

# Project Team on IP-Interconnection and NGN

## Final Report on IP interconnection

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# Final Report on IP interconnection

## Executive Summary

This document describes the significant evolution which is taking place in (IP) interconnection and in the networks of most European operators, particularly PSTN-incumbent's networks, reflecting the developments towards Next Generation Networks (NGN) and the massive adoption of IP based services such as VoIP.

The aim of this document is to present the state of the art in IP interconnection (IP-IC) in Europe and to outline how technological change towards NGNs may affect regulation in this matter. The implications of these developments for interconnection regimes are analysed. Furthermore different billing principles that might be applicable for interconnection in IP-enabled NGNs are discussed.

The document builds on the answers of NRAs and several European industry associations (ECCA, ECTA, ETNO, ETP, GSM-E and EuroISPA) to a questionnaire on issues and problems related to the transition of IP-IC and NGN deployment and the answers from a public consultation on a draft text of this document, concluded November 27<sup>th</sup> 2006.

Currently, the issue of IP interconnection seems to be in a relatively early stage of assessment by the NRAs as well as by the market players themselves. As the migration process towards NGNs proceeds, this issue is already gaining regulatory relevance. Thus, in order to be prepared and to better understand the nature of evolving interconnection regimes several NRAs have taken actions ranging from discussion at various levels with the industry, including technical and procedural provisions (workshops, consultations) to monitoring activities.

The following major issues have been dealt with in the document:

- **Separation of functional levels**

A core feature of NGN architecture is the separation of the main functional levels (service, transport and control). With interconnection possibly taking place at separate levels, this may require availability of different interconnection products or services including interconnection at all levels to ensure end-to-end connectivity. Also, interoperability on different functional levels of an NGN to ensure overall service interoperability may be required.

In most NGNs run by incumbents, transport is separated from the control level (signalling etc.) and services tend to be provided using centralized platforms (Media Gateway, Softswitch). This impacts on the ability of independent service-providers to integrate their services into the NGN-platform. Furthermore such a configuration of services and the centralization of the control function has implications for the locations at which traffic can be handed over to other networks or received from other networks. This feature will therefore be crucial for the possibility to define interconnection points.

- **Quality of Service**

Quality of Service is another relevant topic in the discussion. NGNs have a strong and clear focus on end-to-end QoS models including use of techniques such as prioritisation, resource reservation and admission control to ensure deterministic quality for a multitude of services. One of the challenges is to assure QoS across interconnected network

borders as universally accepted standards do not yet exist to manage QoS on an end-to-end basis for interconnected IP/MPLS networks.

Additionally, and although in general priority is given to commercially negotiated solutions, there may be a need for regulators to ensure the provision of wholesale products by SMP operators at the transport level, possibly differentiated by class of service, allowing independent service providers to offer services using 'guaranteed' QoS at the transport level.

- **Structural implications for the IC regime**

A major building block of any interconnection regime consists of the number and structure of interconnection points stemming from the network architecture.

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

- **Charging Principles**

Pricing principles (e.g. element-based charging, distance independent charging, capacity-based charging, charges based on grades of service) and charging principles (e.g. Calling Party's Network Pays, Bill & Keep), including contractual terms and conditions are two other major building blocks of interconnection regimes. Where commercial agreement cannot be reached, NRAs will be involved in setting charges, charging principles and resolving disputes.

Whereas pricing principles have not been dealt with in the current document, different charging principles have been discussed: At the *retail* level two billing regimes can be distinguished: "Calling Party Pays" (CPP) and "Receiving Party Pays" (RPP). CPP is the most common principle for charging voice calls. The party that originates (initiates) a call pays a fee for the call, usually as a function of the duration of the call in minutes, and often also as a function of the distance from the originator to the point at which the call terminates (is received). In this case, the party that receives the call typically is not charged. RPP is a mixed system where the called and the calling party share the cost of the call. Retail billing regimes in the Internet usually follow the principle of RPP but it is also employed in North American mobile markets.

On the wholesale level, "Calling Party's Network Pays" (CPNP) and Bill & Keep can be distinguished. Under CPNP the network of the caller pays for the whole call. This implies that a charge for termination is being paid for to the terminating network. It is applied for example in calls in the PSTN and also in the European mobile sector. CPNP termination leads to a problem known as the termination monopoly. With Bill & Keep there are no charges for termination. Bill & Keep can be understood as a barter exchange where network operator *A* terminates traffic coming from network *B* and vice versa. A similar system (peering) without charges for exchanging traffic is widely applied for internet traffic and also for example in the mobile sector in the USA. There is no termination monopoly problem under Bill & Keep and there is no need to determine the "right" termination rates. Without payments for termination services the problem of arbitrage is minimised. On the other hand Bill & Keep can lead to a "hot potato" problem because

providers have an incentive to hand over their traffic into another network for termination as close as possible to the point of origination.

Billing regimes on the wholesale and the retail level are closely related. Bill & Keep might even further stimulate the trend towards end-user flat rates schemes.

- **Options for wholesale billing regimes**

At present different billing regimes are applied for the PSTN and for IP-based networks which may lead to arbitrage problems. This document presents possible options for the billing regime in future all-IP networks. In addition to pure CPNP or Bill & Keep regime, a dual regime is conceivable using Bill & Keep in the backhaul network and CPNP in the core network. This would require a clear definition of the boundary between backhaul and core networks. Such a dual approach would on the one hand avoid the termination monopoly. On the other hand the hot potato problem could be alleviated by requiring a minimum number of interconnection points as a prerequisite for participating in the Bill & Keep regime. Determination of these interconnection points may turn out to be the main challenge in implementing such a regime.

Regimes may also differentiate between different services (or QoS classes). Such an approach requires to distinguish clearly between different services and measure usage of (IP) services. Otherwise problems such as adverse selection could occur.

## **Conclusions**

The changes which are taking place in technology affect not only the whole set of interconnection products, but also the provision of networks and services in general. The correct estimation of the impact on competition brought by changes in interconnection products will be one of the most relevant tasks for NRAs in the near future. Incentives to upgrade the network can be attributed to cost savings or to the need to be able to provide advanced services as voice revenues decline, but the use of more efficient technology to provide existing regulated services does not alter the justification for that regulation; the move to NGNs does not provide an opportunity to roll back regulation on existing services if the competitive conditions have not changed.

A crucial feature of IP-architecture having implications for interconnection is the possibility to separate the main functional levels of the network. NGN strategy of implementation typically is based on a horizontal platform that allows for a technical and commercial separation of service, transport and control layers, which may be provided by different market players. This may require defining additional interconnection services accordingly.

The NRAs will therefore need to address several issues:

- Develop some guiding principles in order to clearly identify the regulatory challenges and evaluate regulatory options.
- NRAs may have to ensure that all types of interconnection which are technically feasible are possible, ensuring end-to-end connectivity and allowing for full interoperability of the IP based services offered to the customers of the interconnecting networks; for this reason, operators should be encouraged to give access to the technical interfaces, protocols and all other technologies necessary for the interoperability of IP based services, and to use standard interfaces and protocols.

