Regulation of NGN: Structural Separation, Access Regulation, or No Regulation at All? (*)

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Abstract: Since the introduction of Next Generation Networks (NGNs) by telecommunication network operators, national regulators have begun to adapt their access regulation regimes to the new technological conditions. The regulatory reactions gravitate towards three distinct regulatory trajectories: unregulated competition, access regulation, and structural separation. We first analyze the extent of market power in access Networks in NGNs from a technological perspective. Second, we use case studies to identify patterns between technological and market conditions and regulators' reactions in selected countries. We find that market power in the access network is likely to prevail. Regulatory reactions differ with the extent of infrastructure competition and the regulators position in the trade-off between promoting investment and protecting competition

Key words: Next Generation Network, deregulation, access regulation, structural separation.

The move towards Next Generation Networks (NGNs) has begun to transform the telecommunication sector from vertically distinct, single-service markets into horizontal, converging multi-service markets. The core of an NGN is a software platform (the IP Multimedia Subsystem) that uses the standardized Internet Protocol (IP) to enable the provision of any service, e.g., data, voice, or video, via any physical network infrastructure, e.g., wireline (copper or fiber) or wireless facilities. The platform thus uncouples the classic relationship between infrastructure and services and facilitates technological convergence. From a techno-economical point of view (1) convergence increases the substitutability of

(*) The authors thank Andreas Brenck, Achim Czerny, Johannes Fuhr, Scott Marcus, Kay Mitusch, Stephan Steglich, and two anonymous referees for their comments. Any remaining errors are our own.

network infrastructures, and (2) the disintegration and IP-based horizontal layering of the network reduces economies of scope between infrastructure and service provisioning. Both effects support infrastructure competition in the access networks. Furthermore, (3) since NGNs provide customers access to a wider range of services over their selected access network, the bandwidth demand increases to levels equal to or greater than the demand in the specific legacy networks. Thus, many operators upgrade their access networks [1] when introducing NGNs.

National regulators face the question of how to adapt their current access regulation regimes to this changing competitive and dynamic environment in which many incumbents have announced or begun the migration to NGN as well as the rollout of optical high-speed access networks. We observe three emerging regulatory trajectories: (1) unregulated competition, (2) access regulation of integrated companies, and (3) structural separation. As these trajectories span a wide range of regulatory options, we first ask whether market power justifying regulation persists in NGNs. Second, we search for patterns in the technological, market, and institutional conditions affecting the path choice of national regulators.

Pending infrastructure investments in many countries have brought issues of regulation and investment to center stage in the literature on access network regulation. DE BIJL & PEITZ (2007) provide a variance analysis of regulatory regimes in the light of investment incentives. They argue in favor of light-handed regulation and note that wholesale access regulation may no longer be appropriate. TARDIFF (2007) assesses the impact of convergence on retail prices in the US broadband sector and argues that the intramodal competition renders retail price regulation unnecessary. BAAKE *et al.* (2007) provide an extensive analysis of regulation in dynamic markets, and reason that deregulation is only feasible if convergence leads to a high substitutability of networks. They further argue in favor of regulatory holidays for new networks to protect investment. Furthermore, GUTHRIE (2006) provides a literature review on regulation and investment. The academic literature is supplemented by regulatory inquiries on the national level, e.g., Ofcom (2007) and OPTA (2006c) and supra-national level, e.g. ERG (2007a) that provide insight into the market analysis process and regulatory decision-making.

[1] The term "Next Generation Access Network" refers to broadband access networks. We include all access network technologies in our analysis and therefore refer to "access networks in NGNs".

In this paper, we first provide a technology-centered analysis of the impacts of NGNs on market definition and on market power in access networks. We argue that despite convergence, high-speed network operators may, under certain conditions, retain market power, although less power than legacy networks. Second, we use country case studies exemplifying the three aforementioned regulatory trajectories to identify patterns in technological, market, and institutional conditions that can help explain national regulators' choices. We find two regulatory patterns: one that focuses on promoting specific investments, e.g., in the Republic of Korea and the USA, and one that focuses on protecting competition, e.g., in the Netherlands and the UK.

■ Market power in access networks in NGNs

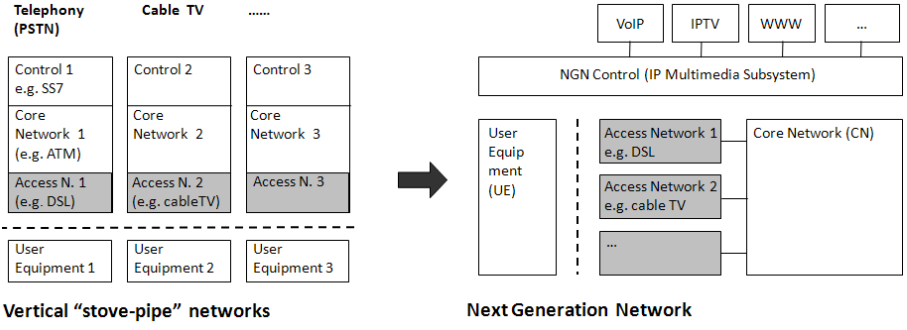
In the past, residential wireline telephony access networks were a textbook example of monopolistic bottlenecks. With the advent of NGNs, economists began to challenge this view, as convergence sparked the hope for infrastructure competition in the local loop (WEY *et al.*, 2006). However, this issue has been debated intensely in the context of fiber network rollouts, e.g., in Germany and the Netherlands (WAR, 2005; OPTA, 2006a).

