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**RULING THE NEW AND EMERGING MARKETS
IN THE TELECOMMUNICATION SECTOR**

***CHALLENGES: THE EMERGENCE OF
NEXT GENERATION NETWORKS***

BACKGROUND PAPER

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NOTE

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EXECUTIVE SUMMARY

In the 1980s and 1990s many countries have started to privatize and liberalize their telecommunications markets, and by the second half of the 1990s the development of competitive structures in traditional fixed-line telephony has been encouraged by new laws and the installation of national regulatory authorities. At the same time progress in information and communications technologies has transformed business models in the telecommunication industry substantially. Most importantly, telecommunication services and Internet access are now being provided by different (yet substitutable) network infrastructures. Currently, telecommunication industries experience a new fundamental transformation which is characterized by a shift through convergence and integration. With convergence towards so-called Next Generation Networks (NGN) several networks (e.g. public switched telephony network (PSTN), mobile, IP, cable TV) are connected under the IP standard which will allow for ubiquitous access to services (both fixed and mobile) in the not too far future.

The transformation process towards NGNs is characterized by three elements which create an urgent need for adapting the regulatory framework to the new realities:

First, traditional market boundaries have become increasingly blurred in the presence of IP-enabled services and fixed-mobile convergence.

Second, access providers and network operators have to make intensive investments in upgrading and building new infrastructures and there is an additional need for commercial innovation.

Third, new potentials for bottleneck structures and market dominance in the telecommunications industry can emerge; e.g., in operating systems and browsers, or routers and network systems, or in terminal devices and microprocessors.

The assessment of current market developments towards IP-enabled NGNs and the future implications for policy regulation are a highly controversial debated issue. Incumbent carriers typically state that the commercial models for IP-enabled NGNs are at an early and evolutionary phase and that it is too early to discuss Open Access or wholesale mandated interconnection regimes. It is also argued that IP-enabled NGNs, particularly the deployment of high speed access networks (e.g. FTTx, VDSL), require massive investments and that “national regulatory moratoria” for incumbents are badly needed to generate an appropriate investment climate. On the other side, competitive providers are worried that without immediate attention by regulators to NGNs, incumbent carriers will rapidly vertically integrate services and that new bottlenecks will emerge for delivery of audiovisual content.

But how should regulators proceed over the next years? The definition and identification of “new and emerging markets” as one basic problem is not solved yet. This comprises the separation of new markets from (regulated) old markets. The problem is complicated further by the ubiquity of bundling strategies and complementarities between services and applications.

Additionally, the regulatory framework for new markets should take care of the vertical structure (and associated complementarities between services and infrastructure) and the pronounced risks these dependencies imply for innovating firms. The creation and upgrading of access networks can increase the scope for effective intermodal competition, which is a necessary prerequisite for a withdrawal of ex ante regulations. Thus, regulators and policy makers could target the competitiveness of alternative access technologies. For example, spectrum policy (for radio broadcast and WiFi access) should make available large amounts of spectrum and licensing policies should encourage the efficient use of it.

Another challenge concerns the implementation of Openness requirements. It has to be studied carefully, whether a separation into a physical layer, communication protocols, a service layer and an application layer is meaningful and how structural separation will bias technical progress and investment decision.

Therefore, the answer to the question how to proceed depends on the longer run market developments. An according longer run perspective should take into account the massive investment projects currently underway in the telecommunication sector. At the same time, it has to be understood that short run market power tests (as, e.g., the SMP test in Europe with a time horizon of one year) are not appropriate in markets where drastic investment projects have a much longer time-frame.

A standard, cost-based regulatory system, which may be optimal in a static environment, necessarily reduces firms' investment incentives, because it does not properly take into account the risks the investor has to bear; or, more precisely, the need for high rewards in successful states of the world that have a small ex ante probability. In addition, cost-based access regulation creates an option of waiting for potential competitors and therefore tends to hinder investment-based catch-up competition, which is essential for generating viable competitive structures in telecommunication markets.

However, a complete withdrawal of sector-specific supervision also appears to be premature because of the particular feature of the telecommunications sector; namely, non-replicable asset problems and significant network effects. As a consequence, the optimal regulator approach lies somewhere in the middle where market forces can unfold while the threat of regulatory intervention remains a viable option, which effectively constraints anticompetitive re-monopolizing of telecommunications markets. Thus, regulators and policy makers are facing a delicate and complex task in telecommunications markets. They have to keep the threat of regulation and at the same time they should abstain from premature intervention.

We suggest that the development of new markets should be reviewed periodically. If there is no discernable trend towards significant competitive structures, the market will be subjected to sector-specific control. This "threat of regulation" approach not only takes account of the risk-laden innovation problem of the investing company; it also increases the incentives for competitors to invest into competing infrastructures which is necessary to develop effective competitive structures in telecommunications markets. Other policy proposals, as outright access and/or unbundling regulations as well as regulatory holidays, which assure access at cost-based prices to the incumbent's new infrastructures, will – to the contrary – create a certain option value of waiting for competitors which necessarily slows down competitors' investment incentives and, with that, retards the emergence of infrastructure based competition.

Market reviews should also examine the innovative threats from potential competitors. As is well known from so-called high-tech industries, very high market shares may not indicate uncontested dominance when competitors are challenging the dominant firm's lead in the innovative market segments. Moreover, the regulatory review process must assess the overall degree of uncertainty in emerging markets which increases the possibility of premature regulatory intervention.

In any case, the effectiveness of future regulatory frameworks critically depend on the degree of commitment on the part of regulators as otherwise any decision to forbear would not change market behaviour. A periodic market review process that delivers a transparent assessment of market developments and a clear reasoning about possible regulatory interventions could help to achieve commitment and credibility.

1 INTRODUCTION

In the last decades telecommunications markets have changed dramatically. Not more than twenty years ago telecommunications industries were characterized by large (often state owned) monopolists. While there was little variety and technological progress in those days, consumers were happy to obtain access even at high costs.

In the 1980s and 1990s many countries have started to privatize and liberalize their telecommunications markets, and by the second half of the 1990s the development of competitive structures in traditional fixed-line telephony has been encouraged by new laws and the installation of national regulatory authorities. At the same time progress in information and communications technologies has transformed business models in the telecommunication industry substantially. Most importantly, telecommunication services and Internet access are now being provided by different (yet substitutable) network infrastructures. While new platform technologies, as e.g., mobile telephony, often serve new needs, competition between access technologies has further intensified the pace of innovation.

Currently, telecommunication industries experience a new fundamental transformation which is characterized by a shift through convergence and integration. With convergence towards so-called Next Generation Networks (NGN) several networks (e.g. public switched telephony network (PSTN), mobile, IP, cable TV) are connected under the IP standard which will allow for ubiquitous access to services (both fixed and mobile) in the not too far future.

The transformation process towards NGNs is characterized by three elements which create an urgent need for adapting the regulatory framework to the new realities:

First, traditional market boundaries have become increasingly blurred in the presence of IP-enabled services and fixed-mobile convergence.

Second, access providers and network operators have to make intensive investments in upgrading and building new infrastructures and there is an additional need for commercial innovation.

Third, new potentials for bottleneck structures and market dominance in the telecommunications industry can emerge; e.g., in operating systems and browsers, or routers and network systems, or in terminal devices and microprocessors.

Faced with separate infrastructures for voice and data business, rapid convergence and growing competition, almost all traditional carriers are fundamentally re-examining their business models and making investments in a move to a common IP-based core infrastructures and deploying high-speed access connectivity (e.g. through FTTx or VDSL) for customers. These new core and access network infrastructures will be supplemented with an “intelligent infrastructure” or a “business layer” for IP networks capable of providing QoS, reliability and security assurances for multiple service scenarios across carriers.¹

IP-enabled NGNs can be seen as a logical progression from separate PSTN- and IP network infrastructures to unified networks for future electronic communications based on IP. The fundamental difference between NGNs and today’s telecom networks is a shift from circuit-switched voice-based single service networks to packet-based multi-service networks (of which voice will be only one of a set of available services).²

Besides such fundamental changes, telecommunications markets often remain subject to ex ante regulations which were designed to prevent the incumbent monopolist from abusing its dominant position, and with that to strengthen competition where possible. Asymmetric regulation has been used as a commitment to attract entrants by providing access to the incumbent’s essential facilities and interconnection with the existing network. More recently, unbundling policies have been implemented to give entrants access to the incumbent’s local copper lines. With this, additional incentives for entrants to build their own broadband infrastructures have been created.

The regulatory environment of upcoming NGN, where major incumbents transform their PSTN network to an all IP network, is quite different from the past where some ISPs provide VoIPs and PSTN is still available as a substitute. Consequently, policy makers and communications regulators around the globe are grappling

with how to best promote the public interest in a competitive and innovative IP-enabled communications environment.

As IP-enabled NGNs will be deployed by numerous service providers around the globe, telecommunication policy makers and regulators should be aware that the days when legislation and regulation could assume distinct services running over distinct networks are disappearing fast. With this, IP-enabled NGNs will shift the regulatory landscape.

Both, the assessment of current market developments towards IP-enabled NGNs and the future implications for policy regulation are a highly controversial debated issue. Incumbent carriers typically state that the commercial models for IP-enabled NGNs are at an early and evolutionary phase and that it is too early to discuss open access or wholesale mandated interconnection regimes. It is also argued that IP-enabled NGNs, particularly the deployment of high speed access networks (e.g. FTTx, VDSL), require massive investments and that “national regulatory moratoria” for incumbents are badly needed to generate an appropriate investment climate. On the other side, competitive providers are worried that without immediate attention by regulators to NGNs, incumbent carriers will rapidly vertically integrate services and that new bottlenecks will emerge for delivery of audiovisual content.

Overall, regulators have to find a new balance between promoting static efficiency and dynamic efficiency considerations. With the emergence of new infrastructures and networks and the creation of new IP based services, regulators’ face many difficult challenges, as e.g., whether or not to unbundle stand-alone bitstream access, or whether voice over IP should be taken as part of the public voice telephony market. While these open issues have to be addressed in the near future, regulatory uncertainties will remain if no stable and predictable regulatory framework will develop.

While technical convergence makes regulatory asymmetry no longer tenable, the question remains, how to proceed? For example, Eli Noam, when asked “What do you see as the FCC’s most pressing problems in the telecommunications sector?” provided the following answer: “There are many medium-sized problems, such as reforming universal service, and integrating the internet into the system, such as with VoIP. The larger issue is the harmonisation of regulatory treatment for cable and telecom. But the most important one is one of long-term strategy: after two decades of opening, liberalising, deregulating, what is next? What should be the goal and purpose of the next generation of policy initiatives? What is the post-liberalisation agenda?”³

A common sense has emerged, that net neutrality will be a basic concept to communication policy, to develop a pro-competitive regulatory framework for NGNs. However, there is a heated debate about the exact definition and implementation of neutrality rules. Some stakeholders argue that the IP communications environment has thrived in an unregulated environment that has produced Darwinian Competition – resulting in new and innovative applications – some even arguing that “network neutrality” should be codified in technical, legislative and regulatory regimes. Others argue deployment of IP-enabled NGNs requires significant investments to build out high-speed environment and this suggests regulatory moratoria for providers. Current competitive telecom providers argue the opposite, saying there are questions as to whether, in the absence of wholesale economic regulation, will market dynamics be sufficient to ensure a competitive NGN environment?

In this study, we will discuss the regulatory challenges resulting from the evolvement of NGNs. We study the new technological realities that are associated with trend and how the regulatory framework should adopt to the new and emerging markets in the telecommunication sector. In the course of our study, we also examine the variety of policy options currently considered by regulators and policy makers.

Our study proceeds as follows: In section 2, we describe the architecture of NGNs and the convergence from multiple separate networks each optimised to single services to one unified IP-based multi-service network. Particular emphasis will be given to new access technologies and new opportunities for providing and bundling services. Moreover, we explore the associated risks and opportunities for telecommunication firms. Section 3 explores, which new regulatory challenges arise in NGNs, where we distinguish between economic, general interest and technical regulations. In Section 4 we analyze the regulatory challenges that follow from the evolution towards next generation networks. For that purpose we start with some basic considerations about regulation in dynamic and uncertain environments and we present a picture of dynamic competition in network markets as well as the associated possibilities for markets failures. We proceed with a presentation of regulatory options that have received some prominence, and in the course of our analyses

we will also touch on the different routes policy makers are taking with regard to NGNs. Finally Section 5 concludes.

2 CONVERGENCE AND NEXT GENERATION NETWORKS

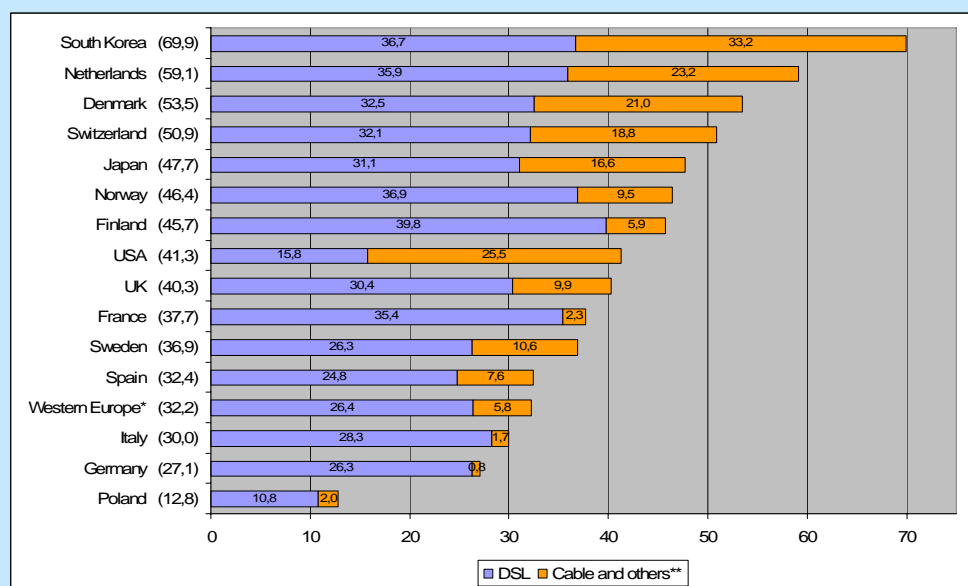
Traditionally networks have been designed and implemented to transmit certain specific types of data such as telephony, data or broadcasting. The new realities in telecommunications can be characterized by the rapid growth of broadband access, an overall convergence process of different network technologies, and the emergence of a uniform IP-standard for individual and mass communication.

The impressive growth of broadband connectivity and IP telephony is widely considered as a step forward and a driving factor for the convergence of the PSTN and IP networks to a unified public network for electronic communications based on IP. Figure 2.1 illustrates the widespread broadband deployments around the world.

Using computers to phone, browsing websites with cellphones or reading emails on tv screens illustrate the idea of convergence. In addition to current services (e.g. voice), future networks will be able to carry services demanding high bandwidth, e.g. ip television (IPTV) or video conferencing and other multi-media applications requiring capacities of tens of megabits per second per user. Furthermore these networks should provide the mobility of wireless networks and very high speed innovation possibilities. Next Generation Networks will deliver true convergence between the traditional world of public switched telephone networks, and the new world of data networks.

Figure 2.1: Broadband connections by country

Number of broadband connections including enterprise broadband connections per 100 households



Note: * Western Europe including Turkey (total)

** Cable and all others, e.g. satellite broadband, wireless local loop (WLL), fibre to the curb/home (FTTx)

Source: BITKOM (2006), based on EITO

Next Generation Networks include three aspects:⁴

- The evolution of existing access or distribution networks (local loop) with the deployment of new high-speed technologies to so-called *access NGNs*.
- The changes in or convergence of the backbone infrastructure from legacy switched and/or ordinary IP-based networks (e.g. PSTN and the “public internet”, respectively) towards an integrated IP-based network with multi-service capabilities and differentiated quality of service, so-called *core NGNs*.

- The use of the design and control of these physical networks according to the NGN concept with a layered structure, where the separation into different layers and planes with open interfaces, that allow service creation and provide control and security, independent from the underlying technologies and infrastructures through the *control layer*.

This layer together with the services determines the “behaviour” of the network and therefore the user experience. This combination will hereafter be referred to as *logical NGN*.

The vision behind NGN is to achieve one universal and ubiquitous network that perspectively realises the possibility to carry all applications and services of all current networks for telecommunication and broadcasting. From a consumers perspective NGNs can combine greater control and personalisation with these innovative new services, can provide a higher level of security, reliability and flexibility and can offer ease of migration between services although offering continuity for existing PSTN services.

While the envisioned development has been summarized under the title NGN, the term refers to a comprehensive concept, not to a special network. Therefore at present, there is no unique definition of Next Generation Networks. The two mainly used definitions for discussion purposes are from the International Telecommunications Union Telecom Standardization (ITU-T) Study Group (SG) 13⁵ and from the European Telecommunications Standards Institute (ETSI) Technical Committee Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN)⁶ (see Box 2.1).

Box 2.1: Definitions and characteristics of NGN

ITU-T⁷ defines NGN according the ITU-T Recommendation Y.2001 - "General overview of NGN" as follows: « A Next Generation Network (NGN) is a packet-based network able to provide Telecommunication Services to users and able to make use of multiple broadband, QoS-enabled transport technologies and in which service-related functions are independent of the underlying transport-related technologies. It enables unfettered access for users to networks and to competing service providers and services of their choice. It supports generalised mobility which will allow consistent and ubiquitous provision of services to users. »

According to this definition, a NGN is characterized by the following fundamental attributes:

- Packet-based transfer
- Separation of control functions among bearer capabilities, call/session, and application/ service
- Decoupling of service provision from network, and provision of open interfaces
- Support for a wide range of services, applications and mechanisms based on service building blocks (including real time/ streaming/ non-real time services and multi-media)
- Broadband capabilities with end-to-end QoS and transparency
- Interworking with legacy networks via open interfaces
- Generalized mobility
- Unrestricted access by users to different service providers
- A variety of identification schemes which can be resolved to IP addresses for the purposes of routing in IP networks
- Unified service characteristics for the same service as perceived by the user
- Converged services between Fixed/Mobile
- Independence of service-related functions from underlying transport technologies
- Compliant with all Regulatory requirements, for example concerning emergency communications and security/privacy, etc.