- Regulators should take account of the need for interoperability and quality of service at all levels of the value chain. A more ubiquitous application of Article 5 of the Access Directive may be needed to ensure end-to-end connectivity as well as allowing users to access services provided by another undertaking.
- The transition towards NGNs entails several structural changes such as rearrangement of core network nodes and points of interconnection, number of points of interconnection or changes in the number of network hierarchy levels, as well as the question of interconnection tariffs. Furthermore IP-interconnection may be differentiated along the lines of services, according to quality of service classes or not differentiated at all.
- Besides regulation such as Article 5, appropriate areas for regulatory intervention have to be defined, based on the existing list of relevant markets and findings of SMP. These changes may require the adaptation of existing SMP products for interconnection. More particularly markets 8-10 so far only include narrowband interconnection services. A broadening of these markets should be allowed to include IP-interconnection by defining the markets more generally in those countries, where NGN related services already play a more important role. Also, the introduction of a Bill & Keep model for interconnection of voice calls on IP networks would have a major impact on the market for call termination. If needed, further markets for regulation and de-regulation may have to be identified.
- Adaptation of existing SMP products in the light of changes. With reference to SMP notifications, some elements of the analysis performed by NRAs will be NGN specific. For instance, control over architectural functions that constitute “control points” – i.e. functions that are necessary for service provision to end users – can result in market power. As long as control points might reside in any layer of the network hierarchy, this might increase the complexity of the competitive assessment. There might be cases where this control provides only a temporary advantage, while in other cases it may trigger abuses of dominant positions which could call for regulatory intervention.
- Determination of the cost of regulated interconnection products in a multi-service environment.

In the migration process towards NGNs, different charging principles (like Calling Party's Network Pays versus Bill & Keep) are currently being used for the interconnection of different networks. Therefore a discussion on the appropriate charging principle for IP-interconnection has begun, considering the following key factors: termination monopoly at the wholesale level, familiarity of end-users with CPP and RPP, relationship between wholesale and retail pricing, compatibility with retail tariff schemes (e.g. flat rates) and network and usage externalities.

This paper reviews options for wholesale arrangements in an all-IP world also considering problems during the transition phase. Bill & Keep and CPNP differ with regard to their relevance to the termination monopoly problem. IRG/ERG do not consider traffic symmetry a strict requirement for the applicability of Bill & Keep. Bill & Keep may lead to Receiving Party Pays (RPP) at the retail level. Possible acceptance problems of this shift might be alleviated by the trend towards end-user flat rates.

Apart from devising an appropriate interconnection regime including charging principles for an all-IP world, regulatory work will have to focus on the migration period towards NGNs, where different network and charging principles are used in parallel. Currently, this particularly applies to the provision of voice services.

# Final Report on IP interconnection

## 1 Introduction

### 1.1 Objectives

This document contains the final Report on IP interconnection which is one of two deliverables in the IRG/ERG Work Programme 2006 dedicated to Next Generation Networks (NGN<sup>1</sup>).<sup>2</sup> It builds on an update of a previous ERG document (ERG (05) 47 rev1) and it describes the significant evolution which is taking place in (IP) interconnection and in the networks of most European operators, particularly in incumbents' PSTN networks, reflecting the developments towards NGNs and IP based services such as VoIP.

Taking into account the migration towards all-IP networks substantial change is expected, especially at the wholesale level, as the markets for network conveyance converge and service intelligence is decoupled from the network. With the gradual replacement of traditional interconnection by IP interconnection the question of possible future interconnection models becomes relevant.

Developments towards all-IP networks can take different forms. Traditional PSTN network operators including incumbents plan to migrate towards NGNs, relying on the ITU<sup>3</sup> and ETSI<sup>4</sup> as relevant standardization bodies. On the other hand, independent ISPs and ITPs (Internet transport providers) continue to develop their IP networks towards multi-service networks, relying more on the IETF as standardization body. The document will focus on developments towards NGNs.<sup>5</sup>

Classical IP interconnection agreements, in place today, governing the public internet between ISPs typically take the form of transit and peering agreement, often using neutral centralised Network Access Points (NAP) to exchange IP traffic. These agreements have been largely outside the scope of activity of NRAs. Although not central in this document, the economics of peering are of relevance when different charging principles (in particular on the wholesale level) are analyzed.

The aim of this document is to present the state of the art in IP interconnection in Europe and to outline how technological change towards NGNs may affect regulation in this matter. This document will also analyse the effects this evolution might have on interconnection regimes and also tries to develop some general principles with regard to regulatory treatment of IP interconnection and interoperability issues reflecting the development towards multi-service NGNs. It also discusses different billing principles that might be applicable for interconnection in IP-enabled NGNs.

The analysis is making use of results from a thorough stock-taking of IP-interconnection and NGNs carried out by the ERG Project Team on IP-Interconnection and NGN. Answers to a

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1 For an explanation of terms see Glossary (Annex 3).

2 The other deliverable dedicated to NGN is the paper "Draft Interim Report on NGN". A first interim report for that paper was delivered by September 4, 2006. Both projects are closely interrelated.

3 See ITU-T information on NGNs in <http://www.itu.int/osg/spu/ngn/>.

4 See ETSI "TISPAN PUBLISHED NGN SPECIFICATIONS" in [http://portal.etsi.org/docbox/TISPAN/Open/NGN\\_Published/PUBLISHED\\_NGN\\_SPECIFICATIONS.doc](http://portal.etsi.org/docbox/TISPAN/Open/NGN_Published/PUBLISHED_NGN_SPECIFICATIONS.doc).

5 For more information of developments of IP networks of ISPs and ITPs under the heading NGI (next generation internet) see Hackbarth/Kulenkampff (2006).

fact finding questionnaire where collected from NRAs and also from several European industry associations (ECCA, ECTA, ETNO, ETP, GSM-E and EuroISPA).<sup>6</sup>

The document was then published for consultation on the ERG website in October 2006. Fourteen comments were received and are summarized as Annex 2. The document has been revised in the light of the comments, and the latest developments were taken into account.

## 1.2 Legal and economic framework for analysis

It is important to underline that, while this document provides NRAs with some indications of what may lie ahead, all the assumptions herewith adopted remain subject to validation in the context of the existing regulatory framework, in particular with regard to proportionality and the imposition of obligations.

The existing Regulatory Framework which came into force in July 2003 is currently under review. It will continue to be the reference legislation for the next two or three years, until new legislation comes into force and the old one is repealed (or amended). The existing Access Directive in particular contains provisions defining the legal basis for access and interconnection agreements, wherein:

- Article 3.1 requires Member States to ensure that there are no restrictions preventing undertakings to negotiate between themselves agreements on technical or commercial arrangements for access/interconnection, in accordance with Community law; undertakings do not need to be authorised to operate in the Member State where access or interconnection is requested.<sup>7</sup>
- Article 4.1 requires operators to negotiate interconnection with each other for the purpose of providing publicly available electronic communications services, in order to ensure provision and interoperability of services throughout the Community.<sup>8</sup>
- Article 5.1 and 5.2 empower the NRAs to set access and interconnection obligations, by explicitly mentioning promotion of efficiency, sustainable competition, and benefit to end users together with operational and technical conditions.<sup>9</sup>
- According to recital 6 (Access Directive) NRAs should have the powers to secure, where commercial negotiations fails, adequate access and interconnection and interoperability of services in the interest of end-users. This indicates that in the first

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6 On April 3rd this questionnaire was distributed to the NRAs that are members of the project team. It was answered by 16 NRAs by the end of April. Due to the high degree of uncertainty on how NGN look like today, how it will actually evolve and how long it will take till the process is completed, it was decided to give the market a chance to provide input at an early stage of ERG'S work prior to the usual consultation process. Therefore, on May 24th the questionnaire was also sent to the following European stakeholder associations: ECCA, ECTA, ETNO, ETP, EuroISPA and GSM-Europe. In addition during a one-day workshop held on June 22nd these associations were given an opportunity to present their position on the issues involved. The stakeholders were also given the chance to provide written answers to the questionnaire by July 7th.