We analyze the extent of market power in access networks in NGNs from a technical perspective. We examine the impact of convergence on the market definition of infrastructure services and discuss the potential for infrastructure competition. We assert that infrastructure services are changing from integrated services such as telephony to "unbundled" transport services that complement applications such as voice, TV, or Internet. Based on this definition, we propose two market scenarios for these infrastructure services, the first with a single, vertically differentiated market comprising all access technologies, and the second with two markets for "normal-speed" and "high-speed" networks. We argue that multiple networks of the same type remain largely inefficient, except where existing infrastructure can be upgraded. This renders multiple high-speed optical networks unlikely. However, infrastructure competition among normal-speed networks seems possible and may also limit the market power of high-speed networks.

Technological background of NGNs

The NGN concept stems from the world of network operators. NGNs integrate classical telecommunication networks and the Internet, which has become a communication service platform competing head-to-head with long-established communication networks. One ingredient in the Internet's success is its flexibility, which comes from the separation of transport and service. This separation enables network convergence, i.e., the integration of networks, sub-networks, devices, and services into a "network of networks" using a common set of rules and a single language – the Internet Protocol (IP). In contrast to the Internet, classic communication networks are tightly controlled by network operators, vertically integrated, and designed for specific applications such as telephony. The NGN, as defined in ITU-T (2007), is an abstract concept for networks that incorporate the Internet's horizontal layering principles and technologies with the centralized control of conventional telecommunication networks and are provided as software by the IP Multimedia Subsystem (IMS). A detailed technological discussion is presented by ELIXMANN & SCHIMMEL (2003) and POIKSELKA *et al*. (2005). The horizontal structure makes services agnostic to the access network technology, while the service delivery and platform control (SDPC), i.e., the IMS, integrates the different access and backbone infrastructures as shown in Figure 1. Therefore, any IP service that is made available on an NGN service platform, e.g., IPTV, VoIP, e-mail, WWW, etc., can be delivered over any IP-enabled access network, e.g., DSL, cable TV, WLAN, UMTS, etc., that is connected to the NGN. The basic idea shown in Figure 1 also holds for the more likely case that multiple NGNs will emerge. However, as NGNs build on the simple and standardized IP, any service can be provided effortlessly on any competing NGN.

Figure 1 - Architectural change through the migration to NGN



Thus, the effects of the migration to NGNs are twofold. First, the demand-side and supply-side substitutability of different access infrastructures increases through convergence. Second, the standardized IP introduces a predetermined breaking point between infrastructure services and application services that greatly reduces economies of scope compared to the integrated and partly proprietary legacy networks. Third, a customer needs only a single converged access network to access any service. If a customer meets his demand on a single network, e.g., with a triple-play product, the bandwidth demand for that network will increase. As the access network marks the bandwidth bottleneck, the migration to NGN may require infrastructure upgrades to provide sufficient service quality. This is one reason for the large infrastructure investments in fiber networks that accompany the introduction of NGNs.

Effects of NGNs on market definition

Access networks in NGN no longer provide integrated transmission and service but unbundled physical transmission capacity and management for packet-based transmission: thus, IP connectivity serves as a complement for IP services. Service bundles such as triple-play - i.e. IP connectivity, telephony, and television - increase value for the customer, but on the supply side, the individual services can be unbundled or offered by third parties since the standardized IP reduces economies of scope between services and infrastructure. However, the access technologies differ in their capability to provide high-quality IP connectivity, i.e. bandwidth. Optical fiber networks currently provide the highest bandwidth, followed by cable TV, DSL, and wireless networks.

The market for IP connectivity can be delimited by the three dimensions; demand substitution, supply substitution, and potential competition (BAKER, 2007). From the demand perspective, IP connectivity presents an upstream product that enables the consumption of downstream application services. These downstream services can be divided by bandwidth requirements into normal-speed services including web browsing, e-mail, music downloads, etc. (up to about 3 to 5 MBit/s) and high-speed services including IPTV, video conferencing, etc. (over 10 MBit/s). While most network operators provide services that are sufficient for normal-speed transmission (high-speed services are accessible with a delay or reduction in quality), so far, only optical and hybrid network operators provide suitable offers for both, normal and high-speed services. Thus, demand substitutability of access

technologies is expected to be high for users of normal-speed services and low for users of high-speed services. From the supply perspective, the substitutability is de facto limited by the capabilities of the network technologies. Currently, only optical and hybrid networks have the capabilities to provide sufficient bandwidth for high-speed services, while all networks are suitable for normal-speed services. Thus, supply substitutability is low for the high-speed segment, because normal-speed network operators have difficulties upgrading their current networks to provide higher speeds.