The ETSI TISPAN definition of NGN results from the TISPAN_NGN Release 1 Documentation, especially the Definition (framework) paper⁸ and extends the explicit requirements that have to be fulfilled by a NGN by the following points:

- The IP-based core network is required to support PSTN/ISDN migration scenarios
- Mobility and nomadicty of both users and devices
- PSTN/ISDN simulation to preserve the operability of existing end user hardware
- Secure, reliable, trusted network management and security
- Peer-to-peer and client-server concepts have to be supported
- Providing possibilities for billing, charging and accounting

There exist different paths by which a NGN could evolve. Few would disagree, the most important possibility should be the IP-expansion of existing carrier networks. The counterpart would be the addition of QoS and authentication support to the existing public internet. However, this option is often considered to have little chance to be realised. Sometimes there exists the possibility for a green-field approach, implementing a NGN from scratch (the BT approach including a nearly complete geographical restructuring could be regarded as a kind of hybrid development path between the carrier network evolution and a green-field approach), . A fourth viable approach is the interconnection and evolution of enterprise networks (so-called Next Generation Corporate Networks (NGCN))⁹. The enhanced security and performance features of NGNs as well as cost advantages in implementing new services, e.g. SingleSignOn (SSO), traffic control and Enterprise Application Integration (EAI)¹⁰, might be rationales to move from Virtual Private Networks and/or Extranets to NGNs, e.g. in the financial sector or automotive industry.

A number of operators are currently deploying NGNs. From an operator's perspective they provide a means of migrating from the old world to the new world, delivering substantial cost savings due to the economies of scope inherent in a single converged network. There is the chance to improve operational efficiency and reduce costs through a common, consistent infrastructure. NGNs provide the opportunity for hardware consolidation based on open standard off-the-shelf hardware with significantly less room and power consumption and according CAPEX and OPEX improvements instead of using multiple service-specific networks.

In addition, the provision of all services on a single platform (eventually engaging logical NGNs and overlay networks, see the following section and Box 4.2) reduces the time-to-market for new and innovative products and services. This may generate a much greater variety of services and opens new possibilities to offer triple-play services which bundle telephony, data and television in a more convenient way for users.

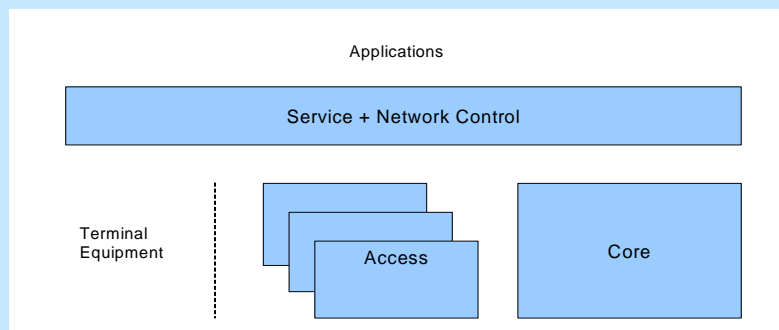
With these technological developments market structures will change significantly. First, several networks, as PSTN, wireless, DSL, 3G, Fibre, Satellite, Powerline Communications (PLC), and CATV, become connected through a convergent network architecture. Second, services are becoming increasingly independent from networks.

2.1 NGN Architecture

The most important consequence of the migration to NGNs besides the shift from circuit-switched to packet-routed networking is the increasing modularity of the network and the separation and resulting independence of applications and services from the network through the introduction of an overarching middleware (the service and network control layer).

The evolution to NGN is built on this foundation that requires operators to evolve and invest in their infrastructure in all three (core, access and control) areas (see Figure 2.2).

Figure 2.2: NGN functional entities



Source: cf. ETP (2006, p.5)

The control layer allows for the complete layering of the network. The base layer contains all physical infrastructures, the control layer spans: the core, backhaul and access network(s),¹¹ thereby the Internet Protocol serves as a common unified network layer. The control layer separates the service network from the carrying network and the service provision from infrastructure operation. The Service Provider becomes principally independent from the Connection Provider. In consequence, access technology should no longer govern the presentation of services to the end user (as long as there are not any influences, e.g. through differences in available bandwidth, QoS etc.).

The control layer is the most important layer since it actually determines the scope of an NGN and shapes the *logical NGN*. Logical NGNs are overlay networks with different properties regarding e.g. QoS, security, traffic management, sharing a common infrastructure (even if there may exist *fast lanes* for traffic and congestion management purposes and to achieve higher QoS-levels only for a subset of the overlay networks). Two examples for overlay networks are given in Box 4.2 below.

Changes compared to the PSTN

Strongly associated with the introduction of the control layer are the possibilities to re-distribute the intelligence over the network. Unlike the design of the traditional PSTN, where the intelligence resides in the network, IP-based networks allow the movement of intelligence to the edges or boundaries of the network. Furthermore, in NGN, functional entities controlling policy, sessions, media, resources, service delivery, security, etc. may be distributed over the infrastructure, including both existing and new networks.

The aforementioned services-transport-separation is based on a new approach to service oriented architectures and leads to a consolidation of both horizontal and vertical interfaces through the convergence of voice, data and future services. A range of former key elements connecting the separate infrastructures for voice and data (e.g. DSLAMs) will become obsolete.

NGN try to combine the advantages of packet-routed networks with the advantages of circuit-switching. But despite of all R&D efforts that have been undertaken in the last years, there are many open issues :

- What Services does an essential Core Network provide?
- Do Flexible Universal Networks really work?
- Are they living up to the promise of being less complex?
- Are they easier to manage and do they simplify the provisioning process?
- Are future services easier to implement and do they scale in a reasonable way?
- How to match current standards on security and reliability?
- What requirements will governments concerning functional objectives have and therefore what influences on architecture and network design?

Facing these issues may lead to the fact that the transition process may take longer than expected. The GENI network (see Box 4.2) coordinators project the timeframe of the network architectural process to take ten to fifteen years from now.¹²

Although it is impossible to tell which business models will emerge, prevail and prove to be sustainable, it is most important not to unnecessarily restrict innovation, evolution and growth. Therefore, the issues of mandated standards and attributes, e.g. *Network Neutrality* and *Openness*, discussed below, are of strategic importance for policy makers and the industry as a whole.

2.2 Transport Technologies

For the most part, next generation networks will physically consist of high capacity fibre optic links in the core and backhaul domains, though for access networks there exist some relevant alternatives. However, there are some significant differences between. All transport technologies are capable of simultaneously supporting various types of services.

Core and backhaul networks

Next generation core networks can be global with access possibilities worldwide or can cover a specific region.¹³ Core networks likely will be interconnected and also connected to various access networks. A multiservice core with high speed optical links (typically at speeds of tens of gigabits or terabits per second) regularly will serve as a backbone network.

The backhaul networks covering the routes between core and backhaul networks are expected to be mostly fibre-based, in some cases copper will serve as a temporarily solution, operating at gigabit speeds.

Access networks

All existing technologies (copper plant, cable, wireless networks, FTTx networks) are technologically able to deliver triple play services. However, for all alternatives significant investments are necessary to be suitable to compete in infrastructure based competition.

The technological means to achieve higher bandwidth exist for all access technologies. This allows true platform competition in the access network where different networks have been established. Various broadband wireless access technologies offer promising opportunities with speeds comparable with fixed next generation broadband either in combination with fixed or cellular networks, although some of them are not ready for large-scale roll-out yet.

- Operators with copper networks currently are improving their networks deploying DSL technologies. The bandwidth of DSL depends on the distances to the fibre-gate and is currently limited to 16mbit/s (ADSL2) and 52mbit/s (VDSL) (downstream) respectively, and is declining with distance. Multi-service access gateways have to serve as border elements between access and backhaul network.
- Hybrid Fiber Coaxial Networks (HFC, e.g. Cable Modems) operators of cable TV networks have to invest in return link capabilities, bandwidth shared by users, and by way of improvement reduce the distance between fibre and the users.
- Ethernet in the first mile (MetroEthernet EFM, IEEE 802.3ah) offers speeds up to 100 mbit/s symmetrically and is to be realised in urban areas at a relatively small cost but the maximum distance to the fibre-link is limited to approximately 100m.¹⁴
- Passive Optical Networks (PON), e.g. FTTCab, FTTC, FTTB, FTTH (generally referred to as FTTx), provide bandwidths up to 155mbit/s symmetrical or 622mbit/s downstream when configured asymmetrically, the distance range is upto 20km, but deployment involves relative high construction costs.
- Powerline Communication (PLC) uses the most widespread wired network available, the power supply system. At the moment there are some unsolved problems with interference and range. Additionally, the power network operators would have to invest significant sums in their infrastructure.
- Wideband Radio Access Technologies (e.g. Microwave Multipoint Distribution Services MMDS or MVDS using Digital Video Broadcasting (DVB) systems using a POTS return link) at the moment count for 6M user worldwide, other systems, e.g. Broadband PMP, Local Multipoint Distribution Systems (LMDS) or Wireless LANs (e.g. HIPERLAN at 5GHz) currently are under development. Ready for production, they will provide speeds up to 54Mbit/s, but at the moment there is no QoS implemented, and only best effort transport available.
- Mobile telephony networks currently are being improved by setting up UMTS and HSDPA, which deliver data at 384kbit/s and 2Mbit/s, respectively. These technologies will not provide sufficient bandwidth in the near future to be regarded as a competitive network for triple play bundles and other applications demanding high bandwidth.

A distinct shift from traditional circuit switched networks where the intelligence of the network resided almost exclusively in the core, results from the fact, that intelligent edges will contain much of the intelligence of next generation networks. This allows for the implementation of different types of access networks to be seamlessly connected to the same intelligent edge.

2.3 Control and service provision in NGNs

The key enablers for operating NGNs are so-called Operating Support Systems (OSS). These Systems together with the according processes provide the ability to manage and flexibly configure networks. These modular OSS are expected to be based on distributed architectures consisting of off-the-shelf commercial systems linked by standard industry interfaces and to replace the vertically integrated OSS systems currently in use.¹⁵

One segment in the OSS is the above mentioned control or business layer. The control layer includes both service control and network control elements. All aspects of network controllability, management and programmability including QoS, service provision, security, user information and identity management, policy management, mobility management, dynamic session management and integration, customer care services, billing, and horizontal and vertical integration are determined by the logical NGN.¹⁶

Next generation service control might be developed functionally separate or fully integrated with the access and/or core infrastructure. In either case, it needs to be accessed through the core network by the customer premises equipment for meeting the functional requirements, e.g. regarding security. As of now, the IP multimedia subsystem (IMS) developed by the mobile industry represents one possible realisation of such a service creation environment.

The IMS has been originally developed by the mobile industry in the Third Generation Partnership Project (3GPP) together with contributions from ETSI and the Parlay group for 3G mobile networks. Its specification has been adopted by the ITU and ETSI-TISPAN to fixed network environments and therefore may constitute a unified architecture for circuit- and packet-switched networks, using a variety of different wireless and fixed access technologies.¹⁷ The IMS is delivering a host of value added services and applications, enabling applications through open, standardised interfaces, allows faster development and rapid launch of applications and ensures their interoperability.

This service control capability allows the control layer acting as a platform with open interfaces between transport, control and applications, providing a service creation environment through so-called Application Programming Interfaces (APIs). This modular structure of NGNs may offer significant advantages which appear to drive operator's investment decisions. For example, the standardisation of the service environment allows for interoperable services and increased flexibility in service procurement. The combination of such a layered architecture and open interfaces connects IT and network infrastructures in a manner that permits a two-tiered integration of IT and network systems, thus lowering the costs for network operators.

Significant advantages for network operators may exist in the following categories, leading to strong incentives to evolve NGNs. However, they could lead to new bottlenecks and monopoly problems as well as options for anticompetitive strategies as illustrated below.

Service Creation

As mentioned, the separation of services and carrying networks is beneficial for the development of new services. Through the use of open APIs operators will be free to customise and create new services with the networking equipment that they already have. In many existing telecommunication networks, services are in effect controlled by equipment manufacturers, thereby sometimes imposing lengthy lead times on the introduction of new services.¹⁸

The vision is to launch new applications like installing software on a computer operating system, e.g. like just double-clicking a "setup.exe" and setting the preferences to make an application available, so the phases of invention, prototyping and controlled operation can interfere increasingly, leading to greater variety and shorter times-to-market.

To achieve this goal, the applications are enabled via Parlay/OSA (Open Service Architecture) gateways. The Parlay/OSA framework unifies authentication, registration, service selection, balancing and debiting and therefore closely connects IT and telecommunication providers and application developers, service providers and network operators in fixed and mobile networks.

This concept allows the operators the flexible provision of personalized services on a per user/per service - basis and develop innovative personalised services, the interworking between different NGNs and existing networks such as PSTN, ISDN and GSM by means of Gateways through seamless service operations across

a multi-provider NGN infrastructure. The OSA framework was designed to provide the necessary portability of service logic and to allow features to be exposed to third party service providers in a secure controlled manner.

For example, France Telecom will offer APIs like the aforementioned by a project called Octave. « This project is coupled with another platform that is developed around so-called *social software* that makes customer data and metadata available in a controlled way to application developers. France Telecom will offer authentication, identity management functionality and customer care services to application builders [...] another scenario is where developers can use the FT NGN as a platform for applications in which they will receive a cut of any generated revenue ».¹⁹

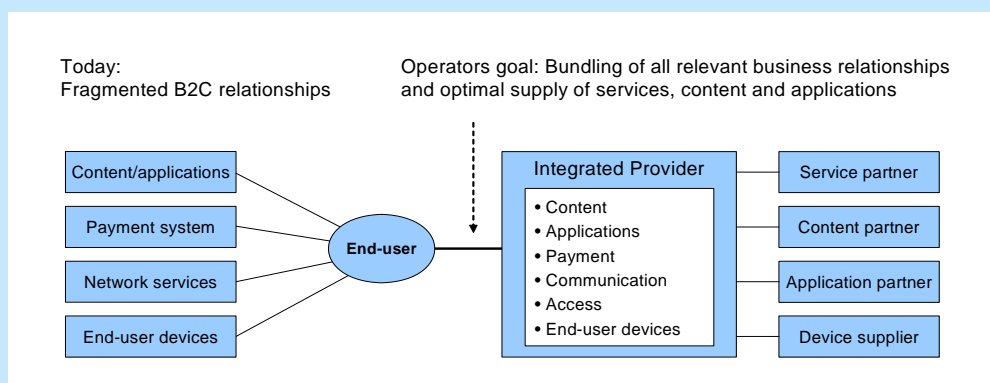
Security, user information and billing

The example of France Telecom illustrates one of the key issues considering the control layer. In contrast to the public internet, where security is often considered as poor, the control layer aims to add secure, reliable and trusted network management to NGNs and thus carriers can provide authentication and identity management not only for purposes of accounting and billing for the services they provide themselves, but also offer these features to third parties.

With the control layer, network operators strive for a compound security platform, including the dimensions authentication and access control, data confidentiality, communication security, data integrity, availability and privacy. E.g., for fixed-mobile-convergence, the secure transmission of charging information is an essential prerequisite for roaming scenarios between different networks. Most of these aspects are not only in the interest of the operators, but also mandated by law, e.g. for compliance with legal requirements regarding fraud detection and management, lawful interception, juridical evidentiary and forensics, network attack mitigation, data retention and preservation, caller location for emergency calls, malicious call identification and tracing and authenticated caller or sender identification.²⁰ These security issues can be regarded as the usual aspects appearing when introducing new information technologies.

The control layer aims to be not only a secure service provisioning and network operating platform but can also serve as an integrated billing platform from a network operator's view. This layer could also contain Digital Rights Management (DRM) and a payment system. Furthermore, the control layer is also key for defragmenting business-to-consumer (B2C) relationships (e.g. integrating the supply for news services, payment, access and end-user devices, see following figure 2.3).

Figure 2.3: Defragmentation of end-user-relationships



The control layer provides personalisation potential through network-centric storage and roaming of user profiles, allowing integrated providers to target individuals rather than households, e.g. for marketing purposes.

Additionally, the interoperation of provider and partner systems through open APIs may create new service, content and application provider markets at the wholesale level.

Controllability, QoS and Interconnection

Closely linked to the aspects just considered are the importance of traffic engineering features and the allocation of network resources. It is essential for network managers to be able to design, adapt and optimise their networks to simultaneously accommodate different types of media with varying network requirements, e.g. QoS-critical service types like voice or video conferencing. These types of services need a guaranteed high level of quality of service to function adequately. Traffic engineering features of next generation networks will help overcome both the problems of guaranteed quality of service in current packet switched networks and the problem of wasted capacity in dedicated circuit switched networks.²¹

A common shortcoming of current packet switched networks is that it can be difficult for telecommunication network operators to specify or guarantee an end to end quality of service, particularly where part of the communications link is carried over a third party's network. The control layer allows for traffic engineering, therefore operators can define specific levels of service and then enter into service level agreements with other operators who have similar traffic engineering capabilities.²²

Besides the aspect of QoS and the corresponding service level agreements, the deployment of NGNs also provides an opportunity to agree on enhanced interfaces to enable operators to interconnect and co-operate in the delivery of services. Such deployment opens up the possibility of defining a set of interfaces with appropriate APIs to delegate the intelligence of NGNs to enable the shared provision of services in so-called *trusted federations*²³, e.g. to consolidate the VoIP voiceboxes of several operators and/or service providers in a shared data processing centre.

Programmability and fixed-mobile-integration

The introduction of the concept of open APIs can be seen as a step towards the *programmable network*. The more programmable and re-configurable next generation networks are the more flexible they will be, and the more they will be able to cope with new services and user requirements.²⁴

The time it takes to provision new capacity in networks can be reduced from several weeks (in manually configurable networks) to a few hours or less through programmability. Fully programmable networks could be upgraded remotely from a single location eliminating the need for expensive site visits. To have next generation fixed and mobile networks using compatible APIs provides the opportunity to finally achieve the fixed-mobile-convergence with the ability for horizontal and vertical handovers that it has been talked about for some years. For manufacturers it also means that they will only have to justify R&D costs once rather than twice.²⁵

Control Points as new “logical” bottlenecks

The control possibilities might result in NGNs creating new bottlenecks and constitute new monopolies at the control and application layers. For example, an alternative provider may need access to additional functionality at the application layer (e.g. customer location data, session control functionality) in order to be able to compete effectively. Some of these functions may need an interface to interact, whilst others may require only one-way access.²⁶

A study by Devoteam Siticom and Cullen International²⁷ mentioned a number of “control points” that refer to potential new sources of market power that might evolve with the implementation of NGNs. The control points were assigned four groups:²⁸

- Network capabilities
- Elementary services
- Service access
- Control and user information

Network capabilities include the options to deny or block, delay or degrade access, interconnection and termination and QoS, routing and signalling capabilities. Elementary services may be necessary to ensure the network capabilities regarding e.g. the degradation of interconnection through the use of proprietary standards or service foreclosure through proprietary or legally protected APIs. The service access discrimination possibilities include *walled gardens*, or restricting access to certain addresses or services.