7 The norm addresses possible limitations in the national laws and lays down the principle of, in first instance, leaving to parties, even outside the national border, autonomy in setting up agreements, as long as they are in conformity with Community law.

8 The rule mandates interconnection – also for ensuring provision of services and interoperability. This rule encompasses regulations which can be imposed using articles 5-8 of the Access Directive, and thus is the explicit legal base for enforcing obligations, also with regard to IP interconnection.

9 Economic efficiency and competition are on a pair with detailed operational and technical conditions in maximizing end user welfare – this allows, for instance – NRAs to impose measures which may address the reluctance of operators in allowing for more expedient and innovative forms of interconnection, such as “native” IP-IP instead of a bulky PSTN-IP-PSTN transaction.

place it is up to operators to reach agreements on interconnection (including the appropriate billing regime).

Besides these provisions applying to all operators, more specific obligations in terms of definition of interconnection services and processes and possibly related services<sup>10</sup> may need to be imposed on SMP operators, following a thorough market analysis (according to Articles 9-13 of the Access Directive).

In a broader context also the Framework Directive must also be considered. Political objectives and regulatory principles are laid out in Article 8 thereby providing NRAs with a framework when developing principles for the regulatory treatment of IP interconnection in the context of the migration process from PSTN to IP based networks and also for evaluation of different conceivable options.

According to Article 8 (2) of the Framework Directive, NRAs shall promote competition by *inter alia*:

- ensuring that there is no distortion or restriction in the electronic communications sector (*Art. 8 (2) (b)*);
- encouraging efficient investment in infrastructure, and promoting innovation (*Art. 8 (2) (c)*).

Further, according to Article 8 (3) of the Framework Directive, NRAs shall contribute to the development of the internal market by *inter alia*:

- removing remaining obstacles to the provision of electronic communications networks, associated facilities and services and electronic communications services at European level (*Art. 8 (3) (a)*);
- encouraging the establishment and development of trans-European networks and the interoperability of pan-European services, and end-to-end connectivity (*Art. 8 (3) (b)*);
- ensuring that, in similar circumstances, there is no discrimination in the treatment of undertakings providing electronic communications networks and services (*Art. 8 (3) (c)*).

Next to the objectives and principles mentioned in the Regulatory Framework also the following economic criteria should be adhered to when NRAs evaluate different conceivable options:

- Transaction costs of market players as well as for NRAs implied by a particular interconnection regime should be minimized.<sup>11</sup>
- Interconnection regimes should avoid potentials for regulatory induced arbitrage.<sup>12</sup> Exploiting such potentials might reduce market efficiency. In practice, any inconsistencies (e.g.) between different wholesale products may give rise to such arbitrage behaviour.
- And finally, network externalities should be internalised.<sup>13</sup>

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10 These related services include all services requested to build a full operational interconnection, e.g. access to interconnect location, bandwidth capabilities, collocation.

11 Transaction costs can take different forms such as: costs of negotiations, measurement costs (traffic), costs incurred through delaying the achievement of interconnection agreements, costs of interconnection disputes (market players, NRS, courts), of determining interconnection rates (e.g. cost modelling), of adapting to a new interconnection regime / possible changes with regard to retail pricing systems. Additionally to transaction costs in a narrow sense (like costs of negotiation) rent seeking behaviour also causes transaction costs. This list is not meant to be exhaustive. See also Vogelsang (2006), ch. 2.1.4. Marcus (2006) elaborates on this issue focussing on intercarrier compensation charges and intercarrier compensation accounting as well as dispute resolution, ch. 3.3.1 & 3.3.2.

12 It should be noted that in competitive markets arbitrage is efficiency-enhancing. The term is regulatory induced arbitrage refers to rent-seeking behaviour that seeks to take advantage of cost or revenue disparities that are due solely to regulation (DeGraba, 2000, p.1).

13 Telephone networks are a typical example of positive network externalities. Network externalities may arise when the decision of an individual to join a network does not take into account the (positive) effect this has on other users of the network.



Vogelsang (2006) extensively discusses these and some other criteria and principles for evaluating interconnection regimes.<sup>14</sup> As a concrete example applied in practice, reference can be made to the UK where NGNuk<sup>15</sup> states that the NGN interconnect framework should:

- Protect and enhance user experience.
- Minimise end user and operator disruption.
- Be the interconnect rules for a core set of services that are common between NGNs.
- Encourage efficient investment in NGNs.
- Encourage efficient routing and network usage.
- Encourage efficient migration from legacy to NGN networks.
- Be cost effective to implement.
- Allow recovery of efficiently incurred costs.
- Enable customer-specific data to be portable.

When analysing different options it becomes necessary to weigh up such criteria and principles because in many instances there will be trade offs between them. A key question for developing an appropriate approach towards (IP) interconnection is how to apply/adjust the tools of the existing regulatory framework to the evolution caused by technological progress towards NGNs.

### 1.3 Drivers for change

Future electronic communications networks will be packet switched, mostly or completely based on the Internet Protocol (IP). They will be multi-service networks for audio (including voice), video (including TV-services) and data rather than service specific networks. Developments towards all IP networks can take different forms. Traditional PSTN network operators including incumbents plan to migrate towards NGNs, relying more on the ITU and ETSI as relevant standardization bodies, while independent ISPs and ITPs continue to develop their IP networks towards multi-service networks, relying more on the IETF as standardization body. The document will focus on IP interconnection within the developments towards NGNs.<sup>16</sup> These developments might imply changes in the type of services, at the infrastructure level and in the profile of the actors in the value chain.

With regard to *services*, VoIP can be considered an important sample of new services in the wider context of migration from circuit switched to packet switched networks. The number and heterogeneity of VoIP services has gained relevance in the last 12-18 months. Therefore VoIP will often be referred to for illustrative purposes without confining analysis to voice services only. Up to now most VoIP services are either routed across the public internet or use PSTN interconnection. However, "native" IP-IP interconnection agreements may soon be concluded in some member states, even though it is not clear at this stage if only one standard protocol will emerge or if several protocols (or families of protocols, regrouping the functions of signalling, codec transaction and information transport) such as H.323, SIP, etc. will continue to sit together, and thus require extended interoperability features.