However, technological advances can be observed in a number of networks that may enhance bandwidth and thus increase supply-side substitutability, while advances in data encoding, for example, reduce the bandwidth demand of some applications and increase demand-side substitutability. We will consider both the single-market and the two-market scenario in the following discussion.

Market failure in access networks in NGNs

In the classic communication networks, the indivisibility of access networks results in deviation from the competitive model, and thus, in market failure. In NGNs, infrastructure-based entry into the local loop can occur in two ways: by constructing new networks or upgrading existing networks. NGNs do not affect the deployment cost of new wireline infrastructures. First, these infrastructures remain subject to significant economies of scale as their deployment requires large, sunk investments e.g. for equipment and civil engineering. For an exemplary cost model of the German fiber to the cabinet (VDSL) network, see ILLIC & KULENKAMPFF (2007). Second, property-owners will likely not allow operators to duplicate the last network section on the premise / indoors (ARCEP, 2006). The plans by three French operators to rollout parallel fiber infrastructures to the homes is an example for this issue (ERG, 2007b). Therefore, the construction of parallel infrastructures that are similar in costs and capabilities remains unlikely in NGNs, with the exception of low-cost wireless networks. One may even go as far as to say that infrastructure competition between DSL and cable TV is a historic coincidence. However, providers can enter the market successfully by deploying a superior network with lower costs and/or higher quality alongside an existing infrastructure. Furthermore, existing networks from other domains, such as cable TV or powerline infrastructures, can be upgraded to provide bidirectional IP transmission. With the infrastructure

already in place, these upgrades affect only management hardware such as routers and therefore cost less than creating new infrastructure. A third possible exception are preinstalled fiber networks in large apartment complexes, e.g., in the Republic of Korea (REYNOLDS *et al*., 2005).

We argued that constructing new parallel infrastructures is unlikely. Except in regions under development, one or more access technologies are usually already available, e.g., DSL, cable TV, or mobile networks. In the following, we discuss the development of market power in multiple static networks for the two aforementioned market scenarios.

In a single market, potential infrastructure competition exists where multiple networks are available at the same location. Depending on the available transmission capacities, consumers can identify quality differences between infrastructures such as time needed to load websites or download movies. Thus, besides the price differences, the infrastructures are vertically differentiated by bandwidth, i.e. quality. However, under this vertical product differentiation, customers will tend towards higher-quality products when the price difference between high-quality and low-quality products is sufficiently low (SHAKED & SUTTON, 1982). This enables the operator of the highest-quality network to strategically use aggressive or even predatory pricing to gain a dominant market position. Low marginal costs allow the necessary pricing flexibility. The operator remains in this quasi-monopoly position until a competitor can deploy a superior network technology, which remains very difficult. However, as long as competitive infrastructures stay in the market, vertical product differentiation limits the ability of the quasi-monopolist to capture monopoly rents, depending on the quality gap between the infrastructures.

In the two-market scenario, existing infrastructures compete only in their respective quality domain. The normal-speed market can be served by most access technologies including wireless infrastructures. An increase in bandwidth does not add value for these services, e.g., audio streaming or text-only website accessibility. Therefore, infrastructure competition between a limited number of networks may be sustainable in this market depending on the population density. If multiple infrastructures, e.g., cable TV, operate in the high-speed market, the vertical product differentiation argumentation from the first case applies. An example of this two-market reasoning can be found in the Netherlands, where the regulator distinguishes between unregulated low-quality wholesale bitstream access and regulated high-speed bitstream access (OPTA, 2006c).

Thus we conclude that high-speed access network providers are likely retain market power, however limited by convergence. At the current state of technology, it appears that only the normal-speed market allows sustainable infrastructure competition, while a single or high-speed market leaves high-quality network operators some leeway to act strategically and acquire a dominant market position through aggressive pricing or similar strategies. In this technical discussion, we have considered the factor of population density only implicitly and assumed it to be ideal, i.e., high. Decreasing population density, which would be considered in a geographic market analysis, amplifies the results of our arguments.

■ Regulatory options for access networks in NGN

The sector-specific policy options to address market power in access networks apply to other network industries as well: access and price (de)regulation and structural measures such as different degrees of operational separation (CAVE, 2006). These options affect downstream competition but also the level of innovation or investment in the regulated market. Regulation aims to increase allocative market efficiency and addresses the distribution of rents, while structural measures target the problem of price and non-price discrimination between an integrated monopolist and its competitors. However, strict regulation (or fierce competition) but also a permanent monopoly, reduce investment incentives. Along with the introduction of NGNs, operators plan or undertake large asset-specific investments in high-speed infrastructure, which we argued to exhibit market power. Thus, regulatory policy has to balance static efficiency on the basis of existing competition and overall industry investment as new networks are built in the transition phase to full NGNs. Theoretical discussion of this relationship is provided by GURTHRIE (2006) and BAAKE *et al*.(2007). In the following, we discuss the impacts of access (de)regulation and structural measures on access networks in NGNs.