Control and user information related control points could be the restriction of user authentication, billing or location data essentially needed for service provision or the restriction of naming and numbering resolution.²⁹

These control points might lead to market power but it is yet unclear which and if they will become an barrier to a competitive market through evolving to an irreversible source of durable dominant control.

However, the identification of such control point could become a central regulatory work area, with the goal to identify control points for further analysis and decision, whether general competition law can be considered sufficient or if and what specific action has to be taken.

Bottlenecks from the « old world »

The items considered as bottlenecks at present are likely to remain in a similar form (e.g. unbundling of the last mile and collocation issues) because last mile operators will keep some advantages over their competitors, but might be extended by further aspects, e.g. QoS or change in their characteristics due to changed technical properties through the conversion of the networks from circuit-switching to packet-routing. Problems regarding procedures, time frames, points and prices for interconnection are likely to stay similar in nature, too.

3 NGNs – REGULATION CHALLENGES

Against this background, key regulatory challenges arise with respect to economic regulation as well regulation of security and social obligations.

3.1 Economic Regulation

The above description highlights that potential control points might appear in any of the four functional planes (access, transport, control and services/applications). The regulatory challenge is to identify the control points which are potential sources of market power and find suitable remedies in the case that market power is used to decrease competition.

With market power in the access plane, potential regulatory remedies may be similar to remedies used in PSTN networks. That is, potential unbundling obligations may foster market entry and thus lead to competition in downstream markets. Potential differences and new challenges, however, arise if the horizontally integrated nature of NGNs is taken into account. Access obligations to just one kind of infrastructure may not lead to a level playing field since horizontally integrated firms operating fixed and mobile networks can offer a potentially wider range of services. Additionally, it is not yet clear that terminal equipments will be standardized such that switching costs for consumers are low enough to allow efficient market entry.

Control over network capabilities allows discrimination of competing service providers by denying, blocking or degrading their data traffic. Furthermore, it enables operators to alter the quality of interconnections with other networks and thus allows for discrimination between on- and off-net services. Similarly, denying the provision of elementary services may also increase the costs for competing service providers. It can thus hinder alternative service providers to offer more elaborate services.

Finally, control over service access and user information allows discrimination against competing service and exploitation of potential economies of scale in offering third parties services.

Taken together, these observations point to potentially severe anti-competitive measures due to the layered nature of the NGN architecture. Vertically integrated operators with market power based on legacy infrastructures may leverage this market power and may gain new and persistent monopoly power in NGNs.

However, the regulatory consequences which can be drawn from this conclusion are not clear at all. Firstly, it is uncertain to what extend and in which markets market power will arise. The above mentioned list of competing infrastructures indicates that competitive market structures could emerge. This is not only due to the observation that investment costs for wireless networks are rather low as compared to fixed line networks

such as FTTx, it is also due to the horizontal structure of the service plane. With infrastructures offering potentially similar bundles of services, intermodal competition could be significant.

E.g. in Hong Kong there has been considerable progress in the roll-out of alternative customer networks installed, on the one hand based on fibre, on the other hand (where the deployment of fibre is inefficient) based on Broadband Wireless Access (BWA) technologies.³⁰

Secondly, it is unclear which discriminatory measures will be used and to what extent they will be relevant. This is especially the case for QoS provisions for which new interconnection models and new business models with respect to the billing of consumers may emerge.

Summarizing these considerations, the layered structure of NGNs offers a wide range of possible control points which can potentially be used for ant-competitive behaviour. It is, however, difficult to appreciate emerging market structures and the future relevance of specific control points. Furthermore, the vertical structure of telecommunication markets points to complex complementarities between access and service markets. As will be discussed in more detail in section 4, these complementarities tend to decrease discrimination incentives when competition in dynamic and innovative markets is considered.

Focusing actual regulatory interventions on the creation of a level playing field may therefore be most appropriate. Assuring access to specific numbers or IP addresses and establishing rules for number portability can facilitate market entry and can increase competition. The same holds for access to legacy infrastructures as the last mile, i.e., unbundling and collocation obligations. Also, a flexible spectrum management can ease market entry and can thus foster infrastructure based competition.

Besides the European Commission and other regulatory authorities, OFTA is currently reviewing the spectrum policy to manage the spectrum in a more transparent and market driven manner. Interestingly, OFTA did not freeze the spectrum allocation in order to facilitate use of wireless technologies. Uncertainties on future spectrum policy are taken into account by clear definitions of the scope and the duration of spectrum rights and credible commitments concerning the future provision of radio spectrum for services similar to BWA. This approach is similar to the approach used in the former 3G spectrum auction.³¹

Hundt proposes for reducing uncertainty, that the FCC should be required by law to publish a blueprint for making spectrum available and obliged to follow the blueprint.³² An independent commission should describe such a blueprint. If auctioned, the buyers should have the right to pay the current users to stop using the spectrum.

3.2 General interest and technical regulation

Besides the economic regulation there are issues expected to be mandated and therefore to be kept or migrated from the “old world”. The regulations that have to be adopted are likely to do far more damage to entrants than to the incumbents, so the latter probably view them as being positive overall. They possibly serve to weaken competitive entry. The main issues to be addressed are security, emergency calls and consumer policy.

*Protecting critical infrastructure*³³

The scope of this area includes network safety and security, integrity and attack mitigation. The goals are to achieve reliability together with the integration of priority service access and restoration in case of disasters, assisting public safety. A further aim is data retention and preservation for emergency tracing and law enforcement purposes. This issue is in the interest of the operator as well as in public interest. Although network security could be achieved through business interests, it is often additionally mandated by law.³⁴ Research in the area of *Economics of Security* yielded the result, that the market incentives for security are too low compared with the social optimum.³⁵

Legal requirements

National security assistance includes cybercrime mitigation, fraud detection and management and possibilities to obtain juridical evidentiary and forensics through lawful intercept (LI) by investigation agencies. Legal interception is considered to be a powerful investigation measure to fight crime. LI in IP networks is different from circuit-switched networks, because there is no dedicated path through the network. The obligations resulting from the US-american *Communications assistance for Law Enforcement*

Act (CALEA) and the European *International User Requirements* (IUR) together with the corresponding ETSI standards³⁶ require substantial investments in special equipment attached to the networks, thus leading to further possible entry barriers for competitive enterprises.

Emergency calls

Emergency calls are of outmost importance for the citizens. For fast and reliable help, location data of the caller may be required, especially in cases when the caller can't communicate or does not know his location. In the USA and Canada there are two types of services, *Basic 911* and *Enhanced 911 Services*. The basic alternative does not offer automatically provided location data, so the caller has to provide the according information to a dispatcher in a central call center who forwards the call to the appropriate emergency response centre. Enhanced 911 services include the user-independent provision of location data, therefore allowing the call to be directly routed to the next response centre.

The importance of at least basic emergency call capabilities are emphasized by the Singapore experience, where consumers accepted voice services without emergency possibilities and attempted unavailingly to place 911 calls in emergency situations, leading to aggravation or to death of these citizens.

Provider of Voice over IP are starting to offer enhanced 911 services at least at fixed locations. All providers have to inform their customers about the abilities and deficits of their services. At the moment, emergency calls in VoIP are not regulated in a comparable complexity as in the PSTN, but the introduction of QoS in NGNs and the possibilities of providing location data, and priority routing could lead to appropriate regulatory remedies.

Consumer policy and protection

Also closely linked to the mentioned network integrity and location data are the aspects of privacy, malicious call tracing and fraud detection and management. Privacy concerns could arise from advanced technologies like real-time location determination and the feasibility of deep packet inspection, requiring commensurate technical solutions and policies.

On the other hand, e.g. authenticated caller or sender identification provide confidence and thus are leading to some trust in communication partners. Together with further obligations like number portability, lifting contractual limits and e.g. the will to create tariff transparency, policy makers may be tempted to intervene and introduce obstacles to the exploration of new technologies.

These issues have been addressed in national as well as in international law, supported by research results in the area of *Economics of Privacy*, stating that the market outcome regarding privacy is socially suboptimal.³⁷ One of the core elements of this regulatory field included in the European "New Electronic Communications Regulatory Framework" is the *EC Privacy Directive*.³⁸

Universal service provision

Universal services, or the obligation to provide a defined set of services at a uniform price, have critical influence on innovations in services in NGNs. In today's framework, electronic communications services are split into private ECS, public ECS and PATS which means that voice services are treated differently from other electronic communication services. The challenge for regulators is to preserve universal service while fostering innovation in services. Therefore universal service might be re-thought, and be considered as a safety option in case of market failures. There might be further problems resulting from differences in the living structure between rural and urban areas, and educational policy goals that lead to the deployment of universal service obligations.

The economic and general interest regulations are linked together with access and interconnection to technical regulation and standardisation. Standards could be agreed upon interfaces, processes and for the description, comparison, measurement and contracts about technical details, e.g. QoS service level agreements when interconnecting NGNs.³⁹

4 REGULATION OF NEW AND EMERGING MARKETS

4.1 Basic Considerations

With the liberalization of telecommunication markets in the last decades state monopolies were privatized and markets were opened up to competition. Typically, telecommunication markets were placed under sector-specific regulation and the supervision of specific regulatory authority. Right from the beginning it was clear that competition will not come overnight. As many countries abstained from imposing structural remedies (as, e.g., the 1984 AT&T breakup into a long-distance operator and seven regional Bell operating companies in the US), price and access regulations have become important regulatory instruments to ensure the development of competition at various levels. Similar to the “ladder of investment” idea of Martin Cave and Ingo Vogelsang,⁴⁰ it was assumed that ex ante regulation that prescribes access to the incumbent’s network would be necessary to kick-start competition. Over time entry at the service level would give incentives to build own infrastructures which would ultimately lead to competition at the infrastructure level.

Accordingly, access regulation to the network of the former monopoly operator has been a primary concern. Moreover, the intention was to create effective competitive structures within telecommunication markets, and with this, to review the possibility of removing specific telecommunication markets from ex ante regulation and placing those markets under the supervision of general competition law.

The question how to phase out regulatory supervision has gained new momentum with the imminent rapid pace of technological progress in telecommunication markets and the paradigm shift from integrated service providers to packet-based transfer world of the Internet, where separation of services from the network become two distinct functionalities.

At the same time regulatory review processes are taking place which should achieve a better alignment between regulations and the changing structures of telecommunication markets.⁴¹ Three more general issues are important in this process:

1. There is a need to provide a uniform legal framework that covers the convergence of telecommunications, media and information technologies.⁴²
2. As competition unfolds convergence between the principles that govern regulatory intervention in telecommunication markets should be brought into line with the principles of competition law.⁴³
3. And related to the former point, regulations of telecommunication markets develop certain criteria to define relevant markets, which may become candidates for ex ante regulation in a further procedural step.

Convergence at the infrastructure level and the service level are changing market structures and market boundaries. As the surge in VoIP illustrates, these market dynamics can be substantial and fast-growing. Moreover, investments into new infrastructures and migration to a NGN architecture opens the window for many new services and applications. Potentially, these new products can serve new consumer needs or improve the quality of existing products. In either way, regulators are confronted with the emergence of new markets, and therefore, have to implement new regulatory policies that formulate how regulatory supervision proceeds.

For example, under the new regulatory framework in the EU a two-stage procedure has been presented. In the first stage, a list of markets is defined in accordance with the European Commission’s Recommendation on relevant product and service markets (C(2003) 497).⁴⁴ It requires the selection of those markets which cannot be expected to generate effective competition and are, therefore, candidates for some sort of sector-specific regulation. Precisely, Recital 9 of the Recommendation sets out the definition of markets susceptible to ex ante regulation, as follows:⁴⁵

“In identifying markets in accordance with competition law principles, recourse should be had to the following three criteria. The first criterion is the presence of high and non-transitory entry barriers whether of structural, legal or regulatory nature. However, given the dynamic character and functioning of electronic communications markets, possibilities to overcome barriers within a relevant time horizon have also to be taken into consideration when carrying out a prospective analysis to identify the relevant markets for possible ex ante regulation. Therefore the second

criterion admits only those markets the structure of which does not tend towards effective competition within the relevant time horizon. The application of this criterion involves examining the state of competition behind the barriers of entry. The third criterion is that application of competition law alone would not adequately address the market failure(s) concerned.” (Recital 9 to the Recommendation on relevant product markets; 2003/211/EC)

The Recommendation specifies three criteria all of which have to be satisfied so that a certain market should be included in the list:

1. There must be “high and non-transitory” structural or legal barriers to entry.
2. There must be no tendency towards effective competition within a certain time horizon.
3. The market failure cannot be addressed with competition law alone.

It is noteworthy that the Recommendation explicitly refers to the dynamic character of markets and requires an assessment of their tendency towards competition.⁴⁶ Moreover, in an Annex the Recommendation specifies seven retail markets and eleven wholesale markets that should be subjected to market analysis by the national regulatory authorities. Those markets not explicitly included in the list will not be subjected to any market analysis and will therefore not come under sector-specific regulation (unless particular circumstances justify regulation by national authorities).

After having defined the relevant product and service markets, the second step is to examine the competitive intensity in those markets. If effective competition is absent, then the national regulatory authority must put firms with substantial market power under sector-specific regulation (see Art. 16(4) of the Framework Directive).

An important issue determining the effectiveness of the new legal framework is the adjustment of the list of relevant markets over time and the associated problem of how new markets should be treated. Recital 15 to the Recommendation on relevant product and service markets states:

“Furthermore, new and emerging markets, in which market power may be found to exist because of ‘first-mover’ advantages, should not in principle be subject to ex-ante regulation.”

The protection of “first-mover” advantages as a reason to exclude new markets from the list of relevant product and service markets is closely related to the objective of the Framework Directive to encourage “efficient investment in infrastructure, and promoting innovation” (see Art. 8 (2c) of the Framework Directive).⁴⁷

Overall, the concept of “new and emerging markets” introduced by the new regulatory framework in the EU explicitly recognizes the need to guarantee “first-mover” advantages so as to protect innovation incentives, and hence, the development of new infrastructures.⁴⁸ While this approach intends to rule out any ex ante regulation for new markets, there is still ample scope for discretion. Moreover, the new regulatory framework leaves many questions unanswered which are important for making it operational and effective. In particular:

1. What is a new and emerging market and how can it be distinguished from more mature markets?
2. What degree of “first-mover” advantage is desirable in terms of efficient investment in infrastructure and innovation?
3. How should the development of new markets towards effective competition be assessed and reviewed?

To answer these questions, it is necessary to keep in mind that new markets pose different regulatory challenges when compared with existing networks and infrastructures. Whereas, in the latter case, infrastructure investments have already been made, this is typically not the case with new markets. The concept of new markets or new infrastructures, therefore, highlights the interdependencies between regulation and private investment incentives; an issue which was barely considered explicitly by the former regulatory framework. The key for understanding the regulation of new markets is, therefore, the difference between static and dynamic market power.

In the following we, therefore, focus on the relationship between regulation and investment incentives that will give rise to some basic principles for an efficient regulatory treatment of new markets. For this purpose we explore the economics of innovative markets. This will allow us to better assess policy options that are currently discussed in the context of regulatory supervision of new and emerging markets.

In all cases, it is however, important to keep in mind that telecommunication markets are currently in a flux, and that stable market conditions cannot be expected in the near future. Technologies are in the process of evolving so that definite answers have not been derived yet.

Despite these caveats, and because of the considerable discretion regulatory bodies have identified a need for transparent guidelines that reduce the associated regulatory uncertainties. We will focus on ex ante regulations imposed on network operators which undertake investments into upgrading their networks and/or the creation of new network infrastructures. In this area, investments are exposed to particular risks that have not been taken into account by regulatory approaches that assume a natural monopoly position of the incumbent operator.⁴⁹

We proceed as follows. In the next Section we describe the main insights of dynamic competition theory which is critical to understand the economic principles behind policy options surrounding new and emerging markets. Then we apply these insights to the case of investments into infrastructure improvements (as vDSL or NGN investments) and elaborate on the associated regulatory trade-offs. Based on these conceptual considerations, we then discuss regulatory options that account for the dynamics of market competition and also more specifically on policies for NGN infrastructures.

4.2 Lessons From Dynamic Economic Theory

The starting point of (almost) all theories of dynamic competition focus on the ideas developed by Joseph A. Schumpeter (1918, 1950, 1964), who pioneered the research on the economic principles that govern technological change and economic development. His thoughts start with the observation that capitalism has led to an unusually long period of constant economic growth, and that economists have been unable to offer any explanations for this phenomenon.

Schumpeter's thoughts provide us with three key insights about the nature of economic dynamics:

First, he established that investigating the economic principles governing economic development and technological change are of paramount importance for identifying the best economic system. According to Schumpeter, technological progress and the creation of new markets are the main sources of competitiveness and general prosperity, while problems of static efficiency are more or less irrelevant.⁵⁰

Second, Schumpeter formulated the theory of stepwise economic development, with small businesses exploiting their freedom within the competitive equilibrium to give a decisive impetus to this development. While this will lead to "creative destruction", effective catch-up competition would ensure that monopolies remain a temporary phenomenon.

Third, Schumpeter developed the counter hypothesis, that innovations by larger and more powerful companies gain ever greater importance for economic development. In this scenario, small companies and catch-up competition would become of minor importance for economic development, while large firms would be the decisive forces for technological progress.

Overall, we can extract several insights from Schumpeter's work about desirable properties of dynamic competition. In particular, neither perfect competition nor permanent monopoly is likely to produce efficient development. An optimal dynamic process entails monopolistic phases which are followed by catch-up competition and with this the restoration of effective competition. In monopoly phases, innovators get rewarded for their risk-taking efforts in enhancing general knowledge. Exploitation of innovators' monopoly power is desirable and not harmful. While this leads to static inefficiencies, it also generates incentives to undertake risky investments which are desirable from a dynamic perspective.

In the innovation phase, several firms should compete for the next innovation, so that a "level playing field" is essential for dynamic efficiency.

The only exception to this rule is the case where a dominant firm has a natural advantage in generating the next innovation. There are, however, good reasons to protect society against permanent monopolization.

Besides static inefficiencies, dynamic efficiency is also problematic. Innovation incentives of a (permanent) monopolist are typically too low as market power creates hold-up problems, X-inefficiencies, and rent-seeking activities.

As is well known from standard R&D theory, market based innovation incentives are typically too low as the innovator cannot reap the entire social gains associated with an increase of the generally available knowledge coming from an innovation. Government intervention can influence the dynamic process by many different policy instruments. Patent law guarantees a state-protected monopoly position, and cartel laws specify the extent to which dominant companies can “abuse” their market power. An effective regulatory authority can help to ensure that markets return to a state of “symmetric” competition after a phase of monopolization, or even implement a competition-like market solution through regulation, if such a process does not start on its own.