Concerning *infrastructure*, in the process of migration towards NGNs traditional PSTN network will be reshaped in terms of technology (DSL, Ethernet, fibre and wireless), network topology (possibly with fewer nodes at the core/transport level and decentralized layers) and space required (because of further reduced reduction of space occupied by the equipment, e.g. used for switching).

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14 Vogelsang (2006), ch. 2.1.1-2.1.7 (pp. 11-25).

15 NGNuk is an independent NGN industry body, with a view to creating an improved framework for industry engagement. See Annex 3.

16 For more information of developments of IP networks of ISPs and ITPs under the heading NGI (next generation internet) see Hackbarth/Kulenkampff (2006).

The *value chain* will also be affected by the appearance of new players, traditional or not, which might bring new competitive, technical and economical features hitherto unknown in the traditional telecom markets.

The following specific points can be identified as relevant to the discussion:

### 1.3.1 Changes in network architecture, structure and cost

#### *Functional Levels*

A crucial feature of NGN architecture having implications for interconnection is the separation of the main functional levels. NGN strategy of implementation typically is based on a horizontal platform that means separation of transport, control and service layers.<sup>17</sup> This implies that interoperability may become necessary on different functional levels of an NGN in order to ensure overall service interoperability. With interconnection possibly taking place at separate levels, this may require defining different interconnection services.

Transport, control and service layers can thus be technically and commercially separated and provided by different market players.<sup>18</sup> Therefore NGN infrastructures potentially allow a greater division of labour hence leading to a more segmented marketplace.

#### *Interoperability*

Closely related to this aspect of different functional levels is the issue of enabling interoperability of services such as voice, video, instant messaging, presence management, directory or payments. Considering that one of the objectives of interconnection is interoperability of user services, it follows that interoperability issues may surface on all functional levels. Therefore NRAs may have to ensure that interconnection is possible at all functional levels: service, control and at the transport (connectivity) levels in a reasonable manner. This may prove to be particularly challenging since a number of “telco” network operators are of the view that a horizontal separation of transport, service and control levels is neither appropriate nor in their interest, particularly if they want to guarantee quality of service (see IMS<sup>19</sup>, adaptation of IMS to fixed networks, etc.). Their understanding of NGN seems to imply a continuation of vertically integrated provision of transport and services as has been the case in legacy “telco” networks.<sup>20</sup>

Nevertheless, in order to enable interoperability of services and the integration of new services and applications, it is crucial that operators and service providers have access to technical (standardized) interfaces and protocols.

#### *Quality of service*

QoS is a complex and contentious issue that needs to be discussed in the context of interconnection. Legacy voice telco networks have been designed to provide a guaranteed level of QoS, in contrast with the Internet which provides for “best effort” QoS. NGNs and other IP based networks (e.g. MPLS<sup>21</sup>) have a strong and clear focus on end-to-end QoS models including use of techniques such as prioritisation, resource reservation and

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17 See also Langmantel (2006).

18 The notion of interconnection at these different layers is elaborated on in section 3.

19 See Ericsson’s White Paper, “IMS – IP Multimedia Subsystem” (2004).

20 See comments of France Telecom, Deutsche Telecom, Vodafone and the GSM-E comments to the ECC 75 report.

21 Stands for “Multiprotocol Label Switching”, See Annex 3 – Glossary for more details.

admission control to ensure deterministic quality for a multitude of services.

Packet loss, latency and jitter are parameters describing the network performance and hence quality characteristics of IP-traffic. They are particularly important for bidirectional real time services such as voice or videoconference. Special attention should be drawn to guaranteeing QoS requirements across interconnected network borders.

#### *Network structure (architecture and topology)*

The migration process potentially entails several structural implications such as a rearrangement of core network nodes, changes in the number of network hierarchy levels and a geographic rearrangement of points of interconnection. Structural implications such as the number of points of interconnection (which is likely to be lower at the core level) and the boundary between access/backhaul network and core network are particularly relevant aspects for IP interconnection issues.

#### *Network costs*

Furthermore, it is commonly assumed that NGNs will be operated at significantly lower operational costs than other fixed networks by moving to a single infrastructure based on IP for transporting any kind of flow, voice, video or data, and for any access technology (DSL, FTTH, WiFi, etc.). NGNs can provide operators ample opportunity to reduce OPEX and CAPEX in their cost base.<sup>22</sup>

### 1.3.2 Transition issues in the migration towards NGN

Traditional circuit switched networks are migrating to IP based NGNs at different pace depending on the strategy chosen by the incumbents and competitors (overlay vs. substitution), the degree of depreciation and life span of the equipment in place and several factors that might differ across member states and operators. It will among other things imply a differing length of period of parallel running of PSTN and NGNs.

This transition also confronts regulators with determining the relevant network cost during a period of parallel operation of PSTN and NGNs, particularly if an efficient cost standard is to be applied.

Furthermore, while developing the appropriate interconnection regime for an all IP world, regulators might have to deal with the problems such as excessive arbitrage – created by different billing regimes for the transition period, during which PSTN and IP based networks exist in parallel. This may arise for example where termination charges occur while calls are conveyed over an IP interconnection subject to a Bill & Keep arrangement.

### 1.3.3 Wholesale billing principles

An important and much quoted difference between PSTN and IP based networks is that they follow different wholesale billing principles. Currently existing interconnection regimes can be broadly summarised by the distinction between a “telco” model and an “ISP” model.

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22 Credit Suisse First Boston: IP: The Holy Grail for Telcos, March 2005.

The telco model is based on the economic principle of interconnection charges (origination charges and termination charges). For traditional PSTN voice services<sup>23</sup> interconnection is being paid for at the wholesale level at regulated rates.

The ISP model is based on the economic patterns of transit and peering, with the use of native IP interconnection.<sup>24</sup> In order to provide Internet connectivity to their customers, ISPs need to interconnect with each other at the IP level. This interconnection usually takes the form of peering and/or transit.

A billing principle known as Bill & Keep is often applied to Internet traffic, whereby no payments for termination are charged between operators. This occurs typically without regulatory intervention because commercial agreements are in place.

The potential for conflict between these different billing principles – paid termination vs. Bill & Keep (without termination payments) – becomes evident when considering a VoIP-service involving PSTN *and* IP networks (e.g. a PSTN user calling a VoIP user or vice versa).

Furthermore, the nature of wholesale billing bears a close relationship to billing and pricing arrangements at the retail level.

The above mentioned issues are increasingly discussed in many countries and member states, be it at industry fora or NRAs and also in international institutions such as the ITU, the Commission and ECC.<sup>25</sup>

#### 1.4 Structure of the document

This document is organised as follows:

Chapter 2 will provide an overview of the current situation in member states (update of both the IP interconnection snapshot and the country synopsis contained in document ERG (05) 47 Rev1).

Chapter 3 will outline the relevant issues on network architecture (separation of functional layers), the implications of network architecture for interconnection, the network hierarchy of NGNs and implications for interconnection products.

Chapter 4 will discuss the rationale of different billing principles at the wholesale level and their relationship to retail billing schemes. The current situation of billing in PSTN and IP networks at the wholesale and the retail level will be described and, furthermore, options will be reviewed for wholesale arrangements in an all-IP world including analysing problems during the transition phase.

