Final Report of the Project Group

"Framework Conditions for the Interconnection of IP-Based Networks"

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Table of Contents

Note: The annexes referred to in this translation are only available in the German version of this report.

List of Figures and Tables

List of Abbreviations

AMGW	Access Media Gateway
APE	abgesetzte periphere Einrichtung (remote peripheral equipment)
ATM	Asynchronous Transfer Mode
ATM-Kon	ATM Konzentrator (ATM concentrator)
B&K	bill & keep
BAN	Broadband access network
BBNu	Breitbandnutzer (broadband user)
BRAS	Broadband remote access server
BRAS-ATM TS	BRAS-ATM Traffic Selector
BVSt	Bereichs-Vermittlungsstelle (local exchange)
CBC	Capacity Based Charging
CPNP	Calling Party's Network Pays
CPP	calling party pays
DSLAM	DSL Access Multiplexer
DWDM	dense wavelength division multiplexing (fiber optics)
EBC	element based cost
ETSI	European Telecommunications Standards Institute
EWSD	Elektronisches Wählsystem Digital (digital electronic switching system)
FMI	fixed mobile integration
IETF	Internet engineering task force
IP	Internet protocol
ISP	Internet service provider
ITP	Internet Transport Provider
ITU	International Telecommunication Union
KEL	Kosten der effizienten Leistungsbereitstellung (costs of efficient service provision)
LER	Label edge router
LRAIC	Long-Run Average Incremental Costs
LRIC	Long-Run Incremental Costs
LSR	Label switch Router

MGWC	Media gateway controller
NGN	Next generation network
NGI	Next generation Internet
P2P	Peer to peer
PSTN	Public switched telephone network
QoS	quality of service
RPR	resilient packet ring
SBNu	Schmalbandnutzer (narrowband user)
SMP	Significant Market Power
TDM	Time Division Multiplex
TKG	Telekommunikationsgesetz (Telecommunication Act)
TMGW	Trunk media gateway
VoIP	Voice over IP
VoNGN	Voice over NGN
WVSt	Weitverkehrs-Vermittlungsstelle (trunk exchange)

1 Introduction

This report presents the results of the project group "Framework Conditions for the Interconnection of IP-Based Networks". This project group was established in August 2005 by the Federal Network Agency for Electricity, Gas, Telecommunications, Post and Railway (Federal Network Agency).

Future networks will be based upon the principle of packet switching and mainly on Internet protocol (IP) and allow a variety of different services to be offered on *one* network. The migration to "Next Generation Networks" has already been started. Deutsche Telekom AG announced its decision in August 2006 to migrate its networks even earlier than originally intended to a *standard* IP platform. This will also be of major relevance for alternative network carriers in Germany.

At present, different interconnection regimes are used for traditional telephone networks on the one hand and for "the Internet" on the other. Due to the increasing importance of Voice over IP (VoIP), new problems have arisen that must be solved. This was the main aim of the work. However, the question concerning a suitable and sustainable interconnection regime is unavoidable in view of the migration process of network structures. This, however, requires a wide-ranging analysis: In particular, the (possible) separation of service and transport in IP networks results in an increased degree of complexity of interconnection since it can occur on *different* layers. Central issues of a sustainable interconnection regime concern network topology (with reference to number, geographic location as well as hierarchy of interconnection points), pricing and the accounting system.

By establishing this project group in August 2005 the Federal Network Agency proactively raised regulatory questions and entered into issues that had arisen during discussions about VoIP.[1] During the wide-ranging hearing in connection with Voice over IP (VoIP) started by the Federal Network Agency in April 2004, intensive discussions were held on the market that also dealt with topics concerning interconnection and access.[2]

If the migration process to *one* IP-based network is also considered a potential change of business models, it becomes clear that the challenges resulting from that cannot be met "by technical measures alone", but also raise mainly commercial issues. To take this into account, the project group headed by the Federal Network Agency was comprised of high-ranking telecommunications experts.

Achim Berg (by 31 Oct 2006)
Gerd Eickers

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1 See project 2006 in the annual report 2005, page 152, http://www.bundesnetzagentur.de/media/archive/5278.pdf.

2 http://www.bundesnetzagentur.de/enid/4e1a0e7046ed4e377c8f32401c02fd97,0/Regulierung Telekommunikation/Voice_over_IP_am.html.

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The project group shall not take any decisions or make provisions or pre-determinations for decisions of the Federal Network Agency that are legally binding for the Federal Network Agency; it only had a consulting role. Any decisions about the specific provision of interconnection services shall be taken during follow-up ruling chamber procedures.

The important thing for the Federal Network Agency when selecting the members of the project group was to integrate the approaches of the various market players (network carriers, Internet service providers, mobile network carriers, etc) into the project group work and to ensure their functionality with an efficient group size. The members were appointed personally and not as representatives of their respective companies and associations.

The study was scientifically supported by three expert reports that were commissioned by the Federal Network Agency. These expert reports were prepared by:

Prof. Dr. Ingo Vogelsang (Boston University), “Abrechnungssysteme und Zusammenschaltungsregime aus ökonomischer Sicht“ (Accounting Systems and Interconnection Regimes from an Economic Point of View);

Scott Marcus (WIK-Consult GmbH): „Framework for Interconnection of IP-Based Networks – Accounting Systems and Interconnection Regimes in the USA and the UK“;

Prof. Dr. Klaus Hackbarth/Dr. Gabriele Kulenkampff (Universidad de Cantabria or WIK-Consult GmbH), “Technische Aspekte der Zusammenschaltung in IP-basierten Netzen unter besonderer Berücksichtigung von VoIP“ (Technical Aspects of Interconnection in IP-Based Networks with Particular Focus on VoIP).

The report shows the possible development trends for a sustainable interconnection regime in view of the upcoming conversion to IP-based networks. It will be published on the website of the Federal Network Agency and comments are invited to initiate a broad discussion of the topic “IP Interconnection” with those interested.

The Federal Network Agency plans to publish any incoming opinions and evaluate them thoroughly. Then a concept on interconnection may be published by the Federal Network Agency.

1.1 Objectives and assignment of the project group

The objectives and assignment of the project groups were set out in the mandate published on 9 Sep 2005.[3] Based on a series of questions, the research group analyzed the framework conditions for the interconnection of IP-based networks.

The relevance of interconnection issues and their implications for different business models is mainly determined by the fact that services that have been rendered via circuit-switched networks so far are now being increasingly implemented via packet-switched networks. Different types of traffic (data and voice) are transported via these mainly IP-based packet-switched networks. They can thus be characterized as service-independent which is reflected in the term “Multi-Service Network”. There may be different quality requirements for different services.

The future integrated all-IP network raises a variety of closely related topics. The interconnection modalities are specified in detail by an “interconnection regime“. This includes the number and geographic location as well as the determination of hierarchy and functionality of the interconnection points.

In addition, an interconnection regime of this kind must specify the Quality of Service class by which the traffic is to be transmitted. Another core element is pricing principles. After all, an interconnection regime includes the accounting system as a core element that determines “who“ pays for which elements in the value chain.[4]

In particular, the migration process towards a long-term and sustainable interconnection regime is now a key issue. By taking the migration aspect into consideration, the question arises if and to what extent temporary solutions or provisional steps are suitable for increasing the practicability of a long-term interconnection regime of this kind. This aspect, however, is less relevant as the transition period is reduced by faster network conversion. The transitional phase period should be completed along with the complete reconstruction of the DTAG network. From a regulatory point of view, it is important to ask for the correct standard efficiency scale that provides efficient migration incentives.

Finally, when answering these questions, the interdependencies between the interconnection regime (wholesale service level) and accounting systems at end customer level must always be taken into consideration.

Current problems already result from the fact that different interconnection regimes and accounting systems exist for traditional telephone networks and the Internet, however, with

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3 http://www.bundesnetzagentur.de/media/archive/3180.pdf.
4 Generally, the term accounting system can refer both to end customer level and wholesale service level.

the increasing importance of VoIP both networks are being used for voice transport.[5] The functional assignment of service and network, i.e. voice was transported via circuit-switched networks and data via packet-switched networks, is now increasingly undermined as a result. This can lead to unwanted arbitrage phenomena.

Possible target regimes and migration paths are evaluated on the basis of the following criteria:

- Intensification of sustainable competition
- Incentives for efficient investment
- Incentives for efficient use of the network
- Minimization of transaction costs,
- Avoidance of arbitrage potential caused by regulation and
- Internalization of network externalities.

The current interconnection topics concerning VoIP were addressed in early 2006 by a group of market participants and dealt with based on the existing accounting system Calling Party's Network Pays. The project group has also discussed the basic issues of an all-IP network in detail.

The ERG also adopted and published a document on IP interconnection in 2006 for consultation.[6] Any possible changes in the accounting system in IP networks for the demarcation of interconnection markets have been taken into consideration in the draft recommendation on demarcating relevant markets of the European Commission. It notes that the introduction of a Bill & Keep model for the interconnection of voice services on IP networks would have a substantial impact on the market for voice termination.[7]

1.2 Project group activities

1.2.1 Basic issues

The core elements of a sound target regime for the interconnection of all-IP networks are firstly the number and geographic location of interconnection points, their hierarchy and functional meaning, secondly a description of quality, thirdly pricing criteria and finally an accounting system.

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5 This is the case if a VoIP user calls another user at their PSTN access (and vice versa).
6 ERG (2006), http://www.erg.eu.int/documents/cons/index_en.htm .
7 European Commission (2006).

In order to be able to answer the question of the number and structure of interconnection points, the structures of future networks must be analyzed. Mobile communications is taken into consideration in the issue of interconnection, but not discussed in detail. A summary of these developments is included in annex 1.

The future communication networks will be packet-switched multi-service networks that are mainly based on Internet Protocol. This development may mean changes in terms of infrastructure, services offered and players in the value chain:

- At infrastructure level, the migration process from PSTNs to NGNs will result in a restructuring of the traditional circuit-switched networks in terms of technologies used and network topology.
- The number and geographic location of the interconnection points is affected by this restructuring of the network topology.
- It is assumed that NGNs in particular have lower operating costs than traditional networks.
- The question arises in the migration phase as to how the technical transition from PSTN networks to NGNs is actually realized and how this impacts interconnection.
- A complex question in this respect is the issue of the QoS level in a multi-service network where services are provided with different quality requirements.
- The pricing structure and the price level of the IP interconnection will have to be determined during the migration to the IP interconnection. In addition, the relation between EBC interconnection rates and (future) IP interconnection rates must be specified and how the transition from EBC rates to future IP interconnection rates will be realized.

Another core element of an interconnection regime is the accounting system that determines “who“ pays for which elements in the value chain and what they are paid for.

A key and frequently mentioned difference between PSTN and IP-based networks is the fact that they are based on various accounting principles on the wholesale service side. While under the “Calling Party’s Network Pays“ principle the terminating network carrier charges a termination rate to the supplying network carrier, no payments are made for termination under the Bill & Keep regime. Instead, the network carrier charges termination services to their own end customers. The accounting systems currently in place can be roughly summed up as “telecommunications model“ and “Internet model“.

Interconnection rates are paid for provision and termination in the telecommunications world. For traditional voice services, interconnection rates are paid under regulated conditions.

Peering and transit contracts prevail on the Internet. An accounting system without termination payments between the contract parties is used for peering Internet traffic. Transit traffic, on the other hand, is paid for. These contracts are generally concluded without the intervention of the regulatory authority on a commercial basis.

Expert report

In order to be able to cope with the complexity of the topics and examine them from various aspects, external scientific experts were consulted. Three expert reports were commissioned by the Federal Network Agency. The textual annotations and suggestions of the members of the project groups have been entered into the project specifications.

The goal of the expert reports was to generate input on both the issues formulated in the mandate of the project group and on issues beyond this scope with the practical usability of the results being of prime importance for the project group's activity. Particular attention was paid to the migration aspect from today's regime to a future one.

- Expert report 1: „Abrechnungssysteme und Zusammenschaltungsregime aus ökonomischer Sicht" (Accounting Systems and Interconnection Regimes from an Economic Point of View); *Prof. Dr. Ingo Vogelsang (Boston University)*

The migration process towards IP-based networks involves a collision of different accounting systems and interconnection regimes from the telecommunications world to date and the Internet world. To develop efficient framework conditions for the interconnection of IP-based networks against this background, the economic implications and incentives of different accounting systems and interconnection regimes were examined in these expert reports and the status of the scientific discussion on this topic presented and analyzed.

On 07 November 2005 (4th project group meeting) an intermediate presentation was given by Mr. Vogelsang. To also integrate practical perspectives and arguments into the expert report, the Federal Network Agency asked for statements on some discussion items (suitable target regime in an All-IP world, differentiation according to services, migration steps for the possible target regimes, effects on the end customer prices) and in particular on the matter of interconnection points. A total of five statements have been received with some generally welcoming Bill & Keep (see later) and others rejecting this kind of regime. While the first group advocated a wide-ranging implementation of Bill & Keep independent of technology and network and at the same time demanded standalone bit stream products, the second group emphasized the market primacy when it comes to regulating interconnection topics, taking the view that the requirements for the introduction of a Bill & Keep regime are not met on the German telecommunication market. This controversial discussion was also highlighted by the presentations held in the expert group.

