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# Next Generation Networks (NGN)

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INDUSTRY, RESEARCH AND ENERGY

# NEXT GENERATION NETWORKS (NGNs)

## STUDY

**Abstract**

The migration to Next Generation Networks (NGNs) has significant implications for the technical architecture and design of (access and core) network infrastructure, and also for the value chains and business models of electronic communications service provision. The nature and scope of competition is affected in many ways. This study seeks to highlight key NGN-related issues that are relevant to public policy, to assess the challenges that have been raised, and to consider options for public and regulatory policy.

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## AUTHOR(S)

WIK-Consult (as part of TNO consortium):
Mr. J. Scott MARCUS, WIK-Consult
Mr. Dieter ELIXMANN, WIK-Consult
Dr. Christian WERNICK, WIK-Consult

## RESPONSIBLE ADMINISTRATOR

Ms. Karin HYLDELUND
Policy Department Economic and Scientific Policy
European Parliament
B-1047 Brussels
E-mail: Poldep-Economy-Science@europarl.europa.eu

## LINGUISTIC VERSIONS

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## ABOUT THE EDITOR

To contact the Policy Department or to subscribe to its newsletter please write to:
Poldep-Economy-Science@europarl.europa.eu

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| | |
|---|---|
| **21CN** | 21st Century Network |
| **3GPP** | 3rd Generation Partnership Project |
| **ADSL** | Asymmetric Digital Subscriber Line |
| **AGCOM** | Autorità per le Garanzie nelle Comunicazioni |
| **API** | User-Network-Interface |
| **ARCEP** | L'Autorité de Régulation des Communications èlectroniques et des Postes |
| **ARPU** | Average Revenue Per User |
| **ATM** | Asynchronous Transfer Mode |
| **BEREC** | Body of European Regulators for Electronic Communications |
| **BnetzA** | Bundesnetzagentur |
| **BS** | Business Separation |
| **CATV** | Cable Television |
| **CFIC** | Crown Fibre Investment Company |
| **DE** | Germany |
| **DSL** | Digital Subscriber Line |
| **DSLAM** | Digital Subscriber Line Access Multiplexer |
| **DT** | Deutsche Telekom |
| **DWDM** | Dense Wavelength Division Multiplexing |
| **EC** | European Commission |
| **ECMA** | European Computer Manufacturers Association |
| **ERG** | European Regulators' Group |
| **ES** | Spain |

| | |
|---|---|
| **ESO** | European Standardisation Organisation |
| **ETSI** | European Telecommunications Standards Institute |
| **TISPAN** | Telecommunications and Internet converged Services and Protocols for Advanced Networking |
| **EU** | European Union |
| **EUR** | Euro |
| **FCC** | Federal Communications Commission (United States NRA) |
| **FR** | France |
| **FTTB** | Fiber to the Building |
| **FTTC** | Fibre to the Cabinet |
| **FTTH** | Fibre to the Home |
| **FTTx** | Fibre to the x |
| **GHz** | Gigahertz |
| **HFC** | Hybrid Fibre Cox |
| **ICT** | Information and Communication Technology |
| **IETF** | Internet Engineering Tasking Force |
| **IMS** | IP Multimedia Subsystem |
| **IP** | Internet Protocol |
| **ISP** | Internet Service Provider |
| **IT** | Italy |
| **ITRE** | European Parliament Committee on Industry, Research and Energy |
| **ITU** | International Telecommunication Union |
| **LFC** | Local Fibre Companies |
| **LLU** | Local Loop Unbundling |
| **Mbit/s** | Megabit per second |

| | |
|---|---|
| **MCL** | Metro Core Location |
| **MEP** | Member of the European Parliament |
| **MHz** | Megahertz |
| **NBN** | National Broadband Network (Australia) |
| **NetCo** | Network Company |
| **NGA** | Next Generation Access |
| **NGCN** | Subscriber Identity Module |
| **NGN** | Next Generation Network |
| **NHH** | Nemzeti Hirközlési Hatóság (Hungarian NRA) |
| **NNI** | Network-Network-Interface |
| **NRA** | National Regulatory Authoritiy |
| **NZD** | New Zealand Dollar |
| **Ofcom** | Office of Communications |
| **OpCo** | Operating Company |
| **OPTA** | Independent Regulator of Post and Electronic Communications |
| **P2P** | Point-to-Point |
| **PoI** | Points of Interconnection |
| **PON** | Passive Optical Network |
| **PPP** | Public Private Partnership |
| **PSTN** | Public Switched Telephone Network |
| **PT** | Portugal |
| **PTS** | Swedish Post and Telecom Agency |
| **QoS** | Quality of Service |
| **RBOC** | Regional Bell Operating Company |
| **RSP** | Retail Service Provider |

| | |
|---|---|
| **SE** | Sweden |
| **SIM** | Subscriber Identity Module |
| **SIP** | Session Initiation Protocol |
| **SMP** | Significant Market Power |
| **SS-7** | Signalling System 7 |
| **TCNZ** | Telecom New Zealand |
| **TI** | Telecom Italia |
| **U.S.** | United States |
| **UK** | United Kingdom |
| **UNI** | User-Network-Interface |
| **URI** | Universal Resource Identifier |
| **VDSL** | Very high speed digital subscriber line |
| **VoIP** | Voice over IP |

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# EXECUTIVE SUMMARY

The European Parliament Committee on Industry, Research and Energy (ITRE) has asked us to provide this brief report summarizing relevant policy and regulatory matters at European level that are raised by the evolution of existing fixed and mobile networks into Next Generation Networks (NGN), largely as a means of informing new MEP Members of the ITRE committee.

This Executive Summary begins by explaining the marketplace changes associated with the evolution of traditional networks into NGNs. We then discuss the regulatory challenges posed by this evolution, and review ongoing developments at European level that seek to address those challenges. Finally, we summarise the recommendations that we have made in this report.

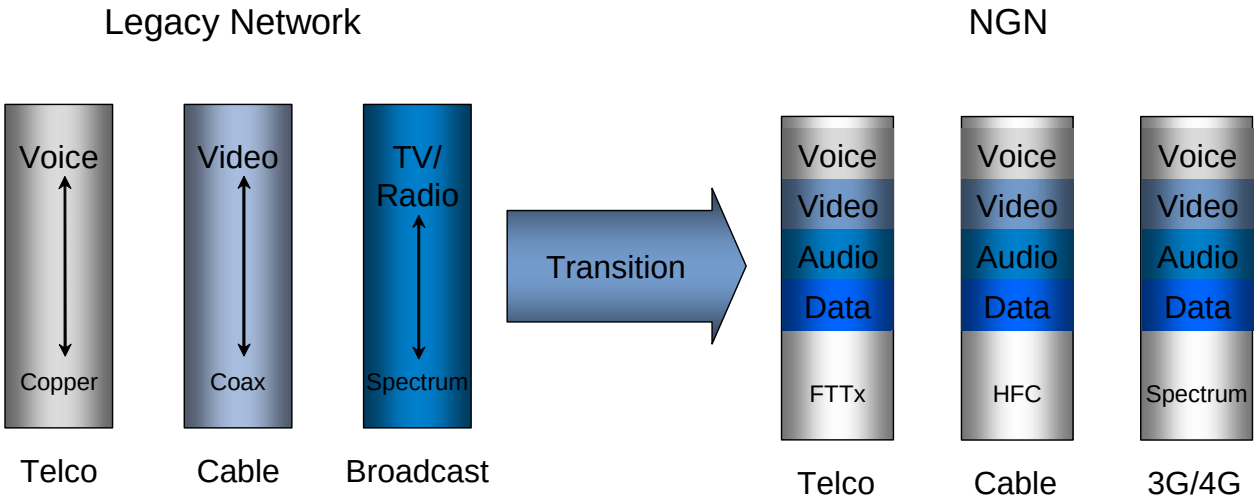
Annexes to this report provide supporting detail on the European regulatory framework for electronic communications, on NGN deployment in various Member States, and on European and global experience with functional separation.

## The evolution to NGN changes the character of competition

The technology of electronic communications networks is transitioning from circuit switching to packet switching (based on the Internet Protocol [IP]). The deployment of IP-based NGNs reflects major interrelated developments in the NGN Core, the NGN Access (NGA) network, and in end-user equipment.

Network operators differ greatly in how they have implemented NGN/NGA. In most but not all Member States, the network operator's initial emphasis has been on NGA, rather than on the NGN core. Technology choices have also been varied, with some network operators preferring FTTB/FTTH, while others prefer FTTC/VDSL.

The migration to NGN changes the character of competition quite substantially. The formerly close linkage between a communications network and the service that it provided is giving way in the NGN. The use of IP as a transport protocol enables the decoupling of the service from the network. Any NGN can simultaneously carry multiple services; conversely, a service provider need not be a network operator at all (and vice versa).




**Source:** WIK-Consult

The increasing complexity of network services has also led to concerns that network operators (especially integrated network operators who have market power) might favour their own integrated or affiliated content and applications over those of competitors. These concerns take on many forms, including fears that network operators might block or degrade customer access to the content of competitors. These concerns have led to calls for regulation to enforce *network neutrality*, which would essentially formalise and strengthen non-discrimination obligations.

## Challenges to regulation and public policy

The European regulatory framework for electronic communications seeks to rely on market forces insofar as possible to govern the behaviour of network operators and service providers. For markets where competition is not effective, however, regulation is necessary *ex ante* (in advance) in order to enable competitive market entry. The changes in the character of competition that are associated with the evolution to NGN could in the longer term mitigate the need for *ex ante* regulation; in the near to intermediate term, however, important competitive bottlenecks are likely to persist, especially in regard to last mile access in the fixed network. It is for this reason that much of the regulatory attention on NGN to date has been on Next Generation Access (NGA) – a focus that is also reflected in this report.

A great deal of regulatory energy has been invested in enabling competitors to utilise last mile incumbent network facilities at cost oriented prices, under arrangements known as *Local Loop Unbundling (LLU)*, *shared access*, and *bitstream access*. The migration to fibre-based NGA has raised a range of challenges to these remedies,[1] and also a range of issues about building wiring and infrastructure sharing.

More generally, there are substantial challenges in getting NGA rolled out in the first place. The existing copper-based last mile access facilities represent a huge investment. Replacing those copper-based facilities with fibre-based NGA promises long term benefits, including greater capacity, lower operating costs, and the ability to support new services; however, the change-over represents a substantial investment per household served, an investment that ultimately has to be paid for. Commercial network operators need a sound business case.

## Initiatives under way at European level

The regulatory framework enacted in 2002 included a provision for periodic overall review of how it is functioning. The first review was initiated as required in 2006, but the corresponding legislative process has not yet been completed. For purposes of this report, we make the assumption that the European Parliament and the Council are very close to agreement, and will soon enact a package very close to that which the Parliament approved at its Second Reading.

A number of the changes in the legislative package associated with the Review are directly relevant to NGN. Recitals 43(b) and 43(d)[2] and changes to Article 8 of the *Framework Directive* seek to ensure that NRAs reflect the increased costs and risks of network operators in their decisions. Article 12 of the Framework Directive (which provides access to physical infrastructure) has been expanded to include building wiring. A number of changes address network neutrality by ensuring that consumers are adequately informed, and can change providers without penalty if they are dissatisfied with restrictions.

The legislative package also makes *functional separation* available to NRAs as an access remedy. Separation aims at constraining market power by separating the parts of a firm that possess market power from those which do not. It can serve to assure equality of access for competitors, and to mitigate non-price discrimination. Functional separation is an intense remedy that should not be imposed where less intrusive remedies would suffice. It is not specifically an NGN remedy, but it has often been applied concurrently with an incumbent network operator's migration to NGN.

Meanwhile, the Commission has published a second draft Recommendation on NGA, which seeks to clarify a range of issues related to access to civil engineering, fibre loops and terminating segments related to NGA deployments of network operators possessing SMP. It should, after suitable refinement, represent an important positive contribution.

[1] Especially in regard to LLU and to shared access under VDSL or GPON access.
[2] Wherever we refer to the legislative package associated with the Review, we are basing our comments on the text adopted at the Second Reading on 6 May 2009.

Many other new or emerging policy instruments influence the NGN landscape. The Commission's Recommendation on fixed and mobile call termination is highly relevant to NGN interconnection. It mitigates an obstacle to migration to IP-based NGN interconnection. The Commission's new Guidelines for the application of State aid are important and positive in regard to the deployment of broadband NGA networks.

### Findings and recommendations

Our findings and recommendations are explained in full in section 7 of the report.

- It is our assessment that the legislative package associated with the Review is generally appropriate, and should be put into force.
- We do not see regulation of last mile access withering away any time soon as a result of the evolution to NGN; however, there may be portions of the national territory where some aspects could be relaxed. We therefore see value in increased emphasis on the use of sub-national markets and/or sub-nationally differentiated remedies.
- Furthermore, we think that the Commission's draft Recommendation on NGA should be further refined in a number of areas and then adopted. It provides needed clarity for a wide range of NGA regulatory issues that are currently open.
- Most significantly, we think that the whole constellation of issues associated with achieving NGN/NGA deployment needs more concentrated attention at European level. We see Europe falling further behind its international trading partners (Japan, the US, Korea, and potentially Singapore, Australia, and New Zealand) in regard to NGA deployment, but the costs and risks of this development are not well understood.
    - In this space, industrial policy interacts with regulatory policy (including universal service) in complicated ways. Initially, we see the need for more rigorous analysis of the potential costs and benefits of evolution to NGA (beyond those already provided by copper-based broadband).
    - If appropriate, a range of policy options could be developed with costs and benefits evaluated using an impact assessment / *ex ante* evaluation methodology.
    - Those analytical results could then serve as an appropriate backdrop to an informed discussion, *which is necessarily a political discussion*, of what Europe's goals should be in regard to the fraction of the population that should be reachable, at what speeds and with what quality, and with what assurances as to price.
- For interconnection, we have recommended a comprehensive assessment of the likely effects of a possible implementation of Bill and Keep voice interconnection arrangements. Bill and Keep is finding increasing support in the ERG, and the Commission has already indicated its intent to launch a study. We also recommend monitoring the migration to IP-based QoS-aware NGN interconnection, which does not appear to be progressing as one might have hoped.
- As a final observation, we recommend continued attention to making additional high quality spectrum available for fixed and mobile wireless broadband access.

Our detailed recommendations appear in the main report as shown:


| | | |
|---|---|---|
| Recommendation 1: | Adopt the pending Review package. | 47 |
| Recommendation 2: | Make greater use of sub-national markets and/or sub-nationally differentiated remedies. | 48 |
| Recommendation 3: | Refine and complete the draft Recommendation on Next Generation Access (NGA). | 48 |
| Recommendation 4: | Develop a solid understanding of the societal benefits of migration to NGA. | 50 |
| Recommendation 5: | Evaluate policy instruments that could be used to achieve greater deployment of fibre-based NGA. | 50 |
| Recommendation 6: | Initiate a political discussion to establish goals, and means of achieving them. | 50 |
| Recommendation 7: | Consider possible implementation of Bill and Keep call termination arrangements. | 51 |
| Recommendation 8: | Monitor the migration to IP-based interconnection. | 53 |
| Recommendation 9: | Make more high quality spectrum available for fixed and mobile wireless broadband access. | 53 |

# 1. INTRODUCTION

**KEY FINDINGS**

- The technology of electronic communications networks is transitioning from circuit switching to packet switching (based on the Internet Protocol [IP]). The deployment of NGNs based on IP technology reflects major interrelated developments in the NGN Core; the NGN Access (NGA) network; and in end-user equipment.
- The formerly close linkage between a communications *network* and the *service* that it provided is giving way in the NGN. The use of IP as a transport protocol enables the *decoupling of the service from the network*. Any NGN can simultaneously carry multiple services; conversely, a service provider need not be a network operator at all (and vice versa).
- The migration to NGN changes the character of competition substantially. The European regulatory framework seeks to let the market operate unimpeded wherever feasible, but to intervene proportionately when necessary to enable competitive entry in the face of market power.
- These changes imply profound shifts in the nature of competition, which may imply a need for regulatory changes. It is highly likely that market intervention will still be required from a competition and regulatory policy perspective. Migration to NGN/NGA raises a range of regulatory and policy challenges. The appropriate responses and potential regulatory instruments might be more or less different from those that we use today in a number of areas: pro-competitive regulation and Next Generation Access (NGA); achieving deployment of current and Next Generation Access (NGA); network interconnection; Quality of Service (QoS), together with its implications for network neutrality; issues during the migration period; standardisation and interoperability; and spectrum management.

The European Parliament Committee on Industry, Research and Energy (ITRE) has asked us to provide a brief report summarizing relevant policy and regulatory matters at European level that are raised by the evolution of existing fixed and mobile networks into IP-based Next Generation Networks, largely as a means of informing new MEP Members of the ITRE committee. Specifically, they have asked us:

- To give a clear and readily accessible overview of current main NGN and NGA related issues.
- To evaluate the features, implementation aspects and effectiveness of regulatory measures available to and used by NRAs.
- To identify and define possible priorities, measures and actions for the coming five years.
- To outline the impact of different technological solutions/deployment on the regulatory options.
- To outline the likely impact of different regulatory paths chosen.

Historically, electronic communications networks[3] were built to support specific services. Fixed and mobile telephony networks were built to support voice telephone calls.[4]

[3] Our focus throughout is on *public communications networks* in the sense meant by Article 2 of the Framework Directive. These are networks that provide publicly available electronic communications services (ECS), generally for remuneration.
[4] Only later did FAX and data capabilities appear.

Cable networks, satellite and over-the-air broadcast were built to support television services (unidirectional linear video). Today, multiple communications networks (including fixed, mobile, and also cable television) are incorporating technology that was developed for the Internet, and are rapidly evolving into multi-service networks that support voice, video, and data over a single, fully integrated communications platform.

This migration profoundly alters the nature and character of competition. Networks that historically did not compete with each other – cable television and fixed telephony, for example – are now able to offer the same bouquet of voice, video and data services to the same end-users. For regulators and policymakers, this is a promising development – the new competitive possibilities might possibly herald an era where market forces are more effective, and where the need for regulation is reduced.

There are many distinct aspects and elements to this evolution. Notably, the evolution of the core of the network raises issues that are quite distinct from those at the edge (which contains the myriad access lines to customers).