The two main options for access regulation are either (1) temporary or permanent deregulation, i.e., the removal of sector-specific rules and regulations, or (2) mandated access, i.e., the obligation to grant access to bottleneck facilities at regulated price and quality. Deregulation increases investment incentives as it overcomes the "truncating problem" and allows above-normal profits (GANS & KING, 2003). However, under limited competition or threat of entry into the upstream market - that is, in the

absence of alternative infrastructures or in areas of low population density - an integrated incumbent may leverage its market power to competitive downstream segments. We conclude that deregulation in NGNs may be applicable in competitive normal-speed markets. On high-speed markets, deregulation spurs investment but operators' market power is likely to increase market concentration in the long run. Access holidays could address this issue. However, deviations from the optimal length will negatively impact either investment incentives or competition. Mandated access to the bitstream or the unbundled line reduces uncertainty and protects competition in the downstream market while the effects on investment depend on the allowed margin. Furthermore, regulated access to cable ducts can help competitors to deploy, restructure, or upgrade their access infrastructure. In NGNs, physical unbundling becomes increasingly difficult with the rollout of fiber-to-the-home (FTTH) deployments as current points of interconnection such as the main distribution frames (MDF) or the street cabinets become obsolete and are phased out. In the case of FTTH, investments by competitors to interconnect physical access points in the local loop could ultimately be stranded. However, independent of the regulatory option chosen, access regulation should be applied symmetrically to all access networks in the market in order to to create a level playing field (CRANDALL *et al*., 2002).

Structural separation, i.e., the virtual or physical division of monopolistic and competitive segments of a vertically integrated monopolist, reduces incentives for price and non-price discrimination and eases regulatory control. Thus, separation supplements access regulation though the disintegration of the monopolist and the introduction of a "bright line of equivalence" that ensures equal treatment of access seekers. CAVE (2006) defines six degrees of separation, from accounting to legal separation. We argued that NGNs technologically reduce economies of scope between infrastructure and services. Thus, structural separation becomes less costly as technical synergy losses from the separation of access networks are mitigated.

We conclude from this brief analysis that the two "extreme" options, deregulation and separation, bear a high risk and have a limited scope of application: the former is particularly suited to cases of competition between multiple, equally capable networks, and the latter to cases of low infrastructure competition and a high risk of non-price discrimination. Access regulation is a flexible instrument that can be attuned to a wide range of cases as it protects downstream competition but also includes mechanisms to facilitate investment.

■ Case studies on the regulation of access networks in NGN

Incumbents in most OECD countries have announced plans for the migration to NGNs, and pioneering incumbent network operators have begun to move their networks towards NGNs. First regulatory reactions provide early evidence of access network regulation regimes in NGNs.

Table 1 – Summary of case studies

	Technological Development	*Market Structure*	*Regulatory Reaction*	*Evaluation*
UK	Migration of Core Network to NGN (21CN) until 2011	BT is dominant firm in broadband market Medium infrastructure competition (cable provider, virgin media reaches 45% of the households)	Functional separation of access networks and some backhaul networks from BT (openreach) Threat of ownership unbundling	Strong regulation to protect service competitors against discriminatory behavior Little investment in optical infrastructures
NL	Migration of the complete network to All-IP and countrywide deployment of fiber until 2010	KPN is dominant telephony provider Strong infrastructure competition between KPN and the cable providers, which reach 94% of households)	Access regulation demanding a "fully fledged alternative" to the current LLU	Access regulation despite strong infrastructure competition protects service competitors Sub-loop unbundling will phase out with FTTH deployment
Kr	Migration to broadband converged network and rollout of 50-100Mbps access networks nationwide	KT is dominant broadband provider (52%) High infrastructure competition through DSL and cable networks	Proactive state intervention drives sector development Symmetric access regulation	Regulator selects and promotes technologies (picking winners) High broadband penetration rate and advanced networks
US	Advanced state of migration to ALL-IP networks and deployment of FTTx	Three integrated telephony providers with geographically separated access networks High infrastructure competition through cable	Information services (including broadband) are deregulated	Regulatory focus on promotion of investment Regulation lacks a transparent framework

Many national regulators are at an early stage of the regulatory process but a survey on a number of OECD countries shows that the regulatory discussion centers on three regulatory models for high-speed networks: (1) access holidays or deregulation, e.g., in the USA and Germany, (2) access regulation, e.g., in the Netherlands, the Republic of Korea, Japan, and

Belgium, and (3) structural separation, e.g., in the UK, Australia, and possibly Italy (European Commission, 2007; ERG, 2007b; OECD, 2005). The DSL networks in all these countries except the USA, are subject to access regulation. We chose four case studies that exemplify the different regulatory regimes, i.e., UK for structural separation, the Netherlands and the Republic of Korea for access regulation, and the USA for deregulation. For these countries, we analyze the structure of access network regulation and the technological and competitive arguments for this system. Finally, we evaluate the regulatory reactions against our theoretical considerations. The results, summarized in Table 1, show that regulators in the UK and the Netherlands take a sceptical view of competitive development under NGNs, in contrast to the USA, where the FCC has granted access holidays for FTTH deployment. The Republic of Korea also promotes investment through state funding in a regulated environment. However, our analysis only provides early evidence since experience with the respective regimes is still limited.