Conclusions will be presented in Chapter 5.

In Annex 1, more detailed technical information on (examples of) NGN architectures can be found. Annex 2 contains a summary of the answers to the consultation. Annex 3 consists of a glossary explaining terms and concepts that are relevant in the context of this paper.<sup>26</sup> Annex 4 presents a list of countries with their respective country codes.

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23 Other services may also use PSTN infrastructure. Referring here to “traditional” voice services is done here for simplification.

24 Referring to the distinction made here between the “telco model” and “ISP model” it should be noted that while currently the termination model is the model preferred by telecom operators, it could be that transit and peering agreements become popular also with telecom operators and not only with ISPs.

25 See ITU workshop, ECC Report 75 consultation process, establishment of industry body in the UK etc.

26 This glossary is not meant to be exhaustive but rather explains some relevant terms and concepts.

## 2 Current situation in member states

Dealing with IP interconnection issues in the context of IRG/ERG requires a thorough stock-taking first. This stock-taking exercise, which – besides NRA answer to the fact finding questionnaire – includes information gathered in the Workshop and associations' answers to the questionnaire, helps to clarify the starting point for further analysis.

Section 2 is based primarily on the results of the "IP interconnection snapshot".<sup>27</sup> Section 3.3 deals with some structural aspects relevant for IP interconnection such as the number of network nodes, number of points of interconnection and the definition of local interconnection (questions 5, 7 and 8 of Fact Finding Questionnaire).

### Relevance of IP interconnection

NRA's views:

In the majority of countries surveyed interconnection with IP networks is not (yet) a relevant problem today (AT, BE, BU, CZ, DK, EE, FI, FR, GR, HU, IR, LT, MT, NO, PL, PT, RO, SK, SI, ES, CH, TR and UK).

On the other hand the following countries consider IP interconnection a relevant problem: IC, IT, DE and NL. This is due to the migration towards IP infrastructures (DE) and the growth of VoIP (DE, NL). NL reported that several parties – in particular cable operators – are in the process of setting up direct IP-based interconnection and will eventually put pressure on the availability of IP interconnection with the incumbent. IT refers to an AGCOM (the Italian NRA) decision on VoIP and that the NRA is about to start a proceeding to define the technical and operative conditions required for the application of the IP interconnection and interoperability obligation.

Stakeholders' views:<sup>28</sup>

ECCA considered that incumbents may force competitors to invest in legacy PSTN technology to get full interconnect; ECCA also outlined the need that SMP operators publish reference (IP) interconnection offers on the same terms as for PSTN. Existing non transparency would entail the risk of stranded investments. Similarly, ECTA sees (*inter alia*) the following risks and problems: (re-)establishing of bottlenecks due to incumbents' decisions on interconnection standards, stranded investments (e.g. when interconnection with legacy equipment is required). According to EuroISPA, NRAs need to address stranding problems<sup>29</sup> and interconnect locations; with regard to cost recovery, the association of IPSs suggested a LRIC approach based on IP technology.

ETNO and GSM-E stress the need for market-based interconnection models. According to ETP the discussion should not solely focus on interconnection of legacy networks with IP-networks but should also focus on interconnection between PSTN and NGN as well as between NGNs. Both ETNO and ETP refer to the evolving nature of NGNs.

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27 See section I of Fact Finding Questionnaire.

28 As indicated above not all questions of this snapshot were answered by each single stakeholder association.

29 Stranding may result when competitors orientate their network structure and their investments in points of interconnection/collocation to the network structure of the incumbent. If the incumbent changes his network structure (e.g. by implementing a "leaner" network with fewer points of interconnection or shifting the boundary between access and core network) this may depreciate the investments made by competitors, see Vogelsang.(2006), ch. 4.3.2. Nevertheless, also incumbents may incur stranding problems, see *ibid.* ch. 2.3.1.1.

### Complaints from competitors / disputes

In the majority of countries there are currently no complaints from competitors or disputes (AT, BE, BU, CZ, DK, EE, FR, GR, HU, IR, IT, LT, MT, NO, PL, PT, RO, SK, SI, ES, SE, TR and UK). This may reflect the observation that the question of IP interconnection is – at present – not yet considered a relevant problem in most countries.

Single cases of complaints have occurred in FI, IS, NL and CH, and DE refers to a Working Group led by the NRA. In FI there has been one complaint about IP transit and a decision of the NRA in September 2005 (the case has been returned to Ficora for rehearing by the Supreme Administrative Court). In IC complaints were informal and NL mentions single cases of complaints from smaller parties requesting IP interconnection with the incumbent. However, there are no formal disputes pending.

### Actions taken or planned by NRAs

Currently the issue of IP interconnection seems to be in a relatively early stage of assessment by the NRAs. As the migration process towards NGNs proceeds, this issue may soon gain relevance. NRAs are taking different actions in this regard (ranging from workshops with the industry to consultations and monitoring activities):

IP interconnection aspects addressed in the context of market analyses:

- FR (access, transparency and non discrimination obligations will at least be applied on SMP operators on markets 8, 9 and 10 to future VoIP interconnections);
- IT (some issues have been addressed in market analyses 8, 9 and 10);
- NL addresses IP interconnection issues in all the wholesale telephony markets (call origination, termination and conveyance);
- SI (to be addressed in coming market analyses).

Formal or informal dialogue with the market players:

- AT (dialogue with stakeholders);
- CH (workshop on NGN and IP interconnection);
- DE (Project group, expert studies);
- FI (working group and separate discussions with stakeholders);
- IR (dialogue with incumbent and other operators on their plans for migration to NGNs);
- IT (technical table with the SMP operator and stakeholders)
- NL (hearing on IP interconnection and wholesale issues);
- NO (dialogue with stakeholders);
- PT (workshop on interconnection and NGN migration in October 2006);
- RO (dialogue with incumbent on its plans for migration to NGN);
- SE (interviews with the major market players)
- UK (NGNuk industry forum focusses on commercial NGN interconnection issues ; the Network Interoperability Consultative Committee (NICC) discusses interoperability issues; BT runs an additional consultation programme with industry called Consult21, which discusses products, services, interconnection and interoperability in the evolution of BT's NGN core network development, 21CN)).

More particularly the NGNuk forum has adopted a vision for the UK industry to deliver, by January of 2008, an agreed NGN interconnect model that allows the predictable and seamless transport of a technically unrestricted range of services across multiple NGNs using a commercial framework that drives service and application innovation and efficient investment. The forum has defined four generic service types which it wishes to see supported over interconnected NGNs: real-time person-to-person, near-real-time interactive, streaming and data connection. In the forum's agreed reference model, NGNs are characterized by a two layer model: transport architecture (representing layers

1 to 4 of the OSI model) and network capabilities (representing layers 5 to 7). The forum has its own governance structure and has defined a work plan which is underway.