Across the different fixed, mobile and cable network infrastructures, fixed telecommunications networks have been at the centre of regulatory market intervention. Regulatory concerns have been particularly acute as regards the access network at the fixed network's edge, because it has been viewed as representing an essential facility or bottleneck that competitors cannot easily replace. The replacement of the traditional copper-based access with new fibre-based access potentially enables a huge increase in capacity, enabling video and high speed data to be transmitted direct to the home. Fibre also potentially has lower operating and maintenance costs than copper; however, the initial cost of deploying it is quite substantial. In substantial parts of the territory of most Member States, it is unlikely that there will be more than one fibre access to (or at least "next to") the home for the foreseeable future.[5] This would appear to imply that the fibre-based Next Generation Access (NGA) network could prove to be even more of a bottleneck facility than the last mile copper access network is today. Moreover, many of the remedies applied to last mile copper today (Unbundled Local Loop (ULL), shared access, and bitstream access) require substantial re-working before they could appropriately be applied to the fibre-based NGA network. All of this implies that regulators face quite substantial challenges in dealing with the evolution to Next Generation Access (NGA).

Thus, the evolution of networks to NGNs unleashes forces, some of which might make competition *more* effective, others of which might make it *less* effective. If competition were to become fully effective, there might be little or no need for a substantial class of regulation. It is difficult to predict today what the net end effect will be for regulators, but on balance it is unlikely that the need for *ex ante* regulation (in advance, rather than after a problem has occurred) will go away any time soon.

This evolution is relevant to Members of the European Parliament for a variety of reasons:

- The European Parliament is, together with the Commission and the Council, responsible for legislation and oversight of the regulatory framework for electronic communications. The evolution to NGN has already required changes to the regulatory framework as part of the current review process (see Chapter 2), and it is likely that further changes will be required over time.
- How, in particular, should policy be adapted to deal with new challenges regarding access to, and interconnection of, Next Generation Networks? How are these impacted by changes in the nature of competition?[6]

[5] See Elixmann et al. (2008). In some areas, however, there could be effective competition from cable. The degree to which mobile will compete with fibre-based access in high density areas is still something of an open question.

[6] As previously noted, it is very likely that there will be only a very limited number of fixed fibre-based access infrastructures to (or close to) the home for the foreseeable future. There could, however, be competition between telecommunications network operator infrastructure based on FTTC/VDSL or FTTB/H technology, and cable network infrastructure based on HFC technology (to the extent that cable has been deployed). Thus, the scope of competition is constrained.

- Aside from the regulatory framework, the evolution to NGN raises a range of related industrial policy and public policy questions. As a conspicuous example, is there a risk that market forces will fail to deliver the deployment of fibre-based NGAs? Should fibre fail to fully deploy, what are the costs to the broader society?[7] Is government intervention warranted to ensure deployment?[8]
- With the evolution to NGN, media policy issues become relevant to telecommunications networks.

Chapter 2 of this report provides an overview of the European regulatory framework for electronic communications, including the still-ongoing three year review of the framework. Chapter 3 discusses, in general terms, the challenges raised by the evolution to NGN. Chapter 3.2.9 discusses NGN deployment in many of the Member States. Chapter 5 discusses functional separation. Functional separation is not solely an NGN issue, but it clearly interacts with the evolution to NGN. Chapter 6 discusses a range of policy initiatives at the European level that are relevant to NGN. Finally, Chapter 7 provides our conclusions and recommendations.

We have also provided three Annexes that supplement the main report. Annex 1 provides an overview of the European regulatory framework for electronic communications, up to but not including the still-ongoing three year review of the framework (which is covered in detail in the main report). Annex 2 discusses NGN deployment in many of the Member States. Annex 3 discusses functional separation as implemented in a number of countries, in Europe and elsewhere. Functional separation is not solely an NGN issue, but it clearly interacts with the evolution to NGN.

[7] The deployment of Next Generation Access (NGA) infrastructure in all likelihood has substantial positive impacts on the economy and citizens alike, see e.g. Fornefeld et al. (2008).

[8] A number of countries, including Australia, Singapore and Finland, have chosen to make quite substantial per capita investments to ensure the full deployment of fibre-based NGA. Whether this judgment will be vindicated by events remains to be seen.

# 2. THE EUROPEAN REGULATORY FRAMEWORK FOR ELECTRONIC COMMUNICATIONS

Relative to this report, it is important to note that the European regulatory philosophy as regards electronic communications is explicitly technologically neutral.[9] No distinction is drawn among different technology platforms (unless there is some specific need to do so). The European regulatory framework seeks neither to impose, nor to discriminate in favour of the use of any particular technology. Instead, it seeks to ensure that any regulation relevant to a specific market is applied irrespective of the means by which the service(s) constituting this market are delivered. This property has already shown its value as networks evolve to NGNs – it means that regulation need not change unless the technological changes raise new policy issues.

The European regulatory framework for electronic communications views much of regulation as a response to the existence of essential facilities (bottlenecks) and market power that would tend to impede competitive entry; however, it is important to note that the regulatory framework contains many other elements as well.[10]

Section 2.1 deals briefly with the history of the regulatory framework, and with the structure of the documents that comprise it. Section 2.2 provides an overall description of the still ongoing review of the regulatory framework that was initiated in 2006; however, detailed discussion of those aspects that are specifically relevant to NGN is deferred to Section 6.1.

## 2.1. History and structure of the regulatory framework

This section provides a quick review of the European regulatory framework for electronic communications, on the assumption that most readers are already familiar with it. A more extensive summary appears in Annex 1.

The European regulatory framework for electronic communications was enacted in 2002. The core of the European Regulatory Framework consists of five Directives: the *Framework Directive*[11] establishes a harmonised regulatory framework for electronic communication networks in the Member States, while four *specific Directives* deal with (1) Authorisation,[12] (2) Access and Interconnection,[13] Universal Service (including consumer rights),[14] and Privacy and Electronic Communications.[15] The Member States transposed these Directives into national law.

The framework seeks to rely on market forces insofar as possible to govern the behaviour of network operators and service providers. For markets where competition is not effective, however, regulation is necessary *ex ante* (in advance) in order to enable competitive market entry. The European Commission has provided guidelines to the Member State National Regulatory Authorities (NRAs), drawing on principles of European competition law, to (1) define relevant markets[16] and to (2) identify undertakings that have *Significant Market Power (SMP)*[17] on those markets.

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[9] Framework Directive 2002/21 EC, of 7 March 2002, OJ L 108/33-49, recital number 18.
[10] The Universal Service Directive, of 7 March 2002, OJ L 108/51-77, for instance, contains quite a few obligations that have nothing to do with market power as such.
[11] Directive 2002/21/EC .
[12] Directive 2002/20/EC of 7 March 2002, OJ L 108/21-32.
[13] Directive 2002/19/EC of 7 March 2002, OJ L 108/7-20.
[14] Directive 2002/22/EC.
[15] Directive 2002/58/EC, of 12 July 2002, OJ L 201/37-47.
[16] Article 14 of the Framework Directive obliges the Commission to adopt a recommendation on relevant product and service markets. The European Commission begins the market definition process by identifying a series of markets "susceptible to ex ante regulation". The Commission's initial list consisted of 18 markets; however, the list was reduced to just seven markets in December 2007.
[17] Framework Directive 2002/21 EC, Article 14, Section 2. "An undertaking shall be deemed to have significant market power if, either individually or jointly with others, it enjoys a position equivalent to dominance, that is to say a position of economic strength affording it the power to behave to an appreciable extent independently of competitors, customers and ultimately consumers."

The framework defines a set of regulatory remedies that can be applied *only* as a means of addressing SMP. Absent SMP, any such remedies must be withdrawn.

The European regulatory framework addresses a range of other issues as well, but these core competition issues are central.

## 2.2. The Review of the regulatory framework

The regulatory framework included a provision that requires periodic overall review of how it is functioning, with the first to take place three years after it officially came into force in 2003.[18] The review was initiated as required in 2006, but has not yet been fully concluded. For purposes of this report, we make the assumption that the European Parliament and the Council are very close to agreement, and will soon enact a package very close to that which the Parliament approved at its second reading; however, there can be no certainty that this will be the case.

This section of the report contains a brief, general overview of the legislative package associated with the Review; Section 6.1 returns to the topic to provide an in-depth discussion of those aspects of the Review package that are specifically relevant to NGN.

Most noteworthy about the ongoing Review is precisely what has *not* changed. All the core mechanisms of the regulatory framework have been kept in place, notably including the mechanisms for applying regulatory remedies only to firms that have SMP. Nevertheless, the amendments are wide-ranging, and some of them have been subject to intensive debates and amendments.

The legislative package deals with a huge number of topics. A number of the changes in the draft legislation[19] are relevant to the evolution to NGN; these are discussed at greater length in Section 6.1.

- **Network neutrality**: There have been concerns in the U.S. that incumbents and cable operators might inappropriately or anti-competitively discriminate, impeding consumer access to desired content, applications or devices (see Section 3.2.5). The current text includes a general principle that access should be unrestricted, empowers NRAs to mandate a minimum Quality of Service for accessing all content (thus preventing discriminatory degradation of access), ensures that consumers are adequately informed of restrictions, and gives consumers the right to change providers without penalty if a network operator imposes new restrictions on access to content, services or applications.[20]
- **Spectrum management**: The text promotes liberalisation in the sense of technological and service neutrality, creates stronger obligations to permit spectrum trading and leasing, and creates a mechanisms for strategic spectrum planning at European level.
- **Functional separation:** The current text empowers NRAs to implement functional separation as an access remedy, but only where less intrusive remedies would not suffice.[21]
- **Strengthened acknowledgment that investment returns must fairly reflect investment risk,** which is especially relevant to potentially substantial and risky investments in Next Generation Access (NGA).[22]

[18] Framework Directive, Article 25.
[19] All references to text of the legislative package are based on the text approved by the European Parliament at the Second Reading on 6 May 2009.
[20] See Carter, Marcus, Wernick (2008) for a detailed discussion of the implications of the U.S. debate on Europe.
[21] See Marcus, Wernick, Carter (2009) who provide an analysis of separation issues in Australia.
[22] See European Parliament (2009), at 57. "When imposing remedies to control prices, national regulatory authorities should seek to allow a fair return for the investor on a particular new investment project. In particular there may be risks associated with investment projects specific to new access networks which support products for which demand is uncertain at the time the investment is made." This has been a point of contention in a number of Member States (see the Annex).

Other noteworthy changes in the legislative package include:

- **BEREC:** A new **Body of European Regulators for Electronic Communications (BEREC)** would replace the existing European Regulators' Group (ERG). BEREC would act as an advisory body to the Commission, the NRAs, and the European Parliament and the Council. BEREC would have a small permanent supporting staff, and more robust organisational underpinnings than the current ERG.
- **Various procedural improvements** in the process of market analysis and imposition of remedies, especially as regards the Article 7 notification process. The text includes refinements to procedures to deal with cases of disagreement on remedies between the Commission and the NRA.

# 3. THE CHALLENGE OF NGN

Section 3.1 explains the technological basis for NGNs, while Section 3.2 discusses the particular policy challenges that NGN raises.

## 3.1. The technology of NGNs

Electronic communications was dominated for decades by the concept of *circuit switching*. The user would enter a telephone number, a connection would be made, and afterwards the call flowed as if there were a simple copper wire circuit carrying voice back and forth between the caller and the receiver. The reality was, of course, more complex – computerised switches were actually implementing those circuits.

As computers began to become widespread, it quickly became clear that completely new concepts of communication were needed. Some services required a connection that was much quicker and simpler to establish than a voice telephone call; at the same time, not all data communications needed to be delivered (nearly) instantaneously. These concepts led to the concept of *packet switching*, where data would be broken up into small packets of data. Beginning in 1969, these ideas led to the creation of the worldwide network that is known today as the Internet.

The Internet is based on the *Internet Protocol*, or *IP*, where information is broken up into *packets* or *datagrams*, each of which contains its own source and destination address information, and each of which is in principle independently routed and transported to its destination (somewhat analogously to a flood of letters delivered by the postal service). If a circuit-like service is needed, communications software can construct a virtual circuit "on top" of the underlying packet data service.

The commercial development of the Internet began in earnest in 1995, as the U.S. government largely withdrew from its earlier operational role. Needless to say, the Internet has been extremely successful. As of December 2008, there are an estimated 398.7 million broadband Internet users worldwide.[23]

For decades, engineers have sought to somehow merge the technology of the Internet with that of conventional telephone networks. It has long been recognised that a merged network would offer economies of scale and scope, and could potentially enable new uses and applications.

Voice and video services are, fundamentally, data services as well – there is no reason in principle why an Internet Protocol-based network could not transport them. At the same time, real time bidirectional voice and video have service quality requirements that are somewhat distinct from those of other data, and that ought to be addressed. We will return to this point in Section 3.2.5.

A strong additional driver for this evolution flows from *Moore's Law*, which is the familiar observation that the price/performance of the semiconductor chips used for computer processing and computer memory is improving by a factor of two every 18 to 24 months. We see this trend constantly in the declining prices or improving quality of personal computers, mobile phones, and consumer electronics. Packet switching devices (such as *IP routers*) benefit from Moore's Law to a far greater degree than the older circuit switched devices. As a result, there are now clear price/performance advantages in upgrading the core of existing fixed and mobile networks to use IP technology.

These factors have come together to drive the migration of networks to IP-based NGNs. The International Telecommunications Union (ITU) has provided the best and most widely accepted definition of this evolution: "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.

[23] See Point topic (2008); World Broadband Statistics: Q3 2008; December 2008.

It offers unrestricted access by users to different service providers. It supports generalised mobility which will allow consistent and ubiquitous provision of services to users."[24]

The deployment of NGNs based on IP technology can be viewed as comprising three major interrelated developments:

- **NGN Core:** The circuit switches that comprise the core of the transport and aggregation networks of existing switched fixed and mobile networks are being replaced altogether by packet switched IP routers. This generates operating efficiencies, and also enables networks to carry voice and video services together with data in a fully integrated manner. This evolution has implications for the intra-network traffic of a network operator ("on-net"), as well as for the traffic exchange between different network operators ("off-net").
- **NGN Access (NGA):** In the fixed network, the "last mile" between the network operator's central office and the end-user has already been upgraded in many cases to provide an IP-based broadband access based on so called ADSL (Asymmetric Digital Subscriber Line) technology. With ADSL, the physical infrastructure is still the traditional copper network. In recent years, fibre optics are being driven progressively deeper into the network, and closer to the customer, thus enabling higher speed access that is suitable not just for data, but also for video. The initial cost of deployment is substantial, but fibre offers lower operating expense and many other advantages compared to today's copper-based last mile solutions.
- **End-user equipment:** A related development is that the end-user's equipment is increasingly likely to be intelligent and IP-based. A mobile phone today is really an advanced computer, with substantial processing power, memory, and display capabilities. A personal computer has all of the capabilities of a television and a telephone. Today, the fixed telephone service coexists with DSL data services over the same telephone line, but this could change over time as conventional telephones are replaced with intelligent IP-based devices. We do not normally speak of this as NGN, and it is largely out of scope for this report, but it is nonetheless clearly an important factor in the overall evolution of NGN.

The evolution to NGN is not taking place in the same way or at the same time in all Member States, or for all operators, but it is felt throughout Europe (and for that matter, throughout the world).[25] Some fixed operators choose to upgrade the core first, while others focus on the access network. Fixed operators are likely to follow a somewhat different path than mobile operators (even when they are under common ownership), cable television operators are on yet another course, while Internet Service Providers (ISPs) are on still another.

The deployment of NGN into the core raises significantly different business and public policy considerations than does NGN access. We expand on this thought in Section 3.2.

Much of our attention in this report focuses on the NGN access network. Three major fibre-based NGN access (NGA) solutions have appeared for the fixed network:

- **Fibre to the Cabinet (FTTC)** coupled with **Very High Speed Digital Subscriber Line (VDSL)**: The copper access line from the network operator's *Main Distribution Frame (MDF)* in the Central Office to the *street cabinet* (close to but not necessarily adjacent to the end-user's building) is replaced by a fibre optic line. The copper line from the street cabinet to the end-user's building remains. The *DSL access module (DSLAM)* must be close to the user, and therefore is located in the street cabinet rather than at the MDF location.[26]

[24] See http://www.itu.int/ITU-T/studygroups/com13/ngn2004/working_definition.html.
[25] Developments in a number of Member States are outlined in Section 3.2.9, and presented in more detail in the Annex to this report.
[26] DSLAMs terminate the electrical copper signal and concentrate it in an Ethernet protocol over fibre up to so called metro core locations (MCL). Ethernet switches in the MCLs further concentrate the traffic through the concentration network to the IP core network. Since the distance between the DSLAM in the street cabinet and the Ethernet switch in the metro core location is not limited by copper transmission characteristics, it may be larger than before.

- **Fibre to the Home (FTTH) – Point-to-Point (P2P):** The copper access line from the network operator's Central Office to the end-user's residence is replaced by a fibre optic line, which is effectively dedicated to a single customer.
- **Fibre to the Home (FTTH) – Passive Optical Network (PON):** The copper access line from the network operator's Central Office to the end-user's residence is replaced by a fibre optic line. Different light frequencies (colours) are used to carry different signals, many of which are used for video (analogous to cable television). No active electronic components are used between the Central Office and the residence, which is why the network is referred to as passive.

Again, these different solutions[27] have substantially different capabilities, different costs to deploy and to operate, and raise significantly regulatory issues. Table 1 contains estimates of the investment costs per home connected (in Euro) across the three aforementioned NGA solutions for different European countries.[28] The table shows that FTTC/VDSL tends to be substantially cheaper to deploy than either of the FTTH solutions, because not all of the copper needs to be replaced; however, its maximum data rate is also less than that of the FTTH solutions, and it is less suitable for large volumes of video content. FTTH/PON solutions are slightly less expensive than FTTH/P2P, and are well suited to linear video, but they are distinctly less flexible and less "future proof" than FTTH/P2P solutions.

**Table 1**: **Investment costs of VDSL, PON, and P2P solutions for six European countries**

| Network Type | Cost per home accessed [in €] | | | | | |
|---|---|---|---|---|---|---|
| | DE | FR | SE | PT | ES | IT |
| VDSL | 457 | n.v. | 352 | 218 | 254 | 433 |
| PON | 2,039 | 1,580 | 1,238 | 1,411 | 1,771 | 1,110 |
| P2P | 2,111 | 2,025 | 1,333 | 1,548 | 1,882 | 1,160 |

**Source:** Elixmann et al. (2008)

## 3.2. Policy challenges raised by the migration to NGN

The regulatory framework for electronic communications that was put in place in 2002-2003 was intended to deal flexibly with precisely the issues of convergence that are raised by the migration to NGN, and for the most part it is doing so; nonetheless, the migration has raised numerous unforeseen (and unforeseeable) practical issues and challenges for public policy, not all of which have been addressed as yet.

This section discusses a range of challenges associated with the move to IP-based NGNs.