Structural separation - The Case of the UK

British Telecom (BT) is one of the European pioneers of the Next Generation Network area. With the migration of its network to NGN (21 Century Network), BT expects savings in operating expenses of £1bn (about 1.5bn €) starting 2008/09. The expected investment amounts to £ 10bn (about 15bn €). BT focuses on the migration of its core network without the deployment of FTTx (NERA, 2007). The core network migration affects only the interconnection points at the edge of the access network as the network hierarchy becomes flatter (Ofcom, 2004, p. 88). Since the geographic structure of BT's network remains unchanged, the overall effects on competitors' networks are limited. The UK telecommunication market is characterized by strong service competition but limited infrastructure competition in the wholesale broadband market. DSL is the dominant access technology with a share of 70% while cable TV has a market share of 30%, and the cable network operator Virgin Media reaches about 45% of British households (Ofcom, 2006).

Regulation of BT's 21st Century network

Ofcom bases its regulation on principles aimed at providing clarity and transparency for the future regulatory regime (Ofcom, 2005b). These principles include promoting competition at the deepest level of infrastructure

that is both economically feasible and sustainable, delivering equality of access beyond this level, and facilitating market entry to remove bottlenecks. Regulation is to be withdrawn where the competitive conditions allow (Ofcom, 2005a, p. 18). In the absence of strong infrastructure competition, Ofcom discussed the options of continuing access regulation or taking structural measures to secure a level playing field through equal access (Ofcom, 2005a, p. 29).

Besides information asymmetries hampering regulatory price control, Ofcom cites non-price discrimination, i.e., the provision of lower-quality inputs to BT's competitors on the retail market, as a major problem (Ofcom, 2005c, Annex F, p. 70). Ofcom concludes that even with regulatory safeguards in place, access regulation has not succeeded in solving the problems of bottlenecks and discriminatory behavior over the last 20 years. CAVE *et al*. (2006) support this view as they find factors increasing the incentives to discriminate in the case of BT's fixed telephone services. These factors are tight upstream regulation of the access network, imperfect competition on the downstream retail market, high substitutability on the downstream market, and downstream economies of scale.

Ofcom decided to introduce a "bright line" along which the equivalence of input can be controlled. In June 2005, BT proposed an alternative approach to the Enterprise Act 2002 in which the company agreed on an organizational separation between its upstream non-access division including retail, wholesale, and global services, and its downstream access network and backhaul division. The separation of the access network division is institutionalized by a physical separation of resources, e.g., separate company premises, separate management, a brand name ("openreach"), and a "Code of Practice" that regulates the interaction between BT and openreach employees (Ofcom, 2005a, p. 90). An "Equality of Access Board" (EAB) was established to monitor compliance with these non-discrimination regulations, as openreach remains part of the BT Group. In the case of BT's failure to comply with the non-discrimination regulations, Ofcom can request market investigation by the Competition Commission under Section 131 of the Act (Ofcom, 2005c, p. 3).

Evaluation

CAVE (2006) notes that structural measures are a viable regulatory solution when the costs of discrimination exceed the costs of implementing these measures, especially in markets with low infrastructure competition.

The functional separation of BT's access division "openreach" creates transparency and decreases openreach's incentives to discriminate against competitors on the downstream retail market. BT's compliance with non-discrimination rules is enforced by the threat of ownership unbundling by the Competition Commission under the Enterprise Act 2002. Recent market analyses show that the number of unbundled local loops has increased since 2005, supported by reduced access prices. Critics argue that BT is implementing these measures too slowly and that the numerous exemptions granted by Ofcom are diminishing the potential positive effects. Furthermore, Ofcom sees the need to promote investments in high-speed access networks and has launched consultations to clarify the necessary regulatory environment (Ofcom, 2007).

Access regulation – The case of the Netherlands

In 2005, the Dutch incumbent Koniklijke PTT Nederland (KPN) announced the migration of its network to an All-IP network and a countrywide deployment of geographically optimized FTTx access networks and phase-out of MDF and PSTN/ISDN services until 2010. KPN expects a reduction in operating costs of €850 million up to 2009 while the total capital expenses for the migration are estimated to be €0.9 billion. The extension of fiber to the street cabinets renders the MDFs obsolete. About 200 of the 1,391 MDF locations will remain in operation as interconnection points to the backbone (HENDRIKS, 2007, OPTA, 2006b). KPN expects an additional revenue of €1 billion from sales of the MDF real estate. The Dutch broadband market is characterized by two full-scale network platforms, DSL and cable TV, which each reach over 94% of Dutch households and split the market (60% DSL and 39% cable broadband connections). KPN is dominant in the DSL retail market with a share of 80%, while the remaining 20% are provided by the largest alternative operators BBned, Tele2/Versatel and Orange/Wandoo.