Consultations:

- BE (IP interconnection addressed in VoIP termination rate consultation);
- DE (Final Report of the Project Group "Framework Conditions for the Interconnection of IP-Based Networks");
- DK ("to identify relevant problems related to NGN");
- ES (mentioned in VoIP consultation);
- IT (public consultation on IP-interconnection started in June 2006)
- GR (VoIP consultation with IP interconnection issues being addressed);
- LT (IP interconnection issues to be addressed consultation on VoIP);
- MT (IP interconnection addressed in VoIP consultation);
- PT (IP interconnection addressed in VoIP consultation);
- UK (Consultation and statement on NGN, set up of NGNuk, NICC workstreams, public discussion document on next-generation access).

BU states that specific provisions on IP interconnection might be included in the Bulgarian regulatory package implementing the EU framework.

Monitoring activities are mentioned by NL and PL.

Some have not taken any particular action or do not have any particular plans (CZ, EE, IS, SK, TR).

### **3 NGN network structure**

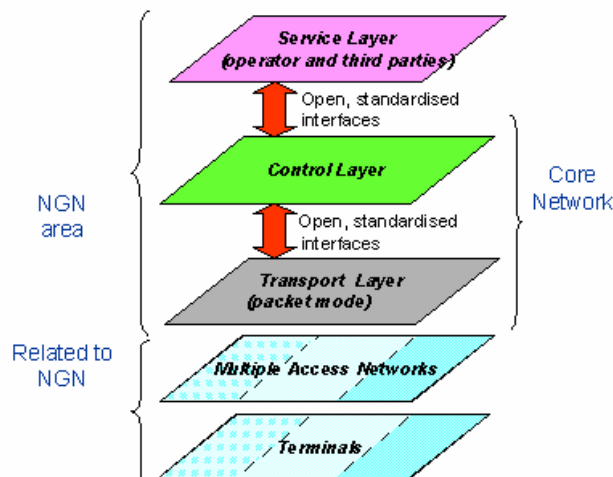
#### **3.1 General principles**

Generally speaking NGN can be considered as a multi-service QoS-enabled network based on a packet mode technology, able to support voice, data and video and where there is a more defined separation between the transport (connectivity) portion of the network and the services that run on top of that transport.

Some reports refer to a NGN functional architecture where all the control functions are grouped into a separate layer, resulting in three layers: transport, control and services.

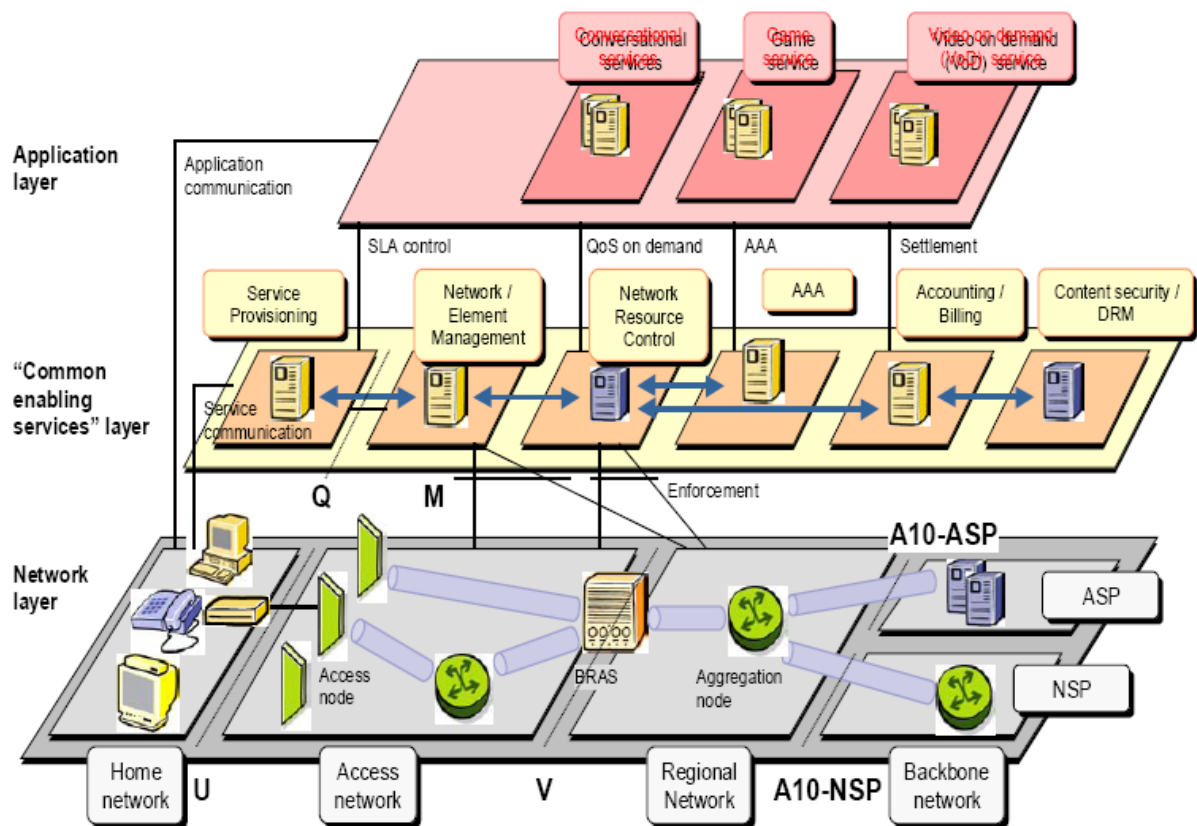
The NGN architecture is intended to offer convergent multimedia services using a single shared core network for all types of access and services and packet mode transport (in native IP, or on ATM in the short term with a progressive convergence to IP). Another key point is the adoption of open and standardised interfaces between each layer, and in particular for the Control and Services layers in order to allow third parties to develop and create services independent of the network.

Figure 1: General principle of NGN architecture (Source: Arcome, 2002)



A NGN supports multiple applications (multimedia, real-time, transactional, mobile) adaptable to the user and growing and varied capacities of access networks and terminals – see the following illustration:

Figure 2: DSLForum layered architecture (Source: DSLForum)



A-10: Service Provider Protocol Interface (Interface between broadband network and applications)

ASP: Application Service provider

NSP: Network Service Provider

U: Interface between DSLAM and end-user modem (line signal)

V: Interface between DSLAM and ATM node

Q: VLAN Q-Tag as defined in IEEE802.1Q-1998



The NGN is characterized by the following fundamental aspects:

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

The standardisation of NGN architecture is an ongoing process within several standardisation bodies. A detailed review can not yet be provided and it is possible that there will be no single architecture for NGN architecture.

Consequently, possible architectures are shown in Annex 1 for the sole purpose of illustrating the complexity that regulators need to take into account in their work. The ERG recognizes that these architectures may not be the only subjects of future regulation and that other implementations may be appropriate.