The expert report was published on 19 May 2006 on the website of the Federal Network Agency.[8] The main results of the expert report can be found in annexes 2 and 3.

- Expert report 2: „Framework for Interconnection of IP-Based Networks – Accounting Systems and Interconnection Regimes in the USA and the UK“ *(Scott Marcus, WIK-Consult GmbH)*

This expert report contained a description of the accounting systems or interconnection regimes in the USA and the UK and, in particular, an analysis and evaluation of interconnection solutions for VoIP. It also showed which implications can be derived for Germany from the institutional solutions and experiences made in the USA and UK.

The initial findings of this project were presented by Scott Marcus during the 3rd project group meeting on 18 October 2005.

The expert report was published on 19 May 2006 on the website of the Federal Network Agency.[9]

- Expert report 3: „Technische Aspekte der Zusammenschaltung in IP-basierten Netzen unter besonderer Berücksichtigung von VoIP“ (Technical Aspects of Interconnection in IP-Based Networks with Particular Focus on VoIP); *Prof. Dr. Klaus Hackbarth, Universidad de Cantabria / Dr. Gabriele Kulenkampff, WIK-Consult GmbH*

The implications of the specific technical characteristics of IP-based networks for interconnection issues were analyzed as part of this project Topics such as network architecture, network structure (number of locations in the core network), types of implementation to ensure Quality of Service (QoS) - overdimensioning, prioritizing, reservation - and the implementation of PSTN/ISDN features for VoIP were analyzed in this expert report. Apart from a comprehensive evaluation of literature, the expert report was mainly based upon own investigations and calculations (see annex A.I of the expert report). Furthermore, a questionnaire was put together during the preparation of the expert report and distributed to the members of the project group whose aim it was to analyze the technical and economic implementation of VoIP in current carrier networks and compare the theoretical results /conclusions with the empiric results.

The questionnaire addressed the following topics:

- Realization of the voice telephony offer,
- Transport, signalling and operation, administration and maintenance (OAM),

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8 http://www.bundesnetzagentur.de/media/archive/6202.pdf.
9 http://www.bundesnetzagentur.de/media/archive/6201.pdf.

- Interconnection of VoIP services,
- Reliability and security of VoIP services,
- QoS requirements of VoIP,
- Characteristics of voice services and
- Reasons for the introduction of VoIP and additional costs for differentiated VoIP services.

The findings from the answers in the questionnaire have been integrated into the expert opinion. A summary and evaluation of the answers are included in annex A III of the expert report.[10]

Professor Hackbarth and Dr. Kulenkampff gave an intermediate presentation at the 3rd meeting of the project group on 18 October 2005. Another presentation was held during the 6th project group meeting on 18 January 2006.

The expert report was published on the website of the Federal Network Agency on 11 August 2006.[11] In addition to the long version of the expert report, an Extended Executive Summary can also be found there.[12] The main results of the expert report are presented in annex 1.

Presentations

Apart from the presentations made by the experts, a variety of additional presentations were submitted by market participants from a practical point of view during the project group activities, in which both general characteristics and features of interconnection regimes for IP-based networks and more specific aspects have been presented and discussed. These presentations were published on the website of the Federal Network Agency:

- “Heutige Angebote und zukünftige Anforderungen“ (Current Offers and Future Requirements), Dr. Rottenbiller (T-Com), 2nd meeting, 12 September 2005

  Interconnection services from and to VoIP customers with (0)32 numbers were presented and the question of suitable business models for VoIP discussed;

- “Technische Möglichkeiten der Zusammenschaltung bei VoIP“ (Technical Interconnection Possibilities with VoIP), Eickers, 2nd meeting, 12 September 2005

  The technical implementation of interconnection for VoIP without or with security measures and for mixed network infrastructures (PSTN/IP) was presented here;

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10 Questionnaire see annex III of the expert report.
11 http://www.bundesnetzagentur.de/media/archive/7105.pdf
12 http://www.bundesnetzagentur.de/media/archive/7106.pdf

- „Arbitragemöglichkeiten bei Voice over IP“ (Arbitrage Possibilities with Voice over IP), Eickers, 4th meeting, 7 November 2005

  Based upon a differentiation between “positive“ and “negative” arbitrage, the arbitrage possibilities were shown in this presentation.

- “Interconnection Tarifierung - Konzeptionelle Überlegungen aus dem Blickwinkel einer IP-basierten Leistungserstellung“ Interconnection Billing - Conceptional Considerations From The Perspective of IP-Based Service Provision), Dr. Mahler (Telefónica), 5th meeting, 15 December 2005

  It looked mainly at how QoS can be ensured by means of dedicated VoIP interconnection (via Session Border Controller) and which cost elements are relevant for termination services;

- „Stellungnahme der Mobilfunknetzbetreiber“ (Statement by Mobile Network Carriers), Wassink (Vodafone), 5th meeting, 15 December 2005

  This presentation focused on the technical framework conditions for mobile communications (shortage of transmission capacities) and the identification of interconnection and accounting methods as competitive parameters;

- “Bill & Keep – ein optimales Regime für die Zusammenschaltung IP-basierter Sprachnetze?“ (Bill & Keep – An Optimal Regime for the Interconnection of IP-Based Voice Networks?), Berg, 6th meeting, 18 January 2006

  This presentation emphasized that the prerequisites for Bill & Keep were not met in practice from T-COM’s perspective and demonstrated the implications of introducing Bill & Keep.

- „Rahmenbedingungen der Zusammenschaltung IP-basierter Netze – ein Zwischenfazit“ (Framework Conditions for the Interconnection of IP-Based Networks - Intermediate Conclusion), Mr. Neumann, 7th meeting, 16 March 2006

  This presentation summed up the findings gathered from the project group work (including expert reports).

1.2.2 Current questions

Since VoIP services affect both IP networks and the PSTN, problems have arisen from the different accounting systems used in the PSTN and on the Internet.

Specific questions cropped up during the project group work that exceed the objectives of the project group and the questions covered by the mandate. These questions were discussed in a separate working group comprised of market participants. Concrete solutions for the interconnection of IP-based voice networks should be developed in practice for these short-term relevant aspects.

The group of market participants has not yet looked in detail at the interconnection regime question (Calling Party's Network Pays or Bill & Keep), but bases its results on the Calling Party's Network Pays regime that currently applies in PSTN/ISDN. It was the main objective of the project group to avoid inefficient potential arbitrage resulting from the no longer fixed connection of call number and specific scope of an interconnection service. The following individual statements were made by the market participant group on the following items (see chapter 3 for detail):

- Differentiation between Voice over NGN and Voice over Internet. This differentiation aims to avoid arbitrage (between PSTN/NGN on the one hand and Internet-based voice connections on the other hand) and ensure inter-network quality for VoNGN as for PSTN.

- QoS parameters, availability, features and security: With regard to quality, minimum quality parameters and voice codecs for VoNGN or VoNGN interconnections shall be determined in the sub-working group NGN of the AKNN.

- Service portfolio: The objective is to gradually convert the service portfolio for PSTN interconnection to NGN interconnection.

- Exchange of porting data: This mainly deals with allowing the party requesting termination to select the appropriate gateway and avoid arbitrage.

- Pricing models and structure: No final decision has been made for pricing models so far. The companies think of a pricing structure with several prices for voice connections within the framework of NGN interconnections.

- Price level: Termination services for VoNGN and PSTN are to be priced at the same level. Another price level shall be charged for voice over Internet however.

Further action is required to clarify these questions, since some of the market participants will convert their networks to NGN in the near future or have already started to do so. Many network carriers request rapid implementation of IP interconnection, for example to allow more efficient routing.

Several reports on the current state of the discussions of the market participants have been submitted by the project group of the Federal Network Agency (7th meeting, 16 March 2006 / 8th meeting, 3 May 2006 / 9th meeting, 8 June 2006).

1.2.3 Structure of the final report

The core elements of an interconnection regime are discussed in chapter 2. Section 2.1 deals with the number and location of interconnection points and the consequences of different functional layers in NGNs. Fixed networks are the focus. Mobile radio has been considered, but not discussed in detail. The matter of quality differentiation in the interconnection regime is addressed in section 2.2. Section 2.3 includes the question of the price structure and the price level of interconnection services in NGNs and during the transitional phase. Section 2.4 focuses mainly on accounting systems as part of the interconnection of IP-based networks. The connection between accounting systems at end customer level and wholesale service level is discussed, the concepts ”Calling Party Network Pays“ and “Bill & Keep“ compared, a dual system with CPNP in the core network and B&K in the concentration network presented, and migration issues during the transitional phase looked at.

The solutions of their working group are presented by the market participants in chapter 3. Based upon the current accounting system at wholesale service level, they are intended to enable short-term interconnection of IP-based networks for voice services in practice. The following individual issues are mainly addressed: Differentiation of Voice over NGN and Voice over Internet (3.2); QoS aspects (3.3), addressing issues (3.4), service portfolio (3.5), exchange of porting data (3.6) and several pricing matters for voice connection during NGN interconnection (3.7).

The results of the final report are summarized in the résumé (chapter 4).

The topics dealt with in chapter 2 were presented in detail in annexes 1 to 3 based upon the expert report (annex 1: Network structure and quality, annex 2: Accounting systems, annex 3: 3 options for an interconnection regime).

2 Core elements of an interconnection regime for an all-IP network

The interconnection modalities of telecommunication networks are specified in detail by an “interconnection regime“ that contains the following core elements:

- Number and geographic location of interconnection points as well as hierarchy and functionality of interconnection points. They are determined by the network architecture (network topology and functional layers in NGNs).

- Taking into account the character of the all-IP network as a multi-service network, the quality standards at which traffic is transferred must be specified.

- Pricing principles for interconnection rates shall be determined, such as progressive rates according to interconnection levels (e.g. for EBC: local, single and double transit) as well as accounting units (e.g. minutes or data volumes). A differentiation of rates according to services or quality classes raises complex questions about cost allocation.

- In addition, the accounting system is a core element that determines "who" pays for which parts of the value chain.[13]

The development of IP-based networks raises new questions for each of these core elements which are discussed below.

2.1 Number and location of interconnection points

Far-reaching structural changes in the network architecture and topology are associated with the development of IP-based networks. In particular the (possible) separation of service and transport is an important feature of future network structures. The functional layers service, control and transport can be differentiated in NGNs and provided separately if required. Compared with the interconnection in traditional TDM-based[14] networks, interconnection in future network structures shows a higher level of complexity as it can occur on several functional layers. To ensure complete service operability (including end-to-end connectivity), it may be required to ensure interconnection on all layers (service, control and transport layer)[15].

The evolution of the traditional PSTN/ISDN associated with integration in the IP platforms of the network carriers is realized with the "Next Generation Network" (NGN), while the further development of independent IP network domains of ISPs and Internet Transport Providers into multi-service networks can be summarized as "Next Generation Internet" (NGI). This report focuses on the NGN concept. A summary of major developments is included in annex 1.

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13 Generally, the term accounting system can refer both to the end customer level and to the wholesale service level.
14 TDM: Time Division Multiplexing.
15 See also ECC Report 75 (2005) as well as IETF working group "Session PEERing for Multimedia INTerconnect –speermint" (http://www.ietf.org/html.charters/speermint-charter.html).

As far as the number of interconnection points is concerned, the number of locations of the future NGN of the national network carrier is of particular importance. This issue has been analyzed in the study of Hackbarth/Kulenkampff using a hypothetical national NGN for Germany as an example. A scenario calculation for all broadband traffic based upon this hypothetical national NGN in Germany showed that no more than 100 IP core network locations can be expected in the long run. This result also applies even on the basis of high growth rates in the bandwidth required by bandwidth users. According to the members of the project groups, 100 locations might be a realistic upper limit for the number of locations for IP interconnection in the core network.

The task during the migration process will likely be the interconnection of PSTN/ISDN networks and their replacement by interconnecting NGN networks. However, it cannot yet be identified whether this interconnection for the termination of VoIP traffic will be limited to the locations of IP network nodes or if interconnection at a lower level between the locations of the concentrator network will be possible. From this perspective, the question of the number of interconnection levels and thus also the number of interconnection points between NGNs of various carriers remains open from a technical and economic point of view.

Supposing that the number of interconnection points is reduced in the medium term (and limited to the IP core network locations if required), it can be assumed that the termination at a PSTN user cannot always be realized locally.

If a network carrier has established an infrastructure of numerous interconnection points to a PSTN so that termination is possible locally as often as possible, reduction of the PSTN/ISDN would mean that the infrastructure would also be reduced during integration into the NGN and the termination capacity (in the sense of added value) of the national carrier increased for the remaining PSTN users as a result. This also implies reduced added value by competitors for transport capacity in the NGN compared to PSTN/ISDN.