### 3.2.1. Changes in the nature and character of competition

The European regulatory framework seeks to let the market operate unimpeded wherever feasible, but to intervene proportionately when necessary to enable competitive entry in the face of market power.[29] The migration to NGN changes the character of competition substantially.

[27] A further variant is FTTB (Fibre-to-the-Building). It can be described in a simplified way as FTTH, while the fibre ends in the basement of the buildings and the communication path to the end users will be continued using existing in-house cables.

[28] See Elixmann et al (2008). The figures presented are based on the scenario that a stand alone first mover deploys the respective infrastructure in an urban cluster and reaches a market share of 50% of the population in this cluster (and 54 % in the case of Germany and P-2-P).

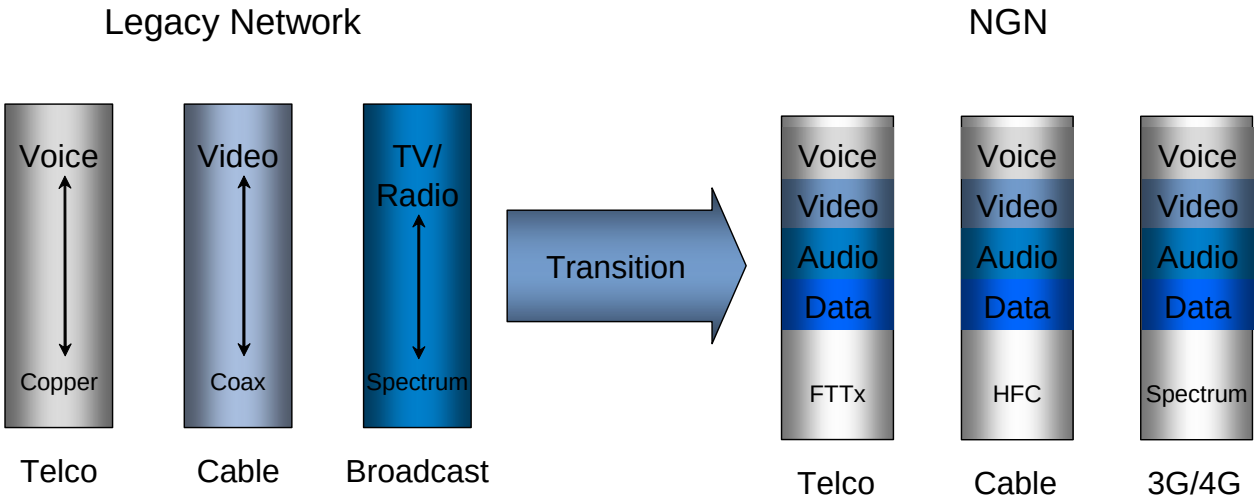
[29] Framework Directive 2002/21/EC, Article 8, requires NRAs to protect competition by "… ensuring that there is no distortion or restriction of competition in the electronic communications sector …"

These changes necessitate refinements in how certain markets should be analysed, and as to which remedies might be most suitable in specific circumstances; however, they do not fundamentally change the process established in the 2002-2003 framework.

Will the evolution to NGN make market problems better, worse, or about the same? As of now, it is difficult to say. There are forces pushing in opposite directions, such that it is difficult to predict what balance will ultimately prevail.

Historically, there was a close linkage between a communications *network* and the *service* that it provided. Moreover, a given network typically delivered a single service (see Chapter 1). A stylised view of this situation is provided in Figure 1.

**Figure 1: Migration from a traditional circuit-switched network to an IP-based NGN**




**Source:** WIK-Consult

The migration to NGN brings to full fruition a trend that was already under way with the implementation of IP as transport protocol into a network: the *decoupling of the service (provision) from the network (transport)*. Specifically, in an IP-based NGN world:

- Any network can carry any service.[30]
- Any network can simultaneously carry multiple services.
- A service provider need not be a network operator at all (and vice versa).

These changes have a number of implications, mostly positive. Ten years ago, a fixed network incumbent might have been subject to little or no effective competition. Today, mobile operators and cable television operators can compete with fixed incumbents and with one another. Moreover, they could compete over the full range of voice, video and data services. Finally, independent firms that do not have a network at all (consider the Internet telephony provider Skype as an example) can become unconventional competitors to traditional telephone service providers.

These new forms of competition tend to weaken the market power of existing incumbents, and might provide a basis for selective deregulation going forward. At the same time, it is clear that certain forms of market power are likely to persist for a long time, if not indefinitely. The shift to NGN is unlikely to eliminate these forms of market power. Notable examples include:

- For the foreseeable future, there will be only limited competition for "last mile" network access (see Section 3.2.2); and

[30] A caveat is needed here: To deliver a service, a network must be able to offer underlying service quality and bandwidth consistent with the application's needs.

- Networks that complete or terminate calls to a phone number possess a form of market power known as the termination monopoly that enables them, in the absence of regulation, to demand termination fees well in excess of their real costs (see Section 3.2.4).

There is also a significant but difficult-to-assess risk that new bottlenecks could emerge. For example, the IMS capabilities that are being developed for fixed and mobile networks could be used to open up service development to third parties, but it is more likely that network operators will attempt to use IMS to restrict the ability of others to offer innovative services to the network operator's customers.

Finally, the change in market value chains brought about by convergence generally, and accelerated by the move to IP-based NGNs, is motivating a constellation of concerns that are collectively referred to as *network neutrality*.[31] One manifestation of net neutrality concerns relates to firms that own not only an electronic communications network, but also own or are affiliated with content or applications that could be transmitted over the network. The concern is that a firm that possesses market power in one market segment might attempt to project that market power into upstream or downstream market segments that would otherwise be competitive, a behaviour known to economists as *foreclosure*. For example, a firm that has sufficient market power over broadband Internet access might block or impair access to Voice over IP (VoIP) services in order to favour its own voice services,[32] or might block or impair access to some Internet web sites in order to encourage access to web sites that it owns or with which it is affiliated. [33]

To date, attempts to exercise this kind of foreclosure have often failed. Witness the AOL/Time Warner merger, where the new entity did not notably benefit from possessing both network and content. Where underlying markets are sufficiently competitive, anti-competitive foreclosure is usually unprofitable. It is nonetheless important to monitor market development and identify competition policy issues particularly where underlying markets are highly concentrated, and where problems could indeed emerge.

On balance, it is likely that the need for regulation will be mitigated somewhat by the shift to NGN, but it is unlikely that the need for regulation will evaporate any time soon.

### 3.2.2. Pro-competitive regulation and Next Generation Access (NGA)

In the traditional PSTN related network world market participants have four different alternatives to offer retail services to end users on the basis of wholesale services of an incumbent: Full unbundling of the local loop; shared access to the local loop; bitstream access; and resale. In the case of full unbundling, the incumbent provides physical access to its copper lines in the local loop at the MDF location; the competitor, in turn, has to establish own transport network facilities up to the MDF and he or she has to collocate at the MDF site. In the case of shared access, both the incumbent and the competitor jointly use the copper loop: The low frequency band remains with the incumbent whereas the high frequency band enabling high speed DSL services is rented by the competitor. In the case of bitstream access the incumbent provides a wholesale service to a competitor consisting of traffic from and to an end-user, i.e. "bits". As such, bitstream access saves investment costs on the part of the competitor because the exchange point for the bitstream usually is far beyond the MDF, i.e. nearer towards the core network of the competitor. Yet, there is also a "disadvantage" for the competitor, inasmuch he or she have limitations in setting up own service characteristics (e.g. regarding service quality), i.e. it is an "off-the-shelf" business. Resale requires the least network investment by the competitor: He or she purchases the service from the incumbent on a wholesale basis and resells it (without changing anything other than the brand and the tariffs) on the retail market.

[31] See Marcus (2008).
[32] In the US, the FCC entered into a consent decree with the local telephone company Madison River in order to prevent it from blocking access to the VoIP provider Vonage.
[33] It is due to concerns over intentional degradation of service quality that network neutrality concerns are often linked to issues of QoS (see Section 3.2.5).

These wholesale services mirror the ADSL related broadband world. Full unbundling, shared access and bitstream access have been subject to regulation in all Member States since the introduction of the regulatory framework in 2002 and they still have a high significance for competition across all Member States. Yet, in parallel with the deployment of VDSL technology and FTTB/H infrastructure that was initiated in the last years in some Member States some NRAs in Europe have already added new regulated wholesale services to this catalogue of remedies. These changes include e.g. access to dark fibre and access to ducts.

Overall, migration to fibre-based NGA greatly complicates pro-competitive regulation due to both physical characteristics of the new (fibre based) networks and economic characteristics of costs of deployment (and, in turn, of business plans). As to the key challenges of the migration to NGA for competition and regulatory policy ahead it is reasonable to take on a functional perspective and differentiate between the passive infrastructure of trenches, ducts, dark fibre, and such ("*NetCo*"); the active infrastructure including lit fibre ("*OpCo*"), and the actual service provision of retail services ("*SalesCo*"). A priori different business models are possible differing in the level of integration of these functions. The challenge for competition (and for competition policy) will be to have suitable forms of "open" access implemented.

*"NetCo" related issues*

In an FTTC/VDSL world crucial issues regarding competition relate to:

- the unbundling of the sub-loop (network part between the street cabinet and the end user's home),
- access to or joint utilization of the cabinet[34], collocation at the cabinet,
- access to civil engineering infrastructure (e.g. "ducts"),
- access to the fibre access infrastructure between the newly established Metro Core Locations and the cabinets.

Regarding FTTB/H, challenges regarding a level playing field for competition relate e.g. to:

- loop access to civil engineering infrastructure, e,g, access to existing ducts,
- the joint establishment of trenches, ducts etc.,
- access to the unbundled (dark) fibre loop,
- the joint utilization of optical switching facilities, like e.g. the Optical Distribution Frame,
- access to different colours in the case of Wave Division Multiplexing,
- access to/joint utilization of in-house cabling.

Thus, overall policy issues regarding access to the passive infrastructure ("NetCo") include: Will the technology deployments allow access to the equivalent of unbundled copper in the PSTN? Will it be possible to provide access to NGN infrastructure (or infrastructure elements) that have quite different requirements than in the PSTN world, e.g. access to optical devices; access to street cabinets in view of requirements regarding physical space, heat dissipation etc.? Are there provisions for access to civil works (ducts, poles, and other pertinent infrastructure), provisions for "getting inside a building" and access to in-house wiring which set the appropriate incentives for viable infrastructure investments of market participants?

Moreover, the migration to NGA architectures inherently has implications for the optimization of network design. In turn, it can be taken for granted that many of today's MDFs are closed down, or remain as a mere infrastructure node point because of the existing duct infrastructure, and be replaced by a metro core location. This brings about the issue of stranded investments of competitors who have deployed their infrastructure with a view to an MDF based network.

[34] Usually, the street cabinets have to be exchanged in order to be able to install the DSLAMs.

*"OpCo" related issues*

Policy issues regarding access to the active infrastructure ("OpCo") might include: Is there an appropriate set of wholesale services provided that allows the provision of those services that are demanded on the retail level? In all likelihood "bitstream-products" will play a role as they do today in the current broadband environment, yet they have to be redefined.

In an NGN environment they might be based on the Ethernet protocol; in view of the migration to triple-play services a crucial requirement might e.g. be the multicast capability. Furthermore, they might (have to) differentiate according to bandwidths and quality of service levels. A particular important issue will be: Is there a need for an ongoing split between voice based wholesale services and data/internet based wholesale services?

*"SalesCo" related issues*

Policy issues regarding the actual service provision ("SalesCo") include: Is there a need for resale and what are the requirements to OpCo/NetCo to enable resale services? To what extent should resellers have the opportunity to innovate and add value to their offerings and what are the requirements to OpCo/NetCo functions and elements to enable this?

*Overall public policy perspective*

The most significant overall regulatory and public policy issues are thus: (1) What are key principles that describe the roles and responsibilities of the specific actors on each of the mentioned layers/functions? What are the wholesale services to be exchanged between NetCo(s) and OpCo(s) as well as between OpCo(s) and SalesCos that might require intervention? Which interfaces should be "open"? What are suitable future market definitions, in particular in view of potential new "local" monopolies? Who is going to be regulated? What are appropriate pricing (principles)?

Overall, from our perspective, the current Commission draft Recommendation on NGA addresses the key issues likely to be brought about by the migration to NGA technology in a suitable way and is a pertinent starting point; however, some aspects would benefit from further refinement. We discuss the draft Recommendation on NGA in detail in Section 6.2.

### 3.2.3. Achieving deployment of current and Next Generation Access (NGA)

This section deals with a range of issues relating to the deployment both of copper-based broadband access and of fibre-based NGA. We discuss how to deal with the risk associated with the deployment; the linkage to aspects of universal service; and the linkage to State Aid policies in the European Union.

*Risk (reduction)*

Regulatory policy and actions in all likelihood have a severe impact on the incentives of market participants to deploy NGA infrastructure and on the viability of their business models. The costs of deploying new infrastructure are affected by a variety of different factors mirroring specific conditions of a country or region. Apart from these specific topographic, socio-demographic and socio-economic conditions "risk" (e.g. due to unforeseeable development of demand, competition, and so on) is a particularly important factor.

Thus, measures which allow market participants to decrease risks have an impact on the cost of capital and therefore are important for the business case at large. A priori there are several potential modes of risk reduction, e.g. cooperation of carriers in a particular venture, exchange of NGA capacity in different regions (carrier A deploys infrastructure in area 1 and carrier B in area 2), binding pre-commitments of a carrier to demand specific capacities once the NGA infrastructure is deployed, etc.

The challenge for competition and regulatory policy is on the one hand that there are appropriate incentives for market participants to make such arrangements and on the other hand to secure that agreements between two or more carriers set to reduce risks are not used to the detriment of other market participants.

*Universal Service*

Several countries in the world (e.g. Finland, the UK, Switzerland) have plans to incorporate "broadband" services into their respective universal service obligations. These countries have defined a specific minimum bandwidth which is currently still equal to or less than 2 Mbps.

It is highly likely that the issue of "broadband universal service" will rank higher on the political agenda in the next years. The definition of a broadband universal service target first and foremost is a political issue. From an economic perspective there is no unique answer as to the overall benefits of such a measure. On the one hand one can expect a benefit for the economy and society at large due to greater bandwidth availability. On the other hand, to the extent that universal obligations lead to subsidization of activities market distortions can be expected, inasmuch as subsidies to the universal service provider might lead to a reduction of investments by other market participants. Thus, a thorough (empirical and theoretical) examination of the pros and cons of broadband related universal service policy targets seems to be an appropriate approach to have a suitable decision basis (see Section 7.3).

*NGA deployment and State Aid*

Many countries (in Europe and abroad) have set up already ambitious plans regarding a "national" deployment of NGA. All of these plans usually specify that a minimum bandwidth of x Mbps should be reached for y % of the population or households by year t. It is likely that these objectives in the overwhelming number of cases are not reachable by pure market based solutions. Thus, it is foreseeable that governmental support will become crucial. In particular, governmental entities might become more and more involved in the actual deployment/operation of fibre based broadband infrastructure (as e.g. national governments in Australia, Singapore and Finland; municipality owned utilities in Sweden, France etc.). Thus, the following issues arise: Is there a clear and coherent frame how these activities fit into the competitive landscape and are the appropriate measures in place to minimise distortions? Are the principles and conditions regarding State Aid appropriate?

### 3.2.4. The changing character of network interconnection

Voice interconnection in the traditional circuit-switched network has been a highly regulated and contentious affair. Data interconnection in the Internet, by contrast, is managed by commercial arrangement, and has rarely required regulatory intervention. Given that NGNs draw on elements of both worlds, which is the appropriate model going forward?[35]

Voice telephony is subject to a form of market power known as the termination monopoly. In general, there is only one network that can complete a call to a given phone number; thus, while there may be competition for call origination, there is only rarely competition for call termination. Consequently, fixed and mobile operators – even relatively small ones – usually charge one another prices greatly in excess of their costs for completing (terminating) calls if they are allowed to do so. Since 2003, nearly all fixed and mobile operators have been subject to regulation of their wholesale termination fees in order to mitigate this kind of gouging, but termination fees remain high even so (see Section 6.3).

In the Internet, by contrast, most interconnection is accomplished by variants on two forms of interconnection:

- *Peering*, where two networks agree to exchange traffic between their respective customers (and customers of their customers); and
- *Transit*, where one network (the transit provider) agrees to carry the other's traffic not only to its own customers, but also to third parties (usually to the entire Internet, the whole world).

[35] For additional background on NGN interconnection, see Marcus et al. (2008).

Peering is often, but not always, implemented free of charge to either party; however, Internet network operators can be very selective as to which networks they are willing to peer with. Transit, by contrast, is almost always charged for.

It seems clear on technical grounds that an integrated NGN carrying voice, video and data should find it economically advantageous to interconnect all of these services by means of a single IP-based interconnection; however, this is not the way that the industry has evolved so far. All network operators use variants of peering and transit to interconnect their *data* services. Small independent Voice over IP (VoIP) providers interconnect their *voice* services by means of IP, as do some cable operators; however we are aware of no instance where a fixed incumbent or a large mobile operator interconnects its own voice services to competitors by means of IP. Instead, fixed incumbent and large mobile operators continue to interconnect their voice services using the same circuit-switched interconnection capabilities (together with the Signalling System 7 [SS-7] protocol) that they have been using for years, *even if they have already converted their core networks to the use of the IP protocol*. Clearly, something is happening here that has little to do with technology.

Our belief is that the revenue from mobile termination rates, and to an even greater degree the retail payment structure that those termination rates enforce, is commercially important to the network operators. They are unlikely to evolve their interconnection arrangements to IP as long as they perceive a risk to their wholesale and retail payment arrangements.

The European Commission has recently taken steps to lower termination charges for fixed and mobile voice interconnection (see Section 6.3). They did so for reasons that have little to do with the migration to NGN, but the lower termination rates are probably a step in the right direction in terms of enabling network operators who wish to do so to shift their interconnection arrangements from circuit-switched SS-7 to packet-switched IP.

The ability of a network to support different levels of Quality of Service (QoS, see Section 3.2.5) is closely linked to these interconnection issues, since the QoS must be preserved across an IP interconnection. Changes in the number of *Points of Interconnection (PoI)* as a result of the migration to NGN are also closely related to these interconnection issues.

### 3.2.5. Quality of Service (QoS) and implications for network neutrality

*Quality of Service (QoS)* has a very different interpretation in IP-based systems than it does in the traditional telephone network.

In the telephone network, if there is too little capacity in the network, a call is simply not completed.