4.3 Dynamic Competition in Vertically Related Markets

While the analysis of dynamic competition generally rests on the firms’ incentives to invest in the development or the adaption of new products, dynamic competition in communication networks is complicated by the fact that communication networks can economically be characterized as comprising of different, vertically related markets. These markets can be classified as the markets for: connections to the infrastructure, infrastructure services, i.e., transport of data, platforms which deliver services and services or applications. Demand for connections, the use of the infrastructure and access to platforms depends directly on demand for the corresponding services and applications. There is a direct positive correlation between the demand in the different markets.

The uncertainty surrounding the demand for access to new and potentially more powerful networks and platforms is therefore determined by the development of new services and potential direct network effects.

In the following we will discuss the implications that these complex interdependencies have on the investment incentives of firms. We start by emphasizing the effects of competition between platforms and infrastructure operators if dynamic environments are considered. We then consider possible anticompetitive strategies and analyze the incentives of dominant operators to use such strategies more carefully. In the third and final section we draw some conclusions on unregulated competition with respect to potential efficiency losses. Again, we focus on dynamic environments and concentrate on competition with new infrastructures.

4.3.1 Platforms

Platforms are valuable due to the services they offer or that can be accessed via the platform.

The simple one monopoly rent argument states that platform operators benefit from lower service prices since lower prices increase the willingness to pay for access to the platform. Thus perfect competition and high innovation rates in service markets is in the interest of platform providers. Vertical integration and discrimination against single service providers would only reduce the operators’ profits.

Although this argument is intuitive on first sight, it rests on several strong assumptions.⁵¹ Most importantly, potential profits from price discrimination are neglected. Monopolization of the service market would increase the possibilities to use discrimination and could therefore increase the overall industry profits. Thus, vertical integration or discrimination of service providers becomes become valuable strategies for platform operators.

While this kind of reasoning is applicable in a static framework, it neglects dynamic competition. As long as platform access involves some kind of sunk investment on the side of consumers, expectations with respect to the development of new services become crucial. The higher the number and range of new services consumers expect to be supplied, the higher their willingness to connect to some platform. In view of the lower innovation incentives in monopolized markets, committing itself to allow service providers to offer new products increases the value of the platform. Hence, in a dynamic market environment one of the main tasks of the platform provider is to find credible commitment devices to maintain the innovation incentives of service providers. While vertical integration is counterproductive since it increases the incentives to discriminate, open interfaces and general long-term access conditions for services providers can be used as

credible commitment devices. Furthermore, they alleviate potential hold-up problems due to sunk development investments of service providers.

Turning to competition between platforms and considering connection decisions of consumers as long term decisions, competition between platforms can be interpreted as competition for the market. The incentives for the operators to build up their platforms are then increased by the incentive to secure a large market share as early as possible and to exploit possible network externalities. These points may be seen as analogous to the considerations that apply to the patent race, as well as the associated pre-emption incentives.

Whether or not these incentives lead to market failures and dynamic efficiency losses is hard to analyze in the general case. While lock in of consumers as well as of service providers can lead to monopolized market structures and long term efficiency losses, the high initial investments associated with monopolization strategies tend to reduce the expected profits of the platform providers. Furthermore, expected platform monopolies are associated with high access prices and thus with a comparatively low number of connected consumers. Given the positive correlation between innovation incentives for service providers and potential demand, monopolization may not be a valuable strategy for platform operators. On the contrary, opting for compatibility between different platforms increases the expected consumer base, leads to higher innovation incentives for the service providers and lowers the risk of losing the race for the market.

This argument is further strengthened by the observation that incompatible platforms potentially increase the costs of developing new services. With incompatible platforms, service providers have to decide whether to build in different standards or to focus on specific platforms. Both effects reduce innovation incentives and thus the expected value of the platforms from the consumers' point of view. Therefore, dynamic considerations and the interdependencies between the vertically related markets for platforms and services imply that platform operators have an incentive to avoid lock in of service providers and consumers.

Summarizing these arguments, the usual reasoning with respect to platforms and potential anticompetitive behavior due to vertical integration and network effects leading to market power based on large installed bases have to be modified in a dynamic environment. Taking into account that connection decisions of consumers and innovations incentives of service providers are driven by expected utilities and revenues, respectively, shows that monopolization strategies are less valuable in dynamic markets with uncertain future demand.

4.3.2 Investments into Infrastructure

Similar to platforms, infrastructure can be interpreted as an upstream market. Ultimately, infrastructures only ensure that services can be offered. Thus, the analysis of investment decisions with respect to infrastructures is economically very similar to the analysis of investments in creating platforms. In both cases the value is derived from downstream markets. Moreover, for access infrastructures such as the last mile the same reasoning with respect to the incentives to allow for competition on downstream markets applies. Again, the value of network access is higher the more valuable the platforms and services which can be offered are. Therefore, the above mentioned considerations and the discussed differences between competition in static and dynamic environments can be used to argue that competition in downstream markets is in the interest of infrastructure operators.

The analysis of competition, however, has to take into account some additional aspects. The incentives for operators to invest are increased not only by the incentive to secure a large market share as early as possible but also by the opportunity to offer competitors access to their network, and to reduce their incentives to build their own networks. The issues to be considered here concern the higher investment costs of more rapid construction, and the potential reduction in prices for consumer access. Against these are the returns from access charges payable by the competitors, and higher profits from a more prolonged monopoly position. If these positive effects prevail, granting access may slow down the construction of competing networks, but the ex ante incentives to invest will also increase.⁵²

While the replacement effect leads to strategic investment decisions pointing to future monopolies, it does not rule out the coexistence of competing infrastructures. Since investments are mainly sunk, competing infrastructures continue to exist even if one operator gets a dominant market position. Therefore, even initial competition feeds positively back to the downstream markets for platforms and services, and hence to the expectations of consumers with regard to the attractiveness of joining the network. If competing networks

are constructed with correspondingly high incentives to invest, platform providers, service providers and consumers can count on rapid diffusion. The incentive to develop new platforms and services will increase, and the resulting changes to consumer expectations will have a positive effect on their willingness to pay for new forms of access. While the incentives of service providers to develop new services are mainly driven by expectations about future network sizes, consumers also benefit from the fact that competition can solve potential hold-up problems. The point is that as long as the investments required from the consumer (modems etc.) are not operator-specific, i.e. they can still be used with a different operator. Initial competition reduces the ex post likelihood of an access making consumers worse off.

4.3.3 Anticompetitive Strategies

Given the above mentioned positive effects of competition, why do firms have an incentive to use anti-competitive strategies? Obvious reasons are expected monopoly profits, and asymmetric starting positions which allow firms to use existing infrastructures and installed consumer bases to exploit economies of scale and scope.

With respect to existing infrastructures, it is clear that additional investments to increase bandwidth may be much lower when compared to the investment costs for building up new networks. Secondly, horizontally integrated fixed and mobile network operators have the natural advantage to offer services based on both kinds of infrastructures. This allows bundling of services and provides a rather strong competitive advantage over not integrated or specialized operators.

A large installed base of consumers implies that – taking potential switching costs for changing the operator into account – the investments required to induce consumers to switch to a new network are comparatively lower if consumers don't have to switch the operator. Additionally, investments undertaken by large and vertically integrated network operators can signal a potentially fast and broad diffusion of new infrastructures or technologies. Thus, large operators are able to alter the expectations of service providers as well as of consumers considerably. This positive correlation between market shares, own investment behavior and expectations of service providers and consumers provides large operators a competitive advantage and can lead to natural first mover advantages.

Upgrading existing infrastructures and economizing on economies of scale with respect to both network costs and expectations makes anticompetitive strategies more valuable for large operators. While denying interconnection, discriminating new competitors or opting for incompatibility and proprietary standards may lower the expected range of new services and may reduce the expected size of the new network, the implied negative effects have to be balanced against the potential losses due to otherwise competitive market structures. The essential point is that competition for new market is substantially decreased if large operators can simply use their dominant position to decrease the expectations with respect to successful innovations of other firms.

Anticompetitive strategies are most relevant in markets with large sunk investments and network effects. Sunk investments increase potential losses in the case that the investments turn out to be not successful and therefore the risk a potential investor faces ex ante. Similarly, network effects imply that the period to develop a new market can be rather long which again increases necessary investments and potential investment risks. Additionally, the probability that dominant operators simply use a fast second strategy if new technologies tend to be successful is higher the longer it takes a competitor to reach the critical mass.

Taken together these arguments indicate that the dynamic considerations mentioned above can be substantially altered if network markets with asymmetric market structures are considered. Since new communication networks imply sunk investments, network effects as well as significant vertical interdependencies between vertically related markets, the potential danger of anticompetitive behavior by dominant operators can not be ignored.

One example for anti-competitive conduct was the blocking of VoIP traffic by Madison River Communication, LLC, that was stopped through a consent decree and a \$15,000 contribution.⁵³ The blocking of voice service was regarded as prohibiting being VoIP a viable option for customers.⁵⁴ To pursue this behaviour, the investigation was resolved with respect to blocking of ports used by VoIP through required compliance with section 201 (b) of the Communications Act of 1934, mandating customers' ability to use

VoIP over one or more service providers. This ex post competition control is a core element in different regulatory games discussed in section 4.5.

4.3.4 Dynamic Efficiency

In view of the above mentioned results and the more fundamental implications of dynamic environments and vertically related markets discussed in section 3.1, it is a priori not clear to what extent dominant operators will use anticompetitive strategies and what welfare effects these strategies may imply.

Firstly, anticompetitive strategies based on existing infrastructures and installed consumer bases are less effective if infrastructure competition exists. That is, the higher the potential risks that monopolization strategies trigger fierce reaction of actual competitors, the lower the incentives to exploit first mover advantages. Secondly, the distinction between competitive and anti-competitive strategies is difficult if vertically related markets and complementary innovations are considered. Vertical integration can solve hold-up problems between infrastructure operators, platform operators and service providers. With sunk development costs, vertical integration can be viewed as an efficient mechanism to solve hold-up problems and to overcome potential free-rider problems due to the complementarity of innovations on different markets. While low price strategies may indicate pre-emption, they can also be necessary to reach the critical mass of new services and consumers. Similarly, even a strong promotion of specific standards can be necessary to alter the expectations of service providers and consumers and to induce them to invest in new services and to connect to new infrastructures, respectively.

While these arguments show that there are no simple criteria to identify anticompetitive strategies, it is also rather difficult to evaluate potential welfare losses due to anti-competitive behaviour. On the one hand, discrimination of platform or service providers lowers static efficiency gains. On the other hand, network effects can be exploited more efficiently with monopolized standards. Costly standard wars and welfare losses due to delayed adoption decisions can decrease expected social welfare drastically. These arguments also indicate that large operators can have significant cost advantages in establishing new networks. The above mentioned signalling and reputation effects show that large installed consumer bases may reduce investment costs. Thus, it is not only the fact that established operators may simply upgrade their infrastructures to implement new technologies which points to efficiency gains of innovations driven by large and established operators, there also exist market based economies of scale when innovations in network industries are considered. Taking these effects into account, dynamic efficiency can heavily rest on innovations by large operators.

Finally, innovation incentives are ultimately based on expected profits. Thus, additional profits due to temporary monopolization or imperfect competition are necessary to spur innovation and investment. Significant welfare losses accrue only if monopolization turns out to be long-term and if it is not satisfied by static economies of scale and scope. However, network effects and investments in infrastructures imply that efficient market structures can be characterized by high concentration ratios. Combining these two observations and taking into account that investments in new infrastructures are risky, leads to the conclusion that even though anti-competitive strategies used by large and dominant operators can reduce welfare, concentrated market structures may nevertheless be dynamically efficient.

Regulation of the telecommunications industry should adapt to these new realities by paying more attention to the dynamic aspects of competition. In particular, price, interconnection, unbundling and resale regulation which are typically cost-based focus on static efficiency consideration and are likely to be counterproductive in “new” markets where large potential for innovation and technological progress exists.

Quite obviously, traditional cost-based access regulation of new infrastructures must substantially lower investment incentives in the first place as the access charges cannot account for the substantial ex ante uncertainties. First, cost-based access regulation would grant a risk-free option to competitors for using the new networks when they have made no investments.⁵⁵ Hence, cost-based regulation reduces investment incentives of competitors. Second, as competition for investments generally increases investment incentives, access regulation to older networks is essential to provide a “level-playing field” in this regard. Third, the possibility of investing into infrastructure may give rise to leap-frogging competition which is another source for dynamic efficiency. Fourth, as there is also a motive to preempt rivals in the absence of access regulation (see Riordan 1992), the regulatory framework should “threaten” to impose standard ex ante regulation

whenever no effective competition emerges. This may counter the preemptive motive, and hence, further promotes the emergence of effective competitive structures.

Overall, regulation of entry therefore not only aggravates the appropriability problem but also runs counter to the objective of achieving infrastructure-based competition in telecommunication markets. As we argued in this section, such a regulatory philosophy neither takes account of the investment risks nor does it cover the incentives for “leap-frogging” competition, and hence, the dynamics of infrastructure based competition.

4.4 Adjusting the Regulatory Framework to New and Emerging Markets

Regulation has changed significantly in the last decades and regulatory frameworks often differ between countries. Overall, regulation in the world has generally exhibited a progression from regulation of a (often state-owned) monopolist towards an opening up of markets to competition. In some countries, notably the United Kingdom, promotion of entry in the form of facility-based entry has become an additional goal that was explicitly incorporated into the regulatory framework.

Most developed economies with competition in telecommunication markets seek to address bottleneck problems by subjecting the former monopolists to various ex ante obligations, typically including some mix of transparency, nondiscrimination, interconnection obligations, an obligation to make unbundled network elements (especially the local loop) available to competitors, cost accounting, and (one-way and two-way) access price regulation.

Regulation is now about to enter a new phase corresponding to a period in which the market power of the incumbent is diminishing. This opens the possibility to choose regulation that is less intrusive and take the widening of markets associated with convergence seriously. While maintaining regulatory provisions aimed at the achievement of social objectives, such as universal service, the question arises whether and how sector specific regulation can be brought into closer convergence with the principles of competition law.

In this regard New Zealand represents an instructive case as this country deviated from the otherwise standard procedure of regulating the transition to competition by a regulatory agency that operates under legislation in addition to standard competition law.⁵⁶ In 1989 the New Zealand government introduced full competition into telecommunications and decided to rely solely on its general competition law, the Commerce Act 1986. Natural monopoly elements were subject to obligations of accounting separation and the Telecommunication (Disclosure) Regulations 1990, which required TCNZ to provide details of pricing of local access related services (including interconnection agreements), any substantial discounts, and financial accounts for local access related activities.

This liberalization strategy led to a high number of legal disputes, almost entirely related to interconnection terms. The main problem with this approach was, therefore, that these antitrust cases would predictably take years to work their way through the court system. In response to its experience, Haucap and Marcus conclude that New Zealand has come almost a full circle and implemented a regulatory system recently that, while still arguably light in many dimensions, is more comparable to that of other industrialized nations.⁵⁷

However, with regard to regulating limited resources, New Zealand’s route of implementing a progressive deregulatory system for spectrum management continues to operate well.

Besides the New Zealand experience, it is fair to say that liberalization of telecommunication markets has adopted a pro-competitive approach that aims at facilitating market entry and with this competition in telecommunications markets. In many instances, this implies the imposition of ex ante regulation, rather than the elimination of regulation. The most significant lesson from the New Zealand experience is, therefore, that the *ability* to apply regulation ex ante should remain a viable option for regulators.

In many countries regulation has been designed to meet the needs of a period in which the transition to competition was beginning. Since then it often developed in a piecemeal fashion. Given the rapidly changing technological environment in telecommunication markets, new policy concepts which vary from a more competition policy oriented ex post intervention to a complete transfer of existing ex ante regulations are being discussed. However, as of now there is no convergence of regulatory approaches. In the following we discuss the most prominent policy options, which should help to achieve greater convergence on substantial issues for an optimal regulatory framework.

4.5 Regulatory Options

The following regulatory options include two regulatory fields of action: Access/interconnection obligations and mandatory standards/attributes. The regulatory timing of these actions can be considered separately and is considered thereafter. Pricing problems, e.g. the emergence of new interconnection regimes, remain unconsidered due to limited space.

4.5.1 Non-Replicable Assets and Open Access

Ofcom as well as Opta propose to focus exclusively on non-replicable assets as a basis for *ex ante* regulations. This approach is theoretically attractive as non-replicable assets by definition constitute an uncontestable monopoly which should be regulated according to standard economic thinking.

The approach, however, critically depends on the regulators' ability to exactly identify the assets used by a dominant new technology platform operator that is non-replicable (either technically or functionally). It can be applied *ex ante* or in form of *threat-based* regulation.

Ofcom discusses its Principle 2 of Equality of access as follows: "In light of the upcoming review of the regulatory framework, such a regime could be considered because the non-replicable assets approach focuses on dealing directly with the problem of investment incentives by concentrating on regulation of infrastructure bottlenecks rather than regulation of markets. The approach deals with the re-monopolisation problem. Entrants have access to non-replicable assets on appropriate, regulated supply terms. They are subsequently able to use these assets, in combination with replicable assets that they acquired themselves, to compete in the supply of new technology services at the retail level. This approach allows NRAs to regulate emerging markets with greater confidence. NRAs do not need to completely predict what new services will run on new technology platforms. Instead, they can consider the investment plans of the main operators; decide where, if at all, the services involve the use of non-replicable assets; and, if structural competition issues are deemed to rise, impose remedies accordingly. The non-replicable assets approach is consistent with the principle that it is more important to maximise dynamic efficiency gains from technology innovation in the telecoms industry than to maximise welfare gains from static efficiency."

However, it's also acknowledged that it may be difficult to determine with certainty that an asset is not replicable; a fact, of course, driven by the highly dynamic nature of communication markets. As a consequence, regulators should adopt a forward-looking perspective in their analysis of the possible non-replicability of assets.

As we will discuss below, this should require regulators to have a more long-term perspective that also entails "more confidence in competitive pressure from alternative infrastructures".

It should be noted that the discussion about the non-replicable assets approach is somehow decoupled from the debate over the rules for new and emerging markets. Overall, this approach is also called a disaggregated regulatory approach that in a sense can be interpreted as a less intrusive mechanism that also achieves the main goal of preventing a re-monopolisation of markets. In new and emerging market environments however, this approach combined with a longer run perspective has additional advantages:⁵⁸

- There is less 'market making' by regulators and more confidence in market forces.
- The current trend of convergence of most electronic communication markets is creating more infrastructure competition. The specific service markets are rapidly losing their significance; what counts are the capabilities of underlying infrastructures.

