-SDH see Kartalopoulos (2004).

2.1.2.1 The perspective of carriers

It is obvious that the players in the telecommunications services industry, in particular the fixed-link carriers, are currently experiencing various challenges concerning their traditional business model.

The established revenue base is eroding. Indeed, in many markets not only the growth rate of fixed-link minutes (for telephony, Internet dial-up) is decreasing, rather, also and in particular the absolute number of minutes. An example is shown in Figure 4.

Figure 4: Development of fixed-link minutes (for telephony, Internet dial-up) in Germany (in billion)



Source: BNetzA (2006); Jahresbericht 2005

Moreover, pricing structures are more and more developing towards flat rate regimes.[11] Intramodal competition is increasing. “Imitators” becoming stronger vis-à-vis incumbents, i.e. they operate more efficiently and, based on greenfield approaches, they can implement the latest technologies. Moreover, voice services are today provided by ITSPs and (not necessarily facilities based) broadband providers. Intermodal competition is heating up due to the players from the cable industry. Fix-mobile substitution is taking place, i.e. traditional PSTN calls are substituted by mobile calls and households

11 See e.g. Schäfer and Schöbel (2006).

are becoming mobile only households, i.e. do not have access to PSTN dial tone anymore.

These factors are not necessarily distinct from each other, rather, they are showing different facets of developments going on in the market, thus, changing the "basic economics" of the facilities based, PSTN/broadband access oriented business model. In total the developments mentioned lead to pressure to reduce costs and the necessity to find an appropriate positioning in converging market environments ("triple play", "quadruple play").

Evaluating carrier information as well as consultant reports yields the following elements to be most important for NGN deployment.

- Costs: The argument is that NGNs allow for greater cost efficiency, i.e. although the CAPEX is higher (but for a limited time) OPEX is lower (but "forever"). In particular it is argued that NGN simplifies networks and as they also are being consistently based upon IP protocols, total costs fall and capacity increases, thus, unit costs are decreasing.[12] Some authors stress that the (All-)IP infrastructure allows operators to better control OPEX by moving all services over an IP network.[13] However, we would like to stress that it needs further analysis if the OPEX reduction alone in any case justifies the implementation of IMS-NGN.[14]

- New services and applications: this argument has several facets. First, there is a capital market perspective: each fixed-link carrier is in desperate need for a new "growth story". Second, there is an end user perspective: carriers can provide their customers with higher bandwidth and more/better services. Third there is a market perspective: For operators, so the argument, NGN allows services and transport in the network to be separated and to evolve independently. Thus, development of content and services will speed up and this will benefit the whole industry.[15]

- Faster time-to-market: This is particularly important from an intra-modal competition perspective, i.e. some carriers are implementing NGN technology sooner than others in order to get a competitive advantage.

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12 See.e.g. Cave, Prosperetti and Doyle (2006).

13 See e.g. ABI Research (2007) who point out: "As we move to the end of the decade, bandwidth-hungry services such as IPTV will need an IP infrastructure to support them. Operators will also want to control operating costs by moving all services over an IP network…This will enable deployment of service delivery platforms and IMS (IP Multimedia Subsystem) in the network, streamlining operations and allowing new services to be introduced quickly." http://www.abiresearch.com/abiprdisplay.jsp?pressid=807; press release February 8.

14 It could very well be the case that a "killer application" is required causing a corresponding traffic increment which compensates the CAPEX. Two caveats are worth noting: first, cost may well be higher, not lower, during an extended period of parallel operation. Second, similar predictions were made a decade ago about ATM – it would be universally adopted in order to reduce costs through economies of scope and there would be a "radical simplification" of the network. ATM saw reasonable levels of use, but failed to achieve anything like universal acceptance. Thus, it is our understanding that one should be careful not to be too hasty in accepting the analyst predictions.

15 See ABI Research (2007), op. cit.

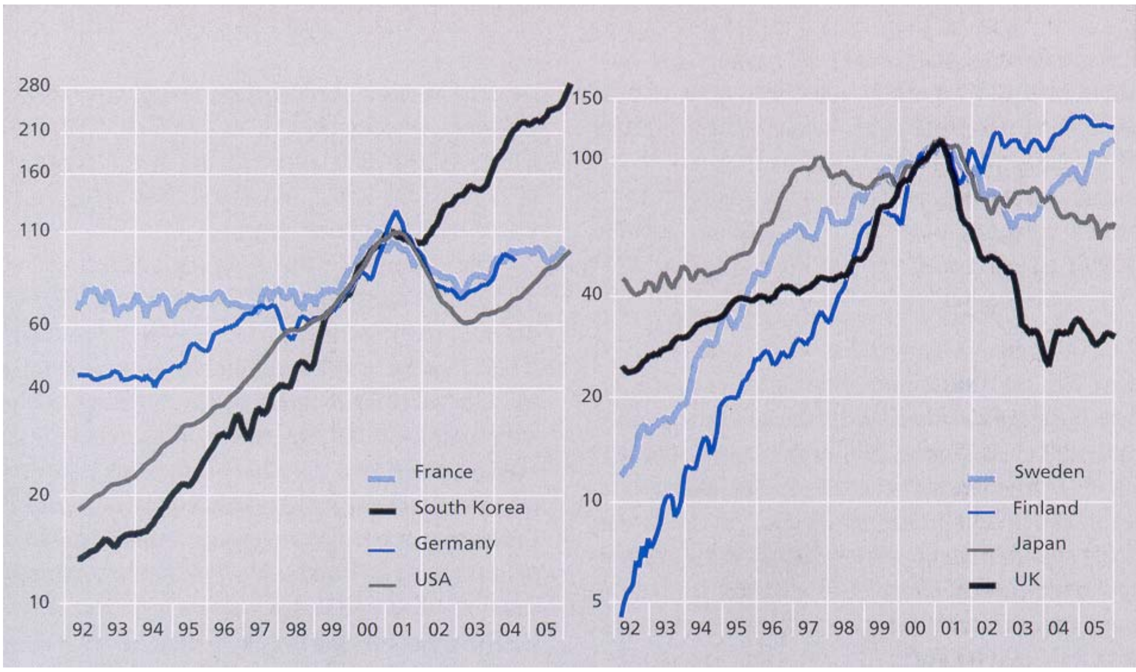
2.1.2.2 The perspective of the communications hardware and software industry

This section addresses changes underway in the worldwide communications hardware and software industry. It aims at clarifying their significance regarding the basic economics and the competitive landscape in the communications markets in general and with regard to NGN in particular.

Empirical evidence world market volume

The boom and bust phase of the second half of the 1990s and the first years after the new millennium can be seen both in the communications service industry and in the communications manufacturing industry. Figure 5 shows the industrial production of communications equipment in different countries for the period 1992 – 2005.

Figure 5: Industrial production of communications equipment in different countries (1992 – 2005)



Source: Rexecode in: IDATE DigiWorld 2006[16]

16 The graphs in this figure have been normalized to the value of 100 in the year 2000.

The figure shows that all of the observed countries have experienced a more or less sharp decline in industrial production. However, one can also see that different countries (or better said the manufacturers in these countries) have had different success in adapting to the new market situation brought about by the dotcom bust. ICT hardware production is back on the rise in all industrialized countries in the past years. However, the most spectacular gains have happened with the manufacturers in South Korea, Sweden and Finland. These countries exhibit a higher production level in 2005 than during the boom in 2000-2001. All other countries, however, have not reached the production levels in previous years.

Internationalization and globalization

The communications manufacturing sector is about to become a global market. Several facets underline this assertion. First, established (often nationally motivated) relationships between carriers and manufacturers of the old monopoly days have eroded. Second, carriers today are globally sourcing, i.e. purchasing network equipment from manufacturers on a worldwide scale. Third, market entry of Asian firms, in particular from China (like Huawei and ZTE), has taken place. These manufacturers have caught up and are able to deliver world class technology, especially in the field of NGN and IMS. In particular, these manufacturers operate on a cost level much lower than that of incumbent Western manufacturers. Fourth, R&D is more and more international, i.e. the big manufacturers in the world as well as the biggest software companies more and more are internationalizing their R&D resources. In this context the People's Republic of China becomes more and more important.[17] The rationale for this is e.g. the large domestic market, access to the (still relatively inexpensive but highly educated) researchers (and research institutions and universities) and the Chinese policy requiring domestic R&D presence and cooperation with domestic research institutions, respectively, if one wants to be a supplier in the Chinese communications industry.

Bellheads vs. Netheads

The key portfolio of the old guys of the PSTN world (the *Bellheads* focusing on switching technology, private branch exchanges etc.)[18] is at the end of the maturity phase. A new breed of companies focusing on IP technology (the *Netheads* providing routers, bridges etc.) have entered the market.[19] As "everything becomes IP-based" knowledge and expertise regarding IP technology becomes a core asset. So the need for the bellheads arises to re-invent themselves. They have done this in the past years through acquisitions with more or less success.

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17 See e.g. Elixmann and Stappen (2003).
18 Examples are Siemens, Alcatel, Lucent, Nortel, Ericsson.
19 Examples are Cisco and Juniper.

Appropriation of knowledge regarding IPTV know-how

Manufacturers (both bellheads and netheads) are currently expanding their knowhow in the field of Video-On-Demand and IPTV. One prominent example is Cisco. Cisco has been very active and it has acquired in the past two years several companies like e.g. Scientific Atlanta (provides e.g. set top boxes), SyPixx Networks (provides network-centric video surveillance software and hardware), Arroyo Video Solutions (provides software designed to help cable operators and phone companies deliver a more flexible video-on-demand service) and Five Across (a software developer of 'social networking' technologies that allows businesses to create 'MySpace-like' communities on their web-sites). Another example is the announced acquisition of the Norwegian company Tandberg Television by Ericsson.

Changing division of labour between carriers and manufacturers

Both in the traditional PSTN and in the mobile world the division of labour between the carriers and the manufacturing industry has been clear-cut. The manufacturing industry virtually has been responsible for Research and Development[20], producing the respective goods (facilities, devices etc.) and selling them to carriers. The carriers, in turn, have been responsible for network planning, operation, maintenance etc. of the networks. This division of labour is, however, changing. In particular in the mobile sector carriers are beginning to outsource activities which previously have been part of the core assets. These activities, in particular regarding network operation and maintenance, are taken over by manufacturers whereas ownership of the network remains with the carrier. Examples are the UK, Italy and Spain where e.g. Ericsson has been awarded respective outsourcing contracts. Just recently Germany’s number three mobile netwok provider, e-plus, has followed suit by outsourcing the network to Alcatel-Lucent.

Concentration

Currently, a new concentration wave in the communications manufacturing industry is observable. Prominent examples in the recent month have been the merger of Alcatel and Lucent as well as the cooperation of Siemens and Nokia. Table 1 provides an overview of the most important mergers and acquisitions in 2006.

20 There are exceptions where telecommunications carriers also are involved in R&D, in particular with respect to basic R&D, on a larger scale. Examples are France Télécom and NTT. In this context it deserves to be noted that obviously Hungary has the oldest Telecommunications Research Centre in Europe, founded in 1891; see Sallai (1991).

Table 1: Top 20 Electronics Merger and Acquisistions in 2006

Rank	Value ($ mill)	Target Name	Target Business Description	Acquirer Name	Acquirer Business Description
1	30,000.0	Siemens: Carrier-related business	Telecommunications	Nokia: Networks Business Group	Telecommunications
2	13,400.0	Lucent Technologies	Telecommunications	Alcatel	Telecommunications
3	6,100.0	American Power Conversion	Power supplies	Schneider Electric	Electrical equipment
4	5,400.0	ATI Technologies	Semiconductors	AMD	Semiconductors
5	4,500.0	Mercury Interactive	Computer software	Hewlett Packard	Computer hardware and software
6	4,000.0	Agere Systems	Semiconductors	LSI Logic	Semiconductors
7	3,900.0	Symbol Technologies	Electronic equipment manufacturer	Motorola	Electronic equipment manufacturer
8	3,748.4	Quanta Display	Computer display manufacturer	AU Optronics	LCD panel manufacturer
9	2,100.0	RSA Security	Security software and hardware	EMC	Storage hardware and software
10	1,900.0	Redback Networks	Telecommunications equipment	Ericsson	Telecommunications equipment
11	1,650.0	YouTube	Online media service	Google	Internet search service
12	1,600.0	FileNet	Computer software	IBM	Computer products and services
13	1,547.6	msystems	Data storage	SanDisk	Data storage
14	1,360.0	SSA Global	Computer software	Infor	Computer software
15	1,350.0	Digital Insight	Online banking services	Intuit	Computer software
16	1,300.0	Internet Security Systems	Computer software	IBM	Computer products and services
17	1,300.0	Intergraph	Computer software	Hellman & Friedman, other investors	Investor group
18	946.7	Toshiba Ceramics	Semiconductor materials	Carlyle Group, Unison Capital	Investment firms
19	928.0	Premier Image Technology	Photographic equipment manufacturer	Hon Hai Precision Industry	Contract electronics manufacturer
20	882.0	Huawei-3Com	Computer networking equipment	3Com	Computer networking systems

Source: Thomson Financial; Reed Business Information

Implications

A single manufacturer today faces severe challenges regarding his business model and his core (strategic) assets. These challenges can best be summarized by Porter's "Five Forces" model. This model provides a framework for a company in a given market to highlight the strategic challenges and opportunities to develop an edge over rival firms.

The five forces are: competition within the market (rivalry), supplier power, buyer power, threat of substitutes, and barriers to entry.

Indicators of supplier power are e.g. supplier concentration, switching costs of firms in the industry, and the presence of substitute inputs. Indicators of buyer power are e.g. brand identity, price sensitivity, product differentiation, and substitutes available. Indicators mirroring the threat of substitutes are e.g. switching costs and the buyer inclination to substitute. Indicators of barriers to entry are e.g. absolute cost advantages, proprietary learning curves, economies of scale, brand identity, and proprietary products.

The preceding discussion has made clear that many of these indicators have changed in the past years or are currently changing in the communications manufactuiring industry. Manufacturers need a new growth story, they need to cope with a severely intensifying competition within the market, the value of preceding strategic assets in the market is eroding due to new competitors and technical progress, and the "market power distribution" between buyer's side and supplier's side is changing.

To sum up, it becomes clear that (migrating carriers to) NGN can be viewed as a crucial vehicle to establish new competencies and competitive edges in the market.

2.1.3 New business models

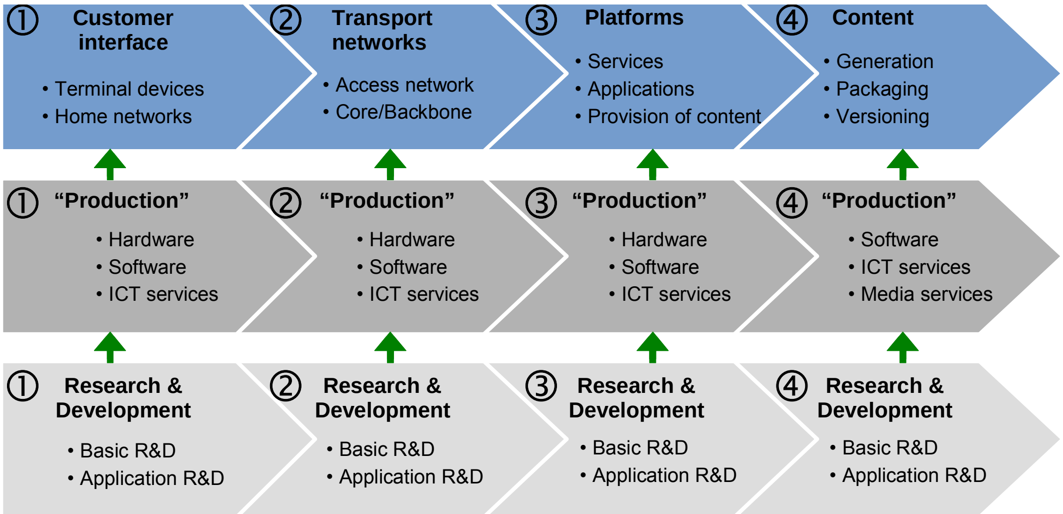
This section aims at illustrating possible new business models in the communications services markets and their effects on the business portfolio. We address these issues by the concept of functional value chains. A functional value chain classifies the main stages that are relevant for the overall provision of a product, service or application.

2.1.3.1 General perspective

Figure 6 provides a general concept. From a vertical perspective there are three layers: provision of products, services and applications (upper layer), manufacturing (the middle layer), and Research and Development (lower layer). With respect to the provision of (converged) electronic communications products, services and applications there are four stages:

- The customer interface, covering the provision of terminal devices or software, home networks etc.,
- Transport networks, covering access and core networks,
- Platforms, where content is actually delivered (e.g. provision of value added services; provision of services by "Google" and the like) and
- The actual content itself, covering creation, packaging, and versioning.

Figure 6: Functional value chain for the communications market: Stylized facts



Source: WIK-Consult

Telecommunications carriers traditionally have their hometurf in the area of transport networks and to some extent regarding the operation of platforms. Due to the convergence of technologies, products and services, as well as markets telecommunications carriers face the challenge to position themselves on this new enlarged value chain. It is still an open issue how far this strategy has to lead "to the right", i.e. by migrating into the platform and content business.

2.1.3.2 Already observable changes in the provision of communications services

This section deals with changes in the business models for the provision of communications services that are already observable today. We focus on the provision of

- Traditional voice services,
- Voice over IP (VoIP).

Figure 7 shows the development of business models regarding the provision of voice services and visualizes in particular where fixed mobile convergence (FMC) takes place.

Figure 7: Provision of voice communications “yesterday” and “today”

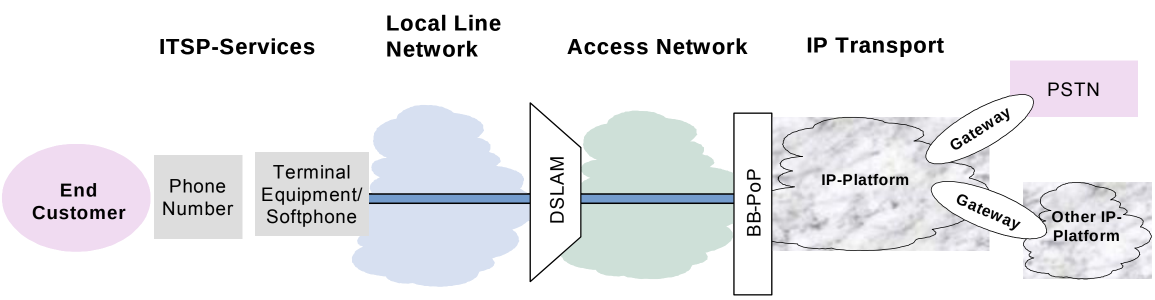
	Medium of transmission	Terminal “devices“	Operators		
Yesterday	Fixed link network	▪ Based on cords ▪ DECT etc.	Fixed link incumbent	Access prov., call by call	Reseller
	Mobile network	▪ Mobile phone	Mobile network operator	Service providers	
Today	Fixed link	▪ Based on cords ▪ DECT etc.	Fixed link incumbent	Access prov., call by call	Reseller
			FMC		
	Mobile network	▪ Multi functional mobile phones 2G, 3G, HSDPA ▪ Smartphones ▪ Dual Phones ▪ PDAs ▪ …	Mobile network operators	Service providers	„No-frills“ providers
	Internet	▪ IP phones ▪ Softphones ▪ VOIP-routers	Variety of business models		

Source: WIK-Consult

The figure shows, that there is already today a multitude of new players providing telephony services and a changed division of labour. Moreover, regulation and competition have created a wholesale market for network services.

Figure 8 is to focus on the provision of VoIP services.

Figure 8: Stylized facts regarding the provision of VoIP



Source: WIK-Consult

Against the backdrop of this figure one can define a multitude of more or less facilities based VoIP business models, provided under different QoS parameters ranging from a PSTN/ISDN quality standard (G.711) up to services without any determined QoS. Examples in the German market are:

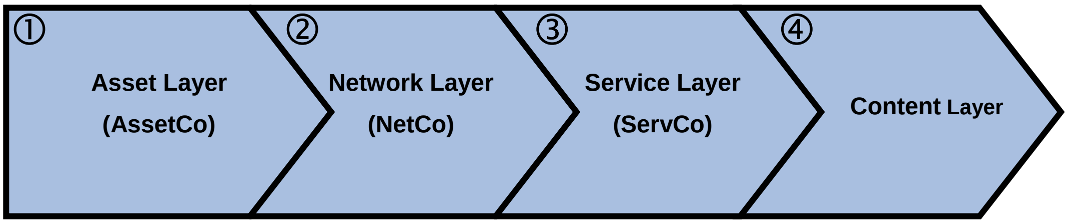
- Fully-fledged infrastructure based provider, VoIP services bundled with broadband access based on fully owned network access facilities and Internet access; objective: full replacement of traditional PSTN incumbent access.
- ISP; VoIP services bundled with broadband access and Internet access; broadband access based on T-DSL resale product by DTAG; customer is contractually obliged to keep his PSTN access line with DTAG.
- ISP; VoIP services bundled with Internet access; prerequisite: DSL access line from DTAG.
- ISP; separate provision of VoIP services; partly bundling with own broadband access facilities and Internet access, however, VoIP offering also for other customers; prerequisite: Broadband access and Internet access of any provider.
- Service Provider; separate provision of VoIP services; services are identical with the services in the preceding category; main difference: the provider is not an ISP.
- „Skype"; pure VoIP offering; prerequisite: broadband access and Internet access of any provider.

2.1.3.3 Disaggregated model of future service provision[21]

In the old days of telecommunications service provision the network operator was also and in particular the entity which deployed and owned the network infrastructure. In the future ALL-IP based NGN world this need not be the case anymore. Figure 9 highlights the stylized facts of such a world.

21 This sections rests on Doeblin, Dowling and Naraghi (2007).

Figure 9: Alternative value chain within broadband delivery



Source: On the basis of Doeblin, Dowling and Naraghi (2007)

This value chain comprises four stages (viewed from the right):

- Content,
- Service,
- Network,
- Assets.

It is obvious that this value chain has some similiarities with the respective value chain presented in section 2.1.3.1.

The content layer comprises mainly generation, packaging and versioning of content.

Functions to be performed on the service layer (ServCo) are characteristic for the provision of services in a narrow sense, i.e they comprise e.g. brand building (or leveraging existing brands), sales and marketing, product innovation and management, IT delivery, as well as billing and accounting.

Functions to be performed on the network layer (NetCo) are characteristic for the operation of networks, i.e. they comprise e.g. provision of broadband access based on mobile radio, copper, fibre, WBA; back-bone transport and distribution as well as provision of active components (open access platform).

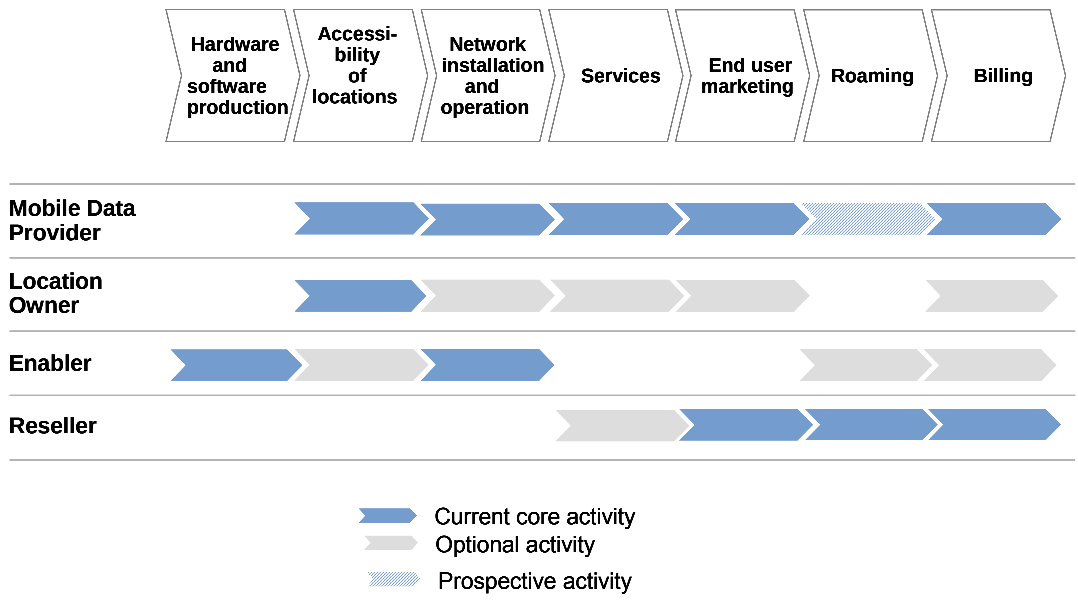
Functions to be performed on the asset layer (Asset.Co.) comprise maintenance and operations of the physical network and ownership of the passive physical infrastructure.

The basic concept behind this value chain becomes obvious if one interprets the functional stages in an institutional way. The main defining concept is that a third party, e.g. an investor or a non-telecommunications company takes on the deployment of network infrastructure and sets up a business model in which this infrastructure is marketed to communications network carriers. The concept of a non-operator based (neutral) infrastructure deployment is already used in many European countries like e.g. in Sweden and France[22] with respect to deploying broadband (i.e. fibre based) infrastructure "nearer" to the customer.

2.1.3.4 Fixed Wireless Access

Figure 10 provides a stylized view on the provision of Fixed Wireless Access services.

Figure 10: Functional value chain Fixed Wireless Access



Source: WIK-Consult

The main players (player groups) regarding the provision of Fixed Wireless Access services are

- mobile data providers,
- location owners,
- enablers, and
- the resellers.

22 For more details see e.g. ART (2005).

Players acting as mobile data providers mainly are mobile network operators, fixed-link operators, big ISPs, and at least sometimes service providers. The business model of a mobile data provider rests on a broad coverage of the value chain, the marketing of system solutions and product bundles in order to embed this into the general company strategy.

Players acting as location owners mainly are operators of airports, hotels, convention centres, gas stations, motorway rest stops, train stations etc. This makes clear that a location owner has his core business outside the Public WLAN and telecommunications carrier market. Rather, activities in the fields of Public WLAN are viewed as as additional service or for marketing reasons (innovative image).

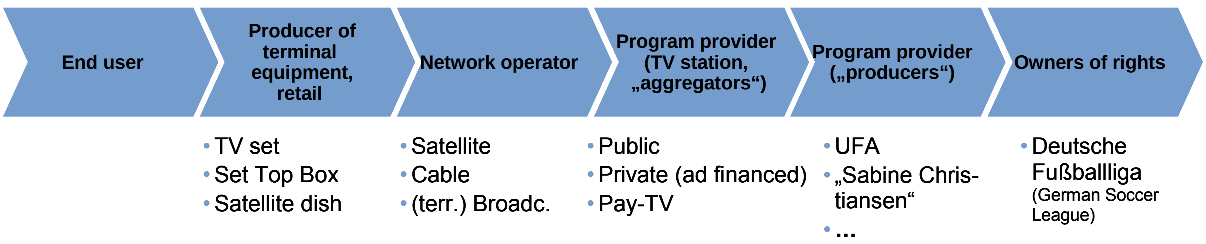
Players acting as enablers mainly come from the IT area or they are ISPs or Start-Ups. The business model of an enabler is heterogeneous. It mirrors primarily a technical orientation with a focus on installation and operation of WLAN, technical solutions, operation of platforms, roaming, and sometimes on billing.

Players acting as resellers mainly are mobile and Internet service providers as well as mobile network operators. Their business model does not rest on facilities based network operation rather on the resale of PWLAN access to own customers under an own brand.

2.1.3.5 Broadcasting

To better understand the changes going along with a migration of telecommunications carriers into the area of triple play, i.e. in particular into IPTV, it is useful to highlight the traditional value chain in the fields of broadcasting, see Figure 11.

Figure 11: Traditional value chain TV production (examples of program providers and owners of rights are taken from Germany)



Source: WIK-Consult

Traditionally, terminal equipment manufacturers, retailers, cable network operators and Pay TV station have a customer (i.e. end user) interface. Moreover, there are a multitude of cooperative and integrated links between program aggregators, program producers and owners of rights. Very often TV stations use the approach of “production on behalf of“, i.e. the TV station is commissioning program production to third parties on the basis of calculated production costs. In reverse all ownership rights are transferred to the TV station.

Against the backdrop of this traditional division of labour the challenge for a telecommunications carrier who is about to migrate into the (IP)TV business is to decide which stages of the value chain he will cover beyond the mere network operation. The crucial issue is to assess the rationale for *integration* of media content (generation, production, aggregation) and communications operation (in a sigle company) of for a *cooperative* solution (i.e. between different companies). It is far too early to make a final assessment of such a strategic decision.

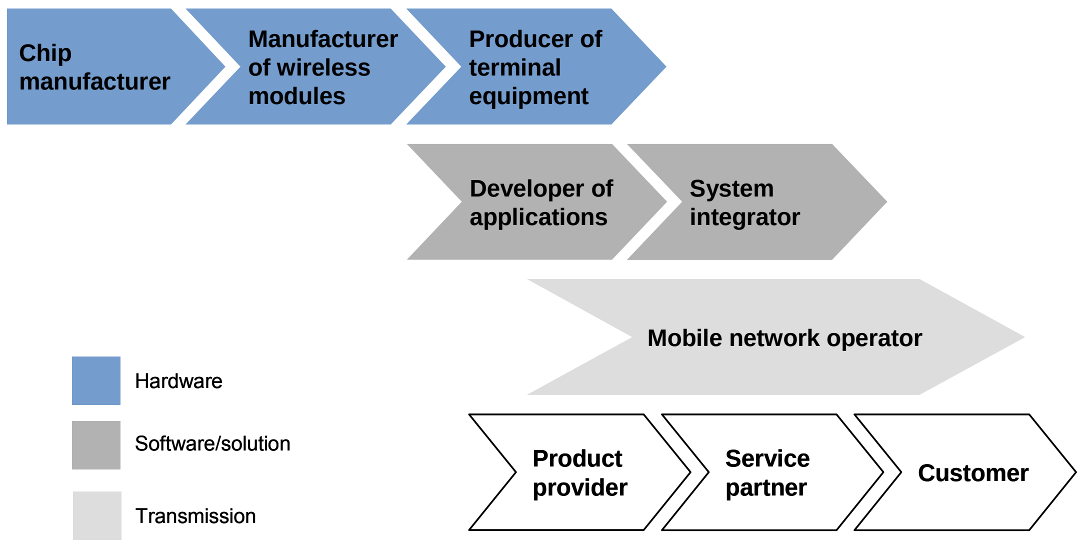
2.1.3.6 Machine-to-machine communication

Figure 12 highlights the stakeholders involved in the area of machine-to-machine communication[23] and their possible interaction. The main stakeholders are:

- Manufacturers,
- Developers of applications and system integrators,
- Mobile network operators.

23 An example is the communication between the product selling machines in the streets and a dispatch centre controlling the status of these machines e.g. with respect to the number of products sold etc.

Figure 12: Value chain machine-to-machine communication



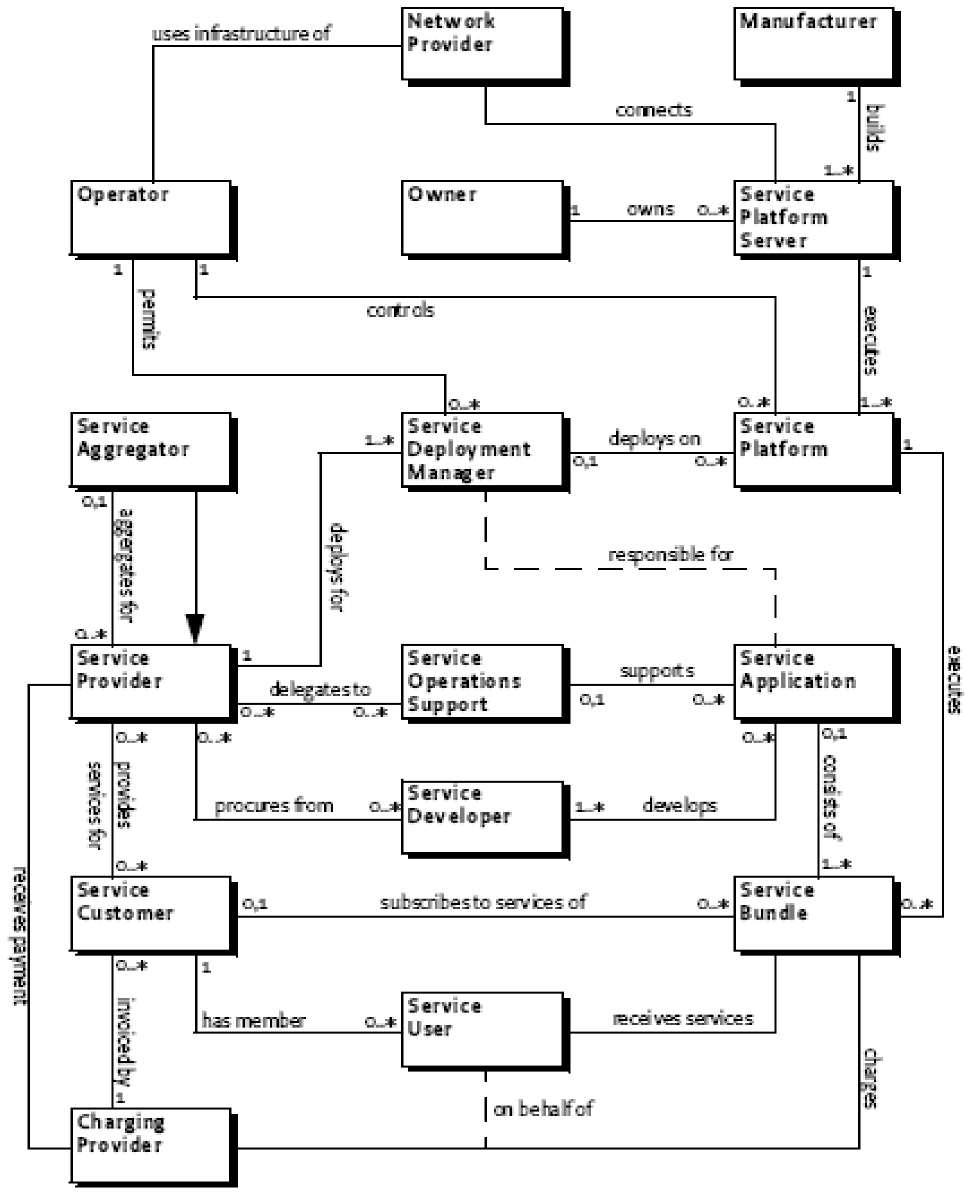
Source: WIK-Consult

2.1.3.7 Provision of ambient home services

Figure 13 provides details about the possible functions/stakeholders that might be involved in the provision of ambient home services. We are referring here to the concept of the Open Systems Gateway Initiative (OSGI).

Figure 13: Value chain home networks/ambient intelligence

- Functional entities und their relationships



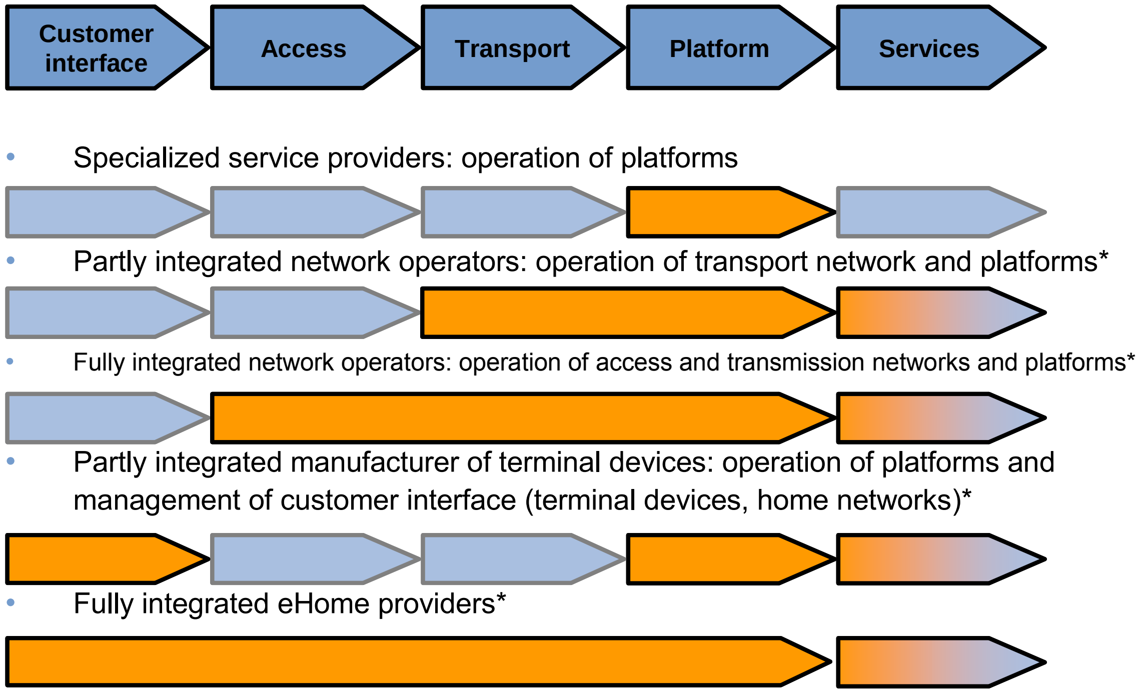
Source: OSGI Service Platform, Release 3, March 2003

The OSGI defines the different functional entities and their roles as follows:

- Service Platform – An instantiation of a Java VM, an OSGi Framework, and a set of running bundles,
- Service Platform Server (SPS) – The hardware that hosts one or more Service Platforms,
- Operator – The organization that is in charge of a number of Service Platforms,
- Service Application – A suite of bundles, documentation, and support software that together form an application that provides a utility to the Service User,
- Service Provider – The organization that procures or develops Service Applications and deploys these applications via a Service Deployment Manager on Service Platforms,
- Service Deployment Manager (SDM) – The system that deploys and partially manages the Service Applications of one or more Service Providers,
- Service Operations Support – Supporting software and hardware that does not reside on the Service Platform Server but is needed to execute the Service Application,
- Service Aggregator – A Service Provider that is responsible for assuring the integrity of service applications from different Service Providers and consolidating them into a single offering,
- Service Developer – An organization that develops Service Applications,
- Manufacturer – The organization that builds a Service Platform Server,
- Owner – The person or organization that has ownership of a Service Platform Server,
- Charging Provider – The organization that receives accounting information and that provides a consolidated bill to the Service Customer,
- Service Platform Identifier – A unique identity for a Service Platform,
- Service Customer – The entity used for billing,
- Network Provider – The organization that provides the network connectivity to the Service Platforms.

The concept of the OSGI shows that the interrelationships between the different functions required for the provision of ambient home services in essence might be very complex. However, from an institutional perspective this does not mean that a lot of these functions actually will be integrated in a single company. Figure 14, thus, focuses on potential business models.

Figure 14: Potential business models regarding home networks/ambient intelligence (based on the simplified value chain of section 2.1.3.1)



* Integrated offering of basic services, additional services by specialized content providers

Source: WIK-Consult

The figure shows that

- Specialized service providers might be focusing on the operation of platforms.
- Partly integrated network operators might be focusing on the operation of transport network and platforms.
- Fully integrated network operators might be focusing on the operation of access and transmission networks and platforms.
- Partly integrated manufacturers of terminal devices might be focusing on the operation of platforms and the management of customer interfaces (terminal devices, home networks) and
- Fully integrated eHome providers might cover all stages of the value chain.

2.1.4 Regulatory consequences of the paradigm shift

In this section we are aiming at illuminating the likely challenges for regulation inherent in the paradigm shift. This section is only concentrating on identifying the relevant issues brought about by NGN.[24] The much more detailed analysis of the subsequent issues and the actual regulatory tasks and instruments to deal with them is presented in the different sections of chapter 4.

In the traditional world of electronic communications, the *network* is closely intertwined with the *service* delivered over that network. Services are typically provided only by the network operator, and, thus, the network operator is inherently also the actual service provider. Indeed, television is delivered over cable by the cable operator, or over the air; a telephone call is delivered over a fixed network or over a mobile network by a respective network operator. To put it more simple, telecommunications operators do not deliver television, cable televison operators do not deliver telephony. In a converged world, as exemplified by the NGN, this rigid dichotomy breaks down. Today, cable television operators are already delivering telephony and Internet access services, and telecommunications operators are delivering Internet access and, to an increasing degree, television.

Inherent characteristic of the NGN concept is the *decoupling of the network from the service (provision).* In an IP-based NGN, any service can be delivered over any transport chain composed from switch/router, transmission facilties and transmission medium. It can therefore be taken for granted that NGN brings in much more flexibility with respect to service creation.

Thus, adoption and diffusion of NGNs in the communications services market presumably require a from-the-scratch re-thinking of many regulatory obligations due to the changes in the physical and logical network infrastructure, the increased flexibility of service provision, the changes in the value chain, and the changes in the "basic economics" of network and service provision, respectively,

2.1.4.1 Changing architecture and topology of the network

The changing architecture and topology of the network has implications for regulation of access as such (i.e. compared to today's available alternatives). New access modes might come into play like e.g.

- Access to ducts, dark fibre,
- Sub-loop unbundling (SLU), i.e. the provision of unbundled local loop elements of the network between street cabinet and end user,

24 See also Hackbarth, Kulenkampff and Rodriguez (2006).

- Bitstream access,
- If carriers are relying on VDSL deployment access to VDSL capable infrastructure at the MDF might come into play.

These options will be further explored in section 4.2.3.

It is likely that also resale will still be an option for a competitor to get into the end user market.

Of course the actual determinants of a competitor's business case regarding one or the other access option depend also on other national and local conditions. Examples are the incumbent's network topology, the current and achievable market share, the whole-sale tariffs of the incumbent, and the conditions of co-location.

The changing architecture and topology of the network will also have implications for regulation of interconnection (modes). Traffic exchange principles in a PSTN world and in a packet based world (based on peering and transit) differ fundamentally. This has technical implications but also economic implications like pricing principles (Calling Party Network Pays vs. Bill and Keep). NGN is likely to also change the (efficient) number and locations of interconnection points.

2.1.4.2 Stranded investments

NGN entails a likely decrease in the number (and location) of interconnection points. Thus, there is the corresponding risk of stranded investments on the part of competitive entrants who have already built out to the former locations.

2.1.4.3 Network control and call control

NGN presumably entails changes in the nature of network control and call control, with the possible risk that these changes will introduce new competitive bottlenecks.[25]

2.1.4.4 Migration of voice services to ALL-IP

Regarding migration of voice services to an ALL-IP infrastructure it is discussed if regulation should require availability of a voice telephony service with pre-defined functionalities and quality provided end-to-end. This issue is e.g. brought about by business users in Germany.

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25 See e.g. Elixmann et al. (2002).

This would have several implications. First, there have to be generally accepted standards regarding the scope of functionalities. The legacy voice communications network exhibits a multitude of additional service featutes. Examples are call forwarding, call blocking, three party calling, caller line identification etc. It can be taken for granted that the most modern (PSTN based) branch exchanges support several thousands of those features. Even if adoption and diffusion of each of these services overall is likely to be (sometimes very) small it can be asked from a regulatory perspective if (regulated) carriers migrating voice to an ALL-IP network should be obliged to offer all of the PSTN features also in the new IP-based environment. Second, should utility independent power supply be obligatory. Third, should emergency calls be mandatory? Fourth, the criteria for end-to-end quality of such a voice service (across all networks) have to be defined (jitter, packet loss, …) and agreed upon. Fifth, it has to be discussed if interconnection should be mandated for all network operators fulfilling the standards and the quality requirements.

Moreover, if one accepts the requirement of a voice telephony service with pre-defined functionalities and quality one could ask in addition if a “basic” voice telephony service (without predefined quality of service) should be available.

Of course it seems reasonable that such a service should enable voice communication across network boundaries. It can in particular be discussed if emergency calls should be mandatory. Also provision of such a service requires the definition of minimum requirements.

2.1.4.5 Who is going to be regulated?

In the past, it was not necessary to make a clear distinction as to whether a particular obligation applied to the network provider or to the service provider, since they were generally the same entity. In the world of the NGN, this can no longer be assumed to be the case. A-priori there will be a continuum of business models streteching from the overall facilities based integrated network and service provider to the pure non- facilities based service provider. Thus, issues of joint production (economies of scope between network operation and service provision) might become relevant for regulation. Moreover, unlike today where it is usual that there is single dominance in a market (usually by the incumbent) joint dominance of several companies might come into play.

2.1.4.6 Market power issues

NGN deployment does not necessarily eliminate market power, rather, it presumably alters its character and influences where and how it manifests itself. Otherwise stated, the changes due to NGN may ameliorate some kinds of market power, but they may also create new forms of market power. If the evolution to NGN opens up competition for services to third parties that are not network providers, then market power associated with those services might disappear over time; under that assumption, it might be possible to deregulate the services over time. At the same time, it becomes crucial to ensure that the broadband Internet access on which those services depends become or remain effectively competitive.

2.1.4.7 Costs, wholesale pricing

NGN in all likelihood will bring about decreases in costs. This will a-priori be the case both with respect to the level of prices and the structure of prices (e.g. due to changes of economies of scale). Thus, all regulated prices depending on concepts like Long Run Incremental Costs (based on an efficient network technology) will be severely affected, provided regulation is necessary in the NGN world.

2.1.4.8 Regulation of coax and fibre

Migration to NGN technology is carried out both by telecommunications carriers and cable network operators. Both of them on the one hand are competing in the end user market (with regard to their triple/quadruple play services). Both of them are possessing on the other hand physical access to the end user. Up until today, the cable market in Europe has not been regulated with regard to granting access to third parties.[26] However, it might turn out that regulatory policy has to cope with unbundling of coax and fibre in the future.

2.1.4.9 Transition period

Despite the sometimes very ambitious deployment plans of carriers seen today it can be taken for granted that for a more or less long time there will be a co-existence of old and new networks. Thus, not only the NGN itself but also and in particular the migration phase brings about challenges for competition policy and regulation.

26 Broadband cable has been taken account of in some EU 25 countries in the current market definition. Process. However, cable operators have never been regarded as dominant or jointly dominant together with a telecommunications carrier and they remain unregulated for the time being.

2.2 Different NGN architecture models

This section is focusing on different NGN architecture models. The first subsection is giving an overview of the basic elements of a NGN. The second subsection is focusing on currently observable voice based networks and their evolution to NGN. Here we present a lot of case studies from carriers in and outside Europe. The third subsection is devoted to IMS and developments towards NGN. The fourth subsection addresses alternatives of migration towards NGN and it is concentrating on the cable networks.

2.2.1 Elements of a NGN

The most widely accepted definition of an NGN is that provided by the ITU:

"A Next Generation Network (NGN) is a packet-based network able to provide services including Telecommunication Services and able to make use of multiple broadband, QoS-enabled transport technologies and in which service-related functions are independent from underlying transport-related technologies. It offers unrestricted access by users to different service providers. It supports generalized mobility which will allow consistent and ubiquitous provision of services to users."[27]

Thus an NGN can be characterized by

- Logical separation of the transport, control and service layer,
- Differentiated network access,
- Unique IP transport network in the core,
- Application of open protocols (ITU,ETSI, IETF) to integrate different services, transport and system providers.

Many institutions currently are involved in one or the other way in the development and standardization of NGN like e.g. the ITU (Next Generation Network Global Standards Initiative (NGN-GSI), especially study group 13), 3GPP and ETSI (TISPAN).[28] Figure 15 presents the stylized facts of a NGN.

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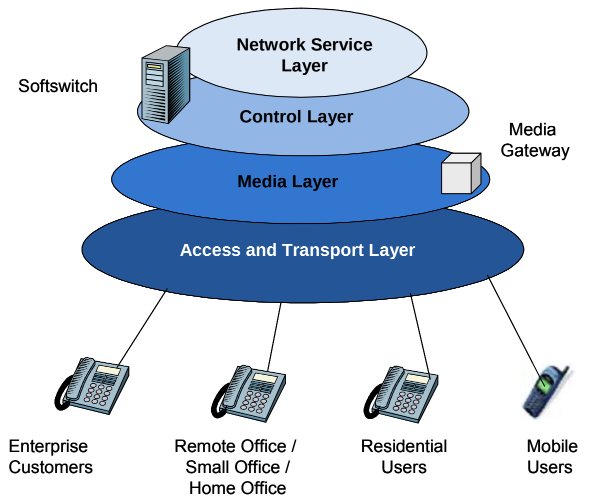
27 See http://www.itu.int/ITU-T/studygroups/com13/ngn2004/working_definition.html.

28 TISPAN is the ETSI core competence centre for fixed networks and for migration from switched circuit networks to packet-based networks with an architecture that can serve in both.TISPAN is responsible for all aspects of standardisation for present and future converged networks including NGN as such and its related service aspects, architectural aspects, and protocol aspects. Moreover, they perform QoS studies, security related studies, studies on mobility aspects within fixed networks, using existing and emerging technologies.

Figure 15: The NGN layered structure: stylized facts



Source: Uebele and Verhoyen (2001).

The figure shows that basically a NGN consists of four different layers: the access and transport layer, the media layer, the control layer, and the network service layer. In more detail the typical network elements of the migration towards NGN and their interrelationship are outlined in the next figure.

The key element of a NGN (apart from the transport function) are softswitch functions, provided either by a central unit (call server or media gateway controller) or distributed over various functional elements (Proxy-, Interrogation-, Serving- Call State Control Functions; PIS-CSCF; see section 3 for more details) in the IMS frame, which are responsible for signalling and the control of resources in the network. The control functions can be specified as follows:

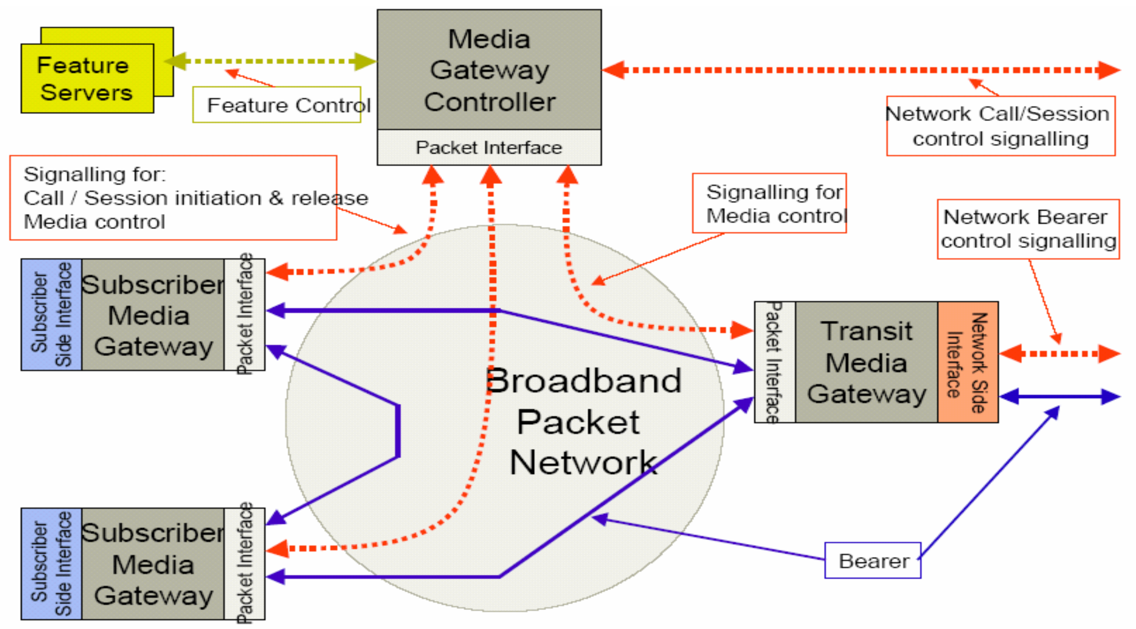
- Call Control,
- Media Gateway Control and
- Service Control.

Regarding telephony, the softswitch function is the essential element within a NGN to establish a telephone call. It is managing and controlling the call set-up by signalling protocols (call control). Moreover, the call server communicates with the media gateways to ensure the physical call set-up (media gateway control) and it controls functions being stored on media, message or application servers (service control).

Media gateways physically are located at the interface between different networks. This can mean the interface between the PSTN/ISDN and the packet network or the interface between packet networks which are supported by different protocols. Media gateways are important because of the presence of access networks which are not being based on packet-switched technology. Media gateways, thus, are converting media information flows of one network into those of the other network based on the specific requirements of the latter network. If for example a PSTN access line is connected to a NGN the media gateway provides for the conversion of frequencies into data packets (transcoding).

Figure 16 shows the different types of gateways required for the migration of the legacy networks to the NGN.

Figure 16: Network elements characterizing NGN migration

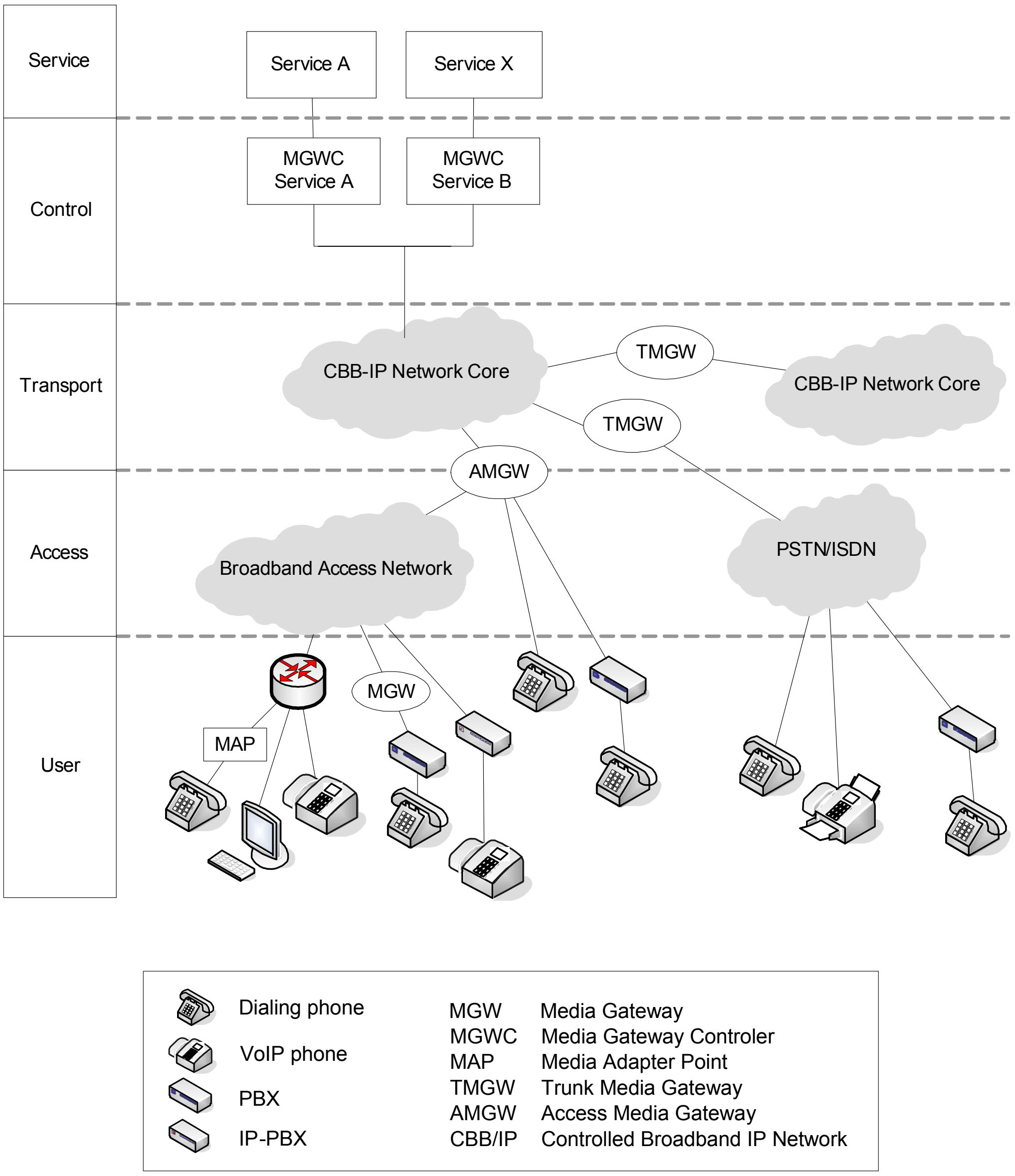


Source: ITU/BDI IP Telephony 2002

The figure shows access media gateways that are located at the network border next to the end user, trunk media gateways that are located at the border to PSTN/ISDN networks, signalling gateways that are responsible for SS7 interconnection and media gateway controllers which can be call agents or softswitches.

Figure 17 shows in more detail the NGN network structure with its corresponding layers that currently is implemented by some legacy operators.

Figure 17: Configuration of a hybrid NGN – PSTN network in connection with the functional layers from the NGN concept



Source: Hackbarth and Kulenkampff (2006)

The figure shows several access devices on the user level connected to a broadband access network and the PSTN/ISDN. Some terminal devices are connected to the broadband network via adapters (MAP) and gateways (MGW), respectively. The figure shows also that some terminal devices are directly connected to the core network of a carrier via an access media gateway (AMGW). The PSTN/ISDN network is connected to an IP based broadband core network via a trunk media gateway (TMGW). Services are controlled in this situation by (service specific) media gateway controllers (MGWC).

The term CBB-IP is not standard but it is used to stress that the IP part is not a legacy best effort IP but an IP based transport platform where the virtual connections and the corresponding capacities are controlled from the corresponding softswitch/MGWC or IMS functions (PDF). Pure service providers can offer their services by connecting to the corresponding MGWC in the control plane or in the IMS environment by the service application function in the service control layer. Even in cases where this connection is provided by standardized open interfaces it requires strong coordination with the incumbent providing the NGN infrastructure and might limit competition in case that a certain service is already offered from the incumbent or one of its corporate partners.

Thus defined, NGN first and foremost is a concept describing the evolution of the traditional legacy networks like PSTN/ISDN in view of the integration into the controlled IP platforms of (SMP) carriers.

Apart from the term NGN several other terms have been coined to capture current and foreseeable developments in the communications services industry. Examples are Next Generation Internet (NGI) and IP Multimedia Subsystem (IMS). We will address the interrelationship of these concepts in section 2.3 and in section 3.1.

2.2.2 Voice based networks and the evolution to NGN

The objective of this section is to analyse how different market players are deploying significantly different NGN capabilities. The section is focusing on the development towards NGN taking voice based networks as a starting point. Otherwise stated, we are analyzing NGN related activities of fixed-link carriers. The objective is to highlight what these activities mean for their network architecture and to characterize commonalities and differences across the market players.

The section addresses NGN deployment approaches of former incumbent PSTN/ISDN operators in Europe (section 2.2.2.1) and of competitors in Europe (section 2.2.2.2). Moreover section 2.2.2.3 focuses on the adoption of FTTx in Europe. Section 2.2.2.4 provides some information about network migration approaches in North America and section 2.2.2.5 refers to carriers in Asia.

Deployment of NGN technology is not a new phenomenon. Rather, NGN type technologies have been deployed for over a decade. In their NGN study Elixmann and Schimmel (2003, section 6) have also focused on actual directions of deployment of NGN architectures in the beginning of this decade and they came to the following observations.

- Sinnreich and Johnston (2001, p. 28) give at least a short list of service providers using SIP technology within (parts of) their networks[29].
- If carriers are deploying softswitches into their network they still address a very specific and limited set of tasks[30]. An overview of the different application areas of softswitches so far implemented is given by a survey recently conducted in the USA among 59 network operators[31]. This survey showed that RBOCs and IXCs were most likely to have deployed softswitches[32]. Other incumbent telecommunications carriers and national wireless carriers were more likely to be in an evaluation or "monitoring and watching" phase.
- Among those who have deployed softswitches the most popular applications cited were
  - Internet offload,
  - as a replacement of Class 4 trunk switches[33] and
  - to expand revenue by offering specific services and applications.
- In the USA a potential for the deployment of softswitches has been seen with regard to cable operators as a Class 5 replacement product. Some telecommunications carriers also are thinking about replacing Class 5 switching technology. For example, in 2001 it was reported that Sprint is planning to replace Class 5 switches by softswitches in a mid- to long-term perspective. Sprint's key drivers were reported to be lower costs to deploy and maintain softswitches and in particular to be able to quickly provide ATM, Frame Relay and ADSL[34].

A-priori the standards that comprise the NGN offer considerable flexibility. We expect that electronic communications services (ECS) market players will choose selectively from among the options available, and that their choices will reflect their respective business needs and business plans. In particular, we envision three distinct evolutionary scenarios:

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29 Companies mentioned are AT&T, Telia, Level 3 and Worldcom. From different sources we know that BT, DTAG and Qwest have implemented SIP or are planning to do so. Likewise a German ISP, mediaways, has announced in October 2002 to use SIP.

30 See Sweeney (2001, p. 34).

31 See Engebretson (2002a).

32 43 % of IXC respondents said they had deployed softswitches with live customers in at least one office – and 50% of all IXCs said they had committed plans to deploy softswitches. 66.7% of RBOC respondents said they had done major deployments – and 100 % said they had committed plans for future deployments. None of the other ILECs or national wireless carriers surveyed said they had done major deployments, but larger ILECs may be the next adopters. 40% of large independent operating companies (e.g. Sprint, Alltel) said they had committed plans to deploy softswitches – and 66.6% of IOCs with 20,000 to 100,000 lines said they had committed deployment plans.

33 The main idea behind this is to save costs by moving long-haul traffic destined for the Internet off more expensive circuit connections. Thus, this makes sense for carriers relying on IP transport of voice in the long haul. See Sweeney (2001).

34 See Sweeney (2001, p. 38).

- Legacy fixed-only operators are likely to evolve to a centrally managed NGN environment.
- Legacy mobile operators are likely to evolve to an IMS NGN environment, especially if they also have fixed operations.
- Internet Service Providers (ISPs) are likely to evolve to loosely coupled NGN environments.

2.2.2.1 European incumbents

British Telecom

BT is a major fixed incumbent, but is in the unusual position of not having a mobile affiliate. Moreover, BT appears to be under little pressure to make major changes in its access network. In consequence, the BT migration to NGN has focused on the core network, and IMS has not featured prominently in their announcements.

The current network infrastructure in the UK consists of about 80,000 street cabinets and about 6,000 MDFs. It is fair to state that the UK network infrastructure is relatively outdated and mainly analogue.

British Telecom (BT) in the UK is about to invest until the year 2010 an amount of 10 bill. £ to deploy a Next Generation Network and to migrate completely to VoIP. This investment is part of the strategic plan „21st Century Network“ (21CN), which in particular means the complete replacement of the PSTN by an All-IP network. Further parts of this strategy are the upgrading of the Operating Support Systems and a new enlarged product portfolio encompassing also triple play offers. BT has launched its BT Vision service (IPTV on the basis of ADSL2+) in December 2006.[35]

The rationale for the decision to migrate to ALL-IP is the expectation to cut costs. BT expects a decrease in OPEX of 1 bill. £ per annum until 2008. BT had announced to be able to migrate 144,000 customers per week to the All-IP network already in the second half of 2006. The launch for the planned migration process, encompassing broadband access lines for all households, took place in Cardiff in Wales.[36] Overall BT is going to migrate a total of 30 mill. access lines. To this end the bulk of the current network hardware has to be replaced.

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35 As of February 2007 there are about 4,000 subcribers to BT Vision.

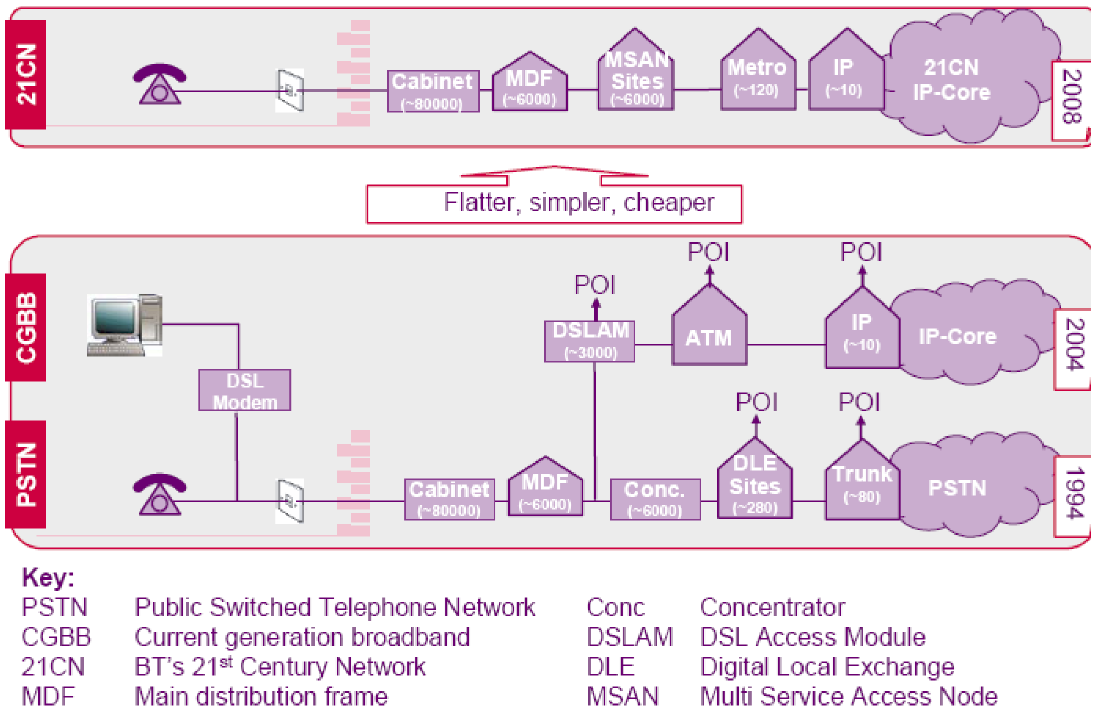
36 According to BT Cardiff wiil be the first city to see full rollout, which will take place in three stages. In the first phase, from November 2006 to March 2007, 10 percent of the 350,000 Cardiff-area voice consumers will be switched onto the new network. During the second phase, from April 2007 to May 2007, another 10 percent will be switched over, and by the summer of 2007, all of Cardiff will be on the new network. See tecCHANNEL, September 6, 2006.

The migration in the UK is organized in four components:

- Component 1 means that particular services like voice transmission will be transferred to IP.
- Component 2 focuses on the complete migration of the voice and data networks to a unique IP platform.
- Component 3 requires the central management layer of the network to be established which then allows to offer to customers new functions and services.
- Component 4 concentrates on the development of the system environment and staff expertise.

BT intends to implement perhaps 100-120 points of interconnection (POI) in their new 21CN NGN, compared to some 3,000 (DSL oriented) POIs in their current traditional network, as depicted in Figure 18 below.

Figure 18: Comparison of existing BT voice and broadband networks with 21CN



Source: Ofcom (2005a), Figure 1, page 12.

As far as we know BT has not committed to deploy FTTx. Moreover, it is worth noting that in the UK network migration obviously is not tied to a strategic policy by the carrier to close down MDF locations.

In addition it seems worth to note that BT has set up Open Reach, i.e. a separate subsidiary for wholesale network services. Open reach was established in 2006 after BT reached an agreement with Ofcom[37] to ensure that all rival operators have equality of access to BT's own local network, i.e. Open Reach has to provide its services both to BT and the competitors in a non-discriminiatory way. Open Reach installs, services, supports and maintains the wiring, fibres and connections to the homes and businesses in the UK.

KPN

The current network infrastructure in the Netherlands consists of about 28,000 street cabinets and about 1,350 MDFs.

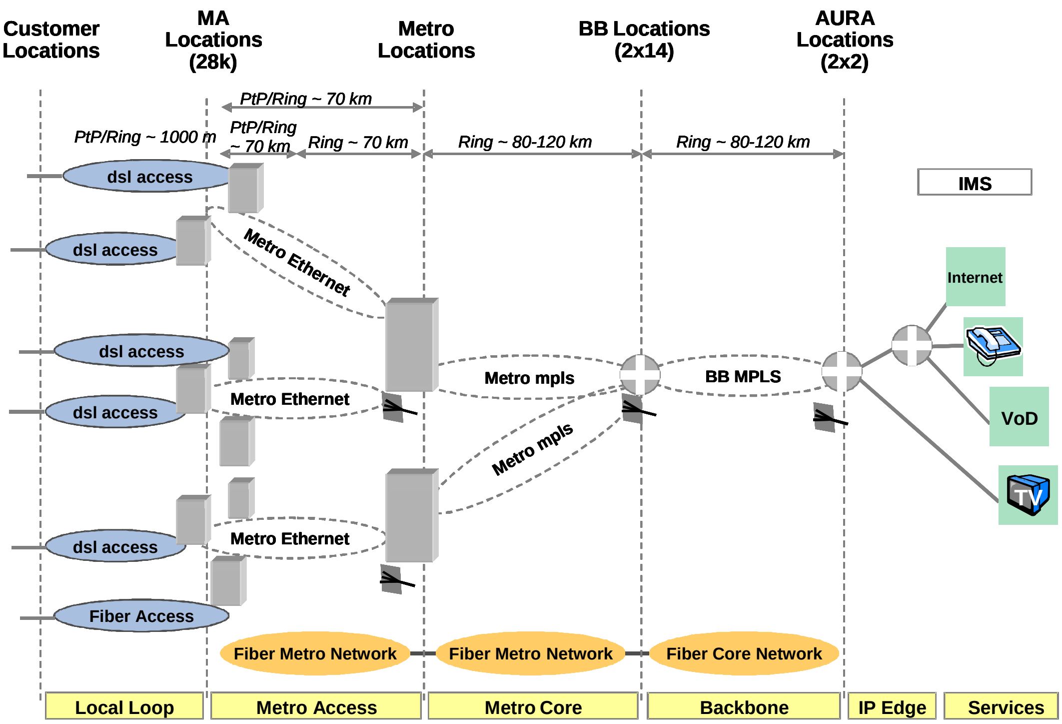
KPN currently is about to introduce an All-IP network in the Netherlands. Figure 19[38] mirrors the stylized facts of the new All-IP network of KPN. The figure reveals that the All-IP network consists of different network layers:

- Access network (local loop,
- Metro access network,
- Metro core network,
- Backbone,
- IP-Edge network.

37 http://www.ofcom.org.uk/telecoms/btundertakings/btundertakings.pdf. Download: February 23, 2007.

38 The following information rests on OPTA (2006): *„KPN's Next Generation Network: All-IP"*, Position-paper, OPTA/BO/2006/202771; October 2, 2006 (in Dutch).

Figure 19: Stylized facts of the planned ALL-IP network of KPN



Source: OPTA (2006): „KPN's Next Generation Network: All-IP", Positionpaper, OPTA/BO/2006/202771; October 2, 2006 (in Dutch)

In comparison to the current TDM (Time Division Multiplexing) based network there is no difference at all between „sub-network" (network between cabinet and end user) and the „primary access network" (network between cabinet and main distribution frame (MDF)) in the ALL-IP world: the copper based access network consists solely of the sub-network. Overall, the number of about 28,000 of street cabinets will be kept in the Netherlands.