The Internet reflects very different design principles. It was created with applications like email in mind, where delay is not a major concern. If there is too little capacity in an IP-based network, it is designed to *gracefully degrade*. In a congested network, IP packets spend more time on queues (internal waiting lines) before being transmitted; if too many are queued up, the routers that comprise the network are even allowed to discard packets, knowing that the system that originated the IP packet will send it again if it was important for the packet to eventually get through.

The more relaxed design approach of the Internet has worked brilliantly for email, and reasonably well for web browsing and other data applications; however, as real time voice and video move to IP-based NGNs, this approach faces more serious challenges. Many of us have spoken occasionally over telephone connections that use geosynchronous satellites (satellites that orbit above the equator, and seem to stay above the same spot on earth all the time because their orbit takes exactly 24 hours). The familiar problem is that parties on both sides of the telephone connection start to talk at the same time – due to the delay, the second person begins to speak before hearing that the first is already speaking!

Many studies show that two way voice conversations start to run into difficulties when delay exceeds about 150 milliseconds (0.15 seconds).[36]

The risk of delay can be a problem for some uses of the network, but not for others. It can be a problem for two way voice and video, but not necessarily for one way "streamed" voice or video (think of YouTube) as long as the user is willing to wait for a second or two as the transmission begins. For most data applications, delay within reasonable bounds is not a problem; however, there are some (think of "shooter" games) where it is critical.

The Internet was not originally designed to control delay, but a great many individual networks have been enhanced over the last ten years to provide two or more classes of service, such that delay-sensitive applications such as two way voice could be given preferential treatment (similar to the express check-out line at a supermarket).[37] The technology is not particularly difficult, nor is it particularly expensive. It is widely deployed *within* networks, but rarely used *between* them, for several key reasons:

- Under normal load, IP-based networks perform quite well most of the time, even for demanding applications like two way voice. This is why services like Skype work as well as they do. Customers will not pay a large premium for better quality, given that service quality seems to be good enough without most of the time.
- Recognizing this state of affairs, some services have already been designed to operate within a single network much of the time.
- Given the lack of commercial motivation, business models (and to a lesser degree technical models) for IP-based interconnection that would provide strong assurance of preservation of QoS have not emerged.
- QoS-aware IP interconnection would be of little value until and unless it were implemented by most networks; consequently, it is hard to get past the *initial adoption hump*.[38]

This technical lack of assurance of QoS is linked to a complex set of policy issues known collectively as *network neutrality*. Net neutrality means different things to different people, but the core concern is that network operators might somehow manipulate the QoS of IP packets so as to benefit themselves (especially in anti-competitive ways), to the detriment of consumers.

Consider, for example, a vertically integrated incumbent network operator that offers traditional voice services as well as broadband Internet access. It might be motivated either to subtly degrade the access of its broadband customers to competing Voice over IP (VoIP) services like Skype, or to block them altogether. As another example, the integrated network operator might strike a cooperative agreement with an online bookseller, and then seek to degrade or block its broadband customers from accessing competing online booksellers.[39] From a public policy perspective, these behaviours are problematic because they represent forms of *vertical foreclosure* – a firm that has market power in one market segment (e.g. broadband) seeks to project it into an upstream or downstream market segment (e.g. voice call origination) where it would not otherwise have market power.

Concerns about deviations from network neutrality have been far more intense in the United States than in Europe, probably as a reflection of differences in competitive circumstances. Most *problematic* deviations from network neutrality represent some form of exercise of market power; thus, effective competition inhibits these problematic behaviours.

[36] Note that the round trip delay in communicating through a geosynchronous satellite is governed by the speed of light, and is roughly 270 milliseconds.
[37] One can also control which packets should be discarded first under heavy load.
[38] This is a common challenge for products and services that are subject to *network externalities* (*network effects*). See e.g. Rohlfs (2003) and Marcus (2004).
[39] The catalogue of behaviours that some have viewed as problematic violations of network neutrality is large, and some of them should arguably not be viewed as problematic. See Carter et al. (2009).

The broadband market in the U.S. could largely be characterised as a series of non-overlapping duopolies between one telephony incumbent and one cable television operator; by contrast, and largely thanks to the effectiveness of the European regulatory framework, most of the EU enjoys a much richer tapestry of competitive alternatives.[40]

### 3.2.6. Challenges linked to the migration period

Experience in the UK and the Netherlands have demonstrated a number of issues that are strongly linked to the migration period itself. Most noteworthy among these is the change in the number and in the locations of *Points of Interconnection (PoI)* used for access and for interconnection.

IP-based networks do not require as much of a hierarchical (tree-like) structure as do traditional circuit-switched networks. Consequently, the migration to NGN usually enables a network operator not only to avoid replicating no-longer-needed equipment, but may also enable the network operator to completely move out of some buildings.[41]

In both the UK and in the Netherlands, serious concerns were raised about not-yet-fully-depreciated investments that the competitors had made to interconnect in locations that would no longer be available for interconnection, or in some cases that would no longer exist at all. In both instances, the NRA eventually concluded that it was necessary to strike some compromise – on the one hand, the incumbent must be able to upgrade its network; on the other, competitors were reasonably entitled to reasonable notice periods, and generally to a migration plan that was understood in advance and not unreasonably disruptive. Once the NRA made this clear, the market players were able to negotiate reasonable outcomes.

Moreover, a crucial issue for regulation might be price regulation in view of the likely co-existence of different (PSTN and IP-based) networks. It is reasonable to assume that the cost structure and in particular the unit cost level of an all-IP-based network (i.e. a fully-fledged NGN) will be lower than those of the traditional PSTN based network; however, during the migration period, the costs of operating two networks in parallel are in all likelihood higher than the costs of the PSTN network alone. Thus, regulation has to find an incentive-compatible way of "getting from here to there", particularly with respect to the pricing of access and interconnection.

### 3.2.7. Implications for standardisation and interoperability

The International Telecommunications Union (ITU) has been instrumental in global NGN standardisation. The most important organisations responsible for standardisation of NGN in Europe are ETSI TISPAN (fixed NGN), 3GPP (mobile NGN) and CableLabs (cable NGN). They are all striving to achieve a single, converged standard for the NGN core. They rely on the work of several other industry fora, of which the IETF, the SIP Forum and ECMA are the most important.

Many hope that the *IP Multimedia Subsystem (IMS)* will serve as a unifying, common session initiation framework across the various NGN standards architectures. The IMS is "a standardised access independent IP based architecture that interworks with existing voice and data networks for both fixed and mobile users".[42] Standardisation efforts of the ITU, 3GPP, and ETSI have led to a specific IMS-based concept which is likely to be the basis for the actual and future core network migration of telecommunications network operators. One important characteristic of the IMS concept is the functional division of a network into a transport layer, a control layer, and an application layer.

[40] Ibid. See also Marcus (2008).
[41] Indeed, KPN initially intended to fund its migration to NGN in the Netherlands to a significant extent by selling off Central Office buildings and real estate that would no longer be needed.
[42] See 3GPP (2006): 3GPP TS 23.228 version 7.6.0 Release 7.

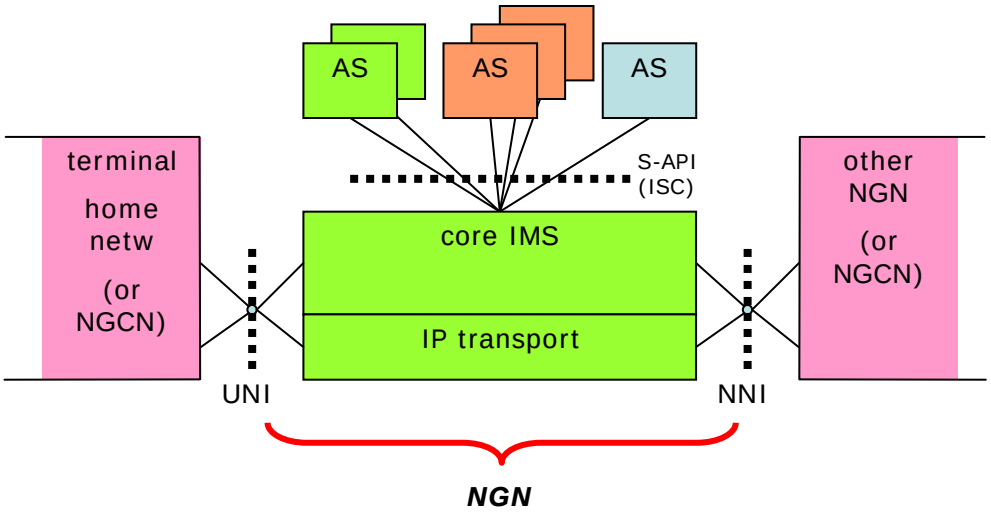
IMS-based network protocols are independent of the specific access mode used (fixed, mobile, or fixed wireless access). Network operators that have both fixed and mobile offerings might find IMS useful as a means of achieving consistency across both in terms of the way in which applications are deployed and made available.

Today, these standards fora tend to deal with architecture, signalling protocols and quality issues as if there were only a single worldwide NGN. Detailed standardisation of interworking of NGNs has just begun.

This not only relates to interconnecting NGNs but also to service interworking. With regard to NGN access, progress is also being made on interworking between NGN and home networks or corporate networks, largely as a result of requirements from industry fora.

There are two defined NGN interfaces that required standardisation because they are by definition open to third parties: the NNI (Network-Network-Interface) and the UNI (User-Network-Interface). By contrast, network operators do not (yet) intend to open the service-API IMS platform interface (between the IMS core and the application servers) to third parties, or even to parties competing on the same service. This interface could prove to be important to the extent that it could serve as an architectural and technical point of demarcation between the network infrastructure operator and a service provider under a functional separation regime.

**Figure 2: User related and network related interfaces in the IMS concept**




**Source:** TNO

Because the IMS architecture originally came from the mobile world, it inherently supports mobility. Many of the same capabilities could be used to support *nomadicity* (the ability to connect to the fixed network at different locations at different times) for fixed users. Roaming agreements between fixed network operators would be required.

The present standards for the handling of emergency calls already address subjects such as priority and location information, but for emergency calls crossing NGN borders (interworking with legacy networks or other SIP-based networks) numerous problems remain, primarily in regard to privacy and security and to being able to recognise return or alarm verification calls. Emergency calls originating in multi-site or multi-national private networks are a particular concern.

In some countries, a public mobile network is obligated to accept emergency calls from all devices, even if the device would not otherwise be permitted to communicate on the network, and even if the device were fitted with a Subscriber Identity Module (SIM) that does not have the correct credentials for the network concerned. Such calls are treated as having an anonymous caller. The migration to NGN raises a number of questions in regard to this practice, including its appropriateness and applicability to private networks (NGCNs).

There is much work for the standards bodies in the years to come, but for the moment we do not feel that there is a need for public policy intervention. In most cases, it is preferable to leave development of standards to the standards bodies and industry fora that routinely deal with them.

Standards for QoS-aware IP-based interconnection might eventually represent an exception. The technology for QoS-aware IP-based interconnection is not particularly difficult, but standards have failed for many years to mature, apparently due to lack of commercial demand coupled with confusion as which business models should be supported.[43] This merits monitoring.

### 3.2.8. Implications for spectrum management

Spectrum management is a large and complex subject area in its own right. For the most part, the migration to NGN has only a limited intersection with spectrum policy.

However, one point bears mentioning. The move to NGN implies new demands for greater transmission bandwidth. Fixed and mobile wireless solutions are likely to be the preferred way to deliver high speed broadband communications to rural areas, and more generally to areas with few subscribers per square kilometre. This is likely to imply an increased appetite for spectrum capable of delivering high bandwidth data over moderate distances, which is to say spectrum in frequency bands below 3 GHz. Mobile operators prefer the frequency range between 400 and 900 MHz due to the physical properties of frequencies which allow geographically larger cells in case of lower frequencies. This is partly reflected in the current discussion on the efficient use of the “Digital Dividend” brought about by the digitalisation of broadcasting. Spectrum management authorities at the Member State level are thus likely to be under continuing pressure to find more high quality spectrum.

### 3.2.9. Other issues

#### 3.2.9.1. Voice over IP (VoIP) issues

Even prior to the migration to NGN, voice telephony has been migrating to an IP basis. Since 2004, there have been ongoing efforts at European level to ensure that regulation of Voice over IP is appropriate and consistent;[44] even so, differences remain from one Member State to the next, and these differences impede the emergence of pan-European and multi-Member State services.[45] Issues that have emerged include (1) ensuring access to emergency services (“112”), especially from *nomadic* users whose ostensibly fixed physical location could in reality move, as well as ensuring that VoIP callers can be located; (2) inconsistent rules among the Member States as regards access to telephone numbers, especially geographic numbers; and (3) lack of consistency in the procedures and administration of lawful intercept (wiretapping). The ongoing regulatory reform package addresses the issue with emergency services. By contrast, lawful intercept is a matter of national, rather than European competence, even if the lack of consistency is a European problem.

#### 3.2.9.2. The future evolution of telephone numbers

In an IP-based NGN world, one could imagine innovative approaches to telephone numbering that seem barely conceivable today. On the one hand, one might delegate numbering control for a defined range of numbers to an enterprise or to a small business user. On the other, one could imagine supplanting the telephone numbering system altogether, for example by email-like SIP Universal Resource Identifiers (URIs).

[43] There is a substantial literature on the economics of standards adoption in markets subject to network effects. See for instance Rohlfs (2003) and Marcus (2004).
[44] See e.g. European Commission (2004, 2005) and ERG (2005, 2007).
[45] See e.g. Marcus, Elixmann and Wernick (2008).

#### 3.2.9.3. User rights and user protection

The evolution to NGN interacts with a range of user rights and consumer protection issues; however, most of these issues were already present for existing broadband and for existing Internet and electronic commerce applications. These are not necessarily *new* challenges.

There is some risk that migration to NGN will exacerbate the Digital Divide between *the haves* and *the have-nots* of good Internet access (see also the discussion of achieving deployment of broadband and NGA in Section 3.2.3). The deployment of fibre-based NGA raises concerns of a three-speed Europe, where some end-users have ultra-high speed access thanks to fibre-based NGA, others have conventional broadband, and still others either have slow access (e.g. dial-up) or else none at all. These speed differences could be linked to a range of social concerns, to the extent that users lacking good access might be poor, or disadvantaged, or residents of newer Member States where infrastructure is not yet fully developed. If NGA truly enables the use of new services, then it could also introduce new disadvantages.

To date, NGN voice and data services have largely presented themselves to the user by means of the same interfaces as traditional voice and data services; however, to the extent that they evolve in the NGN context, they might possibly pose new challenges in terms of digital literacy. This again raises some risk that the Digital Divide might possibly take on a new dimension.

Many of the network and information security concerns that are present in today's Internet will simply carry over to NGNs. It is possible that the NGN will be somewhat more resistant to intrusion than the Internet, because a network that is essentially a closed and private environment may find it easier to exclude hackers than a network that is more open. On the other hand, one could equally well argue that the integration of IP-based technology into the public network exposes the latter to new Internet-style threats from which it was somewhat insulated historically.

Privacy concerns do not appear to be very different for IP-based NGN services than they have been for IP-based Internet services; however, it is possible that new wrinkles will emerge in time.

Taken as a whole, we think that these are areas that need watching, but for the most part they are not immediate concerns today.

# 4. NGN DEPLOYMENT AND REGULATORY RESPONSES IN THE MEMBER STATES

European Member States (and other countries as well) differ greatly as to how NGN/NGA has been deployed. In many, the first major development was deployment of fibre into the access network; in others, the NGN core was built out first. In a few Member States, both the core and the access have been upgraded to NGN. In some Member States, incumbents have driven the migration to NGN, while in others competitors have taken a significant or even a leading role in upgrading to NGN. On the access side, some companies have emphasised FTTB/FTTH, while others have chosen to focus on FTTC/VDSL.

There are no hard and fast rules, but a few trends emerge. In general:

- Migration of the *core network* is driven primarily by the need to reduce operating expense (OPEX), and secondarily by the desire to bring new services to market more quickly.
- Migration of the *access network*, by contrast, typically requires a greater investment, and is often a response to strong competition for network access.
- Core-first migration is unlikely in countries where access competition is strong. The best examples are the UK and Italy, where fixed access competition was comparatively weak.
- For FTTC/VDSL to be superior to high end ADSL, sub-loop lengths (from the street cabinet to the customer) must be fairly short. Countries where loop lengths are relatively long (such as France) prefer FTTB/FTTH over FTTC/VDSL.

Regulatory responses have also been varied, but some common themes emerge. In many Member States, the migration to NGN access has been accompanied by a planned or actual reduction in the number of Points of Interconnection (PoI), and a shift in their locations. This has generally raised concerns about stranded investment on the part of competitors (see section 3.2.2), and about a possible weakening of competition. At the same time, Member State regulators have attempted in various ways to deal with the difficulties that NGA imposes on pro-competitive remedies such as LLU. There has been increasing interest in functional separation as a possible response to these new challenges in the access network (see Chapter 5).

Table 2 summarises how NGN has been deployed in various countries, how regulators have responded, and generally what the results have been. We have selected ten Member States where NGN developments are particularly illuminating, including many of the largest Member States. We have also included Australia and the United States for comparison.

For the European Member States, we have provided additional detail in Annex 2, as noted in the column “Annex Section”.