The changes to the network architecture mentioned with reference to the various functional layers of NGNs can also have an impact on the future number of interconnection points: The NGN is particularly characterized by the separation of the control layer (signaling, etc.) from the transport layer with services provided centrally using own devices (media gateway controller, MGWC or soft switch). The relevant unit of the control platform communicates with functional units of the transport layer to provide adequate capacities based on the QoS features required by the service. The configuration of the services and the planned centralization of control functions have a great impact on the question of which locations the traffic from other networks can be taken over or handed over and how alternative service providers can integrate their services into an NGN platform. If each telephone call is signalled at core network level, the question arises as to how the local interconnection in NGNs can be defined.

It is not realistic to expect continued use of the currently existing system in which voice services can be handed over to competitors on almost all hierarchical levels of the network.

Mainly national or local PSTN/ISDN network carriers are likely to be affected by a reduction in the number of interconnection points. This should mainly be the case if the interconnection points with their PSTN/ISDN networks that have been used so far are abandoned by the national carrier.

From a regulatory point of view, suitable interconnection and access products must be ensured that have the interdependency of the most efficient network structure and topology possible of established carriers and competitors minimizing "stranded investments"[16] among all market participants. They aim at creating equal competitive environments for all market participants even after a conversion to all-IP networks.

The number and geographic location of interconnection points and network nodes as well as the number of hierarchy levels will be the main features of a future interconnection regime.

2.2 Quality differentiation in the interconnection regime?

One characteristic of future networks will be that *different* services with *different* quality requirements can be transported over *one* network. They can be classified into four quality-of-service classes with declining requirements: Real-time services, streaming services, data services and best-effort services.

Traditional PSTN/ISDN networks were conceived to ensure a QoS level for voice telephony, whereas best-effort quality is offered on the Internet. Accordingly, the wholesale service products for broadband service are designed exclusively as best-effort products, although other real-time services such as voice telephony or IPTV are increasingly used alongside the www service. NGNs and other IP-based networks, however, focus clearly on end-to-end quality; three strategies can generally be differentiated in this respect to ensure QoS in IP-based networks. Overdimensioning, traffic prioritizing and capacity reservation.[17] They can be used individually or in combination.

A comparison between the approaches used to ensure QoS in IP-based networks reveals the following: Overdimensioning may be a feasible strategy in the short run to implement voice integration[18] but an inadequate differentiation between best-effort and real-time means

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16 Stranded investments are investments already made that are devaluated by follow-up conditions, in this case the reduced number of interconnection points.

17 Overdimensioning is the provision of overcapacities in terms of bandwidth (transmission systems) and routers. Traffic prioritizing allows preferential allocation of time-critical services over other services. In the case of capacity reservation, traffic is routed separately via reserved capacities according to class of service.

18 This particularly applies to the NGI concept, which is, however, not a major element of this report.

that this approach cannot provide adequate protection against overload (in particular for time-critical services with ”Service Level Agreements“ SLA). Service prioritizing may have the edge over both overdimensioning and capacity reservation in the medium-term if additional traffic management measures (incl. inter-network) have been implemented. In particular, if the bandwidth resulting from VoIP traffic is small compared to the bandwidth from best effort services, VoIP services require less capacity during prioritizing than in the case of traffic separation in tunnels. Therefore, VoIP traffic benefits from the efficient use of capacity that is generated by high best-effort traffic volumes. Service prioritizing mainly poses problems in traffic management and cost allocation. The capacity reservation approach is a resource-intensive strategy that keeps pace with traffic growth inadequately.

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

The allocation of additional costs for the implementation of QoS to several services or types of traffic will definitely raise complex questions, since a variety of interdependencies are involved. The additional costs of realizing QoS depend upon the traffic ratio between best-effort and real-time services. If real-time traffic accounts for only a low proportion of the entire traffic volume dominated by best effort traffic, there will be significantly lower dimensioning requirements than in the reverse case.

Different quality levels will involve differentiated prices for the transport of traffic of various services or service classes.

An interconnection regime could generally treat all traffic equally (as was generally the case in PSTN and on the Internet in different quality) and differentiate according to quality classes or services. Voice transmission is often considered a real-time service. However, a voice service can be transported at best-effort quality with certain restrictions. Differentiating according to different quality classes within one service is therefore conceivable. This approach is pursued by the group of market participants with a differentiation of VoIP in VoInternet and VoNGN that is presented in chapter 3 in detail. The parameters defined for VoNGN interconnection may be relevant for the interconnection of other real-time services at a later point.

2.3 Price structure and price level of interconnection services in PSTN and NGNs

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

Since the costs in the NGN are expected to be substantially lower than in the PSTN, there is much to be said for taking these low costs as a basis for the pricing of IP interconnection particularly since it must be assumed that the migration process towards NGNs has already started. The pricing should be valid irrespective of whether interconnection is realized via PSTN or NGN, since a strict application of the cost structure determined in the TKG of long-term add-on costs requires the efficient technology used by the market to be taken as a basis. Consideration must also be given to the fact that the concept of the cost of efficient service provision does not differentiate price according to technology or account for the existence of different prices. Basing prices on efficient technology also provides incentives for accelerating migration to this technology.

In view of the (potential) cost change due to NGN, an immediate switch of the interconnection rates to this low NGN level is considered too disruptive for the market and particularly for the providers of interconnection services. Such a sliding path could also be understood as resulting from a mixture of the costs of the PSTN/ISDN and the NGN with an increasing proportion of NGN costs over time.

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

The principle of uniform prices for the PSTN and IP interconnection must also be defined in terms of structure. How can the existing structure of the current PSTN/ISDN interconnection regime (local, single and double tandem interconnection) be transferred to the NGN context for the transitional period? With regard to the structural definition of the principle of uniform prices for the PSTN and IP interconnection, the opinions of the experts differ considerably. This topic is a complex challenge in view of the following conditions that need to be discussed in detail:

As shown in section 2.1, the number of hierarchical levels and network nodes in NGNs are expected to be reduced compared to the PSTN. Because of the changes in the network architecture mentioned with reference to the different functional layers of NGNs, there will be no longer an exact correlation between the hierarchical network levels in the PSTN and NGNs. The configuration of services and the scheduled centralization of control functions

have a large impact on the question of which points traffic can be taken over from or handed over to other networks.

The concrete implementation of the principle of uniform prices also affects the incentive to migrate to NGNs: This particularly applies to the different number (of maximum) interconnection points in the PSTN and the NGN. There will be no negative price incentives towards a migration to NGN if the "local" rate of the EBC regime with 474 interconnection points to achieve nationwide network coverage also applies to the maximum number of interconnection points offered in the NGN for nationwide network coverage. This principle provides the correct economic incentives for IP interconnection providers to offer a relevant number of interconnection points in due time and for consumers of interconnection services to make use of efficient IP interconnection early and thus accelerate the transition to this efficient technology.

Before it is possible to suggest final solutions and take final decisions in this context, the topic must be analysed in detail by the Federal Network Agency. A decision on the exact rates for interconnection must finally be taken in a ruling chamber procedure.

2.4 Accounting systems as part of the interconnection of IP-based networks

2.4.1 Accounting systems on wholesale service and end customer level in relation

Accounting systems represent one of the major components of interconnection regimes. Currently there are different accounting systems for interconnection in PSTN and IP-based networks: in PSTN on a Calling Party's Network Pays basis and on the Internet mainly on the basis of Bill & Keep and transit agreements. This raises the question as to which accounting system should be used for NGN.

The accounting systems at end customer level are also relevant in this respect, since there is a close relationship between end customer accounting systems and interconnection regimes at wholesale service level. This relationship results from the fact that the cost structure and the end customer prices are determined by the interconnection prices of the providers and thus affect the pricing structure of the end customer services.

Voice connections are generally based upon the "Calling Party Pays (CPP)" principle under which the connection is fully paid by the caller, i.e. the caller pays for the entire connection including termination at the called party (B-subscriber).

End customer accounting systems on the Internet, however, generally use the RPP principle like mobile calls in the USA. Internet access rates include payment for connectivity and the option of receiving and transmitting data. Under the "Receiving Party Pays (RPP)" principle,

the costs for a voice connection are shared among the caller and the called party. This is a combined system in which the caller pays their network carrier for the originating service and the called party pays the network carrier for their termination service.

These different approaches are frequently rationalized according to various assumptions about who mainly benefits from a connection (CPP - mainly the caller; RPP both subscribers equally) or who can be considered the initiator of the call. Controversial discussions on this topic can be found in the references; depending on the assumption made, either CPP or RPP is considered the best accounting system.[19]

The relation between accounting systems at end customer and wholesale service level is also demonstrated by the fact that structural similarities can be found between CPP (end customer level) and CPNP (wholesale service level) on the one hand and between RPP and B&K on the other hand. However, there are no binding causal relations between the accounting principles at wholesale service level and end customer level.

2.4.2 Calling Party's Network Pays

In the case of the „Calling Party's Network Pays" (CPNP) principle, the network carrier of the caller pays a termination rate to the network carrier initiating the termination. This principle is generally used by PSTN connections and also mobile communications in Europe. Today, fixed network services are accounted for by means of the element-based charging (EBC) system according to the use of network elements. The regulatory authority gears interconnection rates to an efficient cost standard that gives efficient incentives for investments. The costs of efficient service provision reflect this efficiency scale and are comprised of long-term add-on costs for service provision (LRAIC[20]) and an overhead cost surcharge that includes sufficient interest for the capital invested. In Germany this scale is set in §31 TKG for ex-ante rates regulation.

Structurally, the CPNP (wholesale service level) concept is similar to the CPP principle (end customer level). Like end customer level, where the caller initiates a connection prima facie, the network of the caller is considered the initiator at wholesale service level.

The termination monopoly is frequently considered the central issue in the CPNP regime.[21] According to this, the terminating subscriber network carrier has market power over the

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19 DeGraba (2000), page 15 et seq.; Marcus (2006a), page 7; Wright (2002), page 57.
20 LRAIC: Long-Run Average Incremental Costs.
21 See also Marcus (2006a), page 9f, DeGraba (2000), page 7. With reference to the termination problem in mobile radio, see Valetti/Houpis (2005). When explaining the reasons for the termination problem, reference is sometimes made to CPP (i.e. end customer level) and sometimes CPNP (.i.e. wholesale service level) in the literature. This difference can be ignored since the systems at both levels - to a certain extent - are interconnected. Vogelsang (2006, page 153) links both levels and states that "Calling Party Pays" causes a termination problem as long as there are not several independent accesses to the individual call receivers.

termination service if an end customer cannot be reached via several connections. The network carrier of a calling customer must ask the network carrier to which this end customer is connected about the termination capacity before setting up the connection to the called party. There is no option of switching to another network carrier to set up the connection to the desired called party. Therefore, the network carriers have a certain market power for terminating individual calls, independent of their market position in their own end customer market. This also applies, at least to a certain extent, to smaller network carriers, if they offer end customer connections.[22] Consequences of this termination monopoly are agreed termination rates (if required) that are higher than the long-term add-on costs. Excessive termination rates may result in low network usage. Therefore, regulatory measures are considered necessary in termination markets.

2.4.3 Bill & Keep

Termination services are not paid for in the Bill & Keep system. Each network bears the costs for the network features. The Internet uses the principle of Bill & Keep as well as transit agreements. In the USA, Bill & Keep is used in the field of mobile communications and generally also for fixed-network connections between the competitive local exchange carriers.

Bill & Keep can be understood as an exchange deal under which the network carriers involved make available the transport to other providers via the own network. Each network bears the costs for the network service. This can be used both for downstream and upstream data traffic or in the case of VoIP for incoming and outgoing connections. The costs for terminating the traffic from network carrier A into the network of carrier B consist of the provision of network capacities for termination in B's traffic in the network of A. Due to this exchange character of Bill & Keep, the impression is wrong that the interconnection services are rendered *at no cost*, even if no interconnection services are paid for in the presentation of payment flows.

The termination costs must ultimately be borne by the end customer of the terminating network carrier. If the network carrier can be chosen among market competitors, Bill & Keep represents a system that is more adjusted to market mechanisms. [23]

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22 Laffont/Tirole (2000), "It is worth recording here the common fallacy that small players do not have market power and should therefore face no constraint on their termination charges. This fallacy results from a misunderstanding of the definition of a market. A network carrier may have a small market share in terms of subscribers; yet it is still a monopolist on the calls received by its subscribers. Indeed, under the assumption that retail prices do not discriminate according to where the calls terminate, the network has more market power, the smaller its market share: whereas a big operator must account for the impact of its wholesale price on its call inflow through the sensitivity of rivals' final prices to its wholesale price, a small network faces a very inelastic demand for termination and thus can impose higher mark-ups …", page 186.

23 DeGraba (2000, Rz. 4) explains in this connection as " ... competition operates more effectively when carriers recover their costs from their own end users, who can choose among competing carriers, rather than from interconnecting networks for whom the terminating carrier is a *de facto* monopolist. [Bill and Keep]

A major aspect of B&K is avoiding the termination monopoly and thus reducing the need for regulation. Interconnection rates must no longer be fixed.