In addition KPN takes into consideration, beginning in new construction areas, to replace the copper based access network by fiber solution (FTT Home, FTT Office). This fiber based access network will also be linked to the existing cabinets.

The new network entails that the function of the significance of the traditional MDFs and their functionalities is transferred to the cabinets. This means in particular that a new device is placed into the cabinet (the NG-DSLAM), where the customer access line is hooked upon. By means of this device it is possible to provide all services in an integrated way, like e.g. broadband Internet, VoIP and IPTV, but also plain old telephony services. These newly equipped cabinets are also called „Multi Service Access Nodes".

In the new KPN network the NG-DSLAMs (placed in the cabinet) will be linked to so called Metro Core Locations (MCL) via fibre rings. There will be about 200 MCLs and they will be established at former MDF locations. The different NG-DSLAMs will be linked to the Ethernet routers within the MCLs on the basis of Ethernet technology. The connection betwen Subloop Distribution Frame (SDF) and the MCL is also called SDF-backhaul. The remaining MDFs (MDF locations) (out of the currently existing 1,350 MDF locations) will not be needed any longer and they therefore will be closed down.

The different MCLs will be linked to 2x14 so called „Broadband Locations“. Also this network is based on fibre rings, DWDM and Ethernet connections. In addition to the network layers mentioned so far KPN has defined a fourth network layer, the so called „AURA locations“ (stand for Amsterdam, Utrecht, Rotterdam and Arnheim). The Ethernet transport networks will be linked via these network nodes to other networks like e.g. IP, VoIP, IPTV distribution networks, etc..

According to the original plans the switch-off of the PSTN was scheduled for the year 2010. The current discussion in the Netherlands is, however, focusing on the issue if there is a viable business case for competitors if KPN's plans are finalized in the planned form. The answer is that this is highly unlikely, see section 2.4.3. One possible outcome of the stil ongoing discussion within the market and between regulator and regulated company therefore can be a revised time schedule.

KPN has begun to market its triple play offer under the brand "Pakketten Top 3" in the beginning of 2007. Technically this offer is based on ADSL2+.

DTAG

DTAG's current network consists of about 7,900 Main Distribution Frames (MDF) which are entirely accessible on the basis of fibre, and about 290,000 street cabinets. This equals approximately 40 cabinets per MDF. In Germany the average number of access lines per cabinet is less than 200. Furthermore the network disposes of 23 transit switches. Competitiors can get (regulated) access to the incumbents network at 474 POIs for PSTN interconnection traffic, and at 73 PoPs for IP interconnection traffic. In the 1990s there was a major overhaul of DTAG's network by virtue of the digitization and the implementation of ISDN. Currently DTAG's biggest competitors have access to about 3,000 MDFs equalling a coverage of 70 to 80 % of the German population.

About two years ago DTAG has announced plans to deploy fibre between MDF and street cabinet (FTTC) and to install VDSL solutions. Geographically the company focuses on densely populated areas. Currently (as of January 2007) the network deployment covers 12 metropolitan areas with about 5.9 mill. potential customers. On the basis of its original plans DTAG aims at deploying fibre in Germany's 50 biggest cities by 2008. The overall investment budget amounts to roughly 3 bill. Euro. Up until the end of 2006 the company has spent about 550 mill. Euro for its network upgrade. DTAG's VDSL network is able to provide bandwidths up to 50 Mbps per subscriber.

DTAG's FTTC/VDSL investment plans have, however, been made subject to conditions addressed to the German government. In essence, DTAG requires the abolition of ex-ante regulation (i.e. offering a wholesale service at regulated prices) for (access to) the new networks. According to DTAG's argumentation its investment should get protection from regulation because "new products" like IPTV are offered. DTAG has heavily lobbied with the (current Grand Coalition) government and political parties to get these "regulatory holidays". Moreover, the company has communicated that the lay-off of 5,000 staff would become necessary if regulatory holidays are not granted.

The lobbying obviously was "successful". Indeed, the Amendment of the German Telecommunications Law which has been passed in February 2007 contains a far reaching abolition of regulation. This, in turn, has provoked severe measures by the EU Commission. These developments are addressed in more detail in section 2.4.5.

It is premeature to assess if these developments turn out to be a politicial "success" in the long run. Indeed, the main issue at stake is how to reap the economic benefits of NGN migration. In view of the serious labour saving property of technical progress inherent in NGN deployment the main challenge for companies like DTAG in our view is to convince policy and unions to accept that massive lay-offs are likely.

In addition to these changes regarding the access network it is worth to be noted that DTAG (T-COM and T-Mobile) have launched Fix-Mobile convergent offerings.

On the one hand this refers to the T-Mobile@home service. This means a customer has two numbers, a German fixed link and a German mobile number. The customer has full discretion to define a single "homezone" (up to 2 km). Within a homezone the customer can make calls into the fixed-link network at prices which are cheaper than the respective mobile tariffs for these calls.

On the other hand T-Com, the fixed-link arm of DTAG, had introduced at CeBIT 2006 the "T-One" service. Uitilization of T-One required a new terminal device with WLAN functionality and supporting GSM mobility. The idea was that customers get a regular German fixed-link number, a German mobile number, and a VoIP number. The default option of the terminal device was specified to be WLAN, i.e. in the vicinity of a WLAN hotspot and at home (provided there is a WLAN broadband connection available) calls should be handled on the basis of VoIP. Otherwise the communication was to be performed on the basis of GSM. However, a few days before CeBIT 2007 DTAG has announced to close down the T-One service. Obviously, this project never took off in the market. Informal sources talk about only 2,000 users after one year. The market withdrawal of the service presumably also reflects the reshuffling of the management at the top of DTAG in late 2006 which have led to the situation that the CEO and the leading managers within the parent company DTAG are now people with a former T-Mobile background.

TeliaSonera

In March 2005 the Scandinavian carrier TeliaSonera has launched a new service in Denmark encompassing IP telephony at home and mobile GSM telephony while on the move. This is part of the carrier's strategy to foster the migration from fixed-link to mobile and Internet based services. To be able to use this service the customer needs a new (wireless) terminal device acting as IP device at home. As soon as the customer leaves his homezone the wireless handheld automatically requires authorization in the respetive mobile network. This system is based on the international standard UMA (Unlicensed Mobile Access), i.e. a standard where the mobile terminal device communicates over the Internet on the basis of Bluetooth or WLAN. Since April 2006 TeliaSonera offers to ist customers in Finland three new services: mobile TV, video telephony, and music downloads.

Telefonica

In February 2006 Telefonica Móviles España has launched a pilot project for the utilization of DVB-H (TV transmission using the standard Digital Video Broadcasting Handheld). About 500 customers in Madrid and Barcelona were equipped with respective smartphones. Telefonica's IP network comprises about 48,000 ports and 55 PoP (Points of Presence) throughout Spain. Migrating to an IP based infrastructure enables Telefonica to simplify its network, to reduce OPEX as well as maintenenace costs and it enables the introduction of new services. Telefonica's network planning and network design, respectively, for the transport of data and voice rests on DWDM, SDH and PDH technologies complemented by IP technologies.

Telefonica hopes to be able to sufficiently reduce the efficiency of the network (e.g. with respect to the time for establishing a call (50 %), the throughput of transmission capacity (30 %) and the capacity utilization degree of network resources (10 to 20 %). Moreover, the time-to-market for new services will be decreased.

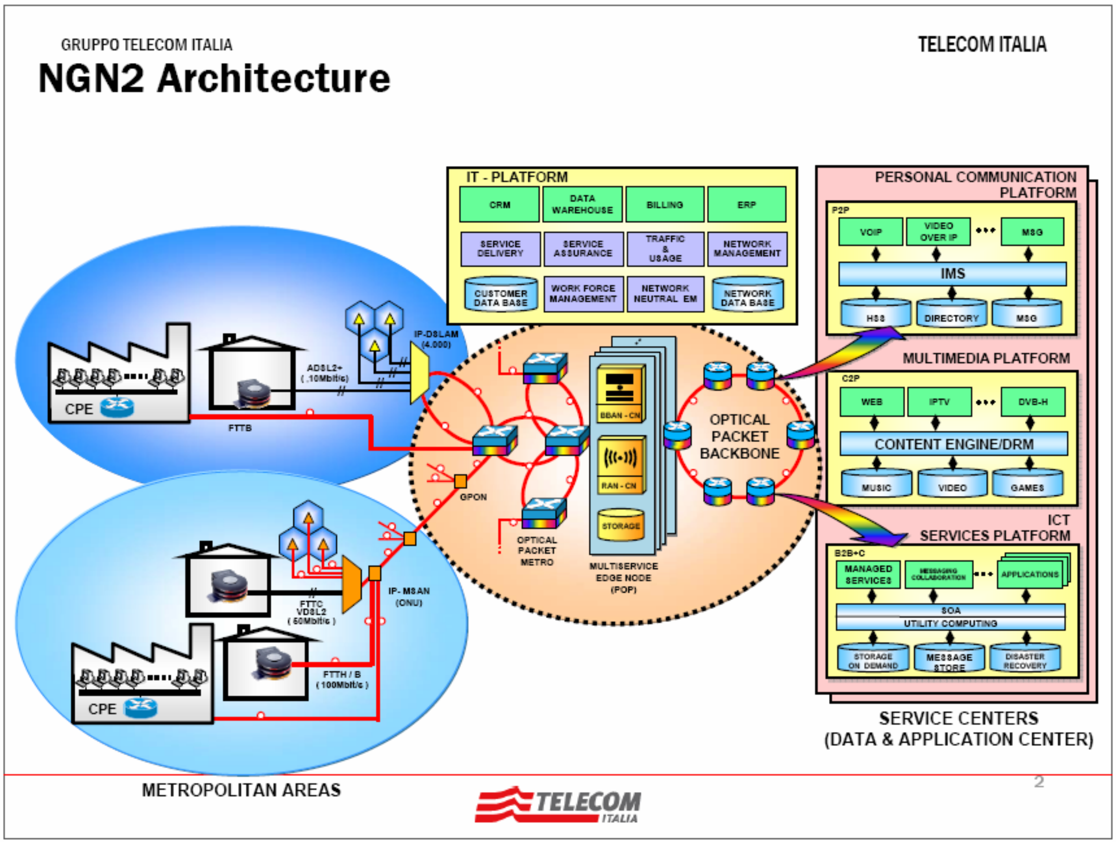
Telecom Italia

In Italy there are about 10,400 MDFs in Italy and about 400,000 street cabinets (the average number of lines per cabinet is 200 in Italy). Unlike e.g. in Germany, the MDFs are not yet entirely accessed on the basis of fibre. Indeed, about 6,000 of the MDFs are fiber based whereas the other 4,400 are not fibre based (as of December 2006). The MDFs accessible by fibre make ADSL available for about 89 % of the population.

Telecom Italia (TI) has launched the transition of the traditional PSTN transmission mode towards IP in their core network already in the year 2000.

TI is currently underway to deploy NGN technology ("piano NGN2"). The intention is to deploy mixed FTTC/VDSL2, FTTH e FTTB solutions, see Figure 20.

Figure 20: Planned NGN 2 architecture of Telecom Italia



Source: Telecom Italia (2006)

The overall investment budget originally was planned to be about 10 bill. € covering a relatively long period from 2007 to 2018. The objective is to to bring fiber optics to 1.200 urban centres and to serve 13 mill. customers[39]. The original plans are somewhat changed recently[40]. Indeed, in March 2007 TI has announced plans to invest EUR 6.5 billion over the next ten years rolling out its NGN2 infrastructure. The system will support broadband access at speeds of up to 50Mbps. The 60,000km NGN2 system will be deployed in more than 1,100 towns and cities by 2010. It is also reported that Telecom Italia is looking at using WiMAX wireless broadband technology to fill in the gaps in coverage in the NGN2 system, making high speed services available to 99% of the population by the end of 2009.

In any case one can expect that VDSL will be available in Italy in the course of 2007.[41]

39 http://www.finanznachrichten.de/nachrichten-2007-02/artikel-7769710.asp. Download February 22, 2007.
40 http://www.telegeography.com/cu/article.php?article_id=17020&email=html; download March 13, 2007
41 See Telecom Italia Group (2006).

Other VDSL deployments across Europe

In many other European countries VDSL deployment is underway or at least planned. In the following we present some examples. The information is taken from the carrier web sites.

- Belgium: Belgacom provides VDSL in urban areas with bandwidths up to 24 Mbps.
- Denmark: TDC started VDSL2 trials in 3Q 2006 using hardware of vendor Ericsson[42].
- Finland: Several of the local carrers in Finland are already involved in VDSL- OPOY provides e.g. VDSL in the City of Oulu, Auria provides VDSL in the City of Turku and 24 Online provides VDSL in Helsinki. The services provided in Turku and Oulu use Long Reach Ethernet (LRE) infrastructure by Cisco. In addition, a few universities in Finland also provide VDSL to their students.
- France: Erenis is offering VDSL in Paris. The bandwidth available is 60 Mbit/s down and 6 Mbit/s up.
- Portugal: Portugal Telecom is planning to provide VDSL2 in the beginning of 2007. This new technology of PTInovação (PT Labs) called mediaDSLAM can provide 100 Mbps.
- Slovenia: Voljatel is providing VDSL2 to enterprises. Telekom Slovenije is planning to provide VDSL2 in 2007 to its customers.
- Spain: VDSL Roll-out by Telefonica began in 2005 in selected parts of Madrid. The commercial launch is planned for 2007.
- Switzerland: Swisscom is currently deploying VDSL2. The overall investment budget is about 700 mill. CHF until 2008. The commercial launch up is announced for summer 2007. The long term goal is to to cover 50 % of Swiss households until the end of 2007[43].

2.2.2.2 European competitors

This section provides a few examples of competitors in Italy, Germany and France with regard to their network deployment (plans). Thereby, we focus on deployment of FTTx technology. This does not mean that competitors in these and other European countries only focus on access network migration. Rather, many competitors in Europe have already migrated their networks to All-IP to a large degree. Examples are QSC, Telefo-

42 http://www.telecomweb.com/international/18346.html. Download (22nd of February, 2007).
43 http://www.idate.fr/pages/index.php?pop=ok. Download (22nd of February, 2007).

nica Deutschland (both domestic players in Germany), Colt and Cable&Wireless (pan-European market players). Ewetel, a regional carrier in (the North Western part of) Germany has announced that they will exclusively rely on NGN infrastructure in areas in which they deploy infrastructure for the first time. Moreover, regarding the existing network it was announced that they will gradually migrate the network to NGN technology.[44]

Fastweb (Italy)

According to IDATE there are about 265,000 FTTH subscribers in Italy (as of June 2006). Moreover, there are 1.6 mill. homes passed by FTTH. Together with B2 (Sweden) Fastweb has been the European pioneer concerning FTTH deployment. Obviously, Fastweb has had a very ambitious deployment programme which, however, has been altered (at least for the time being) in 2005.

Fastweb offers FTTH access in the cities of Milan, Rome, Genoa, Torino, Naples and Bologna. Fastweb reaches more than 300,000 households and 50,000 enterprises (as of September 2006). The operator originally had plans to connect all Italian cities with more than 45,000 inhabitants to its FTTH network until 2010. This would equal more than 1 mill. households[45]. However, the number of Fastweb subscribers connected via FTTH remains actually stable at approximately 200.000 in the past two years. The reason is that Fastweb has stopped the investments in FTTH and it increased the investments in ULL in 2005.

The network architecture of Fastweb is fully based on IP.

NetCologne (Germany)

NetCologne is one of Germany’s biggest so called “city carriers”. It operates as a regional telecommunications carrier in the area of Cologne, Bonn and Aachen. NetCologne has a broadband market share of 44 % in Cologne and suburban areas. In 2006 NetCologne has launched the deployment of FTTB. The strategy is to provide fibre based access to subcsibers who reside in multi dwelling units. The connection of single occupancy houses is not planned (for economic reasons).[46] As a first step, NetCologne aims at accessing about 128,000 buildings out of the about 160,000 buildings in Cologne.[47]. As NetCologne is also a cable provider in the city of Cologne, they have already access to some of the buildings. In the mid- and long term the strategy will be to deploy fibre also in other more rural areas in which NetCologne is active provided the

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44 See e.g. http://www.teltarif.de/arch/2006/kw13/s21073.html. (Message relates to March 2006; download April 2007).

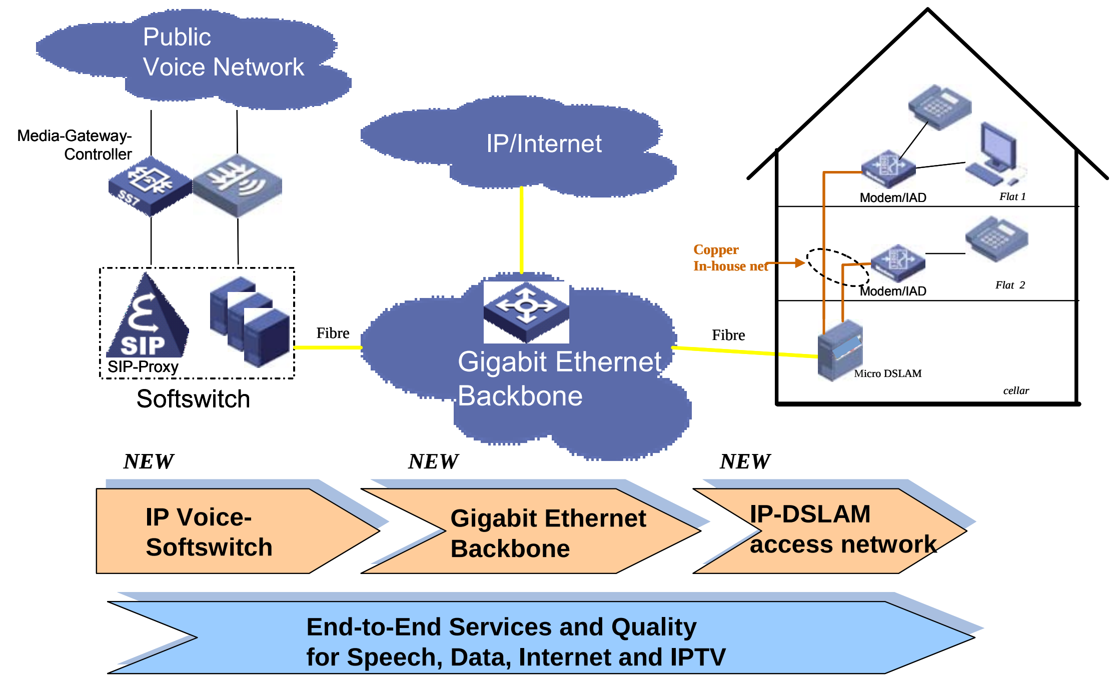
45 http://www.altivis.fr/-Le-FTTH-poursuit-sa-progression-.html. Download (21st of February, 2007).

46 http://www.teltarif.de/arch/2007/kw04/s24615.html?page=2. Download (21st of February, 2007).

47 In December 2006 NetCologne has started FTTH trials in a part of Cologne, namely the Belgisches Viertel. 40 homes have been connected to FTTH, see http://www.teltarif.de/arch/2007/kw04/s24615.html. Download (21st of February, 2007).

carrier has reached a broadband penetration similar to Cologne. The driving force for the fibre activities of NetCologne is to get a competitive advantage over DTAG regarding innovations. NetCologne's new network will be based on Gbit Ethernet. The objective is to provide customers with a bandwidth of 100 Mbit. The basic deployment approach of Netcologne is outlined in Figure 21.

Figure 21: FTTB deployment approach of Netcologne



Source: Zankel (2007).

The figure shows that NetCologne is underway to migrate its network to NGN technology (installation of IP DSLAMs and softswitch technology). The softswitch based network and the PSTN/ISDN network will work in parallel for quite some time before everything is switched to All-IP. The backbone rests on Gigabit Ethernet technology.

According to its current plans NetCologne aims at having the network completely migrated after 5 years, i.e in the year 2011. At this time, the network of DTAG therefore does not play any role for NetCologne. The total investment is approximately 110 mill. Euros in the next 5 years.[48] The business case for the FTTB deployment of NetCologne rests heavily on substituting current wholesale purchases (NetCologne pays around 34

48 The parent company of NetCologne is GEW Cologne, i.e. a utility. Actually, GEW has the fibre investments in their balance sheet and NetCologne leases back the infrastructure from the parent company.

mill. Euros p.a. to DTAG for wholesale services, in particular for the unbundled local loop) from DTAG by own value added. NetCologne does not aim to become a local monopolist, rather, they are open to cooperative arrangements with other German carriers. According to NetCologne they have discussed (triple play solutions based on) VDSL. However, they have come to the conclusion that these are only a transitory phenomenon and that fibre is strictly superior to other access technologies.

Iliad (France)

IIlad (acting in the market under the brand Free Telecom) plans to invest approx. 1 bill. € in fiber to the home (FTTH) in Paris until 2012, with the promise of further roll-outs in provincial cities. The first phase of FTTH deployment focuses on more than 2 mill. subcribers in Paris. The long term goal is to get 4 mill. homes passed in 2012.[49] Iliad aims at installing fiber only in those areas where it has a greater than 15% share of all landlines.[50] Iliad has announced that it will start offering high-speed broadband (with symmetrical 50 Mbps service) in Paris in the first half of 2007. They will also offer FTTH service in 6 to 7 municipalities in the Haut-de-Seine and 3 other large French cities[51].

The optical fiber network of Free will be based on an IP-NGN architecture and it will use Ethernet FTTH (E-FTTH) technology. Free is about to deploy respective Ethernet switches as the E-FTTH access platform at its new optical PoPs with 10 Gbit Ethernet uplinks to its core network.[52]

In addition it is worth to point out that several jurisdictions in France (départements, régions, citées) are involved in local or regional fibre deployment activities, see e.g. ART (2005). These fibre deployment activities are supported heavily by the French State via the State owned “Caisse des Dépots et Consignations”.

2.2.2.3 Adoption of FTTx in Europe

As of mid 2006 there are about 820,000 FTTx customers (06/2006) in Europe. Focusing on countries Sweden has the highest penetration level with about 320,000 FTTx customers (07/2006). Next to Sweden is Italy with about 270,000 FTTx customers (07/2006). In the Netherlands there are about 70,000 FTTx customers (07/2006). France has less than 5,000 FTTX customers (06/2006).

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49 http://www.idate.fr/pages/index.php?pop=ok. Download (22nd of February, 2007).
50 http://research.analysys.com/default.asp?Mode=article&iLeftArticle=2218&m=&n=. Download (21st of February, 2007).
51 http://www.muniwireless.com/article/articleview/5317. Download (21st of February, 2007).
52 See http://www.tvover.net/2006/12/13/Frances+Free+Goes+Cisco+For+FibertotheHome+Deployment.aspx; download 24 April 2007.

2.2.2.4 North America

AT&T (former SBC)

SBC purchased AT&T in 2005 and adopted AT&T's name. Compared to its competitors (Verizon and Bell South) SBS showed relative reluctance towards FTTx deployment until 2004. The company's strategy regarding to FTTx faced a repositioning in June 2004, when Projekt LightSpeed was launched. Lightspeed uses both FTTP (fiber to the premises) and FTTN (fiber to the node) technologies to minimize costs. AT&T currently mainly focuses on FTTN. By the end of 2007, the company expects to reach 17 million households with FTTN technology and nearly 1 million with FTTP. Therefore, it is planned to install 40,000 additional miles of fiber. The overall investment budget is about 4 bill. US $.

AT&T provides FTTP in areas of new construction („greenfields") and it provides FTTN solutions in areas where infrastructure already exists. AT&T connects 300-500 access lines per node. The bandwidth is 15-25 Mbps down and 1-3 Mbps up. Since December 2004 SBC has also made FTTH field trials. Yet, up to now no major FTTH deployment is planned.

Verizon

Verizon is mainly relying on a FTTPremise solution. Obviously, the main focus is on a parallel overbuild of fibre over copper. Only in greenfield situations, FTTH is planned, see Figure 22. Currently, Verizon has fibre activities in 12 States. Verizon actually is focusing on multi dwelling units and apartments and aims at delivering up to 100Mbps downlink speeds per subscriber.

Regarding the total number of FTTx subscribers in the U.S. there are different statements. Ovum provides a figure of 463,000 for the second quarter of 2006. The FCC, however, comes to a substantially higher number and refers to about 700,000 FTTx subscribers (as of June 2006)[53]. Verizon claims to have 375,000 FTTx subscribers (as of second Quarter 2006). Of the 118,000 new subscribers added throughout the country that quarter, 110,000 were customers of Verizon's FiOS video service which has been launched in 2005. Verizon Communications owns about 81% of all FTTx subscribers in the United States[54].

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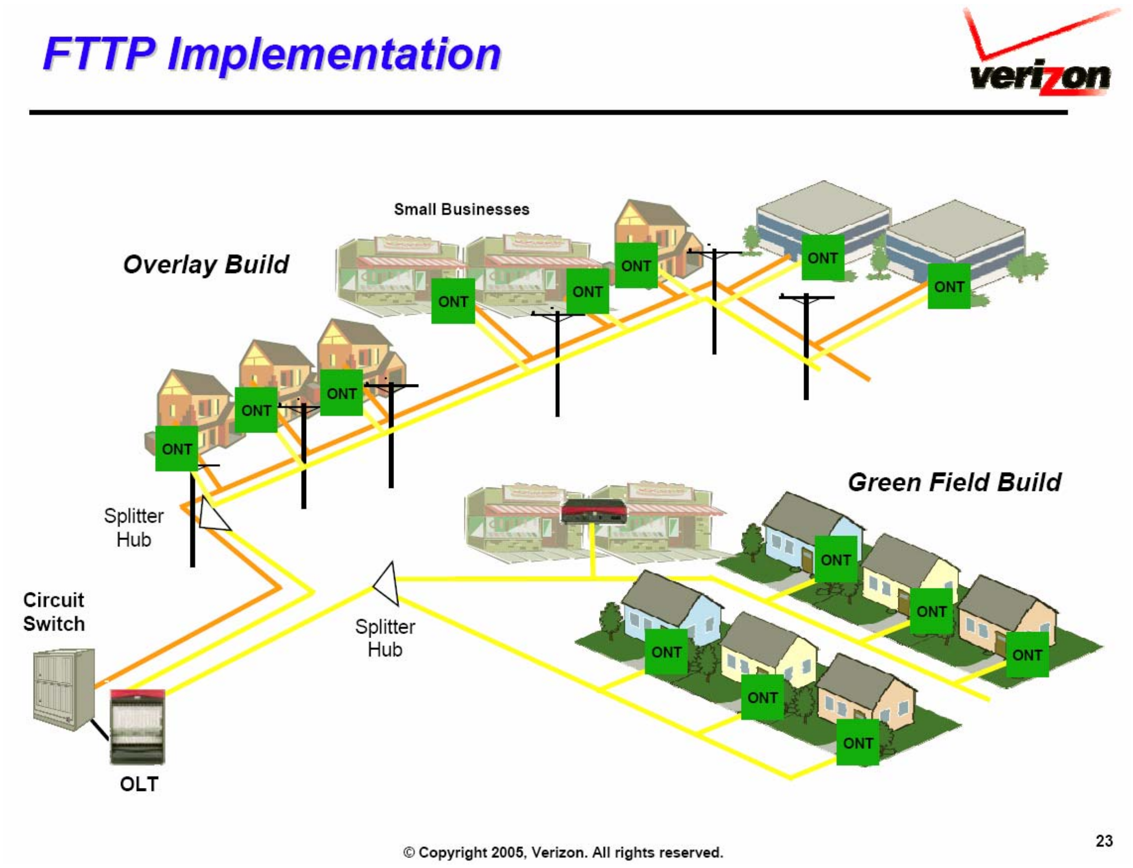
53 http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-270128A1.doc. Download February 23, 2007.

54 http://telephonyonline.com/fttp/marketing/verizon_ftth_subscribers_080906/. Download 21st of February, 2007.

Figure 22: Deep fiber in the loop deployment by Verizon (stylized facts)

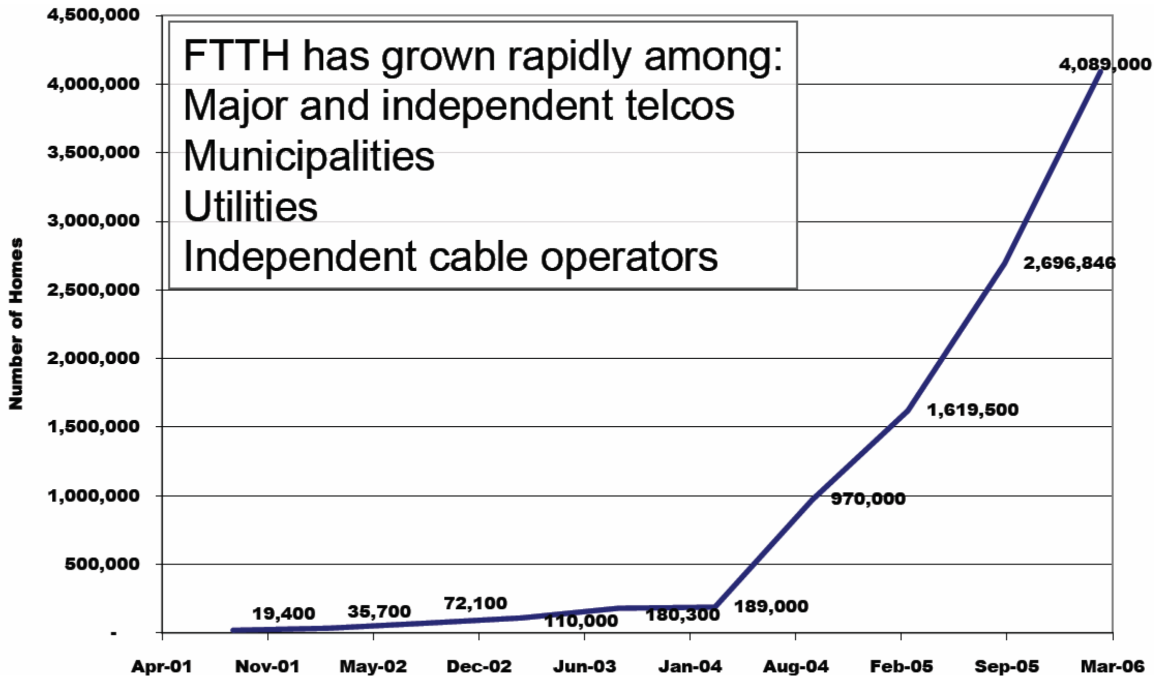


Source: Verizon

FTTx situation: overall perspective

In the U.S. there are a bit more than 4 mill. homes passed by FTTH (as of March 2006), see Figure 23.

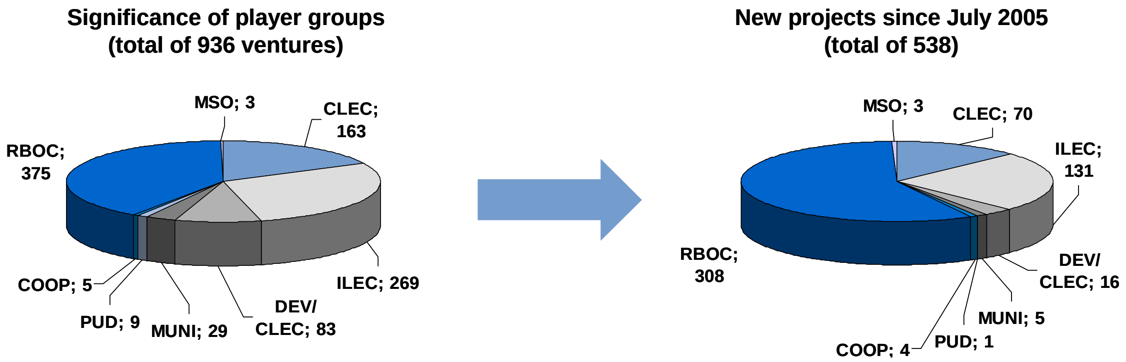
Figure 23: FTTx in the U.S. (homes passed 2001 - 2006)



Source: Woodfin (2006)

Overall, more than 900 (936) FTTx projects have been launched in 47 States of the USA (as of mid 2006). Apart from the RBOCs (Regional Bell Operating Companies) and CLECs (Competitive Local Exchange Carriers) other incumbents (i.e. the smaller regionally oriented telecommunications carriers which are independent of the old Bell system) show strong activities, see Figure 24.

Figure 24: FTTx market players (types) in the USA (as of June 2006)



RBOC	Regional Bell Operating Company
CLEC	Competitive Local Exchange Carrier
DEV/CLEC	Developer/CLEC
ILEC	Incumbent Local Exchange Carrier
MUNI	Municipality
PUD	Public Utility District
COOP	Electrical Cooperative
MSO	Multiple System Operator

Source: WIK-Consult, Aug. 2006

2.2.2.5 Asia

Korea Telecom (KT)

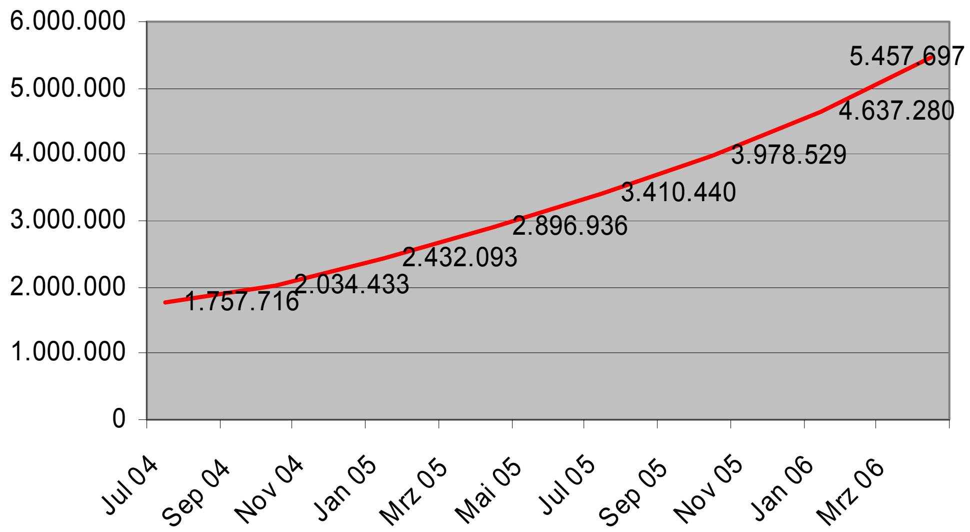
KT has more than 11 mill. customers dispose of broadband Internet access via DSL technology and cable technology. This roughly equals three quarters of KT's total customer base. More than 1.4 mill. out of the 11 mill. customers have already a VDSL access (providing them up to 100 Mbps bandwidth). In South Korea flat rates are dominating and the traditional markets are mainly saturated. In order to set up a new strategy for growth KT envisages to provide bundles of broadband, TV and mobile services for the mass market. KT, thus, aims at providing ubiquitous broadband accessibility where wireline and wireless/mobile offerings complement each other.

The mid-term investment strategy of KT is focusing on the following 5 growth areas: Next-Generation Mobile Communications, Home Networking, Media, IT Services and Digital Contents.

Japan, in particular NTT

Japan is by far the country with the highest FTTH penetration in the world. Figure 25 shows the FTTH market development between the second quarter of 2004 and the second quarter of 2006.

Figure 25: FTTH market development in Japan (II/2004 – II/2006)

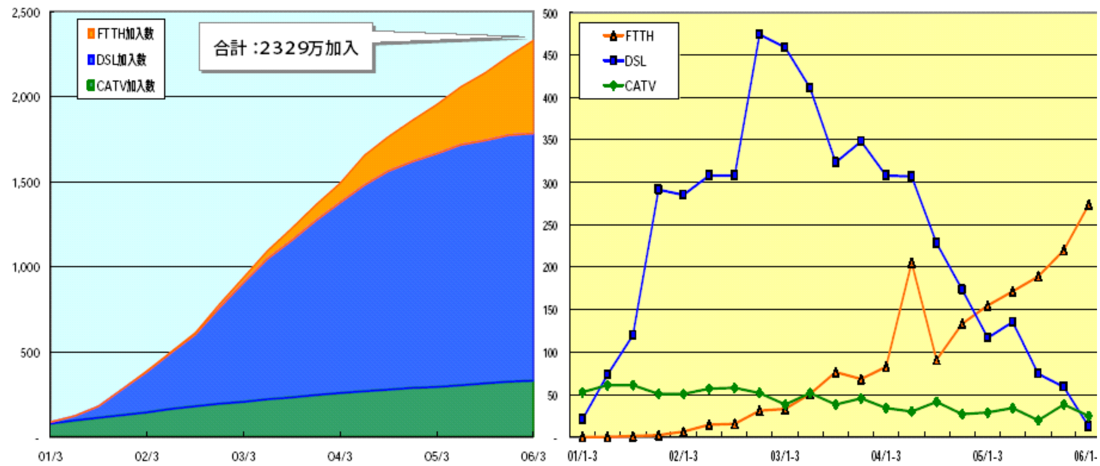


Source: MIC Japan, May 15, 2006 and own research

As of September 2006 Japan has approximately 7.1 mill. FTTH subscribers.[55] FTTH access is, however, already available for use in approximately 80% of households (40.15 mill. households out of 50.00 mill. households). Figure 26 shows the adoption of different broadband access technologies over time.

55 It seems worth to be noted that the very last mile of FTTH deployment in Japan (in particular in the metropoles) rests on aerial deployment, i.e. the fibre strands are not buried.

Figure 26: Market development FTTH, DSL, CATV in Japan (2003-2006)



	01/03	02/03	03/03	04/03	05/03	06/03
FTTH	200	2万6千	31万	114万	290万	546万
DSL	7万	238万	702万	1,120万	1,368万	1452万
CATV	78万	146万	207万	258万	296万	331万

期間	01/1-3	02/1-3	03/1-3	04/1-3	05/1-3	06/1-3
FTTH	67	5,700	33,066	82,692	154,948	273,472
DSL	20,311	73,559	459,104	308,259	116,811	12,300
CATV	54,000	51,000	38,333	34,333	28,879	24,338

Source: MIC, July 2006

The y-axis of the left hand side of the Figure denotes 10,000, i.e. overall there are more than 23 mill. broadband access lines. The left hand side of the Figure shows that DSL today still is the most important broadband access means in Japan followed by FTTH. Cable has a relatively limited importance in the Japanese broadband market. The y-axis of the the right hand side of the Figure denotes 1,000 and shows the changes in penetration over time. It is obvious that DSL has reached its peak growth in 2003 and that there has been a sharp decline in growth rates thereafter. FTTH growth was higher than DSL growth for the first time in 2005.

In Japan several players are active in the field of providing FTTH access services to end users.[56] The main player groups in Japan are:

- *Telecommunications carriers*: Examples NTT-East und –West; KDDI,
- *(Supra-) Regional Utilities*: Examples K-Opticom (Subsidiary of Kansai Electric Power Co.); TEPCO (Tokyo Electric Power Co.)[57],
- *CATV Provider*: Example J:COM,

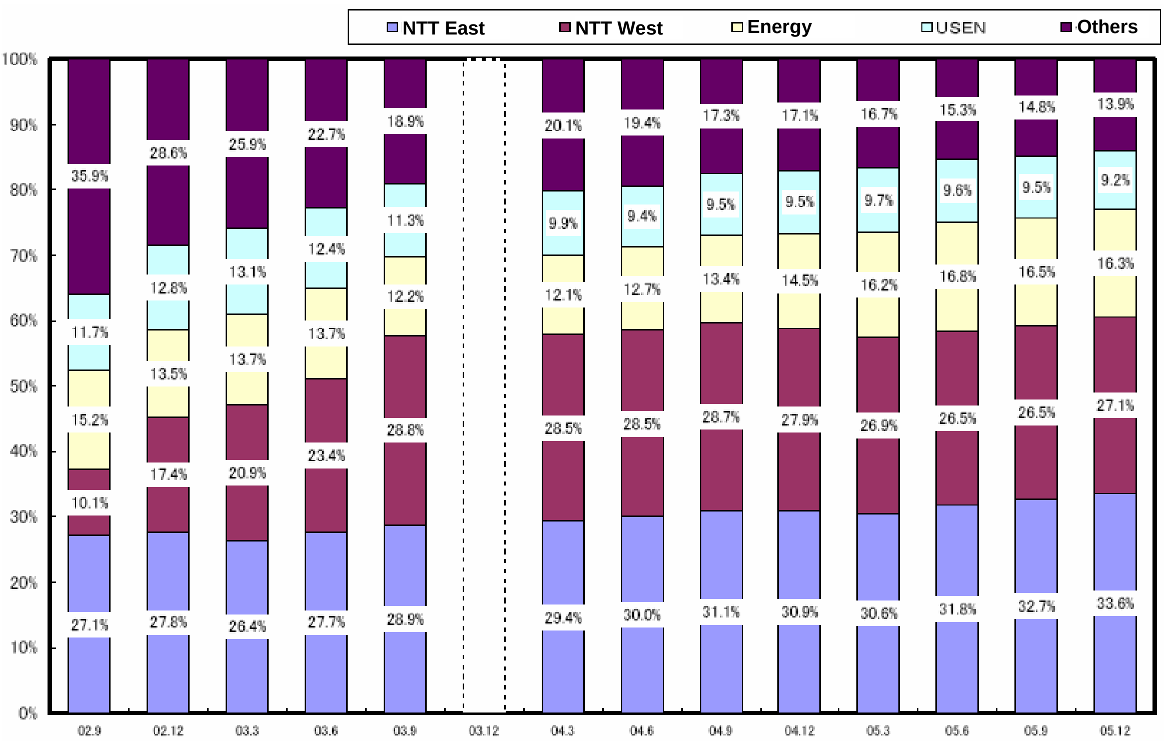
56 This does not necessarily mean that all of the players mentioned actually deploy and own fibre. Rather, some of them build their business model on fibre purchased from third parties.

57 The fibre business of Tokyo Electric Power Inc (TEPCO) has recently been acquired by KDDI.

- *Content Providers*: Example usen Corp. (producing music content),
- *ISPs*: Example Yahoo! BB,
- *Jurisdictions*: they are involved in FTTH deployment in rural and densely populated regions.

Figure 27 exhibits the market shares of the main players active in the fields of FTTH. One can see that the two NTT regional entities still have the largets market share in Japan.

Figure 27: Market shares of FTTH players in Japan (as of December 2005)



Source: MIC, July 2006

Notwithstanding the competitive effects brought about by the multitude of players it is worth to be noted that the two local parts of NTT still have the largest market share in Japan regarding FTTH. Competition seems to be fierce and the market participants still are seeking their appropriate market strategy.

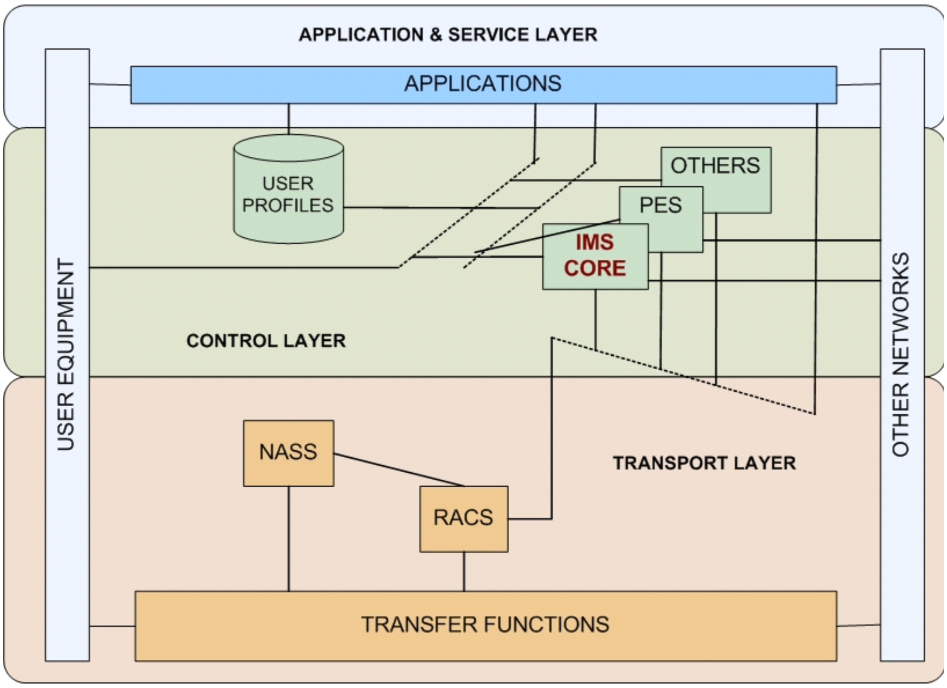
One example is KDDI, Japan's second largest telecoms company. Just recently (March 2007), KDDI Corp says it is teaming up with East Japan Railway Co (JR East) to offer fibre-based broadband services to customers using the latter's cable network. The objective is to challenge the might of former monopoly NTT. This has to bee seen against the backdrop of the recent acquisition of the fibre business of TEPCO and the signing of agreements with several cable TV operators to compete with the incumbent. KDDI obviously is aiming at offering the new service to around 120,000 households using JR East cables installed in an area covering Tokyo and northern Japan. However, as JR East's infrastructure is built alongside its railway tracks, additional investment will be required to connect to nearby homes and businesses.

2.2.3 IMS platform and development towards NGN

As noted in section 2.1, the traffic migration from fixed to mobile networks, and in some cases to Internet Service Providers, is driving standardization initiatives to enable the evolution of the legacy fixed networks towards Next Generation Networks[58] capable of supporting fixed mobile convergence. One of the most important initiative comes from the ETSI TISPAN working group (Telecoms & Internet converged Services & Protocols for Advanced Networks), which has in effect adopted the concepts of the IP Multimedia Subsystem (IMS) that were developed by the 3rd Generation Partnership Project (3GPP). The general architecture of the TISPAN NGN is shown in Figure 28.

58 The general architecture of the NGN core network is detailed in Chapter 3.1.

Figure 28: ETSI TISPAN NGN architecture



Source: ETSI ES 282 001, TISPAN: NGN Funtional Architecture

This figure shows that the TISPAN IMS architecture is divided into three layers:

- The Application and Service Layer, consisting of the Application Servers for the IMS services,
- The Control Layer, with the Home Subscriber Server (HSS), which contains the User Profiles and corresponding subsystems, among which is the IP Multimedia Subsystem core, and
- The Transport Layer, starting at the User Network Interface (UNI) of the User Equipment (UE), and containing the Access Network, the Next Generation Network core, the Network Attachment Subsystem (NASS) and the Resource Admission Control Subsystem (RACS).

The NASS dynamically provides IP addresses and other user equipment configuration parameters. Roughly stated, it combines the functions of a DCHP server and a RADIUS client in legacy Internet. Additionally the NASS provides location management functions. The Resource Admission Control Subsystem (RACS) performs the admission control for multimedia sessions.

The IMS core contains the functions for session and media control, the most important of which are:

- The Call State Control Function that establishes, monitors and releases multimedia sessions and manages the service interactions,
- The Multimedia Resource Function Controller that controls the Multimedia Resource Function Processor and provides content adaptation functionality,
- The Breakout Gateway Control Function that selects the network in which PSTN breakout occurs and selects the MGCF within that network,
- The Media Gateway Controller Function which is used to control the Media Gateway.

2.2.4 Alternatives of NGN migration

It seems that there are carriers (Telecom Italia might be viewed as an example) which have "quietly" upgraded their PSTN facilities[59] to operate over IP, but without implementing IP in a way that differs much from that of a conventional ISP. Our sense is that the desire to improve price/performance plays a vital role in motivating this change.

Moreover, ISPs have for years been successively improving their IP networks by incorporating additional protocols (such as MPLS and DiffServ) that provide most of the capabilities that we today associate with the NGN. These networks may not have been referred to as NGNs, but they are roughly functionally equivalent to NGNs, and they might satisfy or at least approach the ITU definition of an NGN. We refer to this development in this report as Next Generation Internet (NGI), see section 3.1.4.

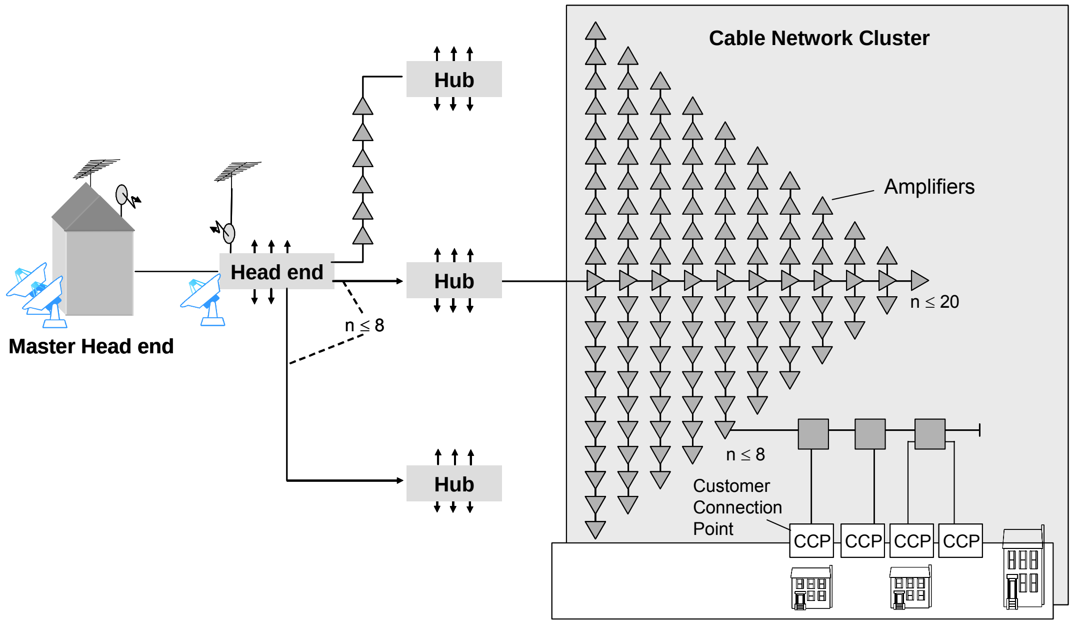
The rest of this section addresses NGN developments from the perspective of cable operators.

Cable networks, originally one way networks optimised for delivery of television and radio broadcasting services, are increasingly upgraded to deliver telecommunications services, in particular broadband internet and telephone services. After their upgrade, cable networks show many characteristics of NGN as defined by the ITU (see section 2.1.1.1). Voice and data services are delivered packet-based and the networks are capable of transporting all other communication services – including video services – in a packet-based mode. Moreover, upgraded cable networks can be viewed as a platform on which service-related functions are independent from the underlying transport-related technologies. Unlike required by the NGN definition, cable networks do not offer unrestricted access by users to different service providers and they do not support mobility.

59 See section 2.2.1.1.

On the last mile the architecture of cable networks differs significantly from that of telecommunications carrier networks (see Figure 29).

Figure 29: Traditional architecture/topology of cable networks



Source: WIK-Consult

Starting from the local cable head end – comparable to the central office within PSTN networks – cable networks traditionally rest on copper coaxial cables. Depending on the size of a cable network, several head ends are connected to a master head end. Subscribers are not accessed by individual twisted pair copper lines, rather, by a common cable network. This network usually has a “tree structure” which follows the streets of a neighbourhood and branches off to connect all of the buildings passed. Several subscribers of a cable network tree are forming a cluster. Between head end and cable clusters there are hubs to distribute the signals. All of the subscribers within one cable network cluster are sharing the capacity of one copper coaxial cable.[60] Originally built for broadcasting services, i.e. all subscribers are receiving the same signals and are not sending any individual signal back to the network, this tree structure had been a sufficient as well as an efficient cable topology.

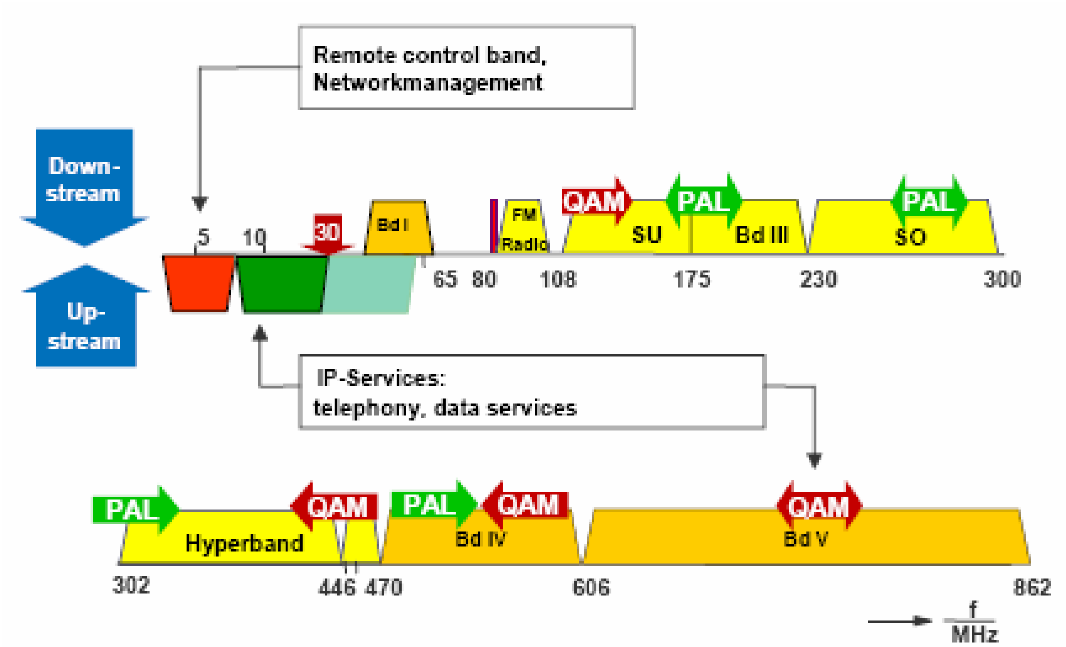
60 The capacity of one coaxial cable is much higher than that of one twisted pair cable because the cable cross-section and the shielding of copper coaxial cables are of much better quality than copper twisted pair cables. Consequently, a much wider frequency range can be used on coaxial cables. The future VDSL 2 standard for example uses frequency ranges between 138 kHz and 30 MHz on twisted pair, whereas on coaxial cable frequencies from 5 to 862 MHz are being used. See Gneuss (2005), p. 34 and Wimoesterer (2005), p. 43.

Since the opening of the telecommunication markets in the 1990s, cable operators (who are not also operating a telecommunications carrier network) have major incentives to upgrade their networks in order to be able to provide bi-directional communications services and more TV channels.[61] Typically, these upgrades rest on two elements:

- Extension of the frequency range,
- Implementation of a return path.

The example of Germany might illustrate this. Cable upgrades in Germany usually comprise the extension of the frequency range used from formerly 20 - 300 or 450 MHz to now 20 – 606 or 862 MHz as well as the dedication of the lower frequencies as a return path (see Figure 30).

Figure 30: Usage of frequency spectrum in an upgraded cable network: the example of Kabel Deutschland in Germany

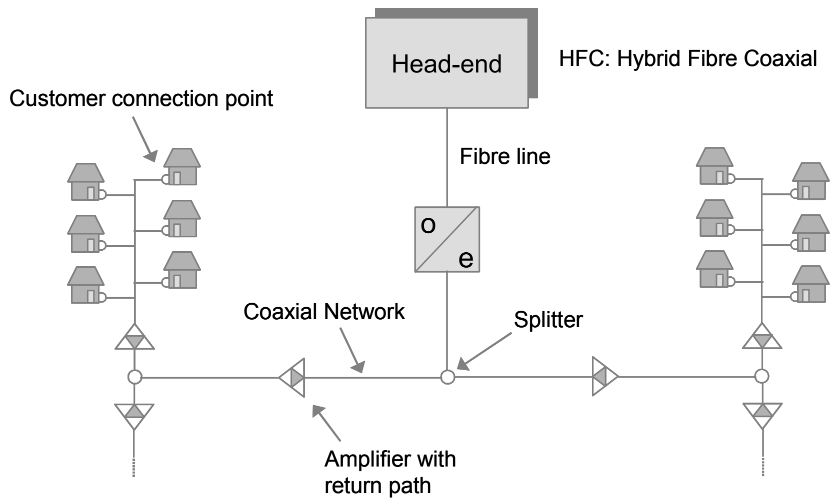


Source: Kabel Deutschland, internal communication

61 In the US the upgrades were driven mainly by the need to offer more channels to compete with satellite. Broadband as such was a bonus, not the driver. Originally, in many countries cable networks were deployed using spectrum up to 300 MHz. In the course of time several cable operators became, however, aware that an extension of the spectrum above 300 MHz was necessary. The reason was the limited capacity of VHF1 and VHF3 bands (requiring frequencies below 300 MHz) and the need for an increase of TV-channel supply using the UHF-IV and UHF-V bands.

These cable upgrades require particular changes in the network topology. The introduction of the return path and the extension of the frequency range require an exchange of all amplifiers along the cable network in the last mile. In order to increase the capacity for IP traffic, some network clusters have to be partitioned and new fibre lines have to be installed to connect these clusters with the head end. Smaller network clusters means less subscribers along the shared capacity of one coaxial line. After the replacement of certain copper coaxial cables by fibre lines, upgraded cable networks are called hybrid fibre coaxial (HFC) networks (see Figure 31).

Figure 31: Architecture of hybrid fibre coaxial cable networks



Source: WIK-Consult

Before 2001 some cable operators realized cable telephony on their upgraded networks with switched technology, which was more expensive than IP technology. Today, as IP telephony has been proven as a reliable and cost saving technology, cable operators concentrate on packet based technologies for voice and data services.

To deliver IP traffic on the upgraded cable networks, cable modem systems have to be installed. They mainly consist of cable modems at the subscribers' premises and the cable modem termination system (CMTS) which is connected to Internet pop-servers and voice gateways at the head end. The maximum distance for the signal transport on coaxial cables is 20 km which is around 50 times higher compared to VDSL systems (on copper twisted pair). This high insensitiveness to distance is due to the installed amplifiers who regenerate the electrical signals.

The commonly used standard for cable modem systems is the Data over Cable Service Interface Specification (DOCSIS) and its variant Euro-DOCSIS. The current DOCSIS version 2.0 is supporting speeds up to 50 Mbps. The upcoming version 3.0 will support speeds up to 200 Mbps down- and 120 Mbps up-stream.

These capacities have to be shared amongst all subscribers within one cable cluster. As soon as the broadband demand within a cluster exceeds a certain limit meaning that the individual data speed gets too slow, a cable operator has the option to invest in additional fibre lines to partition the shared coaxial cable cluster. This, in turn, increases the individual capacities again. The dynamic scalability of HFC networks is supportive for cable network operators in following a demand related, i.e. risk avoiding upgrading strategy.

Of course, an upgraded cable network needs upstream connectivity. Usually, the head ends are connected by fibre backbones which are either operated by the cable company itself or run by carrier's carrier. The major cable companies operate their own long distance fibre networks.

Regarding IP traffic exchange many cable operators, in particular the bigger ones, are engaged in Internet peering at national Internet exchanges (i.e. DE-CIX, AMS-IX or LINX).

They also keep their telephone traffic as long as possible in their own core network and do interconnection on highly concentrated points.

Even if upgraded cable networks still deliver linear and on-demand video services like TV programmes, pay per view, video on demand or digital video recording (DVR) in the traditional broadcasting way. Cable networks have enough capacity to stream several hundreds of digital TV programmes simultaneously. Using the Digital Video Broadcasting for Cable (DVB-C) standard, video services in cable networks so far are not transported packet oriented as in telecommunications carrier based NGN environments. Today, still a large partition of cable networks is being used to broadcast analogue Television (PAL or NTSC).

Nevertheless IPTV is on the agenda of cable operators. By virtue of this technology capacity restrictions diminish and - apart from copyright questions - cable operators could theoretically be offering all TV programmes of the world to their subscribers. At the moment it is discussed in the cable industry to continue with broadcasting the 100 to 300 most popular TV programmes within several free and pay TV packages with DVB-C technology and to supplement this offer with an even larger variety of special interest video services delivered in a package-based IPTV mode. Among the cable operators who have already communicated to introduce IPTV soon are Cablecom in Switzerland and Kabel BW in Germany.

Our analysis so far shows that (DOCSIS 3.0 and HFC based) cable networks and (upgraded, i.e. NGN based) telecommunications carrier networks show many similarities with respect to the service portfolios that they might provide to end users.

We believe it is worth noting once again that cable infrastructure is shared among multiple users, so no single user is assured of bandwidth, unlike DSL. On the other hand, it is fair to state that DSL is distance sensitive (the more km´s the less bandwidth available) and CMTS/cable is not. Cable is an efficient medium for delivering the same linear visual content to multiple subscribers at the same time. However, for video on demand, you have to fall back to a model of individual IP datagrams delivered to individual uses, which is much more bandwidth intensive. There is a limit to the number of on-demand streams of video that can be delivered over cable broadband systems (as currently implemented).

This competitive landscape is reflected, in turn, in the plans of PATS providers who compete with cable operators. In the U.S., Verizon is implementing FTTH using PON, which is a cable-like solution to video delivery, while AT&T is using an IPTV solution.

2.3 IP Multimedia Subsystem

This section focuses on IMS. It aims at highlighting both observable market aspects and technological aspects regarding IMS and its deployment.

2.3.1 NGN and its relationship with IMS

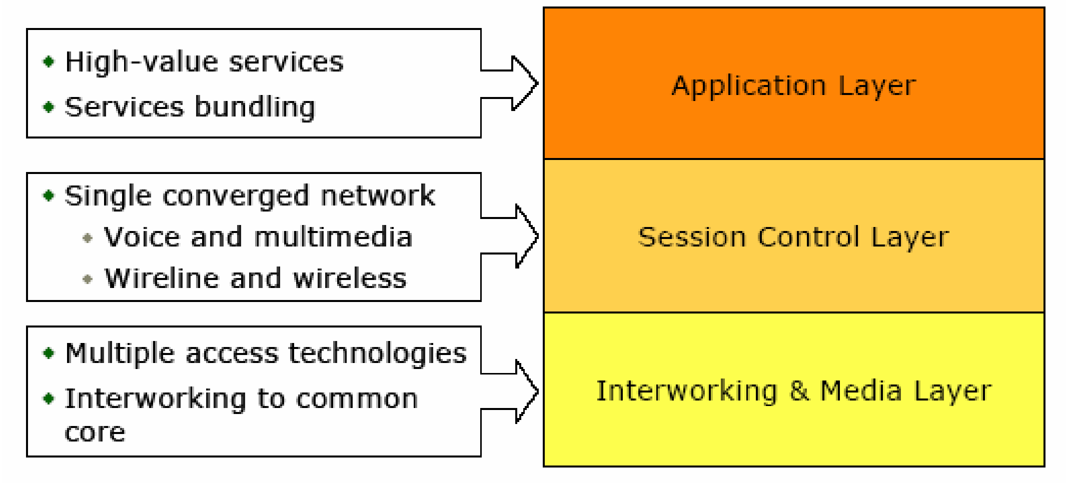
The NGN and IMS standards originated independently, but they now about to converge.

In terms of technical standards, NGN standards were developed primarily by the ITU and by ETSI The IP Multimedia Subsystem (IMS), however, originated with the 3GPP, a standards body focused on mobile networks. IMS was developed primarily in order to provide multimedia services over 3rd generation mobile networks, e.g. UMTS in Europe. IMS first appeared in 3GPP release 5 specifications, finalized in March 2002, but only for mobile access. 3GPP subsequently developed improved versions of IMS in releases 6 (wireless access) and 7 (fixed access).

Later on the European Telecommunications Standards Institute (ETSI) incorporated IMS into the NGN specifications developed by ETSI *Telecoms & Internet converged Services & Protocols for Advanced Networks (TISPAN*). Current ITU recommendations for NGN are based on IMS (NGN-IMS) as incorporated into ETSI TISPAN. Thus, the IMS standards are going to be incorporated into ITU and ETSI NGN standards, but with some differences mainly in the QoS provision scheme.

Like NGN, the IMS is a layered architecture, as shown in Figure 32 below. This similarity of structure facilitated the incorporation of IMS into the NGN standards.

Figure 32: Layered view of the IMS Model



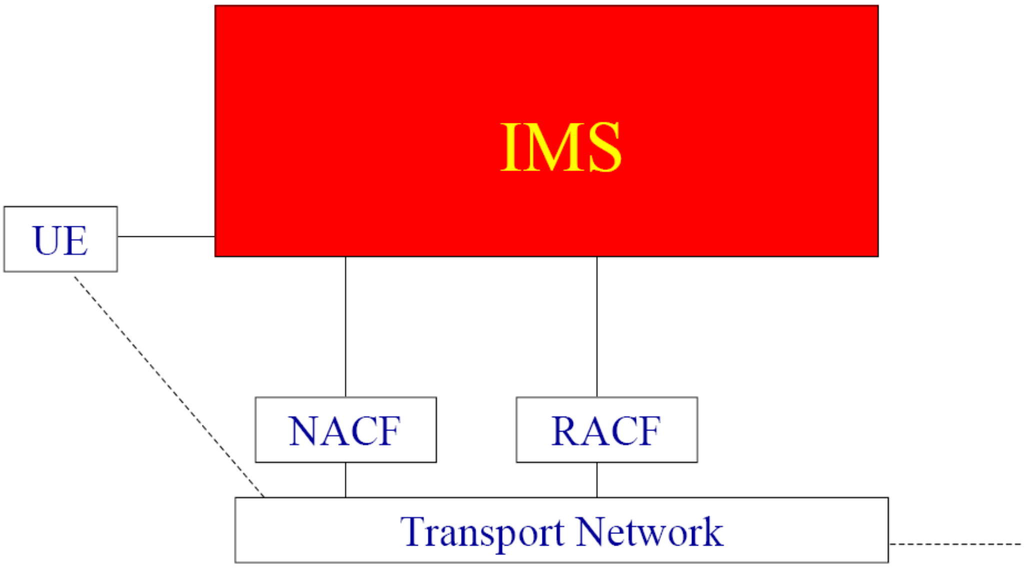
Source: Kinder (2005)

IMS is based on end to end IP services controlled by the SIP protocol. IMS provides the functions of a SIP-based soft-switch, but extends them in order to enable open access to value-added services, applications and content. It thus adds session control functions so as to enable the seamless use of multimedia services from different access technologies, fixed and mobile, thus promoting fixed mobile convergence.

The internal architectural structure of IMS comprises three major elements, as shown in Figure 33 below (see also section 2.2.3):

- The IMS core,
- The Network Attachment Subsystem (NASS) which provides the Network Attachment Control Functions (NACF), including authentication and authorization of the user, and
- The Resource and Admission Control Subsystem (RACS) which provides the Resource Attachment Control Functions (RACF), including resource management and admission control based on the user's profile and the resources currently available.

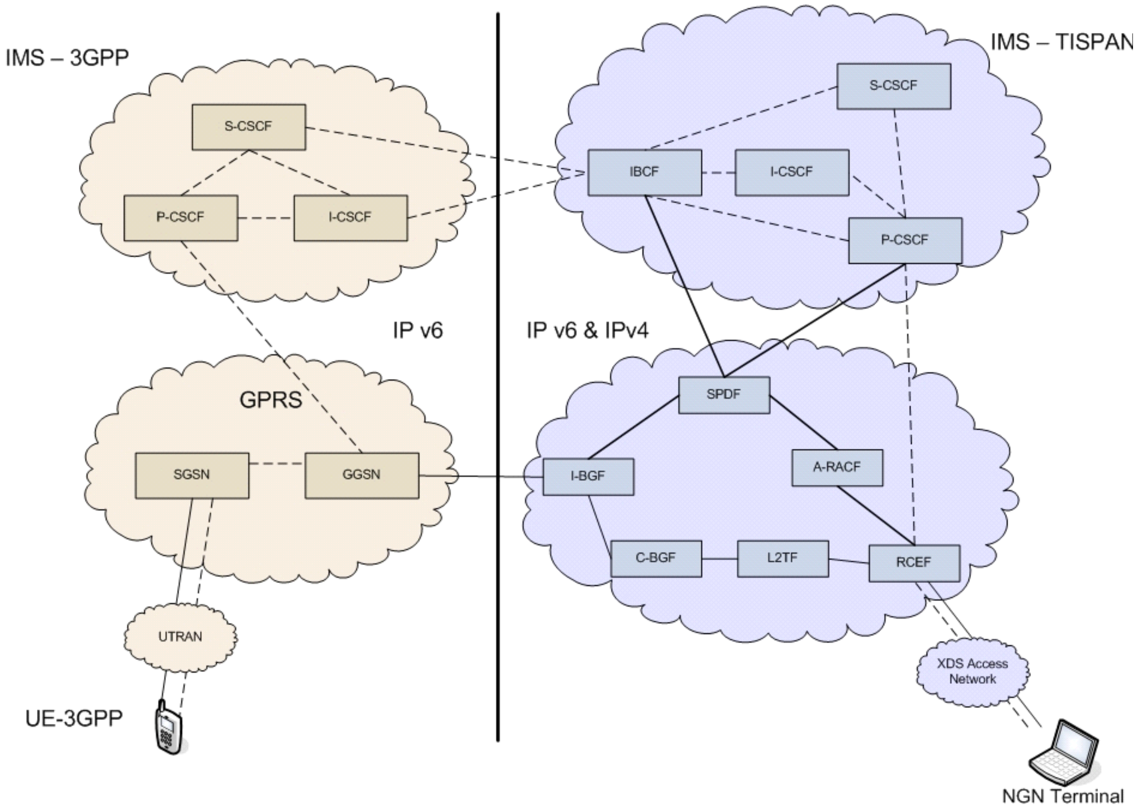
Figure 33: Functional elements of IMS



Source: Knight (2006)

In ETSI TISPAN, the interconnection scheme between the IMS 3GPP and the TISPAN IMS is done in both planes, both control and transport, by means of the Interconnection Border Control Function (I-BCF) in the control plane and the Interconnection Border Gateway Function (I-BGF) in the transport plane, see Figure 34. TISPAN defines these elements in order to enable NGN IMS operators to apply control mechanisms at entry to their respective networks, and to enable users to enjoy seamless roaming (including fixed-mobile roaming).

Figure 34: Fixed and mobile interoperability under ETSI TISPAN



Source: Moro and Fernandez (2005).

Note that the 3GPP IMS operates only under IP version 6, while NGN IMS supports both versions 6 and 4. Should IPv4-IPv6 translation be necessary, it is the job of the I-BGF.

Provision of QoS (defined in terms of bandwidth, delay or packet loss) could be a problem in the interconnection between the ETSI NGN IMS and 3GPP IMS. 3GPP IMS defines separate QoS traffic classes that are handled according to operator requirements. This means that 3GPP provides a *relative* QoS. The ETSI TISPAN IMS has two approaches for QoS control, one is a *Guaranteed QoS* (and thus absolute), the other is a *Relative QoS*. Conflicts might arise when a user in the NGN world subscribed to a service with Guaranteed QoS connects to a user/server/service in the 3GPP IMS world with relative QoS. The user might not receive the expected QoS.