**Table 2: NGN evolution in different countries**

| Country | Annex Section | Competitive environment | Policy challenges | Results |
|---|---|---|---|---|
| Finland | 2.1 | Moderate last mile competition. A large number of incumbents collectively serve 65% of broadband demand using DSL. | Government to ensure 100% access to 1 Mbps broadband by the end of 2010. By 2015, 100% should be within 2 km of a 100 Mbps point of presence. | Too soon to say. |
| France | 2.2 | Heavy competition in Paris and other metropolitan areas, where extensive sewers facilitate FTTB/FTTH deployment. | In deploying FTTB, the French have encountered challenges with infrastructure sharing within buildings, as well as with the applicability of access to a PON infrastructure. | France has an excellent roll-out of FTTB/FTTH, and not just by the incumbent. |
| Germany | 2.3 | Moderate last mile competition. Widespread cable coverage (but with limited effectiveness), moderately strong telephony competitors. Substantial LLU. Steady loss of incumbent market share. | Incumbent claimed “regulatory holiday” for its VDSL deployments. This was acceptable to the German government, but not to the European Commission (pending infringement procedure). Many questions remain unanswered. | The incumbent is deploying VDSL to roughly half of German households. Competitors have also been rolling out high speed access in metropolitan areas. The German government has committed to providing 100% broadband availability by the end of 2010, and 75% at 50 Mbps by 2014. |
| Hungary | 2.4 | The biggest incumbent, Magyar Telekom, owns about 75 % of all subscriber access lines. There are two smaller local incumbents (the smaller being owned by UPC, the largest cable provider). Cable TV penetration is relatively high, only slightly below the PSTN household penetration (~ 60%). | Magyar Telekom is still extremely dominant. Consumer associations mourn that the quality of Magyar Telekom’s services has significantly decreased because the incumbent could afford not to maintain its network properly and not to invest at all or to reduce its maintenance activities and investments. | Magyar Telekom announced an FTTH roll-out plan in September 2008, which aims to connect 200.000 households by the end of 2009, and 780.000 households by the end of 2013. |
| Italy | 2.5 | Cable is absent in Italy. The incumbent was subject to only limited access competition in the past, but is under increasing pressure from FASTWEB. | The changes to the core network had minimal regulatory impact (technological neutrality), since they were largely invisible to customers. The incumbent is subject to a form of functional separation. | Telecom Italia quietly converted its core network to an IP-based NGN some years ago. FASTWEB has been deploying FTTH for years, and is present in about half of Italy. The incumbent has published an NGA plan (“NGN 2”) in 2007 (based on VDSL and FTTB/H). In 2008 Fastweb and the incumbent cooperate with regard to broadband deployment |

| Country | Annex Section | Competitive environment | Policy challenges | Results |
|---|---|---|---|---|
| Netherlands | 2.6 | Very substantial last mile competition. Ubiquitous cable coverage, strong telephony competitors. | Broad discussion of challenges regarding FTTC/VDSL. Proposed abandonment of MDFs would have crippled telephony competitors. Sub-loop unbundling was shown not to be viable. | Original incumbent plan focused on country-wide deployment of FTTC/VDSL. In parallel, many local and regional projects based on FTTB/H. Incumbent refrains from planned VDSL deployment. Rather, focus on FTTB/H thru a partnership. |
| Portugal | 2.7 | Limited last mile competition; substantial cable coverage; Portugal is the only country in Europe with an active reference offer for duct access. | In January 2009, the Portuguese government announced an 800 million Euro credit line for the roll-out of next-generation broadband networks The credit line forms part of an agreement between the government and several operators in exchange for access to the government-backed financing. | Too soon to say |
| Spain | 2.8 | Limited last mile competition. Widespread cable coverage. | The Spanish regulatory agency CMT is following a rather incumbent-friendly approach. Currently, Telefonica is obliged to offer wholesale broadband access for services with data rates of up to 30 Mbps only; but not for services that have data rates greater than 30 Mbps | Telefonica follows an ambitious roll-out plan and plans to pass between 11 and 12 million households with FTTH by 2010. |
| Sweden | 2.9 | Lively competition; widespread cable coverage; substantial deployment of fibre based infrastructure by municipalities. | The Swedish NRA, the Post and Telecom Agency (PTS), published its proposition for a public broadband roll-out program in early 2007. The proposed broadband strategy for Sweden suggests nation-wide access to broadband with at least 2 Mbit/s downstream by 2010. This roll-out should be based on open access under consideration of alternative access technologies. | The Swedish public broadband strategy has not been realised yet. Activity of the municipal broadband ventures under cartel office observation. |
| UK | 2.10 | Limited last mile competition. Cable covers less than half of the country. Fixed competition was ineffective, but is gaining. | The incumbent is subject to functional separation. Proposed abandonment of MDFs would have burdened telephony competitors with stranded investments. Need for regulatory certainty in a fast changing environment. | Steady progress on core migration. Access migration has been slow to date. Digital Britain proposes to charge consumers 50 pence/month to support broadband to lower density areas. |

| Country | Annex Section | Competitive environment | Policy challenges | Results |
|---|---|---|---|---|
| **Outside of the European Union** | | | | |
| Australia | (none) | A highly concentrated market, where the incumbent has bottlenecks for the fixed network, back-haul, mobile, cable television, mobile, and video content. | A limited form of separation was implemented years ago, which has satisfied no one. | Government intends to provide $43 billion AU to fund aerial FTTH to 90% of Australians in the next eight years. The Government is requiring separation of the incumbent, preferably by mutual consent. |
| USA | (none) | An increasingly concentrated market; however, ubiquitous cable competes with the telephone incumbent in almost every part of the country. | Penetration is lower than one would expect in a country with the fundamental advantages of the US. Choice is limited. Anti-competitive behaviour is feared (e.g. net neutrality) and is sometimes present. The Government has committed $7 billion to deploy broadband to rural, unserved or underserved areas. | The US has achieved a moderately high level of broadband adoption, and very substantial fibre deployment; however, many problems remain, and commercial forces are not likely to suffice to cover remaining areas. |

# 5. FUNCTIONAL SEPARATION AND NGN

Functional separation is not solely or specifically an NGN issue, but the migration to NGN has been closely linked to NGN in a number of specific cases.

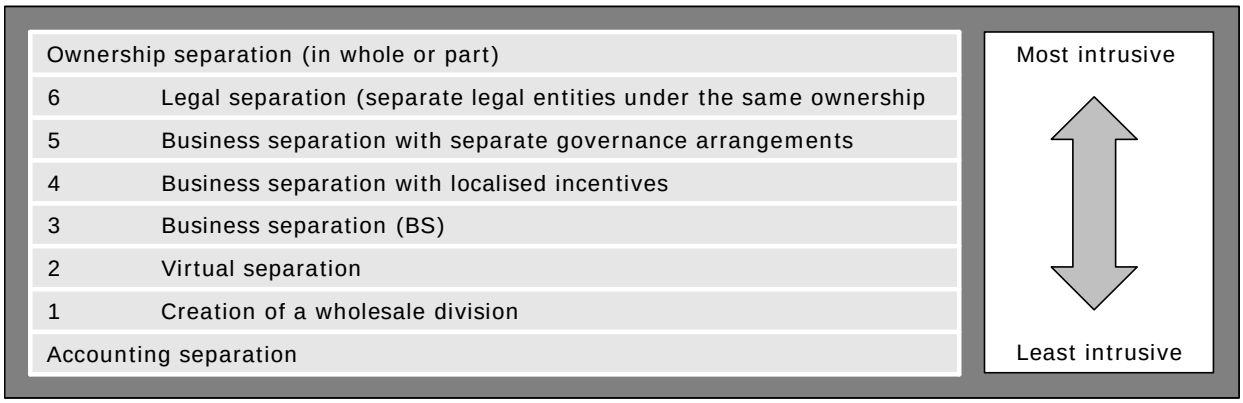
Section 5.1 provides background on the theory and history of functional separation; Section 5.2 provides relevant examples of functional separation in practice.

## 5.1. The theory of functional separation

Separation of incumbent telecom operators enjoys a history of at least a quarter of a century. The break-up of the U.S. Bell system in 1984 was the most spectacular case introducing a system of structural separation. In the nineties, separation became an issue in EU telecommunications as well. On the one hand, the 1995 Cable Directive[46] sought to ensure ownership separation between the telecommunication and cable networks in EU member states.[47] On the other hand, accounting separation of incumbent operators became a standard and meaningful remedy in the context of wholesale regulation.

Martin Cave's "Six Degrees of Separation: Operational Separation as a Remedy in European Telecommunications Regulation"[48] is viewed by many as the definitive paper on functional or operational separation. Cave distinguishes different forms of separation (see Figure 3), which depicts a range of forms of separation from least intrusive (accounting separation) at the bottom to most intrusive (partial or full ownership separation) at the top.

**Figure 3: Different separation options**




**Source:** Cave (2006), p. 6.

Functional separation as an alternative to conventional pro-competitive access remedies gained broad attention in the context of the BT/Ofcom undertakings.[49] It aims at achieving equality of access for affiliated and non-affiliated operators and thus to abolish non-price discrimination. There is, however, a consensus that functional separation should not be imposed where conventional remedies would suffice. This is due to concerns that scale economies might be sacrificed, and investments might be hampered. These issues are addressed in the following section, which summarises existing experiences with functional separation.

## 5.2. Functional separation in practice

Experience with functional separation is still relatively limited. Our assessment is that there are grounds to be cautiously optimistic about the results of a properly implemented separation, but there are those who would disagree.

[46] Directive 95/51/EC.
[47] This attempt had only mixed success. Cross-ownership of cable and telecommunications activities is still in place in Portugal and Denmark.
[48] See Cave (2006).
[49] See for an overview of relevant literature Marcus/Wernick/Carter (2009).

This section of the report provides a brief summary of results from around the world. For supporting details, see Annex 3.

The fairly strong functional separation agreed between Ofcom and BT in the UK has been studied extensively. Stakeholders seem to be generally satisfied with the results. The UK has witnessed an explosion of broadband based on LLU, which has clearly benefited consumers and competitors. At the same time, BT does not seem to have been hurt – indeed, its stock price (prior to the financial crisis) appears to have been positively affected by the structural separation.[50]

The most nearly analogous separation is that of Telecom New Zealand. The operational separation of TCNZ is generally quite similar to that of BT, but slightly less intrusive. Preliminary results suggest that the separation is contributing to the successful introduction of LLU in New Zealand, and is generally working; however, it is rather soon to say anything definitive.[51]

Various forms of separation have been implemented in the United States over the past two decades. Of these, the separation imposed by the Computer Inquiries is the one most analogous to the BT/Ofcom model. Separation in the U.S. has largely been phased out over the past decade, but the US experience is nonetheless important. The forms of separation used in the US were relatively stringent. In each case, incumbents resented separation; however, in each case, stringent separation was reasonably effective in preventing anti-competitive discrimination.

Conversely, experience suggests that mild forms of separation can be problematic. In Australia, Telstra has been subject to a very limited form of separation since 2006. This separation has failed to achieve its prime goal of non-discrimination, and has proven unsatisfactory to Telstra, to its competitors, and to the Australian government. The government is seeking to impose a much more stringent separation in the near future.

Analogously, a the mild form of separation imposed in Italy on Telecom Italia by AGCOM, the Italian NRA, failed to resolve the problem of non-price discrimination. It was replaced by a more stringent separation in January, 2009.

Separation is not solely a response to NGN migration, but the two have often been linked. The BT separation came just as BT was looking to migrate its core network to NGN. The changes to the Australian separation regime are clearly part of the same reform process that is leading the Australian government to make massive investments to deploy fibre-based NGA to 90% of Australians.

At the same time, government deployment of NGA could necessitate substantial re-thinking of functional separation. In Australia and in New Zealand, there are large and still unresolved questions as to how to think about last mile competition in a future marketplace where a government-funded corporate entity represents an alternative last mile network operator, or perhaps the only last mile operator in the long run.

[50] See for instance Bleisch and Marcus (2009).
[51] Ibid.

# 6. NGN POLICY INITIATIVES AT EUROPEAN LEVEL

This section gives a brief overview of current initiatives at the European level. We begin by returning to those aspects of the legislative package associated with the Review of the regulatory framework[52] that are relevant to the evolution to NGN. We then address the Commission's (revised) draft Recommendation on Next Generation Access (NGA) (as of June 12, 2009) and the respective consultation, the Commission's Recommendation on fixed and mobile call termination, and standardisation efforts.

## 6.1. The Review of the European regulatory framework for electronic communications

The legislative package contains a great many features that are relevant to the evolution to NGN, and especially NGA. Our assessment is that the package, in its current form, is generally appropriate.

Relevant themes include (1) incentives for investment, (2) access to infrastructure, (3) functional separation, (4) network neutrality, and (5) spectrum management. We consider each of these in turn.

**Incentives for investment**: The text of Recital 6 sets the right tone at the outset, and makes clear the range of trade-offs that are required at Member State level:

> "*In order to achieve the goals of the Lisbon Agenda it is necessary to give appropriate incentives for investment in new high-speed networks that will support innovation in content-rich internet services and strengthen the international competitiveness of the European Union. Such networks have enormous potential to deliver benefits to consumers and businesses across the European Union. It is therefore vital to promote sustainable investment in the development of these new networks, while safeguarding competition and boosting consumer choice through regulatory predictability and consistency.*"

Recitals 43(a), 43(b), and 43(d) establish the importance of providing a reasonable expectation of a fair return on investment under sensible assumptions. They note that NGN deployment may be associated with risks that are different, and presumably higher, than traditional networks, particularly in regard to forecasting demand for new services. Recital 43(a) is also noteworthy in recognising the value of infrastructure-based competition.

**Access to infrastructure**: The new text of Article 12 of the *Framework Directive* is quite significant. The ability of Member States to require the sharing of key infrastructure, including ducts and conduits, is significantly expanded in comparison to the original 2002 text. Article 12 also creates new powers, subject to due process, to impose sharing of building wiring. Experience in the Member States, especially in France, suggests that these provisions could be very helpful in achieving the deployment of NGA.

**Functional separation**: The package empowers Member States to impose functional separation as an *ex ante* sector-specific access remedy; at the same time, the text in Recital 46 and in Article 13a of the *Access Directive* makes clear that functional separation is appropriate only as an exceptional remedy, and only where the NRA concludes that "*the appropriate obligations imposed under Articles 9 to 13 have failed to achieve effective competition and that there are important and persisting competition problems and/or market failures identified in relation to the wholesale provision of certain access product markets*". The NRA is required to justify the intended separation rigorously, and to submit its justification to the Commission for review.

We feel that the legislative text clearly and appropriately expresses the trade-offs entailed in functional separation.

[52] All references are based on the text approved by the European Parliament in the Second Reading on 6 May 2009. For a general overview of the legislative package, see Section 2.2.

**Network neutrality**: The package establishes network neutrality as an overall goal. It amends Article 8 of the *Framework Directive*, which establishes policy objectives for Member State NRAs, to ensure consumer protection by "promoting the ability of end-users to access and distribute information or run applications and services of their choice".

New language in the *Universal Service Directive* empowers NRAs to establish minimum levels for Quality of Service (thus preventing unreasonable degradation). The *Universal Service Directive* also seeks to ensure that consumers are adequately informed of any restrictions, and gives consumers the right to change providers without penalty if a network operator imposes new restrictions on access to content, services or applications.

We feel that these provisions are appropriate, and not unduly intrusive. Notably, we do not think that it is necessary in Europe at this time to impose detailed regulatory rules on network operators in order to implement network neutrality. The enhancements to consumer protection in the legislative package are likely to suffice.

**Spectrum management**: Recital 6a rightly notes: "*Easier access to radio spectrum will facilitate the development of high-speed broadband services in remote regions.*"

The text promotes liberalisation in the sense of technological and service neutrality (see Recitals 26, 27, 28 and 30, and Article 9 of the *Framework Directive*), and creates stronger obligations to permit spectrum trading and leasing (Recital 31 and Article 9b of the *Framework Directive*).

The package also creates mechanisms for strategic spectrum planning at European level. Recital 20 calls for the Commission to perform a rigorous impact assessment (that is, an assessment of costs and benefits) before proposing any specific spectrum harmonisation measures. Recital 21 goes on, however, to note that although *"… spectrum management remains within the competence of the Member States, strategic planning, coordination and, where appropriate, harmonisation at Community level can help ensure that spectrum users derive the full benefits of the internal market and that EU interests can be effectively defended globally."* The new Article 8a provides the corresponding operative text.

Collectively, we think that the provisions regarding spectrum management represent a step forward. In terms of making spectrum available for fixed or wireless broadband use, which is the most noteworthy linkage to NGN evolution, they are positive and appropriate.

## 6.2. The Commission's Next Generation Access (NGA) consultation

In June 2009, the European Commission released a revised and improved version of their earlier draft Recommendation regarding the regulation of NGA, and launched a public consultation on the revised Recommendation. Several potential regulatory measures and instruments regarding VDSL/FTTC and FTTB/H infrastructures have been defined which might be relevant in the context of the definition of market 4 (access to wholesale physical network infrastructure) and market 5 (wholesale broadband access). The Recommendation addresses mechanisms to limit the investment risk regarding deployment and operation of a high speed broadband network infrastructure in a way that is conducive to competition. In this context the focus is in particular on modes of cooperation.

Regarding markets 4 and 5 the draft Recommendation addresses the following aspects:

- Access to civil engineering infrastructure of SMP operators;
- Access to the terminating segment in the case of FTTH;
- Unbundled access to the fibre loop in the case of FTTH;
- Access obligations in the case of FTTN;
- Wholesale broadband access; and
- Migration.

**Civil engineering:** In case of SMP, NRAs should assess the availability of civil engineering infrastructure including ducts owned by the SMP operator in order to ease the deployment of competitors' NGA networks.

Access to this infrastructure should be mandated at cost-oriented prices where such infrastructure can be used to deploy NGA networks. Furthermore, NRAs should encourage, or, where legally possible under national law, oblige SMP operators to install sufficient capacity for other operators to make use of these facilities when building civil engineering infrastructure.

**Terminating segment:** In addition to mandating access to civil engineering infrastructure, NRAs should mandate access to the terminating segment of the access network of the SMP operator, including wiring inside buildings. The distribution point should be chosen under the precondition, to be able to host a sufficient number of end-users. Access to the terminating segment should be provided at cost oriented prices, including, where appropriate, a higher risk premium. Furthermore, NRAs should encourage, or where legally possible, oblige SMP operators to deploy multiple fibre lines in the terminating segment.

**Unbundled access to the fibre loop:** SMP operators which deploy FTTH should be mandated to offer unbundled access to the fibre loop. Access prices to the unbundled fibre loop should be cost oriented, but include a higher risk premium to reflect additional investment risks. In order to realize non-discrimination, prices charged to SMP operators' downstream arms should be on the same level as third party charges. Exemptions from the principle of cost-orientation should take place where SMP operators have deployed FTTH jointly with at least one competitor or where effective and fully equivalent access is granted. In the absence of cost-orientation NRAs should verify the pricing behaviour of SMP operators' by applying a squeeze-margin test.

**Access obligations for FTTN:** Where SMP operators deploy fibre-to-the-node (FTTN), NRAs should impose copper sub-loop unbundling at cost-based rates. This remedy should be supplemented by backhaul measures ensuring its effectiveness and viability, such as non-discriminatory access to facilities for co-location, or in their absence virtual co-location.

**Wholesale broadband access:** Regarding wholesale broadband access, NRAs should mandate the provision of different wholesale products reflecting the technological capabilities inherent in the NGA infrastructure at cost based rates. Again, exemptions from cost-orientation are foreseen where SMP operators have deployed joint infrastructure or have granted effective and fully equivalent access to at least one competitor.

**Migration:** Finally, NRAs should ensure that alternative operators are informed no less than five years before any de-commissioning of points of interconnection.

More than 900 pages of comments were filed in response to the Commission's public consultation. Four groups of stakeholders can be distinguished: national governments and regions, NRAs, operators, and consumer associations.