Gaming incentives can be avoided with Bill & Keep: If the termination rates exceed the cost limits, the incentive for providers is to concentrate on customer groups with a lot of incoming traffic in order to achieve a maximum termination surplus. Such incentives are prevented by Bill & Keep.[24] Concentrating on certain customer segments is a reaction of market participants to the incentive structures of a given accounting system at wholesale service level. A system of this kind encourages switching to a system that is more compatible with incentives. An abolition of termination rates is expected to increase the trend for balanced traffic flows, even between networks of different sizes.

On the other hand, the negative consequences of termination costs exceeding the cost limits that are passed on to the respective end customer rates and result in sub-optimal demand can be avoided. Bill & Keep is therefore viewed positively in terms of efficient network use.

It is conceivable that the trend towards flat rates that can be observed today would be given further impetus by implementing Bill & Keep and would also facilitate the change to Receiving Party Pays at end customer level.

Some experts take the view that SPIT problems[25] would be aggravated if no payments had to be made for the termination service at wholesale service level. The real-time nature of voice services means that it would not be possible to filter out SPIT. Other experts object that SPIT is a phenomenon that will continue to grow regardless of the accounting mechanism with lower transport costs and increased use of flat rates. In addition, providers can diversify at end customer level with an effective SPIT control in the competitive process which is in effect done on the Internet by using SPAM filters as part of the end customer offer. The SPIT problems seem to be rather a consumer protection issue than a topic that needs to be addressed by the regulatory authorities within the framework of the interconnection regime.

The so-called ”hot potato“ problem is a fundamental disadvantage of Bill & Keep. This results from the incentive for network carriers to hand over their own traffic as soon as possible to another network for termination and to benefit as a free rider from the network extension of the other network That is why Bill & Keep can also result in a suboptimal level of investment.

The ”hot potato“ problem can be responded to by requiring a network carrier to set up a certain number of interconnection points to be able to participate in the Bill & Keep regime.

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takes advantage of the forces of competition, where they exist, by requiring a carrier to recover all of its local access costs from its end users.”

24 Therefore, Bill & Keep must be positively rated both with reference to its static efficiency (allocation, production) and its dynamic efficiency. See also Charles River Associates (2002), Rz. 42, 43, 50.

25 SPIT: SPAM over Internet Telephony.

Bill & Keep only applies in the concentration network in this case, whereas the EBC regime continues to apply for the core network.

In this kind of dual regime of differentiating the accounting system according to network level (Bill & Keep in the concentration network compared to CPNP with EBC in the core network), the area would be delimited by determining the number of interconnection points required to take part in the Bill & Keep regime for which Bill & Keep (in the concentrator network area) or EBC (in the core network) is applicable.

The following connection applies in terms of the location of the required interconnection points: The free rider problem becomes smaller, the closer the interconnection point is located to the target network, i.e. the smaller the termination service is. There is a trade-off between the free rider problem and the number of required interconnection points. The higher the number of interconnection points, the more the free rider problem is reduced, but on the other hand, there is an increased risk of potentially inefficient, duplicate investments in network expansion and pole development. This may result in increased concentration on the market.

The introduction of this kind of dual regime has the following effects on transaction costs:

The advantage of avoiding the termination monopoly implies lower demand for regulation, since no termination rates have to be determined. There is consequently no need to determine the "correct" efficient costs using cost models; the number of interconnection points (and their geographic location), however, must also be determined within the framework of Bill & Keep. This also solves the disputes about the rate amounts both between market participants and between market participants and the regulating authority. Costly regulatory procedures and lengthy court procedures can also be avoided. The result of these disputes is increased uncertainty for market participants and a lack of planning foundations (until a final decision is made). The complexity of accounting for the companies involved might be reduced by Bill & Keep.[26] It is assumed that peering agreements have emerged on the Internet not least because transaction costs can be reduced as a result.

Transactions costs for measuring traffic flow can also arise with Bill & Keep. Such measurements are required to determine if and how traffic flows balance each other. It is conceivable, however, that this measuring work will be required anyway for the purpose of end customer billing and planning of network capacities. In addition, it should also be considered that value-added services must be accounted for. This topic was no longer a subject for discussion among the project group.

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26 See also Marcus (2006b), page 39 et seq.

The discussion of the dual system and thus the regulatory transaction costs will focus on determining the minimum number and location of the interconnection points that entitle participants to take part in the B&K regime. These must comply with the efficiency criteria for network configuration. EBC would be applicable between two points delimiting Bill & Keep, provided the market participants involved make a peering arrangement.

Since the number and location of interconnection points will change as a result of the above specified changes in the network architecture of IP-based networks, an adjustment of the interconnection regime will be required anyway. The outcome will, in any case, be a complex discussion process in view of the expected reduction in the number of interconnection points due to an efficient conversion to NGN and any associated stranded investments, regardless of the changes made to the accounting system. This may limit the effort originally associated with the introduction of a B&K/EBC regime. In addition, transaction costs are saved because no rates must be determined.

By determining an appropriate minimum number of interconnection points, the free rider problem can be effectively limited in terms of network expansion. It must be discussed, however, whether investment in network quality is sufficient given the circumstances of this interconnection regime. Due to the fact that they do not receive any termination rates, the network carrier will be anxious to realize the network features to be provided as cost-effectively as possible. If the quality of the overall capacity in the case of inter-network traffic is not only determined by their own network, but by the network quality of all network carriers involved, there is a certain incentive for free riders to make investments in quality, in particular for network carriers with a lot of off-net traffic. The end customer will only be willing to pay more for investments made by their access network carrier in improved service quality if they actually benefit more as a result. Only then will investments of this kind pay off for the network carrier.

Assuming that the introduction of B&K at wholesale service level results in a Receiving Party Pays system at end customer level, the question remains open as to what extent the end customer will be willing to pay for incoming traffic. This is questioned by some of the experts. There might be limited effects in the case of symmetric telephony behaviour regarding incoming and outgoing traffic due to the reduced cost of outgoing calls.

If the end customer pays a flat rate for telephony, they are not interested in the fact that the charges to be paid on a monthly basis cover part of the costs of incoming traffic and part of the costs of outgoing traffic or only the total costs for outgoing traffic as long as the total amount remains unchanged.

A question that remains to be answered is the role of network carriers in a Bill & Keep regime.

Another item that should be discussed in detail in relation to a possible introduction of Bill & Keep for the concentrator network is the role of the balance of traffic volumes as a condition for the suitability of Bill & Keep. While some experts take the view that the suitability of Bill & Keep does not depend on balanced traffic volumes (as there are no net payments in reciprocal charges at present), others are of the opinion that a certain balance of traffic volumes would be required. In addition, some take the view that Bill & Keep would require equal cost structures of the network carriers.

Some experts can imagine Bill & Keep developing on the market between two interconnection regimes in individual cases, but take the view that a Bill & Keep system established by the regulatory authorities would result in distortions of competition with a particularly negative impact on major networks. They prefer an interconnection regime based upon CPNP in the long run.

Some experts can, in theory, picture a dual regime of this kind differentiated according to network layers as a long-term goal following clarification and thorough discussion of the questions raised above, with Bill & Keep being applied in the concentration network and Calling Network Party Pays based upon EBC in the core network. However, it is not currently considered feasible to fix a specific time schedule for this.

2.4.4 Migration period

Migration questions are raised for two reasons:

On the one hand, the question arises as to the duration of full conversion to an all-IP network and the basis on which the interconnection rates should be determined in the transitional period:

At first, the considerations made in section 2.3 shall apply: Since the costs in the NGN are expected to be substantially lower than in the PSTN, there is much to be said for taking these low costs in the strict sense of the LRIC cost scale defined in the TKG as a basis for pricing IP interconnection, particularly since it must be assumed that the migration process towards NGNs has already started.

In view of the (potential) cost change due to NGN, an immediate switch of the interconnection rates to this low NGN level is considered too disruptive for the market and particularly for the providers of interconnection services. Such a sliding path could also be understood as resulting from a mixture of the costs of the PSTN/ISDN and the NGN with an increasing proportion of NGN costs over time.

In consideration of the fact that different pricing system for different networks involve arbitrage and bypass possibilities, a uniform pricing system for the PSTN and NGN

interconnection should be considered. Consideration must also be given to the fact that the concept of the cost of efficient service provision does not differentiate price according to technology or account for the existence of different prices.[27] The new price level for interconnection services based upon NGN costs should be reached when the transition to NGN has been completed.

If a dual accounting system with B&K for the concentrator network and EBC for the core network is to be introduced, the question arises of the period over which the interconnection rates in the concentrator network will be reduced to zero. As the lower costs of the NGN increasingly take effect, it is feasible to anticipate a reduction in interconnection rates.

If the EBC interconnection rates are gradually reduced on this basis, the transition to Bill & Keep is facilitated by the two-level regime.

Migration towards NGNs has already been started. The opinions of the experts differ on how fast it will be completed. The duration of the migration path depends upon a variety of factors:

- Individual network carriers have different investment cycles and will make their investment decisions according to the quality and depreciation factor of their existing networks. The speed of network reconstruction by the national carrier is crucial to the national interconnection regime.

- Investment decisions made by network carriers are mainly determined, however, by how long manufacturers maintain the old technology (the key words being software updates for EWSD).

- In addition, market development in terms of traffic volume and penetration of NGN services plays an important role.

According to the experts' unanimous opinion, it is impossible to make a precise statement about the actual duration of the migration path yet, since there is some uncertainty about the importance of the various factors and their interaction.

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27 See also section 4.1, 5th para. of the report on "Pricing Structure and Price Level of Interconnection Services in PSTN and NGNs".

3 Current Questions: Cornerstones of an interconnection concept for IP-based voice networks between NGN network carriers

Cornerstones for interconnecting IP-based networks have been elaborated by a group of telecommunication companies[28] that are specified below. The results achieved so far are based upon the Calling Party's Network Pays (CPNP) principle as the interconnection regime. With this, the companies have not made a choice between the CPNP and Bill&Keep models, since the second model has not been discussed yet.[29] A major goal is the avoidance of arbitrage potential resulting from the no longer fixed connection of telephone numbers and the specific scope of an interconnection service. An accounting system must be elaborated for this purpose that takes into account the type of service rendered and its quality. In addition, the investment capability and competitiveness of the providers must be preserved.

3.1 Definition of arbitrage

From an economic point of view, arbitrage potential is where a product is purchased at a low price or produced at a low cost and can be sold on unchanged for a higher price in another market.

Arbitrage potentials can only exist in this case if different value-added services are rendered for interconnection as a result of technological change or have different quality standards for which uniform interconnection rates are charged at the time.

In this regard, it should be noted that arbitrage generally has a positive effect on competition. From this point of view, only cases of arbitrage are dealt with here that may be inefficient and critical for competition.

3.2 Differentiation between Voice over NGN and Voice over Internet

The starting point for the solution developed is the differentiation between two VoIP products: Voice over NGN (VoNGN) and Voice over Internet (VoInternet/Internet telephony). This differentiation aims at avoiding the above specified arbitrage potential between PSTN/NGN on the one hand and Internet-based voice connections on the other. In addition, the inter-network quality of VoNGN is to be ensured like PSTN (VoPSTN).

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28 AOL, Arcor, Colt, Deutsche Telekom, EWE TEL, freenet, NetCologne, QSC, Telefonica, Versatel, E-Plus, O2, Vodafone

29 See sections 3.7.1. and 3.7.2.

VoNGN and VoInternet are defined and differentiated based on the following two cases:[30]

Case (1): The end customer called (B) can be reached via VoNGN with assured or agreed quality.[31]

Case (2): The end customer called (B) can be reached via VoInternet.

The following conditions apply to **VoNGN** (case 1):

The terminating network carrier that has switched the E.164 telephone number of the end customer called (B)

a) provides all the required added value from the gateway up to the subscriber access in fixed networks or up to the terminal equipment of the subscriber in mobile communications (according to mobile network carriers) or ensures this is done by third parties

and

b.) provides the termination service meeting the defined and measurable quality parameters for the connections from the gateway to the end customer.

VoNGN is thus voice via managed IP networks or hybrid networks[32] that ensure quality-assured transport of voice packages.

The subworking group NGN has taken on the task of preparing end-to-end quality and termination quality (quality from the gateway to the end customer).[33] In addition, the defined quality must be contractually assured for the appropriate wholesale service products.

VoInternet (case 2) exists, however, if the conditions of VoNGN are not met.

The following figure 5-1 illustrates the difference between VoNGN and VoInternet and delimitation to PSTN telephony (VoPSTN).[34]

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30 The definition shall apply regardless of the technology of the interconnection interface and underlying network.