2.3.2 IMS and service portfolio

Mobile network operators and the mobile industry hope to avoid being reduced to offering nothing more than commoditized "Bitpipe Transport Service". Against this backdrop, IMS is attempting to facilitate the provision of new applications and services based on new mobile terminals and IMS-based mobile access

IMS drives two developments that are hugely relevant:

- Seamlessness and ubiquity of services. The end user can access any service from any location by means of the optimal access technology via a universal terminal.
- The decoupling of the network from the service. This serves to greatly accelerate the speed of service innovation, since more parties are able to innovate.

3GPP IMS does not provide for standardised services, but instead establishes service capabilities and high level requirements, see Zarri (2003). The following requirements must be fulfilled for IP multimedia applications, see 3GPP (2006):

- Negotiable QoS for IP multimedia sessions
  - During session establishment,
  - During the session; this implies a requirement to be able to change the resources available for the radio access,
  - For individual media components.
- Negotiation of QoS between operators when roaming.
- Support for a variety of media types.
- Within each IP multimedia session, support for one or more IP multimedia applications; note that some media sessions might be prioritized over others.

With all of that said, the GSM Association has characterized IMS services roughly as follows:

- *Rich Media services* use a combination of different media: Audio (voice or music), video (live or streaming), and data (whiteboard, text or pictures). A typical example is Rich Voice.
- *Push to talk over Cellular* provides immediate communication with one or more users. It is similar to a Walkie-Talkie where a user presses a button to talk to another user or to a group. Users hear the caller's voice without any action on their part. This service is half duplex.

- *Advanced messaging:* Offers enhanced capabilities for existing types of messaging. At present, the only defined "enhanced" capability is Rich Media. There are two types of messaging: "Interactive" (Chat) and "Store and Forward" (SMS and MMS). Advance Messaging can work with both types of messages at the same time, and can decide how to send the message.

- *Push Services:* The application provides content to the end user at the initiation of another party (often a commercial service provider). For example, a restaurant "pushes" its menu to nearby customers, or a gaming service alerts subscribed users of a newly available game.

- *Gaming.* There are many variants: Between two users; user vs machine; multiplayer games; online real-time, off-line (using Advanced Messaging).

Note that some applications are feasible only between users, some are feasible only between a user and a server, some are feasible in either configuration, as shown in Table 2 below.

Table 2: Categorization of IMS Service Portfolio

Type of service	Description	Typical services
User to User Services	These services involve 2 or more users The NGN helps to manage services and, thus, adds value	Voice Videophone Rich media Advanced messaging Push to talk Gaming
Services between a User and a Server	These services involve one or more users who communicate with a central server If third party servers are used, the NGN might provide nothing more than raw connectivity	Advanced messaging Gaming Push services

Source: GSMA (2004)

2.3.3 IMS and Fixed-Mobile Convergence

Fixed-Mobile Convergence (FMC) has been a major driver of interest in IMS and later on also in NGN. Service providers who have both fixed and mobile operations see the possibility of substantial price/performance improvements through the economies of scale and scope that can flow from the adoption of an IMS-based NGN.

There are several distinct aspects of fixed-mobile convergence:

- *Commercial Convergence:* For operators with both fixed and mobile operations (such as Telefonica or Deutsche Telekom), economies of scale and scope are possible as regards staff (not just for engineering, but also for marketing, commercial and administrative staff).

- *Device Convergence:* With the ability to access services irrespective of the access network comes the possibility of devices that transparently support multiple physical layers. One can imagine a single device that operates across CDMA, TDMA, WLAN, WiMAX, and fixed networks. Furthermore, the device may be able to support multiple applications that were previously supported by different devices.

- *Network convergence:* Unit costs could be lower due to economies of scale and scope. It might be possible to use common solutions to address common challenges such as QoS, Security, Session Control, OAM and of course Authentification and Billing.

- *Service Convergence:* Homogeneous delivery of service feature independent of the access network, technology and user terminals.

Fix-Mobile Substitution is already market reality in the form of both call substitution and service substitution.[62] Moreover, many carriers currently are trying to blend mobile services in fixed wireless access (e.g. WiFi).

Fixed-Mobile Convergence (FMC) is best thought of as taking place in two distinct phases, see Prasanna (2006):

- in the short-medium term, by means of pre-IMS tactical solutions, most of them based on UMA (Unlicensed Mobile Access) and

- in the long term, based on IMS.

The rest of the present section is focusing on pre-IMS services. The long term development is addressed in section 2.3.5.

UMA is an old name for the *Generic Access Network (GAN)*. UMA describes a system that enables seamless roaming and handover between LAN and WAN using a single end terminal. It was adopted by 3GPP in April 2005. UMA/GAN uses 802.11 or Bluetooth as LAN and GSM/GPRS/UMTS (in EGAN) for WAN.

Pre-IMS FMC services based on UMA can serve as a testbed for customer acceptance. They might answer questions about the key service drivers, the customer buying ex-

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62 See e.g. Elixmann, Schäfer and Schöbel (2007) and Schäfer and Wengler (2003).

perience and the profitability of these services. They can also serve as a testbed for the technology. These services require the use of different technologies from current services and, of course, different billing and customer-care systems.

Initial pre-IMS FMC services can *not* offer information on IMS “blended” services. The initial focus of FMC has been on voice services; however, the idea of IMS is to sell a complete set of services, or better yet, a bundle of services, i.e. video, audio and rich data sessions.

The pre-IMS FMC solutions might also serve as a near term IMS entry strategy for MVNO and TIER 2 ISP operators. A TIER2 ISP operating at national level might not need to offer a complete IMS infrastructure throughout the national territory. Thus, pre-IMS FMC services might provide a smooth transition and entry.

2.3.4 International experiences with IMS

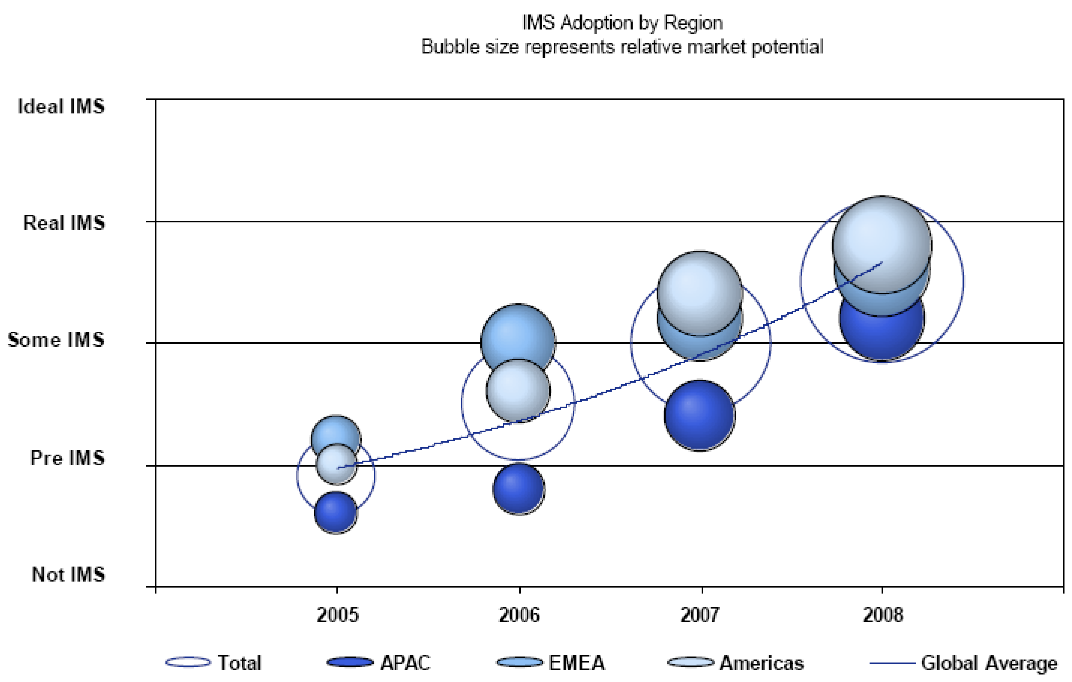
This section aims at outlining empirical evidence what carriers are doing and planning, respectively. CeBit 2006 has evidenced that a multitude of carriers and manufacturers view Fixed-Mobile Convergence as an important driver of future growth.

A number of commercial deployments of pre-IMS convergence services based on GAN or UMA have been announced:

- In September 2006 Orange announced their “unik” service.
- In September 2006 Telecom Italia quietly posted a UMA-based service called “Unico” on their web site.
- In August 2006 Telia-Sonera was the first to launch a Wi-Fi based UMA service called “Home Free”.
- T-Mobile and Vodafone have already launched new services into the market in Germany and the U.K.

Figure 35 shows an estimate of the IMS market for the year 2006.

Figure 35: Adoption of IMS by region (2005-2008)



Source: Hart (2005)

Actual operational experience with IMS continues to be limited, but several deployments have been announced:

- TECORE has started to produce IMS core network elements, based on the TECORE soft-MSC platform.
- Lucent Technologies has signed a contract with Brazil Telecom for IMS VoIP. Brazil Telecom launched the service based on IMS release 6 and TISPAN release 1 in November 2006.
- Optimus (mobile operator) has selected the Ericsson IMS solution for its IMS implementation in March 2006.
- Dutch incumbent KPN has selected Tekelec (February 2007) to expand its signalling network capacity and enable the transition to an all-internet protocol (IP) architecture. According to a joint press release, the Tekelec EAGLE 5 ISS solution supports Sigtran (SS7 over IP) signalling, which is seen as a stepping stone in the cost-effective migration to an IP multimedia subsystem (IMS) at the signalling layer.

- Softbank Mobile of Japan has launched an IP Multimedia Subsystem (IMS) over 3G solution using equipment supplied by Ericsson.

- Sweden's Ericsson has been selected by Cyta (Incumbent mit Mobilfunksparte), the leading operator in Cyprus, to provide its IP Multimedia Subsystem (IMS) solution for the implementation of what it calls 'one of the first truly converged IMS networks in the world'.

- Vietnam telecommunications carrier Saigon Post and Telecommunications (SPT) has engaged Swedish vendor Ericsson to built a nationwide IP Multimedia Subsystem (IMS) network (November 2006).

- French alternative telecoms operator neuf Cegetel has selected Nortel Networks to supply it with an IMS-ready solution to support its new product TWIN, which it claims is the country's first fixed-mobile convergence service (November 2006).

2.3.5 Future IMS trends

An article in IMS Magazine (February 2006) suggests that IMS is likely to roll out in phases. Note that the expectation of a stages regarding the emergence of IMS is consistent with the predictions from Prasanna (2006).

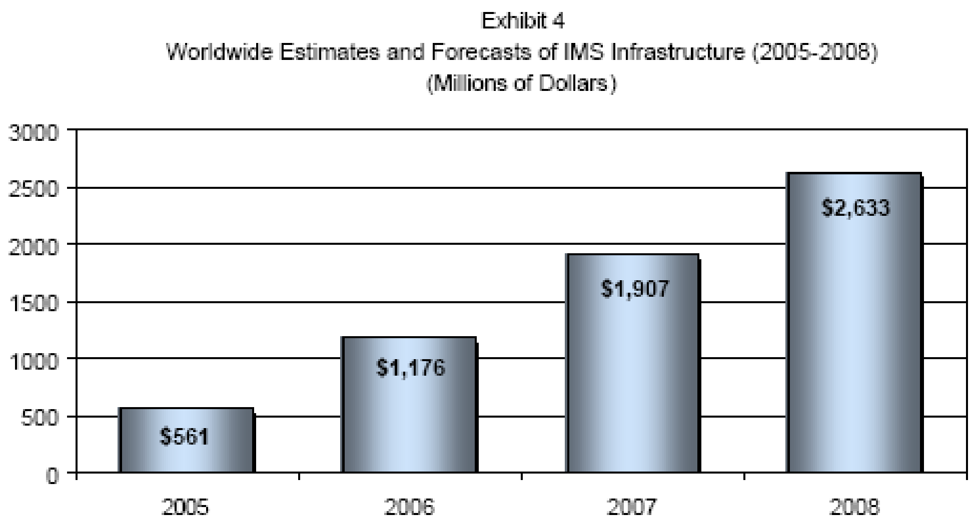
- *Phase 1: 2005-2007.* Emerging phase. Services providers seeking first mover advantages. Proof of concept, testing and some mobile deployments.

- *Phase 2: 2006-2009.* Service providers with significant IMS-capable services and agreements between fixed and mobile operators. Billing and charging will be a key consideration during this phase.

- *Phase 3: From 2010*. Full IMS deployments with broad interconnection and availability of services between fixed and mobile networks.

A number of analysts expect IMS to have success in the marketplace, see Figure 36.

Figure 36: Worldwide IMS market volume in US $ (2005-2008)



Source: Hart (2005).

2.4 NGN regulation: International examples

Several national regulatory agencies have taken account of the shift to NGNs in the market and are in or have already finished consultation processes regarding the regulatory implications, challenges and potential measures to cope with NGNs. This section will therefore focus on international examples of regulatory drafts relating to NGN. Thereby we refer both to European countries and countries outside the EU.

2.4.1 The case of the UK

The UK have already put a lot of thought into the area of NGN. Indeed, Ofcom has completed a number of public consultations dealing with the transition.[63] NGN has special relevance in the UK inasmuch as BT has proposed to phase out its traditional network completely over the next few years (and to be 50% complete in 2009, see above).

Ofcom and BT have agreed to establish BT Openreach as an access services division (ASD), providing wholesale last mile access to BT's retail operations and to competitive

63 For a comprehensive discussion, see Marcus (2006b).

operators on a nondiscriminatory *equivalence of input* basis.[64] Many of the offerings of Openreach are already available to competitors as a result of SMP remedies; however, the migration to the new arrangements implies the implementation of new Operational Support Systems that implement new nondiscriminatory ordering procedures.

The migration to Openreach – which has been a competition law undertaking, rather than an *ex ante* regulatory remedy – reflects careful planning, so as to reduce incentives for Openreach executives to favor the parent company over competitors. Openreach will have its own logos and uniforms, a board to oversee Equivalence of Input, and an employee compensation structure that is not dependent on the profitability of the parent company. The overall approach is promising, but untested – attempts in the United States to achieve something halfway between integration and structural separation have been notably unsuccessful, perhaps due to an overly "porous" boundary between the parent company and the subsidiary.

Underlying the Openreach agreements are Ofcom's belief that the migration to NGN will not, in and of itself, eliminate BT's market power on last mile access. In multiple proceedings, including the November 2006 consultation on Next Generation Access Networks, they have noted skepticism on the willingness or ability of competitors to compete with wired BT solutions, and uncertainty as to the relevance of wireless competition.[65]

Ofcom has also considered the implications of changes in the number of points of interconnection,[66] and how to adjust BT's permissible regulated return so as to deal with the increased risk of deployment for an NGN.[67] For the former, they consider it inappropriate to indefinitely lock BT into its current interconnection arrangements, but note concerns about stranded investments caused by actions unilaterally undertaken by BT without industry agreement, particularly where the stranded equipment was deployed before the change was announced, and would otherwise have had a significant expected remaining longevity. For the latter, they permitted two different rates of return, based on different estimates of the *Weighted Average Cost of Capital (WACC)*, for BT's last mile operations versus BT's other operations.

Following up the 2005 consultation ("Next Generation Networks: Further Consultation") which proposed a number of policy principles and processes to support the development of NGNs in the UK OFCOM has further developed its stance towards regulation of

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64 See http://www.ofcom.org.uk/media/news/2005/06/nr_20050623 and http://www.ofcom.org.uk/consult/condocs/telecoms_p2/statement/main.pdf. See also Ofcom's Final statements on the *Strategic Review of Telecommunications, and undertakings in lieu of a reference under the Enterprise Act 2002*, 22 September 2005.

65 Regulatory challenges posed by next generation access networks, 23 November 2006, sections 1.3-1.8.

66 See Ofcom (2004) and Ofcom (2005b). BT currently has more than 3,000 points at which competitors can interconnect; in the future, they propose perhaps 100-120.

67 See Ofcom (2005c).

NGNs. In its March 2006 publication (Next Generation Networks: Developing the regulatory framework) OFCOM states that in order to support the deployment of NGNs there is a need to help NGN based competition become a reality. According to OFCOM this requires both market led commercial engagement as well as development of an ex ante competition framework so that it reflects convergence and new services such as VoIP. This, in turn, will bring about quite complex questions about the structure of markets and the nature of interconnection between communications providers.

OFCOM views the key challenge in taking forward NGN competition issues to be establishing an appropriate balance between its role in providing certainty as to the regulatory framework and the role of the market in determining the commercial outcome of NGN-based competition. They therefore proposed two parallel and complementary strands of work:

- An improved framework for industry engagement
- Greater certainty as to the application of the ex ante competition regime.

In order to support industry engagement a new NGN industry body has been set up: NGN UK (Next Generation Networks in United Kingdom), see http://www.ngnuk.org.uk.

The objective of this independent body is primarily the improvement of the framework for NGN. It acts as a forum which aims at bringing together the main investors and stakeholders (industry, regulation and policy) involved in the development of the NGN infrastructure. Of course one important element of this forum is the deployment of BT's All-IP network, see section 2.2.2.1. The industry forum aims at finalizing till 2008 an appropriate interconnection regime for NGN which covers in a suitable way transport and provision of services across different NGN networks.[68]

The members of this forum consist of (as of March 2007)

- Executive Members, e.g. the wholesale arm of BT, Cable and Wireless, Carphone Warehouse, Colt, Easynet/Sky, Kingston Communications, NTL Telewest, Orange, Thus, T-Mobile and Vodafone,
- Participating Members, e.g. AboveNet, Gamma Telecom, Global Crossing, Hutchison 3G, London Internet Exchange, Time Warner, Tiscali, Verizon Business and Viatel,
- Asociate Members. Currently only the Federation of Communications Suppliers is an associate member.

68 This implies e.g. the development of and the agreement on the services provided, the agreement on the commercial framework for the provision of services regarding IP interconnection, and the establishment of a timetable for the commercial and technical implementation of interconnection agreements. Moreover, the forum is to address missing standards.

Thus, the industry forum comprises facilties based market participants as well as content providers and application providers. The current NGN UK plan of work is focusing on the definition of requirements, the development of a technical and commercial framework and on implementation and transition issues regarding NGN. To this end NGN UK focuses on the following objectives[69]:

- Establish and agree the reference set of services,
- Establish and agree the capabilities and transport architecture needed to support the reference set of services,
- Distil the commercial issues that, when agreed, will enable successful implementation of the reference set of services and new services across an NGN interconnect,
- Create an implementation roadmap to deliver the commercial and technical interconnect agreements,
- Satisfy the reasonable requirements of all stakeholders,
- Identify and commission missing standards work, if any,
- Work with international groups to ensure the UK is not isolated in any solutions that NGN UK adopts.

The activities of the NGN UK forum are based on a Reference Model. Essential elements of this model are on the one hand a set of reference services:[70]

- Real time person-to-person services (eg. voice calls, video calls, conference calls etc),
- Near real time interactive services (eg. instant messaging, press to talk, etc.,
- Streaming services (eg. live radio, live TV, Video on Demand, etc.),
- Data connection services (eg. IP, Ethernet, etc.).

On the other hand the reference model takes account of different network layers:

- Transport architecture; covers transport requirements within OSI layers 1 (Physical Layer) to 4 (Transport Layer) and associated commercial, legal or regulatory factors. Addresses the physical design requirements of how networks interconnect through

69 http://www.ngnuk.org.uk/8.html, download March 14, 2007.
70 Obviously the following groupings of end-to-end end-user service types include all services and applications which a critical mass of the NGN UK members wish to see supported over interconnected NGNs.

how communication is established and maintained, the quality parameters for the different reference services and how traffic is efficiently routed between NGNs.

- Network capabilities; addresses intelligence and control requirements within OSI layers 5 (Session layer) and above. Addresses how sessions are managed, synchronisation data formatting and conversion through to interaction between applications.

Collectively, Ofcom's consultations represent a thoughtful and forward-looking approach to the problems of NGN regulation. At the same time, relatively little is finally resolved in these proceedings. Rather, they rely on a process where participation of a broad set of stakeholders is intended and supported in order to come to pertinent agreements and solutions.

OFCOM has, however, addressed thoroughly in their 2006 consultation the regulation of VoIP, where special reference has been taken to access to emergency services.[71] Ofcom engaged in extensive industry consultation on this difficult issue. For VoIP-based providers of publicly available telephone services (PATS), Ofcom has announced its intent to enforce PATS obligations, including an access requirement for emergency services, beginning some six months after release; however, not all VoIP providers are PATS. To the extent that a VoIP service does not provide the access to emergency services that would be expected of a traditional voice service, Ofcom looks to the provider to inform and educate the consumer. Ofcom's ruling embraces consumer rights, consumer education, and informed consumer choice — they even went so far as to conduct market research and focus groups.[72]

Recent relevant public consultations of OFCOM include:

- *Next Generation Networks – Future arrangements for access and interconnection* (First Consultation), 24 October 2004,

- *Next Generation Networks – Future arrangements for access and interconnection* (Consultation), 13 January 2005,

- *Ofcom's approach to risk in the assessment of the cost of capital*, 26 January 2005 (updated 2 February),

- *Ofcom's approach to risk in the assessment of the cost of capital: Second consultation in relation to BT's equity beta*, 23 June 2005,

- *Next Generation Networks: Further consultation* (Further Consultation), 30 June 2005,

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71 See Ofcom (2006).
72 See Marcus (2006a).

- *Ofcom's approach to risk in the assessment of the cost of capital: Final statement* (Final Statement), 18 August 2005,
- *Review of BT's network charge controls: Explanatory Statement and Notification of decisions on BT's SMP status and charge controls in narrowband wholesale markets*, 18 August 2005,
- *Final statements on the Strategic Review of Telecommunications, and undertakings in lieu of a reference under the Enterprise Act 2002* (Strategic Review), 22 September 2005,
- *Regulation of VoIP Services: Statement and Further Consultation*, 22 February 2006,
- *Next Generation Networks: Developing the regulatory framework*, 7 March 2006,
- *Regulatory challenges posed by next generation access networks*, 23 November 2006.

2.4.2 The case of Japan

Study Group on a Framework for Competition Rules to Address the Transition to IP-Based Networks

The Ministry of Internal Affairs and Communications (MIC) in Japan has set up a "Study Group on a Framework for Competition Rules to Address the Transition to IP-Based Networks" on October 28, 2005. The group studied a framework for an interconnection and tariff policy and compiled a final report in September 2006, see MIC (2006).

The report mainly deals with the changes in the competitive environment in the transition to IP-based networks and the necessity for a revision of competition rules. MIC points out that "market integration in the transition to IP-based networks has been eroding the traditional distinction among service categories".[73] MIC formulates the following five basic principles for competition policy in the transition to IP-based networks:

- Ensuring fair competition at the telecommunications layer (comprising the physical network layer and the telecommunications service layer),
- Ensuring fair competition focussing on the vertical integration business model,
- Ensuring competitive and technological neutrality,

73 See MIC (2006), p.2.

- Protecting consumer interests,
- Ensuring that competition rules are flexible, transparent and consistent.

Moreover, the study stresses the importance of an appropriate balance between facility-based competition and service-based competition in the communications sector. Furthermore MIC introduces three principles to ensure network neutrality:

- IP-based networks should be accessible to users and easy to use, allowing access to content and application layers,
- IP-based networks should be accessible and available to any terminal that meets the relevant technical standards, and should support end-to-end telecommunications,
- Users should be provided with equality of access to telecommunications and platform layers at a reasonable price.

Study Group on Network Architecture[74]

On January 29, 2007, MIC has held the first meeting of the "Study Group on Network Architecture" with the purpose of gathering information on future shapes of networks and issues to be tackled from a variety of viewpoints. To characterize the background of the Study Group MIC states that along with advancements in IP-based networks, home networks and ubiquitous networks, structures of information and communications networks have been changing in Japan. They also claim to have studied in the U.S. and European countries new-generation network technologies for 10 years ahead. The Study Group was therefore set up with the aim of investigating development stages of networks and the issues that need to be tackled. The main themes addressed by the Study Group are

- Development stages of networks,
- Socioeconomic effects to be brought about through realization of new-generation networks,
- Other relevant issues to be tackled like e.g. R&D, standardization, promotion schemes.

The Study Group will compile its findings as a report by June 2007.

74 MIC Communications News Vol. 17, No. 23; http://www.soumu.go.jp/joho_tsusin/eng/newsletter.html

2.4.3 The case of the Netherlands

OPTA in the Netherlands: OPTA recently has issued a position paper on KPN’s All-IP strategy. In this paper OPTA indicates its intention to develop policy rules (‘beleidsregels') which will impose a series of conditions upon KPN. The essence of the envisaged rules, focusing on the conditions surrounding the phasing out of MDF locations, is as follows:

- KPN may not initiate the phasing out process of MDF locations until OPTA has approved KPN's reference offer for sub-loop unbundling (unbundling the access network from street cabinets).
- The phasing out process for a specific MDF location will have to be initiated by means of an announcement on KPN's website, a written communication to the companies that take MDF access at that location, and a written notification to OPTA.
- KPN must grant MDF access takers a reasonable phasing out time. This means that MDF access and co-location takers will have to have had a reasonable time (proposed to be set at 5 years) to depreciate the one-off fees for co-location paid to KPN for that location, and a reasonable time (proposed to be set at 2 years + 3 months) for carrying out the migration process from MDF access to sub-loop unbundling. The timeframe that KPN will have to respect for each individual location would be 2 years + 3 months unless the timeframe for depreciating co-location investment of some of the alternative operators present at that location is longer (maximum 5 years).
- KPN and takers of MDF access are to be entitled to agree different timeframes for each specific location. KPN will then have to publish on its website for which locations alternative arrangements have been made, what those arrangements entail, and notify these to OPTA.
- When KPN has announced the phasing out of an MDF location, this must in principle lead to the migration away of all parties (KPN and all altnets) from that location.
- Alternative operators may, at all times, continue to request unbundled access at existing MDF locations. KPN is to be required to make a formal phasing out announcement, and within the principles set out above, may limit the duration of MDF access supply to the remaining part of the phasing out process.

OPTA also has indicated that it intends to re-initiate the market analysis of Market 11 of the European Commission's Recommendation on Relevant Markets Susceptible to Ex-Ante Regulation (unbundled access) and Market 12 of the same Recommendation (wholesale broadband access) and to assess to which market(s) backhaul from sub-loop unbundling locations belongs, with a view to being able to determine the appropriate obligations during the process of phasing out MDF access.

These proposals by OPTA have been open for consultation until late 2006. Just recently (on January 24, 2007) OPTA, however, has fundamentally revised its proposed position on KPN's All-IP Project:

OPTA is essentially abandoning (for the time being) its announced intention to publish policy rules ('beleidsregels') for the phasing out of local loop unbundling from Main Distribution Frames (MDF access).

The motivation that OPTA puts forward for this fundamental revision of the previously announced approach is that they have provisionally concluded that a fully fledged alternative ('volwaardig alternatief') for MDF access cannot be guaranteed in the prevailing circumstances. Alternatives previously examined included sub-loop unbundling from street cabinets, (limited consideration of) backhaul from the street cabinet locations, and wholesale broadband access (including over VDSL2). Specifically, OPTA states that permitting KPN to withdraw MDF access would only be conceivable if market entry possibilities and the continuity of service provision by alternative operators would be sufficiently guaranteed.

According to OPTA, the studies conducted, and input received from alternative operators, indicate, however, that it is not sufficiently clear that a fully fledged alternative would be sufficiently guaranteed. The board of OPTA will now examine 'possible avenues for solutions', including explicitly the possibility of maintaining traditional MDF access for local loop unbundling. OPTA indicates that it expects to be able to provide clarification on its stance by the end of Feb 2007. OPTA has also stated that the draft revised market analyses for wholesale unbundled access (Market 11) and wholesale broadband access (Market 12) are progressing and are expected to be put to national consultation in Q2 2007. Moreover, OPTA will publish an external study that it commissioned on 'migration timelines' (for the phasing out of MDF access). Market participants are involved in this study. OPTA will issue its decision on KPN's proposed reference offer for sub-loop unbundling in Q2 2007. Market participants are involved in the consideration of this offer. Furthermore, OPTA has announced to publish a study it commissioned on the UK 'equivalence' model, and its possible applicability in The Netherlands (presumably in February 2007).

One of the key elements that has triggered OPTA's revised position, alongside the market participants' reaction to the consultation, is the study it commissioned on the business case for alternative operators using sub-loop unbundling from street cabinets. Roughly speaking, the study concludes that the threshold for economic viability for an alternative operator using sub-loop unbundling from street cabinets is unlikely to be achieved by any alternative operator unless it reaches an enormous market share (in a market that is characterised by major presence of cable networks) or can operate on the basis of sub-loop unbundling very selectively whilst having a larger global broadband market share than Dutch alternative operators currently control, and under the assumption of considerably increased average revenue per user.

In more detail the key results of the study for OPTA are as follows, see Analysis (2007).

Based on the current interconnect and wholesale offers from KPN the use of sub-loop unbundling (SLU) by an alternative provider is not economically viable as an alternative to continuing to use LLU, except under certain conditions. A business case for SLU with similar economic viability to that of continuing use of LLU for 60% of the population would require both

- a market share greater than 55% of all broadband lines (including cable) in areas served
- the highest estimate for incremental revenue (increase in ARPU across all broadband users of EUR 10 per month by 2016).

For an alternative provider with a 10% market share of all broadband lines in areas served, it may be economically viable to deploy SLU to around 1,000 of the largest street cabinets in the dense urban areas, provided that

- the interconnect and wholesale tariffs from KPN for SLU line rental, co-location and links to the street cabinets are reduced significantly (tested 50%)
- an increase in ARPU of around EUR 9 per user per month can be achieved for the entire period (which is considered reasonable if business customers are targeted).

The strong local economies of scale effects that are evident in deployment at the street cabinet level mean that even if such significant cuts of 50% in KPN's interconnect and wholesale tariffs were to be realised, the use of SLU would still not be economically viable as an alternative to LLU to reach the mass market, unless it is assumed for example:

- a market share of 25%, together with the medium estimate for ARPU increase
- a market share of 16%, together with the highest estimate for ARPU increase.

The current offer from KPN for WBA is also unlikely to be economically viable as an alternative to continuing to use LLU to reach the mass market regardless of the market share, even with the highest estimate for ARPU increase. Analysys concludes that should OPTA wish to influence the prices offered by KPN to make the SLU option more viable, the prices which affect the viability of an alternative operator's business plan the most are those for the line rental, SDF co-location and SDF–MDF link. Furthermore, the assessment of the cost of building a competitive network to provide backhaul to street cabinets indicates that unless very substantial revenue streams can be generated from services other than SLU backhaul, then it will not be possible for a third party to provide such backhaul at prices at the same level as, or below, the current offer from KPN.

On the basis of a separate study commissoned to NERA[75] KPN has learned that OPTA has reached the preliminary conclusion that the incumbent will not be forced to hive off its network into a separate business. The argument is that while such a separation could theoretically prevent anti-competitive practices, it could also result in a situation where the incumbent operator and rivals postpone investments in NGN technologies. In addition, OPTA found that the intensity of intra-modal competition with regard to the cable infrastructure market made it unnecessary to action a split. OPTA also concluded that it currently does not have the regulatory power to force a separation on KPN and said it had decided, for the time being at least, to leave it up to KPN and alternative operators to negotiate on network access for LLU once KPN starts its new network.

2.4.4 The case of the USA

2.4.4.1 Access regulation

Under the Bush Administration (2001-2008), access regulation in the United States has been consistently moving in the direction of reducing or eliminating regulatory support for service-based competition in order to encourage incumbents to invest. Little or no analysis of SMP has been attempted.[76]

This has, as might have been expected, led to mixed results. Incumbent (especially RBOC) investments in FTTx have been quite substantial. At the same time, wired competitors have for the most part been forced either to merge or to exit the business. This is true of MCI and and of the former AT&T, which were acquired by Verizon and by SBC respectively. SBC assumed AT&T's name after the acquisition.

The reality is complex. The U.S. benefits from robust facilities-based competition from cable operators, who continue to provide the majority of wired broadband access in the United States. On the other hand, service-based ADSL wholesale competition, which a few years ago was something like 7% and expanding, now stands at 3.3% of ADSL lines and steadily declining.[77] This is in comparison to some 40% in the European Union as a whole.[78] FCC policy has consciously attempted to stimulate incumbent deployment, possibly with some success, but at the cost of permitting the broadband marketplace to collapse to a series of geographically specific duopolies for wired broadband access. The overall impact on competition, and possibly also on net investment, has been adverse.

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75 See NERA (2007); see also http://www.telegeography.com/cu/article.php?article_id=16912&email=html; March 6, 2007.

76 For a more extensive discussion of the themes in this section, see Marcus (2005).

77 FCC, *High-Speed Services for Internet Access: Status as of June 30, 2006*, Table 6, available at: http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-270128A1.pdf.

78 European Commission, *11th Implementation Report*.

These policies are reflected in a long series of FCC actions:

- *Shared access to DSL.* The FCC eliminated the obligation for incumbents to provide shared DSL access to competitors.[79] Prior to its elimination, this program had effectively spurred deployment and competition.[80]

- *Unbundling obligations for last mile fiber.* The FCC decided not to require loop unbundling for fiber-to-the-premises, ostensibly in order to spur deployment.[81]

- *Internet access via cable modem.* Access to the Internet sold bundled with cable modem access was declared to be an information service, making it by default exempt from common carrier regulation.[82]

- *Internet access via DSL.* Access to the Internet sold bundled with DSL access was declared to be an information service, making it by default exempt from common carrier regulation.[83]

- *Non-discrimination obligations and obligations to offer DSL at wholesale.* These obligations were eliminated for all wired broadband connections offered by telecommunications carriers.[84] The FCC asserted that the wholesale market for DSL and cable modem Internet access services was effective, and would remain so in the absence of regulation. Given that wholesale ADSL access stood at less than 4% of all ADSL lines at the time (and was in decline), and that wholesale access over cable was negligible, this claim is incomprehensible.

The elimination of non-discrimination obligations turns out to be particularly significant. This is the regulatory change that triggered the full emergence of the Network Neutrality debate in the United States. We return to the topic of Network Neutrality in Section 4.5.5.

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79 FCC, *In the Matter of Review of the Section 251 Unbundling Obligations of Incumbent Local Exchange Carriers; Implementation of the Local Competition Provisions of the Telecommunications Act of 1996; Deployment of Wireline Services Offering Advanced Telecommunications Capability, generally referred to as the Triennial Review Order* (hereinafter TRO), adopted February 20th, 2003, released August 21st, 2003, starting at §255.

80 See, for instance Kahn (2001), p. 23.

81 FCC, *TRO*, op. cit.

82 FCC, *Cable Modem Declaratory Ruling and Notice of Proposed Rulemaking*, 14 March 2002.

83 FCC, *In the Matters of Appropriate Framework for Broadband Access to the Internet over Wireline Facilities; Universal Service Obligations of Broadband Providers Review of Regulatory Requirements for Incumbent LEC Broadband Telecommunications Services; Computer III Further Remand Proceedings: Bell Operating Company Provision of Enhanced Services; …* (hereinafter *Computer Inquiries Order*), 23 September 2005.

84 Ibid.

2.4.4.2 VoIP and emergency services

In an order issued in May 2005, the FCC required all VoIP providers that are interconnected with the public switched telephone network (PSTN) to provide enhanced E-911 services.[85] This is a rather stringent standard — while basic 911 services merely require connection to the appropriate public service access point (PSAP), E-911 requires that the user's callback number and, in general, location be accurately reported to the PSAP. The interconnected VoIP providers are effectively required to route 911 calls through the wired E-911 network.

The FCC's proactive stance is perhaps commendable, but the implementation was grievously flawed.[86] By requiring VoIP providers to use facilities of the wired incumbents, but refusing to mandate that the incumbents provide interconnection, the FCC enhanced the market power of the incumbents and undermined competitive entry. They exacerbated the problem by setting an unrealistic 120 day deadline, and threatening to force providers who failed to comply to cease business.

They declined to permit any exceptions for technical feasibility, even though the requirements of the order are in fact not reliably feasible under today's technology. They required consumers whose location could not be unambiguously determined to self-report their location; however, they failed to address the self-evident need for consumer education to deal with the blatantly obvious failure modes where (1) the consumer self-reports incorrectly, (2) the consumer forgets to self-report, or (3) there is a time-lag between the report and the propagation into relevant databases.

They also refused to permit informed consumers to opt out of emergency services.

The FCC approach is clearly the wrong way to go about solving the problem. The Ofcom approach is infinitely superior.

2.4.4.3 CALEA (lawful intercept) applicable to VoIP and broadband

A 2005 FCC order expands the applicability of CALEA – a statute which facilitates wiretapping and similar lawful intercept practices in support of law enforcement, subject to prior consent from a court – to include interconnected VoIP providers and facilities-based broadband Internet access providers.[87] CALEA is not the actual authority to perform the intercept, but rather the requirement that these service providers proactively instrument their respective networks in advance in order to facilitate any requests that they may receive for lawful intercept.

85 FCC, *In the Matters of IP-Enabled Services/E911 Requirements for IP-Enabled Service Providers*, 3 June 2005.

86 See Marcus (2006a) and Marcus (2005).

87 FCC, *In the Matter of Communications Assistance for Law Enforcement Act and Broadband Access and Services, First Report and Order and Further Notice of Proposed Rulemaking*, 23 September 2005.

2.4.5 The case of Germany

There are two main issues relevant for migration of networks to NGN which have been addressed by regulation policy in Germany:

- Interconnection in IP based networks,
- Amendment of the German Telecommunications Law regarding (non-) regulation of "new markets".

2.4.5.1 Interconnection in IP based networks

The regulatory agency in Germany (BNetzA) has set up in 2005 a Project Group „Framework for Interconnection in IP-based Networks". This expert group has submitted its final report in December 2006.[88] This report has been under public consultation by February 26, 2007. The main issues regarding an IP based interconnection regime addressed in this report are:

- Number and geographical location of interconnection points as well as hierarchy and functionality of the interconnection poins. They are determined by the network architecture (network topology and functional layers in NGNs).
- Quality standards at which traffic is transferred, i.e. standards to be specified taking into account the character of the all-IP network as a multi-service network.
- Pricing principles for interconnection rates, such as progressive rates according to interconnection levels (e.g. for EBC: local, single and double transit) as well as accounting units (e.g. minutes or data volumes). Moreover, presumably complex questions about cost allocation have to be taken into account if rates are differentiated according to services or quality classes.
- the accounting system being a core element that determines "who" pays for which parts of the value chain.

The report has come to the following main conclusions (see BNetzA (2006)):

- Compared with the interconnection in traditional TDM-based networks, interconnection in future network structures shows a higher level of complexity as it can occur on several functional layers. To ensure complete service operability (including end-to-end connectivity), it may be required to ensure interconnection on all layers (service, control and transport layer).

88 See http://www.bundesnetzagentur.de/media/archive/8370.pdf (as of January 22, 2007).

- A scenario calculation for all broadband traffic based upon a hypothetical national NGN in Germany showed that no more than 100 IP core network locations can be expected in the long run. This result also applies even on the basis of high growth rates in the bandwidth required by bandwidth users.

- The task during the migration process will likely be the interconnection of PSTN/ISDN networks and their replacement by interconnecting NGN networks. [89]

- A reduction in the number of interconnection points will mainly affect national or local PSTN/ISDN network carriers. This should mainly be the case if the interconnection points with their PSTN/ISDN networks that have been used so far are abandoned by the national carrier. From a regulatory point of view, suitable interconnection and access products must be ensured. ”Stranded investments“ should be minimized among all market participants.

- Regarding end-to-end quality in NGNs and other IP-based networks three strategies can generally be differentiated: Overdimensioning, traffic prioritizing and capacity reservation. They can be used individually or in combination.

- Overdimensioning may be a feasible strategy in the short run to implement voice integration but an inadequate differentiation between best-effort and real-time means that this approach cannot provide adequate protection against overload (in particular for time-critical services with ”Service Level Agreements“ SLA). Service prioritizing may have the edge over both overdimensioning and capacity reservation in the medium-term if additional traffic management measures (incl. inter-network) have been implemented. Service prioritizing mainly poses problems in traffic management and cost allocation. The capacity reservation approach is a resource intensive strategy that keeps pace with traffic growth inadequately.

- Standards do not exist for interconnected IP/MPLS networks to ensure QoS on an end-to-end basis. Therefore, QoS can only be ensured beyond the network boundaries of two independent networks on a bilateral basis (service level agreements, specification of the border gateway protocol for treating prioritized traffic).

- The allocation of additional costs for the implementation of QoS to several services or types of traffic will definitely raise complex questions, since a variety of interdependencies are involved. The additional costs of realizing QoS depend upon the traffic ratio between besteffort and real-time services.

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89 The report concludes that “it cannot yet be identified whether this interconnection for the termination of VoIP traffic will be limited to the locations of IP network nodes or if interconnection at a lower level between the locations of the concentrator network will be possible. From this perspective, the question of the number of interconnection levels and thus also the number of interconnection points between NGNs of various carriers remains open from a technical and economic point of view.”, see BNetzA (2006), p. 13.

- For application of the efficient service provision as the cost standard determined in the TKG, the Federal Network Agency will widen their information basis on the costs of NGNs and may enter into dialog with the market with cost models.

- The costs in the NGN are expected to be substantially lower than in the PSTN. It seems likely that these lower costs have to be taken as a basis for the pricing of IP interconnection. Application of this pricing policy presumably has to be independent of whether interconnection is realized via PSTN or NGN. This is due to the fact that a strict application of the long-run incremental cost principle determined in the TKG requires the efficient technology used by the market to be taken as a basis.

- In view of the (potential) cost change due to NGN, an immediate switch of the interconnection rates to this low NGN level is, however, considered too disruptive for the market and particularly for the providers of interconnection services. Thus, a glide path could be based on a mixture of the costs of the PSTN/ISDN and the NGN with an increasing proportion of NGN costs over time.

- In consideration of the fact that different pricing systems for different networks involve arbitrage and bypass possibilities, a uniform pricing system for the PSTN and NGN interconnection should be considered. The new price level for interconnection services based upon NGN costs should be reached when the transition to NGN has been completed.

- The report addresses in detail the different accounting systems for interconnection in PSTN and IP-based networks (Calling Party's Network Pays regarding the PSTN and mainly Bill & Keep and transit agreements regarding Internet traffic). However, a clear decision in favour of one or the other concept has not been made.

- Inevitably there will be a migration path. According to the experts' unanimous opinion, it is impossible to make a precise statement about the actual duration of the migration path.

- The duration of the migration path presumably depends upon a variety of factors: (1) Individual network carriers have different investment cycles and will make their investment decisions according to the quality and depreciation of their existing networks. With respect to the national interconnection regime the speed of network migration of the national carrier is decisive. (2) Investment decisions made by network carriers are determined also by how long manufacturers maintain the old technology (i.e. availability of software updates for current switching technology like EWSD). (3) Market development in terms of traffic volume and penetration of NGN services plays an important role.

Moreover, section 3 of the BNetzA report contains cornerstones for interconnecting IP-based networks which have been elaborated by a group of German telecommunication companies. The results achieved in this Group are based upon the Calling Party's Network Pays (CPNP) principle as the interconnection regime. The main issues addressed by the Group are

- A differentiation between Voice over NGN and Voice over Internet,
- Quality parameters and the availability at the network boundary, safety (i.e. suitable solutions for the protection of customers against SPIT, spoofing, etc.),
- Addressing; a differentiation is made between network addressing and subscriber addressing. Network addressing is to be realized via protected public IP addresses. E.164 numbers are generally used for subscriber addressing. Other addressing possibilities are conceivable in the future if necessary;
- Transfer of service portfolio that is generally applicable for interconnection in PSTN today to NGN interconnection,
- Exchange of porting data,
- Pricing for voice connections in NGN interconnection.

2.4.5.2 Amendment of the German Telecommunications Law regarding (non-) regulation of "new markets"

The new German Telecommunications Law defines (see Section 3: Definition of Terms; For the purposes of this Act…)

- No. 12b: "new market" means a market for services and products which are more than insignificantly different from existing services and products in terms of performance, range, availability to larger groups of users (mass-market capability), price or quality from the point of view of an informed user and which do not merely replace existing services and products.
- Section 9a (New Markets) then specifies
- (1) Save as provided in the following paragraph, new markets are not in principle subject to regulation under Part 2.
- (2) In derogation of paragraph 1, where facts warrant the assumption that a lack of regulation will in the long term impede the development of a sustainable competition-oriented market in the field of telecommunications services or networks, the Federal Network Agency may subject a new market to regulation under Part 2, pursuant to Sections 9, 10, 11 and 12. When examining the need for regulation and the imposition of measures, the Federal Network Agency shall give particular consideration to the aim of fostering efficient investment in infrastructure and the promotion of innovation.

In principle, the above clauses could mean a far reaching abolition of regulation in particular for DTAG's new investments in VDSL technology, see section 2.2.2.1. This, however, has led to severe tensions between Germany and the EU Commission.

The EU Commission has made clear[90] that under its remedy endorsed, bitstream access will need to be granted by Deutsche Telekom also to its new VDSL infrastructure currently built in several German cities. In its letter with comments under Article 7 of the EU Framework Directive for electronic communications, the Commission makes clear that this access obligation should apply when this new infrastructure is in place. The Commission notes that at present, there is no indication of a lack of substitution between VDSL-based access and other bitstream products, and recalls that a mere upgrade of an existing service (such as an offering with a higher bandwidth) is not considered in itself to lead to new products or services. In any event, a finding of non-substitutability of a particular product or service by BNetzA and consequently an exclusion of a certain product from the remedies imposed would require an amendment of the market analysis and the remedy in force and thus would need to be notified again to the Commission.

Moreover, Commissioner Reding has made clear on several occasions that she will launch infringement proceedings against Germany if the German legislature endorses the decision, which gives Deutsche Telekom immunity from having to offer new broadband lines to its rivals.[91]

These amendments of the German Telecommunications Law have taken effect in Februray 2007. In response, Commissioner Reding has sent the Germen Government a letter "of formal notice"[92], the first stage in a legal challenge to change the law. The matter is likely to end up before the European Court of Justice. This process obviously can last several years. Commissioner Reding has, however, said she will fast-track the case so that Germany is in court by the summer.

It is hard to say what the final outcome of the "regulatory holiday" case will be. Formally, as one can see from the text of § 9a the law does not refer explicitly to fibre deployment up to the cabinet and VDSL. However, of course DTAG is claiming that their respective investments should be covered by the new law. On the other hand the President of the BNetzA has declared publicly on various occasions that deployment of new infrastructure as such does not constitute a new and emerging market. Rather, the crucial issue

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90 Source: Commission gives green light for access of new market entrants to Deutsche Telekom's broadband networks, Reference: IP/06/1110 Date: 21/08/2006.

91 "An exemption from regulation as currently debated by the Bundestag [the lower chamber of Germany's federal parliament] contravenes EU law. We have already determined this through our detailed examination of the issue…. And we will take legal steps against such a violation of the European Union Treaty." Quotation of V. Reding; Source: http://www.cebit.de/newsanzeige_e?news=27049&tag=1163199601&source=/newsarchiv_e.

92 It seems that under legal procedures, the German government has only been given 15 days to answer the legal notice issued by the Commission (information as of February 27, 2007).

is if new services are supplied on top of this new infrastructure. The regulatory treatment of DTAG's fibre/VDSL deployment is still in the beginning and it will presumably been addressed in the regular revisions of the market definition (in particular with respect to market 11 and 12). In a recent draft revision of the market 11 market definition/analysis (as of April 4, 2007) BNetzA has come to the conclusion to impose a new obligation on DTAG, namely to grant competitors access to ducts between the MDFs and the street cabinets.

2.4.6 Other relevant regulatory documents

This section is addressing the ERG stance regarding NGN. The ERG has set up a project team on IP-Interconnection and NGN; a Consultation Document on IP interconnection has been published recently (October 12, 2006).[93] The main issues addressed in this report are:

- Separation of functional levels

  Interoperability becomes necessary on different functional levels of an NGN to ensure overall service interoperability. To guarantee end-to-end-connectivity interconnection throughout all levels is needed. In most NGNs run by incumbents transport is separated from the control level (signaling etc.) and services tend to be provided using centralized platforms (Media Gateway Controller, Softswitch). This has an impact on the ability of independent service-providers to integrate their services into the NGN-platform.

- Structural implications for the interconnection regime

  The migration process towards IP-NGN potentially entails several structural changes such as a rearrangement of core network nodes and changes in the number of network hierarchy levels. This may accordingly lead to a geographic rearrangement of points of interconnection. An overall reduction in the number of points of interconnection can be expected. This might imply stranded investments of alternative operators having rolled-out towards a considerable number of points of interconnection in the existing PSTN.

- Options for charging principles

  Where commercial agreements cannot be reached, NRAs will be involved in setting charges, charging principles and resolving disputes. At the *retail* level mainly two billing regimes can be distinguished: "Calling Party Pays" (CPP) and "Receiving Party Pays" (RPP).

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93 See http://erg.eu.int/doc/publications/erg_06_42_consult_doc_ip_interconnection_rev.pdf

- Options for wholesale billing regimes

  On the wholesale level “Calling Party’s Network Pays” (CPNP) and Bill & Keep can be distinguished. Under CPNP the network of the caller pays for the whole call. CPNP termination leads to a problem that is known as the termination monopoly. With Bill & Keep there are no charges for termination. Basically, Bill & Keep is a kind of barter exchange where network operator *A* on his network terminates traffic coming from network *B* and vice versa. There is no termination monopoly problem under Bill & Keep and there is no need to determine the “right” termination rates.

Part of the ERG’s working programme for 2007 is the formulation of a common position on NGN regulatory principles. This release is scheduled for the Q4 2007.

2.4.7 Interrelationship between regulation and regulated market participants

Comparing regulatory different outcomes in different countries, and notably among different Member States, we see that different regulatory authorities have approached the migration to NGN somewhat differently. This is not suprising: one might reasonably expect countries to more consensus-oriented than others, and some to be more *laissez-faire*, others more *dirigiste*. One might also expect the degree of state ownership of the incumbent to play a role in the regulatory approach.

All of these factors do indeed appear to play a role. Ofcom (UK),for example, has placed enormous emphasis on industry consultative bodies, self-regulation, and self-enforcing remedies to last mile market power.

At the same time, a unifying theme that appears across nearly all countries is that the front line regulators are attempting, as a first step, to consult heavily with industry players. In most cases, this also involves efforts to engage incumbents and competitive entrants in dialogue with one another. This has played a huge role in the UK, but it is also visible in the German BNetzA’s working group on NGN interconnection, and in the French ARCEP’s working group on access to FTTH facilities.

This is entirely appropriate. The migration to NGN potentially implies the need for regulatory change at a rapid pace that has not been seen to date. It raises many complex issues that are not unambiguously addressed by the overall European regulatory framework. Inevitably, industry players will be confronted with at least some of these challenges before they are obvious to the regulator. It is entirely appropriate that regulators should first give the industry a chance to sort things out for itself.

This does not imply that the regulator can abdicate its responsibilities. There is no assurance that industry dialogue will lead to consensus. The BNetzA study of NGN interconnection, for example, apparently did not reach firm conclusions on a way forward, possibly because the commercial interests of the players were diametrically opposed. The regulator must be prepared to step in where necessary.

There is no simple rule of thumb for the regulator, but there is substantial guidance in Article 8 of the Framework Directive. On the one hand, the regulator should not stand in the way of investment; on the other, it must ensure consumer benefits, and avoid distortion of competition – thus, the regulator cannot permit remonopolization of the network.

2.5 Key messages of this chapter

Technological drivers

From a technological perpective several developments, sometimes more than two decades old, have had an influence on the current shift towards NGN and ALL-IP: the success of the Internet (TCP/IP), the development of suitable protocols to provide packet based voice communication (H.323, SIP), the development of broadband access technologies (fix, mobile, fixed-wireless), the development of MPLS (Multiprotocol Label Switching; level “2.5”), Dense Wavelength Division Multiplexing (DWDM) in the physical layer, the development of Ethernet technologies beyond the LAN, the developments in terminal equipment, and the digitalization of media and the convergence of IT and TC.

Challenges in the communications service provision and manufacturing industry

In keeping with these developments both the communications service provision sector and the manufacturing industry are currently undergoing deep-rooted changes.

The carrier perspective: The established revenue base is eroding. Moreover, pricing structures are more and more developing towards flat rate regimes. Intramodal competition is increasing. “Imitators” becoming stronger vis-à-vis incumbents, i.e. they operate more efficiently and, based on greenfield approaches, they can implement the latest technologies. Moreover, voice services are today provided by ITSPs and (not necessarily facilities based) broadband providers. Intermodal competition is heating up due to the players from the cable industry. Fix-mobile substitution is taking place, i.e. traditional PSTN calls are substituted by mobile calls and households are becoming mobile only households, i.e. do not have access to PSTN dial tone anymore. Overall, from a carrier’s perspective NGN deployment therefore is driven mainly by greater cost efficiency, the ability to offer new services and applications and faster time-to-market.

The manufacturing industry perspective: The communications manufacturing sector is about to become a global market. The key portfolio of the old guys of the PSTN world (the *Bellheads* focusing on switching technology, private branch exchanges etc.) is at the end of the maturity phase. A new breed of companies focusing on IP technology (the *Netheads* providing routers, bridges etc.) have entered the market. As “everything becomes IP-based” knowledge and expertise regarding IP technology becomes a core asset. So the need for the bellheads arises to re-invent themselves. They have done this in the past years through acquisitions with more or less success. The division of labour between carriers and manufacturers is undergoing some deep rooted changes. In particular in the mobile sector carriers are beginning to outsource activities which previously have been part of their core assets. These activities, in particular regarding network operation and maintenance, are taken over by manufacturers whereas ownership of the network remains with the carrier. All of these developments are accompanied by a new concentration wave in the communications manufacturing industry.

NGN and its implications for value chains and business models

NGN brings about new enlarged value chains for the provision of communications services encompassing - apart from access and core transport networks - platforms, where content is actually delivered and the actual content itself (creation, packaging, and versioning). Due to the convergence of technologies, products and services, as well as markets telecommunications carriers face the challenge to position themselves on this new enlarged value chain.

In the NGN world a multitude of new business models is possible, which to some extent are already observable in the market. There is already today a multitude of new players providing telephony services. In particular, there is a multitude of more or less facilities based VoIP business models. Moreover, new business models regarding maintenance and operations of the physical communications network and ownership of the passive physical infrastructure might come up (independent NetCos, i.e. operator neutral investors who are deploying physical network infrastructure which is rented to third parties (network operators, service providers). New business models with new functions and players alike are also likely with respect to Fixed Wireless Access, broadcasting, machine-to-machine communication, and the provision of ambient home services.

NGN and implications for regulatory policy

Adoption and diffusion of NGNs in the communications services market presumably require a from-the-scratch re-thinking of many regulatory obligations. Several items therefore might be on the agenda of regulation: (1) The changing architecture and topology of the network has implications both for the regulation of access, i.e. new access modes might come into play, and for the regulation of interconnection (modes). (2) NGN entails a likely decrease in the number (and location) of interconnection points. Thus, there is the corresponding risk of stranded investments on the part of competitive entrants who have already built out to the former locations. (3) NGN presumably entails changes in the nature of network control and call control, with the possible risk that these changes will introduce new competitive bottlenecks. (4) Regarding the migration of voice services to an ALL-IP infrastructure one can ask if regulation should require availability of a voice telephony service with pre-defined functionalities and quality provided end-to-end. (5) NGN deployment does not necessarily eliminate market power, rather, it presumably alters its character and influences where and how it manifests itself. Otherwise stated, the changes due to NGN may ameliorate some kinds of market power, but they may also create new forms of market power. (6) NGN in all likelihood will bring about decreases in costs (level and structure) e.g. due to changes of economies of scale. Thus, all regulated prices depending on concepts like Long Run Incremental Costs (based on an efficient network technology) will be severely affected, provided regulation is necessary in the NGN world. (7) As migration to NGN technology is carried out both by telecommunications carriers and cable network operators one might ask if regulatory policy has to cope with unbundling of coax and fibre in the future. (8) It can be taken for granted that for a more or less long time there will be a co-existence of old and new networks. Thus, not only the NGN itself but also and in particular the migration phase brings about important challenges for competition policy and regulation.

Current NGN deployment approaches by carriers

A multitude of carriers throughout the world are today deploying new network infrastructure both in the access and in the core network. Carriers participating in this development are both incumbents and competitors. Developments are driven both by fixed link carriers and mobile carriers alike. Our case studies yield that the developments consist mainly of one or more of the following characteristics (1) deployment of deep fibre in the local loop whereby both Fiber to the Street Cabinet/VDSL (e.g. DTAG, KPN, AT&T) and Fibre to the Building/Home solutions (e.g. regional competitors in France, Germany, Italy; Japanese carriers; Verizon in the USA) are applied; (2) migration to ALL-IP; (3) launch of Fixed-Mobile convergent services and (4) in some cases like e.g. in the Netherlands the phasing out of a great number of MDFs. Moreover, at least one carrier (BT) has set up a separate subsidiary for wholesale network services (Openreach) which have to be provided both to the end user service branch of the incumbent and the competitors in a non-discriminiatory way.

Major overhaulings and upgradings are also taking place with regard to the network of cable operators. Indeed, since the opening of the telecommunication markets in the 1990s, cable operators have major incentives to upgrade their networks in order to be able to provide bi-directional communications services and more TV channels. Typically, these upgrades rest on two elements: Extension of the frequency range and implementation of a return path.

NGN, IMS

NGN can be characterized by the logical separation of the transport, control and service layer, differentiated network access, an unique IP transport network in the core, and the application of open protocols (ITU,ETSI, IETF) to integrate different services, transport and system providers. NGN standards were developed primarily by the ITU and by ETSI. The IP Multimedia Subsystem (IMS), however, originated with the 3GPP. Later on the European Telecommunications Standards Institute (ETSI) incorporated IMS into the NGN specifications developed by ETSI (TISPAN). Current ITU recommendations for NGN are based on IMS (NGN-IMS) as incorporated into ETSI TISPAN. Thus, the IMS standards are going to be incorporated into ITU and ETSI NGN standards, but with some differences mainly in the QoS provision scheme. Like NGN, the IMS is a layered architecture.

Regulatory treatment of NGN by different regulators

Several national regulatory agencies have taken account of the shift to NGNs in the market and are in or have already finished consultation processes regarding the regulatory implications, challenges and potential measures to cope with NGNs.

In the UK Ofcom has already completed a number of public consultations dealing with the transition to NGN. Underlying the Openreach agreements are Ofcom's belief that the migration to NGN will not, in and of itself, eliminate BT's market power on last mile access. Ofcom has also considered the implications of changes in the number of points of interconnection, and how to adjust BT's permissible regulated return so as to deal with the increased risk of deployment for an NGN. OFCOM views the key challenge in taking forward NGN competition issues to be establishing an appropriate balance between its role in providing certainty as to the regulatory framework and the role of the market in determining the commercial outcome of NGN-based competition. They therefore have in particular focused on an improved framework for industry engagement (establishment of a new NGN industry body, NGN UK (Next Generation Networks in United Kingdom)).

In Japan, the Ministry of Internal Affairs and Communications (MIC) has set up a "Study Group on a Framework for Competition Rules to Address the Transition to IP-Based Networks" which compiled a final report in September 2006. The report mainly deals with the changes in the competitive environment in the transition to IP-based networks and the necessity for a revision of competition rules. MIC formulates the following five basic principles for competition policy in the transition to IP-based networks: (1) Ensuring fair competition at the telecommunications layer (comprising the physical network layer and the telecommunications service layer), (2) ensuring fair competition focussing on the vertical integration business model, (3) ensuring competitive and technological neutrality, (4) protecting consumer interests, (5) ensuring that competition rules are flexible, transparent and consistent. Moreover, the study stresses the importance of an appropriate balance between facility-based competition and service-based competition in the communications sector. In the beginning of 2007, MIC has established the "Study Group on Network Architecture". The main themes to be addressed by this Study Group are the development stages of networks, socioeconomic effects to be brought about through realization of new-generation networks and issues like e.g. R&D, standardization, and promotion schemes.

In the Netherlands OPTA has already made a thorough analysis regarding KPN's All-IP strategy. The current status of their treatment of NGN issues is that they have provisionally concluded that a fully fledged alternative for MDF access cannot be guaranteed in the prevailing circumstances. Specifically, OPTA states that permitting KPN to withdraw MDF access would only be conceivable if market entry possibilities and the continuity of service provision by alternative operators would be sufficiently guaranteed. OPTA's current position is mainly based on a study which focuses on the business case for alternative operators using sub-loop unbundling from street cabinets. Roughly speaking, the study concludes that an alternative operator is likely to achieve the threshold for economic viability for using sub-loop unbundling from street cabinets only under very special circumstances: (1) a big market share or (2) a very selective operation on the basis of sub-loop unbundling whilst having a larger global broadband market share than Dutch alternative operators currently control, and under the assumption of considerably increased average revenue per user.

In Germany there are two main issues relevant for migration of networks to NGN which have been addressed so far by regulation policy: (1) Interconnection in IP based networks and (2) the Amendment of the German Telecommunications Law regarding (non-) regulation of “new markets”. The regulatory agency in Germany (BNetzA) has set up in 2005 a Project Group „Framework for Interconnection in IP-based Networks“ which has submitted its final report in December 2006. The main issues regarding an IP based interconnection regime addressed in this report are: (1) Number and geographical location of interconnection points as well as hierarchy and functionality of the interconnection points (determined by the network topology and functional layers in NGNs). (2) Quality standards to be specified taking into account the character of the all-IP network as a multi-service network. (3) Pricing principles for interconnection rates, such as progressive rates according to interconnection levels (e.g. for EBC: local, single and double transit) as well as accounting units (e.g. minutes or data volumes). Moreover, the report underlines that presumably complex questions about cost allocation have to be taken into account if rates are differentiated according to services or quality classes. (4) The accounting system being a core element that determines “who“ pays for which parts of the value chain. The new German Telecommunications Law which has taken effect in Februray 2007 could mean a far reaching abolition of regulation in particular for DTAG’s new investments in VDSL technology. This, however, has led to severe tensions between Germany and the EU Commission. The EU Commission has made clear that under its remedy endorsed, bitstream access will need to be granted by Deutsche Telekom also to its new VDSL infrastructure. The matter is likely to end up before the European Court of Justice. The regulatory treatment of DTAG’s fibre/VDSL deployment is still in the beginning and it will presumably been addressed in the regular revisions of the market definition. In a recent draft revision of the market 11 market definition/analysis (as of April 4, 2007) BNetzA has come to the conclusion to impose a new obligation on DTAG, namely to grant competitors access to ducts between the MDFs and the street cabinets.

3 Technological basis of NGN

This chapter will be devoted to a more thorough examination of the technological basis of NGN and IMS, respectively.

Most large public communications networks can be viewed as being comprised of three major components:

- The access network, providing access to the subscriber;
- The core, providing centralized switching; and
- In most cases, some layers of intermediate aggregation between the two.

First, we will address the core network. Second, we will analyze access network issues, including aggregation. Thirdly, we will address elements of NGN service control.

This chapter complements the discussion of NGN implementations that appears in section 2.3.

3.1 Architecture of the NGN core network

In this section, we outline the main elements of the architecture of NGN and IMS core networks and analyse their main functions.

3.1.1 Key architectural elements

The ITU has specified NGN in two basic Recommendations

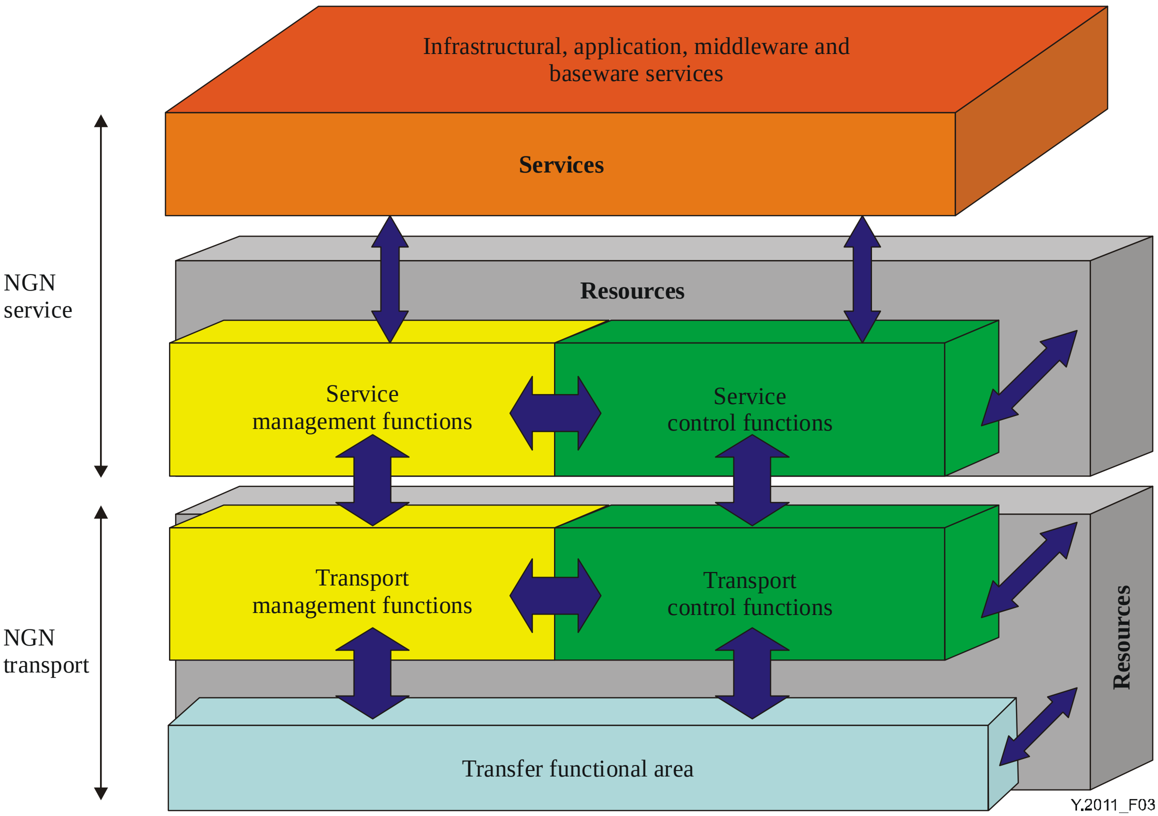
- Recommendation Y.2001 (12/2004) “General overview of NGN”, and
- Recommendation Y.2011 (10/2004), “General principles and general reference model for next generation networks”.

These specifications primarily address the separation among the service provision, control and bearer transport plane and the ability to support a wide range of services and over a range of access media using standardized (open) interfaces.

The work was initiated by the Joint Rapporteur Group, and was subsequently promoted by the NGN Focus Group that was created in the middle of 2004 and completed its work in November, 2005. Currently, ITU standardization work on NGN is under the NGN Global Standards Initiative (NGN-GSI).

The functional architecture of an NGN provides a vertically layered scheme where the application and associated content ("services") are on the top and the physical transport and access ("transfer") are on the bottom (see Figure 37). This vertical layering makes it possible for different market players to participate at different layers in the value chain of service production.

Figure 37: The ITU's layered NGN architectural model



Source: ITU (2004).

These changes in the value chain were taking place long before NGNs came on the scene, as a result of the migration of global networks to layered network protocols based on IP. However, the migration to NGN is accelerating and reinforcing this tendency.

The vertical functional layering reflects the layered model that the Internet Engineering Task Force (IETF) developed for the TCP/IP protocol suite, i.e. for the architectural core of the Internet.

The ITU further divides the layered model of network architecture into three planes:

- the user information transport plane,
- the signaling/control plane, and
- the management plane.

3.1.2 NGN and the voice-based evolutionary strategy

The main function of the NGN architecture (as it existed prior to incorporation of IMS) was to integrate PSTN/ISDN services into an IP-based packet switched network.

When a Plain Old Telephone Service ("POTS") user is connected, the access gateway makes the necessary adaptations in both the user information transport and in the control planes. In the user information transport plane, the voice signal is encapsulated into an RTP/UDP/IP packet stream. In the control plane, the user signaling is encapsulated into H.248/MEGACO control packets. All switching functions are concentrated in a limited number (typically two) of soft-switches which provide the routing and check whether the call should be accepted. Transit media gateways provide interconnection with legacy PSTN/ISDN networks.

A key feature of this design is that the NGN provides a PSTN/ISDN emulation. This means that the user can continue to use his or her terminal equipment installed at his or her premises without change. This property is vital for a nondisruptive transition to NGN[94]. One can easily imagine scenarios where subscribers can directly access the NGN core network in large cities, while rural subscribers remain accessible over traditional PSTN/ISDN facilities.

The centralized control plane, in conjunction with the trunk media gateways (TGW) that provide interconnection with legacy fixed and mobile networks, seeks to provide a level of privacy and security comparable to that of the PSTN.

Note that not all adaptation in the control plane (such as signaling and addressing) is provided by an MGWC (soft-switch). The flexibility implied by the use of soft-switches enables a smooth migration from the legacy PSTN to an integrated NGN. Many experts anticipate that NGN will deploy gradually, radiating from areas of high teledensity (big cities) to areas of lower teledensity.

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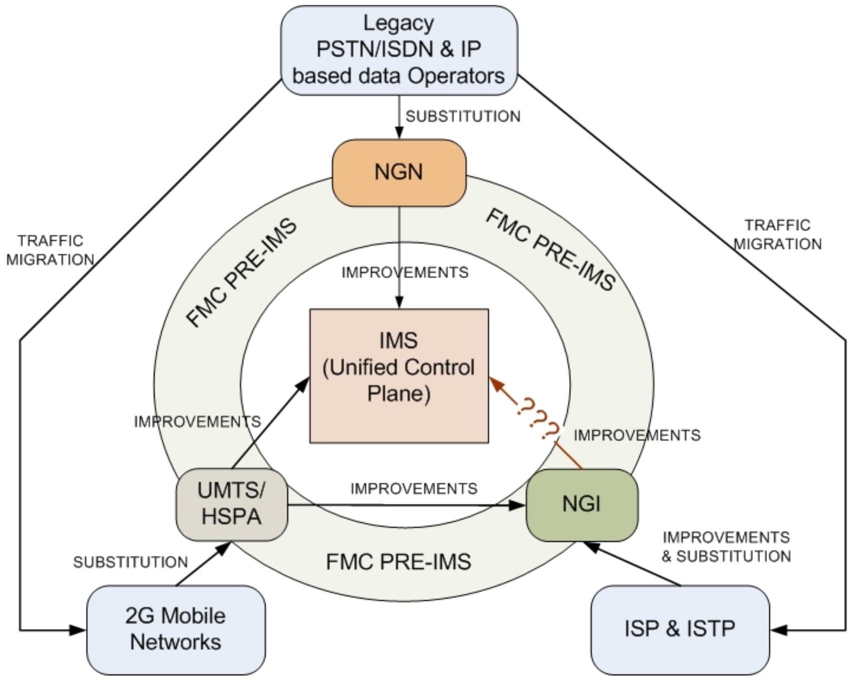
94 The user may, however, choose to install advanced equipment such as an IP-PBX. As before, the access is provided by Access Media Gateways.