The submissions by the national governments and regions show a general consensus regarding the overall aims of the recommendation. There are, however, two points of criticism, which are addressed in a number of comments. First, several governments regret its strong focus on specific technologies. This is seen as being problematic both because it potentially neglects other relevant technologies, and because it represents a departure from the principle of technological neutrality.

Second, some governments consider the recommendation to be too normative and prescriptive. From their point of view, remedies should result from a thorough analysis by NRAs taking the specific circumstances in the country in question into account.

The submissions by NRAs show a similar tenor. The submission of the ERG stands as a precedent arguing that *"… the Recommendation as drafted remains too prescriptive and detailed. As it stands, the draft Recommendation directs the outcome of the market analysis and limits the choice and form of remedies available to the NRA in an inflexible and deterministic manner i.e. certain remedies are either excluded or included depending on mechanistic criteria."*[53]

The submissions by operators and industry associations show a wide spectrum of opinions towards the Commission's draft Recommendation.

[53] I/ERG Response to the draft NGA Recommendation, ERG (09) 16rev3, July 2009.

This is not surprising in light of the sometimes competing aims of incumbent and alternative operators as well as content providers, manufacturers and ISPs.

The majority of incumbent operators felt that the draft Recommendation does not provide for the sufficient regulatory incentives for investments in NGA networks. They complain that the Recommendation in its current form largely transposes the current regulation of copper networks to the NGA environment. Regarding duct access, incumbents call for the establishment of a level playing field for the roll-out of NGA networks by securing non-discriminatory access to civil infrastructures of all infrastructure owners in all sectors (including electricity, gas, municipalities etc.).[54] Furthermore, incumbents are concerned about provisions that may constrain the investors' choice of network technology, topology or architecture. This is particularly emphasized with regard to PON networks.[55]

Alternative operators argue about the danger of a re-monopolization of the market. The competitor's association ECTA points out:

> *"Too much emphasis has been given to well-intentioned but potentially counter-productive strategies aimed at promoting investment and co-operative arrangements with too little attention to ensuring that competition and the principle of non-discrimination are preserved. (...) Some of the proposals made in this Recommendation would fundamentally change the rules of the game with significant risks of failure if prejudgements turn out to be incorrect."*

They particularly argue against provisions which reward a dominant operator for entering into a deal with only one other player.[56] From their point of view, multi-fibre should be pursued where it delivers clear benefits but without assuming the competitive outcome in advance.[57]

Finally, there are a small number of submissions by consumer organisations. They emphasize the Draft Recommendation should strongly stress the importance of competition right from the very beginning of the fibre roll-out.[58]

Our assessment is that the Draft Recommendation is generally on the right track; however, more work is needed. We have concerns about the treatment of multi-fibre access, which could potentially be more burdensome on competitors than on incumbents. Further, we are not convinced that the current document has dealt fully with the treatment of non-SMP operators rolling out NGA infrastructure on their own.

## 6.3. The Commission's Guidelines for the application of state aid for broadband roll-out

In September 2009, the Commission published its "Guidelines for the application of state aid rules in relation to a rapid deployment of broadband networks".[59]

The Commission's Guidelines distinguish between white, black and grey NGA areas. An area where NGA networks do not exist and where they are not likely to be built in the near future by private investors should be considered to be a 'white NGA' area. Accordingly, an area should be considered to be 'NGA grey', where only one NGA network is in place or is being deployed in the coming three years. If more than one NGA network exists in a given area or will be deployed in the coming three years, such an area should be considered to be 'NGA black'. The classification as white, grey or black NGA area is highly relevant for the granting of state aid for NGA roll-out.

The Commission considers that state aid should generally be in accordance with Community law in "NGA white areas". Things look different in "NGA black areas".

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[54] See, e.g., the submission by Deutsche Telekom.
[55] See, e.g., the submission by France Telecom.
[56] See, e.g. the submission by ECTA.
[57] See Ibid.
[58] See, e.g., the submission by BEUC.
[59] See EU-Commission (2009b): Community Guidelines for the application of State aid rules in relation to rapid deployment of broadband networks, (2009/C 235/04), Brussels.

The Commission expects that state support for an additional publicly-funded, competing NGA network is likely to distort competition and is thus incompatible with the state aid rules except in the case of serious market failure. "NGA grey areas" call for more detailed analysis: The Guidelines require that:

> *"Member States should be able to demonstrate firstly, that the existing or planned NGA network is not or would not be sufficient to satisfy the needs of citizens and business users in the areas in question and, secondly, that there are no less distortive means (including ex ante regulation) to reach the stated goals."*[60]

The Guidelines are appropriate for now, in our view, but it might possibly be appropriate to revisit them in the future if there were a concerted European program to deploy NGA on a larger scale.

We see no inconsistency between these new Guidelines and the legislative package associated with the Review.[61]

## 6.4. The Commission's Recommendation on fixed and mobile call termination

Network interconnection for the purpose of completing voice calls has traditionally been associated with wholesale payments from the *originating* network operator (whose customer places the call) to the *terminating* network operator (whose customer receives the call). Given that nearly all network operators have SMP in regard to voice call termination, NRAs generally regulate these termination payments.

The European Commission has recently issued a Recommendation[62] that seeks to enhance consistency among European Member States as regards the approach used to compute these termination rates for fixed and mobile. The new rules are more aggressive than previous practice in requiring strict cost orientation of termination rates. Only "avoided costs" (costs that would not have been present had the service not been provided) associated with a particular voice service can be recovered through the termination charge. The new rules are expected to lower mobile termination rates from present levels (in excess of €0.08 per minute)[63] to new levels of €0.015 - € 0.03 by 2012.

This change is highly relevant to the migration to NGN. There is considerable doubt as to whether the current system of termination payments is either desirable or sustainable in the future NGN world. A 2008 study on behalf of the European Commission[64] argued that present termination rates are well in excess of those attributable solely to the voice service (which is declining in relative importance in comparison to data, and might represent only a tiny fraction of the capacity requirements of a future NGN), and that a sharp reduction would remove one serious impediment to evolving the system to a more forward-looking set of arrangements that would be more attuned to the NGN world.

Meanwhile, the European Regulators' Group (ERG) has for several years been studying interconnection as networks evolve toward IP-based NGNs. The ERG appears to have some sympathy for eliminating termination payments altogether,[65] but they have not reached closure on the matter.

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[60] Guideline, No. 75.

[61] See, for example, recitals 6(a) and 6(b) of the Framework Directive. Recital 6(a) states in part: "In order to ensure investment in new technologies in underdeveloped regions, electronic communications regulation should be consistent with other policies, such as state aid policy."

[62] See Commission Recommendation of 7 May 2009 on the Regulatory Treatment of Fixed and Mobile Termination Rates in the EU (2009/396/EC), OJ L 124/67-74

[63] See e.g. European Commission, 14th Implementation Report; http://ec.europa.eu/information_society/policy/ecomm/library/communications_reports/annualreports/14th/index_en.htm.

[64] See Marcus et al. (2008). Note that the views expressed in that report are those of the authors, not necessarily those of the European Commission.

[65] This would draw on experience in the United States. Many termination rates in the US are zero (referred to as "Bill and Keep").

These issues have come up in many countries in recent years, but international best practice is not yet a settled matter.[66]

## 6.5. Standardisation at European level

Many important NGN standards and specifications come from industry fora such as the IETF and the 3GPP. Equipment manufactures would typically be happy to accept and adopt these standards, but the outputs of these fora are not formally recognised as standards because they are not recognised as European Standardisation Organisations (ESOs). Incumbent operators (who tend to dominate ETSI) sometimes invent competing and incompatible mechanisms. In this regard, the agreement between 3GPP and ETSI over common IMS standards represented a major step forward.

The present lack of legal status of technical specifications published by non-ESO industry fora is a key motivation for modernising the European policy on ICT standardisation (87/95/EEG). The Commission (DG Enterprise and Industry) has published a White Paper to this effect.[67] The paper addresses the use of ICT standards in public procurement, the possible integration of fora and consortia into the ICT standardisation process, and a range of issues concerning intellectual property rights in ICT standards. The associated public consultation closes on 15 September 2009. The Commission intends to present any necessary policy and legislative proposals that flow from this consultation and the associated policy review in 2010. This is an appropriate way forward in our view.

## 6.6. Use of spectrum

As noted in Section 3.2.8, the migration to NGN will tend to create additional demands for spectrum as a means of delivering high speed IP-based network access, especially in areas that are hard to access or that have low density of potential customers. For this reason, the various European initiatives that seek to make more spectrum available, or to make more effective use of existing bands, are important to the evolution to NGN. Fixed and mobile wireless are both relevant.

A number of ongoing initiatives are relevant (beyond the initiatives in the Review package), most of which have elements both at Member State and at European level.

First, the use of the Digital Dividend (the spectrum that will be freed as broadcast television migrates from analogue to digital transmission) clearly represents a key opportunity, and also a key set of challenges. Second, the Review package contains several relevant elements, including (1) an increased emphasis on technological and service neutrality in spectrum management, (2) an increased focus on enabling secondary markets for spectrum, and (3) an increased recognition of the need for strategic planning at European level. All of these elements are positive in our view. Third, there is an emerging and promising interest in improving the effectiveness and the socio-economic efficiency of spectrum management in the public sector (an area that in the past has tended to be overlooked in most countries).[68]

[66] See e.g. Marcus (2007).
[67] See European Commission (2009).
[68] See ERG and RSPG (2009) as well as Marcus et al. (forthcoming).

# 7. CONCLUSIONS AND RECOMMENDATIONS

Next Generation Networks take on a myriad of different technologies, architectures, network design principles and topologies. The actual deployment approaches of market participants relate both to the NGN core and the access network. The evolution of the network core to NGN seems to be driven primarily by the desire to reduce OPEX, and to deploy new services more rapidly. The evolution of the network access to NGA typically requires a greater investment, and appears to most often be motivated by intense competition for network access. Migration to NGN/NGA technology inherently implies the use of a packet switched transport protocol common for all voice, data, and video traffic, which in practice is the Internet Protocol (IP).

The technological shift associated with migration from traditional switched fixed and mobile communications networks to NGN/NGA leads decouples the transport function of the network from the service provision. The migration to NGN/NGA therefore implies fundamental changes for the value chain of providing voice, data, and video services, and, in turn, to changes in future business models.

These changes imply profound shifts in the nature of competition, and thus imply changes to regulation. Nonetheless, it is highly likely that market intervention will still be required from a competition and regulatory policy perspective. In Section 3.2, we discussed a range of regulatory and policy challenges that are raised by the migration to NGN/NGA, and explained that the appropriate responses and potential regulatory instruments might be more or less different from those that we use today.

Following the same sequence as in Section 3.2 (which reviews the regulatory challenges posed by NGN), the balance of this section presents our conclusions and recommendations as regards each of the areas where migration to NGN/NGA raises new challenges. In the interest of brevity and readability, we do not repeat the background provided earlier in the report, particularly in Section 3.2.

- General issues driven by changes in the nature and character of competition (see Section 3.2.1)
- Pro-competitive regulation and NGA (see Section 3.2.2)
- Achieving deployment of current and NGA (see Section 3.2.3)
- Network interconnection (see Section 3.2.4)
- Quality of Service (QoS) and implications for network neutrality (see Section 3.2.5)
- The migration period (see Section 3.2.6)
- Standardisation and interoperability (see Section 3.2.7)
- Spectrum management (see Section 3.2.8)

The legislative package associated with the Review of the Regulatory Framework already incorporates many provisions that address NGN/NGA issues, and we feel that it does so appropriately. We have therefore taken the Review package as our baseline, rather than making recommendations that are already reflected in it. Instead, we make a general recommendation:

**Recommendation 1: Adopt the pending Review package.**

From the perspective of NGN/NGA regulation and policy, we encourage the adoption of the pending Review package.

## 7.1. General issues driven by changes in the nature and character of competition

The primary overall challenges relate to changes in the nature of competition. New forms of competition are possible, potentially reducing the need for *ex ante* regulation in the longer term.

We see no need for a massive overhaul of the regulatory framework. The framework already envisions periodic review to determine which undertakings have SMP in potentially problematic markets. NRAs need to be sensitive to the fact that the game is changing somewhat, as we believe they already are.

Historically, the Commission and most Member States more-or-less automatically assumed that most markets should be analysed at Member State level, and that remedies should be consistent across the national territory. The deployment of NGA will clearly be more intense, and will offer more consumer choice, in dense urban areas than in sparse or rural areas.[69] Other portions of the national territory will have only one facilities-based provider of broadband, if that. Thus, there might be portions of the national territory where it is appropriate to lighten or remove remedies, at the same time that remedies remain appropriate in other portions of the national territory.[70]

**Recommendation 2: Make greater use of sub-national markets and/or sub-nationally differentiated remedies.**

In light of probably uneven deployment of broadband generally and of NGA in particular, NRAs may wish to place greater reliance on market analysis at a sub-national level. Alternatively, they may wish to differentiate remedies among different portions of the national territory.

Some aspects (not all) of network neutrality are linked to Quality of Service (QoS). We take up net neutrality in Section 7.5.

## 7.2. Pro-competitive regulation and Next Generation Access (NGA)

Consistent with our approach in Section 3.2, we treat the pro-competitive *regulation* of NGA as a somewhat distinct topic from the question of how best to ensure deployment of current generation and next generation broadband access.

For the most part, we believe that any necessary actions as regards NGA regulation are already under way. The legislative package associated with the Review of the regulatory framework will likely be passed this year (see Sections 2.2 and 6.1).

This report contains an extensive discussion of functional separation, but we see no immediate need for action beyond adoption of the legislative package. The legislative package reflects a proper understanding of the value of such a remedy, and balances that recognition with an understanding that functional separation is an intrusive remedy that should not be applied lightly.

The Commission's second consultation on NGA needs to be brought to a conclusion, but we think that a number of areas need to be refined if not re-worked, including multi-fibre access, as well as the treatment of non-SMP operators rolling out NGA infrastructure on their own as first movers. We think that further refinement would be appropriate.

**Recommendation 3: Refine and complete the draft Recommendation on Next Generation Access (NGA).**

The European Commission should refine the draft Recommendation on Next Generation Access (NGA) as appropriate.

[69] In other words, there will be a much richer deployment in areas of high density of potential subscribers.
[70] See ERG (2008) and EU-Commission (2008).

For now, we do not see the need for NGA regulatory initiatives beyond those that are already encompassed in the legislative package or else likely to be embodied in an eventual NGA Recommendation from the Commission.

## 7.3. Achieving deployment of current and Next Generation Access (NGA)

We believe that the time is now ripe for an intense European debate as to how to achieve an appropriate level of deployment of both current and next generation broadband access. That discussion needs to be informed by in-depth qualitative and quantitative assessments, but the decision process is at its core political.

There are two closely interrelated objectives that are often blurred together in policy discussions:

- Seeking to ensure that copper-based broadband access is upgraded to fibre-based Next Generation Access; and
- Seeking to ensure that broadband (or whatever speed) is available to substantially the entire population.

The former objective relates to the speed and technology, but does not necessarily imply full coverage; the latter objective insists on full coverage, but not necessarily at NGA speeds. In a country that decides to achieve near-universal coverage at high speed,[71] these objectives could blend together; otherwise, they should be viewed as remaining distinct.[72]

The difference matters. The former objective is generally treated as a matter of industrial policy, under the purview of a ministry at Member State level; the latter has much more the character of a question of universal service, which is normally addressed as a regulatory matter under the purview of the NRA.

As we explained in Section 3.2.3, the question of whether broadband should be included within the scope of universal service was debated intensely as far back as 2002, when the regulatory framework was adopted, and the Commission has twice reviewed the scope of universal with this in mind. With each passing year, this question takes on greater urgency. The position taken by the UK government in their recent *Digital Britain* report, coupled with initiatives in Finland and Switzerland, casts the issue into particularly sharp relief.

Meanwhile, the migration to fibre-based NGA is understood to offer a range of benefits, not only to the network operators who deploy it, but also to the broader society; however, we are not aware of any rigorous quantification of the incremental benefits of migration to NGA, beyond those already available with conventional copper-based broadband. *What is the marginal benefit to society as a whole of the migration to NGA?*

This question, too, takes on greater urgency as it becomes increasingly clear that Europe has been slow to deploy fibre-based NGA in comparison with various trading partners, including Japan, Korea, the United States, and potentially Singapore, Australia and New Zealand. Should this be a matter of concern? Does it matter? Or is copper-based broadband fast enough for now?[73]

[71] See Annex.
[72] See, e.g., UK Government (2009).
[73] This is not just a rhetorical question. There might well be a sound economic rationale, for example, for waiting to deploy until unit costs for equipment for NGA have fallen to lower levels than those that pertain today.

We believe that the most appropriate sequence of actions would be:

- The costs and benefits of a possible imposition of a universal service obligation for broadband at a modest data rate need to be considered using a rigorous impact assessment / *ex ante* evaluation methodology;
- A comprehensive, rigorous, and quantitative understanding of the relative *societal* benefits of migration to fibre-based NGA, beyond those available with copper-based broadband, needs to be developed;
- A range of industrial policy options for migration to fibre-based NGA needs to be developed, and their costs and benefits analysed using a rigorous impact assessment / *ex ante* evaluation methodology;
- With these analytical results in hand, *a political discussion is needed*. How much of the European Union's population should be covered with broadband? How much with fibre-based access? What access speeds are appropriate for each group? What steps if any need to be taken to ensure that access is affordable to all, and access of what quality? How much variation is appropriate from one Member State to another, or from areas of high population density to low within a Member State? What policy instruments are appropriate to the achievement of these goals? To what extent must policy instruments be harmonised among Member States?

Our concrete recommendations flow directly from this sequence of actions. We make no specific recommendation in regard to an impact assessment study of broadening the scope of USO to include broadband, because it is our understanding that the European Commission is already in the process of launching such a study.

**Recommendation 4: Develop a solid understanding of the societal benefits of migration to NGA.**

The European Commission should initiate a study to develop a comprehensive, rigorous, and quantitative understanding of the relative societal benefits of migration to fibre-based NGA, beyond those available with copper-based broadband.

**Recommendation 5: Evaluate policy instruments that could be used to achieve greater deployment of fibre-based NGA.**

Assuming that the benefits of migration to fibre-based NGA are sufficient, the European Commission may wish to develop a range of candidate policy instruments to achieve some reasonable target levels of deployment. They may wish to assess the costs and benefits using a rigorous impact assessment / *ex ante* evaluation methodology.

**Recommendation 6: Initiate a political discussion to establish goals, and means of achieving them.**

With these analytical results in hand, the European Parliament would be equipped to begin a political discussion to determine (1) how much of the population of the European Union should be covered by conventional broadband access versus fibre-based NGA, (2) what speed guarantees if any are appropriate, (3) the degree to which price guarantees might be needed, and (4) the policy instruments that should be used to achieve these goals.