Ofcom considers that its approach to NGNs should be guided by the key regulatory principles proposed in the Telecoms Review. Ofcom should:⁵⁹

1. Promote competition at the deepest levels of infrastructure where it will be effective and sustainable;
2. Focus regulation to deliver equality of access beyond those levels;
3. As soon as competitive conditions allow, withdraw from regulation at other levels;
4. Promote a favourable climate for efficient and timely investment and stimulate innovation, in particular by ensuring a consistent and transparent regulatory approach;

5. Accommodate varying regulatory solutions for different products and where appropriate, different geographies;
6. Create scope for market entry that could, over time, remove economic bottlenecks; and
7. In the wider communications value chain, unless there are enduring bottlenecks, adopt light-touch economic regulation based on competition law and the promotion of interoperability.

Putting both the focus on non-replicable assets and open access together and applying these principles to NGNs, Ofcom has derived four interesting sub-principles:

Competition at greatest depth – Ofcom considers two aspects to ‘depth’.⁶⁰

- First, geographic depth within the topology of 21CN, i.e. how close to the customer is access provided. There are three geographic levels within 21CN at which it might be possible to provide access: the local loop (MDF/MSAN sites), the metro node and the core node. It is likely that a combination of access remedies will be required, focusing on access at MDF/MSAN sites in those geographies where this is likely to result in sustainable competition, and providing metro node access elsewhere.
- Second, service level depth. There is likely to be a choice between end-to-end services (e.g. wholesale calls), service-specific interconnection services (e.g. voice call origination), a generic interconnection service (e.g. bitstream interconnection) or physical unbundling (e.g. LLU). Consistent with its regulatory principles, Ofcom believes regulation should be focused as deep in this service stack as possible, recognising that this might vary with different geographies. If, for example, some form of access were made available at the MSAN, there would be a preference for this to be at the physical or bitstream level rather than service specific.

Potentially another approach is pursued by the German *Federal Network Agency* (BNetzA). The German regulator plans are to “enable competitors to compete on an equal footing” and preparations are ongoing to include very high speed DSL (VDSL) in the market for wholesale broadband access, extending the access by bitstream access.⁶¹ While Ofcom focuses on few well-defined wholesale products at the lowest possible level, the notification of the BNetzA to the European Commission is still expected.⁶²

*Equality of access*⁶³

The design of key regulated access and interconnection products could support equality of access. In particular, new regulated 21CN access and interconnect products will need to support ‘equivalence of inputs’, so that BT uses the same products, the same systems and processes as alternative providers at the same price. Reduced time to market is expected to be one of the key benefits of 21CN, so an effective process for the introduction of new regulated products will also be important. Even where existing regulated products currently support equivalence of access, they may have to evolve in light of new capabilities introduced by 21CN. For example, the requirement to support equivalence of access to the local access network might require changes to the existing Local Loop Unbundling (LLU) service, and may require consideration of some form of bitstream access at the MSAN.

*Regulatory withdrawal*⁶⁴

Ofcom also makes the possibility of regulatory withdrawal for 21CN explicit; this should depend on the following rules:

- 21CN may be the vehicle for delivery of improved equivalence in relation to BT’s wholesale services. This should allow other providers to compete in downstream markets and create the conditions where BT’s downstream services, particularly at the retail level, could be deregulated.
- At the wholesale or network level a key theme of 21CN is convergence. If convergence is effective, this should allow a reduction in service specific wholesale regulation, and provide a greater focus on generic access and interconnection remedies (local loop unbundling, bitstream interconnection).

The feasibility of regulatory withdrawal is proven at least in Hong Kong, where increasing competition has led to lifted ex-ante regulation on the incumbent operator’s prices since 2005 and to adjustments of the regulatory policy. These adjustments include the setting up of a timetable to withdraw mandatory Type II (last mile access) interconnection for buildings connected by at least one alternative access network over a

transitional period by mid-2008. Thereby the main policy goal is to send a clear signal to operators to encourage them to build their own networks. For buildings connected by only one network, Type II interconnection will be retained. In their conclusion, OFTA states, that this interconnection requirement lowers the barrier to effective competition, therefore enhancing consumer benefits and should be withdrawn only if the potential detriment of investment dampening outweighs those benefits.⁶⁵

The FCC also plans “to eliminate mandated sharing requirements on the incumbent’s wireline broadband internet access service”:

“Specifically, the Commission determined that wireline broadband Internet access services are defined as information services functionally integrated with a telecommunications component. In the past, the Commission required facilities-based providers to offer that wireline broadband transmission component separately from their Internet service as a stand-alone service on a common-carrier basis, and thus classified that component as a telecommunications service. Today, the Commission eliminated this transmission component sharing requirement, created over the past three decades under very different technological and market conditions, finding it caused vendors to delay development and deployment of innovations to consumers.”⁶⁶

This decision is coupled with a phasing-out of existing wireline transmission offerings kept unchanged until then. The key target is a level playing field for intermodal competition between different network infrastructures.

*Favourable climate for investments*⁶⁷

Finally, Ofcom presents a caveat; namely, that creation of a “favourable climate for investments” is also important:

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

4.5.2 Network Neutrality and Openness

The issues of mandated standards and attributes, e.g. Network Neutrality and Openness, are of strategic importance with respect to restricting innovation, evolution and growth.

Overall the concepts of openness and network neutrality are not fully defined. They usually refer to the Internet architecture where the transport layer is decoupled by a uniform IP standard from the service layers. As network theorist Jerome Saltzer puts it: “The End-to-End argument says ‘don’t force any service, feature, or restriction on the customer; his application knows best what features it needs, and whether or not to provide those features itself.’”

Advocates of openness as a form of non-discrimination claim for the need to mandate this network attribute by law. They fear that network owners will restrict users in their choice of content, services or devices attached to the network. These concepts can be applied *ex ante* or *ex post* as the case of the AT&T BOCs⁶⁸ illustrates. Similar obligations would be easier and faster feasible and available at lower costs in *programmable networks*, as NGNs are (see also section 2.3).⁶⁹

Certain proponents, like Jerome Saltzer, Larry Lessig and Mark Lemley argue that if e.g. cable operators are allowed to bundle ISP services with cable services, cable operators would be in a position to destroy the neutrality of the network by foreclosing competition among Internet applications. As Lemley and Lessig put it,

“[T]here is, in principle, no limit to what a cable company could bundle into its control of the network. As ISPs expand beyond the functions they have traditionally performed, AT&T or Time Warner might be in a position to foreclose all competition in an increasing range of services

provided over broadband lines. The services available to broadband cable users would then be determined by the captive ISPs owned by each local cable company. This design would contradict the principle that the network should remain neutral and empower users. It further could constitute the first step in a return to the failed architecture of the old AT&T monopoly.”⁷⁰

Openness can be compared to interconnection or standardisation. Like all standardisation issues, standards imply a trade-off between the benefits of establishing a level playing field, the potential to reduce market power asymmetries and the losses through vertical foreclosure potential.

Mandatory openness will surely have benefits, but there are several trade-offs to be inspected in detail to decide whether regulatory intervention is beneficial or not, especially when focusing on dynamic competition.⁷¹

For a more structured approach, it might be useful to consider the different forms of openness regarding their different economic effects. Hundt and Rosston for example distinguishes between the following forms of openness:⁷²

- First, three aspects of “operational” openness aiming at renouncing restrictions regarding what users do with their internet connection, following the vision in which every end user has access to the whole range of available applications and information entities (content):
 - Unrestricted access of users to services and applications.
 - Unrestricted access of users to all content.
 - The right to attach any device to the network that will not do any harm.⁷³
- Second, two types of structural openness implying structural separation:
 - The separation of access and long distance (backhaul and backbone) networks.
 - The separation of the network in different layers (essentially control and transport).

There are several problems in transforming mandated such structural separation in law. Examples for co-occurring questions are:⁷⁴

1. How to implement structural openness through separation? Cellular networks, for example, do not show clean demarcation points, and therefore, such a structural remedy might not be evenly applied to all networks, raising the possibility that inefficient or biased competition might result.
2. Even if structurally separated, would an access network owner attempt to exercise monopoly market power over termination and, therefore, would have to be subjected to the regimes outlined above, raising the possibility that the separation might be fruitless?
3. To what extent might data traffic re-routing defeat the goals of such separation?
4. Is separation justified in terms of new investment and efficiency because of restricted integrated service provision and transaction costs?
5. Which structural separation would be appropriate and feasible?
 - Long-distance – local loop – separation?
 - Layering separation?
6. With competing networks, would structural separation provide any consumer benefits that would offset the costs of dis- and/or nonintegration?

The resulting main argument against openness obligations is the *Access Argument* stated as follows: “The fundamental problem of all communications policy is the access network, also called the last mile or local loop.”⁷⁵ Following this argument, the question arises, whether the openness debate focuses fundamentally on the wrong issue.⁷⁶

If access is assumed to be the least competitive link in the value chain, it is reasonable to concentrate on this bottleneck. Ofcom’s principle 1 “Promote competition at the deepest levels of infrastructure where it will be effective and sustainable” points exactly to the identified fundamental infrastructure bottleneck (see sect. 4.5.1 below for the Ofcom’s approach and also the *single monopoly rent argument* in sect. 4.3.1 above).⁷⁷

Facing the claims for *Net Neutrality*, Yoo (2005) proposed another approach of *Network Diversity* that focuses on solving network and business problems allowing for multidimensional competition.⁷⁸ Yoo claims that it might be beneficial to deviate from network neutrality for different reasons:

- Standardization can reduce welfare both by reducing diversity and by biasing the market against certain types of applications.⁷⁹ (Facing the application requirements of e.g. VoIP, Net Neutrality therefore was a misnomer).
- Increasing the number of dimensions in which networks can compete would be helpful to widening competition from the parameters price and network size (thus leading to competition in quality).⁸⁰
- Network control could help to supply differentiated services and to internalise network effects, therefore strengthening investment incentives.
- Off-limiting possible innovation should leave consumers with a broader range of products to choose from.⁸¹
- The deficiencies in the Internet architecture of today, e.g. in the areas of security, economic incentives, addressing and traffic control, might justify drastic architectural innovations, implying the possibility of network diversity.

Yoo acknowledges, that network diversity *could be* beneficial, but *must not* be beneficial. The trade-off between standardisation and product diversity mainly depends on the underlying structure of demand or the heterogeneity of preferences.⁸² Also the possibilities for excess entry⁸³, excess momentum⁸⁴, transaction costs and the link between long-run dynamic efficiency gains and short-run efficiency losses have to be taken into account. Yoo concludes, that “it is not necessarily given that the multiple entry associated with network diversity is always be welfare enhancing”⁸⁵ and “determining whether network neutrality or network diversity would lead to the more socially beneficial outcome is a context-specific inquiry that cannot be determined a priori”.⁸⁶

A discussion regarding the trade-offs between mandated and market standards is provided by Church and Gandal (2004).⁸⁷ In short, the advantages of mandated standards could help to overcome problems of standardisation failures, the risk of getting stranded, avoid some duplication of development and promotion expenditures and to correct inefficient standardisation caused by market power.⁸⁸ Despite the costs associated with market determined standards, competition for the market is probably preferable to mandated standards in most cases—with two exceptions: The first is when network effects are significant and the presence of multiple competing standards suggests the strong possibility that fragmented expectations on the part of consumers will prevent adoption of a new, superior, technology. The second is the installed base advantage of the incumbent carrier, leading to interconnection obligations nearly all over the world.⁸⁹

One practical problem for empirical analysis is, that the multidimensionality of competition makes simple price-cost comparisons an incomplete way to determine social welfare. Determining the dominating effect from dynamic efficiency gains and static efficiency losses depends on “a myriad of factors, including the magnitude of the gains and losses, the speed of entry, and the appropriate discount rate”.⁹⁰

The main critics on the concepts of net neutrality state that, due to lack of sufficient information, the government distorts markets imposing standards obligations rather than correcting sustainable market failure in a cost-effective manner.⁹¹ Network neutrality not being neutral, the adoption of standards implicitly favours certain applications and disfavours others.

Facing the uncertainty and the speed of technical progress in highly innovative industries like the telecommunication industry, they might lead to serious operational problems for regulatory authorities. On the one hand, since only slight further technological progress could render parts of the regulatory framework obsolete or problematic (think about e.g. the problems in telephony regulation caused by the emergence of Voice over IP), the costs of keeping pace might be prohibitive. On the other hand, forward-looking regulation might become increasingly difficult.⁹²

Additionally it could be argued, that “one of the principal drawbacks about regimes of mandatory interconnection and interface standardization is that they implicitly presuppose that regulation will continue indefinitely. Network diversity, in contrast, is better at facilitating competitive entry. As such, it has the advantage of having embedded within it a built-in exit strategy”⁹³, but also “[a] Adoption of network

diversity would necessarily require the incurrence of transaction costs. [...] When that is the case, society would be better off had network diversity were not permitted.”⁹⁴

The insight from section 4.3.1 on platforms could lead to the expectation, that network operators voluntarily use open standards for their network. On the one hand this allows for multi-vendor procurement and therefore avoids vendor lock-in.⁹⁵ On the other hand it lowers costs to develop, deploy and provide new applications and speeds up the time-to-market through the possibility to implement new technology as soon as it is available from *any* vendor on the market. Katz and Shapiro proposed a formal model that seems to confirm, “competition among proprietary networks is more likely to lead to the adoption of the socially optimal technology than is competition between non-proprietary networks or competition between a proprietary and a non-proprietary network”.⁹⁶ These two opposing incentives could help on balancing an efficient degree of differentiation⁹⁷, or – in the case of overlay networks – network versioning, thus increasing consumer choice.⁹⁸ Additionally, mandated standards and openness obligations are likely to have not only large impact on competition but also on the timing and extent of network investments.⁹⁹

The *access argument* therefore supports product differentiation as one way for new entrants to attract capital for funding network infrastructure investments, e.g. a mobile, lower cost or higher quality network, rather than a duplicate fixed wire network.¹⁰⁰

Yoo states as a result, *ex ante* network obligations should be reserved for cases in which the consequences of a hands-off policy are truly catastrophic and in which irreversible path dependencies are expected, but neither precondition would appear to be satisfied in the special case of net neutrality.¹⁰¹ He concludes that in the absence of clear competitive harm or when regulators can hardly distinguish anticompetitive from procompetitive behaviour, the standard response under competition policy is to forbear from categorically prohibiting the challenged practice and to permit the practice unless such harm can be demonstrated, as deviations from network neutrality are often the result of attempts to meet the differentiated demands on the network.”¹⁰²

There undoubtedly exists anti-competitive dangers, but until a clearer assessment of the multiple trade-offs with their highly complex impact is made available, competition policy might be a better instrument to deal with anticompetitive behaviour, e.g. as in the Madison River case sketched above in section 4.3.3.

Therefore *ex post* competition control could become the core element in next generation regulatory games. Anti-competitive conduct would often be better addressed in a forum, e.g. an antitrust court that can investigate each case on the basis of its individual facts and context.¹⁰³

A more balanced view towards net neutrality

A more balanced view towards net neutrality is expressed by the Australian industry body ACIF which states that technology neutrality is not applicable in all cases and that such an approach would mean a bias towards PSTN, as many neutrality rules were designed for PSTN infrastructures:

“Adapting current regulation to NGN and transitional services may not be the best way to proceed to achieve the best outcome for the development of NGN in Australia, given that IP networks and technologies have fundamentally different capabilities and architectures from those of the circuit-switched PSTN. Unlike the circuit-switched PSTN, many parameters of the services requested by a user will be under the user’s control, either directly or in association with the end-to-end service required. For example, network performance (i.e. QoS) will vary from the performance required to support interactive, real-time communication (voice and multimedia) to the variable performance of the current public Internet. In other cases, limitations of available access technologies may determine the performance. The need to ensure that regulations remain technology neutral is reinforced by the possibility of continuing rapid changes in the underlying network and customer equipment techniques and capabilities. It will be essential for any regulations to be based on technology neutral descriptions of the key service features, to the extent, rather than the delivery processes that could be temporary or not used by all providers, and not exclude innovative services that meet user needs.”¹⁰⁴

Implicitly, the performance of the current public Internet is considered poor mainly due to its lack of security and network management.

The NSF report “Overcoming Barriers to Disruptive Innovation in Networking” on the workshop of the same name by the National Science Foundation in January 2005 summarizes five limits that might result in a

dead-end for the current incremental evolution path, and seven options to meet these problems.¹⁰⁵ These limits requiring disruptive network innovations are a) the changed nature of internet traffic that should be seen as adversarial, b) the network architecture not including commercial considerations, c) host-centric assumptions are likely to get outdated with the adoption and diffusion of e.g. sensor networks, d and e) the intransparency of the network, limiting the extent to which network can meet application requirements.¹⁰⁶

4.5.3 Towards an Balanced Diversity Approach

The new and emerging networks could try to solve the trade-offs in networks that require simultaneous optimisation of different paths and subnets. The mentioned NSF report tries to point a way out of this dead-end, drawing innovation vectors following from the enumerated limits.

The question asked in the NSF report is “What is the appropriate, flexible, stable, truly minimal, universally shared environment consisting of truly universal portions to support the overlays”?¹⁰⁷ For an effective research program a leading-edge testbed is considered necessary.¹⁰⁸ In this environment, even new business models might emerge, e.g. the focus of physical infrastructure providers on virtual networks as their primary customers.¹⁰⁹

Goals, scope, key concepts and the design principles of such testbeds are recommended to be designed to meet the design challenges for according NGN testbeds:¹¹⁰

- *Security and Robustness*: to keep a level that matches or exceeds the levels of the Internet and telephone systems, achieved possibly through an extension across different network layers.
- *Support for New Network Technology*: implies the request for the support node-mobility as a first-level objective and for modularity to keep the network open for future improvements, e.g. ad-hoc networking technologies and the virtualisation of sensor/actor-network middleboxes.
- *Support for New Computing Technology*: End-host assumptions underlying the current architecture have to be corrected as the pattern of computer usage shifted from many to one vice versa and new edge system diversity.
- *New Distributed Applications and Systems*: User-focusing distributed systems and the implications of a viable solution to link low-level addresses to higher-level entities, like objects and people in a coherent design for the various name-spaces and at the same time resolving address binding problems.¹¹¹
- *Service in Times of Crisis*: Critical infrastructure protection is essential to a modern information society. Defining services including crisis resource allocation, limiting opportunities for network compromising and location information, e.g. emergency and health services will be essential due to the increasing dependency on the proper functioning of communication networks.
- *Network Control and Management*: Development chances for new network services, e.g. user-level route choice and artificial intelligence based routing, in combinations with the objectives dependability, network-based security, ease of use and management, value flow signalling etc. (see also Box 4.2).