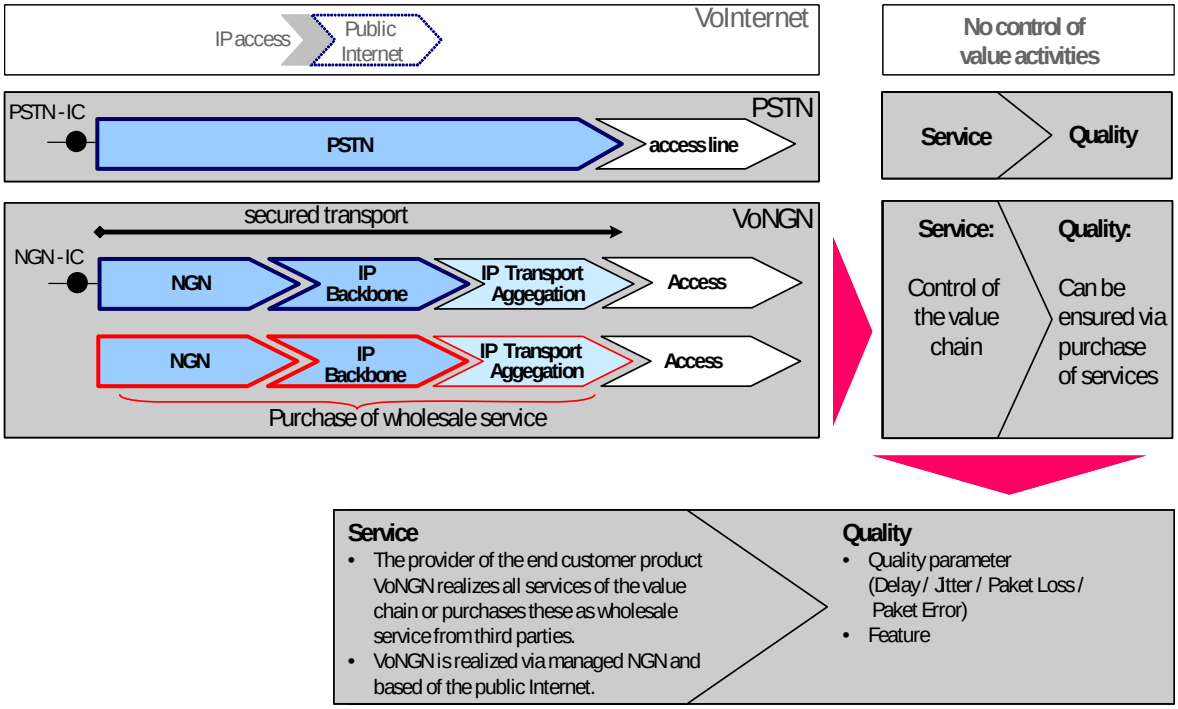
31 Appropriate quality commitments are required for wholesale service products.

32 During the migration phase from PSTN to NGN, there will also be networks that are converted gradually in line with commercial criteria to the new IP technology. Hybrid networks are therefore networks featuring both PSTN and IP components.

33 Detailed, measurable quality parameters are currently being developed and were not available at the time of submission of this chapter to the Federal Network Agency. The plan is to have the results achieved in the subworking group NGN checked by the working group of market participants in terms of the fact that the goal of avoiding arbitrage effects can be reached.

34 Only target values for meeting the quality parameters can be determined at present, since practical experience values are not available. The objective should therefore be the gradual development of quality standards. In the first step, the quality parameters, their target values and appropriate test and measuring

Figure 3-1: Definition of VoNGN and VoInternet



With an interconnection regime based on "Calling Party's Network Pays", different termination rates shall be applied for VoNGN (case 1) and VoInternet (case 2).[35]

3.3 Quality parameters, availability, features and security

NGN interconnection will be based upon ETSI-TISPAN[36] architecture by means of which the service layer controls the transport layer located underneath (see also figure 2). Standardization work at European level has not yet been completed. The topics of the following chapter will be elaborated and provided in detail by subworking group NGN. [37]

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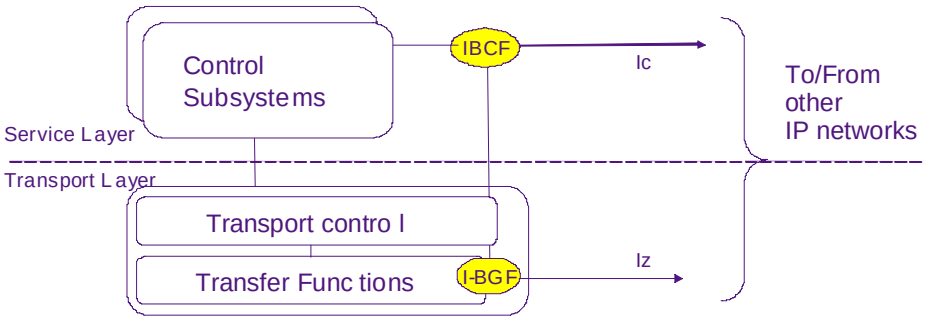
procedures are specified. The quality parameters are then measured and documented on a regular basis during the subsequent test and introductory phase and reviewed in terms of their practicality during a multilateral review prior to entering into a legally binding contract with financial consequences in the case of non-compliance. (Evolution).

35 See also chapter 7.2

36 ETSI TISPAN = ETSI **T**elecommunication and **I**nternet converged **S**ervices and **P**rotocols for **A**dvanced **N**etworking

37 For details see current specification draft of the subworking group NGN.

Figure 3-2: Interplay of Service and Transport Layer



3.3.1 Quality

VoNGN or VoNGN interconnection is to have a ”perceptible“ voice quality like PSTN for which minimum quality parameters and voice codes must be determined in the subworking group NGN. Relevant quality parameters could, for example, be delay, jitter, packet loss and packet error as well as codec. Voice quality between end customer interfaces and between (VoNGN) the network interface and end customer interface (VoNGN interconnection) must be determined in this respect. At present it is still unclear which quality parameters will actually be decisive - the expert group “QoS in NGN” was set up by the subworking group NGN to clarify this.

The current intention is to ensure the parameter values that are yet to be determined by way of dedicated connections between the session border controllers (SBC).

The voice codec G.711 is proposed by fixed network carriers as a fall-back, whereas mobile network carriers prefer the AMR codec. Details are currently being clarified by the subworking group NGN. This avoids a connection not being established due to incompatibility of codecs used in the NGN concerned.

Inter-network end-to-end quality is ensured with appropriate wholesale service products at aggregation level.

In addition, their compliance is checked with suitable measuring procedures (known as quality monitoring). The feasibility, cost and scope of this kind of monitoring have not been evaluated so far.

3.3.2 Availability at the network boundary

Availability at the network boundary is ensured by way of physical network interconnection using adequately dimensioned bandwidths between the session border controllers (SBC) and suitable redundancy concepts.

3.3.3 Features

VoNGN is to have the same features as for the standardization of ETSI TISPAN. Only inter-network features are relevant for NGN interconnection.

3.3.4 Safety

Suitable solutions for the protection of customers against SPIT, spoofing, etc. are still to be worked out.

3.4 Addressing

With regard to addressing, there must be differentiation between network addressing and subscriber addressing. Network addressing is to be realized via protected public IP addresses.

E.164 numbers are generally used for subscriber addressing. Other addressing possibilities are conceivable in the future if necessary.

3.5 Service portfolio

The service portfolio that is generally applicable for interconnection in PSTN today (without the services of T-Com O.12/T-Com O.14 and T-Com-B.2[38]) shall be gradually transferred to NGN interconnection. The service portfolio must be developed in such a way that the range of services can be developed further. When determining the parameters for NGN interconnection, the impact on the introduction of new services must be taken into account.

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38 In its regulatory order on the market analysis procedure of the markets 1-6 (BK2a 06/001-R), the Federal Network Agency has not imposed any obligations for VoIP services with regard to the selection and pre-selection of operators.. Instead, it stated that "these services can be used without pre-selecting a network carrier code on account of their technical realization", so there is no need for such an obligation for VoIP services. As a consequence, no corresponding supply service is required on the wholesale side for VoIP, as is the case in PSTN (here T-Com B.2).

The decision on when and which services of the current PSTN interconnection service portfolio are migrated to the NGN will be made by each network carrier, so that each network carrier can develop their own interconnection offer.

New IP services such as videotelephony are to be realized between network carriers via NGN interconnection in the future.

Termination of calls made by nomadic end customers with geographical numbers is treated as internal call forwarding and is not part of the interconnection termination service (T-Com-B.1/ICP-B.1).

3.6 Exchange of porting data[39]

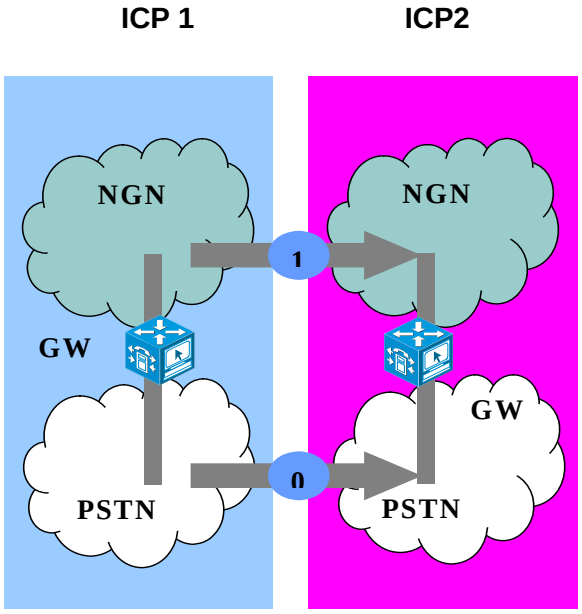
3.6.1 Problem description

The exchange of porting data in its current decentralized form provides the following important information for participating companies. The porting ID used generates both the current destination network of a connection for routing and the originating network for the F&I procedure. Routing is currently restricted to one gateway per company and one “quality class”.

The introduction of NGN alongside the existing PSTN network or hybrid network operation may result in two gateways with different technology (PSTN and NGN/SIP) being offered by various providers of termination services (in this case ICP 2). The exchange of porting data must provide appropriate information to allow the suitable gateway (0 or 1 in figure 3) to be selected for the carrier asking for termination.

39 So far, the statements made refer to the fixed network. A sector-specific solution is used for mobile communication for number porting and treatment of service providers.

Figure 3-3: Traffic handover at parallel gateways



The rates for termination services at gateways with different technology is another aspect affecting the decision made by the carrier requesting termination. The group of experts at the Federal Network Agency advocates applying the same rates for terminations in the NGN and the PSTN.

By means of the information provided by the porting data exchange server, the originating network carrier requesting termination can determine the gateway at which they handover the traffic without paying for an additional protocol conversion service[40] . If the traffic is handed over at the "wrong" gateway, however, the requesting network carrier must pay for conversion to the technology ultimately required as well as the respective termination rate.[41]

In addition, it is necessary to obtain information about the "VoINternet" termination service from the porting database to avoid arbitrage, i.e. to avoid the receipt of the entire termination rate while at the same time avoiding the entire termination costs for a connection that meets the quality requirements.

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40 The conversion service includes all costs incurred by conversion (protocol conversion, exchange, if required, and transport etc.).

41 If the providing network carrier (ICP2) provides only one gateway technology (PSTN or NGN), but uses both identifications for PSTN and NGN in the PDA procedure, the following must be clarified:

a) Can the providing network carrier (ICP2) charge for conversion resulting from the PDA procedure and the gateway offered?

b) Must the providing network carrier (ICP2) reimburse the requesting network carrier (ICP1) for any conversion required in their network?

This information is also evaluated by several carriers for routing purposes so that the gateways can be requested for the exchange of “VoINternet connections” by means of “call server coupling”. Whether all companies offering termination will provide “call server coupling“ and how this could be realized in technical terms still remains to be seen.

3.6.2 Routing principles at parallel gateways

To use the differentiation between PSTN, NGN and the Internet as destination network information in the porting database or in the exchange of porting data, the proposal of implementing this differentiation according to the porting ID is being looked at. According to this, the Federal Network Agency would allocate porting IDs for three systems (PSTN, NGN, Internet) in the future.

As an alternative, a solution using destination network parameters (flags) would be conceivable. This has been discussed on several occasions but turned down for further detailed work. Although it would be possible to obtain the functions specified, their implementation would require costly and time-consuming substantial adjustments in all relevant database systems in addition to process modifications in the PDA procedure that would have to be coordinated multilaterally.[42]

It must therefore be clarified how the “correct“ porting ID for VoPSTN and VoNGN is established:

a.) The network carrier providing termination establishes the porting ID at their own discretion.

b.) The network carrier providing termination establishes the porting ID according to fixed rules with no room for manoeuvre.

To avoid arbitrage potential and ensure quality of VoPSTN/VoNGN connections, the VoInternet termination service is integrated into the overall concept and the assignment of VoPSTN/VoNGN and VoInternet to the “correct“ porting ID is enabled.

If the termination service is a VoInternet service as defined in chapter 2, the E.164 number shall be assigned the porting ID for VoInternet in the exchange of porting data (PDAV).

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42 The following items were taken into account while analyzing both suggestions:
- Cost-benefit analysis and time required for extension possibilities of exchanging porting data, adjustments required in inter-carrier billing and adjustments required for billing and connecting services.
- Discussions in AKNN / subworking group Billing on the treatment of service providers during network interconnection,
- Current business models between service providers / resellers and network carriers for wholesale service products.

Compliance with the rules must be monitored and any violations must be punishable. Monitoring and punishment mechanisms are yet to be elaborated.