3.1.3 NGN and the IMS-based evolutionary strategy

Figure 38 shows likely evolutionary paths for different types of networks. Note that there are three independent paths depending on the starting point of the network operator.

Figure 38: Evolutionary paths to IMS NGN



Source: WIK-Consult

The first path is associated with both PSTN operators (many of which already provide IP data services). This migration is largely driven by loss of market share to mobile operators and VoIP services. The strategy of the fixed operators was to evolve towards the NGN with the softswitch at the heart of the network; however, around 2004 they realized that the evolution in the core network of the mobile operator networks, pushed by 3GPP in Releases 6 and 7, would nonetheless leave them in second place in the telecommunications market. This led them to charter the ETSI TISPAN working group to adapt the IMS concept to the network architecture of the NGN operators.

The second evolutionary path is driven by mobile operators. They need to open new business lines because the traditional business model is nearly exhausted as mobile penetration approaches 100% in first world countries. They therefore seek to evolve the access networks using enhanced technologies as High Speed Packet Data Access HSPDA, and the core network with a unified IMS control platform for service delivery.

Finally, the third evolutionary path comes from the world of Internet providers and their evolution toward what can be characterized as the Next Generation Internet, see section 3.1.4. The underlying concept is different – it is less centralized, but also less standardized.

What is more or less certain at this point is that the evolution of fixed and mobile operators will pass through the IMS. However, this will not be done all at once, but there will be a smooth evolution that can be measured by an "IMS maturity index" (see Table 3 below), which shows the degree of penetration of the IMS equipment in the networks.

Table 3: IMS Maturity Index

IMS Maturity	Name	SIP Elements	IMS / APPs	CSCFs	Data on HSS	IMS Clients	Date
0	Not IMS	None	None	None	None	None	2000-2005
0.5	Pre-IMS	Few	Maybe	Maybe	None	None	2005-2007
1	Some IMS	Some	Some	Some	Some	Maybe	2006-2009
2	Real IMS	Most	Many	Most	Most	Some	2009-2012
3	Ideal IMS	All	All	All	All	All	2012->

Source: WIK-Consult

Note that there is considerable uncertainty about these dates, especially the later ones.

3.1.4 The Next Generation Internet (NGI) strategy

Fixed operators and ISPs that are not the historic incumbent in their respective countries tend to follow a somewhat different evolutionary path, namely a development towards a Next Generation Internet (NGI). As we have seen, hallmarks of NGN network architecture are (1) an IP transport platform, (2) a centralized control plane, and (3) facilities to connect a wide range of terminals from legacy analog telephones up to advanced IP/Ethernet customer premises equipment (CPE).

The NGI is based on a more distributed control plane, and is reached by a more gradual and evolutionary process. Integration of the old and the new is achieved by means of capabilities integrated into peripheral equipment – for instance, session border gateway controllers in the case of VoIP connections.

The motivation for an NGI evolution derives in part from the different business drivers for non-incumbent operators. In general, these operators do not have their own last mile facilities – at least, not over the full national territory. Consequently, their economic drivers are different, and this tends to lead to business strategies that emphasize acquiring wholesale access (bitstream, shared access, or LLU) to the incumbent's facilities. This tends to lead to increased emphasis on NGN in the core network rather than the access network, especially to the extent that bitstream is used.

Figure 39 below depicts an NGI network. Thanks to the distributed concept inherent in the Internet, the evolution is smoother than the one of NGN; however, some have expressed concerns that QoS may be more difficult to achieve. In a pure environment, QoS targets could be achieved either by means of IETF protocols (for example, DiffServ and MPLS) or simply by appropriately dimensioning the network. A challenge for NGI operators is that in many cases they will have limited control over access facilities that they acquire from the incumbent by means of bitstream access.[95] The QoS for connections over IP platforms of different operators (Internet) must be negotiated between the corresponding SMGWC and communicated to the end user terminals over the (SIP) proxy. What the implications are for incumbent bitstream services remains unclear. Presumably, one can think of some combination of DiffServ/MPLS.

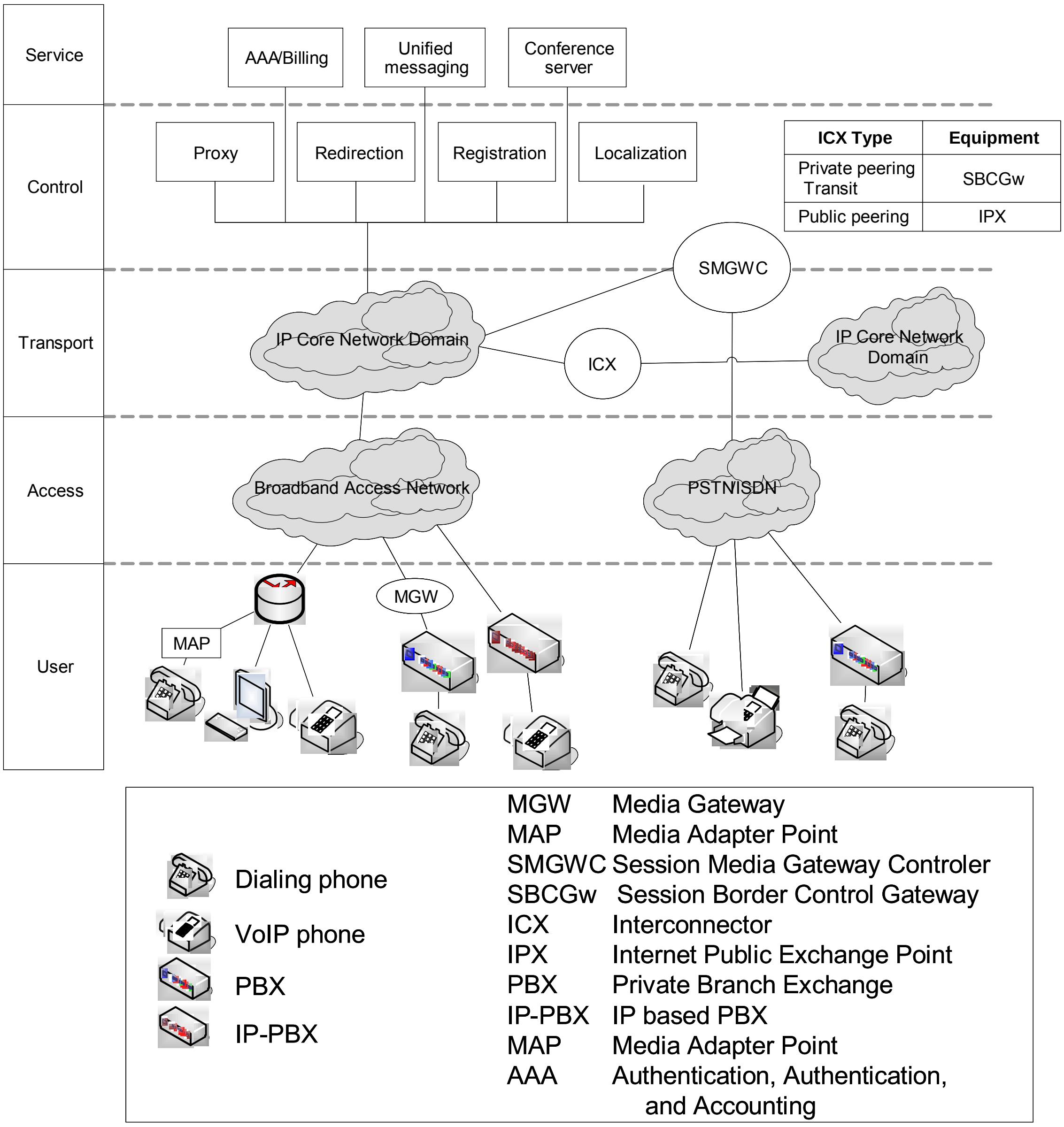
For that matter, there is considerable debate about the long term market implications of Quality of Service in general. This section presents the prevailing view among NGN advocates – the "bellhead" view, if you will – that argues that consumers will not accept NGN services unless quality is guaranteed to be at least as good as those of the fixed network today.

An alternative school of thought – call it the "nethead" view – holds that consumers will in most cases be unable to distinguish between best-efforts and guaranteed QoS, and that they are unlikely to be willing to pay much of a premium for a difference that they cannot routinely detect. This view draws on experience in the U.S. Internet market, where differentiated QoS has been technically feasible, even trivial, for more than a decade, but has never been widely deployed *between operators* due to lack of customer demand.

We return to these issues later in this report, in the section 3.3.5 on "Quality of Service Solutions in NGN" and again in Section 4.3.3 on "QoS differentiation, service specific interconnection". For now, suffice it to say we expect the market to ultimately choose between these views.

95 See European Regulators Group (2004).

Figure 39: The evolution to a Next Generation Internet (NGI)



Source: WIK-Consult

3.1.5 "Islands" and overlay migration

From a network engineering perspective, different migration paths from a traditional TDM-based PSTN and separate IP and data networks towards an All-IP NGN core infrastructure are feasible; due to differing business realities between service providers, different migration paths are likely. This migration is likely in all cases to require significant time.

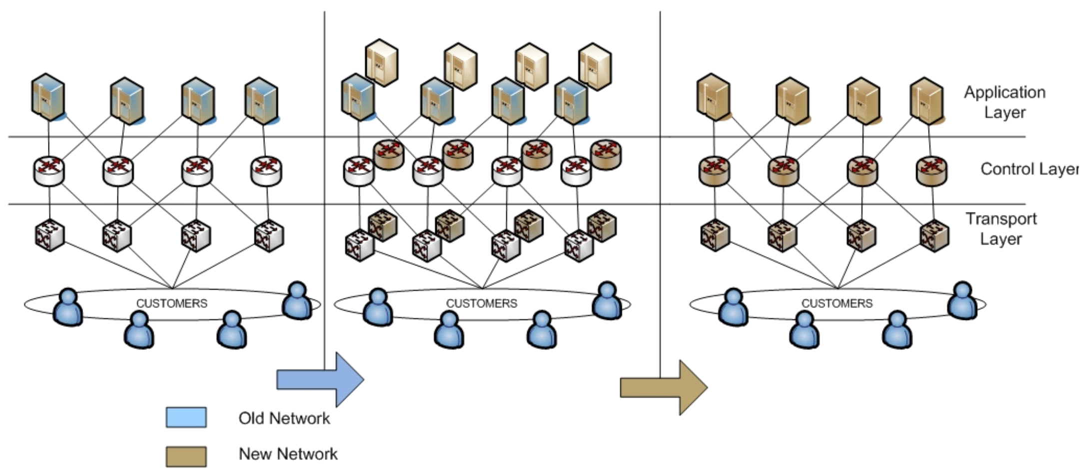
Different migration strategies have different advantages in the real world. A good migration strategy will try to minimize negative impact on the customer. Subsequently we present three migration strategies:

- Nework Replacement,
- Network Overlays and
- Network Islands.

The last two strategies are currently the most important ones.

Network replacement. This strategy means that the network operator builds a complete new network infrastructure and substitutes the old all at once, see Figure 40. In theory, this would mean that the user goes to sleep using the old infrastructure, and wakes up with the new one. This is a high-risk, high-return tactic because it allows an early replacement of a fully converged network over IMS (3GPP or TISPAN), and takes immediate advantage of new services and technology; however, it would tend to make the operators very dependent on external partners, typically the vendors and system integrators.

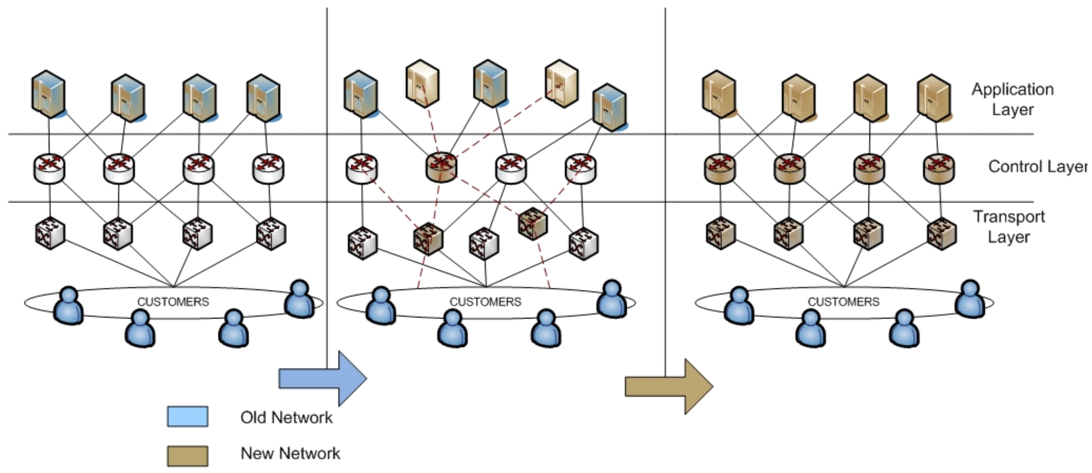
Figure 40: The Network Replacement strategy of NGN migration



Source: WIK-Consult

Network Overlays. This Network Overlay strategy means that new network elements are added as new services are introduced, see Figure 41. The network overlay need not be implemented faster than the growth in the subscriber base for new services. Thus, the revenue stream from the users of new services serves to fund the network deployment (pay-as-you-grow). Over time, the legacy infrastructure can begin to be decommissioned. At the end, the entire network is converged onto the new NGN (which was originally the overlay network).

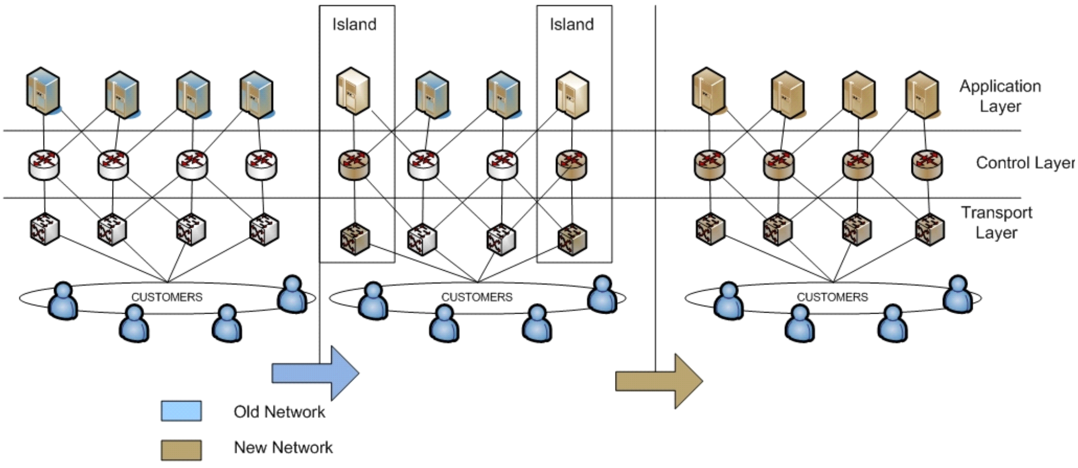
Figure 41: The Network Overlay strategy of NGN migration



Source: WIK-Consult

Network Islands. The *Network Islands* strategy is based on building some geographically limited environments where the new network architecture is fully deployed, see Figure 38. These environments are mutually isolated, but interconnect seamlessly with the old infrastructure. In these islands, the operator offers the complete set of new services. As the number of subscribers increases, the range and number of islands grows, with new technology replacing the old. At the end, as in the overlay case, the complete existing infrastructure is substituted by a new NGN-based infrastructure. This strategy can also be viewed as a pay-as-you-grow tactic.

Figure 42: The Network Islands strategy of NGN migration



Source: WIK-Consult

Note that these two last strategies are based on the progressive replacement of old technology. The Network Overlays strategy evolves (from the point of view of the services offered to customers) across the entire geographic range of the network, and can thus be viewed as a *network-based* evolution strategy; however the Network Islands strategy is based on the increase of the range of the new technology and therefore can be viewed as a *geographically-based* migration strategy.

3.1.6 Standardization and interoperability

This section highlights standardization issues and vendor specificities from a technological perspective.

Even if the basic architectural features of NGN and IMS are already standardized, market observation tells us that it is by no means trivial whether NGNs of different carriers will be fully interoperable in every aspect of traffic flow and service provisioning.

Indeed, the ITU NGN is mainly based on proper protocols specified in corresponding Recommendations; however, some of them are already coordinated with the IETF, as is the case with MEGACO. IMS, however, is based mainly on existing protocols supported by the IETF and published in corresponding RFCs like e.g. RTP/RTCP, IPv6. Where extensions are required, 3GPP promotes corresponding work (e.g. SIP for mobile and wireless).

In the interconnection between NGN and IMS there will therefore be three major problems:

- The first one is the conversion between IP protocol versions. Note that NGN is currently defined under IPv4 and 3GPP IMS uses only IPv6. Therefore the NGN operator has to implement a logical function to perform the translation (I-BCF Interconnection Border Control Function and I-BGF Interconnection Border Gateway Function). Furthermore in the I-BGF some transcoding elements may be necessary in order to perform the codec adaptation.

- The second problem is related with QoS. In the 3GPP IMS the QoS Preconditions, an extension of the SIP protocol which allow both edges to know about the resource availability, are mandatory in the session, but, in the NGN they are only an option given to the terminals.

- The third is the interoperability between the billing and the OSS systems of the two networks. This point is mainly a matter of the equipment providers rather than a standardization problem. We would like to underline that OSS functionality and interoperability challenges could turn out to be a big deal. The difficulties of getting the OSS right have been underestimated in one technology evolution after another.

3.2 Architecture of the NGN access network

This section scrutinizes the (system) architecture of NGN access network’s elements.

3.2.1 NGN and the access network

To a significant degree, the anticipated evolution of the NGN access network reflects changes that were already in train for broadband deployment. Most of these changes would be predictable, quite independent of the presence or absence of NGN. In terms of technology, they tend to be somewhat independent of the evolutionary path of the NGN core; however, they inevitably reflect the economics of market players, and therefore may play out differently for fixed incumbents, mobile incumbents, or competitive entrants and ISPs.

Data aggregation tends to be closely associated with the access network. If we consider the NGN access network, starting at the customer premises and working in to the NGN core, we find the following expected configuration:

- Last mile access, using a variety of physical and logical media, including xDSL,

- The multiservice access node (MSAN)[96],
- Access from the MSAN to an access Ethernet switch,
- Connection between the access Ethernet Switch to a Metro Ethernet Switch and
- Connection between the Metro Ethernet Switch (Metro Ethernet Ring) and interconnection to the IP core.

This development can best be visualized by KPN's migration plan to ALL-IP, see Figure 19. A significant change between this access network and its predecessors is that much of the Level 2 communications are handled not by Asynchronous Transfer Mode (ATM), but by upgraded "carrier grade" versions of Ethernet. We return to this point in the section "NGN and the evolution from ATM to Ethernet", see Section 3.2.4.

3.2.2 Evolutionary strategies for the NGN access network

Network operators have a range of possible options as regards NGN access:

- ***None***. They could choose to offer only the NGN core, assuming that the customer will make other arrangements for high speed access to the network. Whether this market segment is viable in the long run remains unclear – in the U.S., the independent ISP market segment has declined precipitously, although it remains unclear whether this is a market phenomenon or a regulatory failure.
- ***Traditional wired broadband***. Most NGN services can be delivered adequately over existing broadband access, with the notable exception of full-fledged high definition video (which requires 8-9 Mbps per HDTV channel).
- ***VDSL***. Where loop lengths are sufficiently short, either to the central office or to the cabinet, VDSL will often represent the preferred price/performance choice in the near to medium term.
- ***FTTB/FTTH***. Where loops are longer, pure fiber solutions will be preferred. Fiber to the home is viewed as the preferred option in the long term, but it is an expensive solution.

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96 See Wikipedia: "A multiservice access node (MSAN) is a device typically installed in a telephone exchange (although sometimes in a roadside cabinet) which connects customers' telephone lines to the core network and is able to provide telephony, ISDN, and broadband such as DSL all from a single platform. Prior to the deployment of MSANs, telecom providers typically had a multitude of separate equipment to provide the various types of services to customers. Integrating everything on a single node, which typically backhauls everything over IP or Asynchronous Transfer Mode can be more cost effective and may enable customers to have new service enabled far more quickly." Wikipedia contributors, "MSAN," *Wikipedia, The Free Encyclopedia*, http://en.wikipedia.org/w/index.php?title=MSAN&oldid=95604229 (accessed February 25, 2007).

- ***High speed mobile data services***. These services are attractive due to their ubiquity and flexibility, but will tend to be more expensive than wired high speed options. They nonetheless fill a valuable market niche.

- ***Fixed wireless access***. With the advent of WiMAX and other high speed solutions, fixed wireless access becomes an important complement to wired solutions, especially for rural or low teledensity areas. For dense, urban areas, wireless solutions are likely to be less attractive than fiber-based solutions.

- ***Other solutions***. In light of the IP-based nature of the NGN, nearly any data transmission medium could in principle be supported. Entirely new technologies might emerge over time, or existing technologies (e.g. powerline) might evolve so as to be cost-effective.

The migration to NGN enables seamless interoperability and potentially seamless mobility. Many operators will find it cost-effective to deploy some mix of access solutions in order to serve different customers, and in many instances even to serve the same customer. Some operators might choose to use VDSL where loop lengths are short, but FTTH where they are longer. Many operators will offer both fixed and mobile NGN access services, often to the same customers.

3.2.3 Multiservice Access Node (MSAN) systems

The Multiservice Access Node (MSAN) is a key component of the NGN. It is a versatile aggregation vehicle that can be deployed at various levels of the edge or access network, depending on capacity, topology, and other requirements (e.g. at local exchanges or at “minor” aggregation points).

Multiservice Access Node (MSAN) solutions could potentially address the needs of:

- copper pair solutions,
- fiber optic solutions,
- cellular network solutions,
- other wireless broadband solutions,
- terrestrial and satellite solutions.

Two interrelated developments are likely. The first is the concentration of access at common locations, even where the nature of the underlying access network is markedly different (e.g. fixed wired access, fixed wireless access, mobile). The second is the emergence of single devices that support multiple different access media (e.g. using different line cards in a single device).

The geographic concentration of access locations is in large measure a consequence of the underlying IP-based nature of NGN services. It becomes trivial to house access equipment for different transmission media at the same location. Relatively simple IP routers can merge multiple traffic streams. This potentially generates economies of scale and scope in regard to the physical network locations, and also as regards the back-haul network (which also benefits from the inherent statistical multiplexing capabilities of TCP/IP). The degree to which this is beneficial will depend heavily on the characteristics of the underlying access networks.

Market research shows that many equipment manufacturers provide line cards that support a variety of physical connection media such as twisted copper, coaxial cable, and fiber. Deploying MSANs significantly simplifies the access network infrastructure, mainly by reducing the number of active devices. There is, however, the risk that competitive bottlenecks could arise because currently no common standards for these MSAN devices yet exist.

3.2.4 NGN and the evolution from ATM to Ethernet in the access network

In carrier networks, much of the communication at Level 2 of the OSI Reference Model (the Data Link Layer) has historically been accomplished by equipment that implements the Asynchronous Transfer Mode (ATM). In an NGN, these basic Level 2 communications are expected to instead be implemented by means of enhanced "carrier grade" versions of the Ethernet Local Area Network (LAN).

Many factors are driving this evolution. First and foremost, Ethernet equipment is simple, and therefore inexpensive. Ethernet-based solutions can also offer a number of advantages, including better multicast support, and support for virtual private LANs (VLAN). Optional add-on standards to Ethernet already address a number of key needs that were historically lacking, including the ability to deal with much more widely distributed networks, and the ability to provide QoS (dealt with in the IEEE 802.1p standard, typically used in conjunction with 802.1q or with bridging).

Standards bodies are currently taking up eight additional Ethernet improvements that are expected to collectively ensure that Ethernet will be a central element in the future access architecture of NGN:

- Duplex Ethernet,
- Ethernet VLANs,
- Ethernet QoS,
- Multi-level Administrative Domains,

- Hierarchical Addressing,
- Ethernet VLAN Identifier Switching,
- Protection Switching,
- Point to point Ethernet Transport.

3.3 Elements of NGN service control

This section is devoted to different elements of NGN service control.

3.3.1 NGN and nomadicity

Nomadicity means that the service may be provided independently of the access technology, that is, wherever a broadband technology is available. It is also a geographic issue because a Service Provider may offer some services in a country without being physically present. It is the break of the nexus between the person and the location.

Nomadicity is not the same as mobility. With nomadicity, a user may change his or her location from time to time, but typically does not expect to continuously use a communication service while in motion. In this sense, nomadicity is less demanding than full mobility. At the same time, nomadicity is coming into play for services that were historically fixed, as in the case of VoIP. This poses profound challenges, because the possibility that these services might not be stationary has generally not been heretofore considered either by engineers or by regulators.

It has severe implications regarding QoS provisioning, regulation as well as charging and billing procedures. It has already led to serious regulatory challenges in terms of the provision of access to emergency services for VoIP.[97]

3.3.2 Flexibility and mobility of services

Mobility is, in a sense, simpler to address (or at least less novel) than nomadicity. Solutions for the fixed network generally do not anticipate that a user might change his or her location. Mobile services have always had to assume mobility, not only between sessions but also while a session is in progress.

In the context of IP-based applications, the challenge arises because the IP address necessarily reflects the networks topology. This means that the IP address necessarily

97 See Marcus (2006a).

changes when, for example, a user moves and a hand-off to a different mobile location occurs. Solutions to this problem have existed for many years. IMS is important in this context because it provides a standards-based solution that has the potential to see widespread adoption, both for fixed and for mobile services.

It is important to know the user's physical location, not only in order to enable location-aware application services, but also to enable access to emergency services so that help can be summoned when needed. In this regard, NGN does not raise new challenges that were not already present with today's mobile and/or IP-based services. For mobile services, the location can be determined either using triangulation from multiple sites, or based on location-sensing equipment (e.g. GPS) in the user's handset. In the case of nomadic VoIP services, the user might need to self-report his or her location today; however, ongoing work in the standards community might eventually produce reliable automated solutions to identifying the user's location.

3.3.3 Network security aspects

Network security aspects may relate to different requirements:

- Authentication and authorisation (assurance that a user is who he or she purports to be, and is appropriately entitled to use the service that he or she seeks to use),
- confidentiality (no unauthorized information leakage/ access),
- integrity (no unauthorized data modification),
- non repudiation (performed actions can not be denied),
- availability (no denial of service/ accessibility of services or data), and
- privacy (no unauthorized profiling, disclosure and modification).

3.3.3.1 NGNs and security enhancements

This section considers whether NGNs will offer better security than current ISP networks, and to the extent that they do, what sort of a premium customers will be willing to pay.

A network that is essentially a closed and private environment may find it easier to exclude hackers than a network that in principle is more open. It is possible that NGNs will be less vulnerable to intrusion than today's networks of ISPs; however, they will not necessarily be more reliable than today's PSTN networks.

Again, this tacitly assumes that the NGN is a somewhat closed environment. Whether the NGN will in fact be more closed than an ISP environment today is not altogether clear. In the case of the Next Generation Internet (NGI) as we have defined it in section 3.1.4 of this report, the NGN is really just an “ISP network on steroids”, and will thus tend to be subject to many of the same vulnerabilities as an ISP network.

The degree to which consumers are willing to pay a premium for enhanced security is, again, uncertain. Consumers have no way to know. Network operators are understandably reluctant to discuss incidents publicly, so statistics on network reliability/resiliency in the face of hacking tend to be scarce, unreliable, and not necessarily cross-comparable. This might possibly change, however, if the European Commission were to successfully implement a change to the regulatory framework, which they proposed as part of the 2006 review. This change would require service providers to report service outages, and also compromise of personal data, to national authorities and possibly to impacted end users.[98]

It is clear that consumers will pay a premium for security services that are tangible, close to home and under their own control. Consumers pay money to update their virus checkers. Whether they will pay significant premiums for less tangible security embedded in the network is less clear; however, it is possible that they would regard claims of superior security as a positive differentiator when selecting a network services provider.[99]

3.3.3.2 Standardization efforts

Security standards for the NGN and for IMS are being developed in many fora, including the 3GPP-IMS, ETSI-TISPAN, the ITU and the IETF.

Security is a key consideration in 3GPP IMS. Secure access to IMS entails authentication, authorization and communication flow protection applied between (1) the end user and the IMS CSCF; and (2) between CSCFs. It is based on a hop by hop security approach, where the first hop between the end user terminal and the P-CSCF is secured, and then global message integrity is ensured between CSCFs (whether within a single provider’s network or in two different networks).

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98 *Commission Staff Working Document Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions on the Review of the EU Regulatory Framework for electronic communications networks and services {COM(2006) 334 final}: Proposed Changes*, document SEC(2006) 816, 28 June 2006, available at: http://ec.europa.eu/information_society/policy/ecomm/doc/info_centre/public_consult/review/staffworkingdocument_final.pdf.

99 The challenges in achieving upgrades in support of Critical Infrastructure Protection (CIP) are well known, and have sometimes been likened to economic “public goods” problems. See, for instance, Marcus (2004a).

The first hop security between the end user terminal and the P-CSCF is based on the IMS subscriber Identity Module situated in the Universal Integrated Circuit Card (UICC) of the end terminal, thus reusing proven mechanisms from UMTS access, notably the Authentication and Key Agreement protocol. Subsequent communications are then protected by the familar IPsec (IP security) protocol, which provides message integrity and confidentiality.

Hops between CSCFs are globally protected by the Network Domain Security (NDS) system of 3GPP. NDS provides a security architecture and tools to divide a IMS network into security zones; an interoperable security mechanism for exchanges with other operators; and IPsec between Secure Gateways (SEG) at both ends of the connections between CSCFs.

The ETSI TISPAN approach to security adapts the 3GPP-IMS to fit the TISPAN model. Once again, IPsec is used to provide message integrity and confidentiality, but key exchange is implemented using a different protocol (IKE).TISPAN divides the network into three views: the Access view (first hop), the NGN core view (intra-operator), and the Interconnection view (inter-operator).

The ITU is also considering a wide range of NGN security aspects in the NGN Focus group.

3.3.4 Billing principles and possible solutions

As noted in section 4.3, “NGN and network interconnection”, current interconnection arrangements are unlikely to be sustainable in an NGN environment. Current arrangements primarily are based on termination fees that reflect primarily the number of minutes of use, which party originated the call, and to some extent the distance from caller to the recipient of the call. The system in its present form is unlikely to be sustainable for many reasons, both economic and technical, including:

- The NGN will open competition (unless regulators permit operators to inhibit competition) from third party service providers whose costs are very different from those of current network operators, and whose prices will effectively limit the prices that integrated network/service providers can charge.
- All service providers are likely to be motivated to charge at levels that reflect their real underlying usage-based costs, which are only weakly correlated with minutes of use.
- Distinguishing between call origination and termination will be increasingly arbitrary and meaningless.

- Network providers will be unable to meaningfully determine the usage of independent services, and independent service providers will be unable to meaningfully determine underlying network usage.
- The current system, which uses payments for a service to compensate for costs of the underlying network, will become increasingly meaningless when the service provider and the network provider are not necessarily the same firm.

To illustrate these points, suppose a national incumbent were to attempt to charge a price well in excess of its marginal cost for an integrated domestic telephone service. They would run a substantial risk of losing business to non-network-based service providers such as SIPgate, Vonage, and Skype, who could charge a much lower price for the service.

It is premature to say definitively what will happen when the existing arrangements break down. One of the most likely scenarios is:

- Retal prices will decompose into two distinct prices: one for the underlying network access, and another for services that operate over the network access. Bundling will still be present in the market, but will reflect the prices of the underlying components.
- Retail prices for network access will tend to gravitate to flat rate, probably banded based on the maximum bandwidth available for use and possibly reflecting a premium for the amount of QoS-sensitive traffic carried.
- Retail prices for services will reflect usage-based marginal costs, which are low.
- Wholesale payments between network operators, if they exist at all, will reflect some measurable characteristic that correlates with marginal usage-based cost. For example, they might reflect the volume of traffic sent and received, for each level of QoS requested and granted.

Accounting systems will necessarily evolve to track the network usage that is meaningful for billing. To the extent that payment arrangements were indeed to evolve as suggested in this section, this evolution would pose no great complexity. All of these attributes are easily measurable.

3.3.5 Quality of Service solutions in NGN

The NGN standards process has invested a great deal of energy to ensuring an adequate Quality of Service (expressed in terms of average packet delay, variability of packet delay, and probability of packet loss) to delay-sensitive applications such as real time voice over an IP-based NGN. This section reviews the available techniques, considers applications to NGN and IMS, and then explores the questions of (1) whether QoS support is likely to be effective and (2) whether it is likely to be deployed.

3.3.5.1 NGN/IMS and end-to-end QoS

Current IP standards offer different methods for assuring Quality of Service (QoS). The simplest way to ensure adequate performance consists simply of properly dimensioning the network. “Netheads” (Internet experts) tend to think of this as merely representing proper design; “Bellheads” often refer to it as overprovisioning.

The next most difficult is referred to as DiffServ. DiffServ is a hop-by-hop signalling mechanism for specifying the desired delivery characteristics of each IP datagram. Each network is at liberty to employ its own tools (often MPLS) to achieve the desired delivery, and each can choose (based, perhaps, on commercial considerations) whether to honor the request. Even if all systems honor the request, DiffServ provides at best an enhanced probability of success rather than an assured end-to-end QoS.

The most comprehensive IP mechanism is the Integrated Services Architecture (ISA), as embodied in the RSVP protocol. RSVP provides comprehensive end-to-end quality assurance. RSVP has only rarely been commercially deployed – most experts feel that it is much more complex than DiffServ, but produces QoS that is only marginally better.

Table 4: below provides an assessment of the relative merits of these three solutions.

Table 4: Relative merits of different forms of QoS

	ISA/RSVP	**DiffServ**	**Over-Engineering**
Complexity of traffic engineering	High	Moderate	Low
Complexity of coordination of intercarrier connections	High	Moderate	Low
Scalability	Poor	Moderate	Excellent
Fair service costing complexity	Excellent	Good	Moderate

Source: Hackbarth and Kulenkampff (2006)

It is worth noting that neither DiffServ nor RSVP has been used to any significant degree *between different operators*, so some of the above assessments are based solely on theoretical considerations. Also, a number of problems associated with traffic engineering in conjunction with QoS are still unsolved.[100]

100 See e.g. Chapter 3 in Kofmann (2006).

3.3.5.2 Open issues regarding QoS provisioning in interconnection networks

As noted in Section 2.3, 3GPP IMS defines separate QoS traffic classes that are handled according to operator requirements. This means that 3GPP provides a *relative* QoS. The ETSI TISPAN IMS has two approaches for QoS control: one is a *Guaranteed QoS* (and thus absolute), the other a *Relative QoS*. Conflicts might arise when a user in the NGN world subscribes to a service with Guaranteed QoS connects to a user/server/service in the 3GPP IMS world with relative QoS. The user might not receive the expected QoS.

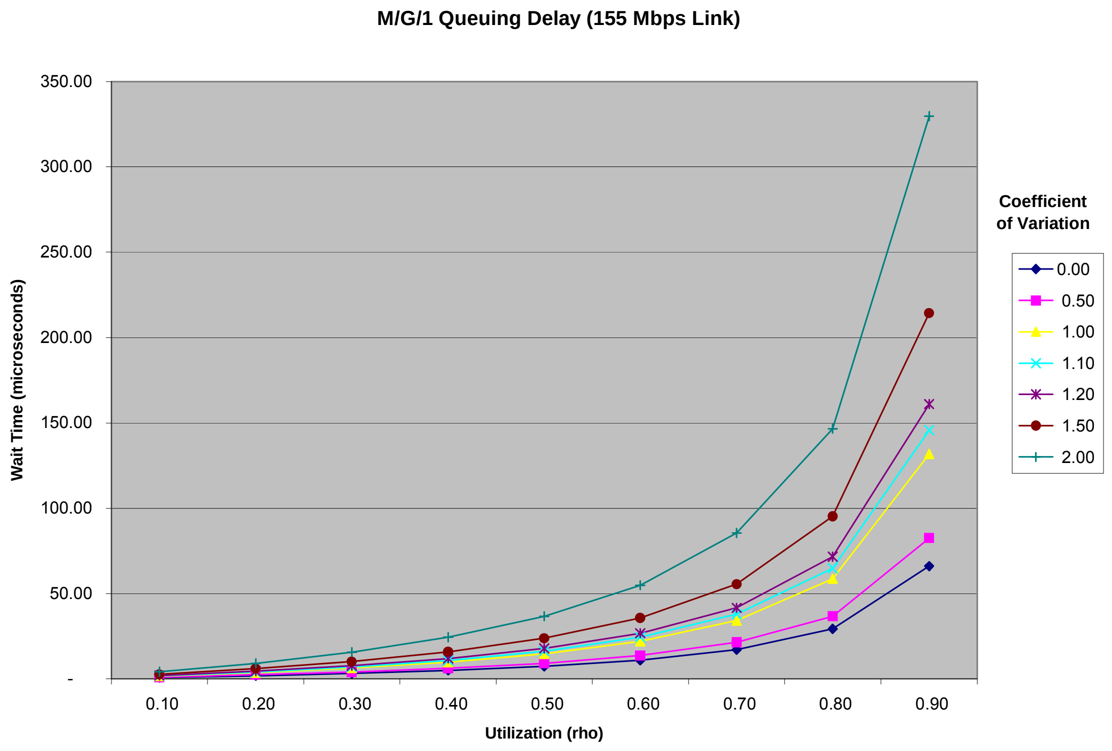
3.3.5.3 NGNs and QoS enhancement in practice

This section considers whether NGNs are likely to offer better QoS than current Internet Service Providers (ISPs) and to the extent that they do, what sort of a premium customers will be willing to pay.

QOS appears to be perceived as a key differentiator of the NGN. In the United States the technical capability to offer differentiated Quality of Service has existed for at least ten years. The experience, however, suggests that consumers perceive little difference most of the time[101], and are in practice (whatever they may say when asked) unwilling to pay much of a premium for better QoS. This follows from basic queueing theory. Packet delay over the slowest SDH high speed fiber-based service would be in accordance with the Figure 43 below, which is based on the standard queueing model (M/G/1) for a single server.

101 In the core of a properly designed network, and under reasonably normal load.

Figure 43: M/G/1 queuing delay for a 155 Mbps link[102]



Source: WIK-Consult on the basis of Marcus (1999)

The graph corresponding to a coefficient of variation of 1.2 would have corresponded best to observed reality in the Internet a few years back.

What the graph tells us is that the variable queuing delay per packet in the slowest fiber link in the core of a large network is on average less than 150 *micro*seconds, even at a high load factor of 90%. Voice over IP (bi-directional voice) is one of the most delay-sensitive and demanding applications, but it can still tolerate delays of up to about 150 *milli*seconds. Even allowing for the fact that any given packet will traverse many hops, the delay "budget" can accommodate much more variable delay than is likely to occur under normal circumstances in a properly designed network.

This is not to say that QoS is of no interest. Many networks normally implement it *within* their networks. It is particularly helpful (1) where one or more links are unavoidably overloaded; (2) where one or more links or nodes are out of service; or (3) for slower links at the edge of the network, especially where they are shared among multiple users (e.g. broadband over cable television).

102 The analysis is based on the Pollaczek-Khinchine formula, using plausible values. See Chapter 15 of Marcus (1999). See also Marcus (2006b).

The relative lack of tangible benefits will, however, tend to limit the premium that consumers are willing to pay. VoIP over the public Internet, for example, and with no special arrangements for QoS, performs quite acceptably most of the time.

In the U.S., cable operators have been able to provide QoS support to their VoIP for years. They have achieved reasonable VoIP market shares, but their success probably has more to do with their established customer relationships than with their ability to support QoS. Rather than charging an explicit premium for QoS, they embed the premium (if any!) into the cost of the service that benefits from it. Furthermore, their QoS capabilities do not appear to have excluded pure VoIP providers like Skype or Vonage.

In sum, QoS capabilities are clearly a good thing, but it is not clear that they will represent a dramatic commercial advantage.

3.3.6 Possible solutions for services depending on presence and location

The advent of NGN potentially expands greatly the scope of location-based services. Potential applications can be divided among two different dimensions:

- Fixed versus mobile,
- NGN (only) versus ETSI TISPAN IMS-NGN versus 3GPP IMS-NGN.

At a technical level, the TISPAN IMS implementation for fixed services is significantly different than the 3GPP IMS implementation for mobile services. In TISPAN IMS, the User Element location is a static entry in the NASS location database. It is referred to as the *Connectivity session Location Function (CLF*). It represents a mapping between the physical access line address and the logical access line address. It is conveyed using the SIP header.

In 3GPP IMS, however, the IMS Location Server (ILS) enables dynamic modification of the user's location. The ILS is a generic SIP Application Server that can dynamically obtain updated location information from a *Location Services Server (LCS*) using the *Mobile Location Protocol (MLP*). Any application that needs user location information obtains it by sending a request to the ILS server.

The question of how one stores and updates the location is largely orthogonal to the question of how one determines location in the first place. There are many possible methods, depending on the access technology used and the accuracy desired. Table 5 below includes fixed wireless access modes because these may be popular, especially with fixed operators. For mobile services, triangulation among cell sites has also been used.

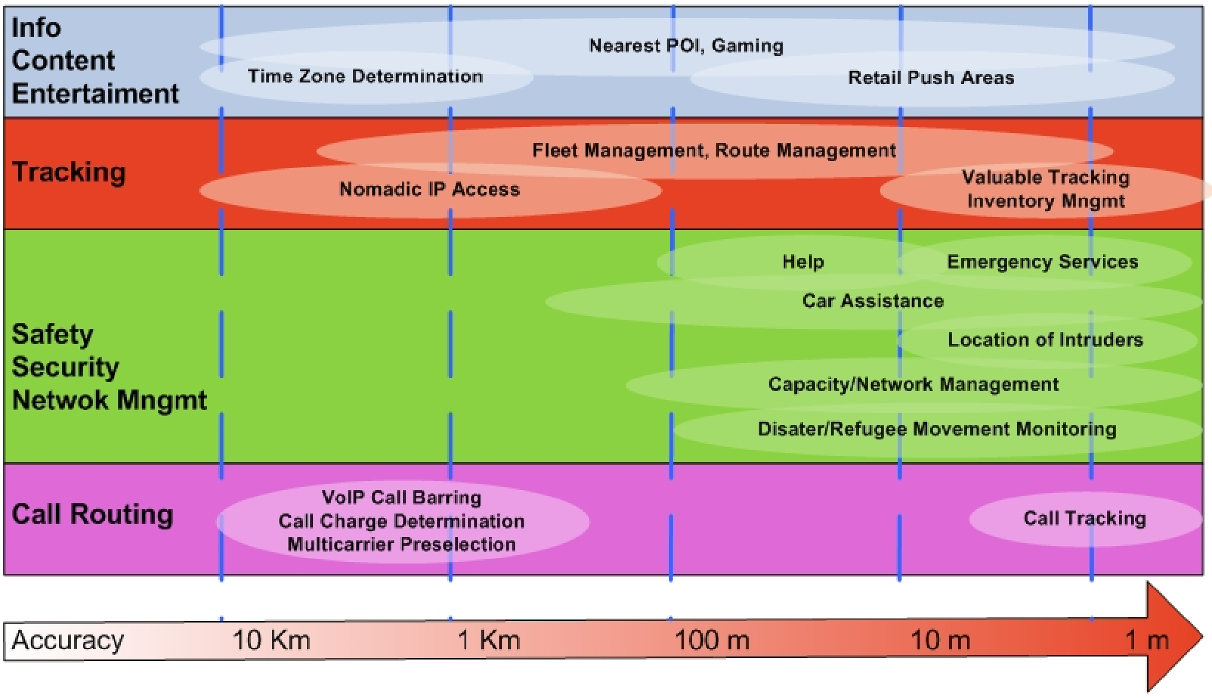
Table 5: Alternative ways to determine location

Access Type	LBS Method	Accuracy
Mobile	Cell ID	500m-10Km
	Enhanced Cell ID	300-500m
GPS	Stand-alone GPS	30-80m
	EAGPS/Galileo	1-3 m
Wireless	WLAN and RFID NAP	25m
	WLAN and Fingerprints RF Predition	3m
	WiMAX Cell ID	300m-1K urban 5-15Km rural
	WiMax and Fingerprints RF Predition	40-130m urban Not for rural
Fixed	Location of access line, terminal based method	2-3 m
	Location of access line, network based method	2-3 m
	Location of access multiplexer serving the user, network based method	Depends on technology PON 3-8 Km GigE 5 Km ADSL 3-5 Km VDSL 1-1.5 Km

Source: WIK-Consult.

The range of applications is potentially quite large, as can be seen in Figure 44. Some are directly useful to the end user. Others address security needs, including the need for access to emergency services.

Figure 44: Applications dependent on location and position



Source: Faggion and Lerot (2005).

It has long been recognized that location-based services could be intrusive. This aspect is specifically addressed in Article 9 (and in Recitals 32 and 35) of the e-Privacy Directive (2002/58/EC) of 12 July 2002. Except where the location data are anonymous, the user must opt-in.

Location-based services can indeed be intrusive. One study (limited to 16 subjects from 19 to 35 years old, but still very suggestive) attempted to rank the intrusiveness of several different location-based services (see Table 5). The scale for intrusiveness ranged from 1 (lowest) to 5 (highest). Note that the “lunch service” was felt (not surprisingly) to be very intrusive.

Table 6: Intrusiveness of various location-dependent applications

Service	Description	Usefulness	Intrusive-ness	Frequency of Use
Service A: Ringing profiles in private settings	The mobile phone ‘knows’ when the user is in a meeting or in class	3.75	2.1	1.5
Service B: Ringing profiles in public settings	The mobile phone ‘knows’ when the user enters a movie theater or a restaurant	2.6	2.2	0.4
Service C: Lunch service	A suggestion for lunch is pushed by the retailer to the mobile phone when the user is around a restaurant or fast food place	2.2	3.7	0.3
Service D: Localization of predefined friends	The mobile phone can locate predefined friends and alert the user when they are within a certain distance	3.75	3.25	1.3

Source: Barkuus and Dey (2003)

3.4 Key messages of this chapter

The migration to NGN has different implications for the core of the network in comparison to the access network. The core migration entails replacing PSTN based network elements with equivalent IP based network elements. The IP-based core not only inherently allows the network to carry a much wider range applications, but also potentially enables independent third parties to offer competing applications. This new form of competition is, from the regulator’s perspective, a key consumer benefit.

IMS standards were developed by 3GPP for the mobile world, but have been incorporated back into ETSI TISPAN standards the fixed world as well. They provide for seamless mobility, and their integration into fixed standards facilitates fixed mobile convergence.

Different migration paths are possible, depending on whether the network operator is fixed or mobile (or both) versus an existing IP-based operator without a traditional network. Existing operators will tend to prefer a more centralized implementation. They are unlikely to choose a “flag day” overnight replacement, but are more likely instead to either implement geographic islands or else to implement parallel infrastructure across their geographic expanse. IP-oriented operators will tend to prefer a more decentralized implementation, and can implement more gradually since they have no PSTN core to replace.

At the access layer, many underlying technolgies are possible. It is possible that not all NGN core operators will choose to offer last mile access. For those that do, VDSL and FTTB/FTTH are the choices that are most spoken of, but mobile services also play a major role, and fixed wireless broadband could be important. Some operators might migrate the core without upgrading the access from existing broadband solutions, as BT apparently is doing. Many operators will employ a mix of access strategies, and often will provide different forms of access to the same customer.

The security challenges raised by NGN were for the most part already present with the migration to IP-based services, but NGN raises these issues with increased force. Network integrity becomes important as IP becomes the basis of core incumbent networks that provide universal service.

Operational Support Systems (OSS), notably including billing and accounting, will necessarily have to evolve. Billing and accounting is, of course, closely linked to the question of what the basis will be for payments at retail and at wholesale levels (see Section 4.3). If current business models were simply carried forward, existing models would be ill-equipped to support them, especially where the service provider is not the same as the network provider. In the more likely case, charges for the service will be somewhat de-coupled from charges for the network, and operators will base charges only on things that they can unambiguously measure, in which case no special challeges for accounting systems are likely.

NGN standards have placed great emphasis on differentiated Quality of Service (QoS). There is reason to question whether the premium that consumers are willing to pay for QoS is as large as most operators assume. The technical capability to implement QoS has existed for many years, and implementations within individual IP-based networks are commonplace. The fact that implementations *between* networks are rare to nonexistent suggests that benefits have not exceeded costs to implement.

4 Regulatory tasks and instruments

This chapter is devoted to a detailed analysis of regulatory issues brought about by the paradigm shift and possible instruments to meet the respective challenges from an overall perspective. The specific market situation in Hungary is addressed in Chapter 6 and final recommendations are contained in Chapter 7.

The publicly available literature on NGN includes a multitude of papers addressing NGN from a technological/engineering perspective. Also a couple of (usually very expensive) reports by analysts and market research firms is available.[103] These reports are mainly providing market overviews, statistics and forecasts. NGN topics have been on the agenda of regulatory agencies throughout the world for quite some time and many papers and studies have been published. However, the academic (economic, competition policy, regulatory policy) literature on NGN issues – apart from the literature on VoIP - is rather limited. Examples are Elixmann and Schimmel (2003) and Hackbarth, Kulenkampff and Rodriguez (2006). Xavier (2006) and Xavier and Ypsilanti (2007) take on the particular issue of NGN and universal service.[104] Several papers by Marcus address interconnection in an NGN environment.[105]

We begin with an analysis of general regulatory implications of the paradigm shift inherent in NGN, and after that we analyse the key regulatory issues in the context of NGN already addressed briefly in Section 2.1.4.

4.1 Basic regulatory implications of the paradigm shift

This section provides a general perspective regarding regulation in the case of technical progress and market dynamics, respectively, and also provides a general review of the relevance of market power to regulation. As such it serves as a frame for the subsequent sections in which the implications of a migration towards NGN and the inherent paradigm shift are analysed in conjunction with specific regulatory topics.

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103 Examples are Ovum (2006), In-Stat/MDR (2006), WinterGreen Research (2006), Paul Budde Communication (2006), or visiongain (2007).

104 The authors address the following issues: quality of voice service (power supply, jitter, virus attacks, security, etc. as well as reliable access to emergency calls, caller location information), directories and directory enquiry services; public pay phones; availability, affordability and accessibility in a NGN environment; should USO focus on access to infrastructure *and* provision of service or only on the first?, and on the issue of funding USOs in a NGN environment.

105 See Marcus (2007), Marcus (2006b) and Marcus (2006c).

4.1.1 Regulation and technical progress

In this section we address the question of whether and under what circumstances would it be in the public interest for the authorities of a country to favour certain new technologies, perhaps through the design of its laws or regulations, or in some less permanent way. We look at:

- Information and incentive problems associated with public sector investing,
- The primary precursor to new technology; research and development (R&D),
- The linkages between competition and technological innovation, and
- Evidence that might support a policy of favouring certain characteristics of technology research programs over others.

History shows us that we should expect the unexpected when it comes to technical innovation (as well as most other things in commerce). The development of new technologies is not predictable and although there are a number of closely related areas where the authorities should be involved in certain cases, e.g. standards and standardisation (discussed below), and R&D support which corrects market failure (discussed below), the competition between technologies should be left for the market to determine. More generally, in a liberalised economy, if utility and transport infrastructure is in place, except in very peculiar circumstances, ‘entrepreneurial’ activity by the state will not be in the public interest. The main factor that prevents the authorities being able to reliably select the most deserving technologies is that the officials who would make such selections typically do not have either the information or the specific competence to reliably make good selections.[106]

It is also typical that the real technological innovators are not in government agencies but are working in public research institutes (e.g. universities) and perhaps more so in private firms, some of which are called public firms because the public can buy shares in them. However, even the most technically gifted do not have all the information needed to reliably predict which technology should be favoured. This is because a successful technology has a development history including R&D, manufacturing design, the organisation of parts supply chains, marketing and the development of sales networks. The supporters of a technology have to succeed with it in competition with other possible technologies, each of which has its own development history. Given that proper policy and regulation exist in regard to the development of standards and to correct for R&D market failure (discussed below), the state should employ a technology neutral approach to technological policy and regulation.

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106 A pejorative phrase commonly used to describe the situation where public funds are being directed according to the views of official or politicians, is “officials picking winners”.

Moreover, when the development of the output of an R&D program into market-ready technologies is guided by public hands, the incentives are not correct; those making decisions about which technologies should be supported, are not those who stand to gain or lose most from it. Even if public sector decision-makers were also technology and industry experts, they would not bear the financial risks of the investment, and consequently might not be motivated to exercise sufficient care in the way that funds are spent.

The primary precursor to a new technology is research and development (R&D). Many countries provide incentives to encourage investment in R&D in pursuit of technological innovation. An economic rationale for this is based on market failure.[107,108] Providing the participants with the incentive to invest in R&D, as if there was no market failure, constitutes good economic policy. The main way the problem is addressed by the state is through the provision of research funds; often, through an allocation in the national budget. In principle, however, the decision as to which applicants will get these funds should not be based on the type of technology they are researching; i.e. the system used to correct for the under-investment in R&D should not be aimed at favouring one technology over another. That would pre-empt the outcome of the R&D competition to establish the winner(s) of a competing technologies battle. There may be a case, however, for prioritising sectors that will be favoured for R&D funding due to the fact that different sectors contribute more or less to the overall economy, and some sectors are known to be enablers of economic activity in general.

Renowned Berkley Economist David Teece provides us with a rationale which could also be used to support an argument for the authorities to favour R&D research programs which exhibit certain characteristics. Teece refers to two factors that will influence who gets to gain most from an innovation: (i) *imitability* and (ii) complementary assets. *Imitability* refers to how easily competitors can copy or imitate the technology or process underpinning the innovation. Complementary assets are those relating to the ability to use the innovation and include such things as distribution channels, reputation, strategic alliances, licensing agreements, marketing capabilities, and customer relationships.[109] None of these factors, however, supports the case for any specific technology to be favoured by the authorities.[110] R&D policies should be technology neutral, even

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107 The problem with R&D is that firms can not keep all the benefits of their R&D expenditure, and so they under-invest in R&D; the sum of firm-related R&D benefits is less than the benefits that accrue to society. Economists describe that as an externality. To correct for the externatlity, the private net reward going to firms that invest in R&D needs to be increased by an amount that would occur if there were no externality involved.

108 In some countries, it is mandated that firms spend an amount on R&D. On the face of it, this is a poor policy which will result in obfuscation by the firm and not solve R&D market failure. It may be that policy makers know this, but the policy exists simply to placate an important interest group.

109 See Teece (2003).

110 Joseph Schumpeter, a leading economist of his generation, hypothesised that innovation and investment in R&D will be stronger in firms that have some degree of monopolistic power. Considerable empirical research has taken place on this topic and the results do not support Schumpeter. They suggest that large firms that have relatively little market power appear to be major investors in R&D.

though there may be a case for some sectors and/or technological characteristics to be advantaged by rules that provided R&D assistance.

The race to innovate is also part of the competitive process. The best innovators survive, the others do not or become relatively insignificant. Indeed, the activity of innovating can be where the real competition takes place. In such cases, the competition may be “for the market” rather than “in the market”, i.e. the innovation winner takes all. This type of competition is very important. It is widely acknowledged that inventions and technological progress provide more tangible benefits to consumers than do improvements in the day-to-day competition that takes place between firms selling into the same market.[111]

In addition to R&D, another related area where some official involvement is sometimes called for is in standards setting. Standards can be the midwife to new technologies becoming widely available. The public policy interest in standards is chiefly concerned with network effects.[112] A lack of technical compatibility due to proprietary standards can lock in subscribers and may also result in highly concentrated markets.[113] This only occurs in a limited number of peculiar situations, however, and is not a reason for the state to be involved in setting standards generally. Standardisation policy is a complex economic and technical topic, and is covered in greater depth in section 4.5.1.[114]

Another important reason that economists are wary about recommending a situation where the authorities favour technology A over B can be found in “Public Choice” economics, and the problems associated with agency;[115] essentially the lack of transparency in the decisions of the authorities makes this type of discretionary activity problematic.[116] It gives politicians and officials a great deal of power and is likely to foster the development of private agendas which do not correspond to the public interest.

Finally, from a regulatory perspective, while special treatment of new and emerging markets may be warranted in certain cases (see section 5.1.1), services that are provided by way of new technologies within an existing network which provide the same or a good substitute service to that provided before the upgrade, will be subject to the 3

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111 Antitrust and *ex ante* regulatory authorities focus on the latter. It is one of the criticisms made of the European regulatory framework that it does not adequately address this type of competition, which tends to take place over a longer timeframe than is used by these authorities.

112 Network effects arise when the average benefit enjoyed by users increases with the number of users.

113 Such an outcome can be consistent with the preference of policy makers to foster technological progress, although where high levels of market concentration arise there are clearly trade-offs involved with this policy.

114 See e.g. DTI (2005) or David and Greenstein (1990).

115 In economics, *agents* are people who are acting on behalf of others (where the others are referred to as *principals*). Due to information asymmetries, the principals can not be certain that agents are always acting in the principals’ interest. For their part, agents know that they can follow to some degree their own agenda.

116 While many economists would argue that the behavioural assumptions of the Public Choice school of economics are too narrow, “Public Choice” economics has been enormously influential; see e.g. Buchanan (2003).

criteria test and the application of suitable remedies in the event that SMP is identified.[117] This is discussed in more depth in section 4.9, which deals with the applicability to NGN of those the European regulatory framework that address market power.

4.1.2 Regulation and disruptive market processes

Migration towards NGN will bring about changes in telecommunications value chains, with profound changes to the relationship between the *service* and *network*. Most commentators think that, in an NGN environment, third party service providers are more likely to be able to provide services to end-users on a level playing field with end-user access providers. The changes brought about by the replacement over time of traditional with NGN networks will require firms to adapt, innovate, reinvest, and restructure themselves. Some firms may not survive in their current form. This section addresses the general role of regulation in circumstances of disruptive market processes. In particular, it considers the regulatory implications of the decoupling of the service from the network, and the implications of this decoupling for the exercise of market power.

Whenever change occurs that impacts the commercial environment, there will be a ripple effect resulting in many other changes, such as: changes in resource allocation, changes in investment, changes in products and services offered, changes in the competition between firms, and changes in the overall level of economic activity (macroeconomic changes). All through history, innovation has imposed change on societies. In regard to commerce, innovation occurs not only through the invention of new technologies, but also through people designing new business models/value chains. At any point in time, an economy will be adjusting to these type of changes.

A good example comes from the world of traditional telecommunications services. Through the 1980s and into the 1990s huge efficiency gains resulted for network operators due to their converting their core networks to fibre and using modern digital switches. Following these changes, operators found that a very large percentage of the workforce was no longer required. Most were very slow to adjust due to the political fallout of making thousands of people redundant, and also because in almost all cases they did not face competition. However, liberalisation required that these inefficiencies be addressed. Tens of thousands of people received large redundancy payments and many almost immediately found a job with new entrant competitors to their former employers. Indeed, studies suggest that even though technological developments led to the loss of thousands of certain types of jobs, liberalisation (in conjunction with new business models, more efficient business practices, and the sale of more services to end-users) resulted in at least as many new jobs being created. Moreover, the innovations resulted in a richer range of lower priced services being offered to end-users, which in turn enabled more efficient business practices, remote working, and changes

117 See European Regulators Group (2006).

in the type of work that people do, resulting in society-wide benefits and economic growth. There was disruption, and many thousands of workers and their families felt the stress of redundancy, job search, job change, and for some even a period of unemployment. Nonetheless, overall these changes improved peoples' standard of living.

Using Christensen's classification of innovation that results in 'disruptive' or 'sustainable' market processes, much of what occurred in incumbent telephone companies was "sustainable disruption"; firms did not die out, but adapted and reformed themselves using the new technology. It is likely that, for upstream suppliers of telecommunications equipment, the innovations may have been more disruptive, e.g. to the extent that copper cable manufactures were not able to switch to producing fibre cables.

In the case of NGN it is instructive to surmise whether and where NGN innovations may be 'disruptive' or 'sustainable'. Our primary motivation for this is not that disruptive innovations are harmful to the economy (in the long-run they are not), or should in general be prevented, or that the introduction of the innovation should be micro-managed. In general, the state should not try to do these things. Indeed Christensen's now well known classification of 'disruptive' and 'sustainable' market processes is not important *per se* to the authorities but to the firms affected by the innovation. Whether an innovation is 'disruptive' or 'sustainable', over the long-run both improve living standards.[118] Rather, the authorities interest in keeping an eye on the market consequences of important innovations primarily concerns: (i) being able to respond with any appropriate new laws and regulations that may be needed to facilitate the introduction of the innovation, and (ii) because of the incentive and capacity of dominant firms to behave strategically in order to engineer 'destructive' consequences. Two other motives for action by the authorities are more contentious: (iii) There may also be a case for the authorities to engineer an adjustment period in case the innovation is predicted to be very abrupt and does not provide firms with time to adapt, and (iv) as we are committed to regulating for sustainable competition, we would like to avoid a situation – however unlikely – that where, in converting to an NGN world, the market power of incumbents were substantially strengthened, even if this were to result "naturally" without dominant firms trying to engineer it.

In the case of (ii), a dominant access network provider might adopt an NGN conversion strategy not only because it is directly beneficial to do so, but also because it would cause difficulties to its competitors. An example might be a strategy that has the purpose of shutting down MDFs early than would have occurred otherwise, as this seems likely to impact negatively on its competitors. It would be very difficult to tell whether this were indeed an anticompetitive strategy – with the arrival of the NGN world, many existing network providers are likely to find that some of their assets are no longer useful to them, or are in the wrong place, especially as network interconnection will move to new

118 See Christensen (1997).

places in a new network. Where this is simply a consequence of innovation, it is tempting to recommend that the market be left to sort it out.

Cases (iii) and (iv) are really very similar, inasmuch as both reflect a desire to avoid harm to competition. How likely is such harm? Given properly designed and targeted wholesale regulations, the decoupling of services from networks over which they are provided (i.e. access and transport layer, and above) suggests that market power might decline. At the same time, it is entirely possible that new competitive bottlenecks will emerge, and new vectors for exercising market power. At this point in time, it is premature to say whether market power is likely to increase or to decrease on balance as a result of the migration to NGN.

One could envisage a situation where the authorities intervene to try to inhibit certain innovative changes (in this case, the migration to NGN) because those changes threaten the ongoing existence of competitors.[119] Before deciding on such a stance, the authorities would want to carefully assess the likely costs (e.g. in terms of increased costs of the innovation forgone, the spill-over cost felt elsewhere in the sector and the economy) against the likely benefits provided by the degree of competition preserved. A serious challenge with this approach is that it relies on conjecture about the degree to which NGN innovations will result in changes that seriously damage the competitive process. It also implicitly assumes that the intervention would be effective. We would caution NRAs not to "bet" prematurely on these outcomes.

4.1.3 NGN and market power issues

Market power issues in the context of migration to NGN may arise from different perspectives. It is a central theme. It is addressed in many different contexts in this chapter:

- In section 4.2, as it relates to access, including cable television infrastructure;
- In section 4.3, in connection with interconnection;
- In section 4.5, in connection with network interoperability, standards, and interfaces; and
- In section 4.9, as a central theme of European regulation.

European regulation deals with market power in its "classical" form, as has been reflected in a century of competition law and economics. This is not the only potential competitive threat posed by NGN. The migration to NGN potentially raises a range of

119 As a possible example, OPTA might be tempted to intervene. OPTA appears to be worried about the possibility that competitors will be seriously damaged by the migration to NGN (see section 2.4.2).

issues tied to a special form of market power especially linked to *network externalities* also known as *network effects* – in many networks, the value of the network increases with the number of people using the network.

A series of generally accepted economics articles[120] conclude that, where one firm has a commanding share of a particular market, both relative to the market as a whole and also in comparison to the next largest player, then the dominant firm will tend to prefer less-than-perfect interoperability or interconnectivity. Perfect interoperability or interconnectivity tends to dilute the ability of the dominant firm to exploit its market power. The analysis first appeared in connection with standards compliance, but it was subsequently recognized that the same analysis applied to interconnection.

Regulators should always strive to do their job with restraint and humility, and should consequently avoid premature or inappropriate interventions where market forces would suffice to prevent consumer harm. Nonetheless, it is generally accepted that the many segments of the communications industry are subject to strong market power effects for many reasons, including high sunk costs, low marginal costs, and generally high barriers to entry. In the absence of *ex ante* remedies, competitors may not be able to enter the market at all.[121] This is the primary rationale for *ex ante* regulatory intervention in electronic communications.

4.2 NGN and network access

This section analyses in detail the regulatory issues concerning access possibilities brought about by NGN. This section bears on the results of the technological analysis in section 3.2. It focuses first and foremost on "access (for competitors) to the access network of the incumbent". Access takes place primarily (but not exclusively) in the lower layers of the network protocol hierarchy, those sometimes referred to as the Physical Layer and the Data Link Layer.

The crucial issue is if the design of the NGN will effectively impede future competition in the market. This, in turn, would be to the detriment of consumers who will be less able to access broadband from alternative operators.

4.2.1 Basic elements of current telecommunications networks

As a preparation for the subsequent discussion, i.e. in order to understand and assess the implications of the changes in the logical and physical access network infrastructure, it is useful to outline at first the basic elements of today's telecommunications net-

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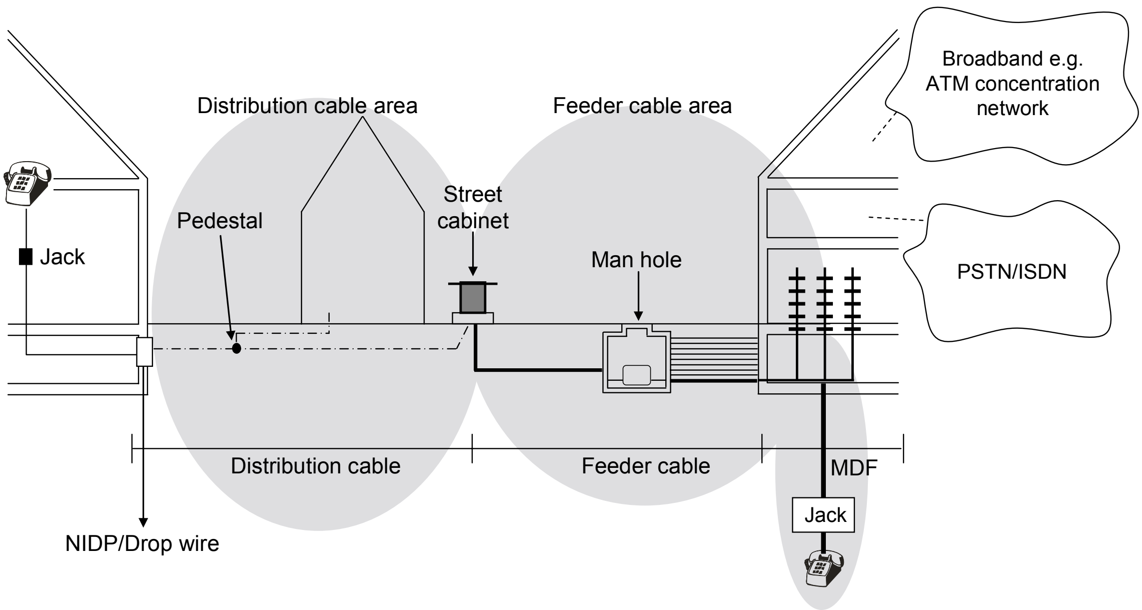
120 Notably Katz and Shapiro (1985), Farrell and Saloner (1985), and Cremer, Rey and Tirole (2000).
121 See, for instance Marcus and Haucap (2005).

works. In this context, the term *access* should be construed to comprise both the aggregation network (local loop) and the backhaul access network.

The following Figure 45 characterizes the main elements of the traditional „local loop".

Figure 45: The traditional „local loop": stylized facts

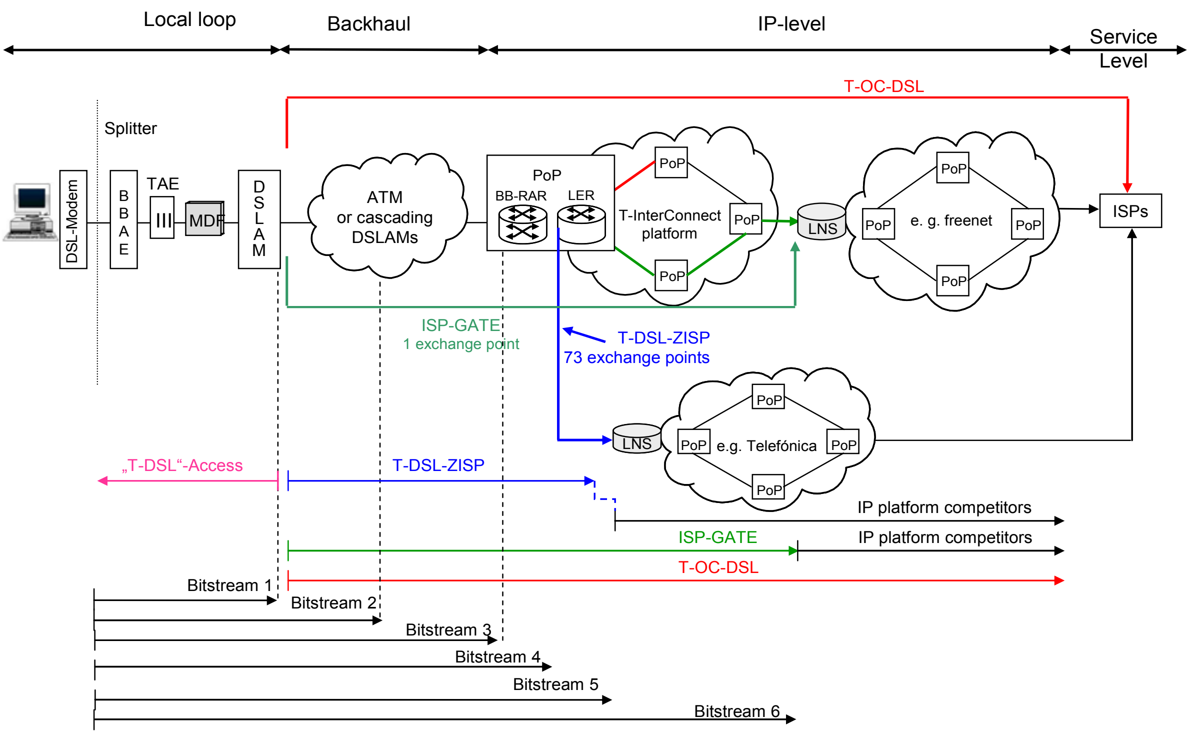


Source: WIK-Consult

The main elements of the PSTN-type local loop are the network interface demarcation point (NIDP) which is connected by a twisted pair copper line (the drop wire) to the pedestal where several twisted pair copper lines come together. This bundle of copper lines is then linked to the street cabinet. The part of the local loop between NIDP and street cabinet is called distribution cable. The street cabinet is the first aggregation point in the access network, i.e. several bundles of copper cables are merged into one single cable, the feeder cable. The feeder cable links the street cabinet to the Main Distribution Frame (MDF). The feeder cable still consists of single twisted pair copper cables, which are, however, twisted into one "big" cable. Usually, there are man holes in the local loop, most often in the feeder cable. If the distance between MDF and the street cabinet exceeds the physical length of a feeder cable then the need arises to extend this cable by an additional one. Man holes provide the possibility to connect two feeder cables. Moreover, they make it possible to add new copper cables in ducts (connecting the MDF and the street cabinet).