In consequence of the NSF workshop the NSF decided to fund and deploy a suitable testbed for experimental validation of architectural research in networking and to substantially increase funding for multi-disciplinary effort in this area. The roots of GENI (see Box 4.2 below) go back on this NSF workshop on Disruptive Network Innovation in January 2005.¹¹² The European GÉANT2 network is already in full-scale operation. Both NGN testbeds are designed as general-purpose facilities for nearly unlimited evaluation of different architectural, service or application settings. In addition, both networks also allow for incremental adoption of new services as deployment drivers.

Analysing backward compatibility from these new networks for seamless interoperability with legacy PSTN and IP networks might be worth some work to keep all existing applications and services as available as today, deriving additional benefits through the advanced options.

Box 4.2: NGN testbeds in the US and in Europe

The mentioned report of the NSF workshop on « overcoming barriers to disruptive innovation in networking » has led to plans for a new US research network, the *Global Environment for Network Innovations (GENI)*. The GENI is an experimental facility planned by the NSF that claims to serve « as a testbed for qualitatively better networks and services than on Internet ». ¹¹³ The conceptual design is currently under development by the computing community. ¹¹⁴ This network is sketched to include innovation possibilities at any level of the architecture, including alternative protocols and architectures running inside the network as well as logical networks, applications and services running as overlays on top of the network, thus allowing « clean slate thinking ». ¹¹⁵ The development path of this experimental network is expected to be a first step the evaluation of new network systems, thereby learning from real workload from the first users and then in further steps of hardening and interconnecting the widespread deployment of this network. ¹¹⁶

The physical infrastructure, GENI will be built on links, forwarders, storage, processor clusters and wireless subnets, collectively called the *substrate*. ¹¹⁷ On top of the network resides a *software management framework* that allows for overlay network experiments, « where every experiment is said to run in a *slice* of the substrate » ¹¹⁸.

In Europe, a network with similar capabilities, the GÉANT2 network is already in place and provides innovative services (see section *use cases* below in this box). ¹¹⁹ The attributes of the GÉANT2 are impressive : A total network capacity of nearly 500 Gbps, based on multiple 10Gbps links on a large fibre footprint with 10Gb access through IP and switched networks; connecting over 30 million potential users across 34 countries through 30 national research networks all over Europe. GÉANT2 also provides switched services through a switched network that creates a dedicated path across the network from point to point that is constant and available only to particular users. This point-to-point service network sits [as an overlay network] on top of the IP network. ¹²⁰

Both networks have predecessors, PlanetLab and GÉANT(1), respectively. They were improved to provide higher bandwidth and are planned to provide a purpose-designed research infrastructure for a particular community. ¹²¹ Both networks explicitly support federation (between networks and also between sub-communities that will be able to specify that resources they want to contribute to the network in a secure manner) and allow the network architects to research on a live operation environment basis, delivering significant empirical data.

The four key ideas to achieve this goal are *programmable network components*, *virtualization of network environments*, the possibility of *seamless opt-in* for end-users to experimental services and *modularity* of the network to allow the extension with new networking technologies as they become available. ¹²²

NGN use cases:

BioCASE (Biological Collection Access Service for Europe) is a project revolutionising the way in which biological collections are used across expansive geographic locations. This is achieved through the inter-connectivity of bio-databases and for example can allow researchers in Budapest to consult collections in Reykjavik. The project consists of 65 data providers across Europe connecting 150 specimen databases with more than 5 million records. ¹²³ Remote access to these collections allows increased precision and depth of research as well as the ability to tap into specimen and observation records from all over Europe – to analyse the distribution of a specific species. It is even possible to predict the likely level of occurrence or even predict the invasion of certain areas by a specific species. The high bandwidth capacity of GÉANT2 makes it ideal for transferring large quantities of data, including DNA samples, high-resolution images, sounds files and video clips. ¹²⁴

The T@lemed project utilises the RedCLARA research network, created by the EU's ALICE (America Latina Interconnectada con Europa) project. This has ultimately brought the knowledge of internationally renowned medical experts to remote parts of the Amazon. The project's portable equipment allows patients to be scanned for a variety of conditions from pregnancy to cancer. Images and data are then transferred, if necessary, to a regional or national healthcare centre. There the image can be viewed immediately and a real-time diagnosis can take place. If required, the information can be sent to Europe, using RedCLARA's transatlantic link. ¹²⁵

NGN testbed opportunities:

Four example opportunities from such NGN testbeds are ¹²⁶

- Development possibilities for artificial intelligence in network management, so that a network operator simply can describe and configure his network segments using high-level declarations of policy, having automated fuzzy-logic tools to configure the individual components to conform.
- Improvements in fibre-optic technology including optical switching and storage.
- Improvements in wired/wireless integration through better network integration.

- The testbeds can provide problem detection, diagnosis, feedback and reporting back to the responsible party, even, as necessary, across multiple networks, therefore leading to faster identifying, analysing and correcting problems.

In both testbed networks the most stakeholders still have to be identified.¹²⁷ This time, the main contributors to the definitions of the two networks are universities and research labs, but there is encouragement the interested public to communicate directly with the working groups on GENI.¹²⁸

Research cooperation and clustering of basic and applied research involving universities, research institutes and industry actors might be helpful to support the research progress in this area significantly. This could help to avoid e.g. mistakes potentially leading to lock-in and therefore are essential for the future development of these networks.

Considering the former arguments about network attribute obligations, questions remain on how to balance network regulation. Trade-offs have to be carefully analysed regarding the following:

- Openness and standards obligations and the identification of the appropriate level, and terms and conditions, eventually.
- Neutrality or some kind of backward compatibility obligations.
- Access and interconnection obligations.
- The regulatory timing.
- The role of ex-post control.

A further issue would be the discussion of reciprocity or symmetry rules not discussed here. Regulatory symmetry in the broadband industry leads to either imposing access requirements on both DSL and CATV or withdrawing regulation in both networks.¹²⁹

4.5.4 Regulatory (Access) Holidays

Considering the timing of regulation it has proven helpful to think about regulatory interventions in environments with substantial uncertainties in terms of two types of error (see also Haucap¹³⁰). A type I error occurs if a market or a firm is regulated even though it would be better (i.e., welfare enhancing) not to regulate it. A type II error means that a market or firm is left unregulated even though regulation would be beneficial.

The costs associated with these two types of errors are quite different. If a firm or market is erroneously regulated while it should either be left unregulated or be subject to more light-handed regulation, the consequences of such over-regulation may be rather dramatic. At worst, innovation and/or investment incentives are reduced so much that efficient investments and/or innovations are effectively prevented. This implies that the entire rent from a market is lost, as nobody can consume the service that is not being produced. If, however, a type II error occurs and a market is only regulated later or in a softer fashion than would be efficient, the welfare loss amounts to the well-known Harberger triangle.¹³¹ While in the latter case the usual welfare loss from monopoly may result, this welfare loss is relatively small, especially in a comparative perspective. At least some consumers get to consume the product or service and receive some utility associated with that consumption. That is, some positive consumer and producer surplus remains even in monopoly situations. In contrast, if an innovation or investment is delayed or prevented altogether, then the entire market rent is lost, which is – from an efficiency perspective – the worst case scenario.

In plain and simple words this means that a monopoly is better than having no market at all.¹³² This suggests that in dynamic markets with rapidly developing technologies and changing market structures the welfare loss associated with type II errors will be much smaller than the welfare loss associated with type I errors. This again implies that, when in doubt, regulators should rather leave markets unregulated and rather err on the side of “too little, too late” than on the side of “too much, too early” regulation.¹³³

In the economic literature the appropriate innovation and investment incentives have been discussed under the phrase “access holidays”,¹³⁴ where network providers get a “holiday” from mandatorily providing competitors with access to their networks. The idea is closely related to the literature on the economics of patents and innovation incentives. Since patents, and similarly copyrights grant firms a temporary monopoly over some product, this prospect provides firms with incentives to invest in R&D.¹³⁵ Even though temporary

monopoly leads to an allocative efficiency loss from a purely static perspective, such a policy can be efficient from a dynamic efficiency perspective as it spurs innovation. Similarly, access holidays can be seen as analogous to a patent as they involve the right to use some newly built infrastructure exclusively for some period of time, thereby increasing firms' incentives to undertake risky and specific investments into new infrastructure.

4.5.5 Contingent Ex Ante Regulation of New Markets

While access holidays are one way to secure investment incentives, the following approach extends this concept by taking the potential long run development of new markets into account.¹³⁶

The basic idea is that new markets should only become subject to ex ante price or access regulation whenever there is no tendency towards effective competition. In terms of market tests and market analyses this implies that regulation should not be based solely on the standard SMP-test or a similar short-term test of effective competition,¹³⁷ but on a *tendency test*, which examines whether effective competition is likely to develop over some time.

Although it is generally extremely difficult to give a precise definition of a new market, we may take as a necessary condition for a new market the existence of an innovation, i.e. an increase in general knowledge on the possibilities of manufacturing or distributing goods or services. The innovation does not necessarily have to be backed up by a patent or other protected right; the essential feature is that the innovation should have "certain significance", so that new services and applications can be envisioned on the improved infrastructure.

Figure 4.1 depicts the contingent regulatory approach for new markets. Similar to the "access holiday" proposal by Gans and King (2003) the framework grants an unconditional access holiday for the first, let's say four, years to allow the new market to develop. After these four years, a modified SSNIP test¹³⁸ is applied to examine whether the needs satisfied in the new market were also adequately satisfied before. This means looking at an "old" market, in which the needs in question were satisfied at a certain time (e.g. four years), and answering the question taken from the SSNIP test: What percentage of consumers in the new market would revert to the products of the old market if the prices of the products available four years ago fell in real terms (i.e. adjusted for inflation) by 20% (= 4 x 5%)? In a new market, this value should be small, and we can surely talk of a new market if let's say less than 20% of customers would revert to the old products.¹³⁹ On the other hand, if more than 80% of customers would revert to the old products in the event of such a price decrease, we can be quite sure that no new market emerged. In between these extremes, the answer depends on other aspects as well; for example, market segmentation such that a considerable proportion of consumers would never substitute to the old product.

If a new market has been identified, then no regulatory intervention occurs while in the opposite case a reversion to ex post regulation takes place.

In the following years, the new market should be examined with regard to its tendency towards effective competition that crucially depends on catch-up competition.

Assuming that the "normal" course in an unregulated market would be that an innovator loses its dominant market position within say twelve years, the regulator should investigate in the period between the emergence of a new market and the transition to static regulation, whether effective competition evolves. For evaluating the tendency towards effective competition the market test must not be based on the current market structure but on the projected structure twelve years after the emergence of the new market. Consequently, using a short-run market test as the SMP test yields false results and should not be used to determine whether regulatory intervention is warranted.

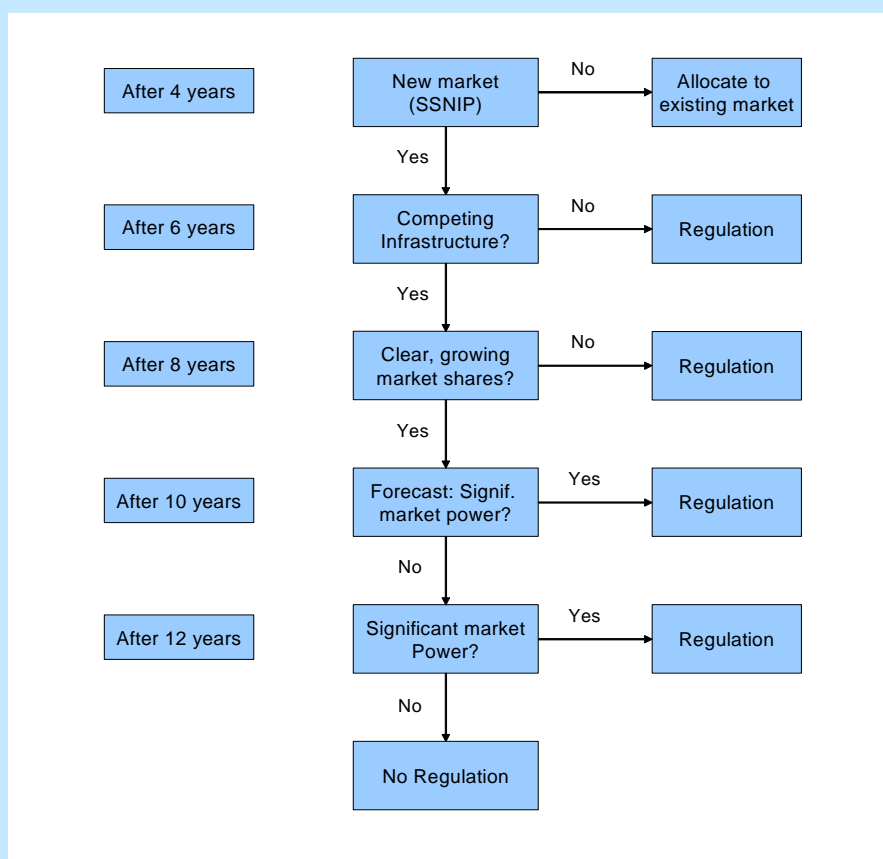
The successive *tendency test* can then be formulated as follows:

1. 6 years after the innovation, it should be possible to observe the development of competing infrastructure.
2. 8 years after innovation, the competitors should have gained significant and growing market share. This process of increasing market share, if sustained at the same rate for the next four years, should result in a market share of over 30%.

3. 10 years after innovation, the current market structure should permit a fairly reliable forecast of whether the next two years will see a situation in which regulation according to the SMP test is no longer necessary.

If the tendency test establishes at any of these investigation that the tendency towards competition defined according to the relevant criteria does not exist, the market should become subject to the existing regulation. Finally, after twelve years a definitive review should be carried out to determine whether the market satisfies the standard SMP test.

Figure 4.1: Regulation of new markets



Source: Baake, Kamecke, Wey (2005)

We conclude the discussion with a short examination of the incentive effects of the proposed framework.

First, in the initial six years, in which there is no regulation of new markets, investments by all companies, including competitors, are protected which provides market based incentives for investments by improving the ability to appropriate the investment rents.

Second, investment incentives are increased by the fact that regulation will only be applied in those cases where no tendency towards competition has emerged; i.e., regulation is contingent on the evolving market structure. Assuming that viable competitors are also better off when no ex ante regulation occurs, then incentives to free ride on the investing firms' investments becomes less likely which stimulates competitors' investments.

Third, a similar argument also shows that strategies to prevent competition for potential market-dominant companies may actually lose value. If the investing firm tries to pre-empt rivals then it must expect to come under regulatory control, and hence, cost-based price and access regulation. Under the proposed regulatory framework the investing firm now faces the option to avoid future regulation by not engaging in such

anticompetitive practices. Hence, the threat of regulation promotes the emergence of effective competition by making entry-deterring practices less attractive.

5 CONCLUSIONS

The economic goal of telecommunication policy should be to promote social welfare that critically depends on investments into new infrastructures and new products and services. Such investments will lead to productivity gains that increase business productivity and increase the benefits to consumers through offers of new products and services and lower prices. In communication markets, those gains depend to a large extent on increasing transmission capacities and decreasing prices for access and transmission.

While these efficiency goals are typically combined with other social and political objectives, as e.g. universal service, there are many reasons to favour markets over state-owned or state-managed telecommunication businesses to achieve the best economic outcomes. Markets are in many ways more effective in collecting and distributing information about firms' supplies and consumers' demands, and they provide high-powered incentives for entrepreneurial activities. Besides those incentive effects of markets, state intervention unfolds its own costs as, e.g., costs of monitoring and bureaucracy, lobbying and rent-seeking cost and the associated government failures of regulatory takings and regulatory capture.

However, markets in communication industries may not produce socially desirable outcomes when uncontestable monopoly power is present. Given the supposed natural-monopoly type of market failures telecommunication industries have been and continue to remain a highly regulated industry in many parts. The emergence of NGNs and the accompanied debate about new telecommunications markets allows for a re-thinking of current regulatory practice and a new assessment of possible regulatory withdrawals and increased reliance on competition policy.

We have seen that current regulatory practice is considering very different regulatory approaches varying from strict ex ante access regulation, openness and net neutrality obligations to a hands-off proposal that mainly relies on competition policy measures. Table 5.1 presents a tentative list of the regulatory options currently discussed in the context of NGNs.

Table 5.1: Comparison of regulatory options

Option	Network neutrality obligations	Access obligations
Network neutrality and openness	Yes	Yes
Diversity approach	No	Can be treated separately or in combination
Open access obligation	No	Yes
Regulatory holidays	No	Depending on SMP test
Contingent ex ante regulation	No	Depending on competition tendency test
Competition Policy	No	Depending on SMP and abuse

Obligations like network neutrality have to be investigated very carefully among other concepts as network diversity and have to be smoothly timed with credible commitments protecting the economic incentives as the proposed contingent ex ante regulation does. One has to distinguish whether these measures are seen as regulatory threats which will be imposed in some sort on a dominant operator so as to achieve the longer run goal of creating more competitive markets or whether these measures should be applied as a remedy as soon as possible. In any case, regulatory intervention creates an option value for competitors (for the possibility to opt-in at better conditions than the incumbent would offer without intervention) and unfolds negative incentives on making investments for entrants, which ultimately delays the dynamic competitive process.

Overall, the regulatory framework for new markets should take care of the vertical structure (and associated complementarities between services and infrastructure) and the pronounced risks these dependencies imply for innovating firms. A standard, cost-based regulatory system, which may be optimal in a static

environment, necessarily reduces firms' investment incentives, because it does not properly take into account the risks the investor has to bear; or, more precisely, the need for high rewards in successful states of the world that have a small ex ante probability. The logic of the market mechanism implies that high rewards will be associated with some sort of market dominance, so that cost-oriented access regulation must deteriorate the incentives to invest in the first place. In addition, from the competitors' perspective failure of the regulatory body to commit to withdraw from overhasty intervention necessarily creates an option of waiting for rival firms', and therefore, tends to hinder investment-based catch-up competition, which is essential for generating viable competitive structures in telecommunication markets based on dispersed ownership of substitutable access infrastructures.

A regulatory system should, therefore take into account the incentives to develop (new) competing infrastructures in order to achieve dynamic efficiency. If new networks are exempted from any regulation for a certain period of time, this will secure potentially high profits for the first innovator. In addition, it also increases the investment incentives of potential competitors. The decisive point is then to determine how new markets should be defined and/or demarcated. As it is not possible ex ante to predict precisely how e.g. the provision of new services and applications, and hence the access to new networks, will develop, it appears to be sensible that regulators forbear from traditional ex ante interventions in the first years of market development.