If a porting ID for “VoInternet” is available, the interconnection partners agree to assign this ID to one of the existing gateways (NGN or PSTN) or, if requested by one of the contract parties, to a dedicated gateway (call server coupling).

Some network carriers intend to open up the option of direct call server coupling to avoid purchasing transit services. The regulatory obligation to offer different gateways is disputed in this respect.

Other network carriers are of the opinion that the price yet to be determined for the VoInternet termination service could make call server coupling redundant.

Discounts on the NGN/PSTN termination rate for these ”VoInternet connections“ help avoid arbitrage. It remains to be seen which cost components determine the price for a VoInternet connection handed over to existing gateways (PSTN or NGN instead of call server coupling)[43].

3.6.2.1 Description of the various approaches

a.) The network carrier providing termination establishes the porting ID at their own discretion.

The porting ID associated in the porting database with the E.164 number identifies the gateway preferred by the network carrier (ICP 2) providing the termination. This allows the network carrier to choose a certain gateway technology for technical reasons, even if this is not totally compatible with the technology of the underlying network components to the destination number (e.g. in hybrid networks)

At the same time the network carrier (ICP 1) requesting termination can choose another gateway if ICP2 offers parallel gateways in another technology. The requesting network carrier can then choose the actual traffic gateway, while the network provider determines the preferred gateway based on the information obtained from the porting database.

b.) The network carrier providing termination establishes the porting ID according to fixed rules with no room for manoeuvre.

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43 See also chapter 7.2

The assignment of the porting ID to an E.164 number is determined by rules in such a way that the network carrier offering termination has no degree of freedom for the assignment of an E.164 number to a gateway technology.

If the termination service corresponds to a VoPSTN or VoNGN service in terms of quality, the E.164 call number will be identified with the porting ID for VoNGN/VoPSTN in the exchange of porting data (PDAV) according to the technological implementation of the network unit to which the subscriber access is connected.

If a network carrier identifies an E.164 number with VoPSTN or VoNGN, they are required to offer the appropriate PSTN or NGN interconnection. If they do not do so, they are required to reimburse any extra costs for conversion, exchange and transport accrued by the requesting network carrier.

Compliance with the rules must be monitored and any violations punishable.

3.6.2.2 Evaluation of the various approaches

There is agreement on all sides that E.164 numbers that address VoInternet services as defined in chapter 2 must be identified as such in the exchange of porting data. This is to avoid arbitrage.

The criteria for identifying gateways for VoPSTN and VoNGN in the exchange of porting data are yet to be determined.

a.) The network carrier providing termination establishes the porting ID at their own discretion.

As a rule, it can be assumed that the network carrier offering termination (ICP 2) will enter information into the porting database that enables them to use the termination service efficiently (e.g. low gateway use). From a purely economic perspective of the network provider, it can be assumed that the requested gateway technology (NGNM or PSTN) is compatible with the technology of the underlying network components to the destination number.

For technical reasons, a particular gateway technology can be chosen even if this is not entirely compatible with the technology of the underlying network components to the destination call number (hybrid networks). Technical reasons, such as threats to certain connection features (e.g. overlap dialling), can advocate a step of this kind that results in higher termination costs for the network provider (ICP 2), but not higher termination revenues. The network provider alone must decide whether these technical reasons are important enough to pay higher termination costs voluntarily.

This approach separates the process of rate determination and actual technical implementation. The termination fee specified above is charged for the gateway (NGN or PSTN) identified by the network provider. If the requesting network carrier (ICP1) makes use of the other gateway offered, an extra transit fee is charged in addition to the termination rate that includes, in addition to the transport costs, any required conversion costs from NGN to PSTN or vice versa.

By identifying the preferred gateway, the network provider (ICP2) indicates to the requesting network carrier (ICP1) the most low-cost solution for ICP1 If the indicated gateway does not represent the most low-cost solution for ICP2 - because a conversion might be required from PSTN to NGN - ICP2 must bear these extra costs.

In this way, the requesting network carrier (ICP1) obtains information on the termination rates incurred. The requesting network carrier is then free to decide whether to perform any required conversion of the connection in their own network or purchase it from the network provider by accepting an extra transit fee.

It is therefore generally in the network provider's (ICP2) own economic interest to enter information into the porting database that matches the technically implemented solution and represents the most efficient path to the destination subscriber. The providing carrier (ICP2) thus gives the requesting carrier (ICP1) the economically correct incentives for their decision on whether to perform any conversion services required themselves or in the target network.

This requires the same price level for the termination service with VoNGN and VoPSTN so there are no arbitrage possibilities. An NGN interconnection at the lowest network level at the maximum number of gateways would be just as expensive as a PSTN interconnection at the maximum number of gateways. (see chapter 7.2 footnote 17)

This approach has the following disadvantages:

The unrestricted freedom given to the carrier providing termination for assigning E.164 numbers to the "correct" porting ID opens up possibilities that can exceed the economic self-interest of a company. Activities in the interests of the providing carrier at the expense of the requesting carrier cannot be ruled out.

The production costs of the requesting carrier (ICP1) depend on which gateway is preferred by ICP2. For example, ICP2 determines by way of porting ID at which gateway the connection will be handed over if a PSTN subscriber (A) of the network carrier (ICP1) calls a customer (B) in the network of the carrier (ICP2) offering termination. If the end customer's (B) access is connected to a PSTN exchange in ICP2's network and ICP2 determines the porting ID NGN for the number concerned, ICP1 is unnecessarily forced

to perform a PSTN-NGN conversion, since direct termination in PSTN interconnection is excluded.

If ICP2 offers less network gateways in NGN than in PSTN, ICP1 is also required to transport the connections - that would be handed over close to the origin in PSTN - to a remoter NGN gateway. This results in increased production costs for the requesting carrier ICP1.

This could only be remedied, however, if all carriers were simultaneously required to provide all parallel gateways in various technologies (NGN and PSTN) and a different handover of the information contained in the porting database was not possible. The make-or-buy decision specified above, however, would then no longer be possible for the requesting carrier,. The providing carrier would then determine both the requested and the actual gateway.

b.) The network carrier providing termination establishes the porting ID according to fixed rules with no room for manoeuvre.

The unrestricted freedom given to the carrier providing termination for assigning E.164 numbers to the "correct" porting ID opens up possibilities that can exceed the economic self-interest of a company. Activities in the interests of the providing carrier, such as the restriction of competitiveness of the requesting carrier can be ruled out if the degree of freedom for assignment is restricted.

Only the carrier providing termination ICP2 can terminate the call in their own network and identify the requested gateway by means of porting ID. Approach b) prevents carriers using the termination service for their own economic interests and to affect the competitiveness of other companies.

If strict rules are imposed on the providing carrier ICP2 under which the porting ID is assigned and thus the gateway chosen, the risk of increased costs for the requesting carrier ICP1 for unnecessary conversion and network services can be reduced in the provision of termination.

This approach has the following disadvantages:

Additional monitoring and punishment mechanisms are required to be able to check if the firm assignment of E.164 numbers to the technology of the last exchange is complied with.

The obligation to indicate the NGN gateway may mean restricting certain features of ICP2 subscribers.

3.6.3 Implementation of the new procedure for exchanging porting data under the new assignment rules for geographical numbers

For COLT Telecom, linking the topic "Solution concept for providers without networks" (as described in chapter 6.3) to the introduction of the overall concept "NGN Interconnection" is inadequate, since a substantial time delay is to be expected. According to COLT, the short-term integration of providers without networks into the existing PSTN interconnection regime is of prime importance due to the currently applicable allocation rules. COLT Telecom demands the immediate implementation of the applicable allocation rules for providers without networks.

3.6.3.1 Background

New allocation rules have been published in the Official Journal no. 9/2006 under Administrative Order no. 25/2006 for geographical numbers in Germany.

This states that geographical numbers are allocated by means of a 2-stage procedure:

a) Local numbers are allocated in number blocks to providers of telecommunication services (original allocation)

b) Numbers are allocated to subscribers (derived allocation) by the party to which the number blocks were originally allocated (allottee).

Unlike in the past, original call number allocations are thus no longer provided to network carriers (providers of subscriber lines). Nowadays all companies that offer telecommunication services, including companies without their own infrastructure, are generally authorized to apply.

By being allocated a number, the allottee is granted the right to allocate numbers to end customers as derived numbers. The right to allocate derived numbers includes the option of contractually commissioning a third party with the allocation. Depending on the contract terms, the derived allottees can be customers of the original allottee or of third parties.

With the number allocation, the original allottee is also granted the right under allocation rules to activate or have activated the numbers allocated to them by using their own porting ID. According to the Federal Network Agency, it can be clearly concluded from the allocation rules that this right can be interpreted in such a way that the allocated call number can only be activated by using their own porting ID with the result that there is ultimately an obligation to use their own porting ID to activate allocated call numbers. If the original allottee contractually commissions a third party with the derived allocation to end customers, the porting ID of the original allottee must be used under the allocation rules.

The new allocation rules have been in effect since 01 July 2006.

3.6.3.2 Problem description

So far, numbers were only allocated to the carrier (provider of subscriber lines). This meant that the original allottee and network carrier were identical. Under the new allocation rules, numbers are also allocated to companies without their own infrastructure. Using their porting ID, these companies can now also participate in the exchange of porting data.

The porting ID thus loses its information function to determine **in which network** the call number is activated. This information, however, is critical market participants to determine the destination network and, if necessary, the originating network.

3.6.3.3 Requirements of the solution

A set of rules must be established that restores clarity and meets the following requirements:

1. Determination of the original allottee
2. Determination of the destination network carrier for routing between network carriers and determination of the originating carrier (offline billing as well as F&I processes)
3. No change and clearly assignable responsibility in the porting and F&I process
4. Identification of individual connections depending on VoPSTN/VoNGN and VoInternet for accounting according to differentiated termination rates.
5. The costs of the solution shall be borne by the requesting carrier or original allottee without a network
6. Short-term implementation of the solution
7. No manifested business model
8. Flexibility for the original allottee without a network (reseller) to activate the call number in several networks

3.6.3.4 Suggestion

1) Determination of the original allottee:

   The original allottee is always identified by means of the porting ID (Dxxx) in the porting database.

2) Determination of the destination carrier and determination of the originating carrier:

If an original allottee without a network wants to activate call numbers, they must name a network in which these numbers and the porting ID allocated to them is activated. This network is called "allocated destination network" below.

The allocated destination network can be determined using the porting ID published on the website of the Federal Network Agency (http://www.bundesnetzagentur.de/enid/696451d956a36e474b7357efd53c5acc,0/Portierungskennung/Verzeichnis_1ct.html). This list contains the assignment of the original allottee to their porting ID and the address of the original allottee. The allocated destination network can also be requested from the original allottee. (See also item 7)

3) Responsibilities:

   The original allottee is responsible for the compliance of all processes concerning porting and F&I. Any existing porting and F&I processes must therefore not be changed.

   This means that the original allottee must ensure that only accountable traffic is provided to services. It must also operate the porting processes (fax process/ESAA).

   It goes without saying that the original allottee can seek assistance in complying with these requirements from a service provider. Whether a service is purchased from the "allocated destination network" and/or clearing house is up to the original allottee. The original allottee listed in the database will ultimately always be responsible. After porting, responsibility switches from the original allottee to the "provider of the telecommunication service" whose porting number is then used for the exchange of porting data.

4) Identification of individual connections depending on VoPSTN/VoNGN and VoInternet for accounting according to differentiated termination rates (see chapter 7.2)

5) Costs:

   The carrier ("allocated destination network") into whose network the additional porting IDs are to be activated charges T-Com with routing these new porting IDs to the existing ICAs, i.e. several porting IDs are handed over to the destination carrier in a bundle and the IC service portfolio agreed and configured with the carrier is equally applicable to all porting IDs in the destination network. The costs for these configuration activities are borne by the requesting carrier or company to whom the porting ID is allocated. This can be arranged individually in the bilateral contract between the relevant carrier (“allocated destination network") and the original allottee without a network. T-Com standard IC offer must then be modified accordingly.

   A great advantage of this solution is that the costs are borne by the companies that participate in these new business models. If the porting database had to be adjusted, all carriers would have to implement these changes and hence bear any costs arising from that.

The costs resulting from future connections to the F&I procedure must be borne by the requesting F&I contract party. According to some carriers, this aspect can be supplemented as part of an "agreement on the future formulation of General Terms and Conditions for billing and collection services of T-Com".

The configuration in the T-Com network means that any carrier can reach the numbers allocated to the porting ID via the T-Com-O.2transit service. It is up to each originating carrier to determine the destination network via the porting ID and send the traffic directly to the allocated destination network.

Since the allocated network is the last entity of termination, the regulated termination rates are charged here (e.g. ICP-B.1, T-Com-B.1). A transit surcharge is not justifiable here.

6) Implementation period

A short to medium-term implementation period seems possible at present. Specific details have not, however, been agreed by all parties concerned yet. A gradual approach is considered feasible by the companies:

Step 1: The Federal Network Agency supports the suggestion submitted on the allocation of several porting IDs to identify the termination service described here and the allocation of several porting IDs to a provider without a network. There are different opinions on treating both items as one.