Figure 46 focuses on the different elements of a backhaul access network.

Figure 46: The backhaul access network (example Germany)



Source: WIK-Consult (2007), based on earlier BNetzA (formerly RegTP) information

Regarding broadband access the figure exhibits theoretical traffic handovers against the backdrop of the current network structure and wholesale input services in Germany. The figure aims at highlighting different facets:

- Firstly, there are several physical points in the network where bitstream access actually can take place
  - Bitstream 1 at the MDF/DSLAM,
  - Bitstream 2 at a location in the ATM network or at a higher level DSLAM (if these DSLAMs are subtending) in the backhaul network,
  - Bitstream 3 at the Broadband Remote Access Router (BB-RAR),
  - Bitstream 4 at the Label Edge Router (LER),

- Bitstream 5 at the Layer 2 tunnelling protocol network server (LNS), where the competitor purchases a dedicated leased line from the incumbent to link the distance between LER and LNS,
- Bitstream 6, basically the same as with Bitstream 5, however, the link between LER and LNS consists of a specific wholesale service of the incumbent between LER and PoP and a dedicated leased line between PoP and LNS.[122]

- Secondly, competitors demand wholesale services from the incumbent depending on the degree of their own network infrastructure deployment. The nearer the competitor has deployed own infrastructure towards the end user the less he has to demand transport services from the incumbent.
- Thirdly, in Germany three different broadband wholesale services provided by DTAG are actually available: T-ZISP requiring the competitor to be present at 73 different BB-RAR sites of the incumbent; ISP-Gate requiring the competitor to be present at a single PoP of the incumbent; T-OC-DSL which is a service mainly for a (near) non-facilities based broadband access provider (e.g. an ISP), i.e. a company based on a resale business model.

Next, we would like to address the issue what requirements for competitors are arising regarding their own network infrastructure depending on their business model with respect to the wholesale services they are purchasing.

Table 7 takes account of the wholesale input services ULL, resale, bitstream access, and shared access. On the network side the table differentiates between the subscriber access network, the (backhaul) access network, and the backbone network. Moreover, it takes into account collocation and up-stream connectivity.

122 It seems worth to note that the options Bitstream 2, 4, 5 have been discussed for a while in Germany, however, they are today (2007) no longer viewed as optjons relevant for actual regulation.

Table 7: Network deployment requirements for competitors (stylized facts)

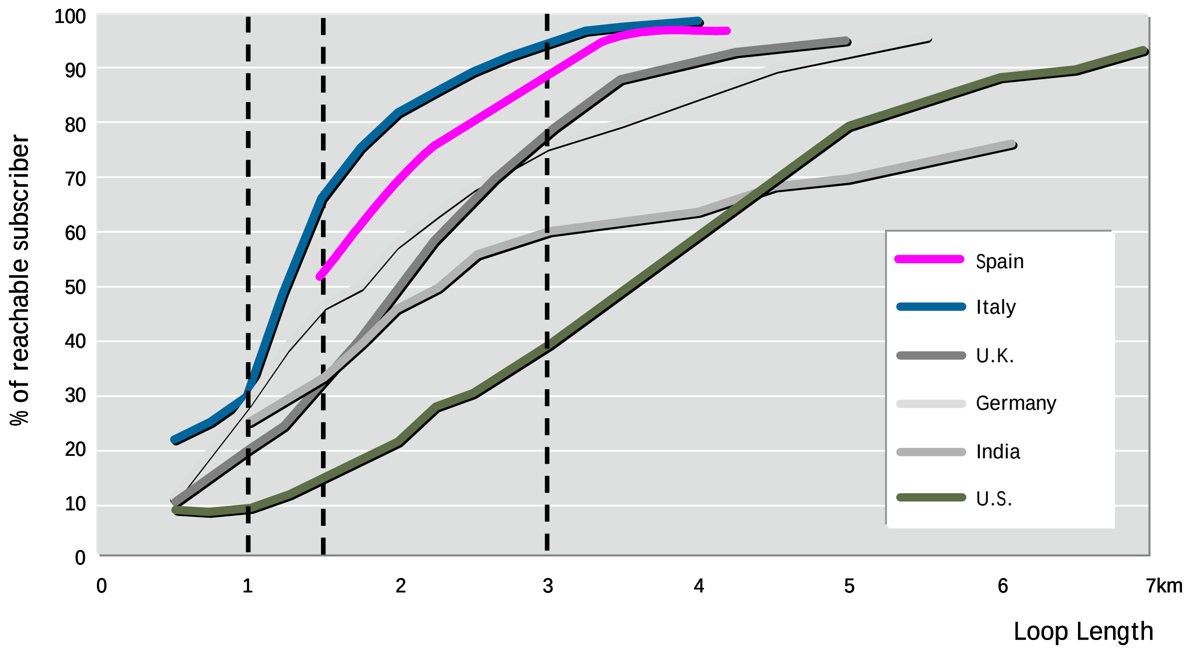
	Unbundled local loop	Resale	Bitstream PoP at the Switch	Bitstream PoP at the DSLAM	Shared
Subscriber access network					
MDF					
Splitter					x
DSLAM					x
Access network					
Switch	x			x	
Backbone network					
Backbone transmission technique	x		x	x	
Layer 2 Tunnelling Protocol Network Server (LNS)			x	x	
Collocation	x		x	x	x
Upstream connectivity	x	x	x	x	x

Source: WIK-Consult

The table makes obvious that different business models of competitors require different (regulated) wholesale input services.

Finally, we would like to stress that the current communications networks in different countries of the world provide different incentives to deploy deep fiber solutions in the local loop. The reason is that the loop lengths vary a lot across countries, see Figure 47.

Figure 47: Distribution of subscriber loop lengths



Source: Wulf (2007).

4.2.2 Facilities-based and service-based competition

This section is devoted to the discussion of basic directions of current regulatory policy, namely the objectives with respect to facilities-based and service-based competition, in the era of NGN. As with all of Chapter4, this section considers these issues from an overall perspective. The specific situation in Hungary is addressed in Chapter 6.

It is fair to state that facilities-based and service-based competition to date mirror different regulatory objectives and require different regulatory tools.

Vogelsang (2005) argues that a regulatory preference for infrastructure competition a-priori could be based on several arguments:

- Firstly, it offers true alternatives for consumers.
- Secondly, there are strong incentives for productive efficiency.
- Thirdly, the selection of the best technology is supported.

- Fourthly, there is an incentive for innovations and, in turn, spill-over effects are taking place.
- Fifthly, it provides for enduring competition.

In contrast, service competition is claimed to provide competition only in limited areas, little product diversification, no alternative technologies, and no enduring competition (thus, requiring continuing regulation). Moreover, it is often argued that service competition virtually depends on infrastructure competition.

In this context it is useful to take a quick look at a concept which has been widely discussed among European regulators in the past years, i.e. the "Ladder of Investment" principle. This principle argues that it is eventually not a decision of "either – or", rather, over time both approaches have their benefits.

Roughly stated, the "Ladder of Investment" principle reflects the idea that regulators need to ensure a range of options (especially for last mile access) available at wholesale, in order to ensure that competitors can achieve market entry and can then become progressively more effective and self-sufficient competitors. Some require minimal investment; others require more investment, but offer a greater return. According to (ERG 2006): "By investing more in own infrastructure, the competitor climbs up the value chain or the 'ladder of investment', in other words as it can use more and more of its own infrastructure it is able to add gradually more value to the product offered to the end user. At the same time it reduces the reliance on the wholesale products of the dominant operator. Thus, the Ladder of Investment encourages efficient investment while promoting competition at the same time. The more complete the chain of access products is, the higher the competitive dynamic. In order to make the ladder of investment operational, NRAs have to ensure that access products are consistently priced and that proper migration processes are in place…."

With this in mind, two key questions emerge as regards service-based competition and the Ladder of Investment: (1) Do these concepts still have the same meaning in the future world of the NGN? (2) If not, what is the relevance of the Ladder of Investment going forward?

One of the most important characteristics of NGN is the decoupling of the transport and service functions. Thus, as we have argued in section 2.1.3 of this study, many different business models will be feasible. Roughly stated, there will be companies who are integrated (infrastructure + service provision), those that are mainly non-facilities-based and engage in service provision, and presumably also those that are mainly focusing on infrastructure (deployment and operation, e.g. companies with a focus on wholesale). That said, infrastructure and service competition obviously will receive a new meaning.

Telecommunications carriers that have migrated to NGN technology in a given market (e.g the incumbent and its main competitors) of course compete with each other on the basis of infrastructure. From a competition and regulatory policy perspective, this situation might bring about challenges with respect to both NGN core networks and NGN access networks (see the discussion in section 4.3 on interconnection and in section 4.2 [this section] on network access). Presumably, the carriers will also compete with each other on the basis of services whereby voice will be only one application out of a portfolio of many other (IP-based) applications (e.g. IPTV). But this does not tell the whole story of service competition today and even less tomorrow.

Service competition in the electronic communications market today is already very fierce today, and it is our expectation that it will become even more so in the future. Examples are Google, Yahoo, and e-bay or non-facilities based providers of voice communications. To some extent, they are competing against each other (e.g. with regard to search engines, voice communications). An interesting question is, however, whether they compete with infrastructure based telecommunications carriers. The answer today is yes with regard to voice communications, but no with regard to their respective core businesses. It is our impression that this situation will also prevail in the future. To put it more concretely: telecommunications carriers will find it very difficult to copy or imitate the business model of a Google, Yahoo etc. Viewed from the opposite side: Google, Yahoo and the like do not necessarily need (that much) their own network (transport) infrastructure. Their business model seems to be viable as long as they have access to end users (which is provided by the telecommunications carriers). The fact that the telecommunications carriers do not like this situation is one facet of the “Network Neutrality” debate.

Thus, for many companies in the market, in particular for the service providers, Ladder of Investment considerations are virtually irrelevant. The Ladder of Investment concept virtually presupposes more or less homogeneous services (in particular voice and broadband access), i.e. it is a “bellhead” concept and it mirrors the service portfolio of telecommunications carriers. Ladder of Investment considerations still might play a role regarding the relationship between incumbents and facilities-based competitors (in particular regarding NGN based access networks).

However, the crucial factor is the willingness to pay of end users. Facilities-based competition between NGN-type telecommunications carriers might make sense and be important to the extent that the customer is willing to pay for those features that can only be provided due to owning infrastructure (e.g. “quality”). If the willingness to pay for infrastructure-based differentiating features is not there, or is not high enough, then the incentives for infrastructure-based competition are not there.

4.2.3 Potential new input services necessary for competitors

The results of the analysis in chapter 2 and 3 underline that migration of network infrastructure towards an All-IP network will in all likelihood mean that the physical and logical locations where competitive carriers can get access to the network infrastructure of the incumbent are fundamentally changed. One particularly important point is that MDFs loose their function in a NGN and, in turn, MDF locations become insignificant, see e.g. the case of KPN described in section 2.2.2.1. Indeed, deployment of fibre to the street cabinet shifts functionality to the locations of the street cabinets. Moreover, new logical and physical functions will be concentrated presumably at locations of former MDFs.

Nonetheless, it is useful to keep in mind that the carriers in Europe face (to some extent very) different pressure to deploy deep fibre in the local loop. One reason for this becomes obvious by referring to the relevant loop lengths.[123] VDSL (i.e. deploying fiber up to the street cabinet) shortens the length of the copper loop (on average) to about 300 metres in Germany, compared to around 900 metres in France. Hence, the incentive for the incumbent to deploy VDSL in France is much lower than in Germany (or in countries with a similar network topology).

Richards (2006) identifies the following drivers for access NGN deployment[124]:

- End to end infrastructure competition,
- Limited opportunities for DSL evolution,
- Pay TV opportunities,
- Availability of unbundled DSL,
- Government led supply side strategies.

Inherent in this shift is on the one hand a reduction of the number of "relevant" MDF locations and on the other hand a substantial increase of locations where competitors a-priori can get access to the network of the incumbent.

In section 2.1.4.1 it was argued that the following wholesale services might come into play for competitors if incumbent access networks have migrated to fiber based NGN:

- Access to ducts, dark fibre,
- Sub-loop unbundling (SLU),

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123 See also **Figure 47** in section 4.2.1.
124 Refering to drivers for core NGN deployment Richards (2006) mentions limited traditional product revenue growth and new product and service development.

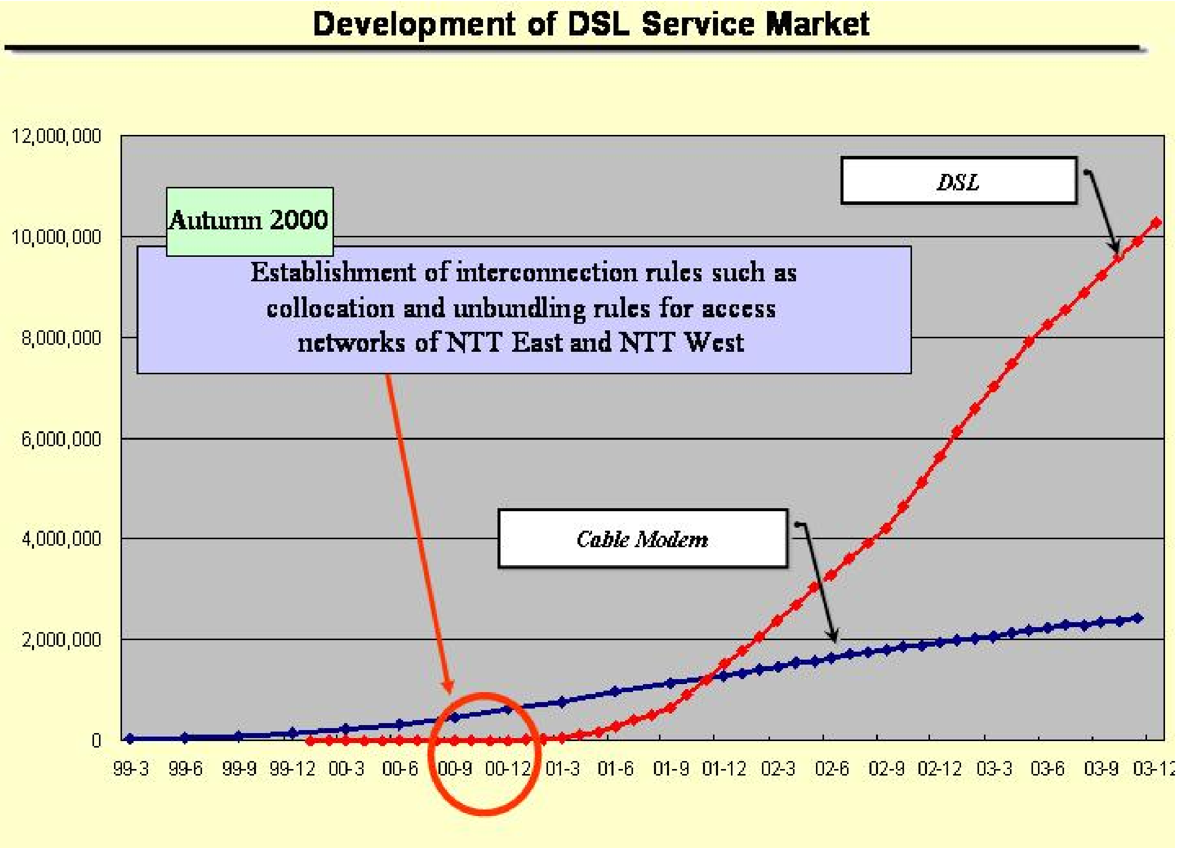
- Bitstream access,
- Access to VDSL capable infrastructure at the MDF (if carriers are relying on VDSL deployment),
- Resale.

Access to ducts, dark fibre

The costs for competitors to replicate a FTTx infrastructure upgrade of an incumbent network are very high, especially due to the costs of digging. German market participants report a ratio of nearly 1:100, i.e. deploying own fibre infrastructure in the local loop is about 100 times more expensive than using existing infrastructure like ducts or dark fibre. This makes obvious that access to ducts and dark fibre can be viewed as a crucial factor for competitors who are basing their business model on own infrastructure regarding access to the end user.

It is fair to state that Japan has followed a rather competitor-friendly policy regarding access to dark fibre. Indeed, in Japan competitive providers are able to use essential elements of NTT's network, particularly low cost access to copper lines to the home and metropolitan fibre connections running between NTT exchanges and to other locations. These elements have been the basic building blocks of competitive ADSL providers' networks. Figure 48 shows the development of the ADSL service market in Japan over time. Our analysis in section 2.2.2.5 shows that FTTH has caught up with DSL technologies in recent years.

Figure 48: Development of the DSL service market in Japan (1999 – 2003)



Source: Taniwaki, Y. (2004)

The figure shows in particular that the unbundling rules for access to the networks of the two NTT local entities have unleashed a very dynamic market development.[125]

Yet, it is fair to state that other countries like e.g. the USA have decided to rely on a completely different approach, see section 2.4.4.1. Indeed, the Federal Communications Commission (FCC) in its triennial review in 2003 abolished most unbundling obligations for incumbent local exchange carriers (ILECs') FTTH loops (whether dark or lit),

125 The subscription-based optical fibre networks owned by NTT East/West are categorized as *"category I designated telecommunications facilities"* under the Telecommunications Business Law. *Category I designated telecommunications facilities* are indispensable facilities (with a "bottleneck" function) in establishing connections with other telecommunications carriers' facilities to achieve further user-friendliness and the development of more comprehensive and more reasonable telecommunications services. NTT East/West, who own such category I designated telecommunications facilities, are legally obliged to lay down clauses regarding connection charges and technical and connection conditions to connection points with other carriers' telecommunications facilities, as well as to seek approval by the Minister of MIC for such clauses.

and these policies have been accompanied by a progressive withdrawal of all of the regulations supporting service-based competition. These policies appear to be contributing to mixed results – the U.S. is experiencing reasonably high levels of investment in FTTx on the part of fixed incumbents, but most competitive fixed operators have been forced either to be acquired by a fixed incumbent or else to exit the market. Thus, the average U.S. consumer perceives few real competitive options, rarely more than two. The negative impact on consumer welfare that is associated with the decline in competition may well outweigh any benefits associated with increased investments by wired incumbents.

Thus, it is obviously a matter of policy objectives and of local market conditions to assess the rationality and market success of a policy of giving competitors access to ducts and fibre.

Sub-loop unbundling (SLU)

A business model based on sub-loop unbundling is focusing on the unbundled "local loop" at the street cabinet. This is particularly relevant in the context of VDSL, if the DSLAM moves to the street cabinet in order to achieve a suitably short copper loop length to the customer premises. Those carriers who are today leasing the last mile to end users at the incumbent's MDFs in this case face the challenge to implement a multitude of new access points at the cabinets. Due to the fact that the number of cabinets is much higher than the number of MDFs – in Germany the ratio of cabinets per MDF on the average is 40:1, in France the ratio is 20:1 – this would require substantial investment resources by competitors.

From a competitor's perspective, migration to SLU requires extending the backhaul (from the MDF site to the core) to the SDF site. Thus, the carrier needs to make a decision about the economically viable options for extending the aggregation and backhaul network:

- Own build,
- Leasing dark fibre from a third party,
- Leasing dark fibre from the incumbent,
- Rental of ducts,
- Leased lines.

Investment in own fibre lines between MDF and street cabinet (i.e. own build) virtually bring about severe challenges: Civil engineering works (trenches in the public domain) drive costs significantly upwards; moreover, getting the respective authorizations for digging might be time consuming.[126] Leasing dark fibre, renting ducts or relying on leased lines necessarily requires availability of the respective resources. With regard to the latter there is no general statement possible, rather, availability needs to be analysed against the backdrop of the specific conditions in each country.

Regarding SLU, there are in general two collocation options at the street cabinet distribution frame, both of which pose difficulties:

- Building a second cabinet adjacent to or at a certain distance from the incumbent's cabinet. This is the virtual collocation solution where the competitor places his own DSLAM near the incumbent's street cabinet.

- Physical collocation. Two options are technologically available: (1) the competitor places his own DSLAM in the incumbent's street cabinet; (2) the competitor places his own line card in the incumbent's street cabinet.[127]

Even though the study of Analysys (2007) a-priori is only providing empirical evidence for the Netherlands, this study seems to call into question the viability of the business case for SLU. It may be viable to deploy SLU for alternative providers only for a small subset of the largest street cabinets in dense urban areas. Any viable business case based on SLU for alternative providers presumably depends to a large degree on the

- wholesale tariffs of the incumbent for SLU line rental,

- conditions of collocation, and

- prices/costs of the backhaul links to the street cabinets.

Moreover, in all likelihood a necessary (not a sufficient) condition for a viable business model for alternative providers with regard to SLU would be to cooperate with one another. Due to the increase in economies of scale associated with rolling out alternative networks to the street cabinet level, it is difficult to imagine that more than one alternative provider can profitably seek access for SLU.

In addition, one should take into account that usually in most countries the number of (outdoor) street cabinets is limited due to municipal restrictions, and possibly also due to restricted accessibility. In addition, the lack of power supply might turn out to be a serious bottleneck for any alternative replicability of street cabinets or sharing of street cabinets.

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126 See Gauthey (2007). She is providing also information on respective costs in France.
127 For more details see Wulf (2007).

Any definitive assessment of the relevance of SLU in a particular country such as Hungary is well beyond the scope of this study. Rather, this would need to be evaluated on the basis of an appropriate empirical study based on the concrete and detailed market and legal situation in Hungary.

Bitstream access

Section 4.2.1 has shown that a-priori there are many alternatives as to the actual part of the network where traffic handover to competitors might occur. Which of these options are reasonable in practice needs to be clarified in the process of consultation with market participants concerning the implications of NGN deployment.

Access to VDSL capable infrastructure at the MDF

The analysis of the carrier plans regarding (access) NGN in section 2.2.2.1 has shown that NGN presumably will significantly reduce the number of access points at the current MDF locations. The MDF, however, is the part of the network which for most of the competitors is the “nearest” point to the end user in their own network. The “rest” of the network for these companies usually relies on unbundled infrastructure from the incumbent. Thus, NGN might generate stranded investments.

Existing wholesale broadband offers of incumbents often hand traffic over at points “far away” from the MDF, see section 4.2.1. Thus, relying on existing offers for a VDSL service would require an alternative operator to route its 'triple play' services at high expense through the broadband backhaul network of the incumbent.

Getting access to NGN-based infrastructure and services at the MDF level (or the DSLAM level) would therefore optimize the opportunities for companies relying on the unbundling model to make use of their existing network infrastructure in order to provide VDSL. This option is receiving serious attention from German competitors. To the best of our knowledge it is, however, still unclear whether such an access option at the MDF will be a technically and economically feasible option.

Potential issues regarding FTTB/H

Compared to the case of fibre deployment up to the street cabinet the regulatory agenda is changing very much if fibre is to be deployed up to the building or the home.[128]

As digging up the streets is costly the availability of existing infrastructure which could be used for the deployment is very important. Examples are

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128 A very thorough analysis of potential FTTB/H business cases and regulatory implications brought about by FTTB/H can be found in the presentation of Gauthey (2007). She is referring to the French case.

- Infrastructure of electricity utilities,
- Water/sewage pipes; open access sewers, however, are presumably available only in metropoles, if at all,
- Ducts of the incumbent,
- Dark Fibre of the incumbent or other carriers.

Moreover, it needs to be discussed if aerial deployment is possible.

A-priori several alternative business models might be viable and relevant. The NetCo (i.e. the company mainly operating network infrastructure which they, however, have not necessarily deployed or which is owned by them) and the ServCo (i.e. the company providing services) might be integrated, they might be separated or an operator neutral third party (strategic investor) renting the infrastructure might be present (AssetCo).

A crucial issue regarding FTTB/H deployment will be if there are comparative advantages of telecommunications carrier incumbents and to assess the necessity of regulated wholesale offers by the incumbent. An assessment of the potential competitive situation has to take into account how many parallel infrastructures are possible and viable. Moreover, the issue of what constitutes "market power" in a concrete FTTB/H case needs to be addressed.[129]

FTTH in particular raises the issue of getting into the building. The transaction costs of negotiating agreements with home owners a-priori are high. Moreover, it is not at all clear if infrastructure for in-house wiring is available. If this is not the case the costs for establishing such infrastructure are raised tremendously. Moreover, it is highly likely that the number of parallel fibre infrastructures within a home will be limited. Thus, an issue of regulatory concern might be if there are first mover advantages and how to deal with them. One approach in this respect (discussed e.g. by the French regulator) might be to impose the sharing of infrastructure within homes.

An important issue for regulatory policy is how unbundled access and wholesale bitstream access can look like in a FTTH environment? Gauthey (2007) argued that LLU is not always technically feasible. According to her analysis unbundling would imply the delivery of the a dedicated passive access at a reasonable number of points (e.g. at the level of the ODF (Optical Distribution Frame)). However, the feasibility of this option depends on the topology and architecture chosen. Gauthey points out that in the case of Point-to-Point FTTH unbundling is feasible because there is one single dedicated fiber per end user to the ODF. However, in a Point-to-Multipoint (PON) environment

129 Of course one might consider the applicability of the regulatory framework and Commission guidance on markets and SMP to FTTB/H. Note in this respect that Market 11 is defined in terms of *metallic* loops and sub-loops.

unbundling at the level of the ODF is not feasible per se. However, a solution of unbundling could be implemented if extra fiber and extra splitters have been deployed at the moment of the roll-out.

Overall, important topics on the regulatory FTTB/H agenda will be to assess the feasibility of potential regulated wholesale services (unbundled access, wholesale bitstream access) and to decide if a national or a regional/local regulation is appropriate.

4.2.4 Stranded investment from a network access perspective

We have seen in the analysis in section 2.2.2 that NGN might lead to the closing of incumbent facilities (MDFs, exchanges) in which other telecommunications carriers have equipment installed for purposes of network access. Thus, capital investment in accessing these facilities (e.g. voice interconnection equipment, leased lines to nodes of the incumbent - written off over a particular period - might become worthless if the incumbent opts to upgrade its network earlier, i.e. within this period. This argument carries through to LLU network investments. Moreover, incumbents are usually deploying FTTC and VDSL technology in areas with high customer concentrations. These are the same locations where competitors are building their networks on the basis of the LLU regime. Competitors in a number of countries have argued that, in the absence of a level playing field provided by regulation (i.e. pertinent regulated wholesale services), these changes would also devalue their own infrastructure.

The issue at stake therefore is whether deployment of NGN technology is likely to increase the risk of stranded investment on the part of competitive operators, and how to deal with the stranded investment if so. It is not surprising that several competitors claim that the introduction of NGN is likely to undermine and damage the more or less considerable investments they have made, and to demand compensation in the event that they are left with stranded assets.

The ERG is about to release the final version of their report on IP-based interconnection.[130] Their public consultation specifically considered whether there were likely to be fewer points of interconnection in an NGN environment. The preponderance of responses were to the effect that there are likely to be substantially fewer POIs, and this is also the ERG/IRG's considered opinion.[131]

Ofcom considered this question in conjunction with BT's migration to 21CN, which is intended to result in the reduction of the number of POIs from some 3,000 to just 100 to 120. Ofcom concluded that BT had an obligation for timely consultation with industry. They did not feel that BT should be restricted in its ability to adopt new technology, in

130 The document is reportedly complete, but apparently has not yet been publicly posted.
131 See e.g. Schwarz-Schilling (2007).

general; however, they felt that there might be obligations to industry to the extent that (1) decisions were unilateral on BT's part, (2) decisions were not agreed with the industry, (3) competitors had equipment and services deployed that still had a useful lifetime, and (4) competitors had not made those investments after the withdrawal of the POIs in question was already announced.

4.2.5 Regulation of access over cable television infrastructure (coaxial cable)

In the U.S., there have been calls over the years for cable operators to provide wholesale access to their broadband capabilities ("open access") in order to enable service-based competition. The cable operators initially claimed that such access was technically infeasible. This was, of course, flatly untrue.

America Online had been one of the prominent companies advocating open access. When they subsequently acquired Time-Warner, a large cable operator, they were unable to reverse their position overnight; consequently, they agreed (in merger undertakings with the Federal Trade Commission (FTC) and the FCC) to a merger condition whereby they would not introduce cable broadband service into an area until they had signed agreements with at least three of their competitors to offer wholesale capability to them.

The results have been strikingly unsatisfactory. Predictably, AOL/Time-Warner struck deals wherever possible with the least capable of its competitors, and imposed terms and conditions that further hobbled their competitors. The FTC had only limited ability to enforce the agreement. Remarkably, the Bush-era FCC flatly refused to enforce its own order. Filings with the FCC clearly establish that, with one exception, these arrangements resulted in pitifully little service deployment.

The exception is Earthlink. Earthlink is a large independent ISP that was mentioned by name in the AOL/Time-Warner merger undertakings. They apparently were successful in enforcing their rights, and signed up several hundred thousand customers over the first year or two of the merger undertakings. Earthlink claimed to be well satisfied with the arrangements, and AOL did not publicly express dissatisfaction.

There is no publicly available document that establishes why Earthlink was successful while its competitors were not. Possible explanations include: (1) Earthlink was much larger than the other firms, so AOL / Time Warner may have been more motivated to deal with it; (2) Earthlink was explicitly mentioned in the merger undertakings, and therefore would have been able to enforce its rights through the courts, or in the "court of public opinion", despite the lack of effective regulatory support for merger undertakings that had already been agreed. Possibly both factors are relevant.

The CRTC in Canada has had an obligation in place for many years to allow wholesale access to broadband capabilities over cable; however, the obligation was completely ineffective for years. The cable industry initially had felt that wholesale sales would expand the market; however, once regulatory disputes emerged in the United States, Canadian cable companies concluded that it was not in their interest to permit service-based competition over their infrastructure. Consequently, they “slow rolled” the process. Initially, they defined a somewhat impractical set of technical recommendations as to how wholesale access should be implemented (including source-based routing).

The CRTC has issued a number of supplemental rulings over the years, but they do not seem to have solved the problem. Competitors are still not effective in offering broadband service over cable infrastructure; in fact, the combined share of the four largest providers (two telecommunications carriers [Bell Canada and TELUS], two cable [Rogers and Shaw]) continues to grow at the expense of competitors.[132] Cable incumbents with market power have considerable ability to slow regulatory initiatives, as do telephony incumbents with market power.

So what is one to make of this rather dismal history?

First, it is worth noting that cable in North America plays a significantly different role than in most European Member States. Cable operators provide more than half of all broadband Internet access in the United States and Canada. There is always a question as to whether a regulatory imposition will do more harm (in this case, perhaps by slowing deployment of broadband over cable infrastructure) than good (by enabling service-based competition). In Europe, where cable broadband plays a much smaller role in most Member States, it might be better to foster cable as a competitor to the incumbent fixed operator, rather than imposing an obligation for service-based access (e.g. bitstream) that might slow the competitive entry of cable. The question of the societally optimal policy would need to be considered in terms of the specifics of a particular Member State.

Second, the European Framework as currently implemented does not make it easy to impose such an obligation on cable broadband operators. Cable is considered part of the broadband market only to the extent that a wholesale service is already on offer, which is rarely if ever the case. An NRA would presumably have to persuade the European Commission (through the Article 7 notification process) to accept a country-specific market definition and to accept that a cable operator possesses SMP (possibly as a result of joint dominance).

Third, the experience in both the U.S. and in Canada suggests that cable operators are likely to vigorously resist any bitstream obligation, and that they are likely to be successful unless the regulator is steadfast.

132 See Canadian CRTC (2006).

Fourth, Earthlink's experience indicates that bitstream arrangements are technically feasible on a sufficiently large scale, and suggests that a business model based on wholesale access could be effective under the right circumstances.

In sum, wholesale access to broadband capabilities over cable could conceivably be implemented if the regulator were sufficiently determined, and assuming that the European Commission were to concur. It would take a lot of work, and in most Member States would probably not be a good idea. Moreover, success of the program could not be guaranteed in advance, given the track record in North America. Whether it should be considered at all under the specific market conditions that prevail in Hungary is a question to which we will return in Chapter 6 of this report.

4.2.6 Numbering, naming and addressing

In a computer network, a *name* identifies a source or destination, while an *address* is an identifier that enables data to reach its destination. Thus, www.nhh.hu is the familiar domain name of the web site of the Hungarian NHH, while 86.206.44.200 is the much-less-familiar (and also potentially more transitory) IP address associated with an interface on a computer that runs that web site.

A *number*, in the sense of a so-called E.164[133] telephone number, embodies elements of both – historically, it served as an address, but today telephone numbers (especially non-geographic numbers) serve primarily to identify a service that could potentially be reached by many different addresses. In an era of number portability, the telephone number serves primarily as a key to a database look-up, and does not necessarily indicate unambiguously the physical routing to the customer's telephone.

Today, IP-based (Internet) services run over telephone circuits and services, so to that extent domain names and Internet addresses are already linked to the telephone network. What is new with the migration to NGN is that the telephone network will now run over IP-based facilities. This is new, and it implies that domain names and IP addresses will soon become fundamental to critical NGN communications infrastructure.

At one level, this does not imply fundamental changes to IP addressing or the DNS name system. These naming and addressing systems are already nearly as mature as the Public Switched Telephone Network. At another level, it may create an increased need for security and stability in the naming and addressing system, and also increased scale.

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133 E.164 is the ITU standard that assigns telephone numbering country codes to their respective countries.

The current IP addressing system, based on IPv4, can accommodate at most some four billion addresses. At one time, this was felt to be hugely in excess of demand; however, at this point there are credible forecasts that the address space will be exhausted under current practices in the 2011 – 2012 time frame.[134] The Internet Engineering Task Force (IETF) defined a successor protocol, IPv6, many years ago; however, IPv6 has seen scant deployment to date. The migration to NGN may create additional pressure for migration to IPv6. Indeed, the use of IPv6 is optional in NGN generally, and mandatory in IMS.

No changes are specifically required in the Domain Name System in order to support NGN (other than minor updates to support IPv6), although it is likely that there will be demands for enhanced security. The DNS, which maps names to addresses (and vice versa), does not inherently provide assurance that a DNS response comes from a trustworthy source. Current unsecured DNS runs the risk of an impostor computer posing as a reliable source. The DNSSEC protocols, which deal adequately with this problem, have been standardized; however, there has been scant deployment to date.

Some have anticipated that telephone numbers will become superfluous in an ear of IP telephony. Telephone numbers are, to be sure, a very primitive identifier, but they have the advantage that a great deal of existing equipment is set up to deal with them. To some extent, they no longer indicate the wire to a customer's home; instead, they can be viewed as an abstract identifier, that may possibly encode the country (and perhaps the city and neighbourhood) associated with a fixed telephone. The relative absence of semantics (meaning) associated with the number can be viewed as a strength, rather than a weakness – there is no need for interminable arguments as to whether a given numeric configuration merits a telephone number. The high order identifiers are allocated to countries, and the countries administer their national numbering plans as they see fit within that high level identifier.

With that said, there has been a desire to map telephone numbers to Internet services. The ENUM protocol can do precisely that, using the underlying mechanisms of the Domain Name System. A telephone number can be unambiguously mapped to a prioritized list of different services, thus expressing the subscriber's preferences as to how he or she can best be reached over the Internet. With ENUM, the telephone number truly becomes a name rather than an address, serving primarily as a key to identify the best way to reach a subscriber.

Hungary has had a formal ENUM delegation (to the CHIP/ISzT) since 15 July 2002.

134 See http://bgp.potaroo.net/ipv4/.

Although there have been a lot of field trials in the world[135] it is fair to state that the commercial adoption of ENUM is still very limited throughout the world. Carrier ENUM as a glue to link IP-islands in principle makes sense. However, obviously carriers up until now have found ways to convey VoIP traffic across network boundaries without the e164.arpa ENUM.

There has been an active European discussion about the telephone numbers to assign to VoIP services. Some Member States have expressed a preference for the use of geographic numbers, while others have assigned non-geographic numbers to VoIP subscribers. The European Commission has recognized that each form of numbers could have advantages for subscribers and for service providers, and has advocated making both available to service providers on a technologically neutral basis. Ofcom (UK) and BNetzA (Germany) have both done so, although BNetzA permits a geographic number only where the subscriber has a bona fide connection to the geographic area in question.

It is also worth noting that the fairly rigid numbering distinctions that have historically existed between fixed and mobile services are really driven by retail and wholesale pricing arrangements, not by underlying network characteristics. In the United States and Canada, where the price of calling a mobile telephone is often the same as that of calling a fixed telephone (and where both are usually included in flat rate plans), mobile phone numbers typically and somewhat arbitrarily correspond to the area where the subscriber lived when he first subscribed to the service. There is no perceived need to distinguish, at the numbering level, between fixed and mobile services. The need for distinct numbering is driven by the need to signal the approximate cost to the consumer who places the call. In the absence of high wholesale termination fees (which will surely change with the advent of NGN), retail prices for calls to fixed and mobile services might be similar, and thus the need to signal a price difference might either disappear or at least become less compelling.

4.3 NGN and network interconnection

This section explores the principles and regulatory issues associated with network interconnection in the context of NGN. We consider what kind of regulatory involvement is likely to be optimal, and in what contexts. In an NGN, interconnection is implemented using the Internet Protocol (IP) and occurs in a technical sense at the Network Layer, the middle layer of the network protocol hierarchy.

135 A comparison and evaluation of the international filed trials can be found in Elixmann, Hillebrand and Schäfer (2006).

4.3.1 Modes of traffic exchange

The economic theory of network interconnection has been extensively analyzed by Armstrong (1998) and in a series of papers by Laffont, Rey and Tirole (1998a,b). For a comprehensive treatment of interconnection in the PSTN, see Laffont and Tirole (2001). A number of more recent papers provide detailed analysis of likely interconnection arrangements in an IP-based NGN environment.[136]

Section 4.3.1.1 deals with economic analysis of the traditional telephone network, while section 4.3.1.2 deals with the equivalent theory for the Internet. Both are relevant to future IP-based NGN interconnection. The Internet theory may be somewhat more directly applicable inasmuch as Internet interconnection is, like NGN interconnection, IP-based.

4.3.1.1 General theory of telephone network interconnection

In the conventional telephone world, *retail* plans have typically been based on a system known as *calling party pays (CPP*), in which the party that places or originates a call pays for the call based on the number of minutes of use, while the party that receives the call generally pays nothing. This model reflects the tacit assumption that the party that places the call is in some sense the *cost causer*. In recent years, there have been revisionist challenges to this view – if the party receiving the call did not perceive value, he or she would simply hang up (the principle of *receiver sovereignty*).[137] So the newer view argues that both parties benefit, that "… it takes two to tango".

At the *wholesale* level, *calling party's network pays (CPNP*) is the usual counterpart to CPP. Since there is no retail payment from the party receiving the call, the receiving party's network should be compensated by the calling party's network. Thus, a wholesale payment flows from the originating party's network to the terminating party's network.

What is known about these wholesale payments is that they tend to be set at rates much higher than would be the case under full and effective competition. Once someone subscribes to a network, that network effectively derives market power (the *termination monopoly*) over the termination of calls to the subscriber, because the call originator has no ability to choose the network that is to terminate the call. In Europe, these rates are generally regulated and are floating downward today, but they are still quite high.

136 See Marcus (2007) and Marcus (2006c).

137 See Jeon, Laffont and Tirole (2004). See also Hermalin and Katz. (2001) as well as Hermalin and Katz (2004).

In North America, a completely different system ("bill and keep") is in place. At the wholesale level, many network operators are under no obligation to make wholesale payments to one another; however, any mutually agreed payment rate *must be symmetric*.[138] Most network operators choose to set the rate at zero (i.e. they waive payments). Under bill and keep, network operators have great flexibility about how to set retail rates, but competitive forces have motivated most operators to adopt plans that are flat rate (or that are flat rate up to some maximum number of minutes – a "buckets of minutes" plan).

If traffic and rates are both symmetric, one might imagine that network operators would not care about them since they net to zero. As Laffont and Tirole perceptively observed, this is not quite right – the rate matters because it is perceived as part of the wholesale marginal cost of making a call, and therefore tends to be reflected in retail rates. It is for this reason that flat rate plans in European countries usually exclude calls to mobile phones (where termination rates tend to be high).

High termination rates thus lead to high retail prices per minute. These high retail prices depress use of the service, as a simple demand elasticity response.[139]

At the same time, the high profitability of these services (partly as a result of high termination rates) motivates mobile operators to compete vigorously and to offer subsidies in order to initially acquire mobile customers. This stimulates take-up of mobile services, which is generally a positive thing; however, there is a price associated with these subsidies. To the extent that termination prices exceed true usage-based marginal cost, they have had a tendency distort the evolution of national networks toward the mobile network and away from the fixed network.

Bill and keep countries tend to experience somewhat slower rates of take-up of mobile phones than CPNP countries, but much higher usage of the phones once they have been taken up. With this in mind, two observations are worth noting: (1) Bill and keep achieves clearly superior results for developed countries that have already achieved widespread adoption of mobile phones. (2) Developing countries with CPP but low fixed and mobile termination rates (especially rates less than about 0.02 euro per minute) seem to be achieving excellent penetration and excellent use (e.g. India).[140] Both observations are potentially important for Hungary. We return to these points in Section 6.1 of this study.

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138 In this discussion, we are attempting to abstract and simplify an extremely complicated system. In the U.S. there are distinctions between local interconnection, where payments are two-directional and symmetric, versus the interconnection of long distance operators to local operators, where payments are one-directional and asymmetric. See Marcus (2004b).

139 See the previously cited papers by Marcus.

140 See Marcus (2007).

4.3.1.2 Economic theory of IP-based interconnection

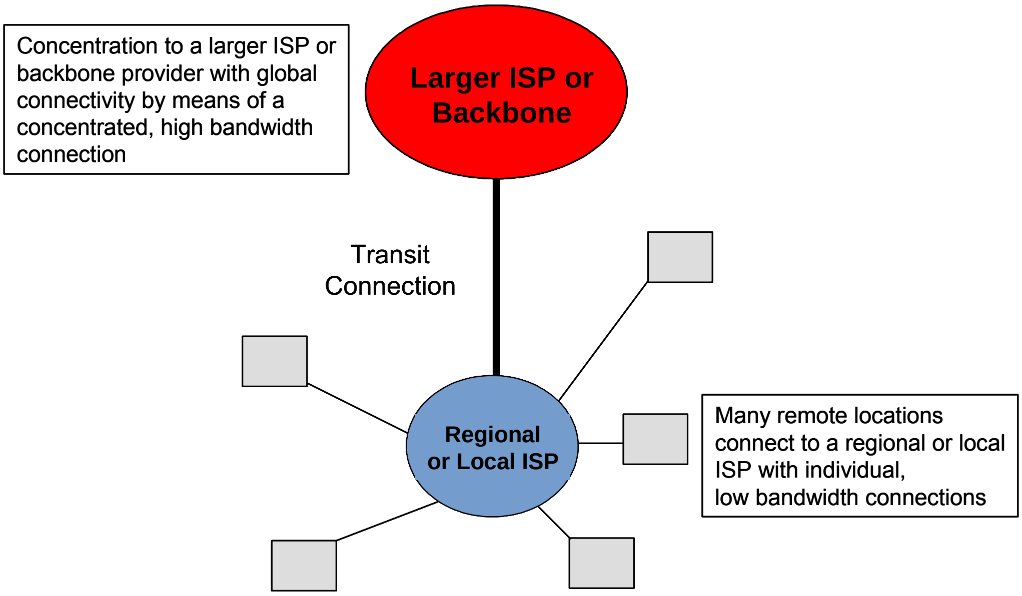
In an IP environment, most traffic exchange reflects one of two prevailing models: *peering* or *transit*. With *peering*, two providers offer access only to their respective customers (and to the customers of their customers). *Transit*, by contrast, provides access to third party customers, and usually provides access at a predictable price to the entire Internet.

NRIC V (an advisory council to the U.S. FCC) provides a good set of defintions:

> "*Peering* is an agreement between ISPs to carry traffic for each other and for their respective customers. Peering does not include the obligation to carry traffic to third parties. Peering is usually a bilateral business and technical arrangement, where two providers agree to accept traffic from one another, and from one another's customers (and thus from their customers' customers).
>
> *Transit* is an agreement where an ISP agrees to carry traffic on behalf of another ISP or end user. In most cases transit will include an obligation to carry traffic to third parties. Transit is usually a bilateral business and technical arrangement, where one provider (the transit provider) agrees to carry traffic to third parties on behalf of another provider or an end user (the customer). In most cases, the transit provider carries traffic to and from its other customers, and to and from every destination on the Internet, as part of the transit arrangement. In a transit agreement, the ISP often also provides ancillary services, such as Service Level Agreements, installation support, local telecom provisioning, and Network Operations Center (NOC) support.
>
> Historically, peering has often been done on a bill-and-keep basis, without cash payments. Peering where there is no explicit exchange of money between parties, and where each party supports part of the cost of the interconnect, … is typically used where both parties perceive a roughly equal exchange of value. Peering therefore is fundamentally a barter relationship."

Nearly all Internet Service Providers (ISPs) have an upstream transit provider, as shown in Figure 49. The economic "potential energy" that drives the Internet business is statistical multiplexing – the connection to the upstream provider can be much smaller than the sum of the sizes of the downstream connections, because the ISP can be reasonably certain that not all downstream customers will use their connections to the maximum degree possible at the same moment.

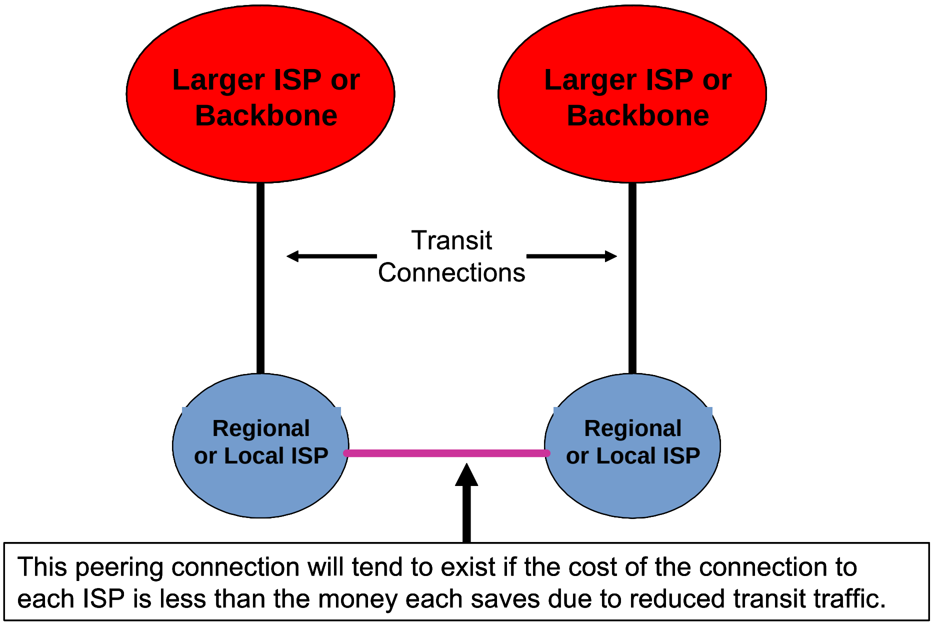
Figure 49: A single ISP with an upstream transit provider



Source: WIK-Consult

Now consider two ISPs downstream with two upstream transit providers, as depicted in Figure 50 below. Under what circumstances are they motivated to peer, rather than to send their traffic over their transit connections?

Figure 50: Two ISPs with two upstream providers. Will they choose to peer?



Source: WIK-Consult

The answer reflects a simple economic optimization. They are motivated to peer if the cost of the peering connection (including transaction costs, such as implementing contracts and monitoring traffic across the connection) are less than the monetary savings associated with sending less traffic over the upstream transit connections.

The largest "backbone" ISPs may not have an upstream transit provider at all – they achieve all of the connectivity that they need by means of peering arrangements. The logic is nonetheless the same – they choose to operate on a peering-only basis if it is less expensive than using a transit provider to reach the "hard" destinations.,

An economic literature on the economic theory of Internet interconnection has emerged in the last few years, largely inspired by a number of large merger cases in the late Nineties.

In Laffont, Marcus, Rey and Tirole (2003),[141] we analyzed the interconnection of two backbones subject to an access charge. We were specifically interested in understanding the possible implications of perturbing the system to incorporate multiple classes of service. The model led to straightforward results – access fees could be higher for classes of service where the end user perceived a greater economic surplus. Today's

141 See Laffont, Marcus, Rey, and Tirole (2003).

Internet is a special case of this model, where access fees assosciated with interconnection happen to be zero.[142]

The level of the access charge is largely neutral overall; however, a low rate tends to favor content providers (e.g. websites), while a high rate might favor consumers. It is not immediately clear which outcome is socially preferable, inasmuch as the Internet can be viewed as a two-sided market[143] where both sides of the market must be present. The proliferation of websites has arguably made it attractive for more consumers to acquire Internet access, thus sustaining a virtuous cycle of increasing content and increasing subscribership.

There has been a tendency to think of Internet interconnection as being totally distinct from interconnection in the Public Switched Telephone Network, but in fact the two are closely linked. Tirole has observed that the differences between the two economic models flow from the "missing price", that is, from the fact that the recipient of a telephone call (under CPP) is not charged.[144]

4.3.2 Challenges with accounting for use as networks evolve to NGN

As networks evolve to NGNs, the ability to measure the kinds of usage that traditionally underpinned wholesale CPNP charges will face significant challenges. Retail charges will also involve challenges. Moreover, the whole economic basis for these charges will need significant re-thinking – it is by no means clear that minutes of use correlate closely with the underlying usage-based marginal costs of an IP-based NGN.

Billing in general, and call termination fees in particular, have historically depended on a few variables that in the past were relatively easy to determine:

- The duration of a call,
- The time of day and day of the week at which the call was placed,
- The physical location from which the call was placed, and the physical location of the party receiving the call,
- The identity of the network operator to which the party receiving the call is subscribed, and finally
- Where a mobile customer is placing or receiving a call at a location not served by his or her normal network operator, especially where the customer is roaming in a different country, then additional rules come into play.

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142 Fees for network *access* (as distinct from *interconnection*) are, of course, non-zero, and tend to be subject to market power effects.
143 See Rochetand Tirole (2004).
144 See Laffont, Marcus, Rey, and Tirole (2003).

The migration to NGN poses challenges in all of these areas, not only for wholesale termination payments between operators, but also for retail payments to the VoIP service provider.

First and foremost, changes in the value chain come into play – to the extent that voice calls are provided by an independent third party, and not by the network operator, accounting becomes a nightmare. The independent third party VoIP service provider generally does not know or care which networks are used to carry the traffic, and cannot measure network utilization. The networks can measure traffic, but have limited visibility into the nature of the voice traffic that they carry.

In any case, the network's costs are driven by the volume of traffic carried under near-peak load, which has little to do with the number of minutes of voice telephony use. For that matter, voice, which is a relatively low bandwidth application, will in general be only a minor contributor to the network's overall costs.

4.3.3 QoS differentiation, service specific interconnection

The issue to be addressed here is the degree to which interconnection based on different levels of Quality of Service (QoS) reflecting, for example, average delay, variability of delay, of the fraction of packets lost, is a viable business option as the traditional network evolves to the NGN.

Section 4.3.3.1 evaluates the underlying economics in light of the distressingly slow deployment of differentiated QoS in the Internet to date. Section 4.3.3.2 considers challenges relating to accounting for the use of differentiated services. Given that these obstacles have collectively been insurmountable in the Internet – the environment most similar to the NGN – it is by no means a given that differentiated QoS *between NGN operators*[145] can be successfully rolled out.

4.3.3.1 Slow adoption of differentiated QoS in the Internet to date

Given that the technology of differentiated QoS is not particularly challenging, and given its widespread use *within* IP-based networks, why has it been so slow to achieve deployment *between and among* IP-based networks?

From an economic perspective, the basic answer is obvious: Had the benefits of deployment clearly exceeded the costs, it would have deployed. Thus, one might infer that either the perceived costs are too high, or the perceived benefits too low, or perhaps both.

145 Differentiated QoS *within* a single NGN network is trivial in the Internet and will doubtless appear in individual NGNs.

For reasons noted reporting Section 3.3.5.3, there are indeed questions as to whether the perceived benefits are too low. In addition, a series of challenges related to *network externalities* and to *transaction costs* have inhibited deployment.

Many industries experience network externalities. A service may be most useful when a great many people use it (and not just because of economies of scale). This is true of telephone service, and also of the Internet. My telephone is worth more if there are a great many people whom I can call. My Internet connection is worth more when there are a great many people to whom I can send an email, and a great many websites to which I can connect.

Getting a new service launched in a sector dominated by network externalities can be challenging. In effect, the externalities of the old service keep pulling you back. It is difficult to get past the *initial adoption hump* in order to achieve critical mass. Different services have historically gotten past the initial adoption hump in different ways.[146] VCRs were initially purchased for time-shifting of television programs; only when enough consumers had purchased VCRs did a rental business emerge. CDs were successful because Matsushita and Phillips had commercial interests in both CD players and studios, and were thus motivated to ensure that both players and content were available.

Differentiated QoS *between and among networks* is subject to these network effects. The service has some value within a network. It might have great value if it were available to every destination on the Internet. If it were available to only two or three networks, then it would be of limited value. Thus, the value of deployment of differentiated QoS might be significant to those networks that implement it later, but the initial benefit to the first two or three networks to deploy it is minimal.

At the same time, extending differentiated QoS to each additional network implies *transaction costs*. Agreements, monitoring tools, and coordination in general would need to be put in place. These costs are in addition to any direct costs associated with establishing and maintaining the interconnection. These transaction costs might be roughly linear in the number of networks with which one network has agreements in place.

Thus, it is hard to get the process started, and it would be hard to get it to completion once it had been launched.

These concerns are not unique to differentiated QoS. A number of Internet capabilities are faced with similar economic challenges. The adoption of Internet Version 6 (IPv6, a new version of the Internet Protocol with a greatly expanded address range) and of DNSSEC (a security enhancement to the Domain Name System) have arguably been impacted by similar considerations.[147]

146 See Rohlfs (2001).
147 See Marcus (2004a).

4.3.3.2 Challenges associated with accounting for use

The implications for Operational Support Systems (OSS) in support of differentiated QoS tend to be overlooked in most discussions. Technologists tend to focus more on the problem of getting the bits to move as they are supposed to move, and less on the problem of how to ensure that someone pays for those movements.

It has generally been assumed that a network operator would be willing to provide better-than-best-efforts quality only to the extent that either the end user or another network operator were willing to pay them a premium to do so. To the extent that this implies the need to account for QoS-capable traffic, it implies surprising complexity.

First, a pair of network operators would need to agree on how much QoS-relevant traffic each delivered to the other. Second, they would need to verify that each actually delivered the quality that it had committed to the other. Finally, each would need some tools to deter fraudulent use or “gaming” of the system. The first is trivial, the second and third are difficult. Finally, there would be the need to reconcile statistics, and to deal with discrepancies between the measurements of the parties.

Measuring traffic across a link would seem to be straightforward, and distinguishing among different marked classes of traffic is no harder. Capturing first-order statistics on traffic sent between the parties is straightforward. Even here, some prior agreements would be needed as regards what is being measured, and when – otherwise, there is the risk that network A has a slightly different view of the traffic delivered on the link from A to B than does network B, even though both are measuring (different ends of) the same link using substantially similar tools. And sampling intervals need to be mutually agreed, otherwise any measures of variability (quantiles, standard deviation) are likely to reach different conclusions due to the perverse effects of the Central Limit Theorem (if two sensors sample the same distribution, the one that is sampling at more frequent intervals will tend to see an apparently more lumpy distribution).

Reconciling data would be challenging. There is an old Dutch proverb: “Never go to sea with two compasses. Take one or three.” If the providers do not agree, whose statistics should govern? Is there scope here for a trusted intermediary, and if so who might that trusted third party be?

The challenges in verifying that the service was actually delivered are much more profound. In this case, network A needs to ensure that network B delivered the committed performance, and neither will want to rely on measurements provided by their respective end users. Network A thus needs performance statistics about network B’s network, and *vice versa*. At the same time, these networks are likely to be direct competitors for the same end users – network B is not about to let network A place sensors in its network. Both networks are likely to be skittish about providing internal performance data to one another.

It might be far simpler to bill, not for the use of the network, but rather for the services that benefit from differentiated QoS. Here, too, however, there are challenges – in an IP-based NGN, the service provide might not be the network provider. Moreover, it is quite possible, for reasons noted earlier, that services without QoS will compete successfully with services that are supported by QoS. It is not clear that network operators would be able to extract enough revenue from independent service providers to enable them to fund the differentiated services.

4.3.4 Number and locations of interconnection points in a NGN

In section 4.2.4, we considered the number of Points of Interconnection (POIs) in the context of *access* to the end user. It is possible that *interconnection* will raise somewhat different issues as regards the number of POIs. Nearly all of the regulatory analysis of NGN interconnection to date has focused solely on access.

Access and interconnection are so familiar to regulators that we often lump them together without clearly distinguishing them; moreover, the conventional definitions tend to be so turgid and technical as to shed little light on what is really meant. Access and interconnection are related, but they are not the same thing. For our purposes, *interconnection* enables an operator to establish communications with the customers of another operator, while *access* enables an operator to utilize the facilities of another operator in the furtherance of its own business and in the service of its own customers.[148]

In the NGN world, both access and interconnection will be implemented using IP-based interconnection; however, they will not necessarily be implemented using the same points of interconnection. In the case of access, the operator that provides the IP-based transport service to the end user will not want the operator that provides the physical last-mile IP access to be visible in the IP-level routing. Today, traffic is often delivered using ATM as a level 2 transport mechanism, thus avoiding this problem; tomorrow, it is quite possible that the traffic will be “tunnelled”, still enabling the service provider to offer an apparently end-to-end service to the end user, without making the last-mile access provider visible in the end-to-end IP routing.

In the case of interconnection, both providers will necessarily be visible in the end-to-end routing.

Interconnection with the incumbent will presumably be implemented by means of IP-based peering, or alternatively perhaps by a transit relationship with the incumbent or with some other service provider that has a peering relationship with the incumbent. There are several possbilities for NGN access, but peering will most likely not be desired by either party.

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148 See Marcus (2007).

It is conceivable that both access and interconnection will be implemented using a single set of IP-based interconnection points; however, it is also possible, and perhaps more likely, that operators will instead prefer to implement distinct points of interconnection for access and for interconnection.

To the extent that the POIs are the same, interconnection does not appear to raise new interconnection issues that are not already present in the case of access.

For interconnection, very few POIs are required. Most operators will want a minimum of two or three POIs, for reliability and redundancy. In a large country (e.g. the United States), propagation delay due to the speed of light is such that a somewhat larger number might be desired, but even there the largest IP-based operators typically have less than ten POIs for purposes of interconnection. For most European countries, two or three POIs should be sufficient for purposes of interconnection. If an operator chooses to interconnect using a third-party transit arrangement, then no points of interconnection at all to the incumbent are necessary.

There will likely be a reduction in the number of POIs for interconnection, then, but *potentially much greater* than the reduction in the number of POIs for access.

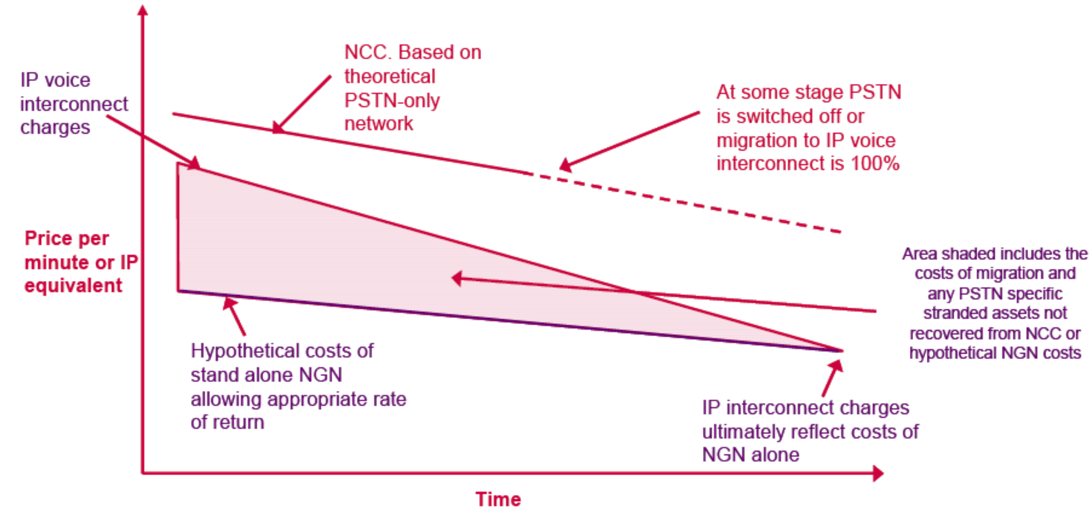
The same issues of stranded investment that have been raised for access POIs are also relevant for interconnection POIs, but the actual costs could be quite different. At the same time, the substantial reduction in the number of POIs might have a tendency to substantially reduce costs for competitive operators over time.

4.3.5 Costs of interconnection in the migration phase

There are also unresolved questions over the appropriate *cost* for interconnection. Under Coasian negotiated arrangements, the regulator need not set rates, but may still want some yardstick by which to measure whether the negotiated outcomes are appropriate. If, however, the regulator must set a price for interconnection, then NGN directly introduces additional complexities.

The migration to NGN may ultimately lead to lower costs, but in the near term it quite likely leads to higher unit costs as the operator runs two parallel networks. The operator is entitled to a reasonable recovery of its costs, and a reasonable return on its investments. If a regulator must set interconnection fees so as to ride this roller coaster of costs that first increase, and then decrease, it will be very difficult to avoid introducing problems or economic distortions. In a recent proceeding, Ofcom modeled the problem as shown in Figure 51 below.

Figure 51: 'Holistic' approach to narrowband voice interconnect cost recovery (illustrative only)



Source: Ofcom (2005b), Figure 5, page 14.

This intriguing diagram represents a fascinating thought model, but it also raises many questions that do not appear to be explicitly answered in the Ofcom documents. The upper line, "NCC. Based on theoretical PSTN-only network" is the expected trend for the Network Charge Control (NCC) for BT's existing wholesale interconnect. It declines over time because BT's efficiency is presumed to improve over time. It is implicitly assumed that the efficiency of a network that is part PSTN and part NGN will improve no less quickly than BT's current PSTN network. In the event that the migration to NGN enables still greater efficiency gains, then BT reaps the benefit over the defined lifetime of these cost controls, which is 2005-2009 – the NCC level will not be revised other than in exceptional circumstances. The next line below, "IP voice interconnect charges", represents an as-yet-undefined NCC for a new wholesale SMP product enabling interconnection to narrowband voice services. It is presumably some form of IP interconnection. Given that this interconnect offering is not yet defined, much less implemented, the level of these charges has not yet been set; however, the general notion is that they should be less than those of traditional voice interconnect charges, but still sufficiently in excess of incremental cost to enable BT to recover the cost of migration from the PSTN to the NGN.

4.4 Cost models, wholesale pricing

From a methodological point of view regulatory studies for network interconnection and call termination cost determination are mainly based on so-called bottom up models in combination with a Forward Looking long run incremental cost model FL-LRAIC[149].

In evaluating the impact of NGN on cost models, it is appropriate to begin by considering the cost models currently used in the regulatory practice. These cost models can be divided into two types

- PSTN/ISDN related models,
- Broadband related models.

Regarding traditional cost models for the PSTN/ISDN network, one can usually distinguish local loop/access line models and core network models.

Local loop/access line models can be characterized as follows:

- Objective: cost determination of the provision of the access line.
- Primary indicator to be calculated: total cost of network divided by the (given) number of access lines.
- Usually: Averaged across all access lines (in metropolitan and rural areas), i.e. uniform “cost” per access line.
- Main cost drivers: aggregate number of access lines; distribution of population across the country (affects average line and trench lengths).

Core network models have the following characteristics:

- Objective: cost determination of the interconnection services (local, single and double tandem interconnection).
- Primary indicator to be calculated: total cost of the core network divided by the (given) traffic volume.
- Usually: Averaged costs per minute per interconnection service (uniform across metropolitan and rural areas).
- Main cost drivers: length of core network infrastructure; number and kind of transmission facilities used; traffic volume; if based on TELRIC[150] all services have to be taken into account that use an element which is also used by the actual service in question.

149 See Gonzales, Hackbarth, Kulenkampff and Rodrigues (2002).
150 TELRIC: Total Element Long Run Incremental Costs.

Broadband cost models can be further subdivided into those related to broadband access networks (aggregation and backhaul networks) and broadband core networks.

Broadband access network models usually have the following characteristics:

- Objective: cost determination of the provision of broadband access services (in general: bitstream access service).
- Primary indicator to be calculated: different approaches are in use across different countries; some NRAs (e.g. BNetzA in Germany) focus on total cost of network divided by (given) traffic volume (kbit); others (e.g. EETT in Greece) are focusing on a combination of total cost per access line (for network elements driven by access lines) and total costs per traffic volume (kbit) (for network elements driven by bandwidth).
- Usually: Averaged across all (metropolitan and rural) areas, i.e. uniform "cost" per kbps.
- Main cost drivers: aggregate number of access lines; traffic volume, distribution of population across the country (affects average line and trench lengths); models have to take into account whether PSTN and broadband network can use the same infrastructure and transmission technique (example: common use of Add/Drop Multiplexers); if based on TELRIC all services have to be taken into account that use an element which is also used by the actual service in question.

Broadband core network models currently used can be characterized as follows:

- Objective: cost determination of the conveyance services in the core network.
- Primary indicator to be calculated: total cost of network divided by (given) traffic volume (kbit).
- Usually: Averaged across a country-wide network.
- Main cost drivers: traffic volume, average line and trench lengths; models have to take into account whether PSTN and broadband network can use the same infrastructure and transmission technique (example: common use of cross-connectors); if based on TELRIC all services have to be taken into account that use an element which is also used by the actual service in question.

The migration to NGN implies that PSTN networks will be supplemented and ultimately replaced by broadband networks. Thus, migration to NGN in all likelihood will have severe implications on costs (level and structure) and therefore also on wholesale (input) prices. So if regulation is still necessary, then new bottom-up cost models have to be established and FL-LRAICs of a large number of new network elements comprising a completely changed network architecture and topology have to be taken into account.

Application of a FL-LRAIC methodology to NGN implies that the respective network must be modeled and correspondingly designed and dimensioned. However, from the perspective of today there are still a lot of uncertainties regarding the input parameters like e.g. user number/number of lines, type of services, traffic volume etc.. To meet the challenges caused by the uncertainties, a reasonable approach could be to design the network in question by referring to different types of scenarios covering variants of the most important input values. In particular, regulatory studies in order to model the migration path from the PSTN/ISDN to a pure NGN or NGI would therefore require such flexible network design tools. These tools would have to consider several aspects. Examples are technical characteristics resulting from the network architecture and the network design being affected by service type specific traffic modelling and routing. Moreover, other network design and dimensioning algorithms have to be applied than in the traditional models mentioned above.

One particular point of interest will be what the appropriate unit for the pricing of services should be in the future. Even in a fully fledged NGN world facilities based carriers might still have an incentive to charge voice calls to end users on a per minute base and to find a corresponding minute based interconnection charge regime on the wholesale side. However, this implementation of a minute based world might not reflect actual cost causation. The reason is that the main cost driver in a NGN network first and foremost is traffic volume (i.e. kbit) and not the duration of a call (i.e. the length of a SIP session measured in minutes). One might of course be able to convert minutes into traffic volume, however, this presupposes some form of guaranteed bandwidth (across network boundaries) for voice calls. If this will actually be the market outcome in a given environment (both from the perspective of willingness to pay of end users and of the incentives to find a coherent solution among market participants offering (IP-based) voice services) is unclear.

Moreover, migration to NGN might bring about a new discussion on geographically de-averaged wholesale pricing. In other words, rather than pricing access at wholesale at a single level for the whole country, it might be more appropriate to price differently for rural areas than for dense urban areas. The degree to which this becomes an important item on the regulatory agenda hinges on the particular conditions in a given country. Arguments in favour of de-averaging might be changed economies of scale and scope brought about by NGNs. In all likelihood traffic in rural areas will be lower than in densely populated areas. Moreover, the number of kilometres of circuits to be built and maintained per subscriber will tend to be higher in rural areas than in densely populated areas. Thus, the unit costs per traffic unit might be higher in rural areas than elsewhere. Moreover, in a world of IPTV there is an incentive to locate the respective network equipment “close” to the end users (in order to reduce high traffic loads in the core and backhaul network). Thus, the costs for the IP equipment per end user will be higher in rural areas than elsewhere.

4.5 NGN and network interoperability

The need for interoperability, in the sense of compliance to standards, could pose challenges as networks evolve to NGNs. The issues are somewhat analogous to interconnection, in that operators who lack market power will tend to be motivated to maintain excellent interoperability, while operators that possess sufficiently strong market power will tend to prefer less-than-perfect interoperability as a means of enabling the exploitation of their market power.[151]

As regulators, we will tend to prefer open standards, inasmuch as they facilitate competition, which tends to benefit consumers. At the same time, imposition of standards can interfere with technological innovation. Further, industry is usually in a better position than the regulator to identify areas that would benefit from standardization and to craft standards to meet those perceived needs.

All of this implies that government in general, and the regulator in particular, must walk a careful line as regards standards. Where industry processes break down, or where a market participant with market power impedes interoperability, regulatory intervention may be appropriate. Where industry processes can be effective, the regulator should refrain from (potentially counterproductive) intervention.

Economic theory provides a useful lens through which to view, and to try to make sense of, the standards-based network interoperability standards. Will participants want interoperability? Under what preconditions? Will interoperable network standards achieve critical mass, or will they stall (as with IPv6[152], DNSSEC[153], sBGP[154])? Is it possible that some NGN features easily achieve critical mass, while others do not?

Sections 4.5.1 and 4.5.2 deal, respectively, with the rationale for standardisation and with the market incentives that motivate market players either to seek or to resist standardisation. Section 4.5.3 considers the implications of new interfaces associated with the advent of NGN, especially of IMS NGN. Section 4.5.4 explores the appropriateness of QoS mandates as functionality migrates to the NGN platform, while Section 4.5.5 takes up closely related issues associated with the Network Neutrality debate that has been raging in the United States.