Regulation of KPN's All-IP Network

Despite the high level of infrastructure competition between DSL and cable TV, the Dutch national regulatory authority for telecom and postal services (OPTA) reasons that even in the absence of tactial collusion, two infrastructure platforms form an oligopoly that is likely to lead to cournot prices (OPTA, 2006a). However, structural separation of the access network following the British example is less promising because of the high level of

infrastructure competition between DSL and cable, and because OPTA as well as the Dutch competition commission lack the legal power to threaten ownership unbundling in the case of discriminatory behavior (NERA, 2007).

Consequently, OPTA decided to maintain access regulation. However, the extension of fiber to the street cabinets renders the current interconnection points obsolete. Therefore, OPTA demanded that KPN provide a fully-fledged alternative to the unbundled access at the MDF. KPN proposed Sub-Loop Unbundling (SLU), i.e., access at the street cabinet, and Wholesale Broadband Access (WBA), i.e., virtual bitstream access, as options to connect to the new access network. These options were regarded as imperfect substitutes for MDF access. SLU requires competitors to expand their network to the street cabinets, which is only feasible in densely populated areas. Further, such investments bear the risk of being stranded if KPN extends the optical network to the homes, entailing the phase-out of street cabinets. In the case of WBA, interconnection usually takes place at a core network switch. Thus, WBA is a step downward on the ladder of investment as it increases competitors' dependency on KPN's infrastructure, e.g., backhaul to the point of interconnection is part of the offer. KPN entered negotiations with its MDF customers and reached an agreement on conditions for MDF phase-out, whereas KPN will phase out only those MDFs by 2009 for which there is no competitive access seeker. Further, KPN continues to offer access to the approximately 180 MDF locations used as metro nodes based on a reference offer, and lines that interconnect at locations to be dismantled are being migrated to either SLU or WBA (KPN, 2007).

Evaluation

In the Dutch case, the speed of the incumbent's network migration is particularly striking. KPN plans to migrate its entire network to ALL-IP and deploy fiber in its access network in only four years, primarily financed through real estate sales of MDF locations. Despite the competition between two infrastructures, OPTA sees a need for access regulation to KPNs network. The definition of an access regulation regime ensures competitive access to KPN's bottleneck facilities at regulated rates. However, the long-term option of SLU is not convincing, as street cabinets are likely to be phased out with the introduction of fiber to the FTTH networks.

Access regulation and a proactive public policy
The case of the Republic of Korea

In 2004, the Korean government launched "IT839", the nation's third consecutive national information infrastructure program with the goal of developing a "ubiquitous" network society. One cornerstone of the US$70 billion IT839 project is the development of a fully converged NGN, the so-called "Broadband converged Network" (BcN) (REYNOLDS *et al*., 2005; LEE *et al*., 2007). The incumbent KT plans - in line with IT839 - to connect 20 million subscribers to 50-100Mbps broadband over a seamlessly integrated wireless (WLAN, Wireless Broadband) and fixed-line FTTH services by 2010. Korea was the world's leading country in broadband development up to 2005, and still enjoys the fourth highest broadband penetration rate within the OECD (OECD, 2007). Its telecommunication sector is characterized by strong infrastructure competition in the wireline as well as the advanced wireless sector. KT is the leading broadband provider with a market share of 52%, followed by Hanaro Telecom, which operates both a DSL and a cable TV network, with 30% (NCA, 2006).

Broadband converged Network Regulation and Government Support

The Korean telecommunications sector is administered by the Ministry of Information and Communication (MIC). The telecommunications policy is based on government-sector development programs intended to promote Korea's economic growth as well as symmetrical access regulation. The political strategy behind the development programs relies on "picking" winners by financially supporting specific infrastructures but also creating additional demand for these infrastructures (REYNOLDS *et al*., 2005). Korea has a history of four consecutive national information infrastructure projects, the National Basic Information System (1987-1991), the Korean Information Infrastructure (1993-2000), IT839 (2004-2006), and u-IT839 (starting 2006). All these projects were carried out in close partnership between the public and the private sector including the incumbent as well as competitors. The Korean Information Infrastructure-Government project (KII-G) is an example of the government's course of action. The initial funding of US$1 billion was provided by the government who also became the main tenant on the network to create additional demand. Furthermore, about 10 million Koreans were trained in the use of IT. Thus, the government acted as a major driver for the development of the country's communication network on both the supply and the demand side.

Besides the national development projects, the regulation of access networks facilitates competition on the service market. The Telecommunications Business Act distinguishes among facility-based, specific, and value-added telecommunications providers, whereas the former group is comprised of any network (DSL, cable TV, etc.) that offers telecommunication services. These facility-based network operators are subject to symmetric open access requirements for bottleneck facilities. Furthermore, wireline infrastructure competition is supported by the communication infrastructure of large apartment complexes, which enable operators to connect at central main distribution frames. Hanaro Telecom, for example, has succeeded in building a parallel fiber network that connects apartment blocks with more than 200 potential customers (REYNOLDS *et al.*, 2005).