However, a complete withdrawal of sector-specific supervision also appears to be premature because of the particular feature of the telecommunications sector; namely, non-replicable asset problems and significant network effects. As a consequence, the optimal regulator approach lies somewhere in the middle where market forces can unfold while the threat of regulatory intervention remains a viable option, which effectively constraints anticompetitive re-monopolizing of telecommunications markets. Thus, regulators and policy makers are facing a delicate and complex task in telecommunications markets in the future. They have to keep the threat of regulation while at the same time we should abstain from premature intervention. With this regulation becomes a walk on a tightrope that cannot rely on a cookbook of regulatory instruments anymore.

But how should regulators proceed over the next years? The answer to this question clearly depends on the longer run market developments. Thus, regulators are well advised to take a longer run perspective, which takes into account the massive investment projects currently underway in the telecommunication sector. At the same time, it has to be understood that short run market power tests (as, e.g., the SMP test in Europe with a time horizon of one year) is not appropriate in markets where drastic investment projects have a much longer time-frame.

Therefore, the development of new market should be reviewed, say every two years, with a view to create effective competition, and with an ever-increasing emphasis on structural competition. Such a series of successive development must converge after some time with the existing SMP test when the innovative process abates. If, however, there is no discernable trend towards significant competitive structures, the market will be subjected to sector-specific control at an earlier stage.

This "threat of regulation" approach not only takes account of the risk-laden innovation problem of the investing company; it also generates positive incentives for competitors to invest into competing infrastructures. The reason for this is that competitors investing on their own behalf may generate effective competition and avoid the need for any future regulation of the market. Moreover, the incentive to free-ride on the innovators investments are also mitigated by the rather long review process. Finally, the threat of regulation if no effective competition emerges counters possible incentives of the innovator to protect its monopoly by entry-deterring tactics and strategies.

Market reviews must examine the *innovative* threats from potential competitors. As is well known from so-called high-tech industries with market shares over 40-50 per cent may not indicate uncontested dominance when competitors are challenging the dominant firm's lead in the innovative market segments. Moreover, the regulatory review process must assess the overall degree of uncertainty in emerging markets which increases the possibility of a type I error of regulatory intervention.

In any case, the effectiveness of the future regulation critically depends on the degree of commitment on the part of regulators as otherwise any decision to forbear would not change market behaviour. A periodic market review process that delivers a transparent assessment of market developments and a clear reasoning

about possible regulatory interventions (which will not come effective immediately but only if the next review process confirms negative market developments) could help to achieve commitment and credibility.

Another pressing problem is the definition and identification of “new and emerging markets” which is not solved yet.¹⁴⁰ This comprises the separation of new markets from (regulated) old markets. This task is complicated by the ubiquity of bundling strategies and complementarities between services and applications. Again, a longer run view should be adopted that takes into account the time frame of the drastic changes of the telecommunications sector in the next years.

We conclude this study with other important challenges regulators face in new and emerging market environments. In our study we have concentrated on the regulations vis-à-vis incumbent fixed line telephone companies. As we have argued in the first part of this study, the evolution towards NGNs is very much driven by convergence at the level of access technologies. Clearly, the creation and upgrading of access networks should increase the scope for effective intermodal competition, which is a necessary prerequisite for a withdrawal of ex ante regulations. Thus, regulators and policy makers are well-advised to enable the competitiveness of alternative access technologies. For example, spectrum policy (for radio broadcast and WiFi access) should make available large amounts of spectrum and licensing policies should encourage the efficient use of it.

Another challenge concerns the implementation of openness requirements. It has to be studied carefully, whether a separation into a physical layer, communication protocols, a service layer and an application layer is meaningful and how structural separation will bias technical progress and investment decision.

Social service regulations are another challenge that becomes important with the evolution towards an all-over-IP world. This concerns technical and general interest regulations, which are necessary, as the architecture of Internet has not been designed to incorporate those public needs adequately. Relatedly, as societies transform to information societies the role of governmental intervention with regard to universal broadband access provisions (to counteract a deepening digital divide) and the active promotion of new networks, as e.g., sensor networks, with significant public good features, becomes an issue.

It remains to future research to explore the evolving markets in the telecommunication sector and the continuing adjustment of the regulatory framework. It is to be hoped that contentious issues will be settled so that a convergence on substantive regulatory issues will be reached among regulators. This may however, take some time as countries’ telecommunications markets are quite heterogeneous which makes comparisons and benchmarking of regulatory approaches difficult so that different opinions about the best policies are likely to persist.

REFERENCES

- ACA (2003): "Next Generation Networks, An ACA perspective on regulator and policy issues", Australian Communications Authority, May 2003, [http://www.aca.gov.au/aca_home/about_aca/futures_panel/next_gen_networks_persp_may_2003.pdf; March 10, 2006].
- ACIF (2004): "ACIF NGN Project Policy and Regulatory Considerations for new and Emerging Services", [http://www.acif.org.au/__data/page/275/NGN_Report_-_Policy_and_regulatory_considerations.pdf; March 10, 2006].
- Acquisti, A. (2004): Privacy and Security of Personal Information. Economic Incentives and Technological Solutions (Preliminary Draft). In: Economics of Information Security. L. J. Camp and S. Lewis, Eds. (Norwell, MA, USA: Kluwer Academic Publishers).
- Anderson, R. (2001): Why Information Security Is Hard - An Economic Perspective. University of Cambridge Computer Laboratory. (Cambridge, MA, USA). January 30, 2001.
- Au, M. (2004): „Promoting Competition and Encouraging Investment“ [http://www.ofta.gov.hk/en/dg_article/au_articles/20040617.pdf; February 08, 2006].
- Au, M. (2005): „Let the Market Decide“ [http://www.ofta.gov.hk/en/dg_article/au_articles/20051115.pdf; February 08, 2006].
- Au, M. (2006): „Telecommunications in Tune with Market“; Economic Weekly, January 1st, 2006 [http://www.ofta.gov.hk/en/dg_article/au_articles/20060101.pdf; February 08, 2006].
- Baake, P., Kamecke, U. and Wey, C. (2005), "Efficient Regulation of Dynamic Telecommunications Markets and the New Regulatory Framework in Europe", forthcoming in: R. Dewenter and J. Haucap (eds.), Access Pricing: Theory and Practice, Elsevier: Amsterdam.
- BITKOM (2006): Daten zur Informationsgesellschaft [http://www.bitkom.org/files/documents/Daten_zur_Informationsgesellschaft_2006.pdf; March 12, 2006].
- Cabral, L., and Kretschmer, T. (2004): "Standard Battles and Public Policy". [http://www.chicagofed.org/news_and_conferences/conferences_and_events/files/cabral.pdf; June 09, 2005].
- Cave, M. (2003): Remedies for Broadband Services, University of Warwick, mimeo.
- Cave, M. and Vogelsang, I. (2003): "How Access Pricing and Entry Interact". *Telecommunication Policy* 27, 717-727.
- Chae, K. (2002): "Introduction to Critical Network Infrastructures"; ITU Workshop Discussion Paper [<http://www.itu.int/osg/spu/ni/security/docs/cni.03.pdf>; March 12, 2006].
- Christensen, C.M. (1997): The Innovator's Dilemma, Harvard Business School, Cambridge, Massachusetts.
- Church, J. and Gandal, N. (2004): "Platform Competition in Telecommunications". Erscheint in: The Handbook of Telecommunications, Volume 2, M. Cave, S. Majumdar und I. Vogelsang (Hrsg.). [<http://spirit.tau.ac.il/public/gandal/platform.pdf>; February 16, 2005].
- CNNMoney (2006): Broadband's Utility Player, [http://money.cnn.com/magazines/business2/business2_archive/2006/01/01/8368133/index.htm; March 12, 2006].
- Comptel (2005): A global IP network for Deutsche Telekom [<http://www.comptel.com/p10612.html>; March 12, 2006].
- Devoteam Siticom (2003), Regulatory implications of the introduction of next generation networks and other new developments in electronic communications. Study by Devoteam Siticom and Cullen International for the European Commission [http://europa.eu.int/information_society/policy/ecomm/doc/info_centre/studies_ext_consult/regulatory_implications_study.pdf; December 12, 2005].

EC (2005): "Telecommunications: Commission approves decision of the German regulator to open up broadband markets, including very high-speed internet access (VDSL)"; Commission of the European Communities; IP/05/1708, Brussels, December 23, 2005 [<http://europa.eu.int/rapid/pressReleasesAction.do?reference=IP/05/1708&format=PDF&aged=1&language=EN&guiLanguage=en>; February 08, 2006].

ecma (2005): "Enterprise Communications in Next Generation Corporate Networks (NGCN) involving Public Next Generation Networks (NGN)"; Technical Report ECMA TR/91 1st edition (December 2005), ecma International, Geneva [<http://www.ecma-international.org/publications/files/ECMA-TR/TR-091.pdf>; February 08, 2006].

ETP (2006): On the technology, business models and regulatory aspects of NGN, European Telecommunications Platform, ETP (06)01, [http://www.etp-online.org/downloads/06_01_ETP%20public%20NGN%20final.pdf; March 12, 2006].

ETSI (2006): "Telecommunications and Internet Converged Services and Protocols for Advanced Networking (TISPAN); Release 1 Definition. " Technical Report DTR 00001 V0.4.9 (2006-02) [<http://portal.etsi.org/docbox/tispan/Open/NGN-R1%20LATEST%20DRAFTS/00001v049.pdf>; 2006-02-21]

European Commission (2002): RL 2002/58/EC "Processing of personal data and the protection of privacy in the electronic communications sector" (Directive on privacy and electronic communications).

Farrell, J. and Saloner, G. (1985): "Standardization, Compatibility, and Innovation", 16 *RAND Journal of Economics* 70, 71 (1985).

Farrell, J. and Saloner, G. (1988): "Coordination through committees and markets". *RAND Journal of Economics*, 19 (2), S.235–252.

Farrell, J. and Weiser, P. (2003): Modularity, Vertical Integration, and Open Access Policies: Towards a Convergence of Antitrust and Regulation in the Internet Age, *Harvard Journal of Law and Technology*, Vol. 17, No. 1, Fall 2003.

FCC (2005a): "FCC Chairman Michael K. Powell Commends Swift Action to Protect Internet Voice Services"; Federal Communications Commission FCC News (March 3, 2005) [http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-257175A1.pdf; February 08, 2006].

FCC (2005b): Consent Decree in the Matter of Madison River Communications, LLC and affiliated companies; Federal Communications Commission, File No. EB-05-IH-0110 [http://hraunfoss.fcc.gov/edocs_public/attachmatch/DA-05-543A2.pdf; February 08, 2006].

FCC (2005c): "FCC Eliminates Mandated Sharing Requirement on Incumbents' Wireline Broadband Internet Access Services"; Federal Communications Commission FCC News (August 5, 2005) [http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-260433A1.pdf; February 08, 2006].

Fudenberg, D. and Tirole, J. (1984): "The Fat-Cat Effect, the Puppy-Dog Ploy, and the Lean and Hungry Look". *American Economic Review*, 74, pp.361–368.

Gans, J. and King, S. (2003): Access Holidays for Network Infrastructure Investment, *Agenda*, 10 (2), 163–178.

Gans, J. and King, S. (2004), "Access Holidays and the Timing of Infrastructure Investment", *The Economic Record* 80, 89–100.

Geroski, P. A. (1995). "What do we know about entry?" *International Journal of Industrial Organization*, 13, S.421–440.

Hazlett, T. and Havenner, W. (2003): The Arbitrage Mirage: Regulated Access Prices with Free Entry in Local Telecommunication Markets, *Review of Network Economics*, 2 (4), 440–450.

Haucap, J. and Marcus, J. (2005): "Why Regulate? Lessons from New Zealand", *IEEE Communications Magazine* 43 (11), 2005, 15–16 [<http://www.ruhr-uni-bochum.de/wettbewerb/dlls/forschung/01541683.pdf>].

Haucap, J. (2006): "What Regulation for Tomorrow's Telecommunications Markets?", forthcoming in: A. Picot (Eds.) "The Future of Telecommunications Industries", Springer: Munich (2006).

Haucap, J., U. Heimeshoff and A. Uhde, "Credible Threats as an Instrument of Regulation for Network Industries", forthcoming in P. Welfens (Ed.) "Regulatory Changes, Innovations and Investment Dynamics in the Digital World Economy", Springer: Berlin (2006).

Hausman, Jerry (1997), "Valuing the Effect of Regulation on New Services in Telecommunications", *Brookings Papers on Economic Activity: Microeconomics*, 1-38.

Hausman, J. and Sidak, G. (1999): "A Consumer-Welfare Approach to the Mandatory Unbundling of Telecommunications Networks", *The Yale Law Journal*, 109, 417-505.

Hori, K. and Mizuno, K. (2005): "Promoting Competition with Open Access under Uncertainty". [<http://www.realloptions.org/submission/papers2005/pcoau042505.pdf>; September 25, 2005].

Hundt, R.E. and Rosston, G.L. (2006): „Communications Policy for 2006 and Beyond“; forthcoming in *Federal Communication Law Journal* (58) No.1, [<http://www.law.indiana.edu/fclj/pubs/v58/no1/HundtPDF.pdf>; March 10, 2006].

ITU-T (2005); "International Telecommunications Union - Telecommunications: NGN definition" [<http://www.itu.int/ITU-T/ngn/definition.html>; Version last updated 2005-12-19].

Katz, M. and C. Shapiro (1994): "Systems Competition and Network Effects," *Journal of Economic Perspectives*, 8: 93-115.

Katz, M. and Shapiro, C. (1986): "Technology Adoption in the Presence of Network Externalities", 94 *J. POL. ECON.* 822, 825 (1986)

Keiichi Hori, K. and Mizuno, K. (2004): Network Investment and Competition with Access-to-Bypass. Faculty of Economics, Ritsumeikan University, Mimeo.

Lessig, L. (2001): "The Future of Ideas : The Fate of the Commons in a Connected World" (2001).

Lessig, L. (2002): "The Government's Role in Promoting the Future of Telecommunications Industry and Broadband Deployment"; Hearing Before the S. Comm. on Commerce, Science & Transp., 107th Cong. (2002) [<http://commerce.senate.gov/hearings/100102lessig.pdf>; January 05, 2006].

Liebowitz, S. and Margolis, S. (1996): "Should Technology Choice Be a Concern of Antitrust Policy?", 9 *Harvard Journal on Law & Technology* 283, 310, 312 (1996).

Noam, E. (2005): Interview conducted by Yves Gassot in: *Communications & Strategies*, 60, 4th quarter 2005, pp. 149-154.

NSF (2005): "Overcoming Barriers to Disruptive Innovation in Networking", Report on the equal named workshop of the National Science Foundation (January 2005).

ODTR (2001): ODTR Briefing Note Series "Next Generation Networks"; Irish Commission for Communications Regulation [<http://www.odtr.ie/docs/odtr0188.doc>; March 10, 2006].

Ofcom (2005): Next Generation Networks: Future arrangements for access and interconnection. [<http://www.ofcom.org.uk/consult/condocs/ngn/ngn.pdf>; March 12, 2006].

Ofcom (2006): Next Generation Networks: Developing the regulatory framework. [<http://www.ofcom.org.uk/consult/condocs/nxgnfc/statement/ngnstatement.pdf>; March 12, 2006].

OPTA (2005): "Regulating Emerging Markets?", Economic Policy Note no.5, April 2005; [http://www.opta.nl/download/EPN05_uk.pdf; March 10, 2006].

Owen, B. and Rosston, G. (2003): "Local Broadband Access : Primum Non Nocere or Primum Processi? A Property Rights Approach", 11-12. AEI-Brookings Joint Center for Regulatory Studies, Related Publication No. 03-19 (Aug. 2003) [<http://www.aei.brookings.org/admin/authorpdfs/page.php?id=285>].

Political Intelligence (2003): Policy Implications of Convergence of Naming, Numbering and Addressing. Report for the European Commission, Brussels. [http://europa.eu.int/information_society/topics/telecoms/regulatory/studies/documents/nna_final_15sept.pdf; 13.01.2006].

Reinganum, J. (1989), "The Timing of Innovation: Research, Development, and Diffusion", pp. 849-908 in: R. Schmalensee and R. Willig (eds.), *Handbook of Industrial Organization*, Vol. 1, Elsevier: Amsterdam.

- Riordan, M. (1992), Regulation and Preemptive Technology Adoption, *RAND Journal of Economics* 23(3), 334-349.
- Schumpeter, J. (1950): Capitalism, Socialism and Democracy, 3rd ed., New York, Harper.
- Schumpeter, J. (1918/1964): Theorie der wirtschaftlichen Entwicklung: Eine Untersuchung über Unternehmerrgewinn, Kapital, Kredit, Zins and den Konjunkturzyklus, (1st edition 1918), 6th edition, Duncker & Humblot, Berlin.
- Schumpeter, J. (1964): The Theory of Economic Development: An Inquiry into Profits, Capital, Credit, Interest and the Business Cycle, Cambridge University Press.
- Scotchmer, S. (2005): Innovation and Incentives. MIT-Press.
- Shapiro, C. and Varian, H. R. (1999). Information Rules: A Strategic Guide to the Network Economy. Harvard Business School Press, Boston.
- Sicker, D. (2005): "The End of Federalism in Telecommunication Regulations?"; *Northwestern Journal of Technology and Intellectual Property*, Vol. 3 No.2, Spring 2005 [<http://www.law.northwestern.edu/journals/njtip/v3/n2/3/Sicker.pdf>; March 12, 2006].
- Valletti, T. M. and Cambini, C. (2004). "Investments and Network Competition". Imperial College London, Tanaka Business School Discussion Paper. [<http://www3.imperial.ac.uk/pls/portallive/docs/1/39666.PDF>; September, 23, 2005].
- Verisign (2005): Building a Security Framework for Delivery of Next Generation Network Services, White Paper, University of Southern California and VeriSign [<http://www.verisign.com/static/035478.pdf>; January 08, 2006]
- Yoo, C. (2005): "Beyond Network Neutrality". Vanderbilt University Law School Public Law & Legal Theory Working Paper 05-20 and Law & Economics Working Paper 05-16 [<http://ssrn.com/abstract=742404>].
- Wu, T. (2003): "Network Neutrality, Broadband Discrimination"; *Journal on Telecommunications & High Tech L.*, Vol.2 (2003), pp. 141-179.