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151 See Katz and Shapiro (1985) and Farrell and Saloner (1985).

152 The current addressing in the Internet rests mainly on the 32 bit code IPv4. Thus, theoretically 2^{32} IPv4 addresses are possible. IPv6 rests on a 128 bit code and thus, provides, a much higher number of addresses.

153 DNSSEC is a family of protocols that seeks to ensure the integrity and authenticity of DNS name resolution responses in the Internet. DNSSEC is fully standardized, but deployment to date is minimal.

154 sBGP is a protocol that seeks to ensure the authenticity and integrity of routing information exchanged between independently managed networks. A protocol has been developed and extensively tested, but it is not an official standard and there is no significant deployment to date.

4.5.1 Rationale for standardization

The standards process reflects a desire to develop *interoperable* products and services. Standards-based products and services offer many advantages to manufacturers, carriers/service providers, and corporate and consumer end users, including:

- Improved *economies of scale* for manufacturers and carriers/service providers,
- Improved price/performance for end users and carriers/service providers implementing network facilities because *interchangeability* of equipment enhances competition between suppliers,
- Enhanced value of network services to end users thanks to *network effects* – the network is more valuable as more people can be reached over the network,
- Enhanced *portability*, as equipment can still be used when end users travel, change addresses, or change carriers/service providers.

4.5.2 Incentives to standardize

The standards process in the telecommunications as well as in the Internet world usually comprises a lot of different players (and groups of players). However, not all players in the standards process necessarily benefit to the same degree. In fact, some players may not benefit at all. A substantial economics literature, as exemplified by Katz and Shapiro (1985) and by Farrell and Saloner (1985), exists on this subject. A key finding of the Katz and Shapiro is that:

- Where no firm has market power on a market characterized by strong network externalities, then all firms will tend to be motivated to achieve near-perfect interoperability and interconnection in order to maximize positive network externalities (network effects).
- Where some firm has sufficient market power – both in absolute terms, and in comparison to its most significant competitor – then that firm is likely to be motivated to implement less-than-perfect interoperability, because perfect interoperability would prevent the firm from exploiting its market power.[155]

Rohlfs (2001) has analyzed the take-up of new high technology products and services in the presence of *network effects* (often referred to as *network externalities* or *bandwagon effects*). The factors that enable a new product or service to successfully achieve critical mass are complicated, but standardization can clearly contribute to suc-

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155 See also Crémer, Rey and Tirole (2000).

cess. At the same time, for any particular market player, the question of whether it is better to seek proprietary advantage or to offer full compatibility is complex. [156]

Rohlfs has also explored the interrelationship between the technical standardization process and the take-up of new technologies in the presence of network effects. In the absence of interoperability, suppliers may be motivated to move aggressively, even at the cost of incurring initial financial losses, in order to achieve a "first mover advantage" and to build a superior base of customers. Once this base is launched, it can build on itself – "nothing succeeds like success". Network effects in the absence of interoperability can lead to a virtual monopoly.[157]

A supplier that is seeking this kind of commercial advantage may prefer that a standard not emerge, since a standard would interfere with the supplier's ability to build a *de facto* monopoly.

Rohlfs notes that the gravitational pull toward a single supplier can be averted if suppliers can sufficiently differentiate their products or services. In that case, each supplier develops and maintains a stable, specialized market niche, much as Apple has done with its computer products. This is not necessarily an optimal outcome for the society (it sacrifices both network effects and scale economies), but it may be the only available option for the supplier; moreover, consumers are probably better off with this oblique or indirect competition than with none at all.

Notwithstanding the current developments in the communications manufacturing industry (see, section 2.1.2.2) it is plausible to assume that this industry is and will be far away from monopolistic tendencies. Our impression is that competition on a world wide scale is fierce, and that NGN technology presumably will become an important feature for product differentiation. Yet, there might be some manufacturing companies that currently have a lead over others. Although not based on a representative sample, we have the feeling that, evaluating the recent announcements of manufacturers, Alcatel/Lucent, Ericsson and Huawei have been most successful in selling their NGN solution to carriers throughout the world.

It is, however, far too early to make an appropriate assessment if this (preliminary) observation speaks in favour of a sustainable longer lasting competitive edge of these companies. Our impression is that standardization of main features of NGN/IMS is finalized and that the manufacturing industry currently has finalized their part to develop marketable NGN solutions. This does not mean, however, that NGN developments at large are finalized. Rather, the opposite is the case. Indeed, in November 2006 the

156 Consider, for example, Apple's decision to largely disregard compatibility with the IBM PC in designing the Macintosh. Did the lack of compatibility enhance product differentiation of the Macintosh, or did it merely interfere with sales? The fact that many compatibility capabilities were subsequently offered, both by Apple and by third parties, suggests that Apple did not strike the optimal balance.

157 See Rohlfs (2001), sections 4.3.3 and 4.6.

Japanese equipment manufacturer NEC and US-based Juniper Networks announced the extension of their existing next-generation network (NGN) partnership, to include the development of IP multimedia subsystems (IMS)-based fixed-mobile convergence (FMC) solutions for the service provider market.[158]

On the other hand, it is entirely possible that individual service providers that possess market power might choose to implement capabilities in ways that impede interoperability. They might implement capabilities in ways that do not fully conform to the standards, or alternatively in ways that formally comply but that capitalize on aspects of a standard that are not widely implemented. They might intentionally exploit ambiguities in the standards. Given that service providers that possess market power will tend to have both the motivation and the ability to impose less-than-ideal interoperability, we assume that they will attempt to do so.

For the time being, we see no necessity for regulation or competition policy to step in; however, regulators should remain alert. For now, it might be best to deal with abuses as they emerge (that is, *ex post*) rather than trying to anticipate them *ex ante*.

4.5.3 New interfaces brought about by NGN

As we have seen in Chapter 3, the introduction of NGN, and of IMS in particular, introduces a number of standards-based compatibility interfaces into the public network. The implications for consumer welfare are complex.

Relative to the sale or lease of hardware and software for use in the public network, the migration is generally positive for consumer welfare. Standard interfaces will tend to increase the ease with which products of one supplier can replace those of another, thus enhancing global competition and enhancing consumer benefits. This change may tend to reduce the pricing power of equipment suppliers, but will correspondingly reduce costs to service providers and should thus increase consumer surplus (assuming that markets are competitive).

Relative to the services offered, the story is more complex. The good news is that these standard interfaces open a great many new avenues for competition in regard to services offered to end-users. The bad news is that service providers presumably will not want to open their networks to competition at the service level, and therefore will limit the use of these capabilities. This conclusion follows from the same economic arguments (Katz-Shapiro) that we have made repeatedly in this chapter.

158 TeleGeography 22 November, 2006.

It is clear that regulators would hope to see competition at the application layer of the NGN. It is not so clear that external access to IMS capabilities is the only acceptable way to achieve that goal.

In an IMS system, IMS can definitely serve as a gatekeeper relative to applications provider by the network operator. If operators choose to, they can prevent third parties from offering such services, or could perhaps extract rents from the application service providers.

However, this is not the only way to provide services in an NGN. The end-users will presumably still have best efforts Internet access. A range of services, including VoIP and IPTV, will be available over best efforts IP.

Network operators presumably anticipate that they will have an advantage to the extent that they can provide better QoS to their own applications. For reasons noted in Section 3, this is questionable – under most circumstances, best efforts IP service will deliver these services at quite acceptable performance *unless NGN operators are allowed to intentionally degrade their best efforts performance* (either by intentionally crippling them or equivalently by failing to obtain necessary capacity upgrades).

Government probably has adequate tools to deal with this potential problem of intentional degradation. At the regulatory level, it might be appropriate to impose non-discrimination obligations on incumbents with SMP. Whether this should be done in advance, or whether the regulator should instead wait to see if the harm really appears, is a complex judgment call. The regulator can also require the operator to make QoS information publicly available pursuant to Article 22 of the *Universal Service Directive*. The alternative to a regulatory *ex ante* solution would be to instead approach this kind of intentional degradation as an *ex post* competition law matter, since intentional degradation would appear to represent a form of anticompetitive foreclosure or tying.

We consequently assume that regulators and national competition authorities will be able to guard against intentional performance degradation, and that competition at the IP-based best efforts application layer will not be blocked (in most European Member States).

Assuming that incumbents cannot intentionally degrade successfully, then it would seem to be premature (and probably not proportionate) to consider a regulatory intervention to open interfaces such as IMS to third parties. At this point, it is not yet clear whether the incumbent's integrated IMS/NGN capabilities represent an unacceptably high barrier to entry to independent IP-based providers of applications and services over the network.

4.5.4 Migration of functionalities of PSTN voice services to NGN

In section 2.1.4.4, we raised the following two issues

- Should regulation require availability of a voice telephony service with pre-defined functionalities and quality provided end-to-end?
- Should regulation require in addition availability of a “basic” voice telephony service (without predefined quality of service)?

It is a bit early in the game to try to resolve these questions, but it is possible to identify some decision criteria.

As far as mandating features, the arguments in favour hinge largely on issues of *consumer protection*, and especially on the economics of *public goods*. Public goods are goods or services where the value to society is substantially greater than the value to the firms or consumers who must invest in them – consequently, it is often necessary for government to intervent to ensure that they are available, since the market would not produce them. Typically, it is difficult to exclude someone from using a public good, and the public good is not significantly diminished when it is used. The public road system, the judiciary, the military are sometimes used as examples of public goods.

The arguments against reflect first, a desire not to hinder innovation or to impede competitive entry, and second the ever-present risk that regulatory meddling might do more harm than good.

Access to emergency servces is an example of a public good. The value to society is high. The value to the consumer may be high when the service is used, but willingness to pay at other times might not be high, or is at least ambiguous. For obvious reasons, it would be inappropriate to let the carrier charge whatever the user is willing to pay only at the instant the service is used. Consequently, some kind of public mandate is required in order to ensure that the service is available.

At the same time, emergency services demonstrate one of the challenges in implementing these services in an NGN context. NGN, and VoIP generally, provide the user with the flexibility to move a phone that otherwise would have been fixed (i.e. “nomadic” use). This is somewhat different from mobility. For nomadic users, no reliable solution exists today to enable the network to determine their location. Forcing VoIP service providers to perform exactly as the PSTN does potentially hinders competitive entry, and potentially also locks in the service providers and also the emergency responder community into outmoded or obsolescent technology.

Lawful intercept is another public good. Society benefits from the ability, subject to appropriate legal safeguards on privacy, to intercept the communications of criminals and terrorists. The individual, however, does not benefit from having his personal telephone be capable of being intercepted, and is unwilling to pay for the capability. Again, the migration to NGN implies both technical and economic challenges as regards lawful intercept.

The traditional PSTN network supports literally thousands of features – significantly more in local switches than in those that implement longer distance services. Some of these are used only by large enterprises, or by very specialized users. Some have very few users.

IP-based voice services will not initially support the full range of features. For some of these features, this is not yet an issue, because a PSTN-based incumbent can offer the services to those residential and business customers who need it. Later, as incumbents migrate to NGN, it may no longer be possible to provide these features using outmoded PSTN technology.

Presumably, VoIP will eventually support those features for which there is sufficient demand, to the extent that it is cost-effective to do so. To a first order, the market should choose which features are supported, and which not. The market will make better choices than the regulator, in general. Regulators would be well advised to avoid intervention, except where necessary to address a pressing public goods problem such as access to emergency services, or lawful intercept.

Analogous concerns relate to provision of services with defined quality (in the sense of delay, "jitter" [variability of delay], or packet loss). If the market is competitive, different firms may be motivated to offer services at different levels of quality. In choosing mobile phones, consumers have already demonstrated that they are willing to accept quality that is not the same as that of the fixed network. As long as the market is competitive, consumers will be able to choose services that meet their needs, because providers will be motivated to supply the services that the market demands. All of this suggests that the first line of defense for the regulator should be to ensure a competitive market. Intervention would be warranted only in the event of some demonstrated market failure.

4.5.5 NGN and "network neutrality"

The migration to NGN offers many new opportunities to competitors, but it will not necessarily eliminate certain forms of market power, and it may introduce new forms of market power. An emerging question, especially in the U.S., has been whether newly IP-based operators might favor their own content, or affiliated content (and/or own applications, devices and services) over those of unaffiliated third parties. This question becomes especially relevant, in Europe as well as America, as operators who historically were dominant incumbents migrate their networks to an IP base. Will operators seek new ways to exploit market power? Will they be successful?

The *technical capability* to favor certain content, applications or services has been available for at least a decade. In the crudest case, routers could simply drop packets if they were destined for certain servers (IP addresses) or ports (particular applications). At a slightly more subtle level, they could be assigned a lower queuing priority or could otherwise be disfavored in any of a number of ways. The migration to NGN potentially opens new technological avenues to favour preferred content, and thus to exploit market power.

The exercise of this capability historically was limited by economic factors. In a competitive market, if a provider limits access to sites or services that customers want to use, customers may switch to another network provider.

In this context, a huge debate has been raging in the U.S. over the last few years on *Network Neutrality* as cable television operators and local incumbent telephony operators have threatened to use their control over last mile facilities to interfere with customer's ability to access certain web sites with good performance (in other words, to forcibly impose poor performance on web sites that are not favored) in order to enable the network operators to extract rents.[159] Whether these last mile operators can successfully exploit their market power is at yet unproven, but the degree to which U.S.-based web content firms have been mobilized by the threat suggests that the threat warrants close attention on the part of regulators.

It has long been recognized that providers of goods or services could potentially achieve some pricing power and profitability by distinguishing their goods and services, and by offering different qualities at different prices to different groups of customers.[160] When we buy a ticket for a train or an airplane, we take it for granted that we may be offered first class and second class tickets, with a higher price for the former.

In some cases, price discrimination may be linked solely to the willingness of the customer to pay, and largely unrelated to underlying costs. When an airline offers cheaper tickets to passengers who are willing to stay overnight on Saturday, it has nothing to do with their costs; rather, it reflects the greater willingness to pay (lower elasticity of demand) of business travellers. Business travellers are able to pay more, but are in most cases unwilling to stay overnight outside of the Monday to Friday time frame.

In the absence of market power, this kind of price discrimination tends to enhance consumer welfare. Deregulation of the airline industry, and emergence of price discrimination, is generally acknowledged as having resulted in lower prices for consumers.[161]

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159 "The chief executive of AT&T, Edward Whitacre, told Business Week last year that his company (then called SBC Communications) wanted some way to charge major Internet concerns like Google and Vonage for the bandwidth they use. 'What they would like to do is use my pipes free, but I ain't going to let them do that because we have spent this capital and we have to have a return on it,' he said." *New York Times*, March 8, 2006.

160 See Hotelling (1929).

161 To be sure, it also led to many unanticipated effects and to some unanticipated problems.

In the United States, a recent debate has emerged over *Network Neutrality*. The arguments on both sides of this complex debate have been somewhat confused, but it is worth noting that a number of experts have implicitly objected to price discrimination and to the use of technology to support the excludability that would make price discrimination effective.

The underlying causes for the emergence of the Network Neutrality debate at this time in the United States are a "perfect storm" of three simultaneous market and regulatory changes:

- The collapse of the wholesale market for broadband Internet access,
- A series of mergers (Cingular/AT&T Wireless, SBC/AT&T, Verizon/MCI, and now AT&T/BellSouth) with insufficient conditions imposed, and
- The overly hasty and ill-considered withdrawal of procompetitive regulation.[162]

The concerns about price discrimination reflect excessive concentration in the U.S. market – regulatory experts are objecting to many practices that, in a healthy market, would be welfare-enhancing. In the U.S. context, these concerns are real; moreover, they cannot easily be fixed through regulation. The problems are too complex. The FCC has already demonstrated (first in the Madison River proceeding, and again in the "Broadband Policy Statement") the difficulty of distinguishing between welfare-enhancing service discrimination versus harmful anticompetitive acts. In any case, once markets have been allowed to deteriorate to this degree, no regulatory fix is likely to be satisfactory. The fox is already in the chicken house, the horse has already left the barn.

In Europe, by contrast, the underlying markets are much more competitive; moreover, the regulatory system in Europe is likely to ensure that they remain competitive. Even in relatively concentrated markets such as Germany, most consumers can choose among multiple broadband service providers (many of them service-based rather than faciltiesbased). For the most part, the Network Neutrality debate has not emerged in Europe, and it is unlikely to emerge in the same form in which it has in the United States.

There are, of course, possible risks going forward. For example, if incumbent operators were to use differentiated Quality of Service to block independent offers of VoIP services, such conduct could raise serious concerns. But it is not clear that such a strategy would be effective, and European regulators (and competition authorities) probably have sufficient tools to deal with that kind of abuse were it to emerge.

In Europe, as long as regulators continue to ensure competitive underlying markets, offers of different quality of service at different prices are likely to enhance consumer welfare rather than to detract from it.

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162 See Marcus (2005).

4.6 NGN and security

Against the backdrop of the technological discussion of security in section 3.3.3, this section of the report evaluates regulatory implications of NGN security. Many potential NGN security concerns are already present for IP-based networks; however, we nonetheless review them here for completeness. On the other hand, to the extent that security issues do not raise particular regulatory concerns, we ignore them.

The ITU's "Best Practice Guidelines for Next-Generation Networks (NGNs) Migration" developed by the 2007 "Global Symposium for Regulators", recognize the importance of security. [163] Recommendation number 12 provides the following guidance, which, if obvious, is nonetheless appropriate:

> 12. Consumer awareness, security and protection:
>
> a. We believe that regulators should focus on raising awareness of the benefits of NGN for the market and consumers, and at the same time carefully consider issues relating to security and consumer protection (for example personal and data protection, protection of minors, the protection of end-users from the invasion of privacy, as well as e-commerce, law enforcement related issues and access to emergency telecommunications services.)
>
> b. We believe that the security of communications will become increasingly important in a new IP based communication environment, and therefore encourage regulators to follow developments of security issues, and implement appropriate measures such as, for example consider requiring reports from relevant service providers on security incidents and failures.
>
> c. We recommend that regulators should also define ways to inform consumers on security and privacy risks in IP/NGN environment and look for ways to increase consumer awareness on protection methods, including, for example, media campaigns and telecommunications fora and seminars.

We are addressing the following specific network security issues:

- critical infrastructure protection (network attack mitigation),
- cybercrime, phishing, SPAM, etc.,
- lawful intercept,
- data retention.

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163 ITU, Press Release 09/02/2007, www.itu.int/newsroom/press_releases/Guidelines.html.

4.6.1 Critical infrastructure protection (network attack mitigation)

Years ago, the Internet was created as an academic research network. It was initially a research project, not a critical infrastructure. The initial design was intended to be robust in the face of *force majeure* incidents, but not necessarily to be robust in the face of cyber-threats.

There are many aspects to security. It is increasingly recognized that major networks represent a key form of critical infrastructure, whose operation is vital to society.

Network operators may not be motivated to make the societally optimal level of investments in protecting the continuity of operation of these networks, because the value to the network operator, while high, is much lower than the total value to society. Thus, there may be a role for policymakers to seek to ensure that network operators take adequate measures to address likely threats. This needs to be balanced against the sober recognition that the regulator is probably not well situated to judge the level of risk associated with various threats, nor the comparative cost-benefits of various remedies to a range of potential threats. On balance, we tend to think that regulatory intervention at this point in time is likely to do more harm than good; however, this balance might shift over time. For now, regulatory authorities in general, and the NHH in particular, may at least want to ensure that they have a good understanding of the level of preparedness of significant network operators.

With the migration to NGN, the IP-based technology that characterizes the Internet moves to the core of primary telephony networks. Infrastructure security for IP-based networks now becomes a central concern.

The United States does not refer to the changes taking place as NGN, but the evolution is similar, and in some respects happened earlier there than in Europe. In the deregulatory climate of the U.S., surprisingly few concrete actions have been taken by government; however, many of the advisory bodies to government have done good work that can benefit European regulators.

The FCC's advisory body, the Network Reliability and Interoperability Council (NRIC), has published extensive lists and databases of industry best practice, both for voice and for data.[164] NRIC is chartered to provide industry advice to the FCC, but much of NRIC's advice represents advice to the industry itself. Much of this guidance is directly relevant to IP-based networks. This body of work tends to reflect good, practical advice that was developed by teams of very experienced U.S. experts.

The Network Infrastructure Advisory Council (NIAC), an advisory panel to the President of the United States that is housed within the Department of Homeland Security, has

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164 The online database of best practices is available at http://www.bell-labs.com/user/krauscher/nric/.

published useful guidance on a wide range of infrastructure security policy issues, including outage disclosure (the disclosure to the public or to the government that a security of breach has taken place).[165] The discussion of outage disclosure is illuminating – a challenge with outage disclosure is the risk that malefactors might benefit from being informed of a vulnerability.

The U.S. National Institute of Standards and Technology (NIST) has evaluated the security the security risks associated with VoIP technology.[166] The study concentrates primarily on private and corporate VoIP systems and networks, rather than on the introduction of VoIP into a public network.[167] They stress that VoIP and other real time are time-critical; consequently, security measures such as firewalls, network address translation (NAT), or cryptographic engines could incur additional delay and thus introduce unacceptable latency into the VoIP service.

A problem that has been recognized in the literature but rarely discussed by policymakers is the degree to which network infrastructure security represents an economic *public goods* problem. The companies that would ideally make investments do not necessarily realize commensurate economic returns as a result. The benefits to society are far larger than those to the service providers; moreover, it is legitimately difficult for a firm to invest more than its competitors, since the higher costs associated with doing so might make it less competitive. These public goods problems lead to underinvestment in infrastructure security on the part of service providers.

A number of academic papers explore these public goods problems in regard to network infrastructure security. Marcus (2004a) considers possible public policy remedies, up to and including outright mandates and public funding. Today, we would have to say that this is a largely unsolved problem.

The threats to infrastructure are numerous. Noteworthy are (1) the threat of intruders hacking in to network servers or routers, and (2) the somewhat less obvious threat of *Distributed Denial of Service (DDoS)* attacks.

Hackers have succeeded in infecting huge numbers of computers on the Internet. Armies of these “zombie” computers, or “botnets”, can be enlisted to send enormous volumes of unproductive traffic to victim networks or computers, effectively preventing legitimate traffic from getting through. The unproductive traffic thus blocks the victim’s normal network traffic, hence denying service to that network’s customers. Since the army of attackers is likely to be dispersed, it is a Distributed Denial of Service (DDoS).

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165 See NIAC (2004).
166 See Kuhn, Walsh and Fries (2005).
167 The NIST study is based on IP systems with distributed control functions over the terminals and over some proxies (e.g. SIP proxies) located at the net periphery. As noted later in this section, the NGN concept using soft-switches or IMS provides for a separation between the control plane and the user information transport plane; consequently, the centralized control functions can be better protected against attacks.

Network operators can configure their network routers to refuse to admit unwanted and unexpected surges of traffic, but in general this is a process that requires some human intervention to recognize that an attack is under way and to respond. Responding to DDoS is not instantaneous. In the evolution of the NGN towards TISPAN IMS, this type of network attack should in theory be mitigated by means of the control plane of the IMS, because the resource allocation has to be granted by the elements of the Call State Control Function.

A weakness of the Internet in comparison to the legacy PSTN/ISDN, at least in terms of security, is that signaling and control in the Internet take place in-band – that is, signaling and control take place over the same network that carries customer data.[168] This implies that the Internet is somewhat more vulnerable to attack from end-users. With the migration to NGN the signalling and control traffic will be handled over the control plane of the network. As explained in section 3.3.2, there is an important effort for the provision of security mechanism to reduce the exposure of the NGN to external attacks; however, although the NGN security mechanism are well designed, they will be likely to suffer implementation problems.

Again, we do not advocate NHH action at this time, other than increased vigilance; however, it is possible that NHH will have a role to play in the future as the European Commission becomes progressively more activist on network security and integrity.

4.6.2 Regulatory responses to cybercrime, phishing, SPAM

The widespread availability of online electronic services has generated enormous benefits for consumers, but it has also exposed them to a broad range of potential exploitation and abuse. Most of these exposures are already present in Internet-based applications today. In a sense, Internet-based electronic communications provide a conduit for abuse that would not be very different, in principal, if the abuse were carried out using telephone calls or, for that matter, conventional post.

To a first order, the migration to NGN does not change the nature of these risks. It may, however, make them more frequent or more visible to the extent that NGN drives more widespread adoption of IP-based services than has been the case to date.

Many of these problems are most often dealt with through the criminal justice system, rather than through the regulatory system. Identity theft, fraud, or theft of services can often be prosecuted under a country's laws.

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168 At the same time, experience with the PSTN shows that hackers have occasionally gotten into the supposedly secure control network among the carriers, and that the consequences can be severe if the control network is not implemented with due regard to infrastructure security.

Laws and/or regulation are sometimes used to try to mitigate various kinds of offenses. One example is the CAN-SPAM Act that the U.S. enacted just a couple of years ago. The CAN-SPAM Act required the sender of unsolicited email to provide a real email response address, and made it illegal to send unsolicited email to a recipient who requested to "opt out" of receiving mail from this recipient.

In practice, CAN-SPAM has been utterly ineffective. SPAMmers can simply move their operations to a country that does not enforce this U.S. law. Alternatively, they may open a different "virtual storefront" for each business that they attempt, thus obliging the consumer to opt out of many different services, one at a time. Most consumer advocates specifically counsel *against* requesting to opt out – doing so is unlikely to be effective in stopping the SPAM. Moreover, the opt out request confirms to the SPAMmer that someone read the SPAM, thus encouraging the SPAMmer to continue to send to that address.

The European Union's e-privacy Directive has not done much better. The e-Privacy Directive includes an "opt in" scheme, where unsolicited email may not be sent until and unless the recipient expressly indicates willingness to receive (unless the recipient already has a commercial relationship with the sender). Again, it is too easy for SPAMmers to simply move off-shore.

Many experts have observed that a fundamental economic problem is that email is simply not expensive enough. Once a SPAMmer has designed a solicitation, whether for a legitimate product or for a scam, it costs very little to send it to an enormous number of people. The incentives to SPAM are large, the disincentives are small.

In the absence of unambiguous identification of the sender, and of international agreements to prosecute unsavory SPAMmers, enforcement efforts against SPAMmers are unlikely to be effective.

4.6.3 Lawful intercept and data retention

Lawful intercept (wiretapping) is the ability to capture information about criminal activities that have been or are likely to be committed, or threats to national security. In Europe, lawful intercept is treated as a matter of national rather than European competence. In general, countries conduct lawful intercept only where an independent authority, typically a court, has granted prior authorization based on a recognition that there is a sufficient basis for suspicion in the specific instance to override the target's normal presumption of a right to privacy.

Data retention is the closely related practice of requiring providers of electronic communications services to retain records about communications placed by their subscribers, again for purposes of law enforcement or national security. Ideally, these would be records that the service provider might normally retain in the course of business even in the absence of a data protection mandate. Data protection is a European Community prerogative, and is now implemented by the Data Retention Directive.[169]

The migration of traffic to IP poses new challenges to both lawful intercept and data protection. The PSTN and VoIP technologies are substantially different. VoIP is implemented using a number of distinct technologies, each with somewhat different implications for capturing the beginning and end of an interaction. Data can be encrypted by the end user, making lawful intercept fruitful only for intelligence operations with competence and computer capability to crack codes quickly (and perhaps not even then, depending on the quality of the cryptography). Data packets are routed individually, making it potentially challenging to recover an entire data stream (although this last is usually addressed by tapping as close to the target as possible).

Again, the migration to NGN does not necessarily raise new technological issues that were not already present in IP-based communications; however, it raises the visibility of these challenges, and elevates them to a more central role in the network.

4.7 Universal service issues

Universal service in the context of NGNs is a complicated topic that may well merit a study in its own right. In the interest of brevity, and recognizing that the NHH has not identified universal service as a prime interest for the current study, this section provides just a few initial impressions.

The migration to NGN may reduce the unit costs associated with delivering service to remote or high cost areas of the national territory. To the extent that this is so, NGN may reduce the need for explicit mandates or subsidies.

Interconnection fees have historically provided an implicit subsidy to areas of relatively higher cost to the extent that cost-based termination fees generate subsidies to providers that have higher costs. As previously noted, the migration to NGN is likely to make it difficult if not impossible to sustain current interconnection payment arrangements. To the extent that subsidies might still be required, they will need to be provided in some other way. This is not necessarily a problem – indeed, it will tend to force governments to abolish subsidies that are no longer needed, and to make explicit any subsidies that are still required.

169 European Commission (2006), *Directive 2006/24/EC … on the retention of data generated or processed in connection with the provision of publicly available electronic communications services or of public communications networks …*,March 15, available at: http://europa.eu.int/eur-lex/lex/LexUriServ/site/en/oj/2006/l_105/l_10520060413en00540063.pdf.

A significant problem with current interconnection-based subsidy mechanisms is that in many cases they imply economic distortions. Since society as a whole benefits from near-universal interconnectivity, it would be appropriate that any subsidies be funded from as broad a base as possible, so as to minimize economic distortions. An approach favored by some economists, and explicitly authorized in the Universal Services Directive, would be to fund universal service out of general revenues.

4.8 Convergence of peer-to-peer regulatory elements and the contract-chain

As noted in Sections 2 and 3, the migration to IP-based services is substantially changing the value chain of services. The migration to NGN does not fundamentally alter this evolution, but it may accelerate it or necessitate even greater emphasis on the part of policymakers. Meanwhile, the *character* of business relationships at the application and services layer is changing over time.

Historically, most content and most application services were offered by commercial service providers, and this continues to be an important business model. Amazon.com offers books for sale over the Internet; newspapers such as the *New York Times* offer portions of their content for free, but other portions for a fee; radio stations may make their broadcasts available to the public, often for free. In some of these cases, the customer "pays" by being subjected to advertising.

In all of these cases, the technical implementation can be viewed as being client-server, in the sense that the software running on the customer's Personal Computer (PC) (often just a web browser) is the *client* of software running on a *server* platform of the service provider. The relationship is *asymmetric* – the client's job is not the same as that of the server, and a single server can support a great many clients.

In newer business models, the "customers" or users may provide their own content, and share it with others over the Internet. *YouTube* is a conspicuous example of this new development, which is often referred to as *Web 2.0*. Högg et all. (2006) define Web 2.0 as a philosophy of mutually maximizing collective intelligence and added value for each participant by formalized and dynamic information sharing and creation.

Where users have the ability to legally share their own materials, they also have all the technical capabilities necessary to share materials copyrighted by third parties – either by copying the recorded medium directly, or by recording the event (for instance, by making an unauthorized recording of a live performance, or by pointing a video recorder at a screen display of a movie).

These capabilities raise profound public policy questions, perhaps best exemplified by the *Napster* case in the United States. Do these recordings suppress the incentives for artists to innovate? Or are they instead more akin to an individual's use of a videocassette recorder (VCR) to record a television program, which has generally been viewed as appropriate under the *fair use* doctrine of copyright law?

In these systems, the users typically have a symmetric relationship with one another. The content is shared among users, rather than emanating from a central server. At a technical level, these services are often implemented as *peer to peer (P2P)* systems, a technical realization that better fits the traffic flows and control relationships that characterize these systems.

The TCP/IP connection model of the Internet inherently supports both models of application interconnection – both client-server and peer-to-peer. NGN/IMS could enhance these interactions (for example by communicating bandwidth requirements back to the underlying transmission platform), but basically the migration to NGN does not alter these dynamics.

These are important public policy issues, but they are not necessarily *regulatory* policy issues. In particular, they are related to content, and explicitly excluded from the European framework for electronic communications.

Since these issues are not new with NGN, and moreover are not directly relevant to the NHH, we have not provided recommendations associated with the migration to P2P.

4.9 NGN and the present EU regulatory framework

This section analyses the relation between NGN and the present EU regulatory framework and market analysis system.

Two themes will recur throughout our discussion of NGN and the regulatory framework:

- The evolution to NGN implies changes not only in technologies, but also in markets; not only changes in the implementation of services, but also changes in supply chains.
- In many cases, European regulations contain subtle and unrecognized dependencies on the underlying technology.

We expand on these themes as we consider the specific relevance of particular regulatory measures to NGN in the following sections.

In analyzing the relevance of the migration to NGN to regulation under the European framework for electronic communications, it is helpful to distinguish between

- remedies to *Significant Market Power (SMP)* versus
- obligations that are unrelated to SMP.

Section 4.9.1 considers the implications of the migration to NGN as regards the regulatory mechanisms associated with market definition, determination of Significant Market Power (SMP), and imposition of regulatory remedies. Section 4.9.2 considers implications as regards the other mechanisms of the regulatory framework, especially those that appear in the Universal Service Directive.

4.9.1 Regulatory mechanisms associated with market definition, SMP and remedies

The European regulatory framework was designed to be as future-proof, and as independent of underlying technology as possible. It was recognized that the technology and the markets were about to be profoundly transformed. The European system arguably comes closer to this objective than any other, thanks in large part to its reliance on analysis and policy rooted in economics to identify markets and market power, and to impose remedies to address such market power as may exist. Nonetheless, challenges remain in all three key areas: the definition of markets, the determination of undertakings that possess Significant Market Power (SMP), and the imposition of remedies to address likely competitive harms.

In identifying the markets that NRAs are to evaluate *ex ante* (in advance, without waiting for some demonstrated competitive harm), the European Commission applies the *three criteria test*. For a market to be susceptible to *ex ante* regulation, it must be characterized by (1) high and durable barriers to entry, (2) limited prospects of increased competition over the period of interest, and (3) likely competitive harms that are not easily remedied by competition law or other means. In determining the applicability of the Commission's market definitions, NRAs can apply the three criteria test themselves, taking national circumstances into account.

The European regulatory framework is specifically designed to address technological change in general, and convergence in particular, by striving for *technological neutrality* insofar as possible. The appropriateness of regulatory remedies is predicated on the market power of the provider, based on an economic analysis of the service as perceived by the customer, irrespective of how a service is delivered.

This technologically neutral market definition process will accommodate many changes in a natural and straightforward manner. For example, it is fairly clear that a phone-to-phone VoIP service, delivered by a network operator over its own network and readily perceived by the end-user as a substitute for conventional telephony, can be viewed as being part of the same market as conventional voice telephony (for fixed or mobile as appropriate, and for both origination and termination). The Commission specifically considered this issue as part of its public consultation on VoIP in June of 2004, but did not find that the use of VoIP necessarily triggered any special considerations in regard to the market definition, nor to the analysis of SMP.[170]

Other aspects are not so straightforward. The migration to NGN, and especially to IMS, will tend to introduce a great many new control plane capabilities that could be used either to facilitate or to block competitors. This has profound implications as regards the three criteria test. At this point in time, it is impossible to predict which bottlenecks might actually be exploited by operators, especially by operators that have been historically dominant. Which ones constitute durable bottlenecks? What countervailing forces might amerliorate competitive problems over time? What is the relevance of competition law? It is simply too soon to say. For now, we can say that new NGN-based markets that might be susceptible to *ex ante* regulation do not yet appear in the Commission's recommendation, and that it may not be so easy for the Commission or the NRAs to address them if and when the need arises.

Determination of SMP is also not so straightforward. In conventional markets, concepts of market power have evolved in the course of a century of case law. Not all of the market effects of interest for NGN follow these rules. Three noteworthy challenges relate to (1) network externalities, (2) two sided markets, and (3) joint dominance.

In the case of market power based on network externalities, the economic literature does not clearly establish the market share that an undertaking must have in order to find it profitable to act in uncompetitive ways. The effects are clearly identified in a series of well accepted classic papers,[171] but there is only one paper that attempted to establish a market share threshold, and the value that it reached is probably incorrect (unreasonably high).[172]

Many of the markets of interest here are two-sided. These markets are characterized by the need to bring together multiple parties, for example buyers and sellers. As a notable example, ISPs bring web sites and other content providers together with end-user consumers. In such a market, it can be perfectly economically rational for the intermediary to price low to one side of the market and high to the other. These markets are notoriously difficult to analyze.[173]

Finally, we observe that joint dominance has always had an uneasy relationship with the regulatory framework. It is clearly appropriate to react *ex post* to exploitation of a dominant position. It is less clearly appropriate to respond with *ex ante* remedies to po-

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170 See European Commission, "*The treatment of Voice over Internet Protocol (VoIP) under the EU Regulatory Framework*", 14 June 2004. Mr. Marcus was attached to the European Commission in 2004, and participated in this proceeding.
171 See Katz and Shapiro (1985), Farrell and Saloner (1985), and Cremer, Rey and Tirole (2000).
172 See Malueg and Schwartz (2001).
173 See Rochet and Tirole (2004).

tential explicit or tacit coordination that undertakings might undertake. This issue is not unique to NGN, but it is likely to emerge in new ways.

Article 5(1) of the Access and Interconnection provides NRAs with extensive authority to intervene where undertakings that control access to end users impede interconnection, *even in the absence of a showing of SMP*, thus entirely bypassing the challenges just raised. It is a powerful source of authority – perhaps *too* powerful. It potentially provides NRAs with substantial ability to intervene based on a somewhat subjective assessment. It is for this reason that the Commission has consisted counseled that it must be used with great restraint.

Finally on the remedies side, it is by no means clear that the remedies defined in the regulatory framework are the right ones to deal with, for example, exploitation of potential bottlenecks in the IMS control plane.

A substantial array of regulatory remedies are available to address market power, and to enable competitors to achieve market entry; however, these remedies are available only against service providers that possess SMP.

4.9.1.1 Implications for the definition of specific markets

The European Commission has identified a total of 18 markets as being susceptible to *ex ante* regulation.[174] A review of the framework is currently under way, and potentially there will be a reduction in the number of markets, perhaps to somewhere between ten and twelve.[175] Yet, the framework as such is open to the definition of new upcoming markets. Where a provider offers a service that is significantly different from traditional electronic communications services, it is likely to be perceived differently by consumers and thus to possibly imply a different market or market segment; however, where a provider *changes the means of delivery, without changing the service*, one would expect *ceteris paribus* that the market analysis would be unaffected by the change.

OPTA in the Netherlands is currently considering whether changes might be required to key market definitions, partly as a result of their study of sub-loop unbundling (including back-haul to the sub-loop unbundling location):

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174 European Commission (2003), *Commission Recommendation of 11 February 2003 on relevant product and service markets within the electronic communications sector susceptible to ex ante regulation in accordance with Directive 2002/21/EC of the European Parliament and of the Council on a common regulatory framework for electronic communication networks and services (2003/311/EC),* L 114/45, 8 May.

175 European Commission (2006), *Commission Staff Working Document on Relevant Product and Service Markets within the electronic communications sector susceptible to ex ante regulation in accordance with Directive 2002/21/EC of the European Parliament and of the Council on a common regulatory framework for electronic communication networks and services (Second edition*), SEC(2006) 837, 28 June.

- Market 11: wholesale unbundled access (including shared access) to metallic loops and sub-loops for the purpose of providing broadband and voice services and
- Market 12: wholesale broadband access, covers bit-stream access that permit the transmission of broadband data in both directions and other wholesale access provided over other infrastructures, excluding broadcasting transmission services.

4.9.1.2 *Implications for access and interconnection*

A range of remedies are appropriate where a firm has been found to have SMP. Two of the most noteworthy relate to *access* and to *interconnection*. In the IP-based NGN of the future, access is arguably even more important than it is today, inasmuch as high speed network access is central to the ability to provide any services.

It is, however, interconnection that potentially poses some of the greatest challenges: To date, the IP world has generally managed interchange by means of voluntary arrangements among providers, with no explicit regulatory obligations. In the traditional PSTN, firms with SMP have generally been subject to regulatory obligations to interconnect. To the extent that the NGN represents a blend of the PSTN with an IP-based network, it is not clear which of these two seemingly diametrically opposed regulatory models should be preferred. In previous work, we have suggested that regulators might be well advised to focus their energies on ensuring competitive markets for key underlying inputs, including leased lines and broadband Internet access. There is some basis to believe that unconstrained private negotiations over interconnection (that is, arrangements based on the *Coase Theorem*[176]) will lead to fair, efficient and consumer-friendly outcomes if the market for these underlying inputs are either effectively competitive or are effectively regulated.[177]

The Commission and the NRAs have substantial ability to respond to interconnection problems where one of the operators in question has SMP. NRAs also have the unusual power to take action to ensure interconnection *even in the absence of SMP*.[178] The Commission has repeatedly cautioned, however, that this unconstrained authority must be used with great restraint.

A related concern has to do with changes to network topology as the network migrates to an NGN. Section 2.4 has shown that the network migration plans of several carriers in particular imply to reduce substantially the number of POIs for access and for inter-

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176 In his famous paper, "*The Federal Communications Commission*", Coase (1959) argued that commercial negotiations would often reach better outcomes than even the most public-spirited regulator.

177 See Marcus (2006c).

178 *Access and Interconnection Directive*, Article 5(1)(a) ("Powers and responsibilities of the [NRAs] with regard to access and interconnection").

connection, and we have considered regulatory implications of this issue in sections 4.2.4 and 4.3.4.

To the extent that incumbents make this change unilaterally, thus stranding investment already sunk by their competitors, it is not altogether clear who should bear the cost.

4.9.2 Obligations that are unrelated to SMP

In crafting the European regulatory framework that came into effect in 2003, the European Community placed great emphasis on those aspects of regulation that address market power. Many experts tend in consequence to forget that there are a great many aspects of regulation under the framework that have nothing to do with the presence or absence of SMP.

As a notable example, the *Universal Service Directive* contains dozens of obligations, only a few of which are based on SMP. Some seek to ensure that key services are available to all Europeans at reasonable prices; others ensure the rights of consumers. The "triggers" for the consumer rights obligations are in many cases ill-defined. The availability of VoIP has already led to many complications (for example, the question of whether access to emergency services should be mandated[179]), and the migration to NGN will doubtless expose many more. This section of the report deals with a few of the more obvious examples.

Access to Emergency Services

The growth of VoIP has raised particular challenges as regards access to emergency services. It is generally accepted that access to emergency services is of vital importance and should be supported wherever possible. At the same time, there are profound challenges in correctly and reliably identifying a VoIP user's location, especially where the user is "nomadic" (able to change his or her location at will).[180]

A 2006 ruling by Ofcom appears to represent a good and appropriate balance between opposing goals.[181] Ofcom mandated access to emergency services for providers of PATS based on VoIP; however, for other providers of VoIP, they require that consumers be reasonably informed and educated, following guidelines that were developed in consultation with industry.

179 *Universal Service Directive*, Article 26 ("Single European emergency call number").
180 See, for instance, Marcus (2006a).
181 See Ofcom (2006).

Network reliability

Another of these non-SMP-based obligations relates to network reliability. Providers of Publicly Available Telephone Service (PATS) at fixed locations are to ensure that their networks reliably deliver the service, even in the face of *force majeure* disruptions.[182] The drafters of these provisions apparently did not consider that, in a converged, IP-based world, the voice service provider might have nothing to do with the network provider! A service provider such as Skype or SIPgate has no meaningful ability to ensure the reliability of the service. Analogously, the ability of the NRA to ensure the quality, reliability or security of the service offered to the end-user is ambiguous if the quality of that service depends on one or more underlying networks provided by other undertakings.

In migrating to NGNs, the incumbent operators are seeking insofar as possible to provide *integrated* networks and services, and to use their unique ability to ensure quality and reliability as the means of enticing their customers to prefer their fully integrated NGN-based solutions. Thus, the move to NGN is an attempt to thwart the migration toward separation of the network and the service. Nonetheless, many customers are likely to prefer the independent services that IP inherently enables, unless they are specifically blocked from choosing independent services. For a provider to offer different levels of Quality of Service is in general perfectly appropriate; however, it should not imply the ability of an operator that possesses SMP on some market to intentionally degrade the Quality of Service of reaching a competitor's services.

It is too soon to say how all of this will play out in the marketplace, but it is quite possible that regulators might need at some point to intervene to ensure that the marketplace remains competitive. This is probably best addressed as an interconnection issue, but it could conceivably be dealt with by mandating some minimum Quality of Service. It is important to note that imposing a minimum Quality of Service obligation would have the negative impact of reducing consumer choice.

Interoperability, standards

As noted in section 4.5, it is possible that operators that possess market power will not be motivated to implement good interoperability with their competitors. The European Commission has authority, where standards "have not been adequately implemented so that interoperability in one or more Member States cannot be ensured," to compel their implementation "… to the extent strictly necessary to ensure such interoperability and to improve freedom of choice for users."[183] We suggest that this rather broad authority should be exercised with restraint; nonetheless, it is clear that the Commission has substantial ability to take action in order to ensure interoperability should it prove necessary.

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182 *Universal Service Directive*, Article 23 ("Integrity of the network").
183 *Framework Directive*, Article 17.

Terminology

The *Universal Service Directive (USD*), unlike the market-based portions of the *Framework Directive*, imposes obligations based on definitions of specific services. These definitions are already under great strain as a result of the growth of VoIP, and they will come under increasing strain with the advent of NGN.

A notable example is Publicly Available Telephone Services (PATS), where an ambiguous and circular definition has created headaches in identifying which VoIP providers should be obligated to provide access to emergency services.

More generally, even though the USD seeks to distinguish between electronic communications *networks* versus *services*, the distinction is not drawn with sufficient clarity. The drafters were thinking about MVNOs, perhaps, but not about the kind of separation that is possible in an IP-based network. Consequently, the boundaries are blurred. Even though the USD attempts to distinguish the network from the service, in many cases it is not clear whether obligations are being placed on the right party.

4.10 Key messages of this chapter

Basic theoretical considerations

In a market economy (incentives for) innovation and technical progress are always present. The actual development of new technologies is, however, not predictable. Ex-ante the competition between technologies should be left for the market to determine, i.e. supporters of a technology have to succeed with it in competition with other possible technologies. The State should not "regulate technical progress", rather it should employ a technology neutral approach to technological policy and regulation. The issue might arise if competition needs "shaping". It is our firm belief that innovative changes should not be inhibited because they threaten the ongoing existence of competitors. The main issue for intervention is to preserve a certain degree of competition, i.e. to assess if innovation does damage the competitive process. The issue at stake is not to keep competitors alive. Intervention always carries the risk of "betting on the wrong horse". The market is usually more capable than the regulator of determining which innovations have real value.

New and emerging markets exhibit higher than normal risk. Basically, the risk for investors increases with the proportion of investment costs which are sunk, the uncertainty about demand as well as about the future supply responses by competitors and the expected timeframe over which the investment will be recovered. Where new and emerging markets exhibit higher than normal risk, investors require a higher than normal return on their capital in order to make the investments. Moreover, high risk product/service markets have an uncertain life cycle (pay-off period). Premature regulation of such markets can be expected to reduce the level of investment, and can lead to the market being undeveloped or underdeveloped. In innovation-driven markets characterised by ongoing technological progress entry barriers can be less relevant, i.e. not all firms are equally well placed to enter a market first. Rather, some are less tolerant of risk and there might be an option value of waiting.

If new infrastructure is used to provide wholesale services that substitute for services previously provided over another infrastructure the new wholesale services should fall within the existing wholesale market. Thus, where new infrastructure is used to provide a familiar service ("old wine in new bottles"), there should be no access holidays for the new infrastructure. Thus, the crucial issue is that actually new services are provided over the new infrastructure.

NGN and network access

The main characteristics of NGN access networks are (1) deep fibre is deployed in the customer access network. (2) Depending on the actual FTTx solution new "concentration" points emerge. This affects both the number and the location of the concentration points. (3) Regarding the backhaul network network optimization brings about new concentration points. (4) The ultimate goal of NGN deployment will be a world where IP is carried over Ethernet over fibre.

In view of this there we view several items to be on the regulatory agenda: (1) Collect comprehensive and suitable information about NGN deployment plans (What? When? Where?) of both the incumbent and the competitors. (2) Assess the (present and foreseeable) competitive market situation. (3) Identify and communicate a coherent set of objectives of regulatory intervention regarding NGN. (4) Identify available options for competitors to compete on a level playing field with the incumbent. In particular, identify potential bottlenecks and essential facilities, i.e. generic disadvantages of competitors against incumbents. (5) Derive a suitable process to ensure dialogue and consultation among the stakeholders involved in the migration towards NGN.

Regarding facilities-based and service-based competition the conventional wisdom tells that service competition has its merits but infrastructure competition should be the ultimate goal. Moreover, service competition virtually depends on infrastructure competition. We believe, however, that infrastructure and service competition require a new definition and understanding in the NGN world due to the inherent characteristic of NGN of the decoupling of the transport and service functions. Thus, there is room for more or less dis-integrated business models where NetCos (companies focusing on network deployment), (migrated) telecommunications carriers and non-facilities-based service/application providers are active in the market simultaneously. This change is already visible with the migration of services to IP, but NGN potentially accelerates and emphasizes it.

If an incumbent market player announces its intention to deploy FTT street cabinet/ VDSL the need will arise for regulatory policy to analyse the options for competitors to compete on a level playing field.

Thus, the regulator has to check the availability/viability of Sub-loop Unbundling (SLU) options like (1) own build, i.e. investment in own fibre lines between MDF and street cabinet; (2) leasing dark fibre (from a third party or from the incumbent); (3) rental of ducts and (4) leased lines. Moreover, regarding co-location at the street cabinet the feasibility has to be checked. Several options a-priori are possible: Building a second cabinet adjacent to or in a certain distance to the incumbent’s cabinet (virtual co-location, i.e. the competitor establishes its own DSLAM near the incumbent‘s street cabinet) or physical co-location (i.e. the competitor installs his own DSLAM in the incumbent’s street cabinet or the competitor installs his own line card in the incumbent’s street cabinet. As to bitstream access we see the need for a check of the feasibility of options for traffic delivery at current PoPs, at the location of the Main Distribution Frame (MDF) or on a still more aggregated basis.

If the issue of phasing out of MDFs arises the potential scope of “stranded investments” with competitors needs to be assessed. This has both a physical/geographical dimension (What? Where?) and a time dimension (How long are investments in MDFs still relevant in the balance sheets of competitors?). In this case regulatory policy needs to assess the future potentials of infrastructure competition, the sustainability of a FTT street cabinet solution, and the potential of FTTB/H as the “final outcome”. In particular, the implications of a withdrawal of the incumbent from MDF locations on (FL-LRAIC) wholesale MDF access costs for competitors have to be assessed.

Deployment of FTTB/H brings about different challenges for the regulatory agenda. We view as most important (1) to check the availability of existing infrastructure which could be used for deployment (e.g. infrastructure of electricity utilities, water/sewage pipes, ducts of the incumbent, dark fibre of the incumbent or other carriers and to assess if aerial deployment is possible), (2) to check the viability/market relevance of different business models (integrated NetCo, ServCo; NetCo and ServCo separated; operator neutral third party (strategic investor) renting infrastructure); (3) to evaluate the presence of comparative advantages of incumbents and to assess the necessity of regulated wholesale offers by the incumbent; (4) to assess the potential competitive situation (How many parallel infrastructures? What constitutes “market power”?); (5) to consider the applicability of the regulatory framework and Commission guidance on markets and SMP to FTTB/FTTH; (6) to assess the possibilities of getting into the building; (7) to assess the feasibility of potential regulated wholesale services (unbundled access, wholesale bitstream access) and (8) to assess the relevance of a nationally oriented or a more regionally/locally oriented regulation.

As to the regulatory imposition of wholesale access to cable operators’ broadband capabilities we see a basic trade-off: slowing deployment of broadband over cable infrastructure vs. enabling service-based competition. Thus, we want to underline that the issue needs to be considered in terms of the specifics of a particular State. In Europe an NRA would presumably have to persuade the European Commission (through the Article 7 notification process) to accept a country-specific market definition and to accept that a cable operator possesses SMP (possibly as a result of joint dominance). Moreover, experience from the U.S. and Canada tells that cable operators are likely to vigorously resist any bitstream obligation and that they are likely to be successful unless the regulator is steadfast. Overall, we view the rationality and viability of this option in Europe questionable. However, it might be considered if the Hungarian market tilts strongly toward cable.

NGN will bring about changes regarding numbering, naming and addressing. We view the forecasts as credible that the IPv4 address space will be exhausted under current practices in the 2011 – 2012 time frame. We underline that IPv6 is there although its scant deployment to date. We see no changes specifically required in the DNS system in order to support NGN. Yet, it is likely that there will be demands for enhanced security. We view as main regulatory items on the agenda the requirements for the correct registration in a user ENUM (E.164.arpa based) world and the decision about assignment of (non-)geographical numbers to VoIP services.

NGN and interconnection

It can be taken for granted that the current modes of traffic exchange of the telephony world (Calling Party Pays, Calling Party Network Pays; Bill and Keep) will be changed in an ALL-IP NGN world. For a variety of reasons, the current arrangements are likely to be unsustainable in an NGN world. Using the *service* to recoup the costs of the underlying *network* is not viable if the providers are not necessarily the same firm. The minutes of use only weakly correlate to usage-based costs and there are measurement challenges. The main task of the regulator should be to continue to drive termination rates lower in order to enhance usage by consumers and to ease the transition should Bill and Keep prove to be inevitable.

An important issue will be if QoS differentiation, hence, service specific interconnection will be a likely market outcome. Current Internet experience suggests that QoS differentiation *across* network boundaries is not a viable option. The reasons are mainly that there is a low willingness to pay (at least in the mass market), the reach of critical mass is difficult due to network effects (initial benefit to the first two or three networks to deploy it is minimal), non-neglectable transaction costs and severe challenges associated with accounting for use. For now, we see no regulatory action required. If network operators attempt to implement differentiated QoS, the market should determine the viability of such business models.

In a NGN world operators will presumably prefer to implement distinct Points of Interconnection (POIs) for access and for interconnection. In this context we understand *interconnection* to enable an operator to establish communications with the customers of another operator, while *access* enables an operator to utilize the facilities of another operator in the furtherance of its own business and in the service of its own customers. To the extent that the POIs are the same, interconnection does not raise new issues that are not already present in the case of access. For IP-interconnection it can be taken for granted that very few POIs are required: for most European countries two or three POIs should be sufficient. Thus, the likely reduction in the number of POIs for interconnection is much greater than the reduction in the number of POIs for access. Thus, issues of potential regulatory relevance are stranded investment and the likely substantial reduction of the costs for interconnection.

The migration to NGN may ultimately lead to lower costs. However, in the near term it quite likely leads to higher unit costs as the operator runs two parallel networks. Thus, the regulatory challenge arises how to set interconnection fees that allow a reasonable recovery of costs and a reasonable return on investments. A-priori the regulator could strive to set two different prices for old and new network interconnection. This is presumably not incentive compatible. Another option that we would prefer is to focus always on a single price and to define a suitable glide path of cost decrease over time. The challenge that has to be met in this context is to derive suitable information about the ultimate cost level in a NGN world.

Cost modeling

The migration to NGN will in addition bring about the need for new suitable bottom-up cost models reflecting both the migration path from the PSTN/ISDN to a pure NGN and the fully fledged NGN world. We expect that new network design tools related to NGN network architecture and topology have to be developed as well as new algorithms e.g. for network dimensioning.

NGN and network interoperability

Regarding standardization we note that the incentives of market players to engage in it depend on market power. However, we see no immediate regulatory action necessary.

The introduction of NGN and IMS introduces a number of standards-based compatibility interfaces into the public network. Technically, IMS can definitely serve as a gatekeeper relative to applications providers by a network operator. Thus, several issues might arise on the agenda of regulation and competition policy, respectively: (1) Network operators could prevent third parties from offering their services and applications. (2) They could try to extract rents from the application service providers. (3) Network operators could anticipate that they have an advantage to the extent that they can provide better QoS to their own applications. Thus, they might have an incentive to intentionally degrade their best efforts performance to the detriment of competitors (either by intentionally crippling them or equivalently by failing to obtain necessary capacity upgrades).

Several options for policy interventions are a-priori available: (1) It might be appropriate to impose non-discrimination obligations on incumbents with SMP. (2) A requirement might be imposed on the operator to make QoS information publicly available pursuant to Article 22 of the *Universal Service Directive*. (3) The alternative to a regulatory *ex ante* solution would be to instead approach this kind of intentional degradation as an *ex post* competition law matter, since intentional degradation would appear to represent a form of anticompetitive foreclosure or tying. For the time being we assume that incumbents cannot intentionally degrade successfully. Thus, we believe it would be premature (and probably not proportionate) to consider a regulatory intervention to open interfaces such as IMS to third parties already now.

In keeping with this we recognize that NGN might support the desire of last mile network operators to favor affiliated content or devices. Generally speaking, we underline that in the absence of market power price discrimination would enhance consumer welfare, and should not be viewed as a threat. Thus, we recommend that European regulators address Network Neutrality problems more appropriately by maintaining competition in the underlying markets.

IP-based voice services will presumably not initially support the full range of features known from the voice telephony world. Rather, it is likely that VoIP will eventually support those features for which there is sufficient demand in the market. We strongly advocate that the m*arket* should choose which features are supported, and which not. Regulators would be well advised to avoid intervention, except where necessary to address a pressing public goods problem such as access to emergency services, or lawful intercept. The regulator first and foremost should ensure a competitive market; intervention would be warranted only in the event of some demonstrated market failure.

NGN and security

Overall, migration to NGN does not necessarily raise new technological issues that were not already present in IP-based communications; however, it raises the visibility of these challenges, and elevates them to a more central role in the network. For network integrity, the European Commission has proposed (1) outage and breach disclosure requirements, and (2) applicability of network integrity obligations to mobile and IP-based services. Regulators should allow these developments to play out at European level. NGN raises no obvious new issues as regards cybercrime. Regulatory authorities should continue to enforce relevant laws. For lawful intercept, NGN does not raise issues that were not already present with the migration to IP. Regulators should consider proportionate obligations for broadband providers and VoIP service providers.

Universal service issues

NGN may reduce the *unit cost* of providing universal service. At the same time, NGN puts pressure on traditional implicit subsidies to universal service, including mobile termination rates that are well in excess of true usage-based marginal cost. Reducing termination rates, or eliminating them altogether, would reduce the distortion in the system, but might also introduce a funding gap for universal service to areas of low teledensity or high cost. The promotion of broadband Internet access across the national territory is a legitimate policy objective, consistent with i2010, but it is not specifically a universal service issue. The migration to NGN will change the character of the universal service challenge over time, but for now we see no regulatory response to be required on the part of the regulators.

Currently there is already observable a migration from asymmetric to symmetric communications patterns on the Internet (peer-to-peer file sharing, user generated content, Web 2.0). This will bring about profound challenges concerning digital rights. Regarding potential regulatory implications we note that issues related to content are explicitly excluded from the European framework for electronic communications. P-2-P and Web 2.0 will in all likelihood bring about inherently important public policy issues, but not necessarily *regulatory* policy issues.

NGN and the present EU regulatory framework

The European regulatory framework was crafted with technological and market convergence in mind. Competition law and economics provide a rational basis for regulatory decisions, even in a rapidly changing and converging environment.

Nonetheless, the migration to NGN poses challenges to European regulation. First, there are various problems at the level of detailed analysis and implementation under the competition-oriented parts of the framework (those dealing with market definition, market power and remedies). Second, there are large problems as regards those obligations that are not conditioned on an undertaking possessing SMP.

In the competition-oriented parts, of the framework, there are challenges at all three levels: market definition, determination of SMP, and remedies. The migration to NGN potentially raises issues associated with market power that derives from network externalities, which is somewhat distinct from conventional market power. There is the consequent risk that competitive bottlenecks might emerge at the application level, a level that does not appear in the Commission's list of markets susceptible to *ex ante* regulation. The remedies provided for in the regulatory framework might not be appropriate to addressing these new potential competitive harms.

The migration of the NGN access network to VDSL and to FTTB/FTTH potentially raises additional challenges that are not necessarily addressed by today's remedies. The implications of unbundling in conjunction with street cabinets and with building wiring are net yet fully understood, and are certainly not well established in existing European regulatory practice.

For obligations that are not linked to SMP, the decomposition of the link between the service and the underlying network has profound implications, especially for the many obligations defined in the *Universal Service Directive (USD)*. Even though the USD attempts to distinguish between the service and the network, the distinctions are incorrectly drawn in much of the text. The obligations sometimes fall on an entity that has no possibility of implementing them. For example, a non-facilities-based provider of VoIP-based PATS has no possibility of ensuring network integrity – it does not provide a network.

5 Possible regulatory alternatives

This chapter expands on the discussion of possible regulatory alternatives. The analysis in this chapter reflects findings from the previous chapters.

5.1 Theoretical issues of NGN regulation

In this section we will analyse general theoretical issues of NGN regulation.

5.1.1 Regulation on new and emerging markets

This section addresses the necessity of regulatory intervention on the new and emerging markets such as NGN. We analyse the implications of the paradigm shift from a regulatory theory and policy perspective.

Before addressing matters of regulation, we need to define what we mean by a "new and emerging market". It is generally agreed that such markets exhibit higher than normal risk.[184] Risk for any investment is that the project's output will not generate sufficient revenues to cover operating costs and to repay debt obligations.[185] Risk for investors increases with:

- The proportion of investment costs which are sunk,
- Uncertainty about demand,
- Uncertainty about future supply responses by competitors,
- The expected time frame over which the investment will be recovered.

Much of this risk can be compressed into expectations about the mean and variance of expected returns and a confidence variable applied to each. Where new and emerging markets exhibit higher than normal risk, investors require a higher than normal return on their capital in order to make the investments.[186, 187]

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184 Perhaps the main risk factor is the degree of uncertainty in the revenue stream. These risks may be mitigated for the initial entrant by large first mover advantages and a low risk of abrupt technological obsolescence.

185 There are clearly similarities here with section 4.3.2 on services and infrastructure competition; regulations should not undermine or remove incentives to invest. Section 4.3.2 was concerned with the incentives of new entrants to move along a "Ladder of Investment". In this section we are primarily concerned with not undermining or removing the incentive of dominant firms to invest into new and emerging markets.

186 These issues are discussed in detail in Part III of Dixit and Pindyck (1994).

Herein lies the reason why it is advisable to treat new and emerging markets that involve these types of risk differently from established markets, even where there appears at first sight to be a dominance problem. Premature regulation of such a market can be expected to reduce the level of investment, and can lead to the market being undeveloped or underdeveloped. Moreover, where this occurs the overall risk of investing in that country goes up because regulation comes into play as a potentially important cause of abrupt reductions in investment returns. The financial returns that flow to any firm or firms that later make investments in such a market must exceed those that would have been expected in the absence of premature profit-reducing regulation.

New high risk product/service markets (i.e. involving risky investments) often involve a high degree of innovation, and also carry a risk that innovations by competitors may cut short the life cycle of those innovative products that precluded them. Thus, the prospect of profits may look good for a few years, but might then dramatically fall due to a new innovation by a competitor, possibly resulting in investors in the ‘older’ innovation being unable to earn an adequate return.

Occasionally such markets can appear highly concentrated and at first glance the authorities may be tempted to apply some regulatory remedies. However, such markets can also be characterised by competition “for the market” rather than competition “in the market”, and where this occurs a market definition and market analysis can suggest dominance in what in practice is a market that is relatively efficient and where profits are not excessive given the risks. A longer time frame of analysis than would normally apply in antitrust cases may be needed if the authorities are to get a balanced view of the competition that is taking place.[188] We also note the Commission’s point that entry barriers entry can be “… less relevant with regard to innovation-driven markets characterised by ongoing technological progress”.[189] This is because potential entrants are rather likely to wait outside the market until they see that the market is a “safer bet”, i.e. until they are more confidence in being able to make a profit. In this regard, not all firms are equally well placed to enter a market first. Some are less tolerant of risk, or may have less experience in similar markets, or lack experience with the relevant technology, or have not developed linkages to supply and/or distribution chains to the same degree.

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187 Note then when regulation focus on the retail market they remove or undermine the incentive to invest not just of the dominant firm, but also by competitors. For this reason retail regulation is not usually advised in markets where competition is thought likely to develop.

188 See Chapter 1, section II.4.C. of Squire Sanders & Dempsey and WIK-Consult (2002).

189 “Public consultation on a draft Commission Recommendation, On Relevant Product and Service Markets within the electronic communications sector susceptible to ex ante regulation in accordance with Directive 2002/21/EC of the European Parliament and of the Council on a common regulatory framework for electronic communication networks and services”. EXPLANATORY MEMORANDUM, Brussels, 17 June 2002, p 10.

The European regulatory framework provides the flexibility to address new and emerging markets with existing regulatory tools, notably by means of application of the 3 criteria test. The 3 criteria test, which assesses whether a market is susceptible to *ex ante* regulation, requires that the following be true of a market:

- Presence of high and non-transitory barriers to entry,
- Lack of dynamic trends moving the market towards effective competition,
- Competition law not adequate to address market failure.[190]

If a market does not pass the 3 criteria test, it would not normally be analysed for possible market power problems, and consequently would not be subject to *ex ante* regulatory remedies. When applying the test, care must be taken when considering the first and second criteria to consider whether the competition is sitting out the market (as discussed above), as can occur when competition is *for* the market rather than *in* the market.

It is possible for a dominant firm to leverage its market power into a new unregulated market. The ERG notes that this would typically breach Article 82 of the EU competition rules governing unilaterally anticompetitive actions by dominant firms.[191] Moreover, NRAs should also impose remedies on the dominant firm in regard to the market from which they are leveraging dominance.[192]

A closely related issue raised by the ERG concerns access holidays for new infrastructure. In the case where new infrastructure is used to provide wholesale services that substitute for services previously (or presently) provided over other infrastructure, the new wholesale services fall within an existing wholesale market and would thus be subject to remedies that would necessarily be notified to the European Commission via the Article 7 procedures.[193] Thus, where new infrastructure is used to provide a familiar service ("old wine in new bottles"), the new infrastructure must be treated the same as the old. This equality of regulatory treatment is consistent with the principle of technological neutrality.[194]

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190 The 3 criteria test is discussed in, Commission Recommendation 2003/311/EC of 11 February 2003 on relevant product and service markets within the electronic communications sector susceptible to ex ante regulation in accordance with the Framework Directive, OJ L 114, 8.5.2003, p. 45 (the "Recommendation").

191 See European Regulators Group (2006) p.19.

192 Haucap discusses why the error of needless regulation of a new market will result in greater economic welfare costs than the error of failure to regulate when the NRA should have; see Haucap (2006).

193 See European Regulators Group (2006), p117.

194 We can imagine, however, a situation where the suitable remedy suggests a different result for the regulated firm. This is because the NRA may apply a price cap to the wholesale services such that efficiency savings involving innovation, including in new infrastructure, which enable cost reductions in excess of that required by the price cap, are retained by investors. In this case the rate of return on

An important clarification needs to be added here. Where the dominant firm faces no risk of being replaced by another provider, any remedies imposed need to provide an incentive for the dominant firm to innovate in the provision of the wholesale service; otherwise, innovations may not occur. For instance, it might be appropriate for the NRA to apply a price cap to the wholesale services, such that innovations that enable efficiency savings (cost reductions) in excess of those required by the price cap are retained by investors. In this case, the rate of return on the new investments will be higher than the rate of return on the previous investments over which the wholesale service was provided.

Where the innovation is in retail services, and these are provided over existing infrastructure, the risk is that market power might be leveraged across markets. Remedies at a wholesale level might thus be applied to the dominant firm. These remedies may need to be carefully thought out in order not to dis-incentivise the dominant firm from innovating in retail services.[195] This is a tricky area which requires great care. Where differentiated remedies are imposed, they may involve, for example: a retail-minus approach to setting access prices; a higher cost of capital being used to price wholesale access.[196]

In summary, regulatory authorities will want to consider carefully whether to impose remedies in new and emerging markets. Those that do not pass the 3 criteria test would not be subject to regulation, even if there appeared to be a dominant firm in the market. Markets that are unlikely to satisfy the 3 criteria test include:

- Markets that are growing rapidly,
- Markets that are subject to ongoing non-trivial innovation.

5.1.2 Regulation and different migration strategies towards NGN

Different service providers, in different countries or competing within the same country, will follow different migration strategies towards NGN. This relates both to the speed of deployment and to the specific architectural and topological changes that will take place in their respective networks. These distinct NGN adoption strategies on the part of different service providers will have an impact on competition and market structure.

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the new investments will be higher than they were on the previous investments over which the wholesale service was provided.

195 The ERG provides the following example: “For example, the non-imposition of remedies on Voice over Broadband (VoB) services, where SMP has been found on a retail market comprising both PSTN calls and VoB services, may be justified if wholesale access regulation is sufficient to prevent leveraging. If the SMP player offers a retail bundle of VoB and internet access, this can in principle be replicated by any competitor able to gain wholesale access on non-discriminatory terms or to provide its own broadband connection on a competitive basis”. See European Regulators Group (2006) p. 117.

196 Interested readers are urged to see section 5.6 of European Regulators Group (2006) for further discussion.

This section therefore aims at highlighting implications for regulation in light of these different migration strategies towards NGN, and on the implications for regulation in view of the market phases characterised by different NGN deployment states across service providers. The section also addresses options related to soft or hard regulation, depending on the competitive market position of NGN.

5.1.2.1 Different migration paths

Service provider migration plans will tend to reflect (1) the nature of their current pre-NGN business model, and (2) the company's immediate business realities. Service providers of many different types are all expected to eventually migrate to IP-based NGNs, but not necessarily in the same way or at the same pace. In each case, there is a *path dependency*: the route that is taken and the final destination both depend somewhat on the point of departure.

NGN migration plans are likely to be different for:

- Fixed incumbents,
- Competitive fixed operators,
- Mobile Operators,
- Internet Service Providers (ISPs),
- Cable television operators that also offer Internet access and/or telephony services.

A fixed incumbent without a significant mobile service might tend to favour a rapid NGN migration. They conceivably might not see a compelling need for IMS; however, we expect that most incumbents will nonetheless include ETSI IMS in their NGN migration plans. This is also underlined by the expectations of carriers and manufacturing industry alike that were expressed in personal interviews at CeBIT 2007. The main message was that the migration phases might be different across countries and carriers, respectively. However, there was no difference whatsoever regarding the ultimate goal of the transition which is an integrated NGN/IMS solution.

More typical fixed incumbents that also have substantial mobile operations will tend to have a strong preference for an integrated IMS-NGN solution, and might tend to spend more time on the transition due (in part) to the complexity of integrating their fixed and mobile operations.

Fixed incumbents, with or without mobile operations, will tend to replace a centralized PSTN switching environment with a still-somewhat-centralized IP-based server environment. The initial objective will tend to be to change the underlying technology base over which they offer their existing palette of services. To date, the primary drivers seem to be lowering unit costs and improving fixed-mobile integration, with somewhat less emphasis on deploying new services. (The migration to video is a driver, but this migration does not uniquely depend on NGN.)

BT was initially unique in proposing a true “fork lift upgrade”, where the traditional PSTN is to be phased out altogether in a small number of years; however, we are seeing similar overtures from KPN, and we can expect to see more from other incumbent operators over time.

Competitive fixed operators and non-incumbent mobile operators will tend to follow paths somewhat similar to those of their incumbent counterparts in the countries in which they operate; however, they seem to be under less pressure to migrate their networks. At least, they seem unlikely to take the plunge until the incumbent with which they compete does. As with incumbents, they will attempt to inject an IP transport beneath their existing services. Again, mobile operators are likely to emphasize IMS-NGN, while fixed-only competitive operators might not see so strong a need for IMS.