## 7.4. Network interconnection

This is an area that will require ongoing monitoring, but for the moment we do not see the need for a significant policy intervention.

The current system of mobile termination rates (MTRs) that are well in excess of true marginal usage-based cost creates some disincentives for an otherwise promising migration of voice calls to IP-based interconnection.

It also seems inappropriate to an NGN world where voice services represent a small and declining fraction of the cost of the network, and where the voice service provider need not even be the operator of the network. The Commission's recent Recommendation on fixed and mobile call termination[74] is expected to lower MTRs by a factor of three or four, which significantly mitigates all of these concerns.

Some experts have argued in favour of going further, and eliminating MTRs altogether (as is largely the case under so-called *Bill and Keep* arrangements in the United States).[75] There have been sentiments for this for years within the ERG, and it appears that there is an emerging consensus in favour of *Bill and Keep*.[76] The potential advantages and disadvantages of a possible migration to *Bill and Keep* are complex (and many of them have little to do with the migration to NGN);[77] moreover, the objectivity of many existing studies is unclear to the extent that they were sponsored by parties with strong commercial interests in the outcome. An intensive, objective, and open-minded study of *Bill and Keep* at this time would be useful.

**Recommendation 7: Consider possible implementation of Bill and Keep call termination arrangements.**

Possible implementation of *Bill and Keep* merits serious consideration at European level at this time. The Commission has already taken steps to initiate an objective and intensive consultant study of the merits of call termination charging arrangements at European level, which is a good first step.[78]

These steps serve to lower or eliminate MTRs, which in turn mitigates or eliminates a large impediment to the migration of voice calls to IP-based interconnection; nonetheless, it remains unclear whether that migration will actually occur (among fixed incumbents and large mobile operators) on its own in any case, despite the fact that it seems to be clearly advantageous technologically and financially. An apparently desirable migration is unlikely to happen without help. For now, it is not clear that public policy intervention is appropriate; however, policymakers need to be aware that there is an apparent blockage.

## 7.5. Quality of Service (QoS) and network neutrality

QoS-aware IP-based interconnection has failed to emerge on the kind of large-scale commercial basis that one might have expected, even though the technology would appear to be straightforward. There has been some positive movement, both on the part of the GSM Association (GSM-A) with its IPX, and on the part of large network operators that interconnect in support of MPLS-based VPNs for enterprise customers.[79] It is not clear that public policy intervention is appropriate at this time; however, policymakers need to be aware of the situation.

Network neutrality issues could take on many forms. Some of the best known reflect quality discrimination, while others represent price discrimination or outright blockage of the ability to access content or to use an application or service.

The problematic forms of deviations from network neutrality depend critically on market power. The European regulatory system is doing a reasonable job of maintaining effective competition. Under effective competition, anti-competitive deviations from network neutrality are unlikely to be profitable.

In other words, the normal functioning of the European regulatory framework already does a great deal to inhibit anti-competitive deviations from network neutrality.

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[74] Commission Recommendation of 7 May 2009 on the Regulatory Treatment of Fixed and Mobile Termination Rates in the EU (2009/396/EC), OJ L 124/67-74.
[75] See Littlechild (2006).
[76] See ERG (2007a), ERG (2007b), and ERG(2009).
[77] See Marcus et al. (2008b).
[78] See European Commission (2009): Tender for a study on the future of interconnection charging methods, INFSO/B - SMART 2009/0014.
[79] See Vogelsang et al. (forthcoming).

The proposed changes in the Review package strengthen existing protections against network neutrality problems, by (1) establishing network neutrality as a general goal in Article 8 of the Framework Directive, and (2) ensuring that users are informed about deviations from network neutrality, and can change service providers without penalty if they take issue with a deviation.

Finally, if occasional problematic deviations were nonetheless to occur, they might well be actionable *ex post* under competition law.

For all of these reasons, we do not see the need for further action in regard to network neutrality (beyond enactment of the pending Review package).

## 7.6. The migration period

Experience in several Member States shows that changes in the number and locations of the incumbent's Points of Interconnection (PoI) as a result of the migration to NGN/NGA can be problematic; however, they have been adequately addressed (in the UK and the Netherlands, for example) through the creation of suitable dialogue mechanisms or fora among the market players, usually accompanied by an implicit threat of regulatory intervention if the participants cannot reach agreement.

Policy needs to strike a balance between (1) the incumbent's legitimate right to upgrade its network as it sees fit, and (2) equity to competitors, coupled with the need to maintain competition overall.

Inasmuch as NRAs have been responding appropriately, no action at European level is necessary.

The migration also raises any number of questions as to how costs should be interpreted for regulatory purposes. We feel that *Long Run Incremental Cost (LRIC)* cost computations should indeed be based on the ultimate long term cost, but that remedies might implement a suitable glide path; in other words, the need for a glide path should not be reflected in the computation of the cost.

It has also raised questions about how to deal with the increased uncertainty of demand when the NGN is built out. The language in Recitals 43(b) and 43(d) and the changes to Article 8 of the *Framework Directive,* which seek to ensure that NRAs reflect the increased costs and risks of network operators in their decisions,[80] deals with this problem appropriately.

## 7.7. Standardisation and interoperability

For the most part, technical standards for NGN appear to be evolving as they should. We see no immediate need for policy intervention, but we think that developments bear watching.

As previously noted, there is a constellation of unresolved issues as regards IP-based interconnection. Why has there been so little movement by large network operators to migrate their voice services to IP-based interconnection (see Section 7.4)? Why so little movement to implement QoS-aware IP data interconnection (see Section 7.5)? And why has there been such glacial movement on technical standards for QoS-aware IP interconnection?

[80] E.g. by reflecting the risk associated with uncertain demand in the *Weighted Average Cost of Capital (WACC)*. See European Parliament (2009), at 57. "When imposing remedies to control prices, national regulatory authorities should seek to allow a fair return for the investor on a particular new investment project. In particular there may be risks associated with investment projects specific to new access networks which support products for which demand is uncertain at the time the investment is made."

**Recommendation 8: Monitor the migration to IP-based interconnection.**

Policymakers should monitor developments in regard to IP-based interconnection. Intervention does not appear to be warranted at this time, but policymakers should be aware that migration of voice and data services to QoS-aware IP-based interconnection does not appear to be happening spontaneously.

## 7.8. Spectrum management

The migration to NGN makes it even more important to make high-quality spectrum (i.e. spectrum below 6 GHz, and especially spectrum below 3 GHz) available for fixed and mobile wireless broadband access, both as a complement to the fixed network in areas of higher density of potential subscribers, and as a primary means of broadband access in areas of lower density of potential subscribers.

This is largely a matter for Member State governments and spectrum management authorities, but there is also a role for European coordination (for example, in regard to the Digital Dividend, and in terms of promoting initiatives such as WAPECS). The initiatives already under way in several Member States to simultaneously auction multiple bands (in a "little Big Bang"), some of them suitable for WAPECS, is a good example of cooperation between European and Member State level.

Coordination and harmonisation at European level can be important as a means of promoting manufacturing economies of scale for equipment, and ensuring equipment interoperability among the Member States; however, this must be weighed against some potential loss of efficiency to the extent that circumstances in individual Member States cannot be fully reflected in decisions at European level. Recital 20 of the legislative package associated with the Review (which calls for case by case impact assessment of costs and benefits)[81] strikes the right balance.

**Recommendation 9: Make more high quality spectrum available for fixed and mobile wireless broadband access.**

European and Member State bodies and spectrum management authorities should be alert to possible opportunities to make additional high quality spectrum available for fixed and mobile broadband wireless access.

[81] "Before a specific harmonisation measure under [the] … Radio Spectrum Decision … is proposed, the Commission should carry out an impact assessments [sic] on the costs and benefits of the proposed measure, such as the realisation of economies of scale and the interoperability of services for the benefit of consumers, the impact on efficiency of spectrum use, or the demand for harmonised use in the different parts of the European Union."

# ANNEX 1: THE EUROPEAN REGULATORY FRAMEWORK FOR ELECTRONIC COMMUNICATIONS

Relative to this report, it is important to note that the European regulatory philosophy as regards electronic communications is explicitly technologically neutral.[82] No distinction is drawn among different technology platforms. The European regulatory framework seeks neither to impose, nor to discriminate in favour of the use of any particular technology. Instead, it seeks to ensure that any regulation relevant to a specific market is applied irrespective of the means by which the service(s) constituting this market are delivered. This property has already shown its value as networks evolve to NGNs – it means that regulation need not change unless the technological changes raise new policy issues.

The European regulatory framework for electronic communications views much of regulation as a response to the existence of essential facilities (bottlenecks) and market power that would tend to impede competitive entry; however, it is important to note that the regulatory framework contains many other elements as well.[83]

Annex section 1.1 deals briefly with the history of the regulatory framework, and with the structure of the documents that comprise it. Annex section 1.2 deals with the identification of markets where regulation may be appropriate, and with the identification of network operators or service providers that may have significant market power on such a market. Annex section 1.3 describes the process by which national regulatory authorities impose remedies that seek to address market power in order to enable competitive entry. The still ongoing review of the regulatory framework that was initiated in 2006 is discussed in Section 6.1 of the main report, rather than in this Annex.

## Annex 1.1: History and structure of the regulatory framework

The current regulatory framework for electronic communications came into force in 2002 and was to be transposed into national law by the Member States by the middle of 2003. Most Member States required considerably more time before the framework was completely and effectively transposed into national law and fully in force.

The core of the European Regulatory Framework consists of five Directives:

- The Directive on a common regulatory framework for electronic communications networks and services (the "Framework Directive")[84] establishes a harmonized regulatory framework for electronic communication networks in the Member States;
- The Directive on the authorisation of electronic communications networks and services (the "Authorisation Directive")[85] regulates conditions for the approval of public and non-public electronic communication networks;
- The Directive on access to, and interconnection of, electronic communications networks and associated facilities (the "Access and Interconnection Directive")[86] harmonises the manner in which Member States regulate access to and interconnection of electronic communication networks;
- The Directive on universal service (the "Universal Service Directive")[87] ensures the provision of a defined minimum set of services to all end-users at affordable prices, and also ensures a range of consumer rights;

[82] Framework Directive 2002/21 EC, of 7 March 2002, OJ L 108/33-49, recital number 18.
[83] The Universal Service Directive, of 7 March 2002, OJ L 108/51-77, for instance, contains quite a few obligations that have nothing to do with market power as such.
[84] Directive 2002/21/EC .
[85] Directive 2002/20/EC of 7 March 2002, OJ L 108/21-32.
[86] Directive 2002/19/EC of 7 March 2002, OJ L 108/7-20.
[87] Directive 2002/22/EC.

- The Directive on the processing of personal data (the "Privacy and Electronic Communications Directive")[88] addresses the protection of privacy in the electronic communications sector.

A range of supporting Recommendations have also been established.

## Annex 1.2: Market definition and identification of market power

The framework seeks to rely on market forces insofar as possible to govern the behaviour of network operators and service providers. For markets where competition is not effective, however, regulation is necessary *ex ante* (in advance) in order to enable competitive market entry. The European Commission has provided guidelines to the Member State National Regulatory Authorities (NRAs), drawing on principles of European competition law, to (1) define relevant markets and to (2) identify undertakings that have *Significant Market Power (SMP)*[89] on those markets. The framework defines a set of regulatory remedies that can be applied *only* as a means of addressing SMP.

The European Commission begins the market definition process by identifying a series of markets "susceptible to *ex ante* regulation".[90] It does so by applying the so-called *three criteria test* to markets that could reasonably be expected to present challenges to competition. Informally, the three criteria could be said to represent: (1) high *static* barriers to competitive entry, (2) the absence of a substantial *dynamic* tendency toward competition within the relevant study period, and (3) the inability of competition law applied after the fact (*ex post*) to correct the problem. Markets that satisfy all three criteria are likely to be subject to SMP in a significant number of Member States, and must be evaluated by the NRA; however, for a market to be susceptible to *ex ante* regulation does not necessarily mean that SMP must be present.

The Commission's initial list consisted of 18 markets; however, the list was reduced to just seven markets in December 2007, as part of the overall review of the regulatory framework that commenced as required in 2006. These markets are:[91]

1. Access to the public telephone network at a fixed location for residential and non-residential customers.
2. Call origination on the public telephone network provided at a fixed location.
3. Call termination on individual public telephone networks provided at a fixed location.
4. Wholesale (physical) network infrastructure access (including shared or fully unbundled access) at a fixed location.
5. Wholesale broadband access.
6. Wholesale terminating segments of leased lines, irrespective of the technology used to provide leased or dedicated capacity.
7. Voice call termination on individual mobile networks.

For the purpose of this report, Markets 4 and 5 are of particular relevance.

Member State NRAs evaluate each of the markets that the Commission has defined, first to determine if the market definition is appropriate to national circumstances, and second to determine whether any single undertaking acting individually, or any group of undertakings acting jointly, have SMP on that market.

In doing so, the NRA is to take the utmost account of the Commission's guidelines on market analysis and the assessment of SMP.[92]

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[88] Directive 2002/58/EC, of 12 July 2002, OJ L 201/37-47.
[89] Framework Directive 2002/21 EC, Article 14, Section 2. "An undertaking shall be deemed to have significant market power if, either individually or jointly with others, it enjoys a position equivalent to dominance, that is to say a position of economic strength affording it the power to behave to an appreciable extent independently of competitors, customers and ultimately consumers."
[90] Article 14 of the Framework Directive obliges the Commission to adopt a recommendation on relevant product and service markets.
[91] See Commission Recommendation on relevant product and service markets (2007/879/EC).

If an NRA concludes that the market in their Member State should be defined somewhat differently than the Commission did in light of national circumstances, or if they identify some other market as being problematic, then the NRA should itself apply the three criteria test to the circumstances at hand.

## Annex 1.3: Imposition of remedies to address significant market power

Once an NRA has determined that one or more undertakings have SMP on a market susceptible to ex ante regulation, it must apply suitable remedies, generally from the following list (in ascending order of severity): transparency, non-discrimination, accounting separation, access, price control and cost accounting.[93] The remedy imposed must be based on the nature of the problem identified, and must be *proportionate* (i.e. no more intrusive than necessary) and justified in the light of the objectives set out for NRAs.[94]

Article 7 of the Framework Directive seeks to ensure consistent regulation across all Member States by requiring NRAs to notify the Commission of the market definitions, SMP determinations and remedies that they have arrived at before putting them into effect. The Commission can approve the decision, or it can seek improvements, but it must operate within strict time limits. If the Commission takes strong issue with a market definition or an SMP determination, it can require the NRA to withdraw it. If the Commission disagrees with a remedy, the NRA can in principle nonetheless ultimately implement the remedy (or lack of remedy) it chooses. Disagreements over remedies have occasionally led to infringement proceedings (where the Commission claims that the measure is incompatible with Community law) and to protracted litigation.[95]

[92] Framework Directive 2002/21 EC, Article 16 Section 1.
[93] See Articles 9-13 of the Access and Interconnection Directive and Articles 17-19 of the Universal Service Directive.
[94] Framework Directive 2002/21/EC, Article 8.
[95] The most familiar example of an infringement proceeding is the case the Commission launched against the German government over “regulatory holidays” (see Section 0).

# ANNEX 2: NGN DEPLOYMENT AND REGULATORY RESPONSES IN THE MEMBER STATES

European Member States show large differences with regard to NGN/NGA deployment. In most of them, the network operators' emphasis has been on NGA. However, a few (especially the UK and Italy) saw NGN core build-out by incumbent operators first. With regard to NGA, we observe both, companies with emphasis on FTTB/FTTH, and others with focus on FTTC/VDSL. The following sections give an impression of the range of the distinct roll-out strategies, regulatory responses and governmental actions regarding broadband infrastructure deployment.

## Annex 2.1: Finland

NGN/NGA activities in Finland currently concentrate on access network migration. A far-reaching national broadband project was passed in December 2008. It applies a two stage approach. Private and business users should have access to broadband connections with downstream rates of at least 1 Mbit/s by the end of 2010. This data rate will be classified as a universal service obligation. By the end of 2015, optical fibre or cable networks permitting 100-megabit connections will be available throughout the country. At least 99 percent of permanent residences and permanent offices of businesses and public administration bodies will have access to that network through a fixed or wireless subscriber line of no more than two kilometres' length. Up to one third of the cost of broadband roll-out will be provided by the central government if market solutions are lacking. A sum of up to 66 Million EUR is designated for this task. End-users will have to pay for their connections to the network themselves. It is planned, however, to grant tax advantages to end users who install and operate broadband access.

## Annex 2.2: France

The fibre roll-out in France benefits from lively competition between the telecommunications carriers France Télécom, Iliad-Free, Neuf Cegetel, and the cable operator Numéricâble. All of them have initiated FTTB/H deployment strategies in specific densely populated areas. Moreover, there are a number of local and regional projects where French jurisdictions (e.g. "régions, "départements", cités") play a leading role.

The aforementioned national carriers will be exclusively relying on FTTB/H technology. FTTC/VDSL is economically not efficient in France because of very long sub-loops. All market players deploying fibre infrastructure in Paris (and some other French cities) benefit from a network of man-high sewage channels, leading into each building. Thus, fibre deployment under these conditions is comparatively cheap due to the existing infrastructure. That said, access to the fibre infrastructure has been a crucial issue in France for quite some time and several measures have already been taken. In particular, the law on modernising the economy of 4 August 2008 introduced a set of rights and obligations for operators deploying optical fibre in buildings including a clear commitment to open access. ARCEP released guidelines for the regulation of optical fibre in April 2009[96]. It envisages varying approaches for the realization of the principle of mutualisation depending on the local circumstances, notably the population density and housing structure.

## Annex 2.3: Germany

Deutsche Telekom (DT) announced plans to spend 3 billion Euro for a far reaching roll-out of VDSL/FTTC infrastructure in September 2005. At the same time, the German incumbent lobbied to be released from wholesale obligations for this infrastructure to limit risks associated with the planned investment, threatening to otherwise refrain from investing this sum in Germany.

[96] See http://www.arcep.fr/uploads/tx_gspublication/guidelines-fiber-thd-070409-eng.pdf

The German government supported DT's position and amended the German Telecommunications Act with a new paragraph, hampering regulatory interventions in new markets. This led to serious disagreements with the European Commission and culminated in an infringement procedure against Germany which is still pending.

DT's VDSL network focuses on densely populated areas. As of end of 2008, DT has deployed FTTC/VDSL infrastructure in about 50 cities. Apart from DT, several local and regional ventures have initiated projects focusing on the deployment of FTTB/H infrastructure, notably NetCologne in Cologne and M-Net in Munich. Furthermore, some NGA roll-out projects are realized through cooperative arrangements between DTAG and its competitors.