Evaluation

The Korean government has adopted a very pro-active approach to IT-policy and regulation that one could almost characterize as "strategic planning." The government selects suitable technologies and shapes the institutions and markets to promote their development. In contrast to the Netherlands, the Korean state is the main driver of NGN deployment. Today, Korea has one of the world's most technologically advanced networks, a very high level of broadband penetration, and infrastructure competition in many access markets. However, the interventionist approach is sometimes criticized because the government generally lacks sufficient information and incentives to decide on suitable technologies.

Deregulation – The case of the USA

In the USA, the migration to IP networks is considered a continuous network evolution rather than a radical innovation (as with NGNs in Europe), and began well ahead of European migration; in fact, the USA leapfrogged the ISDN network evolution altogether. Although the new US networks comprise NGN components such as the IP Multimedia Subsystem (IMS) as a service delivery platform, the term Next Generation Network is not used in the USA. AT&T and Verizon have largely switched their networks to All-IP and have begun to roll out fiber access networks, whereas AT&T deploys fiber-to-the-curb or premise (currently reaching about 5.5 million homes) while Verizon deploys fiber-to-the-home (currently reaching about 6.5 million homes).In the US broadband market, cable TV was the forerunner and

dominant infrastructure while DSL followed. Cable TV network operators have a footprint of over 80% of the US households and a share of 44% in the broadband market (FCC, 2007). The telephony access market is shared by three large companies, AT&T, Verizon, and Qwest, whereas competitive local exchange carriers provide about 17% of access networks. As the telephony companies traditionally operate in geographically distinct markets, most areas are governed by access network duopolies.

Regulation of "Information Services"

The US employs a vertical regulatory model that classifies infrastructure along the classical "stove-pipes". This categorization by media types leads to the dichotomie between telecommunication services, i.e. common carrier services, and information services, i.e. provision and management of information via telecommunications. While the former are subject to regulation, the latter, which include broadband access, are substantially unregulated (FRIEDEN, 2003). However, this vertical regulatory model becomes increasingly difficult to uphold in converging networks, as e.g. DSL integrates telecommunications and information services. Based on this argument, DSL was declared an information service in 2005 and set on equal footage with cable TV and promotes technology neutral regulation (FCC, 2005). A main argument for this ruling, as well as for the granting of regulatory holidays for fiber to the home and to the premise was the FCCs goal to promote infrastructure investment (FCC, 2003, 2004).

Evaluation

The results of this approach are mixed. Companies such as AT&T and Verizon have begun to deploy fiber to the local loop, either to the curb or to the home. The broadband availability and penetration is high, compared to the G7 states and the entry price level for DSL is low. However, fiber investment rates are moderate and it is possible, that the US is on the way to a less competitive environment than Europe and that so far, the industry structure may have mitigated negative effects (MARCUS, 2005). Further, Marcus notes that the vertical regulation lacks technological neutrality and a rigorous framework for economic analysis.

■ Conclusion

This paper has discussed the need and options for the regulation of access networks in NGN and provided early case study evidence on the regulation of the evolving networks. We argue from a technical perspective that multiple parallel infrastructures of the same technology are unlikely because of scale economies, and that high-speed networks may exhibit a competitive advantage over lower-speed networks because of vertical product differentiation. Further, we suggest two market scenarios for access networks that may result from convergence: either a single market containing all access networks, or two markets, one for "normal" bandwidth and one for "high" bandwidth, whereas we conclude that market failure is likely to prevail in all markets that include high bandwidth networks. We observed a wide range of regulatory trajectories in different countries, gravitating towards three models: unregulated competition, access regulation, and structural separation. The relation between technical market conditions, e.g., the degree of infrastructure competition, is shown by the case studies on the "dense" IT countries, the Netherlands and Korea. Furthermore, we showed that regulators take different stances on promoting incumbents' access network investments and on protecting competition, as seen in the different regimes in the Netherlands and the USA. We conclude that NGN access networks still need regulatory oversight with instruments against price and non-price discrimination. These instruments need to be handled deliberately to support efficient investment. *Ex ante* access regulation may be attuned to a wide range of cases. Structural separation can supplement access regulation where the potential for infrastructure competition is low. Deregulation may be appropriate under high infrastructure competition among multiple, equally capable infrastructures. While our approach provides early and specific case study evidence, further empirical research is needed extending the sample to provide a more comprehensive picture of regulatory reactions, e.g. their relation to structural variables such as population density and urbanization and to understand the success of the different regulatory regimes in the evolving NGN world.

Bibliography

ARCEP (2006): *Very high-speed - Points of Reference and Outlook.* http://www.art-telecom.fr/fileadmin/reprise/dossiers/fibre/slides-fttx-prog-101106ang.pdf, retrieved: 10.12.2007.

BAAKE P., HAUCAP J., KÜHLING J., LOETZ S. & WEY C. (2007): *Effiziente Regulierung in dynamischen Märkten,* Baden-Baden.

BAKER J.B. (2007): "Market Definition: An Analytical Overview", *Antitrust Law Journal*, Vol. 74 / 1.

CAVE M. (2006): "Six Degrees of Separation: Operational Separation as a Remedy in European Telecommunications Regulation", *COMMUNICATIONS & STRATEGIES*, Vol. 64, pp. 89-103.