ISPs and cable operators are already evolving in the direction of NGN, but at a somewhat relaxed pace. They already have an IP-based infrastructure, so the changes in this instance are gradual and evolutionary. As was noted in section 3 of this report, their evolutionary path tends to be distributed rather than centralized – a tendency that we have characterized as Next Generation Internet (NGI) rather than classic NGN.

5.1.2.2 Regulatory implications

Among these various plans, some key distinctions are evident:

- The degree to which the service provider already possesses SMP that it might seek to leverage into related markets (for example, last mile market power that it might seek to leverage into the market for applications over the NGN),
- The speed with which the transition takes place,
- The speed with which the traditional PSTN disappears, especially for the wired incumbent,
- The degree of centralization or decentralization of the resulting infrastructure,
- Whether the service-provider is already primarily IP-based, and
- Whether the transition to NGN is likely to include IMS.

Considering the implications of each of these, in turn:

- **SMP:** SMP is, as usual, an important lens through which to view regulatory issues. When an operator that possesses SMP on a market of interest (typically an incumbent) migrates to NGN, the migration raises many questions. Notably, competitors will need both access and interconnection, before, during, and after the transition.

  The various regulatory challenges posed by this scenario have been discussed in Chapter 4. Should access and interconnection be provided using traditional PSTN-based means, or by IP-based NGN means? Does this imply old SMP offerings, or new, or both? Is the incumbent obliged to offer traditional PSTN-based access and interconnection offering longer than it would want to? Can the incumbent unilaterally withdraw PSTN-based access or interconnection SMP offerings in favour of new IP-based SMP offerings, and if so, what are its obligation to consult with and/or compensate competitors?

  All of the issues previously considered as regards a reduction in the number of POIs are relevant in this scenario.

  Future interconnection will take place at many levels, not just at the physical interface level. Will SMP operators seek new ways to leverage market power in the upper layers of the network, closer to the application? In an NGN world, is it easier – or perhaps less blatant – to impact interconnection or interoperability, and thus to raise rivals' costs?

  At the same time, what are the risks that overly aggressive regulation hinders the migration to NGN, thus impeding investment and delaying or denying the advent of consumer benefits?

- **Speed of deployment**: To the extent that incumbents and competitors migrate to NGN at roughly the same speed, there might be fewer concerns as regards the maintenance of effective competition. Interconnection might take place over both traditional and new interconnection offerings during a transition period. Incumbents and competitors would tend to write off obsolescent equipment at a comparable pace.

  Conversely, if the incumbent transitions much faster than its competitors, the strain on competitors will tend to be greater. It is worth noting in this context that the goal of the regulator in this case should be to *protect competition, but not individual competitors*. Ensuring adequate interconnection rights during the transition is a legitimate function of the regulator; protecting weak or inefficient competitors (or incumbents for that matter) from their own mistakes is not.

- **The speed with which the PSTN disappears**: The continued presence of PSTN-based capabilities, and of pre-NGN SMP service offerings, enables competitors that have not modernized to stay in the market (at least, in geographies that are still not fully modernized). Thus, a long transition period may benefit competitors. At the same time, to the extent that maintenance of PSTN-based access and interconnection implies delay in phasing out the PSTN, it may imply substantial inefficiencies for the incumbent. These inefficiencies carry a societal cost. It is too soon to say what the optimal transition period should be, but it is clear that it should be neither too short nor too long.

- **Degree of centralization**: To a first order the degree of centralization of the network is not a regulatory topic. Centralized and decentralized networks can be comparably *reliable*; however, experience suggests that decentralized networks are more *robust* in the face of major outages and/or force majeure incidents.[197] This difference could be an issue for national policy.

- **Service provider is already IP-based**: ISPs do not in general have market power unless they also operate last mile facilities. In general, the migration of an IP-based player to NGN/NGI raises no obvious new regulatory issues.

- **Presence or absence of IMS**: For the most part, the presence or absence of IMS is a technical matter, not a regulatory matter. A notable potential exception is that IMS, as a session initiation platform for a wide range of NGN services including voice, could conceivably serve as a "gatekeeper" that would prevent competitors from accessing NGN applications and services. Whether it will in fact be used in this way remains to be seen, but the technological capability appears to be there.

5.2 NGN regulation in an international context

This section aims at condensing the international experiences regarding NGN regulation. The basis for this evaluation is the information collected inside and outside of the EU described in section 2.4.

Many NRAs have already focused in one or the other way on NGN issues and several different topics regarding NGN have been addressed. We will highlight the most important topics in the subsequent subsections.

Cooperation between national regulators

At first it deserves to be stated that the regulators addressing NGN issues clearly see a need for working together also on an international scale. Our impression is that

197 For example, a report from the CSTB of the National Academies (U.S.) shows that, after the attacks of September 11, 2001, much of the telephone network of the Financial District of New York City was down; however, the Internet was not much impacted. The first serious problems on the Internet happened three days later, because police refused to admit fuel trucks into Lower Manhattan to refuel the generators that were driving the equipment in the absence of external electric power.

notwithstanding that every regulator has to make decisions subject to domestic market conditions and policy requirements no regulatory agency is keen to start a Garden of Eden approach. Rather, regulators throughout the world express open interest to focus also on experiences made already in other countries and to learn from one another. In Europe there will obviously be an ERG based common position on NGN regulatory principles within the year 2007.

General policy principles governing transition to NGN

Almost all regulatory agencies define a more or less large list of competition/regulatory policy principles regarding their future stance towards NGN. These actual principles are not necessarily the same across countries; rather, they reflect specific domestic market conditions and general policy requirements.

Categories that are addressed are, for example:

- Competition objectives (sustainable, fair) (in general but also related to the different functional layers of NGN),
- Investment incentives,
- Consumer interests,
- Technological neutrality,
- Incentives for efficient use of the network.

We would like to underline that setting up a consistent (and reliable) set of principles governing the actual decisions to be made with respect to NGN is a pertinent approach to future NGN regulation. Such an approach should in particular give the market a guideline with respect to the envisaged stance towards facilities-based competition and service-based competition in the communications sector.

Access network NGN

In some countries there have already been final regulatory decisions regarding access to fibre based infrastructure in the local loop. Roughly stated, the regulator in the USA has taken on a rather “incumbent friendly” stance and the regulator in Japan has done the opposite. However, these decisions reflect to a large degree domestic market conditions and policies. Yet, one cannot (and should not) take these decisions as a blueprint in one or the other direction, i.e. for a pro or con decision in a given country.

In Europe, access to fiber based infrastructure still is an open and unresolved regulatory issue. We have the feel that currently a very important issue regarding the NGN access network, primarily in the case of a VDSL deployment, is the apparent (non-) viability of a business case for sub-loop unbundling from street cabinets (brought about in the discussion in the Netherlands). However, there is no general answer to this issue. Rather, each regulator has to address this question against the backdrop of the domestic conditions in his or her home country.

Depending on the outcome of this quite general issue – the answer to which is in principle an empirical one – the related issue has been raised if and how rapidly phasing out of “old” network elements (like e.g. MDF locations) should be allowed? Or to put it another way, are maintaining “traditional” wholesale inputs like access at the MDF (ULL) and the specific wholesale broadband access alternatives provided in a given market (i.e. access at current locations and under current terms) still necessary and for what reasons? These issues are on the agenda of each regaulator and need to be resolved in a pertinent way.

New locations for traffic exchange, stranded investment

There can be no doubt that every regulator who has addressed NGN issues so far has a clear understanding that NGN will definitely change the physical and logical architecture of communications networks. Otherwise stated, regulators anticipate that completely new NGN network design and traffic optimization principles will prevail and that this will inevitably lead to a substantial reduction of network “nodes”. Thus, the current regime of where traffic is exchanged between the incumbent and competitors will have to be re-designed, too.

The crucial issue for competitors and regulators alike is, however, how long the old world shall be maintained. To put it another way, the issue in question is in particular how long the incumbent should keep its current interconnection arrangements. Regulators in several countries have already expressed openly that the risk of stranded investments by competitors will be on their agenda. Thus, from a regulatory perspective it has to be clarified under what conditions unilateral actions undertaken by incumbents without prior industry agreement shall cause regulatory concerns and actions.

(Self-) Regulation of NGN

Almost all regulators state explicitly or implicitly that (migration to) NGN brings about complex questions about the structure of markets and the interrelationship between communications providers in these markets. Thus, the “regulatory mainstream” today consists both of a “top-down” and a “bottom-up attitude. Top-down in this context shall mean that the regulators identify (sometimes together with market participants) a set of (country specific) issues they regard as most important as to NGN. These issues usually are analyzed and discussed by using established instruments and processes (papers published by the regulator containing general guidelines commented by industry, workshops, establishment of expert groups etc.). Bottom-up shall mean that (usually after some time) institutionalized forms of participation of stakeholders (fora, expert groups etc.) involved in (the migration to) NGN comes into play. We interpret the latter as a form of self-regulation of the market. Otherwise stated, the regulator encourages and supports (e.g. organisationally) industry and consumer group participation, and sometimes defines the agenda frame; however, the regulator seeks to leave the actual decisions to be made and agreements to be concluded to the market.

Examples of tasks assigned to the self-regulatory bodies are defining a reference set of services, sorting out technical details, agreeing on commercial conditions and identifying fields for further standardardization.

These self-regulatory bodies are less likely to find consensus or agreement, and thus less likely to be effective, where the interests of the participants are diametrically opposed, especially where large sums of money are concerned.

Migration period

All regulators having dealt with NGN regulatory issues anticipate a more or less long lasting migration between the old and the new world. We address the issue of how to manage this transition period in more detail in section 5.3.

Establishment of a separate subsidiary for wholesale network services

Several regulatory agencies have dealt with the issue of whether NGN might bring about the need to impose the condition on the regulated firm to establish a separate subsidiary for wholesale network services. The rationale for this is on the one hand the correct anticipation that in the NGN world transport and service provision are functionally different and separated. Thus, one could think about also to complement this by an organizational separation. On the other hand, the economic argument of (increased) market power due to the migration to NGN is raised. Of course the example of the UK (establishment of Open Reach as the BT wholesale entity) is widely discussed among the regulators in Europe.

It is fair to state that imposing obligations on a regulated company to provide specific activities in a separate subsidiary is not a new instrument of regulatory policy. Indeed, structural separation has been an instrument of regulatory policy in the USA already in times of the old AT&T system, i.e. before the divestiture of AT&T in 1984. Prominent examples are the Computer I and II proceedings of 1971 and 1976, respectively, where the regulator tried to define and demarcate telecommunications (basic) services and computer (enhanced) services. In this context, the FCC decided that telecommunications common carriers who wanted to offer computer services had to organize the services in separate organizational units.[198] They subsequently eased this restriction to permit implementation subject to accounting separation and nondiscrimination obligations in Computer III.

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198 See Wieland (1985) for more details.

In Europe, many regulators accept the general hypothesis that NGN might bring about market power concerns. However, those who have so far addressed the separate subsidiary issue view the actual status of competition in the market (in particular intermodal competition with respect to cable) as sufficient to prevent abuse of market power. If a regulator seeks to design a policy of structural separation, two issues deserve particular attention:

- What are pros and cons of such a decision in particular with respect to the overall competition policy/regulatory policy principles to be applied to the market for electronic communications in the country (e.g. with respect to the (dis)incentives for investments)?

- Does the regulator possess the power at all to enforce such a separation affecting the property rights of a company (quoted at the stock exchange) and its owners? OPTA in the Netherlands has clearly indicated that it lacked authority to do so.

Regulation and incentives to invest

The discussions surrounding the regulatory treatment of FTTx deployment in the USA and on VDSL deployment in Germany have in particular centered on the issue of the degree to which regulation is impacting investments in the communications sector. Of course, market investments consist of investments on the part of the incumbent and of the competitors. So, it is plausible to anticipate that (*ceteris paribus*) making regulation incumbent-friendly would entail disincentives for investments by competitors and *vice versa*.

Many studies (cross sectional and time series based) have dealt with the relationship between regulation and investments empirically in the past years. The outcome is, however, rather vague, i.e. there is no overall and sound empirical evidence about the quantitative impact of regulation on investments in the sector.

Thus, regulators should analyse in detail under the economic and sectoral conditions in their respective home markets the (potential) impact of their decisions on investments. An issue of particular importance is to derive a coherent concept how to deal with the (presumably increased) risk of deployment of NGN technologies.

Regulation of VoIP

Many countries throughout the world have already dealt comprehensively with VoIP issues where in particular special reference is taken to access to emergency services. Thus, with regard to this part of a fully migrated NGN world substantial regulatory progress has already been achieved. This has already been addressed elsewhere in this report, notably in Section 4.9.2.

Network neutrality

For several regulatory agencies in the world (e.g. in the USA and Japan) network neutrality issues are ranking high on their agenda. We have addressed this issue already in section 4.5.5. The NHH should continue to ensure adequate competition in telecommunications markets wherever possible, and effective regulation of those markets where competition is not effective. No additional response to the Network Neutrality challenge is necessary at this time.

5.3 Managing the transition period

This section deals with the organization of a "suitable" transition period in which "old" and "new" technology, networks and interrelationships between market players co-exist. There are inherent dangers in "parallel" regulation.

Several issues seem to be relevant. Examples are:

- How long shall the "old" world be maintained and regulated?
- What obligations are appropriate going forward as regards the number of interconnection points to the incumbent's networks? Should competitors be compensated for stranded assets caused by actions that the incumbent undertakes unilaterally, e.g. by closing down MDFs?
- What are regulatory principles regarding cost based input prices (LRIC) in times where two networks are working in parallel (which presumably increases costs for "quite some time")?
- What are the implications if the termination fee were different for NGN services versus PSTN termination?

We consider each of these in turn. Ofcom proceedings feature prominently in our analysis because Ofcom has done leading edge work in this area.

5.3.1 Old or new SMP service offerings

As regards existing SMP obligations, and specifically existing SMP interconnection offerings, Ofcom has come to the unsurprising conclusion that those offerings would need to be maintained for some period of time. At the same time, they also came to the equally unsurprising realization that new SMP interconnection offerings would be appropriate in the future. This necessarily implies some period of overlap:

> To enable business planning for alternative providers there initially needs to be continuity of existing SMP products (those products that BT is obliged to offer in markets where they have Significant Market Power), but we believe that this should only be for an interim period during which both legacy and next generation products are available. To ensure a timely move to next generation interconnect we propose that legacy products should be withdrawn once there is no longer reasonable demand or when next generation products provide an adequate replacement that providers are able to migrate to.[199]

5.3.2 Points of Interconnection (PoIs)

As explained in Sections 4.2.4 and 4.3.4, the number of Points of Interconnection (PoIs) in the NGN will almost certainly be less than in the current PSTN. This is true for both access and interconnection, perhaps more so for the latter. Moreover, there is no assurance that the NGN PoIs will be at the *same* locations as PSTN PoIs.

The regulatory principles in this case are reasonably straightforward to understand, but difficult to apply in practice. The first principle is that the incumbent should not be needlessly frustrated in its efforts to invest in its network (thus providing not only cost savings for the incumbent, but also enhanced consumer benefits). A second principle is that this migration must not lead to an overall weakening of competitors, and surely not to a profound alteration of the competitive landscape. A third is that the legitimate need on the part of incumbents to move their PoIs should not be interpreted as permission *carte blanche* for incumbents to engage in strategic behaviour to weaken their competitors.

This thought process has been most clearly articulated by Ofcom in the UK. The essence of the British approach has been to establish consultation mechanisms between BT and its competitors, and this approach seems to be working reasonably well. At the same time, it must be seen in the context of the overall regulatory evolution in the United Kingdom, where wholesale access services are provided by a wholesale division that has non-discrimination obligations and an arms-length relationship to the parent company.

In a key consultation, Ofcom found[200] "…that the key factors relevant to compensation arrangements for BT's 21CN migration are:

- the extent to which these changes are unilaterally decided by BT without industry agreement;

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199 See Ofcom (2005b), section 1.11.
200 See Ofcom (2004), section 1.13.

- the distribution of benefits that accrue from these changes;
- the remaining life of any legacy interconnect equipment employed at the time of the change;
- the extent to which new interconnect investments are made by communication providers after they have been made aware of forthcoming changes that would impact that investment; and
- the additional cost necessarily and directly incurred as a result of having to bring forward investment in new interconnect equipment."

5.3.3 Cost Modelling

As noted in section 4.3.5, the migration to NGN may ultimately lead to lower costs, but in the near term it quite likely leads to higher unit costs as the operator runs two parallel networks. The operator is entitled to a reasonable recovery of its costs, and a reasonable return on its investments. If a regulator must set interconnection fees so as to ride this roller coaster of costs that first increase, and then decrease, it will be very difficult to avoid introducing problems or economic distortions.

This has complex implications as regards the cost modelling of the incumbent's network (which typically might be necessary for setting any regulated prices for LLU and for call termination).

Ofcom has tentatively proposed to deal with this by means of a single set of "narrowband" (i.e. conventional telephony) termination rates, ramped down over time, but set to levels somewhat in excess of anticipated unit costs (plus a reasonable return), as shown in Figure 51 in section 4.3.5. The difference between the permitted termination rate, versus the rate that would be justified on a future forward-looking set of costs, helps to fund the transition.

This makes sense, but it implies very complex judgment calls. By how much should the termination rate exceed the future costs? What is the risk that a high but cost-based termination rate might disincent BT from achieving the most efficient network that it could? The regulator attempts to permit BT to achieve a reasonable rate of return, but BT's profitability results from a great many distinct factors – the regulator has only a file control knobs to spin, and in any case is not directly responsible for BT's profitability.

Meanwhile, Ofcom has acknowleged that the migration to NGN may be associated with higher risk, at least initially, which should appropriately be acknowledged with a higher permissible Return on Investment (ROI), and thus with a higher Weighted Average Cost of Capital (WACC) than would otherwise be the case. As can be seen in Figure 51, the intent is not to actually increase prices, but rather to establish a rate of return consistent with a slower decline in price than would otherwise be the case.

Risks associated with the transition to an NGN core may be somewhat distinct from those for the access network – they have acknowledged this by assigning different levels of beta (a measure of investment risk) to the BT access network versus the BT core network.

The British consultation also tentatively explored the possibility that BT's NGN transition risks might need to be explicitly reflected in Ofcom's cost modelling methodology by means of a technique known as *Real Options*. This is an interesting idea, but we have not studied it in depth. The basic notion of Real Options – that a firm benefits by deferring its decision to commit risk capital – seems logical; however, its use in a regulatory context is unproven and would entail regulatory risk of unforeseen consequences. We do not recommend that the NHH implement a Real Options approach at this time, but we suggest that NHH may want to monitor any implementations that other regulators might undertake.

5.3.4 Distinct termination fees

As noted in Section 4.3, the migration to NGN will place enormous stress on interconnection pricing arrangements. The entire termination fee mechanism has been an attempt to use wholesale payments between service providers to compensate for usage of the underlying networks. In an NGN world, *where the service provider is not necessarily the same as the network provider*, it is hard to see how such a system *could* be maintained, and even harder to find a rationale why it *should* be. The system will necessarily evolve.

Several recent studies have suggested that the most likely evolution is to drop these rather artificial arrangements altogether and instead to adopt principles that have worked well in the Internet, and in portions of the North American telephone environment.[201] In the absence of a regulatory mandate to pay a termination fee, network operators could negotiate their own arrangements, and would often choose voluntarily to forego fees. In the context of telephony in the U.S., these wholesale arrangements are often referred to as Bill and Keep (see section 4.3.1.1).

Such arrangements would tend to lead to lower retail prices, greater use of communications services, a reduction in economic distortions, and generally enhanced consumer welfare. They might possibly slow the rate of further adoption of mobile phones, but this is hardly a concern in Europe or in Hungary.

201 See Marcus (2004a), Littlechild (2004), Marcus (2006b), Marcus (2007).

Such a migration raises transition concerns that have received scant attention in the literature to date. To what degree can traditional interconnection arrangements simultaneously accommodate the traditional CPNP system (see Section 4.3.1.1) and Bill and Keep?

Experience does not provide a simple, clear-cut answer to this question. It is immediately clear that there is a risk of arbitrage where two very different set of regulatory arrangements exist side by side; however, it is not clear that the problem is unmanageable. Moreover, arbitrage is not necessarily a bad thing – often, it forces systems to converge over time to arrangements that are more economically rational and sustainable.

In France prior to 2004, interconnection among mobile operators was on a Bil and Keep basis, while interconnection between fixed and mobile was CPNP. This led to widespread adoption of “SIM boxes” by businesses, a practice that was criticized in some quarters. At the same time, most stakeholders were reasonably satisfied with the system. It was eliminated in 2004, not because of distortions, but simply because the distinct termination rates were felt not to be compatible with European regulatory system that was put in place in France at the same time.

The U.S., Canada, and Singapore all use Bill and Keep for calls to mobile operators (and to non-dominant fixed operators), but CPNP with cost-based termination fees for calls to fixed incumbents. All three countries enjoy very low prices (as measured by service-based revenue per minute of use of originated or terminated traffic)[202] and very high usage (minutes of use per month), Singapore has very high mobile penetration (98%), the U.S. and Canada somewhat less but still respectable. These systems must be regarded as working well, and in general as producing results greatly superior to those of Europe.

The challenge in this case is more complex. If a wired incumbent were in the process of transitioning from PSTN to NGN, could it offer one set of termination arrangements for the telephones associated with the PSTN parts of its network, but a different set of arrangements for telephones associated with the NGN parts?

Some of the issues have already begun to emerge in the context of independent VoIP service providers. To date, the tendency has been for regulators to require independent VoIP services to pay for termination to PSTN telephones as if the calls were placed from the PSTN. At the same time, call termination to telephone services operated by independent VoIP service providers appears to raise issues that have not been much looked at as yet.

202 See Marcus (2007).

For now, the whole question of coexistence of these arrangements during transition should be viewed as being open and unresolved.

As an immediate recommendation, we suggest that the NHH should continue to exert downward pressure on fixed and mobile termination fees. Experience in a number of countries, notably India, suggests that quite low termination fees can be consistent both with high use of fixed and mobile services and with rapid adoption of service.[203] Indian termination fees for both fixed and mobile services are about 0.4 euro cents. Dropping the termination rate serves both to enhance usage of the service, and to reduce the transition shock should a migration to Bill and Keep wholesale arrangements prove necessary.

5.4 Key messages of this chapter

The chapter begins with a general, theoretical discussion of the regulation of new and emerging markets. The regulator must be careful to avoid premature or inappropriate imposition of remedies. At the same time, where a new technology is used to deliver an established or existing service, it would be inappropriate to permit re-monopolization of the market.

Service provider migration plans will tend to reflect (1) the nature of their current pre-NGN business model, and (2) the company's immediate business realities. Different NGN deployments are likely depending on whether the firm in question in primarily a traditional fixed or mobile operator, or both; incumbent versus competitive entrant; cable operator; or Internet Service Provider (ISP). These differences will tend to influence the speed and character of migration; the speed with which existing points of interconnect are withdrawn; the choice of centralized versus decentralized solutions; the degree of emphasis on IMS; and perhaps most important, the likely implications of whatever SMP the operator in question may possess on related markets.

In general, traditional incumbents will be motivated to migrate more quickly, and to phase out existing locations quickly in order to reduce operational expense and possibly to sell existing physical plant. They may also look for ways to reinvent themselves so as to reassert their traditional market power. In most cases, competitive operators are responding to the moves of the incumbents rather than initiating their own NGN migrations. Internet-based players, on the other hand, tend to be migrating gradually, progressively improving their existing IP-based networks in a decentralized and nondisruptive fashion.

The implications for the regulator are different primarily in the sense that the speed of the incumbent's migration (and thus the pace of withdrawal of SMP-based remedies and of access and interconnection locations) has impact on competitors.

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203 Ibid.

Regulators should require the incumbent to maintain wholesale offers that were instituted as SMP remedies for some reasonable period of time, neither too long nor too short, in order to enable competitors to make an appropriate transition. Similar considerations apply to withdrawal of access and interconnection locations – the incumbent should not be forced to indefinitely maintain locations that it no longer needs, but this needs to be balanced against the need to minimize stranded investments on the part of competitors. In the UK and in the Netherlands, these issues are being addressed by means of industry consultative processes, and reasonable periods of notice of closure of a facility. Only in exceptional cases would outright compensation to the competitor be required.

Cost modelling of (incumbent) networks needs to reflect the true costs of the new infrastructure. It may also need to reflect (1) the legitimately higher costs that incumbents incur due to parallel operation of two networks while transition is in progress; and (2) the significantly higher business risk associated with migration to NGN.

The entire system of call termination fees is likely to break down in an NGN world; moreover, there were serious questions as to its impact on consumer welfare even in the present environment. It is quite likely that the only long term viable arrangements will be based on a withdrawal of regulated termination fees, and replacement with a system of negotiated arrangements (with perhaps some regulatory ground rules, possibly including symmetry) similar to mobile arrangements in North America and Singapore and to Internet peering. For now, we recommend that regulators continue to exert downward pressure on termination fees, both to enhance consumer welfare (increasing use of the network) and to reduce the shock in the event that termination fees ultimately disappear.

There are many lessons to be learned from leading edge NGN regulatory experience in other countries, especially other Member States. Exchanging views with other regulators, especially in the context of the ERG/IRG, can be fruitful. Many countries face similar issues in regard to withdrawal of SMP remedies; disappearance of points of access and interconnection; challenges to loop unbundling as the access network migrates to VDSL and to FTTB/FTTH; and consumer welfare obligations (emergency services, lawful intercept) in conjunction with VoIP. The Ofcom/BT structural separation arrangements are interesting, promising, and quite likely important, but should still be viewed as an experiment that is in its early days.

6 NGN issues from a Hungarian perspective

6.1 Characteristics of the Hungarian market and its expected development

In this section we discuss those characteristics of the Hungarian market, which may be relevant regarding implementation, development and regulation of NGN. We pay special attention to those characteristics which are substantially different from the Western European markets.

6.1.1 Specific characteristics of the Hungarian market

6.1.1.1 LTO system in the fixed line market

The most notable difference between the Hungarian and other European fixed line markets is the LTO structure in Hungary developed in the 1990s. The biggest incumbent Magyar Telekom owns about 80% of all subscriber access lines, and currently there are four smaller local incumbents in the market. Prior to liberalisation in 2002 there were even more players in the fixed line market, which is now moving towards further consolidation. The latest development was the announced merger of the two biggest LTOs in the recent past, HTCC and Invitel. Following this merger, besides the merged company and Magyar Telekom (MT), there are only two small LTOs left on the market: Monortel, which is an affiliate of the biggest domestic cable company UPC, and Emitel, owned 100% by MT. A consequence of this LTO structure is that incumbents in a given area can contest each other’s markets, which a-priori might help to intensify competition. Yet, it is fair to state that this effect proved to be weak in practice in the past.

Against the backdrop of this market structure, a newcomer’s disadvantage in Hungary is significantly higher than in other European markets, because it has to make a wholesale arrangement with five incumbents instead of one, if it wants to reach every domestic subscriber. The LTO structure also imposes additional burden on the regulator, who has to deal with five incumbents, instead of one (five Reference Interconnection Offers (RIOs), five Reference Unbundling Offers (RUOs), five accounting separations, etc.).

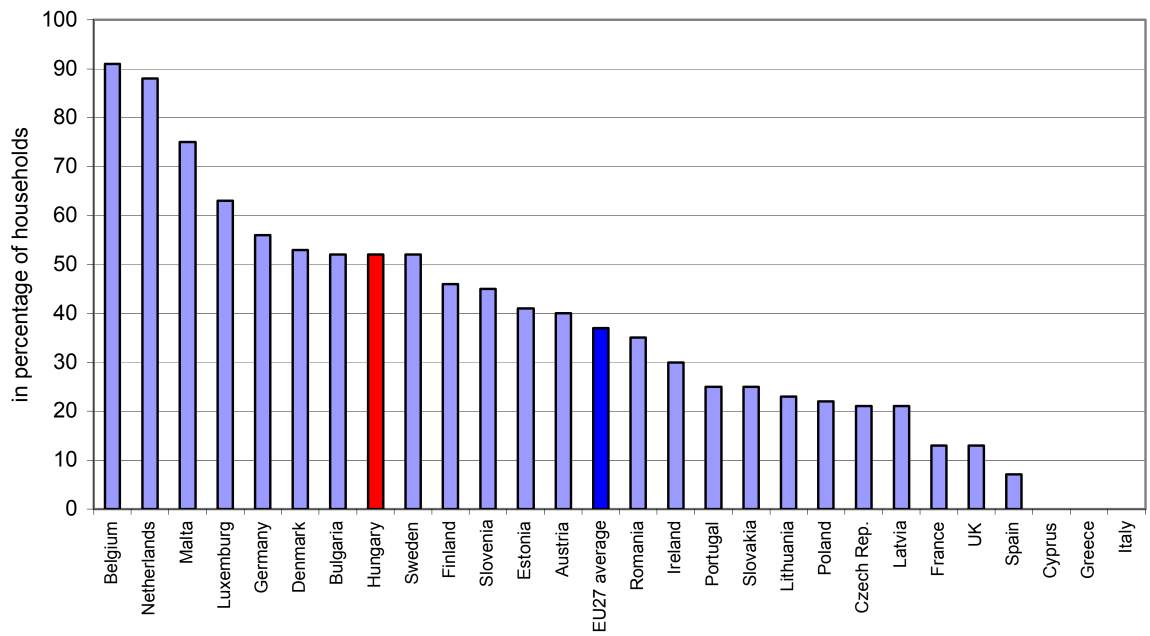
From an NGN point of view the LTO structure can cause difficulties for the regulator despite the consolidation under way. Up until now the market analysis, the results and the obligations imposed by the regulator were very similar for all of the fixed incumbents. However, probably the incumbents cannot be handled in such a similar way any more because of the different pace of NGN implementation across the players. Thus, the main problems to be addressed in the market analysis are different, depending on the phase of NGN implementation, namely if it is at an advanced stage or has not started yet in the region where a certain operator is the incumbent.

The geographical location of LTOs and the relationship between them (interconnection) probably lead to different result in the case of NGN (e.g. regarding the number of PoIs) compared to countries where one single incumbent covers the whole country.

6.1.1.2 High cable penetration

A further important characteristic of the Hungarian market is the relatively high cable television (tv) penetration of 52%. It is higher than the European average (36%), and significantly higher than in most of the European countries, see Figure 52.

Figure 52: Cable television penetration across European countries (% of households, 2004)



Source: Dataxis

There are almost 400 players in the Hungarian cable market, but market concentration is still very high: UPC and MT's subsidiary T-Kábel own about half of all subscribers, the five biggest players have two thirds of subscribers, while the remaining one third is shared by the other, almost 400 players.

An important characteristic of the cable tv market is that most of the smaller networks are out of date (serial system), and are not appropriate for provision of IP services and quality broadcasting.

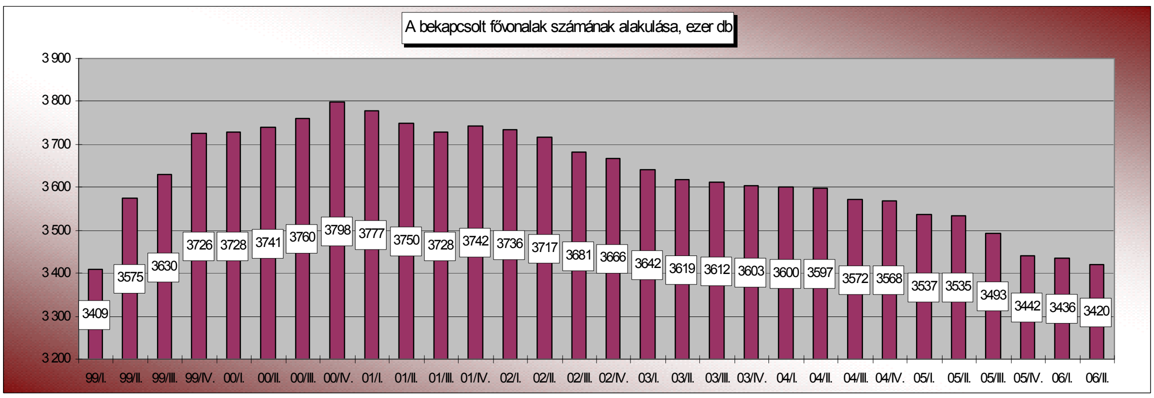
The relatively high cable penetration might lead to a particular pressure in favour of facilities based competition in the NGN era. Thus, the widespread availability of cable infrastructure might raise regulatory questions that are not relevant on markets with a lower cable penetration.

6.1.1.3 Low fix penetration, high mobile substitution

The Hungarian fixed and mobile markets have several characteristics that differ from Western European markets, but the latter are similar to those observed in Eastern Europe.

Fixed line penetration is well below the Western European average. Its growth stopped in 2000 at a penetration rate of 38%, and it is decreasing permanently since then.[204] Currently one third of households have no fixed line access. Figure 53 gives an overview of the recent development of the number of telephone lines in Hungary.

Figure 53: Number of telephone subscriber lines in Hungary in 1000 (1999 – 2006)



Source: NHH

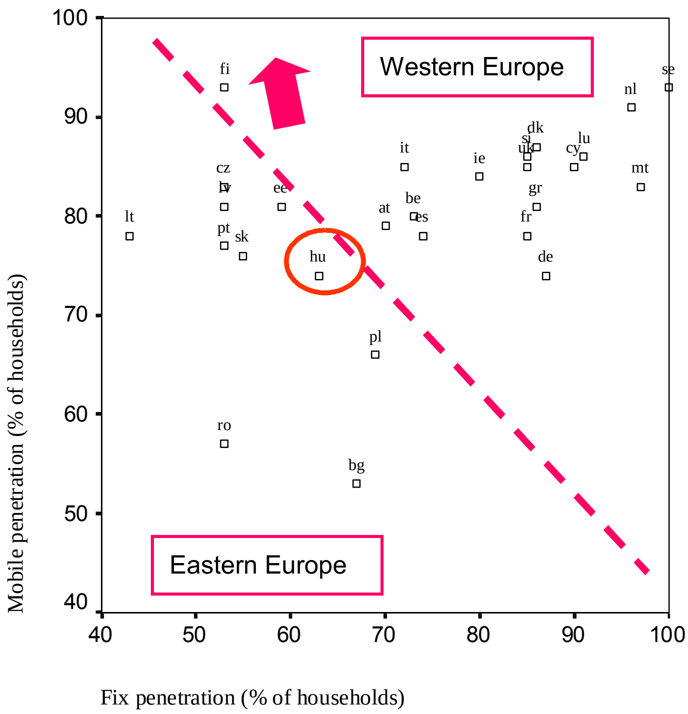
204 By analysing the low fixed voice telephony penetration the spread of the IP based voice services and the advance of the broadband Internet must be taken into account too. The fixed telecommunication providers move towards broadband Internet services without NGN.

Mobile penetration, however, evolves similarly to the Western European markets, and by now it is close to 100%. It is a domestic (Eastern European) feature that growth in mobile penetration – because of stronger substitution – is accompanied by a stronger decrease in the number of fixed line subscribers, as compared to Western Europe.

Figure 54 shows that fixed and mobile penetration rates in Central- and Eastern Europe follow that in the Western European countries only regarding the mobile dimension. While the mobile penetration is more or less balanced between the Eastern and Western European markets, the difference in the fixed penetration is not decreasing. This unequal situation probably remains in the long run (even worse, the direction of the current trends suggests that a slow decline in fixed penetration and further increase in mobile penetration should be expected).

These structural patterns underline that the telecommunication markets of Eastern Europe and of Western Europe – at least regarding the relative role of the fixed and mobile technologies – do not develop in the same way. Thus, regarding the regulation of these markets it is significant to note, that a simple adaptation of the Western European approaches is not appropriate.

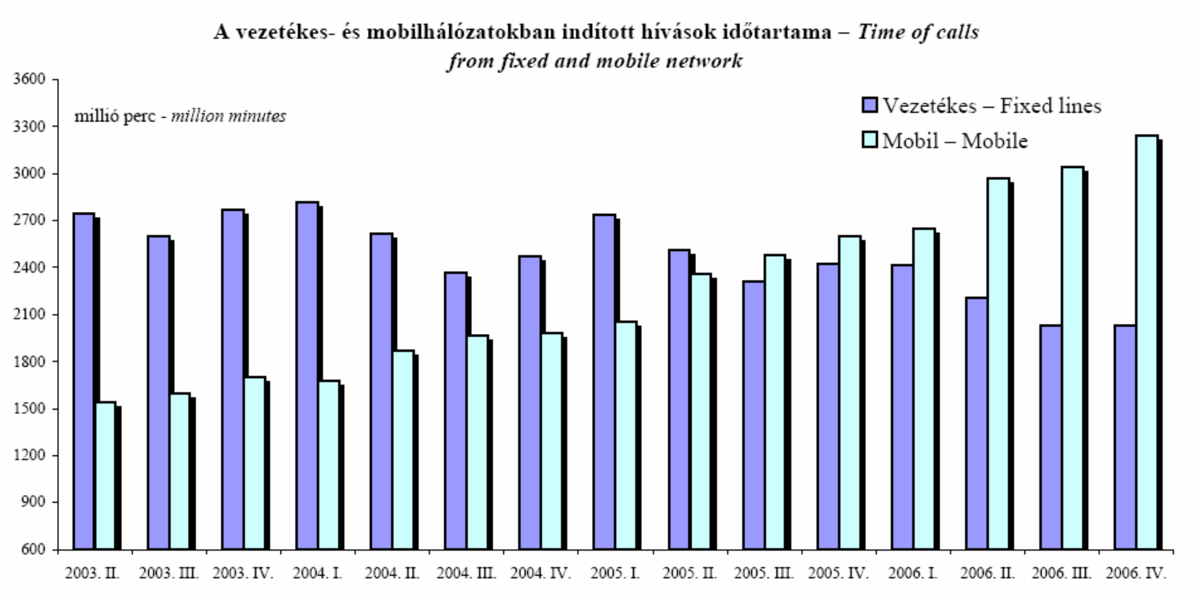
Figure 54: Fixed and mobile penetration as percentage of the total number of households in European Countries (2005)



Source: based on E-Communications Household Survey (Eurobarometer)

Moreover, in Hungary it is not only the number of mobile subscribers that exceeds the number of fixed line subscribers. Rather, unlike in Western Europe, mobile usage is also higher than fixed line usage[205]. This is shown in Figure 55.

Figure 55: Total traffic originating from fixed and mobile networks in Hungary (in mill. minutes)



Source: KSH

The different weights of fixed and mobile services in Hungary compared to the Western European countries, can affect the NGN deployment strategies of some of the players in the domestic market.

Although the development of a fix-mobile converged product may seem to be attractive for a fixed operator, especially for compensating the decreasing PSTN traffic, the success of this strategy is doubtful because of its weakness on the demand side. The proportion of mobile-only subscribers is higher in Hungary than in other Western European markets. Consequently the potential target market of fix-mobile converged services is smaller, since fewer consumers have both types of access.[206] The mobile operators are able to acquire bigger traffic without NGN at the expense of the fixed operators, thus for them there is no specific value in the development of a converged product.

205 Besides the migration of a part of the fixed network traffic towards mobile networks, which provide an additional service (mobility), the move towards VoIP (providing nomadity) becomes more significant.

206 Reasons for the fact that less consumers have both types of access (fixed and mobile) can be the lower income and knowledge level.

Other incentives may appear that should become the drivers of NGN deployment because of the special Hungarian (Eastern European) market features. The strong decline of fix market can be stopped due to the introduction of NGN, and this can be an important incentive for fixed operators to deploy NGN technology.

6.1.1.4 Low Internet penetration

This section deals with Internet and broadband penetration, respectively.

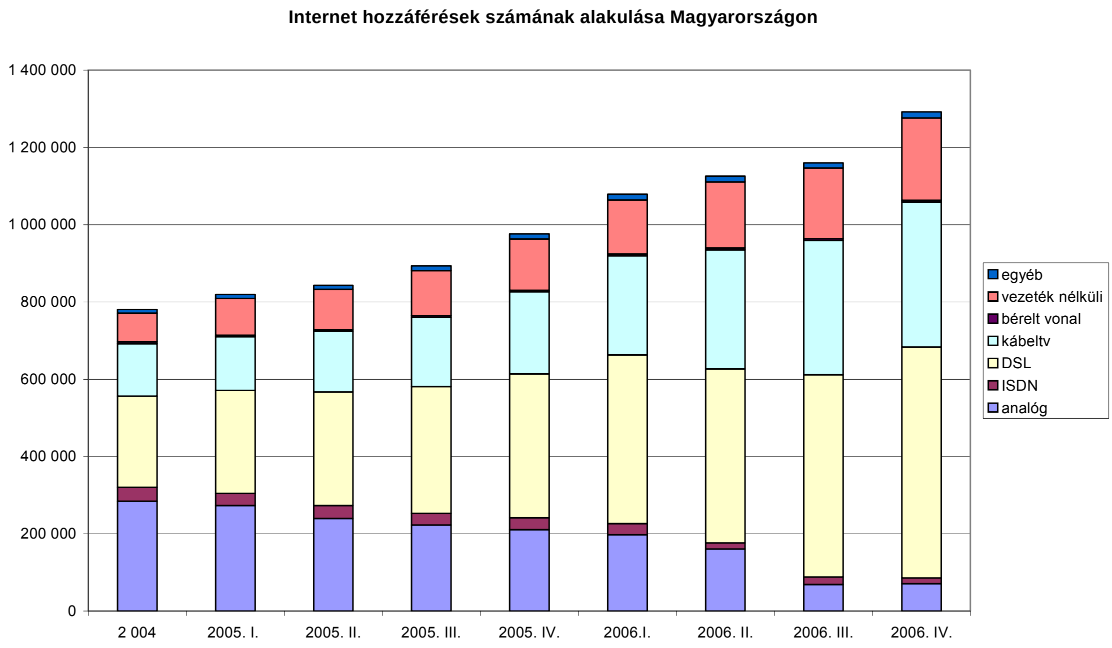
Regarding Internet penetration, Hungary is lagging not only behind Western European countries, but also behind several Central and Eastern European ones.

In recent years – in keeping with international trends – the technological alternatives for Internet access have changed considerably. The previously dominant narrowband (analog and ISDN) technologies have been mainly replaced by broadband[207] (DSL and cable) technologies, accompanied by increased subscription numbers.

Figure 56 shows the development of the different modes of Internet access in Hungary over time.

207 We are aware that there are many definitions of the term "broadband" in Europe and in the world. In the present study, however, we do not consider any of the problems that may arise from these differences. Rather, we use the expression broadband pragmatically.

Figure 56: Total number of Internet access lines in Hungary differentiating between alternative access technologies (2004 – 2006)



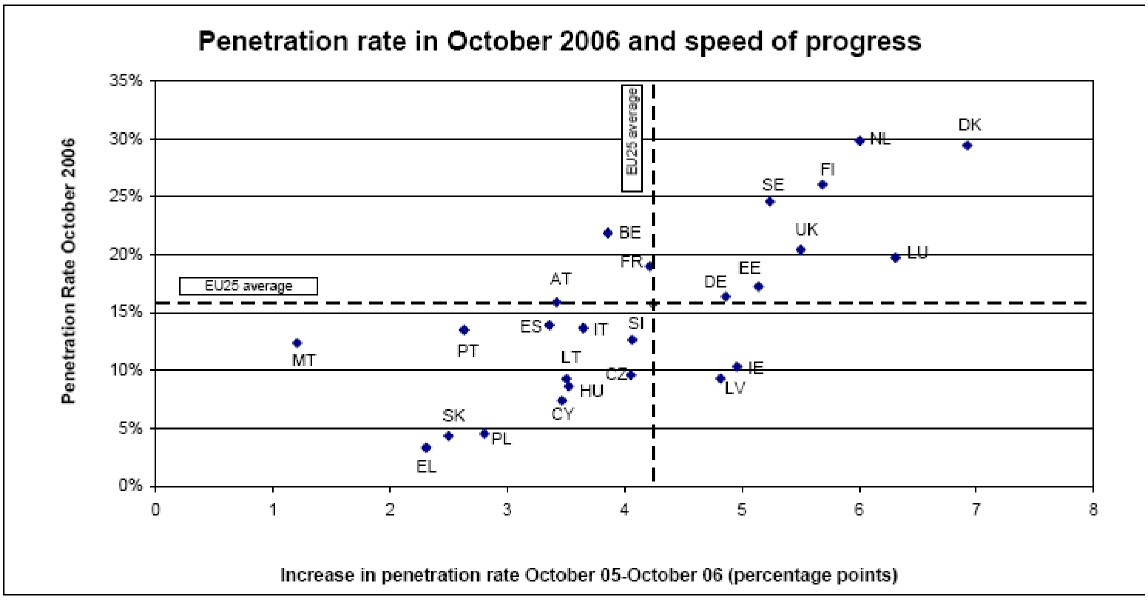
Source: KSH, Infrapont

While in 2004 the share of Internet access through DSL and cable was less than 50%, by the end of 2006 they accounted for more than 75% percent of all access lines. Broadband penetration was increasing partly due to lower prices (especially if increased bandwidth is taken into account), and also driven by the fact that it became available for more and more households. At the end of 2004 DSL technology passed 70% of residential users, while broadband capable cable passed 52% of the residences.

The trend towards a higher importance of DSL technology in Hungary is likely to be supported by Magyar Telekom's plans, according to which DSL coverage on the firm's service territory will reach 90% by 2008.

The proportion of broadband access in the total number of Internet access in Hungary is higher than in most Western European countries. Hence, at first sight one is tempted to argue that Hungary looks less lagged behind regarding broadband penetration, relative to European markets. However, this is a cold comfort. Considering the significantly lower growth rate of broadband in Hungary, compared to Western Euroean markets, the lag is likely to increase even more in the future.

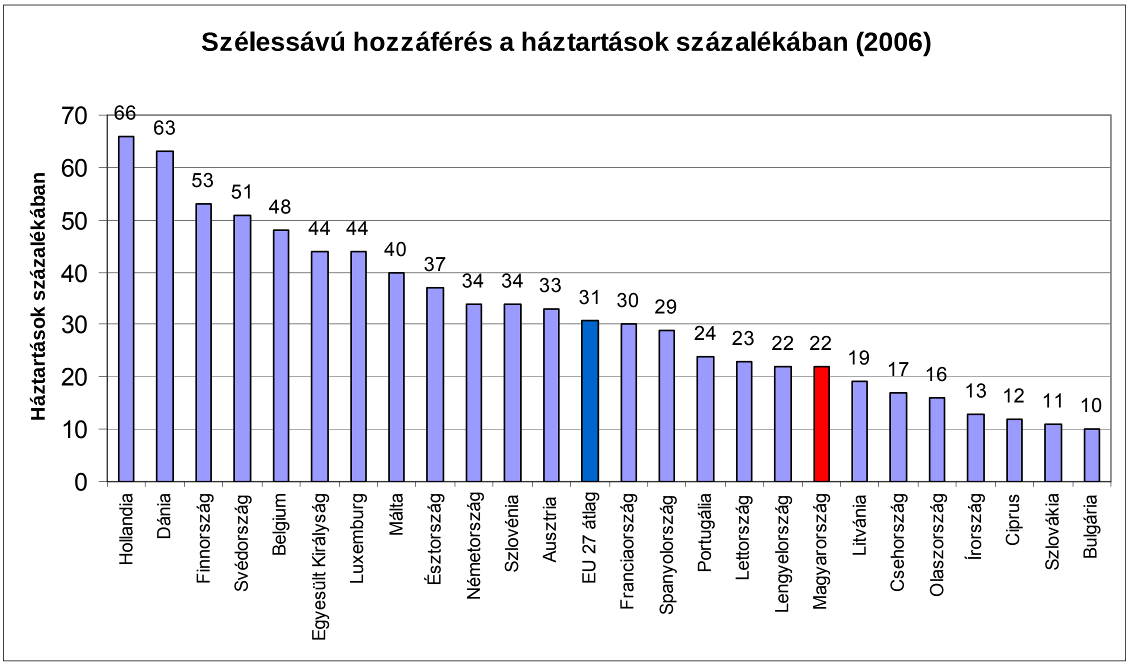
Figure 57: Broadband penetration rate 2006 and change of penetration rate 2005/06 in the EU



Source: EU 12th Implementation Report

Figure 58 presents data for 2006 on broadband access across European countries (relating to households). It is obvious from this figure that the Hungarian penetration rate of 22 % is significantly below the EU 27 average of 31 %.

Figure 58: Broadband penetration rate across European countries in percentage of households (2006)



Source: Eurostat (2006)

Considering the low Internet penetration rate in Hungary, research has come to the conclusion that the primary reasons are not the high fees or the lack of PC. Rather, the motivational problem seems to be more decisive. Many consumers are not interested in the Internet and/or they do not have the capabilities for the usage (digital literacy).[208]

The broadband access demand can be viewed as a basic precondition of NGN deployment. It seems however, that in Hungary there is a permanent lag in Internet usage, which is one of the main drivers of broadband access demand. This may therefore have a significant impact on the NGN plans of operators, the scheduling of the deployment, the migration phase and the length of the transition period. Overall, this means that relatively large consumer segments presumably will not be interested at least for a while in the “more complex” electronic communications services, beside the basic voice services. IPTV can be another potential driver of the demand for broadband access. How-

208 Lásd pl. NHH - Szonda Ipsos: A lakosság távközlési szokásai, available : www.nhh.hu ever IPTV is still in its infancy in Hungary, and it is far too early to predict the further development.[209]

It is fair to state that the low level of knowledge of foreign languages in the Hungarian population (which is significantly lower than in the similar big Benelux or in the Scandinavian countries) severely restricts demand for non Hungarian content. Also on the supply side the Hungarian media content is limited. Thus, it's hard to offer new, attractive Hungarian content for the households having analogous, multichannel television services. In particular, in the Hungarian media market there is less event type content available which had proved to be succesfull in many other countries[210]. A further lag is that e-applications (e-administration, e-commerce, e-learning, e-health) are still in an early phase of development in Hungary.

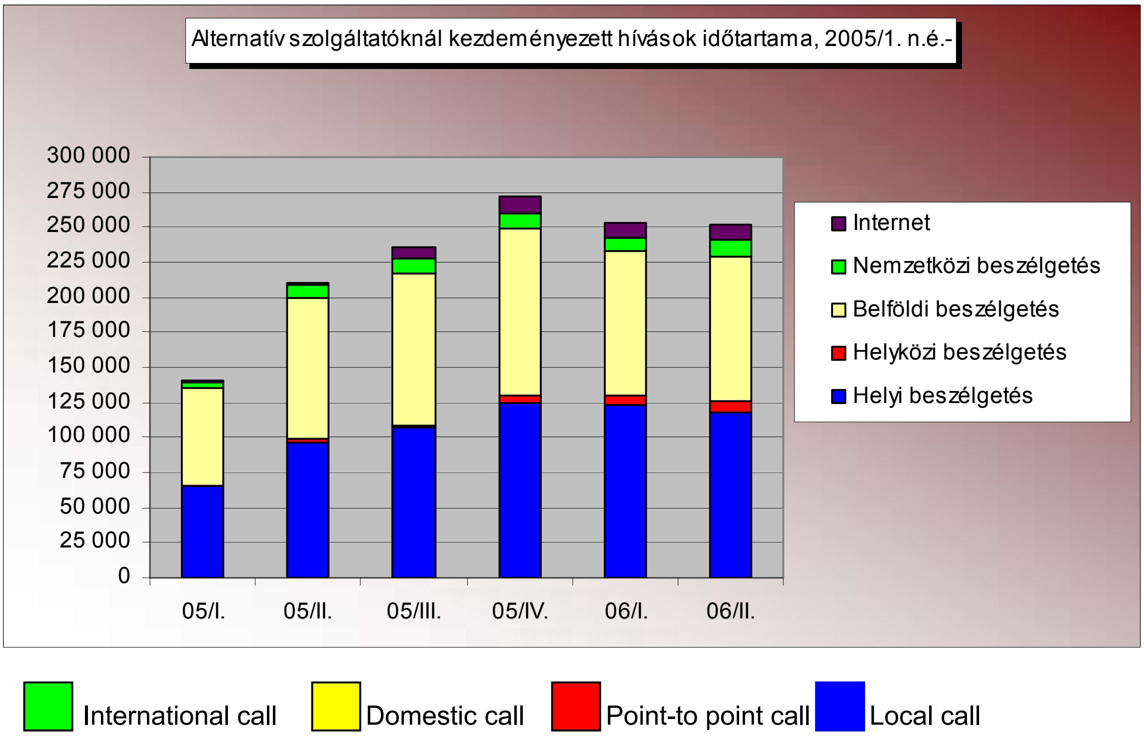
6.1.2 Characteristics of competition and the positioning of competitors

Competition in Hungarian fixed telephony market has evolved slowly after the liberalization, especially in the residential segment, mostly because the new entrants faced unfavorable wholesale conditions. According to a NHH survey, two years after market opening the loss of incumbents was negligible in the market for residential fixed calls (the only exception was the market for international calls, where alternative carriers were able to gain perceptible market share using international prepaid calling cards). Competition intensified in 2004, mainly due to a substantial decrease in interconnection fees. Alternative carriers typically entered the end user markets with CS/CPS, focusing on the business segment. Competition was extended to the residential segment by the market entry of Tele2. By the end of 2005, the market share of alternative providers in the end user market was more than 10%, see Figure 59.

209 Considering the future of broadband actually leads also to the issues of content, the Hungarian media market and its regulation. Though we refer to these problems many times, a detailed discussion of these issues does not fit into the frame of the current study.

210 The main example are the popular sports events (especially football) attracting large audiences in many other countries.

Figure 59: Total number of minutes originated by competitors in Hungary for different call segments (I/2005 – II/2006)

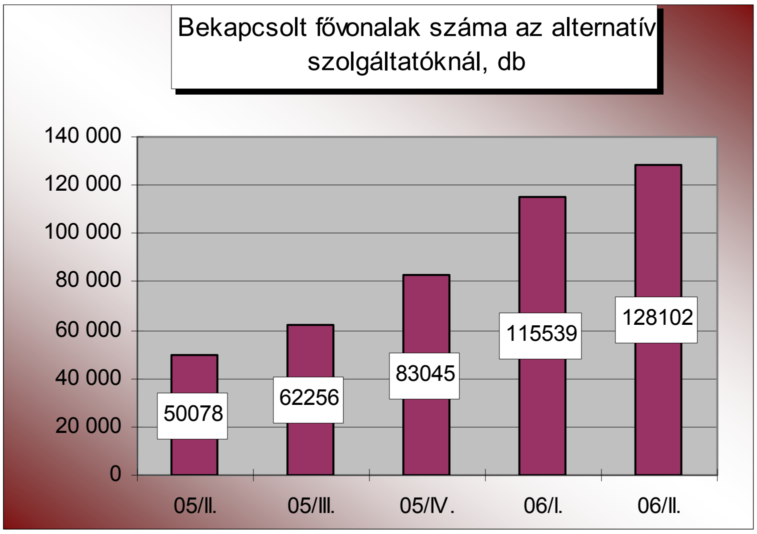


Source: NHH

The access market has not been affected by competition for a long time. The situation changed in 2005, when a cable television provider (UPC) launched its VoIP-based service. The voice service offered by UPC as an element of its triple play (television, internet, voice) strategy had quickly become very successful: by the end of 2005 the cable providers' share in the total number of residential lines exceeded 2%.

Furthermore, in 2006 the regulator significantly modified the conditions for local loop unbundling. As a result players already in the market (e.g. GTS, Pantel) and new alternative providers (e.g. Actel) entered the access market. Their business models were often based on a triple play strategy, or at least on bundling broadband Internet access and voice services. As a result the proportion of main lines provided by alternative operators exceeded 4% in mid-2006, see Figure 60.

Figure 60: (Absolute number of) Mainlines of alternative service providers in Hungary (II/2005 – II/2006)



Source: NHH

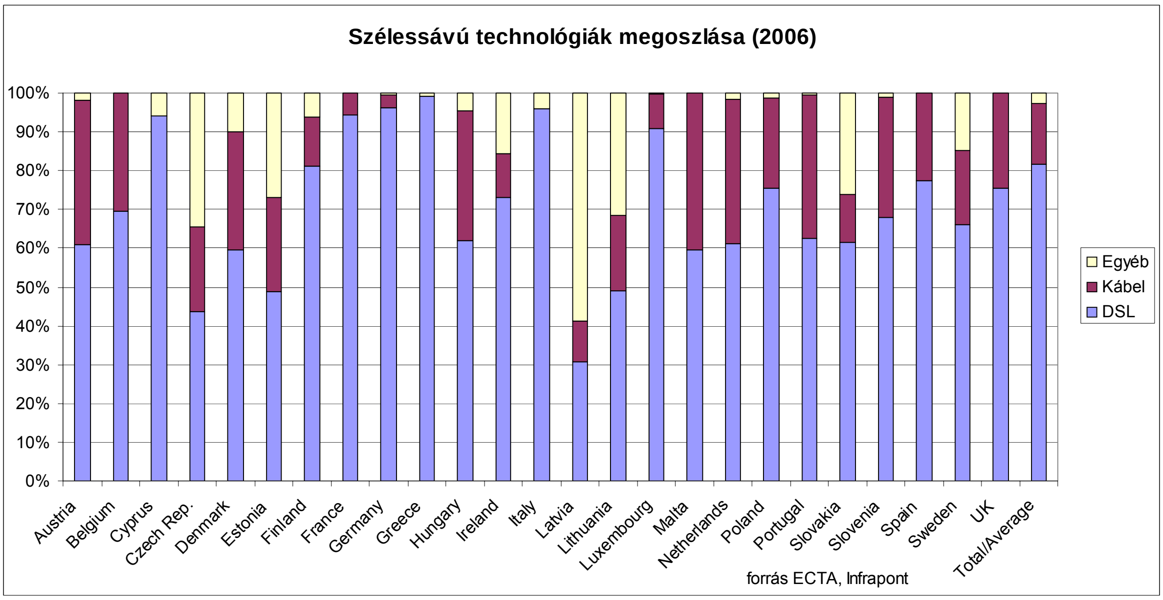
A new competitive element in the Hungarian market is the offer introduced by Vodafone in 2006 (Otthon). Through this offering the mobile operator entered the fixed line market, hence positioning itself in the end user market as a direct competitor to the fixed line providers. The service is provided on the mobile infrastructure of Vodafone, so it is a FMS (fix-mobile substitution) product rather than a converged fix-mobile service. Vodafone resorts the (fix) numbering blocks of Invitel.

By this time it has become clear that on the fixed line market competition increasingly affects not only the usage, but also the access market.

For the PSTN voice traffic there is an ever stronger challenge due to the voice services offered through Internet access. By this we mean the globally available VoIP services (e.g. Skype) on the one hand, and voice services offered together with broadband Internet access (Voice over Broadband) on the other hand. The latter category is also offered by Internet Service Providers (ISPs). ISPs are already able to provide non-geographical numbers (with prefix 21) to their customers, by which they can offer full coverage (including non-Internet users), just like with PSTN.

In the Hungarian broadband Internet access market there is a strong infrastructure competition between DSL and cable modem providers, see Figure 61. The result of this competition is reflected in both lower prices and higher bandwidth. In Hungary cable modem access is among the highest in Europe. One reason for this is the high cable penetration. Another driving force is the intention of providers to play a significant role in the Internet and increase their market share. Although the growth rate of DSL is much higher than that of cable modem access, and therefore the market share of the latter is decreasing, competition between the two technologies will have a substantial effect even in the mid-and long term.

Figure 61: Share of different broadband technologies in the Hungarian market (2006)



DSL Cable Others

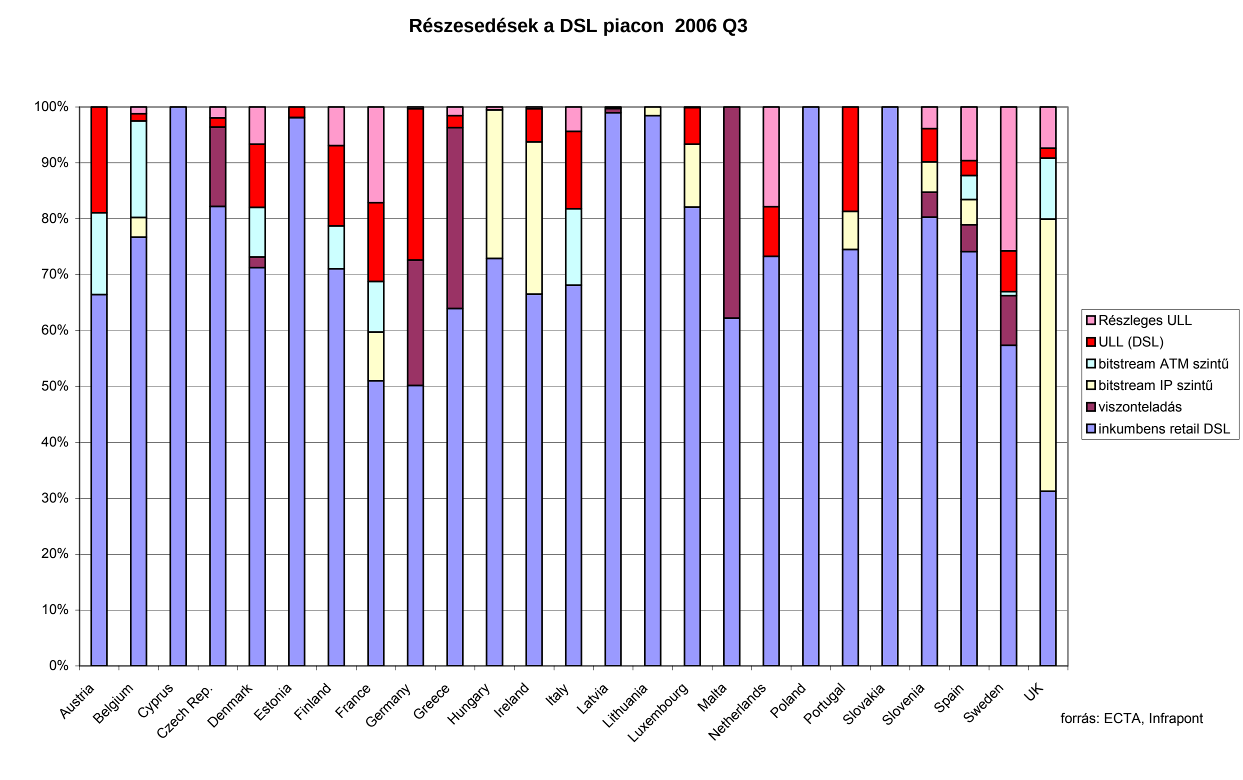
Source: ECTA, Infrapont

In case of DSL, several providers have been present in the Hungarian market already from the very beginning. This is mainly due to the fact that NHH (at that time HÍF), for licensing the retail DSL service, required the incumbent to prepare a wholesale offering. The alternative providers and ISPs entered the market with their services based on the incumbents' unregulated wholesale IP bitstream access offerings. Partly because of the potential occurrence of a price squeeze, in 2006 a *retail minus* price regulation for IP bitstream access was introduced.

The Telecommunications Act of 2004 and the market analysis procedure based on that mandated all SMP carriers (MT and the LTOs) to provide also local bitstream access (at the DSLAMs). These wholesale products, with a cost based price regulation, were part of the incumbents' reference offers, although without any practical effect on the market because alternative carriers did not demand them.[211] Bitstream access at the ATM level, existing in many EU countries, is not regulated in Hungary, or better said the incumbents are not required to offer it.[212]

At a first glance, the international comparison yields that competition in the Hungarian DSL access market seems to be normal, see Figure 62. In the end of 2006 the incumbents' share in the retail DSL market was somewhat below the non-weighted average of the 25 EU members (in weighted terms it was much above, though).

Figure 62: Provision of DSL services across European countries: Incumbent market share, total shares of competitors according to the different input services used (as of III/2006)



Partial ULL | ULL (DSL) | Bitstream (ATM level) | Bitstream (IP level) | Resale | Incumbent retail DSL

Source: ECTA, Infrapont

211 For that matter, local bitstream access is not offered by any Western European incumbent. See the database of Cullen International.

212 Theoretically an incumbent is required to negotiate, if an alternative provider claims to need bitstream access, but we have no information that this has ever happened.

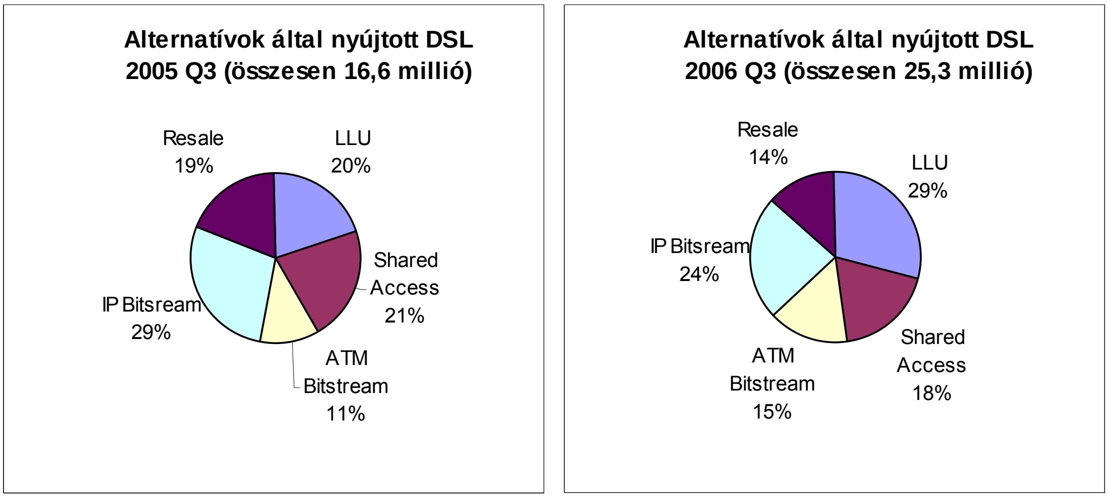
The case of domestic competition is not so favorable if the role of infrastructure based competition in the DSL market is examined.[213] In many European markets characterized by retail market shares similar to ours, an important difference is that the alternative providers base their offerings primarily on full or partial (line sharing) local loop unbundling, while in Hungary the IP bitstream access was practically the only way of access until the end of 2006. This means that if we were to analyse who owns the DSL lines, then a 100% incumbent share would be found in the case of Hungary, while in the Netherlands, France and Sweden the incumbents' share would already be much lower.

It should also be added that the data presented from 3Q2006 does not yet reflect the effect of the NHH decision, in which the regulator made the use of local loop unbundling (LLU) much easier for alterative operators. This, in turn lead to the situation that many providers entered the market with LLU-based services.

On the EU level, competition in DSL markets is clearly shifting towards infrastructure based solutions. Between 2005 and 2006 (Q3) the number of DSL subscribers of the alternative operators grew by more than 50%, see Figure 63 (while that of incumbents grew by 33%). The highest growth took place in the number of total ULL lines (122%). The share of bitstream access (resale included) declined to around 50%, but the share of ATM level access, which is more infrastructure based, increased.

213 Competition is more infrastructure based, the higher the use of those wholesale services presuming the alternative provider to get closer to the consumer by building up its own infrastructure. Hence the highest level of infrastructure based competition – apart from the case when a carrier actually deploys own infrastructure up to the end user – is reached in the case of services offered through local loop unbundling (LLU). On the other hand resale basically mirrors pure service based competition.

Figure 63: Distribution of DSL lines provided by alternative carriers according to their underlying wholesale service, in the European Union (III/2005, III/2006)



Source: ECTA, Infrapont

On the whole we think that the special features of the Hungarian market outlined in this chapter show significant differences compared to Western European markets. We therefore think that they clearly will have an impact on the NGN implementation. On the one hand the strategies of the operators can be different. Even if they analyse the Western European experiences regarding NGN, they will have to make their own decisions based on the domestic environment. On the other hand the Western-European regulatory solutions should not be adopted without a careful analysis and perhaps some modifications, because the very same techniques might not work.

6.2 NGN strategies and regulation in Hungary

The different NGN development strategies chosen by market participants in Hungary will clearly have an impact on the market structure, the competitive relationship between market players, as well as on regulation. If migration to NGN strengthens the dominant position of Magyar Telekom (MT), which already has significant market power, a paradigm shift in the Hungarian regulation might be necessary.

A possible scenario is that only MT will build up the NGN infrastructure, as it is also indicated in the NHH strategy.[214] This extreme scenario should, however, be modified. The fixed operators in the Hungarian market will also deploy a NGN core network. Regarding a NGN core network MT will therefore not be alone in the market. In the access market a monopoly situation of MT (and the LTOs on their home territories alike) is only likely if we focus on telecommunications networks only. If we take into account the NGN networks deployed by the cable operators a monopoly situation of MT may be present only in some places of the country.

A different extreme scenario would be, if besides MT the alternative telecommunications operators also deploy their NGNs in a similar way. In this case a more balanced market structure would arise, with more intense competition, which in turn might call for a milder and less asymmetric regulation. In other words, in this case Hungarian consumers have a choice regarding (NGN based) broadband access, i.e. migration to NGN will lead to a wider range of opportunities (ie. stronger competition). In this scenario a NGN system would consist of rather open networks, where third party service providers (those without their own network) were able to offer their new services easily – not due to the incumbent's altruism or the network providers' preference for competition, but simply because the network operators can make profits through granting access to the application and service layer.

Currently it is too early to make a precise forecast on the likelihood of the different scenarios. It is quite clear, however, that among present market players it is MT which is most concerned with NGN development (and not only on theoretical grounds). It is also probable that the issue of access and interconnection regulation will be fundamental in order to build realistic scenarios in order to promote competition in the related markets.

6.2.1 Magyar Telekom's NGN strategy

Among the Hungarian service providers Magyar Telekom is the only one that has a more or less well established NGN strategy. Although based on presentations of firm representatives a somewhat clear strategy can be perceived, the contacted experts and managers expressed the view that NGN related issues at MT are still in the phase of planning and discussion. They are indeed concerned with these issues, but in many cases they have no clear answers, and developments up to now are rather tentative, looking for the most appropriate solutions. In the near future (1-2 years) strategy developments similar to the case of BT or KPN are by no means expected. NGN development and later on the actual implementation itself will presumably take place during a

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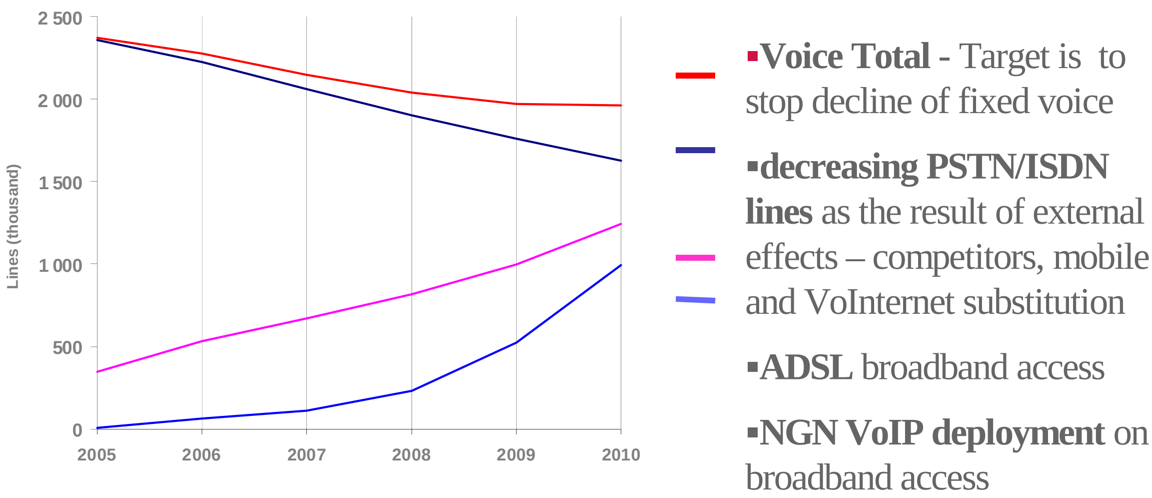
214 The National Communications Authority's Strategy on Electronic Communications Regulation 2006-2010, http://www.nhh.hu/dokumentum.php?cid=10753&letolt.

more extended time frame, more gradually, and will closely depend on initial experiences.