Step 2: Operational implementation of the integration of resellers without a network into the exchange of porting data can be done rapidly.

Step 3: The complete operational implementation of identification of the correct gateway (PSTN, NGN, Internet) for routing and accounting has an impact on various database systems (billing systems) and must be scheduled accordingly.

7) No manifested business model

The allocation rules enable the original allottee to allocate the derived allocations to end customers themselves or via a third party. This is their undisputed right.

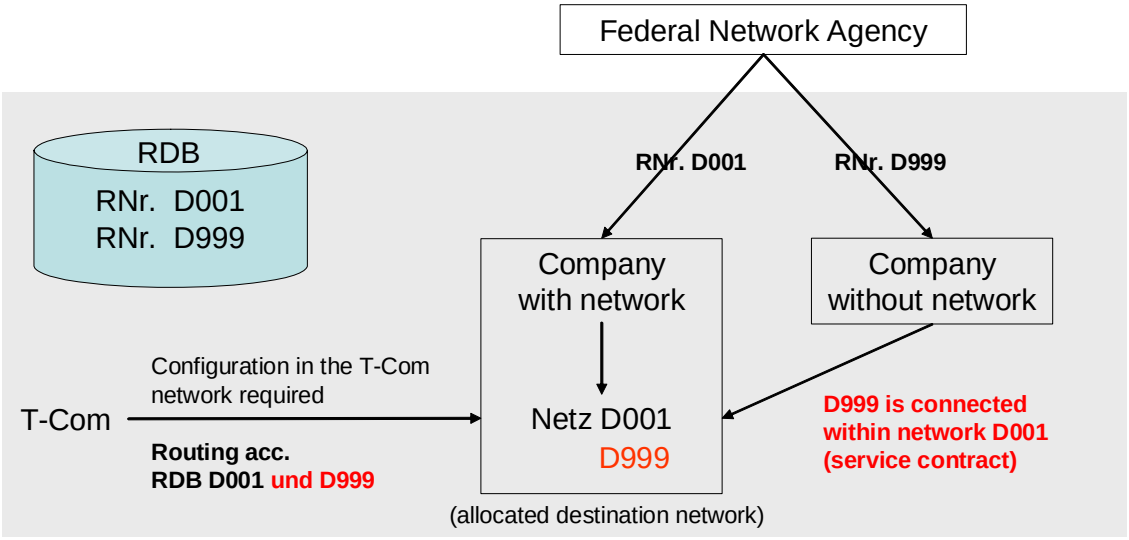
If an original allottee without a network wants to implement a telecommunication service (call numbers), they are free to decide which parts of the value chain they will provide themselves or alternatively purchase as wholesale service products or services (see also item 3).

8) Flexibility for the original allottee without a network (reseller) to activate the call number in several networks

This suggestion offers no flexibility for the reseller. A reseller in the role as an original allottee can activate the porting ID allocated to them in a network only. This initially means that the resellers must tie themselves down to a carrier.

This obvious disadvantage must be avoided by relaxing the allocation rules for porting IDs. If the Federal Network Agency agreed to adjust their allocation rules to the extent that up to 3 porting IDs are allocated to each company, competition would be possible and this disadvantage avoided. The fact that numerous porting IDs are allocated is no cause for concern, since configuration costs are charged for all new porting IDs. This concept would not be acceptable for service providers without the allocation of several porting IDs per service provider and network technology.

Figure 3-4: Illustration of the use of porting IDs



3.6.3.5 Evaluation of the suggestion

All of the requirements described above can be met by changing the regulations on the allocation of porting IDs by the Federal Network Agency. Companies with new business models are integrated into the existing multi-carrier landscape and must comply with the processes agreed and established between carriers.

This ensures that uninvolved networks (TNB or VNB/SP) only have to modify their processes and/or existing database systems with a reasonable amount of effort. The suggestion can be

implemented for these carriers on a cost-neutral basis in some cases. The implementation costs would have to be borne by the party responsible.

3.6.4 Required porting IDs

The procedure suggested in chapter 3.6 would require the allocation of at least 3 porting IDs to the requesting company for differentiating the technology for the correct traffic handover and accounting specified in chapter 3.6.2. Additional porting IDs would be required for providers without a network to realize their numbers in different networks. An upper limit is recommended. Dxyz porting IDs are available from D001 to D999 at present.

A variety of hexadecimal IDs have already been used for internal purposes in current PSTN networks. Modifications are always associated with substantial efforts and should be avoided for this reason.

If the number range of 1,000 IDs available is insufficient based on efficient use of the number resources, an industry solution will be suggested to the Federal Network Agency by the market participants.

3.7 Pricing for voice connections in NGN interconnection

3.7.1 Pricing models and structure

The pricing for voice connections during NGN interconnection was mainly based upon two pricing models. On the one hand, the zone model was discussed in the form of Element Based Charging (EBC) - a hierarchical price model that is applied today for interconnection in PSTN. On the other hand, the non-hierarchical Pol model (Point of Interconnection = Pol) was considered, which is used for interconnection in mobile communications today.

The following description focuses on the provision of termination as the most important connection service in terms of volume. Supply, transit and value-added services are described in detail following determination of the pricing principles.

Charges for the EBC model are based upon the number of continuous network elements that are located on several network layers. There are currently three different rates: local, single transit and double transit.

If a carrier has developed interconnection points in all 23 basic catchment areas of the T-Com network at present, they only pay the "local" and "single transit" rates for termination provided by T-Com. In the case of less than 23 interconnection points with the T-Com

network, the "double transit" rate is also charged. However, if a carrier is interconnected with T-Com at 474 local catchment areas, their termination service only requires the lowest rate - "local". As a result, the EBC model rewards the extension of own infrastructure.

The amount of the termination charge in the Pol model depends upon the number of interconnection points developed by the carrier requesting the interconnection service. As a rule, the more interconnection points that have been developed, the lower the termination rate. In an extreme case, a new rate would be required for each interconnection point. Rate groups would however also be conceivable as in the EBC model.

A unit price model would also be a possible alternative. This model was not considered in the discussion, but a unit price model could be a reasonable approach for future services that are transmitted beyond network boundaries.

The evaluation of the pricing models has not been completed yet with the result that a particular pricing model has not been decided on . Considering and rewarding infrastructural investments, considering efficiency criteria and accountability are important assessment criteria for the individual models.

The choice of pricing model also depends on the efficient type of traffic handover of geographical numbers (close to destination/origin). If an EBC model is used, the traffic handover of geographical numbers would have to be realized close to the destination as in the current PSTN. This would require, however, handover close to the destination being realized in a controlled and efficient manner.

The question of traffic handover for location-independent call number ranges such as the national subscriber number (0)32 or mobile communications numbers is clearly answered. Due to the lack of geographic location determination, traffic is always handed over close to the origin.

The companies envisage a pricing structure with several rates for voice connections in the case of NGN interconnection.

The concrete determination of rates and rate levels, however, depends on the network structure and mainly on the number of interconnection points. Since the NGN technology is still under construction and the market is only at the beginning of migration from the PSTN to the NGN technology, no definite statement can be made as yet about the final network structure and final number of future interconnection points in the NGN. The number of interconnection points mainly depends upon the development of traffic volumes for the service portfolio within the framework of NGN interconnection, which cannot yet be assessed for the future. The carriers intend to provide efficient network structures and determine the technically and economically optimal number of interconnection points for the interconnection

partners involved. Therefore, a gradual extension is intended depending upon the development of traffic volumes based upon efficiency criteria and cost aspects.

With regard to billing units, voice connections transmitted beyond the network boundaries are also charged in minutes with NGN interconnection. In this respect, a differentiation of rates according to peak and off-peak as an instrument for controlling network capacity and comparing the price level in the migration phase would be feasible as is the case at present in PSTN.

3.7.2 Price level

Since VoNGN shall have the perceptible quality of PSTN and these voice products are perceived by the end customer as being equal, the termination services must have the same price level.[44] This is essential to avoid arbitrage potential between PSTN and VoNGN. This also ensures investment-compatible migration to NGN technology. The method of determination and absolute amount of a uniform price level is not subject of the discussion.

As already mentioned in chapter 2, however, a differentiation is made between VoNGN and VoINternet due to differences identified when determining certain quality parameters and controlling the value activities. Since this involves different services, different rates shall be applied for VoNGN and VoInternet in the case of an interconnection regime based upon the "Calling Party's Network Pays" principle. The individual rate components of the termination services and the cost allocation in the case of NGN interconnection (NGN-IC) must still be determined in this connection.

The aim is also to use an efficient type of interconnection. If a call has its origin in PSTN and the destination is also a PSTN customer, an efficient interconnection would be realized via the PSTN gateway, since no additional protocol conversions are required. The same applies if the origin of a call is located within NGN and the destination customer is also in the NGN. The price level for both interconnection types would be the same in this case. However, if a protocol conversion is required because the caller is a PST customer, the called party is connected in NGN, a rate for the protocol conversion service is charged in addition to the termination rate. This is always the case if the protocol conversion service is not rendered by

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44 See also the discussion of the expert group at the Federal Network Agency on 03 May 2006 and 07 June 2006. Practical implementation would be conceivable for some companies in a way that the amount of the "smallest" termination service in the case of PSTN and NGN interconnection, i.e. in the case of an activation of a maximum possible number of interconnection points, is equal. This involves the risk for other companies that existing infrastructural investments for nationwide PSTN interconnection would lose their value, since the number of interconnection points of future NGN interconnection will be lower than today. According to some companies, this could be counteracted by charging absolutely equal rates only in the case of the same rate and zoning structures in PSTN and NGN.

the carrier requesting termination but the traffic handover is realized in another protocol and thus at another gateway.[45]

3.8 Summary of results so far and next steps

The analysis and results on NGN interconnection for voice connections have been performed based on the "Calling Party's Network Pays" principle. The aim is to avoid arbitrage potentials, set investment incentives and ensure inter-network quality.

There will be two different types of voice products via the IP protocol in the future: Voice over NGN in which the perceptible voice quality is ensured via managed networks, and Voice over Internet (Internet telephony) which is realized via the public Internet and does not ensure the quality parameters of the NGN.

VoNGN thus represents an analogue service to PSTN telephony. To avoid arbitrage potentials, the price level must be the same for PSTN and VoNGN interconnection. Since VoInternet differs from PSTN and VoNGN with regard to ensuring a quality standard, they shall be treated differently compared to PSTN and VoNGN interconnection.

To differentiate between PSTN, VoNGN and VoInternet traffic in terms of routing/traffic handover and the interconnection rate, information about the type of destination network should be obtained from the porting database.

The following items still have to be assessed:

- Required and feasible realization schedule and implementation costs for NGN interconnection (standardization, quality standards, measuring systems, etc.)
- Required and feasible realization schedule and implementation costs for the gradual change of the exchange of porting data, including adjustments in the CRM systems for the differentiation between VoPSTN/VoNGN/VoInternet
- Call-server coupling at VoInternet including technical and commercial implementation as well as legal and regulatory obligations
- Discussion of the Bill & Keep model within the framework of the existing cornerstones for NGN interconnection
- Discussion about future price models/pricing structure

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45 See also chapters 6.1 and 6.2. If the terminating carrier does not provide any parallel gateways for PSTN and NGN, it must still be clarified, who will be responsible for providing the protocol conversion service possibly required and paying for it.

- Procedure for determining the porting ID in the exchange of porting data by the providing carrier (criteria for the allocation of VoNGN/VoPSTN)
- Consideration of the European and international discussion and solutions on interconnecting IP-based networks for voice.

4 Résumé

4.1 Executive Summary

This final report shows the possible development trends for a sustainable interconnection regime in view of the upcoming conversion to IP-based networks.

Chapter 2 includes considerations for a long-term sustainable interconnection regime in an all-IP world. In addition, the chapter includes thoughts on the implementation of the migration process into such an interconnection regime.

Chapter 3 looks at solutions for current questions arising for VoIP services from the different accounting systems used in PSTN and the Internet.

Chapter 2: Core elements of an interconnection regime for an all-IP network

Number and location of interconnection points

In order to be able to answer the question of the number and structure of interconnection points, the structures and resulting implications of future networks must be analyzed. It must be taken into consideration that fixed networks are the key issue of this report. Mobile radio has been considered, but not discussed in detail.

Far-reaching structural changes in the network architecture and topology are associated with the development of IP-based networks. In particular the (possible) separation of service and transport is an important feature of future network structures. The functional layers service, control and transport can be differentiated in NGNs and provided separately, if required. To ensure complete service operability (including end-to-end connectivity), it may be required to ensure interconnection on all layers (service, control and transport layer). [46]

The configuration of services and the scheduled centralization of control functions have a large impact on the question of which points traffic can be taken over from or handed over to other networks. It is not realistic to expect continued use of the currently existing system in

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46 See also ECC Report 75 (2005) as well as IETF working group “Session PEERing for Multimedia INTerconnect –speermint” (http://www.ietf.org/html.charters/speermint-charter.html).

which voice services can be handed over to competitors on almost all hierarchical levels of the network.