### **3.2 Implications of NGN architecture for IP-Interconnection**

In order to allow full interoperability of services interconnection in NGNs need to be assured at the service level, control level and at the transport level.<sup>30</sup>

An illustration of the range of technical, legal and functional requirements for NGN interconnection is presented in the next table:

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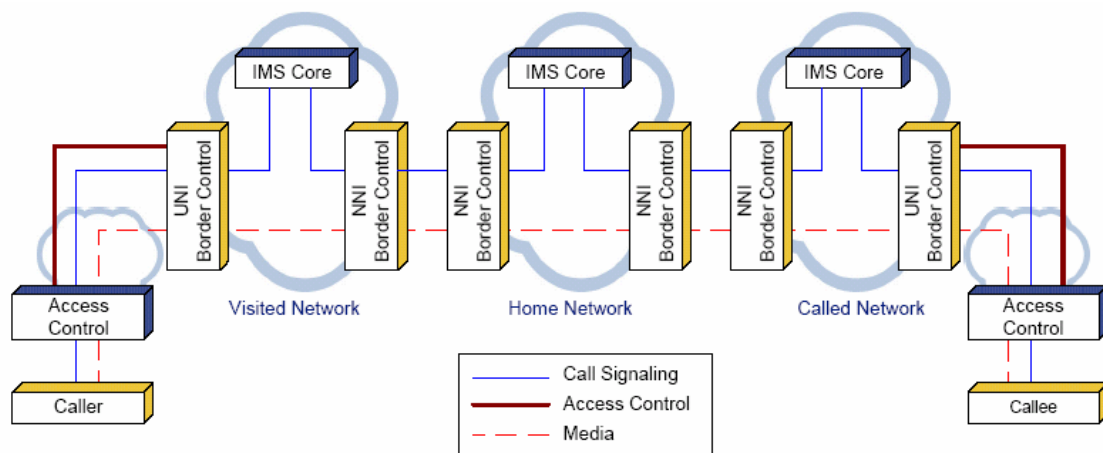
<sup>30</sup> See ECC 75 Report (2005). See also IETF working groups "Session PEERing for Multimedia INTerconnect – speermint" (<http://www.ietf.org/html.charters/speermint-charter.html>).

Table 1: Requirements for NGN interconnection. Source: Alcatel’s contribution to the public consultation.

Functional Family	Interconnect Requirements
<b>Transport Functions</b>	<ul style="list-style-type: none"> <li>• Service independent transport (transparency)</li> <li>• Open interfaces</li> <li>• End-to-End QoS</li> </ul>
<b>Control Functions</b>	<ul style="list-style-type: none"> <li>• Bearer capabilities</li> <li>• Call/session set up</li> <li>• Application service</li> <li>• Admission Control</li> <li>• Security</li> </ul>
<b>Service/ Applications Functions – building blocks</b>	<ul style="list-style-type: none"> <li>• Real-time (e.g. VoIP)</li> <li>• Streaming (e.g. IPTV)</li> <li>• Non real-time (IM, presence)</li> <li>• Multi media (e.g. IMS)</li> </ul>
<b>Service User Profile Functions</b>	<ul style="list-style-type: none"> <li>• OSS interfacing</li> <li>• Exchangeable data parametering</li> <li>• Identity Management</li> </ul>
<b>Legal requirements</b>	<ul style="list-style-type: none"> <li>• Emergency calls</li> <li>• Localization</li> <li>• Legal/lawful Interception</li> <li>• Personal data protection</li> <li>• Network integrity/security</li> <li>• Open access</li> </ul>

The global NGN architecture consists of interconnected core networks belonging to different carriers, with endpoints connected through attached access networks, and gateways to non-NGN networks. Border gateways control access into and out of each core network, monitoring and regulating the data flows on each interface. This interconnection is illustrated in the diagram below.

Figure 3: NGN interconnection (source “White paper” on IMS: [www.dataconnection.com](http://www.dataconnection.com))



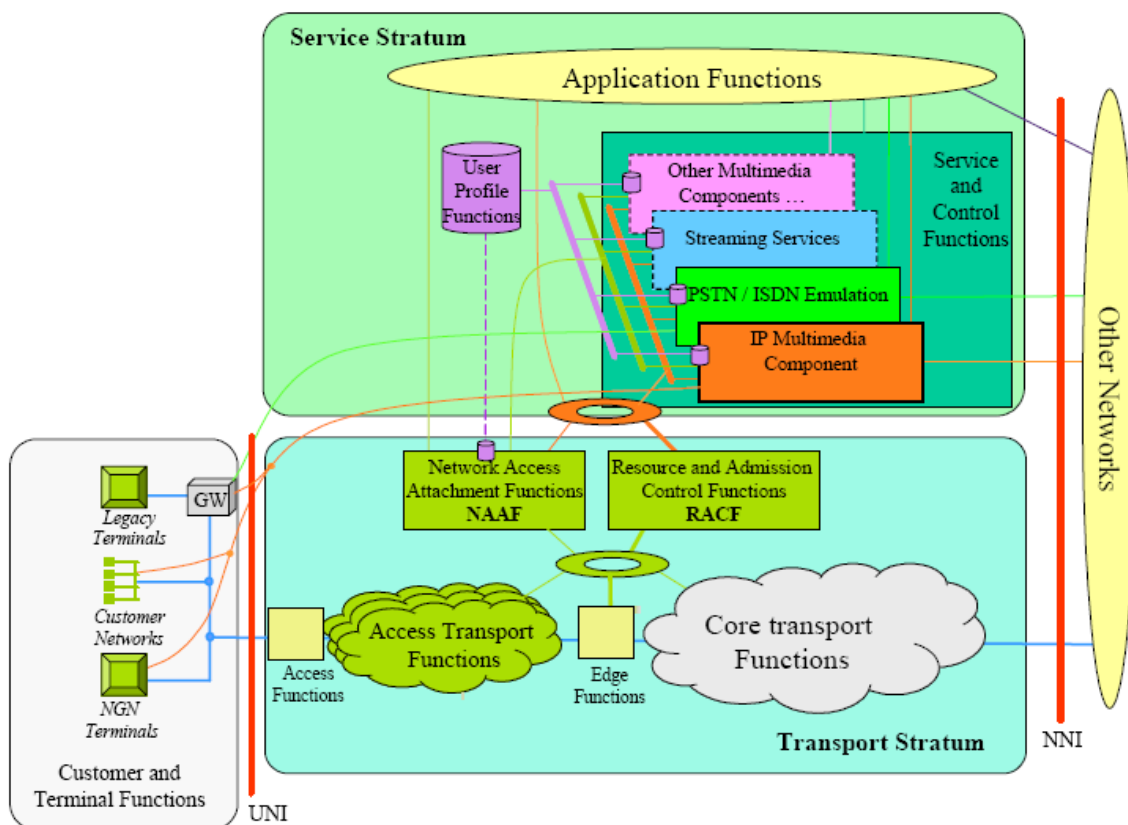
The interconnection of different access and core networks raises some issues such as:

- Security, both at UNI and NNI;
- Monitoring (of SLAs, Lawful Intercept, etc.);
- Privacy of network topology and user information;
- Interoperability issues due to a wide variety of protocol variants, network topologies, and media codecs.

The Figure 4 below shows a more detailed diagram of the transport and service configuration of the NGN<sup>31</sup> including the interfaces between:

- customer premises equipment and NGN access networks (UNI interconnection);
- NGN networks (NNI interconnection);
- NGNs and other networks, e.g. PSTN/ISDN, Internet;
- Third party application provider equipment and NGNs (out of scope of NGN Release 1 of ITU-T<sup>32</sup>).