The German regulatory agency BNetzA published a consultation paper in May 2009 on the regulatory framework for the future development of modern telecommunications networks and the establishment of a high-capacity infrastructure.[97] The German NRA is pursuing four goals in its approach to broadband deployment: Reduction of risks, assurance of investment and innovative power of affected enterprises by appropriate access and pricing regimes, granting of a high level of planning certainty, and the realization of transparency. In particular, the BnetzA welcomes cooperative roll-out plans (subject to "open access" conditions) and underlines its preference for privately negotiated solutions over the imposition of regulatory obligations.

The German Government established a broadband stimulus plan in early 2009. The political goals are: (1) provision of broadband infrastructure with a minimum speed of 1 Mbit/s throughout Germany by the end of 2010, (2) provision of minimum speeds of 50 Mbit/s for 75 % of German households by the end of 2014, and (3) provision of access at minimum speeds of 50 Mbit/s for all households shortly thereafter.

## Annex 2.4: Hungary

The market structure in the Hungarian fixed-line markets differs from other European markets. The biggest incumbent, Magyar Telekom, owns about 75 % of all subscriber access lines. Moreover, there are two smaller local incumbents (the smaller being owned by UPC, the largest cable provider). Hungary has a relatively high cable TV penetration of 58% of all households, a figure which is only slightly below the PSTN household penetration which is a little bit above 60%. Thus, the fixed line penetration in Hungary is well below the Western European average.

The market analysis undertaken by the Hungarian regulatory agency NHH in late 2007 noted a marginal number of local loops based on optical fibre in Hungary. Magyar Telekom announced an FTTH roll-out plan in September 2008.[98] It aimed at accessing around 200.000 households by the end of 2009, and 780.000 households by the end of 2013. At the same time, Magyar Telekom announced its intention to upgrade its hybrid-fibre-coax (HFC) network to the EuroDocsis 3.0 standard, thus, reaching an additional 380,000 households by the end of 2009. With the planned network deployments, a combined total of close to 1.2 million Hungarian households will have access to high speed broadband by end of 2013. As a competitive challenge to fixed line incumbents, cable companies (and especially UPC) are aggressively upgrading their HFC networks to EuroDocsis 3.0.

The Hungarian regulator launched an NGN consultation paper in July 2008, and plans to address NGN issues in the next round of its market analysis.

## Annex 2.5: Italy

NGN and NGA roll-out in Italy is mainly driven by two companies, the incumbent Telecom Italia (TI) and its largest competitor Fastweb (a subsidiary of the Swiss incumbent Swisscom).

[97] See http://www.bundesnetzagentur.de/media/archive/16268.pdf.
[98] See http://www.telekom.hu/investor_relations/investor_news/2008/september_23.

Telecom Italia quietly converted its core network to an IP-based NGN some years ago. It announced its plans for a Next Generation Access Network ("NGN 2") in March 2007. The main elements of NGN 2 combine the implementation of an All-IP network, the deployment of deep fibre in the local loop with a mix of technologies comprising FTTC and FTTB solutions (especially in main cities), and the installation of VDSL2 technology.[99]

Fastweb has about 1.3 million customers (as of the end of 2007) and its network covers 45% of the Italian population. The network passes about 2 million homes via FTTH technology and the remaining 8 million via metallic local loop unbundling.

TI and Fastweb signed an agreement in June 2008 that provides for reciprocal access to ducts in order to enable them to deploy NGN infrastructure more rapidly. The agreement is said to be open to all interested operators. The two companies agreed to cooperate with regard to the planning of civil infrastructure necessary for the deployment of fibre optic networks (encompassing e.g. empty ducts along the streets) with the objective of avoiding infrastructure duplication; the reciprocal exchange of usage rights for civil infrastructure; and the examination and testing of innovative techniques regarding civil infrastructures, e.g. the utilization of newest generation micro tubes for the deployment of optical fibre.

## Annex 2.6: Netherlands

Two phases can be distinguished regarding FTTx and NGN deployment in the Netherlands. KPN initially announced its intention to migrate to an ALL-IP network based on FTTC/VDSL technology. From a regulatory perspective a crucial point of this plan was the envisaged phasing out of MDFs (the number was supposed to decrease from about 1,300 to less than 200).

Much of this planned deployment is, however, put on hold. First, a study conducted on behalf of OPTA called into question whether competitors could survive solely on the basis of sub-loop unbundling (i.e. at the level of the street cabinets) once the MDFs were relinquished.[100] Second, OPTA was concerned that competition in the fixed network could be severely impacted because of potential stranded investments by competitors. These concerns led to lengthy discussions and negotiations with stakeholders in the Netherlands.

In parallel with KPN's All-IP plan, many local and regional ventures in the Netherlands were initiating the deployment of FTTB/H infrastructure. Although in each case usually one or more local entities were involved there was one player, called Reggefiber, which was active in many of these ventures. In late 2008 KPN acquired a 41% stake in Reggefiber with a call option on a majority stake. At the same time, KPN announced a strategic shift and put emphasis on rolling out FTTB/FTTH infrastructure instead of FTTC/VDSL. The main goals of this strategy are regaining lines from cable operators, raising average revenue per user (ARPU), and raising customer life time value.

## Annex 2.7: Portugal

Broadband access infrastructure in Portugal is mainly based on ADSL/ADSL 2+ technology and CATV. Up until now, VDSL is not deployed in Portugal and no VDSL deployment plans have been announced so far.

Portugal Telecom launched a triple play offering in the market which has been quite successful in attracting customers. Apart from tests regarding FTTH in specific zones (dedicated city centres), there is little transparency about PT's NGA and NGN plans. In February 2008, Sonaecom, a competitor active in the fixed and mobile market segment, announced to spend 240 Million Euro for the deployment of FTTH in the next three years.[101] This network is to be an open access network. Onitelecom, currently active in the corporate and the wholesale markets owns an extensive fibre optic network, too.

[99] See Elixmann et al (2008).
[100] See Analysys (2007).
[101] See Elixmann et al (2008).

In January 2009, the Portuguese government announced an 800 million Euro credit line for the roll-out of next-generation broadband networks in the country as part of an economic stimulus plans. The credit line forms part of an agreement between the government and the operators Portugal Telecom, Zon Multimedia, Sonaecom, and ONI on expanding broadband access, in exchange for access to the government-backed financing.

Portugal is the only country in Europe with an active reference offer for duct access. This is mandatory for PT and not based on SMP, rather, there is a direct obligation for PT to provide this access by the Portuguese National Law.[102] Access to ducts in Portugal does not include access to poles, but PT, recently, has provided alternative network operators with the possibility to use such infrastructures.

## Annex 2.8: Spain

In 2008, Telefonica announced deployment plans regarding FTTC/VDSL and FTTB/H. Telefonica's direct fibre access is, however, restricted to selected areas of major cities including Madrid and Barcelona. It announced plans to pass between 11 and 12 million households by 2010 with FTTH under its Trio Futura plan. Since September 2009, Telefonica has been offering Internet access services of up to 30 Mbps by means of the VDLS2 technology. Telefonica is currently negotiating with its main competitors over shared fibre investments.

Overall, the Spanish regulatory agency CMT is following a rather incumbent-friendly approach regarding NGA regulation. A crucial issue in recent years was wholesale broadband access. CMT imposed in its draft regulation regarding markets 4 and 5, submitted to the European Commission in October 2008, an obligation for Telefónica to provide wholesale broadband access only for speeds of up to 30 Mbps. The Commission has expressed serious doubts on this in November 2008[103]: they "considered that CMT provided insufficient evidence to support the exclusion of speeds above 30 Mb/s from the market. Moreover, the Commission considered that the evidence provided by CMT did not warrant the inclusion of alternative infrastructures - cable and local loop unbundling ("LLU") - in the market definition. The geographic differentiation of remedies was also queried." In December 2008, the European Commission approved a revised version of the draft measures in which the CMT altered the definition of the relevant product market. Nonetheless, the Commission continues to be concerned about the remedies imposed by the CMT. Even though the relevant market had been defined as including all speeds, the CMT nonetheless notified the Commission of its intent to impose wholesale broadband access oligations only for speeds of up to 30 Mb/s.

As things stand, Telefonica is obliged to offer wholesale broadband access for services with data rates of up to 30 Mbps, but not for services that have data rates greater than 30 Mbps.[104] However, an obligation was imposed on Telefonica to provide access to its civil works infrastructure.[105]

## Annex 2.9: Sweden

The Swedish broadband market differs from other European Member States due to the substantial deployment of fibre based infrastructure by municipalities (in particular through utilities and housing companies). Broadly speaking, these ventures usually have a far reaching monopoly status (at least regarding the passive infrastructure).

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[102] See Electronic Communications Law, http://www.anacom.pt/template20.jsp?categoryId=103282&contentId=159011.
[103] See for the following the Press Release of 24/12/08. Available at http://europa.eu/rapid/pressReleasesAction.do?reference=IP/08/2060&format=HTML&aged=0&language=EN&guiLanguage=en.
[104] Resolution about Markets 4 and 5, CMT. Available at http://www.cmt.es/es/documentacion_de_referencia/redes_nueva_generacion/anexos/Resolucion_mercados_4_y_5.pdf.
[105] Ibid.

Just recently, a report by the Swedish Competition Authority dealt with the issue of implications of this market structure for competition.[106]

The Swedish NRA, the Post and Telecom Agency (PTS), published its proposition for a public broadband roll-out program in early 2007. The proposed broadband strategy for Sweden[107] suggests nation-wide access to broadband with at least 2 Mbit/s downstream by 2010. Funds of around 100 Mio Euro should be made available by the Swedish government and the EU for this task. This roll-out should be based on open access under consideration of alternative access technologies, in particular with regard to rural areas. This strategy has not yet been realised.

## Annex 2.10: The UK

British Telecom (BT) announced its intent to migrate its entire network to an IP-based Next Generation Network, the 21st Century Network (21CN), in the summer of 2004. The 21CN was envisaged to be a single IP and DWDM-based network that will carry both voice and data. A rapid roll-out was envisioned, coupled with a complete replacement of BT's PSTN operations in the UK. The actual pace of deployment has been notably mellower.

In late 2003, Ofcom initiated its strategic review representing a detailed analysis of the state of the art in UK telecommunications, which culminated in the functional separation of BT and the creation of Openreach in early 2006.[108]

In July 2008 BT announced its plans to invest £1.5bn in Next Generation Access networks over five years. The announcement promised delivery of download speeds of up to 40 Mbit/s to 10 million homes by 2010. BT has stated that the deployment will involve a mix of FTTH and FTTC solutions. This investment was identified as being contingent on certain regulatory decisions, such as the rate of return on capital and rules on network access for BT's competitors.

In June 2009, the British government published its report "Digital Britain".[109] This report contains more than 20 recommendations with regard to the future of society and economy in the context of the proceeding digitisation of every day life. Its recommendations with relevance for broadband (access) infrastructures include:

- The removal of barriers of access to ducts and comparable "primary" infrastructures.
- The imposition of an obligation on users of fixed lines to pay 50 pence per month to fund deployment of next generation broadband (of whatever technology, under a reverse auction mechanism) to areas where commercial deployment is not occurring.
- Plans to put in place a universal service obligation for broadband, which ought to comprise bandwidths of up to 2 Mbit/s by 2012, as well as an analysis of financing options.

[106] See Konkurrensverket (2009).
[107] See http://www.pts.se/upload/Documents/EN/Proposed_broadband_strategy_eng.pdf
[108] See Section 0.
[109] See UK government (2009).

# ANNEX 3: EXPERIENCE WITH FUNCTIONAL SEPARATION

This annex provides relevant examples of functional separation in practice. We begin with European examples, starting with the UK (Annex Section 3.1) and Italy (Annex Section 3.2). We proceed to the Pacific with New Zealand (Annex Section 3.3), Australia (Annex Section 3.4), Singapore (Annex Section 3.5). We conclude with pertinent examples from the United States (Annex Section 3.6).

## Annex 3.1: The UK

Facing the danger of an enduring anti trust law procedure with ambiguous outcomes, BT offered Ofcom a set of undertakings *in lieu* of Ofcom making a reference to the Competition Commission under the Enterprise Act 2002 in June 2005.[110] These undertakings finally resulted in the functional separation of its access and service divisions and the establishment of Openreach.[111] To ensure workability and achieve real equality of access different measures were undertaken, including the establishment of the "Equality of Access Board" overseeing the work of Openreach, the introduction of a detailed code of practice to be followed by all employees,[112] and several organizational changes ensuring a high degree of separation between Openreach and BT.

Due to its role as a precedent, the establishment of Openreach has been subject to some analysis, in particular with regard to its effects on investment incentives (both of BT and its competitors) and competition.

It is noteworthy, that the establishment of Openreach did not discourage BT from investing 10 billion British pounds to establish BT's 21st century network (21CN). BT presumably realised two benefits associated with the functional separation of its access and service divisions: to avoid an enduring antitrust lawsuit with unforeseeable consequences, and to increase planning certainty due to the cementation of its dominant position in the wholesale market governed by Ofcom.[113] These well-known historical facts suggest that functional separation need not imply a reduction of investment; however, BT's investments were primarily in the NGN *core* network, not in the access network.

Kiedrowski (2008) outlines the main effects of the Openreach separation from the perspective of Ofcom:[114]

- Residential monthly cost of a basket of fixed telecoms services has fallen.
- Residential market shows both growth and replacement of dial-up with broadband.
- UK now has one of the highest broadband penetrations in Europe.
- Offers of bundled services increase and take-up gains momentum.
- The Undertakings have been effective for LLU operators (rise from 100.000 to more than 4.000.000 unbundled lines between 2005 and 2008).
- Sources of dissatisfaction are associated with quality and timely availability of wholesale products.

Thus, the experiences in the UK seem to indicate that benefits associated with the establishment of Openreach outweigh its disadvantages. One should, however, keep in mind that the stimulation of the UK broadband market in terms of competition and penetration was not solely the result of the creation of Openreach. There was also a significant cut in ULL prices in 2005, which likely served as an additional and probably substantial spur to competition.

[110] See in detail Ofcom (2005a).
[111] See Ofcom (2005b).
[112] See British Telecom (2006).
[113] See Wernick (2007), pp. 161-163.
[114] See Kiedrowski (2008).

## Annex 3.2: Italy

According to AGCOM, previous experiences with wholesale access regulation in Italy represent a mixed result. The regulation of wholesale access products offered by the incumbent TI proved successful for launching competition; it failed, however, to solve the problem of non-price discrimination.[115] Since AGCOM was not vested to impose a separation on Telecom Italia, the Italian regulator was dependent on TI's cooperation, which was again furthered by a number of ongoing infringement procedures initiated by the regulator. Finally, TI proposed an operational separation (undertakings), which was, in an amended version, accepted by AGCOM.

TI's operational separation resulted in the creation of Open Access, a new division in charge of the passive elements of TI's access network. Moreover, TI has to fulfil a number of requirements with respect to non-discrimination, transparency and quality and performance measurement. A supervisory board monitors and oversees the implementation of the Undertakings. Three out of the five members of this board are appointed by AGCOM.

The undertakings became legally binding in January 2009 only. It is thus too early to make an assessment.

## Annex 3.3: New Zealand

In May 2006, New Zealand implemented new rules to mandate access to Telecom New Zealand's (TCNZ's) assets and to impose operational separation on the company. TCNZ was separated into three distinct entities: (1) access networks services (ANS), (2) wholesale and (3) retail business units.[116] In the course of the resulting consultations, TCNZ proposed a structural separation of its access business, which was not pursued. On 30 March 2008, the Minister for Communications and Information Technology finally approved the three way separation plan.

Parallel to the separation plans regarding TCNZ, the New Zealand government intends to deploy high speed Internet to 75% of its inhabitants by means of a newly constructed network. The government has pledged to spend 1.5 billion NZD for the new fibre network which is to be constructed as PPP under the principle of open access. The model proposed in April 2009 states that the government will invest at dark fibre wholesale level with a range of partners, leaving the commercial side of the business to the industry. To realize its goal, the government will establish the Crown Fibre Investment Company (CFIC) which will essentially manage the government's share in the project. CFIC and private partners will invest in Local Fibre Companies (LFCs), which will roll-out and manage access to the new infrastructure on the principle of open access. It may be necessary to make adjustments to the operational separation regime in light of these high speed fibre initiatives, inasmuch as they change the competitive landscape for last mile access.

## Annex 3.4: Australia

In Australia, a loose form of separation was implemented by Telstra in 2006. It involved the creation of a separate wholesale division, to be responsible for sales by the incumbent to competitors. This has, however, not proven to be successful. Telstra represents one of the most powerful incumbents in the world with a high level of vertical and horizontal integration.

Government is likely to impose structural separation and/or strong functional separation as part of the envisaged transition to a nationwide FTTH network (*the National Broadband Network*, or *NBN*) to 90% of Australians.[117]

[115] See Mannoni (2009).
[116] See also Bleisch and Marcus (2009).
[117] See also Marcus, Wernick, Carter (2009).

## Annex 3.5: Singapore

The government of Singapore follows a three layer approach with regard to its next generation broadband network. The first layer represents the network company (NetCo); The NetCo is the owner of the passive infrastructure including ducts and wirelines. This layer will be supported with at most 750 Million US$. An Operating Company (OpCo) represents the second layer. The OpCo is a wholesale operator for active infrastructure, including switches and transmission equipment; the government announced to invest 250 million US$ on this level. Finally, a number of retail service providers (RSPs) will compete for private customers. In order to realize low entry barriers for RSPs, structural separation is mandated for the NetCo and operational separation for the OpCo.

## Annex 3.6: The United States

In the United States, the courts and the Federal Communications Commission (FCC) have employed various implementations of separation as a means to constrain the market power of dominant telecommunications. Most famous is the 1984 divestiture of AT&T, breaking it into a competitive long lines carrier and seven non-competitive Regional Bell Operating Companies (RBOCs). Apart from the AT&T break-up, there are numerous other instances where partial separation requirements were imposed on firms which were or would seek to be integrated telecommunications firms. Three lessons can be taken from the U.S. experiences: First, there are many ways to implement functional or structural separation, not just a single way. A second is that all of the stringent approaches worked, more or less. That they were subsequently phased out (either because the market had become more competitive or else under arguably misguided US deregulatory policies) should not detract from that fact. They achieved what they were intended to achieve, when they were intended to achieve it. Third, a closely related corollary is that relatively simple separations that establish bright lines that are easily enforced should be preferred over softer separations that potentially leave murky ambiguity and thus impediments to oversight and enforcement. [118]

[118] See ibid, p. 20.

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