As far as the number of interconnection points is concerned, the number of locations of the future NGN of the national network carrier is of particular importance. This question has been analyzed in a study with a hypothetical national NGN for Germany as an example. A scenario calculation for all broadband traffic based upon this hypothetical national NGN in Germany showed that no more than 100 IP core network locations can be expected in the long run. This result also applies even on the basis of high growth rates in the bandwidth required by bandwidth users. According to the members of the project groups, 100 locations might be a realistic upper limit for the number of locations for IP interconnection in the core network.

However, it cannot yet be identified whether the interconnection for the termination of VoIP traffic will be limited to the locations of IP network nodes or if interconnection at a lower level between the locations of the concentrator network will be possible. Thus, the question concerning the number of interconnection points between NGNs of various operators remains open from a technical and economic point of view.

Reducing the number of interconnection points particularly affects national and local PSTN/ISDN network carriers if the interconnection points they have used so far are abandoned by the national carrier.

From a regulatory point of view, suitable interconnection and access products must be ensured that have the interdependency of the most efficient network structure and topology possible of established carriers and competitors minimizing ”stranded investments“ among all market participants. They aim at creating equal competitive environments for all market participants even after a conversion to all-IP networks. This particularly applies in view of the regulatory target stipulated in the telecommunications act to support efficient infrastructure investment and innovations.

Quality differentiation in the interconnection regime?

One characteristic of future networks will be that *different* services with *different* quality requirements can be transported over *one* network. At present, they can be classified into four quality-of-service classes with declining requirements: Real-time services, streaming services, data services and best-effort services. NGNs and other IP-based networks clearly focus on end-to-end quality. The implementation of QoS will be associated with additional costs. The allocation of these additional costs for the implementation of QoS to several services or types of traffic will definitely raise complex questions, since a variety of interdependencies are involved.

An interconnection regime could generally treat all traffic equally (as was generally the case in PSTN and on the Internet in different quality) and differentiate according to quality classes or services. Differentiating according to different quality classes within one service is also conceivable. This approach is pursued by the group of market participants with a differentiation of VoIP in VoInternet and VoNGN that is presented in chapter 3 in detail.

Price structure and price level of interconnection services in PSTN and NGNs

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

Since the costs in the NGN are expected to be substantially lower than in the PSTN, there is much to be said for taking these low costs as a basis for the pricing of IP interconnection particularly since it must be assumed that the migration process towards NGNs has already started. The pricing should be valid irrespective of whether interconnection is realized via PSTN or NGN, since a strict application of the cost structure of long-term add-on costs requires the efficient technology used by the market to be taken as a basis. Consideration must also be given to the fact that the concept of the cost of efficient service provision does not differentiate price according to technology or account for the existence of different prices. Basing prices on efficient technology also provides incentives for accelerating migration to this technology.

In view of the (potential) cost change due to NGN, an immediate switch of the interconnection rates to this low NGN level is considered too disruptive for the market and particularly for the providers of interconnection services. Such a sliding path could also be understood as resulting from a mixture of the costs of the PSTN/ISDN and the NGN with an increasing proportion of NGN costs over time.

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

The principle of uniform prices for the PSTN and IP interconnection must also be defined in terms of structure. This represents a complex challenge that needs to be discussed in detail; firstly because hierarchical levels may be reduced and secondly because the functional levels of PSTN and NGN are not necessarily equivalent. With regard to the structural definition of the principle of uniform prices for PSTN and IP interconnection, the opinions of the experts differ considerably.

The concrete implementation of the principle of uniform prices also affects the incentive to migrate to NGNs: This particularly applies to the different number (of maximum) interconnection points in the PSTN and NGN. There will be no negative price incentives for a migration to NGN if the "local" rate of the EBC regime with 474 interconnection points to achieve nationwide network coverage also applies to the maximum number of interconnection points offered in the NGN for nationwide network coverage. This principle provides the correct economic incentives for IP interconnection providers to offer a relevant number of interconnection points in due time and for consumers of interconnection services to make use of efficient IP interconnection early and thus accelerate the transition to this efficient technology.

Before it is possible to suggest final solutions and take final decisions in the context of price structure and level, the topic must be analysed in detail by the Federal Network Agency. A decision on the exact rates for interconnection must finally be taken in a ruling chamber procedure.

Accounting systems as part of the interconnection of IP-based networks

Another core element is the accounting system that determines “who“ pays for which elements in the value chain and what they are paid for.

Accounting systems on wholesale service level are a major part of interconnection regimes. Currently there are different accounting systems for interconnection in PSTN and IP-based networks: in PSTN on a Calling Party’s Network Pays basis and on the Internet mainly on the basis of Bill & Keep and transit agreements. This raises the question as to which accounting system should be used for NGN.

The termination monopoly is frequently considered the central issue in the CPNP regime[47], which is why termination rates are regulated. Bill & Keep avoids the termination monopoly and thus reduces the need for regulation - termination rates would no longer have to be fixed.

With Bill & Keep there is no longer an incentive to concentrate on customer groups with increased incoming traffic.[48] If termination rates are no longer charged, this will presumably increase the trend towards balanced traffic flows, even between networks of different size.

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47 See also Marcus (2006a), page 9f, DeGraba (2000), page 7. With reference to the termination problem in mobile radio, see Valetti/Houpis (2005). When explaining the reasons for the termination problem, reference is sometimes made to CPP (i.e. end customer level) and sometimes CPNP (i.e. wholesale service level) in the literature. This difference can be ignored since the systems at both levels - to a certain extent - are interconnected. Vogelsang (2006, page 153) links both levels and states that ”Calling Party Pays“ causes a termination problem as long as there are not several independent accesses to the individual call receivers.

48 Therefore, Bill & Keep must be positively rated both with reference to its static efficiency (allocation, production) and its dynamic efficiency. See also Charles River Associates (2002), Rz. 42, 43, 50.

The so-called “hot potato” problem is a fundamental disadvantage of Bill & Keep that can result in a suboptimal level of investment. The ”hot potato“ problem can be responded to by requiring a network carrier to set up a certain number of interconnection points to be able to participate in the Bill & Keep regime. Bill & Keep only applies in the concentration network in this case, whereas the EBC regime continues to apply for the core network. The discussion of such a dual system and thus the regulatory transaction costs will focus on determining the minimum number and location of the interconnection points that entitle participants to take part in the Bill & Keep regime. In addition, the following questions must still be discussed:

- Is there enough investment in network quality for the dual regime (B&K in the concentrator network/EBC in the core network)?
- What is the role of the connection network carriers in a Bill & Keep regime?
- What part do balanced traffic volumes play as a prerequisite for Bill & Keep?
- Is the end customer ready to pay for incoming traffic assuming that the introduction of B&K on the end customer side results in RPP (which is however not necessarily the case)?
- Implications for value-added services.

Some experts can imagine Bill & Keep developing on the market between two interconnection regimes in individual cases, but take the view that a Bill & Keep system established by the regulatory authorities would result in distortions of competition with a particularly negative impact on major networks. They prefer an interconnection regime based upon CPNP in the long run.

Some experts can, in theory, picture a dual regime of this kind differentiated according to network layers as a long-term goal following clarification and thorough discussion of the questions raised above, with Bill & Keep being applied in the concentration network and Calling Network Party Pays based upon EBC in the core network. However, it is not currently considered feasible to fix a specific time schedule for this. In view of the still unanswered questions, a decision about a sustainable interconnection regime cannot be made by now.

Migration period

Migration questions are raised for two reasons:

On the one hand, the question arises as to the duration of full conversion to an all-IP network and the basis on which the interconnection rates should be determined in the transitional period. Reference should be made to the section 'Price structure and price level of interconnection services in PSTN and NGNs' for this.

If a dual accounting system with B&K for the concentrator network and EBC for the core network is to be introduced, the question arises of the period over which the interconnection rates in the concentrator network will be reduced to zero. As the lower costs of the NGN increasingly take effect, it is feasible to anticipate a reduction in interconnection rates. This would facilitate the transition to a Bill & Keep regime.

Migration towards NGNs has already been started. The opinions of the experts differ on how fast it will be completed. The duration of the migration path depends upon a variety of factors:

- Individual network carriers have different investment cycles and will make their investment decisions according to the quality and depreciation factor of their existing networks. The speed of network reconstruction by the national carrier is crucial to the national interconnection regime.

- Investment decisions made by network carriers are mainly determined, however, by how long manufacturers maintain the old technology (e.g. software updates for EWSD).

- In addition, market development in terms of traffic volume and penetration of NGN services plays an important role.

According to the experts' unanimous opinion, it is impossible to make a precise statement about the actual duration of the migration path yet, since there is some uncertainty about the importance of the various factors and their interaction.

Chapter 3: Current Questions - Cornerstones of an interconnection concept for IP-based voice networks between NGN network carriers

In chapter 3 the market participant workgroup presented their approaches in response to the challenge posed by the current coexistence of different accounting principles for voice services at interconnection level in PSTN and the Internet. Based upon the current accounting system at wholesale service level, they are intended to enable short-term interconnection of IP-based networks for voice services in practice. A final decision on the accounting system (CPNP versus B&K) to be used in the long run is still outstanding.

The following individual issues are mainly addressed: Differentiation of Voice over NGN and Voice over Internet (3.2); QoS aspects (3.3), addressing issues (3.4), service portfolio (3.5), exchange of porting data (3.6) and several pricing matters for voice connection during NGN interconnection (3.7). This chapter was prepared by the group of market participants.

The analysis and results on NGN interconnection for voice connections have been performed based on the "Calling Party's Network Pays" principle. The aim is to avoid arbitrage

potentials (if a cause of concern for the competition), set investment incentives and ensure inter-network quality.

There will be two different types of voice products via IP protocol in the future: Voice over NGN in which the perceptible voice quality is ensured via managed networks, and Voice over Internet (Internet telephony) which is realized via the public Internet and does not ensure the quality parameters of the NGN. Ultimately, the market and consequently the consumers will decide which voice telephony model will be successful.

VoNGN thus represents an analogue service to PSTN telephony. To avoid arbitrage potentials, the price level must be the same for PSTN and VoNGN interconnection. Since VoInternet differs from PSTN and VoNGN with regard to ensuring a quality standard, they shall be treated differently compared to PSTN and VoNGN interconnection.

A decision on the exact rates for interconnection must finally be taken in a ruling chamber procedure.

To differentiate between PSTN, VoNGN and VoInternet traffic in terms of routing/traffic handover and the interconnection rate, information about the type of destination network should be obtained from the porting database.

The following items still have to be assessed:

- Required and feasible realization schedule and implementation costs for NGN interconnection (standardization, quality standards, measuring systems, etc.)
- Required and feasible realization schedule and implementation costs for the gradual change of the exchange of porting data, including adjustments in the CRM systems for the differentiation between VoPSTN/VoNGN/VoInternet
- Call-server coupling at VoInternet including technical and commercial implementation as well as legal and regulatory obligations
- Discussion of the Bill & Keep model within the framework of the existing cornerstones for NGN interconnection
- Discussion about future price models/pricing structure
- Procedure for determining the porting ID in the exchange of porting data by the providing carrier (criteria for the allocation of VoNGN/VoPSTN)
- Consideration of the European and international discussion and solutions on interconnecting IP-based networks for voice.

4.2 Further need for clarification

The future work programme initially involves detailing the short-term approaches in terms of the items still to be evaluated. With reference to the long-term approaches, agreement on major topics could be reached within the expert groups. This applies to the shared assumption that

- there will be a reduced number of interconnection points in NGNs compared to the PSTN,
- a uniform price level for PSTN and NGN interconnection is suitable for avoiding arbitrage,
- it is impossible at present to make a clear statement on the actual duration of the migration path.

Discussions about other core issues and their central elements have only been touched on so far. Differences in the evaluations of the experts have become clear here.

Given the complexity of the topics dealt with, the current uncertainty about the specifics of the DTAG network restructuring and the different impact that a new interconnection regime will have on market participants with various business models, it is no wonder that there are discrepancies in the evaluations. With the progress in further technological development and the continuing discussion in Europe, it may be that the outline of a solution to the questions that are still open (appropriate accounting system, concrete implementation of an identical price level for PSTN and IP Interconnection, assessment of arbitrage possibilities in the current system) is emerging. The criteria[49] that have already been defined in the mandate of the expert group will provide guidance for solving the questions.

Further steps mainly include the continuation of the discussion among market participants about the proper accounting regime (CPNP versus B&K) and the appropriate price structure.

For cost application of the efficient service provision as the cost standard determined in the TKG, the Federal Network Agency will widen their information basis on the costs of NGNs and may enter into dialog with the market with cost models if a glide path is determined for adjusting the EBC interconnection rates to the level of the interconnection rates of NGN.

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49 Intensification of a sustainable competition, incentives for efficient investments, incentives to efficient use of the network, minimization of transaction costs, avoidance of arbitrage potentials induced by regulations as well as internalization of network externalities.

The publication of the report gives all market participants the chance to evaluate the analyses and arguments presented from their own perspective and submit their views to the Federal Network Agency.