CAVE M., CORREA L. & CROCIONI P. (2006): "Regulating for Non-Price Discrimination - The case of UK Fixed Telecoms", Centre for Management under Regulation, Working Paper.

CRANDALL R.W., SIDAK G.J. & SINGER H.J. (2002): "The Empirical Case against Asymmetric Regulation of Broadband Internet Access", *Berkeley Technology Law Journal*, Vol. 17, pp. 953-987.

DE BIJL P.W. & PEITZ M. (2007): "Innovation, Convergence and the Role of Regulation in the Netherlands and Beyond", TILEC Discussion Paper no. 2007-016.

ERG (European Regulators Group):

- (2007a): *ERG Opinion on Regulatory Principles of NGA*.
- (2007b): *Supplementary Document to the ERG Opinion on Regulatory Principles of NGA.*

European Commission (2007): Annex 1 to the *European Electronic Communications Regulation and Markets 2006* (12th Report).

FCC:

- (2003): *Triennial Review Order*, Wireline Competition Bureau.
- (2004): *Order on Reconsideration*, Wireline Competition Bureau.
- (2005): *Notice of Proposed Rule Making in the Matter of Appropriate Framework for Broadband Access to the Internet over Wireline Facilities*, Wireline Competition Bureau.
- (2007): *Trends in Telephony Service. Industry Analysis and Technology Division*, Wireline Competition Bureau.

FRIEDEN R. (2003): "Adjusting the Horizontal and Vertical in Telecommunications Regulation", *Federal Communications Law Journal*, Vol. 55 / 2.

GANS J. & KING S. (2003): "Access Holidays for Network Infrastructure Investment", *Agenda*, Vol. 10 / 2, pp. 163-178.

GUTHRIE G. (2006): "Regulating Infrastructure: The Impact on Risk and Investment", *Journal of Economic Literature*, Vol. XLIV, pp. 925-972.

HENDRIKS P. (2007): "The Road to All-IP. VDSL – The way to Next Generation Networks", WIK International Conference, Königswinter, 21.03.2007.

ILIC D. & KULENKAMPFF G. (2007): "VDSL Roll out in Germany: An Assessment of its Economic Feasibility", 18th European Regional ITS Conference, Istanbul.

KPN (2007): *KPN Wholesale*. www.kpn-wholesale.com, retrieved: 05.12.2007.

LEE K.O., KIM S.K., CHUNG T.S. & KIM Y.S. (2007): "Reference Model of Broadband Convergence Network in Korea", Asia-Pacific Conference on Communications 2007, Bangkok.

MARCUS J.S. (2005): "Is the U.S. Dancing to a Different Drummer?", MPRA no. 2514.

NCA (National Computerization Agency Rzepublic of Korea) (2006): *Informatization White paper 2006*.

NERA (2007): *Ofcom's Strategic Review of Telecommunications and BT's Undertakings*, NERA Economic Consulting.

OECD:

- (2005): *Next Generation Network Development in OECD Countries*, O.F.E.C.-O.A.D.
- (2007): *OECD Broadband statistics: 1h. Broadband penetration, historic, top five OECD countries for June 2007*, retrieved: 08.02.2007.

Ofcom:

- (2004): *Strategic Review of Telecommunications - Phase 2*, consultation document.
- (2005a): *Final statements on the Strategic Review of Telecommunications, and undertakings in lieu of a reference under the Enterprise Act 2002*.
- (2005b): *Next Generation Networks - Future arrangements for access and interconnection*.
- (2005c): Notice under Section 155(1) of the *Enterprise Act 2002*.
- (2006): *The Communication Market 2006*.
- (2007): *Future broadband - Policy approach to next generation access*.

OPTA:

- (2006a): "Is Two Enough?", *Economic Policy Note*, Vol. 6.
- (2006b): "KPN's Next Generation Network: All-IP", Issue Paper.
- (2006c): "KPN's Next Generation Network: All-IP", Position Paper.

POIKSELKA, M., MAYER, G. & KHARTABIL, H. (2005) The IMS. Hoboken, NJ.

REYNOLDS T., KELLY T. & JIN-KYU J. (2005): "Ubiquitous Network Societies: The Case of the Republic of Korea", International Telecommunication Union (ITU).

SHAKED A. & SUTTON J. (1982): "Relaxing Price Competition Through Product Differentiation", *Review of Economic Studies*, Vol. XLIX, pp. 3-13.

TARDIFF T. (2007): "Changes in industry structure and technological convergence: implications for competition policy and regulation in telecommunications", *International Economics and Economic Policy*, Vol. 4 / 2, pp. 109-133.

WAR (Wissenschaftlicher Arbeitskreis für Regulierungsfragen) (2005): *Stellungnahme zum Projekt Glasfaserausbau des Zugangsnetzes der Deutsche Telekom AG.*

WEY C., BAAKE P. & HEITZLER S. (2006): "What rules for IP-enabled NGNs?", ITU Workshop on Next Generation Networks, Geneva, 23-24.03.2006