In the current pre-NGN stage, for MT NGN means a more extensive use of softswitches, partly replacing traditional technology in the core network. MT has launched several new services based on the use of softswitches, such as NGN related VoIP service (KLIP), which is similar to Skype, voice over cable tv, and VoIP service offered through the Unified Governmental Core Backbone (Egységes Kormányzati Gerincháló, EKG).

According to MT's plans, migration to NGN will be implemented through increased broadband access penetration. Increasing broadband penetration is of key importance for the firm not only because of internet provision. Introducing and improving NGN based VoIP service offered through broadband access is a strategic step, which MT wants to use in order to stop (or at least slow down) loosing grounds in traditional PSTN access and fixed voice traffic, see Figure 64.

Figure 64: Strategy dimensions of Magyar Telekom (2005 -2010)



Source: NGN development at Magyar Telekom, The future of our fix network Peter Janeck, Head of Magyar Telekom Network Division

Figure 64 shows the plans of MT. The dark blue line (the second from above) represents the decreasing trend of the traditional PSTN/ISDN lines due to the competition and substitution effects. The main goal of MT is, shown by the red line (the top line), to stop the decline of fixed voice. In order to reach this goal, the focus is on the expansion of the VoIP service (the bottom, light blue line) provided over the broadband access infrastructure making use of the dynamic increase of the numbers of broadband access lines (pink line, second from bottom).

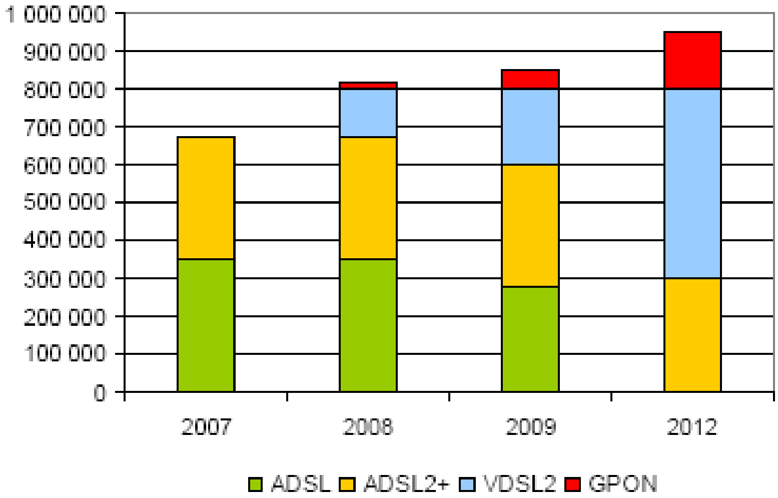
Besides VoIP and the Internet, IPTV forms the third pillar of MT's future strategy based on triple play through broadband access.

In the next few years, besides ADSL, ADSL2+ will play an important role among broadband access technologies in Hungary. Replacing ADSL with more advanced ADSL2 and ADSL2+ is a simple task according to the MT experts, since present DSLAMs can easily deal with the change between different ADSL technologies.

As our interviewees told us, MT has specific (business) plans regarding FTTx: the firm is planning to launch FTTH and FTTB pilots in specific new residential areas by the end of 2007, or more likely by the beginning of 2008. The future of MT's deployment of FTTx technology will depend on the experiences of these projects, i.e. a business plan will be based on these results. In case of VDSL, they will rely on the experiences of DTAG in Germany, their main shareholder.

Based on the presentation of the firm's deputy technical officer, much more explicit plans are reflected regarding FTTx and VDSL developments, compared to the information revealed during the interviews, see Figure 65. In his opinion the two technologies providing the fastest broadband access should play a central role already in the medium term, while the final (longer run) goal would be to achieve complete fiber coverage.

Figure 65: Magyar Telekom's broadband access infrastructure plan

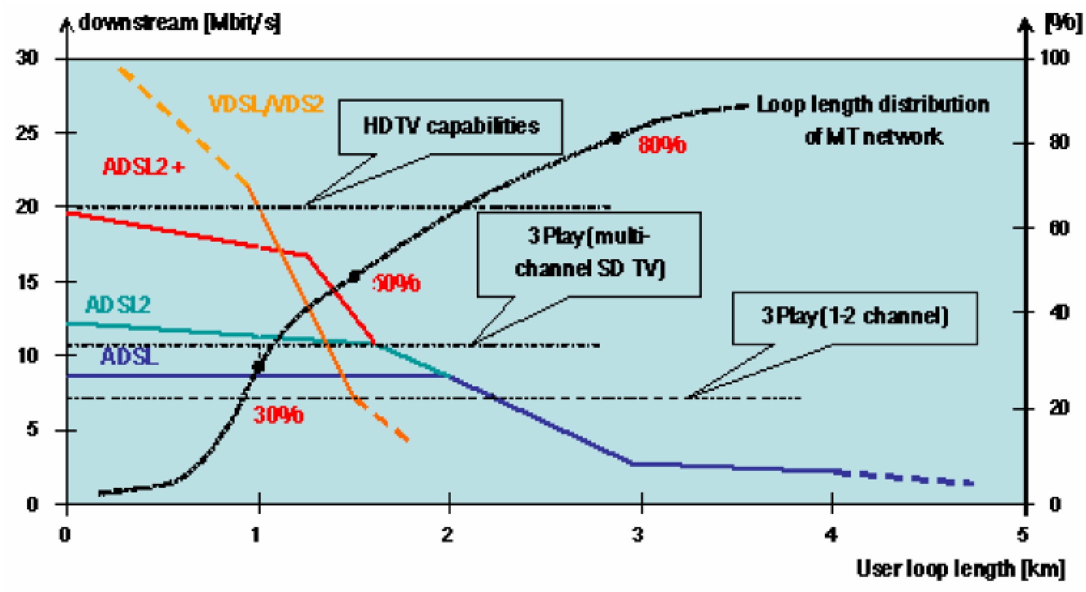


Source: Magyar Telekom technical approach for broadband access, Peter Janeck CTO, Magyar Telekom, Networks 2006 Conference New Delhi, November 6-9, 2006

The introduction of solutions that allow faster access than ADSL 2+ technology (VDSL, FTTx) depends crucially on the bandwidth needed for services being offered to, or demanded by consumers.

As shown in Figure 66 MT's current copper based network is able to provide the bandwidth needed for triple play service with multichanel IPTV using ADSL 2+ technology. HDTV quality, however, needs VDSL. Yet, offering this (with at least 20Mbit/s) is possible for only 30% of subscribers via MT's network. In other cases the length of the local loop is prohibitive.

Figure 66: Available bitrate of DSL technologies and loop lengths in Hungary; percentage of reachabale subscribers



Source: Magyar Telekom technical approach for broadband access, Peter Janeck CTO, Magyar Telekom, Networks 2006 Conference New Delhi, November 6-9, 2006

Figure 66 also points out how strong the incentive is to make the local loop shorter, locating DSLAMs into street cabinets. Inasmuch as consumer needs for bandwidth do not exceed 11-12 Mbit/s, which is a necessary minimum to offer triple play service including multi channel IPTV (in SD TV quality), it can be offered to the majority (60%) of MT subscribers with the present network structure.

The development of the core IP network will depend on the extra traffic generated by the increased access lines. The motivations that led to the substantial network restructuring (plans) at KPN, see section 2.2.2.1, are not present (or they are weaker) in the case of MT:

- Selling properties which are made unnecessary by eliminating a vast number of local switches/MDFs,
- Increasing bandwidth by locating DSLAMs into street cabinets. The demand for higher bandwidth is not perceived to be strong enough to justify it. Nonetheless, MT experiments with such solutions.

For the above reasons, at least in the short run, it is not expected that issues raised by KPN's network restructuring (e.g. phasing out of a great number of MDFs) will come up at MT soon.

MT's NGN development and migration strategy is an overlay approach. The orientation of development is mainly driven by the introduction of new services and acquisition of new costumers (expansion of broadband penetration). According to the overlay approach, services offered through NGN should be extended to the growing broadband clientele. According to the firm's strategy, an increasing part of voice traffic will move from the PSTN network to NGN (through VoIP broadband). As a consequence, exchanges with highly decreased traffic are planned to be phased out, and their traffic will be diverted to NGN. There are yet no clear and exact ideas about how complete the actual NGN implementation will be. (As MT's technical executive had put it: 'I would be the happiest, could I answer this question.'). Regarding the migration, MT wants to considerably rely on DT's experiences.

Implementation of fixed and mobile NGN at MT is coordinated, although taking place separately. They purchased two separate IMSs for fixed and mobile networks. The main reason for this is that they think manufacturers do not offer IMSs, which are capable to handle both networks at once. Requirements and interoperability needs of the two networks still are perceived to be different. According to the MT experts in fact there is no unified standard being able to handle both networks. The services offered will also differ in the two networks; for the time being there are no access independent NGN services. The installation of the two IMSs is an entirely practical solution to this situation.

Due to the NGN, networks have/will have similar elements (moreover, for T-Mobil's UMTS service the core backbone service will be provided by T-Com's IP network). This, however, does not imply technical convergence between the two networks. Regarding FMC, the most important consideration for MT is to offer such products that can be sold and ensure an appropriate return. On the demand side this is not yet visible, however; there is no considerable market demand for fix-mobile convergence, at least not for services, which also require technical convergence. Up to now convergent type services were based on bundling and pricing practices. Our interviewees expressed opinions that the introduction of true FMC services would presumably raise regulatory issues as well.

The IMS-related activity of MT is only tentative at the moment, it can be viewed as a test. There is no such service available that is specifically IMS-related and which has a marketing and revenue plan. MT's experts say IMS is not a fully mature technology, despite the fact that its standardization is already far-reaching. At present, so the assertion, it does not offer much more than softswitches, although undoubtedly the control and service layers are separated. The main impediment is viewed to be the lack of interoperability between terminal equipment and IMS (e.g. there is no IMS compatible IP telephone). This is also true for application servers. On the other hand, at present there is no such service (or consumer demand) for which adaptation of IMSs would be indispensable. On the mobile side, the main impediment regarding IMS implementation is also the terminal equipment: IMS requires broadband, while 3G handsets are expensive, and their functionality is not uniform. Besides the terminal equipment issue, should IMS be integrated into the network (supervision, billing, etc.), interoperability with existing networks should be guaranteed, which again is viewed as problematic.

6.2.2 NGN related plans of alternative providers

In this section we summarise the NGN related plans of the Hungarian alternative providers.

Pantel, the biggest alternative provider in Hungary, has a nationwide backbone network, and an access network primarily serving business customers. Pantel has been acquired by HTCC, the number three LTO, and the number two LTO Invitel is also expected to be integrated into this group.

According to Pantel, the concept of NGN is primarily related to incumbents. The alternative providers, who entered the market later with newer technologies, do not perceive these changes to be as overwhelming as the PSTN incumbents might see, or might want to represent them.

In case of Pantel, the introduction and widespread deployment of IP has taken place differently than with the incumbent. The access network was IP-based already at the very beginning. The backbone network, on the contrary, was basically a SDH based TDM network, however, the ATM level was missing. The reason was the high price of softswitches at that time (around the year 2000), and the fact that they had to had switches capable for SS7 interconnection.

Currently the number of softswitches and their role in the network is continuously increasing, but the network parallelism is not planned to be eliminated in the near future.

No IMS deployment is intended for the next 1-2 years. In their view, interconnection of service platforms does not yet require it. The available IMS technology is viewed as not yet fully matured. They therefore do not see any need for services that can not be provided by using their softswitches, which are based on open standards and can be improved in-house. They think, however, that within 5-10 years the deployment of IMS's will be necessary (due to both market and technological developments).

They regard it as a serious threat that under the banner of NGN MT will by-pass the current model of loop unbundling. In this respect on the part of the regulator a reliable and predictable policy is considered to be most important – hence they expect a regulatory stance and commitment already before actual deployment of NGN by MT. In their view, in the short and medium term, the conditions and a fair price for sub-loop unbundling should be provided as well as the dark fiber rental to the street cabinet.

Pantel experts interviewed underline that the regulation of local loop unbundling is incomplete in the absence of both well established, detailed conditions and a truly fair price. A permanent solution would be, following OFCOM's approach, the separation of the essential network facilities (local loop) from the incumbents other business and the transfer into a distinct organisational entity. In their view by this outsourcing process a level playing field competition could evolve also with regard to this critical infrastructure.

According to their experience, the interconnection (transit) fees are rapidly falling in the IP-world. The traffic is growing exponentially, while transit revenues are decreasing, even in nominal terms.

GTS-Datanet is the second largest alternative provider (the third largest fixed line player) in the Hungarian market. It has built up primarily core network capacities, and it is relying on rental in case of access and backhaul network. Its core network is SDH–TDM-based, which is not intended to be changed within the next 1-2 years.

Resulting from their business model, they are particularly sensitive to the expected change in the number and location of access points. In their view the key problem is the fixing of conditions of access to the ducts yet unsettled, although this could significantly strengthen infrastructure based competition. According to them, the regulatory authority in Hungary could already help now by making a public database about the available ducts (including those of all non-telecom players, too).

In order to ensure competition, a suitable regulatory mixture of sub-loop unbundling and dark fibre leasing is viewed as necessary. GTS-Datanet experts do not accept the incumbents' argument that there is a need for regulatory holiday in order to maintain incentives for investment. They underline that especially in Hungary this is not the case: According to them the incumbents are in a position where 80% of the access market is not contestable. Thus, the market share potentially obtainable by the alternatives is too small to alter the incumbents' investment plans. The incumbent still using this argument would mean that the incumbent's investment is not serving market goals, but is intended to harm competitors.

They noted that cable operators in Hungary have a higher market share than the European average, so it would be reasonable to impose on them the same access obligations (local loop unbundling, and bitstream access?) as on the PSTN incumbents. The fact that cable companies are the only players who can raise prices in the sector also suggests that they are in a privileged position. From their point of view the privileged position of the cable providers would be even less justified with the expansion of NGN.

Actel is a new, flexible player in the fixed voice market, who aims at introducing triple play services, mainly based on rented infrastructure. Currently it only provides voice and Internet access, but the introduction of IPTV is planned. Its services are entirely IP-based, according to the explanation of the general director of the company essentially with NGN technology. The network's softswitch offers an appropriate platform for application development, which can be joined by developers of new services.

The future conditions for interconnection and local loop unbundling are important for the company – since these are essential input factors for them. At present they are not planning to deploy their own optical network. Furthermore they also noted that while there is a need to regulate local network access, backbone capacity can be purchased on the market. They regard it as a threat that the number of potential sources of wholesale capacity supply is decreasing (because of the mergers), which is viewed as a risk factor for both the company and the whole market.

Actel's present business model, which is based on infrastructure rental, is a good example of the ladder of investment approach. It is showing the model's viability and the company's commitment – represented by further, potential investments. It makes also obvious how sensitive the model is to regulation and to the environment, which is also affected by regulation. This should not change neither with the migration to NGN nor in the mature phase of NGN.

In the opinion of **UPC**, Hungary's largest cable TV provider, the concept of NGN is wider than in the TISPAN's definition, and clearly includes all broadband communications. Not only the pure packet switched network can be viewed as the main element of the future network, since DVB-C is also the future's video service technology. Moreover, DVB-C is viewed as more stable and more mature than IPTV.

Following the digitalization of networks, the further development of cable networks is evolutionary. In case of modern HFC networks, it is possible to install the head end located at the optical endpoint closer to the user, as the demand for bandwidth increases. Using HFC with Docsis 3.0 standard, which allows even higher bandwidth on the user's side, it is possible to provide multi channel digital TV, broadband Internet, stable voice and video-on-demand services in HDTV quality together. As fiber gets closer to the user, bandwidth is increasing. Thus, the ladder of investment approach of cable companies allows them to keep up with the development of new generation telecom access technologies on the subscriber's side. Hence, according to UPC experts, cable is going to remain a competitive and efficient alternative for broadband access infrastructure. Cable TV networks have the advantage that with coaxial cable it is possible to increase bandwidth in smaller investment steps in order to follow market demand for transmission capacity.

A modern cable TV network is already capable of providing true triple play services, and in addition, providers have advantages in technology and experience related to video services. The profit content of cable TV (distribution) service is much higher than that of voice and internet services, which are more exposed to competition. A significant advantage of cable providers compared to fixed telecom market players is, besides a „safe" source of cable television revenues, that they are not affected by ex ante regulation in any market. Program distribution is basically handled as a local monopoly by ex post competition law tools, and in case of broadband Internet access, despite their significant market presence – but in accordance with the current European regulatory practices – they are not obliged to provide wholesale broadband access to third parties.

Cable TV networks – where present – are equal competitors of telecom infrastructure. Nationwide this is only partly true though, for several reasons:

- The first reason is the relatively scattered pattern of the cable networks, since there are more than 400 providers in Hungary, very diverse in size. The otherwise desirable consolidation process of the networks is slow. It is further impeded by the media law's – non-euro conform – „one-third" restriction, according to which any provider is allowed to pass at most only one third of the population with cable TV service, in order to avoid concentration of program distribution networks. The largest market player, UPC has already reached this limit. Elimination of this restrictive rule is an obligation of the Hungarian government, so we can expect this to be ceased in the future. However, overall we expect that the necessary market consolidation will advance slower than desired.

- The other special characteristic of the Hungarian market is that T-Kábel, the second largest cable TV provider is the member of the Magyar Telekom group, thus it has a „dual" role in the market. As a competitive cable provider it is interested in the provision of DVB-C, as well as of triple play services, but at the same time it is subordinated to MT's strategy. This fact might affect the strategy and timing of network and service development, as well as the pricing of services.

For those cable television providers who have their own local network, the backbone network service is an important input, which is now rented from telecom backbone providers. Although it is possible to deploy and possess such a network, there will be no need to do so in an NGN case, inasmuch as there will exist a market based supply, but it is indeed an option. From this point of view it is a threat that, as a consequence of the already ongoing consolidation in the fixed telecom sector,[215] the independent supply will decrease significantly.

Regarding new generation cable networks and services it can be stated that for cable television networks – which are completely competitive in terms of technological opportunities and growth potentials – there are two major impediments concerning the com-

215 HTCC acquired Pantel in 2005, Invitel in 2006, which clearly leads to a lower number of backbone service providers.

petition of technologies: one is the present market structure, the other is difficulties in concentration, which is however necessary to improve efficiency. The expected migration policy of cable networks will by all means be gradual, but its dynamics will be affected not only by market strategies, but also by the evolution of the above mentioned, country specific market structure characteristics. The cable infrastructure could be a full fledged competitor of the telecommunication infrastructure, if the artificial barriers would not prevent reaching the efficient scale. Thus, the support of the consolidation and concentration process in the cable tv sector is worth to be considered both for the authority and for the sector policy in favour of increasing the viability of facilities based (intermodal) competition.

In sum, Hungarian alternative providers have a much less clear plan regarding NGN deployment than Magyar Telekom. In their networks some NGN-related elements can be found (broadband access, VoIP, softswitch), but they lack a specific, consistent strategy for NGN deployment.

We opine that the NGN-related activity of the alternatives will highly depend on the future steps of Magyar Telekom. Based on past behaviour of the alternative providers and their attitude depicted in the interviews, it can be expected that they will not play a proactive role regarding NGN, rather, they will try to adapt to the new market environment brought about by MT.

What might be interesting to think over is that the alternative providers (currently) are not fully aware of the fact (or they do not view it as urgent enough to be concerned with it already now) that the incumbent's NGN deployment might put them at a disadvantage in many cases, adversely affecting their future competitive position. Of course they immediately see all the problems that have been raised (e.g. phasing out of the MDFs), and they also sketch out possible solutions, but in our view a proactive behaviour on the part of alternatives is not expected. This raises the question of responsibility of the regulatory authority in considering potential future anti-competitive scenarios, and discussing these issues with market players.

6.3 Adoption and diffusion of NGN and domestic regulation

This section focuses on different phases of NGN presence in the Hungarian communications markets and the respective implications for regulation. The section differentiates between

- the early phase of NGN's presence,
- the mature phase of NGN's presence, and
- the transition phase.

The regulatory tasks can be divided into different groups, depending on the type of services they are concerned with, as well as on what kind of relationships between market players they deal with:

- Tasks related to interconnection,
- Tasks related to wholesale access,
- Tasks related to service provisioning. Related issues are VoIP, security, quality requirements, emergency call, universal service, lawful intercept.

Depending on the dimensions of time spans and regulatory tasks mentioned above, different regulatory challenges and problems will arise.

The farther we look forward, the greater the uncertainty regarding the relevance of specific regulatory issues. We are able to address quite concrete issues and problems for the early phase. This is, however, not true for the issues in the transition and mature phase of NGN presence. Uncertainty stems not only from actual NGN deployment, but also from the fact that it can not be predicted clearly which new services will be successful and which market players will play the most significant role in providing these services. As we have explained in the previous sections, the need for regulation is highly dependent on whether other market players beside MT will deploy their own NGN infrastructure. Regulatory issues in the transition and mature phase of NGN presence will arise more sharply, if this will not take place, and MT will be the single NGN based player in the Hungarian market. However NHH has to be prepared for handling the challenges of all possible scenarios.

6.3.1 Regulatory issues in the premature phase of NGN

The premature phase of NGN, as it turned out in the review of MT's concepts and steps regarding NGN, has already started. Thus, regarding this phase we can identify several regulatory issues that are relevant already now or in the near future.

One of the main characteristics of the national NGN's premature phase is the proliferation of VoIP. VoIP is no longer a service provided only by CATV providers and small alternative providers, rather it is the central element of MT's strategy, and therefore its wide scale diffusion can be expected. The foreseeable migration of MT's fixed voice traffic to VoIP, provided by broadband access, raises several questions:

- To what degree is the regulation worked out for PSTN services – in particular regarding quality requirements and emergency calls – adaptable to VoIP services? According to the experts of MT, the decree No. 345, concerning service quality issues, couldn't be applied for IP based services.

At first glance the decree seems to be flexible enough, and will not set back market expansion of VoIP services. Nevertheless, we advocate that the regulatory authority, together with service providers, should consider this issue and identify those aspects of the regulation which are problematic for IP-based voice services.

If quality of service requirements are to be changed, it should be taken into account that excessively restrictive, or unnecessary requirements might impede the expansion of a service, which is valuable for the consumers. In our view on the one hand a situation should be avoided where a service, serving the consumers' true needs, is blocked while defending perceived consumer interests. On the other hand, a situation should also be avoided, where a provider is trying to get rid of inconvenient obligations by reference to problems related to new technologies. The regulatory authority should have a clear view of the problem and scrutinise it. We emphasize that a consultation with affected players might be pertinent.

- Can we handle VoIP traffic or broadband access as part of the fixed retail (1-6) markets? Note, that in France the regulator defined VoIP as a separate market.

  Under current legislative circumstances the regulatory authority should answer this question within the ongoing regulatory process of market analysis. The answer has to be based on (demand and supply) substitution between PSTN and VoIP services. Without providing a final result for the market analysis, we note that in its strategy discussed above MT takes its VoIP through VoB services as substitutes for PSTN.

- Even if the answer for the previous question is yes, it needs to be decided if the same obligations have to/ could be imposed as in the case of PSTN. Is there any sense to require CS/CPS obligations in case of Voice over Broadband? The demand for this is strongly questionable, at the same time the provision of it requires significant investments (according to MT it is about 100 million HUF).

  It is an open issue whether the incumbent's argument is acceptable, and if so, what consequences it would have. Again, MT's strategy should be considered, a central element of which is increasing the role of VoB. If this strategy succeeds, and CS/CPS obligations do not apply to VoB, MT might be able to draw out its customer base from CS/CBS-based competition. In particular, we note that the value of these customers is probably above average. A situation might arise in which VoB is a marginal element of a complex service bundle and where the incremental price for the VoB offering to the consumer is almost zero. In this case CS/CBS-based competition would indeed have only a limited role. We expect the above situation only to occur in the future, while in the early phase of the migration to NGN voice services and their revenues will have more than a „marginal" role in the providers' portfolio. Thus, in the early phase of the NGN, the issue of incumbent's VoIP service obligations should be considered within the process of market analysis. The incumbent's claims regarding the amount of required additional investments for VoIP Carrier Selection should also be verified.

- The migration to IP-traffic also raises new issues related to interconnection.

  Virtually, these issues should be treated within the process of market analysis. In principle each network operator should give interconnection to any other network operator. However, from a supply side perspective those carriers are particularly relevant for the interconnection market who can terminate traffic, i.e. who dispose of physical access to the subscriber. Thus, in the case of services provided through a PSTN network the source of SMP is the fact that a company has the physical access to the subscriber. In our view the potential competitive impediments of IP interconnection are similar to PSTN interconnection, hence presumably similar principles should be applied by regulation of IP interconnection.

  Another challenge might arise because the present Hungarian PSTN interconnection regime is zone-based. It is unlikely that a distance dependent interconnection fee is feasible in the VoIP world. Hence completely new principles are to be developed for interconnection.

  Moreover, a key issue is the change in the way interconnection fees are determined, due to the increased VoIP traffic. The incumbent's present LRIC model deals only with the PSTN network. Therefore a separate model is needed in order to incorporate VoIP traffic. Based on the idea of Ofcom presented above, it might be considered that cost based termination fees can form the base of a decreasing glide path, where termination fees converge to a prespecified target level within a specific time period, relying on some predictable fee setting rules.[216] With non-increasing, predictable fees the development of a robust cost model might be postponed to a later date. If a bill and keep regime will prevail, and the system of interconnection would be completely transformed, there will be no need for such a cost model.[217]

- Concerning network security, data protection and legal interception, immatureness and lack of standards is typical for NGN, and especially in case of VoIP. In the PSTN world the place of the data-gathering for legal interception was clear, while in the NGN world this is not the case. Therefore the issue of legal interception can not be handled in the same way as in the case of the PSTN. The data should be collected at the transport layer and handed over to the secret services. However the realization of the information extraction and processing requires developments and investments. Placing the burden of implementation on the service providers may be problematic, because distinct solutions (depending on the different equipments used

216 Although in the next few years the pricing of wholesale and retail voice services are going to be based on minutes of use, it is possible that because of the proliferation of different VoIP-based alternatives this pricing method will not be sustainable in the medium and long term.

217 Of course, cost models for determining the costs of access will be needed henceforward.

by the individual operators) might occur causing difficulties for the user of the information. A paradigm shift is needed also with respect to this issue. A solution must be found in cooperation with the operators. Uncertainty related to this issue is further increased because in the case of the PSTN the EU *data retention* directive[218] must be executed from September 2007, but in case of the internet (and internet telephony) there is a derogation possibility till 2009.

An additional main characteristic of the national NGN's premature phase is the expansion of **broadband access**, in which not only ADSL - now handled by regulation - can play a significant role, but other access technologies (VDSL, FTTH/B) as well. The regulation has to be prepared for the development of principles regarding access to these alternatives. This leads to general and basic issues, to the proper use of investment incentives, and to the implementation of the appropriate regulation regarding new and emerging markets.

We agree with the approach underlined in the NHH strategy: According to this strategy only the appearance of a new service is seen as an emerging market by the NHH. Such markets are not intended to be regulated. However, a new technological platform appearing in a mature service market couldn't be granted regulatory holidays. The problem that will occur is that the service provider will establish a new network platform not only for the old service (e.g. voice), but also for new ones. The approach on the part of retail regulation is simple: the former service provider with SMP can not avoid the regulation hereby. But what kind of wholesale (particularly access) obligations can be applied to this case?

An overwhelmingly „strict" regulation could deteriorate the investment incentives of the incumbent to a critical degree that could be harmful with respect to the infrastructure development, the launch of new services, and after all to the consumer. At the same time, in the absence of regulation competition could decrease and the (dominant) position of the incumbent could further be strengthened.

Regarding wholesale access to the traditional, „legacy" infrastructure elements of the incumbent the requirement seems to be a clear: The regulation of the wholesale services continues to be reasonable, particularly if the bottleneck in the copper local loop is still existent. The respective wholesale access services have to be provided for the alternative operators, even if new services (too) are provided over the infrastructure. The precondition for the evolution of alternative NGNs is the possibility for the alternative operators to use local loop unbundling economically. Otherwise stated, the key issue of the deployment of an alternative NGN is related to access. For alternative providers, deployment of an NGN core network is much easier than building their own NGN ac-

218 Directive 2006/24/EC of the European Parliament and of the Council of 15 March 2006 on the retention of data generated or processed in connection with the provision of publicly available electronic communications services or of public communications networks and amending Directive 2002/58/EC.

cess infrastructure. However, the existence of alternative NGN core networks does not ensure that consumers are able to buy all the elements of more complex services from different providers – which is really important for competition. With respect to subscriber access, the incumbent still has the significant advantage of owning facilities which are a bottleneck. Thus, it is a-priori difficult for alternative providers to compete on a level playing field with the incumbent. Since duplication of that part of the network infrastructure which forms the basis of access (for quite some time this will still be the copper line) is not economical, the alternative providers can deploy their own access infrastructure only in a limited way (business customers, possibly new residential areas). However, it can be viewed as an own NGN infrastructure if alternative providers realize subscriber access through unbundled local loop, using own active equipment.

We have shown above that Hungary is lagging behind other countries significantly regarding the usage of LLU. In our view it is worth to analyze in more detail if the results desired actually emerge in the admittedly accelerating LLU market after the change of the regulation in 2006. Moreover, it should be on the agenda of the regulatory agency to analyse what kind of further regulatory measures are necessary in this respect to enable and support the shift towards facilities-based competition in the broadband access market.

The current still low significance of LLU in Hungary has a rather special, NGN related consequence. There are yet no significant stranded investments, which would arise when MT, similarly to KPN, announced the phasing out of an important number of its MDF's.[219] Such an announcement would cause a harm to LLU-based competition. The competitors relying on LLU could not expect any compensation in this case after the actual closing of MDF's (since they knew that MT will close them), hence LLU usage would be severely affected and possibly disappear.

Although such an announcement would prevent the occurrence of "Dutch problems", it would set back the development of an infrastructure based competition in the telecom market – which is just about to evolve, as LLU usage is spreading.

The NHH should support infrastructure based competition, so it should take measures to avoid such a scenario to occur. A possible solution would be a careful definition of conditions for sub-loop unbundling. In this respect it seems to be inevitable to analyse potential business cases for SLU and the conditions which obstruct SLU usage.

Although the scenario outlined above is not likely to occur, at least based on our interviews, the above mentioned solution (SLU) is still worth to be considered. The reason is

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219 Phasing out the MDF's need not necessarily imply the complete phasing-out of their locations as well. It is possible that some kind of multiplex facilities will be implemented at these locations directing subscriber traffic to other switches located higher up in the network hierarchy, i.e. new broadband access points could be established at these locations. In this case, the issue of stranded investments would not occur.

that it can be taken for granted that the MDF's will be closed anyway, although not in the near future, and by that time a significant LLU usage will bring about the issues of stranded investments and compensation. The regulatory agency therefore should consider if the current lag in Hungary can not be converted into an advantage, by setting up a regulatory framework which prefers SLU to LLU.

A prerequisite for this is to scrutinize the (price and non-price related) conditions for SLU usage. Past Hungarian experiences show that incumbents are trying to shape the conditions to use their wholesale products in such a way that these will not become a viable option for alternative carriers. The NHH, as a consequence of the asymmetric information, is not always capable to identify all the pitfalls in the reference offers. The alternative providers, who actually will have to use the wholesale products, might be able to help a lot in this respect, as they did in the case when the LLU conditions were changed in 2006. Of course, the information provided by the alternatives might also be biased in such a way that it serves their purposes and it should therefore also be treated in a critical way.

In our view, setting up a well functioning SLU regime would be an extremely important step on the market. With this not only the problems related to stranded investments could be solved, but it would also be possible to achieve a market situation, where – exceptionally – alternatives would not be lagging behind the incumbents. This is the case because by using SLU, the alternative carriers are not only able to produce all the services currently offered by incumbents (typically ADSL), but they could also offer services (e.g. VDSL) that have not yet been introduced by the incumbent.[220] This could lead to stronger competition, benefiting the consumers. A fundamental condition for an economically viable SLU is that the alternative providers should be able to get to the street cabinet, for which it is necessary to provide them access to the ducts and dark fibre.

6.3.2 The period of transition

In our opinion (and according to the interviewees as well) traditional PSTN and NGN will run in parallel for a long time in Hungary.

In this transition period NRA faces a dual challenge: 1) Special regulatory problems due to the parallel operation of the two different networks, 2) preparing for the issues linked with the full migration.

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220 Iliad in France introduced its LLU-based IPTV service before the incumbent France Telecom. Fastweb in Italy also overtook Telecom Italia by introducing IPTV. Fastweb is using partly LLU, partly its own fiber access.

In our view the planned „overlay strategy" by MT as such does not require any regulatory intervention. However the regulatory monitoring remains an important task because of two substantial risks:

- MT under the cover of the communicated overlay strategy can create later a situation that is forcing its competitors to adapt to MT's policy. NHH therefore should observe MT's strategy with attention because investments, network elements deployed, network architecture developed etc. can raise entry barriers or can support future arguments that interoperability needs too much extra-investment from the side of MT. Moreover, services provided on the overlay network (via migrating to VoIP) can get out of the sight of NRA. Thus, MT would manage to transfer its currently regulated competitive services to an unregulated or otherwise regulated environment.

Concerning MT's future strategy there is not even a rough deadline for the full migration of its network. For the time being, MT does not plan significant changes in the structure of the PSTN network except the drop off of switches the traffic of which has been reduced. This probably does not have great importance for the alternative operators in Hungary. Therefore at this moment the Hungarian regulator does not have to deal with such access problems like the Dutch regulator. However, it does not mean, that there is a holiday for the regulator. Rather, the handling of the mentioned regulatory risks and the prevention of foreclosure or of the behaviour leading to foreclosure need continuous regulatory attention.

It is clear, that the architecture and topology of NGN will certainly lead to a significant reduction of MDFs and POPs after the full migration in Hungary as well. Thus, sooner or later all the issues regarding the treatment of stranded investments and of the change in the numbers and locations of POIs and POAs will occur in Hungary as in the current British, Dutch and German cases. Consequently, it is necessary for the Hungarian regulatory authority to continuously observe the progress and dynamics of migration. Moreover, it should prepare itself for the complete migration by carefully studying the international experiences made so far.

Generally the following regulatory tasks can be identified:

- Collecting information concerning NGN by evaluating both the theoretical literature and the international experiences and market developments.

- Agreeing upon and communicating the domestic regulatory policy principles regarding NGN. This requires consultation with the industry players and the discussion of the principles beforehand.

- Paying close attention to the NGN developments in the domestic market, especially with respect to the plans and actions of MT. The aim is to identify in time actions and behaviours possibly leading to distortions of future competition via foreclosure and SMP.

- Regulatory intervention, if – based on the previous task – it is deemed to be necessary. In the present framework a regulatory intervention can take place within a market analysis procedure. Market analysis provides a regular (cyclical) possibility for the NHH to review (in a forward looking approach) and to evaluate the effect of NGN on different markets, and to impose obligations on the SMP providers, if necessary.

The regulatory issues of the transition period are very similar to the ones we mentioned in the section on premature NGN. Most of the regulatory tasks in the premature NGN world are still relevant in the transition period. Moreover, other issues become really significant in the transition period. In this period not only the setting of regulatory policy, but also the implementation of the policy principles laid down in the previous phase and of the concrete regulatory steps are necesarry. In particular, in the transition period the regulatory authority must have final and pertinent regulatory solutions regarding voice service quality, the requirements to provide emergency calls and for lawful interception.

It is worth to emphasize, that the transition period of the NGN development is not only built upon the premature phase because of the wider deployment of the technology. The sequential relationship must show up during the realization of the regulatory tasks. The more substantial the preparation was in the premature period the easier the problems of the transition period can be solved. Regarding the issues likely to occur in the future it is crucial to establish a coherent regulatory stance in time. This is not only important for the regulator, but also for the service providers, whose behaviour in the market and investment decisions are taking into account the stated regulatory policy principles. In order to establish a regulatory stance, though, consultation with market participants is necessary.

In our view the concrete regulatory issues occurring in the transition period are the following:

- In the transition period larger and larger volumes of traffic will be migrated to NGN. The change of the proportion between PSTN and VoIP traffic will have an impact on the level of the cost-based interconnection fees. It is conceivable that the incumbent will use the migration of its traffic to increase the PSTN interconnection fees. Due to (dis)economies of scale effects, the incumbent might argue that the decreasing PSTN traffic implies the increase of the unit costs. This should of course be proved on the grounds of LRIC. This situation would have a severe negative effect on the competition via carrier selection. However if we take into account that the costs of VoIP interconnection are presumably lower than those of PSTN interconnection, it is conceivable that the average (PSTN/VoIP) interconnection fees will not have to increase. Thus, by applying a regulation based on the average fee the NHH could avoid the negative effects on competition without forcing the incumbent into pricing below costs.

- In the transition period the alteration of the basic principles of the present PSTN interconnection system and the migration to a peering and transit system being more appropriate for an NGN environment can become a more and more crucial issue. The less important the interconnection revenues are for the service providers, the smoother the migration can be. The cost of VoIP interconnection are presumably significantly lower than the present PSTN fees, thus the average interconnection prices of the incumbent are continuously decreasing with the increase of the share of VoIP traffic in total voice traffic.

- The obligation of setting cost-based termination fees is not definitely applied for the alternative operators in Hungary (however according to the current regulation they are also operators with SMP in their networks). Thus, setting termination fees above costs could be a significant revenue source for the alternatives, and accordingly they could be reluctant regarding the migration to a peering and transit system.[221] In order to avoid this the NHH can consider to prescribe the application of symmetrical termination fees for the smaller operators, thereby abolishing the disincentives of the migration.

- In the transition period the regulatory authority must have a clear agenda regarding the treatment of the reduction in the numbers of POIs (compensation for stranded investments, rules for the phasing out of POIs). In this case the domestic peculiarities (LTO system, the characteristics of the NGN network under deployement) must be taken into account besides the international examples.

- The reformulation of the RIOs and adaptation to the NGN world will be definitely necessary.

- Regarding access the issue of SLU or of its functional equivalent is not only a regulatory alternative (which only has to be considered) as in the previous period, but it is a vital precondition for the alternative carriers to be able to stay in the market. In order to ensure the viability of SLU there would be a need to provide access to new, or yet unregulated wholesale services.[222] The problem is that the competitors have to reach the street cabinet from the local switch. Since the deployment of their own infrastructure is presumably not feasible, they are depending on existing infrastructure e.g. by getting access to ducts or dark fibre. Access to these wholesale services will play a significant role for the deployment of alternative NGNs. In order to impose obligations for the provision of these services under the current framework, it has to be defined to which market they belong (part of market 11 or perhaps a new market?), and the analysis of this market must be carried out. Independent from these requirements, we think it should be worth for the NHH to start already

221 A good example is the current practice of many Hungarian non incumbent competitors (for example GTS) in setting termination fees.

222 The availability of these new wholesale services are prerequisites for the SLU to work, but this does not necessarily imply that SLU is an economically viable alternative.

now an enquiry for revealing the market situation regarding availability of ducts and dark fibre in Hungary.

- The shortening of the local loop and the phasing out of the MDFs raise the issue of stranded investments and therefore compensation. The size and significance of this problem in Hungary depends on the take up of LLU and the success of the potential stimulation of the take up of SLU instead of LLU (suggested above).
- Actually, issues regarding bitstream access become crucial when the access technologies (VDSL, FTTx) different from ADSL appear in the market. The issues, however, even though related to new services, will in all likelihood be similar to the present issues of bitstream access regulation: Which points should be the access points provided by the incumbent? What kind of basic and complementary services must be provided by the incumbent? What kind of wholesale price regulation should be applied (cost-based, retail minus)?
- The issue of functional separation of wholesale services from the rest of the business of incumbents could enter the regulatory agenda and require a profound examination in the transition period. This analysis must be based on an evaluation of the evolving competition. The crucial issue is whether the observed market processes and the applied wholesale regulation could provide enough incentives and viable business options for alternative NGNs to be implemented in the market. If this is not the case it must be examined if the deployment of alternative NGNs could be supported by the functional separation of the incumbents. The functional separation can't be applied for its own sake. Rather, it is a means aiming at a clear regulatory objective, and it should only be applied if it can be proved that this objective couldn't be reached by another "less stringent" regulatory measure.
- In the transition period it could turn out how the merger of incumbent LTO-s and Pantel will influence the behaviour of the company in the market. A-priori it is the alternative carrier most likely to deploy a NGN. Due to this merger a significant market player has come into existence, which intends to be a serious challenger of Magyar Telekom. This could also lead to strong competition in the NGN world. According to another scenario the "incumbent mentality" will be the dominant one in the merged entity, and both "incumbents", dominant in their own area will "live next to each other in a peaceful way". The two scenarios yield different competitive market outcomes, so they also require different types and degrees of regulatory intervention.
- In our opinion issues raised regularly in markets characterised by significant CATV penetration become more and more acute in the transition period: Is asymmetric regulation of the DSL and cable modem broadband access market pertinent and reasonable? Does the cable market generate enough competition to make the wholesale regulation of the DSL market unnecessary? Is it necessary to introduce a wholesale regulation of the cable market?

- In the future the NHH can't get around these questions. However, the nationwide or the LTO-region based geographical definition of the market (for example Markets 1-6, or 11, 12) can obscure real and important issues: What is the competitive situation in those areas where only cable access is available? Is effective competition already reached in markets where only two parallel infrastructures are available? In our opinion the appropriate market analysis of the broadband retail and wholesale markets has to encompass the examination of adequately set geographical market definition.

6.3.3 Regulatory issues in the mature phase of NGN presence

Analysing the regulatory issues in the mature phase of NGN presence is not an easy task at a time when we are only at the beginning of the premature phase of NGN. The scope and the nature of the regulatory challenges will basically be determined by the issue mentioned several times before, namely, if alternative NGNs will evolve beside the NGN network of MT, and if the development of HFC cable networks will keep up with the NGN network development of MT. If things go on like this, there is a chance that ex-ante regulation can be abolished in most cases, and ex-post regulation can play the main role.

However, if the market does not develop in this way (we anticipate this scenario to have a greater chance), ex-ante regulation must play a permanent role also in the mature phase of NGN.

The principles of ex-ante regulation and the types of the regulatory measures will be similar to the present ones. The central issues will be the obligations to be imposed to operators with SMP and the regulation of wholesale services related to the bottleneck infrastructure (elements) in the mature phase of NGN. In particular, we view the regulation of interconnection and access as the key issue, even though in a significantly different form than today.

The importance of interconnection regulation could decrease on the one hand due to the declining role of carrier selection, on the other hand due to the fact that bill and keep is possibly the prevailing solution at the final stage of NGN implementation.

At the same time, the importance of access regulation could increase. The issues related to unbundling of fibre based subscriber access lines or to bitstream access based on such technologies could come to the top of the agenda. Moreover, new light could be thrown upon the issue of structural separation, emerging lately in the European regulatory concept (in the UK also realized in practice). .

NGN will bring about changes not only in the technology, but it will transform the borders between the markets. In our view it is highly unlikely, that the current well known

18 markets or the 12 relevant markets planned by the Commission remain the same in the developed NGN world.

The separation of fixed and mobile markets could become meaningless due to fix-mobile convergence brought about by the mature NGN. Such a development will change the market positioning both of the fixed operators without mobile service and of the mobile operators following a pure play mobile strategy. In particular this leads to an emerging demand for new wholesale services.

The regulation of the relationships between the communications providers will be similar to the present one (access, interconnection), although it handles other issues. There is, however, a special characteristic of the mature NGN that could make necessary the regulation of new types of provider relationships. NGN/IMS makes it possible for non-facilities based telecommunications providers (i.e. for content- and application providers) to use a NGN network of a third party for providing services directly to consumers. Up until now, such an arrangement hasn't been requested to MT. Moreover, MT is not sure that such an interoperation could be technologically and economically feasible. And if after all yes – in their opinion – they consider it as acceptable business only in case of a revenue sharing agreement. This example underlines that the regulation of such a new type of provider-relationships could turn into an important issue in the absence of alternative NGNs.

Regarding access to the NGN the chances and possibilities of service providers depend on whether alternative integrated NGN networks (with access) are deployed, which are competing for the service providers to give them access to their network.[223] In the case of fierce competition between the alternative networks, there will probably be no need for regulatory intervention, since the owner of the network will not be able to abuse its dominance. The case of joint dominance can occur if the number of alternative networks is small. Yet, it is conceivable that only one NGN network will be deployed. In this case the service providers will not have the chance to operate independently (without the severe control of the incumbent) in the market without regulatory intervention. Regulation can handle this situation. One alternative is imposing quality requirements, which prevent the incumbent to impede the market entry of truly independent players through deterioration of the quality. Another alternative is to impose reference offer obligations containing quality requirements and access conditions.

These solution of course can be applied in the utmost case. However, the use of these means becoming necessary could also be viewed as a sign that other regulatory efforts facilitating the deployment of competitive alternative NGN infrastructure have failed.

223 The relationship of non facilities based service providers and NGN owners are similar to the relationship between the current premium rate service providers and PSTN operators. The relative position of content providers is better, the stronger the competition between players owning networks.

6.4 Relationship between domestic and EU NGN regulation

The EU framework and the Hungarian law define the legal boundaries of the possible actions the Hungarian regulator could take. A further, but not legal, constraint could be the regulatory strategy announced by the Regulator and the recommendations of the EU and ERG.

In today's regulatory environment market intervention can only be based on a market analysis and within the framework of the market analysis process. However, the market analysis regularly conducted is not always sufficient for the handling of the emerging questions and problems. If the deployment of the NGN and the migration of the incumbent accelerates, or if critical events happen that affect the future competitive environment, the regulatory agency cannot afford to wait until the beginning of the next market analysis procedure. If there are sufficient reasons the regulatory agency can initiate a procedure and can investigate the market situation and can impose remedies. Market analysis is an appropriate tool for the identification and handling of the problems, because in such a process there is space for taking account of national specificities and the evaluation and development of the most adequate regulatory solutions to the relevant problems.

Though the present EU regulation does not give an exact guideline for handling all of the emerging problems, it contains many elements that the NRAs have not applied yet. There is a possibility for identifying new markets for ex-ante regulation, or imposing obligations without the identification of any SMP. Moreover the regulator could build on experiences of other NRAs and the results of works commissioned by the ERG (operating as a professional forum and playing a regulatory coordination role). Thus, the regulatory agency in Hungary has to ponder what are the special features of the Hungarian market, if they need distinct treatment, and if yes how this could be solved in the Hungarian and EU legal environment.

In our view the following questions and topics are of particular importance:

- Dominance of the Magyar Telekom in certain fields,
- Consequences of local telephone operators' existence (LTO system),
- Significant market share of the cable operators in broadband and VoIP,
- Greater proportion of mobile with respect to the overall access to communications networks compared to fixed lines access,
- Role of alternative operators in the market,
- Special features of demand and consumer habits.

Some related problems can not be handled within the frame of the market analysis procedure because the NRA has no authority to use particular remedies (for example mandating separation). However the NRA should not preclude pondering particular alternatives:

- Functional separation regarding MT and/or LTOs for handling access related problems,
- Setting up a legal framework to constrain foreclosure,
- Differentiated but transparent handling of the investment incentives.

Last but not least the Hungarian regulatory agency has of course the opportunity to participate in the work of the ERG. It should make pertinent efforts to influence the EU framework and the upcoming regulatory approaches.

6.5 Key messages of this chapter

The Hungarian market differs substantively from the West-European markets in many ways. The main component of this is the greater role and the higher penetration and use of mobile relative to fixed services. Moreover the considerably high cable penetration and the significant role of cable networks in the provision of broadband internet is also a strong differential factor. The key structural element of the fixed markets is the legacy LTO system. These characteristics together will have a profound impact on the emergence of the domestic NGNs, the speed of development, the length of the transition period, etc. Due to these idiosyncracies the regulatory solutions that have been worked out for West-European market environments can be implemented only after a careful analysis and adaptation. It may also happen that a completely new solutions will be necesarry.

Among the domestic operators only Magyar Telekom has a more or less determined NGN strategy yet, although the deployment plans still are rather preliminary. MT's NGN deployment and migration strategy is based on an "overlay" approach. The direction of the future development are characterized by the introduction of new services, the acquisition of new broadband consumers, the further promotion and the rise of broadband penetration, encompassing at first experimental, later on the commercial introduction of new access technologies (VDSL, FTTB/FTTH). According to the strategic expectations a larger and larger portion of the voice traffic will migrate to NGN (VoIP on broadband) from the legacy PSTN network. However, in the near future (in 1-2 years), we do not expect a fast migration as in the case of BT or KPN. It seems that the development and the migration toward NGN will take place gradually, during a longer period, after careful evaluation of the results and examples of foreign first movers. Besides the evaluation of its own tests and trials, MT takes considerable account of the experience of its main shareholder, namely DT. Thus the monitoring of the German (market and regulatory) situation is especially important for the NHH.

The Hungarian alternative operators have less determined concepts about the introduction of NGN than Magyar Telekom, nevertheless some network or service elements relating to NGN technology are already present in their networks. The concrete activities of alternative players regarding NGN deployment (similar to the international examples) depend largely on the steps and speed of Magyar Telekom. At present it seems that they do not want to act proactively, rather, they intend to adapt to the new market environment worked out by MT. For the mobile operators the appeal of the FMC opportunities under NGN is less attractive due to the present success of their mobile service, thus, the market incentives for introducing mobile NGN-s are relatively weak.

In this situation there are several regulatory issue, a part of which, however, doesn't require any direct regulatory intervention. During the changes the regulator may play a significant role by using soft measures, in the role of the catalyst or moderator, supporting the progress of market processes. By organizing consultations, it may help in clarifying several crucial issues and reducing uncertainty regarding the changing environment. This naturally requires carefully studying both the international examples and the following up of the domestic market processes. Direct regulatory intervention is required only in those cases, where despite the supportive activities the market solutions fail due to the emergence of new types of market power, external effects or other market failures.

The regulatory activity regarding NGN is not a single task, but it requires the continuous monitoring of the whole sector, especially of the market processes. The regulator can only react firmly, but proportionally to the gravity of the emerging problem, if it is able to monitor and understand the conversion in the sector.

In the different phases of migration towards NGN the fulfilment of different tasks will become necessary. In general we can say that a successful solution to any regulatory problem presumes severe preparatory work in an earlier phase. In the early phase of NGN deployment those problems and challenges that should be solved in a later phase of the transition can be identified relatively early. From a regulatory point of view, managing the transition period is by far the biggest challenge, since old and new worlds exist in parallel in this period, whilst the paradigm shift is going on.

In the following we identify the main tasks in the three periods (early phase, transition phase, mature phase) with respect to three different topics (interconnection, access, service related issues)[224] and summarize them in the following tables:

224 Since the monitoring of market developments by the regulator is an essential acivity in each phase in order to be able to keep pace with the continouos devopment, it is not mentioned in the tables explicitly. The same is true for investigation of the emergence of new forms of bottlenecks.

Table 8: Challenges for the NHH in the early phase (pre-NGN)

Interconnection	Access	Service related issues
Clarifying VoIP interconnection principles: symmetry, issue of cost based interconnection, studying the cost basis of minute based accounting, studying the impact of a minute or data based accounting system Launching of studies and consultations regarding future network Interconnection issues, studying the conditions of the “peering and transit” type interconnection	Providing balanced conditions regarding ULL Launching of a study and consultation regarding viable SLU conditions Studying bitstream access issues Studying QoS opportunities using bitstream access Studying the issue of investment incentives Supporting the emergence and the expansion of the wireless access possibilities with flexible spectrum policy	Considering VoIP in the market analysis Handling the quality issues of VoIP service: creating the compatibility with 345. Statutory order, balanced handling of the VoIP emergency call and localization (following the pragmatic approach of Ofcom is proposed) Supporting the consultation regarding the technological and regulatory issues of the lawful intercept between the sector and the intelligent services

Table 9: Challenges for the NHH in the transition period

Interconnection	Access	Service related issues
Analysing IP-PSTN interconnection in the cohabitation: how to avoid fluctuating interconnection charges and provide incentives for change, *glide path* for the expected cost based VoIP charge level Working out of a cost model which is appropriate for the market developments Studying the role of the Reference Interconnection Offer obligation in an NGN environment Monitoring the interconnection issues of NGN core networks, working out a regulatory solution in case this is necessary Working out of the regulatory requirements regarding the location and number of interconnection points and phasing out of MDFs against the backdrop of sustainable competition Monitoring the issues of QoS differentiation, IP interconnection regulation in case this is necessary	Regulation of SLU and complementary services: working out the conditions and a pertinent system regarding access to street cabinets, the issue of providing the backhaul, access to ducts, and dark fiber, working out bitstream access conditions, which are appropriate for QoS differentiation Working out the regulatory requirements regarding the location and number of access points against the backdrop of sustainable competition Studying the role of Reference Acess Offer (RAO) obligations Working out a strategy and regulation regarding investment incentives and stranded investments Investigating the case for functional separation regarding access, if the actual level of infrastrucutre competition is inadequate Studying the symmetrical regulatory handling of acces to the DSL and cable network	Adaptation of the methodology and practice of market analysis for the dynamic environment Study of universal service issues, scope of universal service in a NGN context (harmonized with the current EU framework) Support of finding legally and technically agreeable solutions for legal intercept Investigation of service quality issues (is there any need for regulation, where?, how?) …

Table 10: Challenges for the NHH in the mature phase

Interconnection	Access	Service related issues
Analyse price and non price issues of interconnection in a NGN world Studying and handling of any market power issues in a pure NGN world Studying the actual situation of CPP/NPP	Studying and handling the issue of access to the fibre access network Dealing with investment incentives Service provider access to the application level, with regulation in case this is necessary Handling the issue of functional separation, according to the international experience and market developments Prescribing open network obligation for cable infrastructure if the market situation justifies it	Regulation of universal service provision Monitoring issues regarding quality Regulatory handling of compatibility issues

7 Conclusions and suggestions

This section privides in a condensed form the main conclusions of our study relating to NGN regulatory policy and it provides our most important suggestions to the Hungarian regulatory agency.

The inherent characteristic of NGN is the decoupling of the transport and service functions. Thus, infrastructure and service competition obviously require a new understanding.

The regulatory NGN agenda in general consists of several items: (1) Collect comprehensive and suitable information about NGN deployment plans of the incumbent and the competitors alike. (2) Assess the present and foreseeable competitive market situation. (3) Identify and communicate a coherent set of objectives of regulatory intervention. (4) Identify the available options for competitors to compete on a level playing field with the incumbent. (5) Identify potential bottlenecks, essential facilities, and generic disadvantages of competitors against incumbents. (6) Derive a suitable process to ensure a dialogue and consultation among the stakeholders involved in the migration towards NGN.

In the following discussion, we consider public policy implications of NGN in regard to (1) access, (2) interconnection, (3) migration, and (4) other issues. We then consider steps that NHH may want to consider going forward to prepare for the transition to NGN.

7.1 Access

NGN technology will change both customer access networks and backhaul to those access networks in fundamental ways. Customer access networks will experience deployment of deep fibre solutions and, depending on the FTTx solution, specific new “concentration” points will evolve. Network optimization in the backhaul networks will also bring about new “concentration” points. Ultimately, communications networks will rest on IP over Ethernet over fibre.

Hungary is lagging behind other countries significantly regarding the usage of LLU; however, the use of LLU may be accelerating in response the regulatory change of 2006. NHH needs to ensure that a full Ladder of Investment is maintained. Given the relatively low take-up of LLU to date, the NHH needs to be especially sensitive to the need to avoid regulatory uncertainty that might hinder competitors from investing in LLU, such as (1) insuperable barriers to LLU as incumbents migrate to VDSL or FTTB/FTTH, or (2) excessive stranded investment as the number of POIs declines with the migration to NGN.

As soon as some market player announces an intention to deploy FTT street cabinet/VDSL solutions, regulatory policy should fulfil the following tasks: (1) Check the availability and viability of Sub-loop Unbundling (SLU) options. (2) Check the feasibility of co-location at the street cabinet. (3) Check the feasibility of options for bitstream access traffic delivery. (4) Assess the potential scope of "stranded investments" with competitors. (5) Assess the future potentials of infrastructure competition in the FTT street cabinet world, in particular assess the sustainability of a FTT street cabinet solution. (6) Assess the potential of FTTB/H as the "final outcome". (7) Assess the implications of withdrawal of incumbents from MDF locations on (FL-LRAIC) wholesale MDF access costs for competitors.

The regulatory agenda regarding FTTB/H encompasses a somewhat different list of items: (1) Check the availability of existing infrastructure which could be used for deployment. (2) Assess the potential competitive situation (How many parallel infrastructures? What constitutes "market power"?) and check the viability and relevance of different business models. (3) Evaluate the presence of comparative advantages of incumbents and assess the necessity of regulated wholesale offers by the incumbent. (4) Consider the applicability of the regulatory framework and Commission guidance on markets and SMP to FTTB/FTTH. (5) Assess the possibilities of getting into the buildings (6) Assess the feasibility of potential regulated wholesale services (unbundled access, wholesale bitstream access). (7) Assess the relevance of a nationally oriented vs. a regionally/locally oriented regulation.

Regarding wholesale access to cable operators' broadband capabilities, an NRA would presumably have to persuade the European Commission (through the Article 7 notification process) to accept a country-specific market definition and to accept that a cable operator possesses SMP (possibly as a result of joint dominance). Yet, we judge the rationality and viability of this option in Europe as questionable in general;.however, it might be considered if the Hungarian market were to tilt strongly toward cable.

7.2 Interconnection

With respect to NGN and network interconnection, the migration to NGN will inevitably bring about changes in the principles of traffic exchange. For a variety of reasons, current arrangements are likely to be unsustainable in an NGN world. The distance-dependent aspects of the Hungarian PSTN interconnection regime, which is zone-based, may pose special challenges. The regulator should continue to drive termination rates lower in order both (1) to enhance network usage by consumers, and (2) to ease the transition should Coasian negotiated arrangements (probably with zero access fees in most cases) prove to be inevitable.

Regarding QoS differentiation and service specific interconnection, for now no regulatory action is required. Consumer willingness to pay for differentiated QoS *between* *networks* may be less than operators seem to assume. If network operators attempt to implement differentiated QoS, the market should determine viability.

We see no need to address Network Neutrality issues directly. Rather, European regulators can more appropriately address these problems by maintaining competition in the underlying markets

For interconnection in a NGN world, very few POIs are required. For most European countries, two or three POIs (for purposes of *interconnection* rather than access) might be sufficient. Thus, the likely reduction in the number of POIs for interconnection is much greater than the reduction in the number of POIs for access. Potential regulatory issues are therefore on the one hand stranded investments. On the other hand a substantial reduction of the costs for interconnection is likely.

7.3 The period of migration

It is not contentious to state that migration to NGN will take time and their will be a more or less long migration phase. Migration to NGN may ultimately lead to lower costs. A key regulatory challenge in the migration phase is how to set access and interconnection fees that allow a reasonable recovery of costs and a reasonable return on investments. One might think of two different prices for old and new networks, but this option presumably will not be incentive compatible. The option that we favour is to set a single price and to define a glide path of cost decrease over time. The challenge for regulatory policy will be to gather suitable and sound information about the ultimate cost level in a NGN world.

During migration, regulators should also require the incumbent to maintain wholesale offers that were instituted as SMP remedies for some reasonable period of time, neither too long nor too short, in order to enable competitors to make an appropriate transition. Similar considerations apply to the withdrawal of access and interconnection locations. The incumbent should not be forced to indefinitely maintain locations that it no longer needs, but this needs to be balanced against the need to minimize stranded investments on the part of competitors. These issues might be addressed by means of industry consultative processes and reasonable periods of notice of closure of a facility (example UK, Netherlands).

NGN will definitely bring about the regulatory challenge to establish suitable bottom-up cost models reflecting both the migration path from the PSTN/ISDN to a pure NGN and a fully fledged NGN world. Thus, the need arises to derive appropriate network design tools related to NGN network architecture and topology and to establish suitable algorithms for network dimensioning.

7.4 Other regulatory and policy issues

Concerning the migration of functionalities of PSTN voice services to NGN, the market should choose which features are supported, and which not. Regulators would be well advised to avoid intervention, except where necessary to address a pressing public goods problem such as access to emergency services, or lawful intercept. Regulators first and foremost should ensure a competitive market, and to intervene only in the event of some demonstrated market failure.

With respect to NGN and network interoperability, our general conclusion is that the incentives of market players to engage in standardization depend on market power and that no immediate regulatory action is necessary. Technically, IMS can definitely serve as a gatekeeper relative to applications providers by a network operator. For the time being we assume however that incumbents cannot intentionally follow such a strategy successfully. Thus, we believe it would be premature (and probably not proportionate) to consider a regulatory intervention to open interfaces such as IMS to third parties already now.

As to NGN and security we come to the following conclusions. For network integrity, the European Commission has proposed (1) outage and breach disclosure requirements, and (2) applicability of network integrity obligations to mobile and IP-based services. Regulators should allow these developments to play out at European level. As regards cybercrime NGN raises no obvious new issues. Regulatory authorities should continue to enforce relevant laws. Likewise, for lawful intercept, NGN does not raise issues that were not already present with the migration to IP. Regulators should consider proportionate obligations for broadband providers and VoIP service providers.

Regarding universal service issues, the promotion of broadband Internet access across the national territory is a legitimate policy objective, consistent with i2010, but it is not specifically a universal service issue. The migration to NGN will change the character of the universal service challenge over time, but for now no regulatory response is required on the part of the regulators.

As to the issues of numbering, naming and addressing, few issues require regulatory attention. The main regulatory items on the agenda are, first, that user ENUM implies crucial requirements for the correct registration of a user. Second, a decision is required about the assignment of geographic and non-geographic numbers to VoIP services.

Currently, there is already observable a migration from asymmetric to symmetric communications patterns on the Internet (peer-to-peer file sharing, user generated content, Web 2.0). These developments raise profound challenges concerning digital rights. From a regulatory perspective, however, we underline that issues related to content are explicitly excluded from the European framework for electronic communications. Overall, P-2-P and Web 2.0 bring about inherently important public policy issues, but not necessarily *regulatory* policy issues.

7.5 Suggested next steps for the NHH

Inasmuch as migration to NGN is not yet advanced in Hungary, relatively little is yet required in the way of actual regulation. Nonetheless, there is much that can be done to prepare for the transition, in terms of research and education, fact-finding, internal training, and the establishment of consultative mechanisms with industry and other stakeholders. We have not made specific recommendations as regards continuing to enhance the competence of staff, or continuing to strengthen industry consultation processes, but we emphasize that both are potentially valuable in addressing the changes that are to come.

With that in mind, we recommend the following concrete actions.

7.5.1 Specific immediate regulatory steps

There are a few areas where immediate regulatory initiatives, consistent with European practice and with the emerging 2006 Review of the European regulatory framework, should be considered.

1. NHH should internally review decree No. 345 as it relates to access to emergency services to ensure that it requires VoIP service providers to provide location information to the extent technically feasible (taking account of difficulties with nomadic services). In doing so, NHH should be sensitive to the need to balance the need for consumer safety against the potential harm of impacting competitive entry by needlessly strict rules. Also, NHH should bear in mind the ongoing need for consumer education as regards VoIP. Finally, NHH should respect Commission and ERG/IRG guidelines in this area. In our view, Ofcom's 2006 ruling in this regard represents a good example of best practice. If the internal review concludes that rule changes merit serious consideration, NHH should launch a public consultation.

2. NHH should internally review decree No. 345 as it relates to access to quality of service requirements to determine the degree to which the requirements are reasonably achievable for IP-based services. In doing so, NHH should be sensitive to the need to balance the need for consumer safety against the potential harm of impacting competitive entry by needlessly strict rules. If the internal review concludes that rule changes merit serious consideration, NHH should launch a public consultation.

3. NHH should internally review current requirements for lawful intercept to determine whether they adequately address law enforcement and national security requirements in connection with IP-based services, including VoIP, but keeping in mind challenges to technical feasibility. In doing so, NHH should be sensitive to the need to balance the need for consumer safety against the potential harm

of impacting competitive entry by needlessly strict rules. If the internal review concludes that rule changes merit serious consideration, NHH should launch a public consultation.

4. Once incumbent VoIP services emerge, NHH should reflect the services in subsequent market analysis. In this regard, recent French practice is instructive: they treat VoIP delivered over the incumbent's own broadband facilities as being in the same market as other incumbent voice services, but voice over the public Internet as being in a distinct market. This is an appropriate way to respect technological neutrality.

5. Termination fees have been moving downward in Hungary as in other Member States. NHH should maintain downward pressure on termination fees, moving them progressively closer to true marginal usage-based costs. Doing so tends to foster lower retail usage-based prices, and thus serves to encourage use of the network (and thus provides immediate consumer benefits), but the NGN aspect is that it reduces the shock to industry should the termination fees prove unsustainable in the longer term.

6. As new forms of access appear, notably VDSL and/or FTTB/FTTH, the NHH should reflect them appropriately in market reviews, adhering to Commission and ERG/IRG guidance.

7.5.2 Topics that the NHH should study

There are a number of areas where more detailed preparatory work could make sense, such that NHH is well prepared as the transition unfolds.

7. To the extent that incumbents upgrade the access network to reflect new technologies such as VDSL or FTTB/FTTH, or that core networks are upgraded to NGN, the NHH's cost models will need to be updated to reflect the changed characteristics of the network. (Even in the event that network interconnection fees were to entirely disappear in a Bill and Keep world, it is likely that there will still be a need for SMP operators to provide access at rates that reflect cost.)

8. NHH may wish to develop a more detailed understanding of conditions in the Hungarian market that are likely to affect access competition in a VDSL and/or FTTB/FTTH world. Understanding the geographic distribution across Hungary of the number of MDFs, the number of street cabinets (and thus the number per MDF), the length of loops from the MDF and from the street cabinet, and possibly the availability of ducts and rights of way from parties other than the incumbent could all be useful in understanding the likely evolution of competition, and in responding to future market challenges.

9. NHH may want a more detailed understanding of the relative geographic distribution across the national territory of wired telephony services and of cable television services. What areas have access to zero, one, two, or three or more full facilities-based alternatives? This is relevant both to universal service and to competition.

7.5.3 Topics that the NHH should monitor

There is a great deal that can be learned by observing best practice in other countries. In many cases, Hungary can benefit by studying developments in Member States that confront these issues before Hungary must.

10. The NHH should be aware as Hungarian operators begin to deploy NGN in the core network, or VDSL and/or FTTB/FTTH in the access network.

11. The NHH must, of course, monitor the 2006 review process, which will interact with a number of these recommendations in ways that cannot be fully predicted today.

12. The lightweight structural separation agreements that Ofcom and BT have reached represents an interesting and promising but still largely unproven regulatory model. NHH should track developments with Openreach, and with any similar systems that evolve in other countries.

13. NHH should track the evolution of interconnection arrangements in other Member States (and globally) to see if a trend away from CPNP wholesale interconnection payments is emerging, and particularly to see if the movement that some have predicted toward negotiated “Coasian” arrangements (and/or Bill and Keep) is developing. Also, RIOs will presumably evolve if and as IP-based interconnection becomes the norm. The ERG/IRG will likely be a good source of ongoing information.

14. NHH should continue to monitor the take-up of LLU and of other competitive options to ensure an ongoing balance between facilities-based and service-based competition, and the ongoing overall effectiveness of the Ladder of Investment. More generally, the NHH should continue to monitor the state of competition in the markets identified by the Commission as being susceptible to ex ante regulation, and should be generally vigilant as regards the state of electronic communication markets overall.

15. As cable television operators in Hungary gain traction with triple play services (an evolution closely related to that of the NGN), they increasingly become effective competitors to the traditional SMP operators of telephony services. NHH should monitor this evolution and its impact on competition.

16. NHH should monitor the evolution of regulatory arrangements as regards unbundled access to newer fiber-based technologies. For sub-loop unbundling in conjunction with VDSL, developments in the Netherlands and in Germany bear watching. The recent German decision to mandate competitive access to incumbent ducts is particularly interesting – access to ducts is a critical factor in the cost of fibre deployment. The work that the French have undertaken in regard to unbundling of FTTB/FTTH bears watching. Again, the ERG/IRG will likely be a good source of ongoing information.

17. It is likely that many Member States will apply bitstream access obligations to the VDSL and FTTB/FTTH offerings of SMP operators. These arrangements are likely to prove to be effective. Given the relatively high use of IP bitstream in Hungary, the NHH should pay particular attention to the emergence and effectiveness of bitstream in connection with VDSL or FTTB/FTTH.

18. The migration to NGN could raise market power concerns either at the Network Layer (IP) or at the Application Layer of the NGN, or both. NHH should monitor experience in other Member States to see the degree to which this in fact develops, and should also be alert, especially during the transition to NGN, to the possibility that it might develop in Hungary.

19. As soon as some incumbent announces a migration to NGN, NHH will have to address questions relating to (1) how long existing SMP obligations should be maintained, and (2) how to deal with stranded investment as the number of POIs is reduced. NHH should monitor developments in other Member States, including the UK, the Netherlands, and Germany.

20. The NHH should continue to monitor developments regarding fixed-mobile convergence (FMC). For many operators, FMC is a driver of the migration to NGN.

21. NHH must of course continue to monitor Hungarian markets as players merge or consolidate.

22. As operators in other Member States migrate to NGN, many will attempt to commercialize the ability to offer different grades of Quality of Service (QoS). Differentiated QoS could be relevant to interconnection and to competition. NHH should monitor developments.

23. During the transition period to NGN, other Member States will have to deal with cost-based prices in a context where prices are first increased due to the need for parallel operation, then presumably decreased due to the benefits of NGN technology. NHH should monitor the approaches taken by other NRAs, including Ofcom, to cost modelling and price-setting in this transitional context.

24. NHH should monitor the ways in which other countries, in Europe and around the world, adapt their universal access and universal service policies as NGN and other IP-based services become increasingly prevalent.

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