ENDNOTES

- ¹ See draft workshop document (version January 17, 2006) for the ITU NGN Policy and Regulatory Workshop “What Rules for IP-enabled NGNs?” (March 23-24, 2006 at ITU Headquarters, Geneva) this background paper was presented for [<http://www.itu.int/osg/spu/ngn/event-march-2006.phtml>].
- ² See ibd.
- ³ See Noam (2005, p.149).
- ⁴ A closer look of the relevant details for the further discussion will be provided in section 2.2.
- ⁵ “SG13 is responsible for studies relating to the architecture, evolution and convergence of next generation networks including frameworks and functional architectures, signalling requirements for NGN, NGN project management coordination across study groups and release planning, implementation scenarios and deployment models, network and service capabilities, interoperability, impact of IPv6, NGN mobility and network convergence and public data network aspects”, see <http://www.itu.int/ITU-T/studygroups/com13/area.html>.
- ⁶ “TISPAN is responsible for all aspects of standardisation for present and future converged networks including the NGN (Next Generation Network) and including, service aspects, architectural aspects, protocol aspects, QoS studies, security related studies, mobility aspects within fixed networks, using existing and emerging technologies”, see http://portal.etsi.org/tispan/TISPAN_ToR.asp.
- ⁷ See ITU-T (2005).
- ⁸ See ETSI (2006).
- ⁹ For a overview of the interoperation of Next Generation Networks (NGN) and Next Generation *Corporate* Networks (NGCN) see ecma (2005).
- ¹⁰ Enterprise Application Integration (EAI) is defined as the use of software and computer systems architectural principles to bring together (integrate) a set of enterprise computer applications. EAI has increased in importance because, traditionally, enterprise computing often takes the form of islands of automation. This occurs when the value of individual systems are not maximized due to partial or full isolation. If integration is applied without following a structured EAI approach, many point-to-point connections grow up across an organization. The number of n connections needed to have a fully-meshed point-point connections is given by $n(n-1)/2$. Thus, for 10 applications to be fully integrated point-to-point, 45 point-to-point connections are needed. However, EAI is not just about sharing data between applications; it focuses on sharing both business data and business process. Currently, it is thought that the best approach to EAI is to use an Enterprise service bus (ESB), which connects numerous, independent systems together. Although other approaches have been explored, including connecting at the database or user-interface level, generally, the ESB approach has been adopted as the strategic winner. Individual applications can publish messages to the bus and subscribe to receive certain messages from the bus. Each application only requires one connection, which is to the bus. The message bus approach can be extremely scalable and highly evolvable. Enterprise Application Integration is related to middleware technologies such as message-oriented middleware (MOM), and data representation technologies such as XML. Newer EAI technologies involve using web services as part of service-oriented architecture as a means of integration. Enterprise Application Integration tends to be data centric. In the near future, it will come to include content integration and business processes. See http://en.wikipedia.org/wiki/Enterprise_Application_Integration [March 11, 2006].
- ¹¹ Viewed from the ISO/OSI-model perspective, “physical infrastructures” in this context include the Physical Layer (ISO layer 1) as well as the Data Link Layer (ISO layer 2).
- ¹² See <http://www.geni.net/faq.php>.
- ¹³ E.g. the “Deutsche Telekom AG initiated a large-scale project in 2001 which was geared to building an IP-based global network. The project was named TGN, short for Telekom Global Net. The purpose of the project is to create a global, adaptable network based on IP technology, which will combine the new voice, Internet, data and multimedia services with the existing network infrastructure. Deutsche Telekom will first introduce the TGN network in Germany and later expand it to cover other countries. According to estimates, approximately 40 countries around the world will be included in the network by 2004”; see Comptel (2005).
- ¹⁴ An impressive example for MetroEthernet is the offer from City Telecom. This company in Hong Kong offers 100 mbit/s internet access for just \$25 per month, regarding internet access as “broadband utility”. But because of a maximum range of 100 meters for the last mile, the Ethernet technology used is unfortunately a feasible technology only in relative densely populated areas, see CNNMoney (2006).
- ¹⁵ See Ofcom (2005, p.4).
- ¹⁶ See Verisign (2005).
- ¹⁷ With the acceleration of broadband access around the globe and service providers starting to offer according content, e.g. VoIP services, they are confronted with similar problems to them, that mobile operators had been confronted with in the past and developed solutions or viable concepts.
- ¹⁸ See ODTR (2001).
- ¹⁹ See interview with Norman Lewis, director of research for France Telecom, <http://www.telephonydiscussion.com/index.php?name=News&file=article&sid=12>.
- ²⁰ For a more detailed discussion see section 3.

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- ²¹ See ODTR (2001, p.14-15).
- ²² See *ibid.* (p.15).
- ²³ See Verisign (2005, p.9-10).
- ²⁴ See ODTR (2001, p.15).
- ²⁵ See *ibid.* (p.16).
- ²⁶ See Ofcom (2005, p.6).
- ²⁷ See Devoteam Siticom (2003).
- ²⁸ See *ibid.* (pp.102-105).
- ²⁹ See *ibid.* (pp.102-105).
- ³⁰ See Au (2006).
- ³¹ See *ibid.*
- ³² See Hundt and Rosston (2006, p.11).
- ³³ For an introduction to Critical Network Infrastructures see Chae (2002).
- ³⁴ E.g. in Germany, § 109 of the telecommunications act (TKG) is titled “technical protection measurements” and includes most security and safety aspects of network operations.
- ³⁵ For a general overview over the Economics of Security see Anderson (2001).
- ³⁶ The standardisation at the ETSI takes place in the working group SEC LI and provides a preliminary framework of six documents, covering the whole range of telecommunications (the base report TR 101 331 “Definition of user requirements for lawful interception of telecommunications; Requirements of the law enforcement agencies” and the extending documents ES 201-671 “Telecommunications Security; Lawful Interception (LI); Handover interface for the lawful interception of telecommunications traffic”, ES 101-671 “Telecommunications Security; Lawful Interception (LI); Handover for GSM, GPRS, ISDN and PST”, ES 133-108 “Telecommunications Security; Lawful Interception (LI); Handover for UMTS”, ES 102-232 “Telecommunications Security; Lawful Interception (LI); Handover specification for IP delivery” and TR 101 944, updating the framework for a separate view on access and service providers).
- ³⁷ For a general overview over the Economics of Privacy see Acquisti (2004).
- ³⁸ See European Commission (2002).
- ³⁹ For example, there are several activities at the ITU and the ETSI regarding QoS-standards.
- ⁴⁰ See Cave and Vogelsang (2003) for this idea which was also formulated in Cave and Prosperetti (2001). See Oldale and Padilla (2004) for a recent critique.
- ⁴¹ For example, in the European Union the new 2002 regulatory framework is currently reviewed. It mainly consists of EU Directives 2002/19/EC to 2002/21/EC: Directive 2002/21/EC on a common regulatory framework for electronic communications networks and services (OJ L 108 of 24 April 2002, p. 33), also known as the “Framework Directive”; Directive 2002/20/EC on the authorisation of electronic communications networks and services (OJ L 108 of 24 April 2002, p. 21), known as the “Authorisation Directive”; and Directive 2002/19/EC on access to, and interconnection of, electronic communications networks and associated facilities (OJ L 108 of 24 April 2002, p. 7), known as the “Access Directive”. The new legal framework also includes two further Directives, the so-called “Universal Service Directive” and the “Data Protection Directive”; however, these are of subordinate importance to our study.
- ⁴² For the EU, this is stated in the Framework Directive 2002/21/EC, Recital 5.
- ⁴³ Again, for the EU, see “Commission guidelines on market analysis and the assessment of significant market power under the Community regulatory framework for electronic communications networks and services” (2002/C 165/03) published in the Official Journal of the European Communities C 165/6, 11 July 2002.
- ⁴⁴ See European Commission’s Recommendation on relevant product and service markets (C(2003) 497).
- ⁴⁵ See “Commission Recommendation of 11 February 2003 on relevant product and service markets within the electronic communications sector susceptible to ex ante regulation in accordance with Directive 2002/21/EC of the European Parliament and of the Council on a common regulatory framework for electronic communication networks and services” (2003/311/EC), published in the Official Journal of the European Union L 114/45, 8 May 2003.
- ⁴⁶ Referring to Germany, the Telekommunikationsgesetz (TKG) amended in 2003 states in a similar way in Article 10 that markets should only be subject to ex ante regulation where they do not display any longer-term tendency towards competition.
- ⁴⁷ A similar reasoning is stated in the explanation to Art. 14 (Review of market definition and analysis) of Germany’s new TKG, p. 87: “New markets are not therefore automatically subject to supervision by the Bundeskartellamt [the Federal Cartel Office], but should first be reviewed by the RegTP - in conjunction with the Bundeskartellamt - for their need for regulation under the TKG.”
- ⁴⁸ First, competition-winning firms tend to obtain market power and may have incentives and ability to deter new entry. In addition, winning firms have different incentives than new entrants that may affect the introduction of new products and services. See Hundt and Rosston (2006, p.2). As Stan Liebowitz and Stephen Margolis have observed, “If a market is growing rapidly, the number of users who have made commitments to any standard is small relative to the number of future users.” See Liebowitz and Margolis (1996).
- ⁴⁹ Most of the economic principles can, of course, be applied to other innovations such as new services. However, markets for services are typically characterized by much lower investment requirements and smaller barriers to market entry.

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- ⁵⁰ Thus Schumpeter writes (1950) that the reality of a capitalist economy is essentially different from the static price-theory model of economic theory. The most important form of competition is then not competition within a market with established technologies, production processes and industry structures, but competition for new products, technologies, sources of supply and organizational models.
- ⁵¹ See Farrell and Weiser (2003).
- ⁵² On this so-called replacement effect, cf. Gans (2001), and Hori and Mizuno (2004).
- ⁵³ See FCC (2005b).
- ⁵⁴ See *ibid.* (2005a).
- ⁵⁵ Similar conclusions are reached by Hausman (1997), Hausman and Sidak, G. (1999) and Hazlett and Havenner (2003). For new networks, the dynamic regulation of access prices proposed by Cave and Vogelsang (2003) and Cave (2003) following the “ladder of investment” theory results in a one-sided distribution of risk to the detriment of the regulated company: progressive increases in access prices mean that competitors – who have not been forced to invest – have a risk-free exit option.
- ⁵⁶ See Haucap and Marcus (2005).
- ⁵⁷ See *ibid.* (p. 16).
- ⁵⁸ These two points have been recognised by the Office of the Telecommunications Authority (OFTA) in Hong Kong, where the main goals are to minimise the obstacles to the introduction of new technologies and to create an environment conducive to investment. See Au (2006).
- ⁵⁹ See Ofcom (2006, p.3).
- ⁶⁰ See *ibid.* (p.4)
- ⁶¹ See EC (2005).
- ⁶² See *ibid.*
- ⁶³ See Ofcom (2006, p.4)
- ⁶⁴ See *ibid.* (p.4-5)
- ⁶⁵ See Au (2006) and Au (2004).
- ⁶⁶ See FCC (2005c).
- ⁶⁷ See Ofcom (2006, p.5)
- ⁶⁸ After the breakup of AT&T, the Bell Operating Companies were obliged to interconnect with all long-distance carriers and to redesign and reprogram their switches to incorporate a standardized interface by 1986. See Yoo (2005, p. 3).
- ⁶⁹ See switchreconfig - Bell.
- ⁷⁰ See Lemley & Lessig, *supra* note 1, at 942-43.
- ⁷¹ See sect. 4.3.4 and Yoo (2005, pp. 4, 8, 26).
- ⁷² See Hundt and Rosston (2006, p. 21++).
- ⁷³ It may be reasonable for the network owner to charge differential pricing for different services, but equipment discrimination is less likely to have the same positive benefits so that this openness [accordingly to Yoo and referencing the *Carterfone case*] should be adopted by law and regulation. See Yoo (2005, p. 3).
- ⁷⁴ See Hundt and Rosston (2006, p.25).
- ⁷⁵ See *ibid.* (p.5).
- ⁷⁶ “Indeed, economic theory suggests that network neutrality proponents are focusing on the wrong policy problem.”, see Yoo (2005, p.5)
- ⁷⁷ Eliminating the access bottleneck is also one of the main targets of spectrum policies reviewed around the globe these days. See e.g. Au (2006).
- ⁷⁸ See Yoo (2005).
- ⁷⁹ See *ibid.* (p.83).
- ⁸⁰ See *ibid.* (p.7).
- ⁸¹ See *ibid.* (p.272) and *ibid.* referencing Farrell and Saloner (1985) (counting “reduction in variety” as one of the “important social costs” of standardization).
- ⁸² “The net impact of entry under network diversity is thus quite complex, depending on whether the customers result from demand creation or demand diversion and the magnitude of the welfare gains resulting from providing network services that better satisfy the customers cannibalized from the incumbent network. Again, this is not a question that can be answered a priori.” See Yoo (2005, p.65, 69).
- ⁸³ For excess entry, see Geroski (1995).
- ⁸⁴ For excess momentum, see Farrell and Saloner (1988).
- ⁸⁵ See Yoo (2005, p.68).
- ⁸⁶ See *ibid.* (p.8).
- ⁸⁷ See Church and Gandal (2004).
- ⁸⁸ See *ibid.* (pp. 28-29).

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- ⁸⁹ See *ibid.* (pp. 30-31).
- ⁹⁰ "It is possible, but not definite, that the reduction in welfare associated with the deadweight losses might be offset by increase in welfare made possible by greater product diversity." See Yoo (2005, p.67, 70).
- ⁹¹ "Regulators seeking to distribute communications services to everyone in the nation, for very laudable social and economic reasons, have tended to interfere in ways that diminish the responsiveness of the market as well as the magnitude and speed of the introduction of new goods and services." See Hundt and Rosston (2006, p. 2).
- ⁹² See Church and Gandal (2004, p. 27) referencing Cabral and Kretschmer (2004) who explicitly model the behaviour of a regulator to impose a mandatory standard. They examine how uncertainty over the preferences of consumers between competing standards affects when and which standard is adopted. See Cabral and Kretschmer (2004).
- ⁹³ See Yoo (2005, p.9).
- ⁹⁴ See *ibid.* (p.69).
- ⁹⁵ E.g. BT made multi-vendor procurement possibility a key requirement designing its 21CN.
- ⁹⁶ See Yoo (2002, p.281) and *id.* referencing Katz and Shapiro (1986).
- ⁹⁷ "However, as Katz and Shapiro (1994) observe, an additional advantage of having multiple networks not considered formally in the theoretical literature is that multiple competing networks have an option value. Preserving multiple networks and selecting a standard after technical and demand uncertainty is resolved makes it more likely that the optimal standard will be implemented. Too early a choice may preclude a subsequent change to a superior standard total surplus would rise if there was a switch to an alternative." see Church and Gandal (2004, p.17) referencing Katz and Shapiro (1994).
- ⁹⁸ For versioning, see Shapiro and Varian (1999).
- ⁹⁹ Hori and Mizuno show formally a condition for open access policy to make a leader's entry late: when the level of access charge is low and a positive externality generated by network expansion is small, a leader in an open access environment enters late, if uncertainty is large or a monopoly profit flow is large. See Hori and Mizuno (2005). Valletti and Cambini analyse the impact of two-way access charges on the incentives to invest in networks with different levels of quality. In their model, the incentives to invest in higher quality depend on the network externalities regarding on- and off-net transmission quality and network size. See Valletti and Cambini (2004).
- ¹⁰⁰ See Hundt and Rosston (2006, p. 6).
- ¹⁰¹ See Yoo (2005, pp.79-80).
- ¹⁰² See *ibid.* (p.4) referencing *White Motor Co. v. United States*, 372 U.S. 253, 262-63 (1963) and Owen and Rosston (2003).
- ¹⁰³ See *ibid.* (p.295).
- ¹⁰⁴ See ACIF (2004).
- ¹⁰⁵ See NSF (2005).
- ¹⁰⁶ *Ct. ibid.* (p.3).
- ¹⁰⁷ See *ibid.* (pp.14-15).
- ¹⁰⁸ See *ibid.* (p.16).
- ¹⁰⁹ See *ibid.* (p.15). In Germany, QSC engages yet in this business, providing the infrastructure for different (virtual) network operators on one single converged platform besides their own retail activities. See <http://www.qsc.de/>.
- ¹¹⁰ See *ibid.*
- ¹¹¹ See Political Intelligence (2003).
- ¹¹² See <http://www.geni.net/overview.php>.
- ¹¹³ See <http://www.geni.net>.
- ¹¹⁴ See <http://www.geni.net/overview.php>.
- ¹¹⁵ See *ibid.*
- ¹¹⁶ See *ibid.*
- ¹¹⁷ See *ibid.*
- ¹¹⁸ See *ibid.*
- ¹¹⁹ GÉANT2 is co-funded by the European Commission within its 6th R&D Framework Programme and the funding support is likely to be continued within the seventh framework programme.
- ¹²⁰ For a quick Géant 2 overview, see Géant 2 Fact Sheet included in the Géant 2 Press Kit [www.geant.net].
- ¹²¹ See <http://www.geni.net/faq.php>.
- ¹²² See <http://www.geni.net/overview.php>.
- ¹²³ See www.biocase.org and the description of Géant 2 Network Applications included in the Géant 2 Press Kit [www.geant.net].
- ¹²⁴ See description of Géant 2 Network Applications included in the Géant 2 Press Kit [www.geant.net].
- ¹²⁵ See www.alis-telemet.net.
- ¹²⁶ See <http://www.geni.net/research.php>
- ¹²⁷ See <http://www.geni.net/faq.php>.
- ¹²⁸ See *ibid.*

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- ¹²⁹ See Yoo (2002, p.284-285).
- ¹³⁰ See Haucap (2006).
- ¹³¹ See Baake, Kamecke and Wey (2005).
- ¹³² In this context, a study by Hausman (1997) is illuminating, as it demonstrates the welfare loss that can be caused by regulatory failure. As Hausman describes, the introduction of mobile telephony in the US were effectively delayed by about 10 years through protracted decisions by the FCC and slow licensing proceedings. According to Hausman, these delays have resulted in a welfare loss of between US\$19 and US\$50 billion (basis: 1994). See Hausman, Jerry (1997).
- ¹³³ See Haucap (2006, p.4).
- ¹³⁴ See Gans and King (2004).
- ¹³⁵ See Scotchmer (2005) and Reinganum (1989).
- ¹³⁶ The following refers to Baake, Kamecke, Wey (2005).
- ¹³⁷ The SMP test is used to establish whether one or more companies hold significant market power.
- ¹³⁸ The SSNIP test measures the change in demand caused by a “small but significant and non-temporary increase in price”. It is generally used to capture the price-elasticity of demand.
- ¹³⁹ This will also apply where relatively close substitutes have been developed for the new market. For example, alternative options for broadband access have no bearing on how many DSL customers would return to ISDN if the price dropped by 20%.
- ¹⁴⁰ E.g. the german federal network agency (Bundesnetzagentur) published the consultation document on february 22, 2006, the closing date of the response is april 19, 2006. Similar consultations are in progress in Hong Kong, Singapore, Australia and Sweden. The main purposes of the regulatory reviews in Hong Kong are to minimise the barriers to introduce new technologies and to improve the climate for investments.