Figure 4: Transport and service configuration (source: ITU-T “Security Requirements for NGN – Release 1”<sup>33</sup>)



NRAs may have to ensure that all types of interconnection above mentioned are possible, allowing for full interoperability of IP based services offered to the customers of the interconnecting networks; for this reason, operators should be encouraged to give access to the technical interfaces, protocols and all other technologies necessary for the interoperability of IP based services, and to use standard interfaces and protocols.

31 In the diagram, the customer and access networks are only representative and not all inclusive.

32 See ITU-T NGN FG Proceedings in <http://www.itu.int/ITU-T/ngn/release1.html>.

33 See “ITU-T NGN FG Proceedings Part II” – NGN GSI (Global Standards Initiative), ITU-T 2005.

This may prove to be particularly challenging since a number of “telco” network operators are of the view that a horizontal separation of transport, service and control levels is neither appropriate nor in their interest, particularly if they want to guarantee quality of service (e.g. see IMS, adaptation of IMS to fixed networks etc). Their understanding of NGN seems to imply a continuation of vertically integrated provision of transport and services as has been the case in legacy “telco” networks.<sup>34</sup>

Service characteristics and required interoperability standards, that include support of voice services e.g. SIP-I (Session Initiation Protocol-ISUP) and requirements of new multimedia services are dependent on QoS, device capability, security, number portability/translation (including ENUM) and authentication across service provider network boundaries.

Quality of service is a complex and contentious issue that needs to be discussed in the context of interconnection. Legacy voice telco networks have been designed to provide a guaranteed level of QoS, in contrast with the internet which provides for “best effort” QoS. NGNs and other IP based networks (e.g. MPLS) have a strong and clear focus on end-to-end QoS models including use of techniques such as prioritisation, resource reservation and admission control techniques to ensure deterministic quality for a multitude of services.

Packet loss, latency and jitter are parameters describing the network performance and hence quality characteristics of IP-traffic. They are particularly important for bidirectional real time services such as voice or videoconference. Special attention should be drawn to guaranteeing QoS requirements across interconnected network borders.

In any case, QoS management requires additional resources leading to higher costs. The extent to which QoS management will be a successful strategy for network operators and the willingness to pay a price premium for a specified QoS are not yet clear.

QoS assurance is most challenging across networks because for interconnected IP/MPLS networks the standards do not yet exist to manage QoS on an end-to-end basis, since the border gateway protocol (BGP) does not specify the treatment of prioritisation (although work is underway in this area in the IETF). Thus, across two independent networks, QoS can be achieved on a bilateral basis, using SLAs and specifying the BGP.

In general, priority is given to commercially negotiated solutions. However there may be a need for regulators to ensure the provision of wholesale transport products and control interfaces by SMP operators, possibly differentiated by class of service allowing independent service providers to offer services using ‘guaranteed’ QoS at the transport level.

NRAs are also likely to participate in defining technical standards, which are essential for interconnection, IP interconnect architecture and charging structures. This involvement may take the form of promoting discussions or cross industry bodies comprised of incumbent, alternative network providers, equipment manufacturers and software suppliers.

### **3.3 Network topology of NGNs and their implications for interconnection**

With regard to interconnection at the transport layer, the transition towards NGNs has further structural implications.<sup>35</sup> It may for example entail a rearrangement of core network nodes,

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<sup>34</sup> See comments of France Telecom, Deutsche Telecom, Vodafone and the GSM-E comments to the ECC 75 report.

<sup>35</sup> Furthermore it is commonly assumed that Next Generation Networks will be operated at significantly lower costs than other fixed networks by passing to a single infrastructure based on IP for transporting any kind of flow, voice or data, and for any access technology (DSL, FTTH, WiFi, etc.). NGNs can provide operators ample flexibility in their cost base to reduce OPEX and CAPEX (see: Credit Suisse First Boston, IP: The Holy

changes in the number of network hierarchy levels and consequently a geographic rearrangement of points of interconnection.

As NGN questions are dealt with in greater depth in a separate paper on NGN, the focus here will be on those structural aspects that are relevant for IP interconnection.

How does the migration process towards NGN affect the number of points of interconnection at the different levels of the network hierarchy? As a starting hypothesis it can be assumed that the number of interconnection points (at the lowest level of the core network) might be reduced which might lead to stranded investments.<sup>36</sup> A related question refers to the boundary – edge - between access/backhaul network and core network. This may be of importance in case interconnection regimes differ according to network level.

The results of the fact finding questionnaire provide some tentative insights on these issues. Relevant in this context are in particular the number of network nodes and points of interconnections in NGN and the definition of local interconnection in NGN.

#### Number of network nodes (question 5)

NRA's views:

The number of network nodes at each hierarchy level for NGNs is not yet decided upon (or relevant information not available) in most countries<sup>37</sup>. In IT, 12 area gateways<sup>38</sup> replace 33 Transit TDM nodes; the number of nodes replacing the local switches is not yet defined. Following the three levels model, in NL the numbers of nodes will be respectively 4, 200, 28,000 (MSAN<sup>39</sup> level); in NO 4-5, 500, 2,500 (MSAN level) and in UK 10, 100, 5,000 (MSAN level). The relation between the number of nodes at the highest and the medium network hierarchy level ranges from 10 (for the UK) to 100 (for NO). The respective relation between the medium and the lowest level shows a greater variety.

Stakeholders' views:<sup>40</sup>

ECTA says that it varies by country and that plans of incumbents are not transparent. Some information has been given in NL and UK but without firm commitments.

#### Number of interconnection points (question 7)

NRA's views:

In most countries (BE, CH, DE, DK, ES, FI, FR, GR, HU, PT, RO, SI, TR and AT) the number of interconnection points at the different hierarchy levels of the network is not yet decided or the relevant information is not available. However it is expected that this number will be less than for PSTN networks. Sometimes it is also argued that a more ubiquitous diffusion of TV services requiring servers close to the end-user might point in a different direction.

In CH, two types of interconnections are expected: an international interconnection with 2 nodes and national interconnections with a not yet defined number of interconnection points.

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Grail for Telcos, March 2005) . This issue of NGN implications for network costs will be further dealt with in the NGN document taking into account the results of the Regulatory Accounting Working Group.

36 Stranding investments are not restricted to either incumbents or competitors.

37 BE, CH, DE, DK, ES, FI, FR, GR, HU, PT, RO, SI, TR and AT.

38 Each gateway is a cluster of 2 nodes in separate location in the same city.

39 MSAN – Multi Service Access Node.

40 Not all the questions of section 3.3 were answered by each stakeholder association.

In IT all nodes of area gateways (24) are available for interconnection. No decision has been taken for the future lower level. A specific definition will be given at the end of a formal procedure on IP interconnection that is about to be started by the NRA.

In NL, IP data interconnection will be available respectively in 4 / 200 / 1,000 nodes, while voice interconnection between PSTN and VoIP (SS7 interconnection on Media Gateway) will only be provided at the 4 core nodes. In NO, IP data interconnection will be available at the 500 distribution nodes; telephony interconnection is only available at 13 core nodes (reduced from 27 in the previous TDM network). In UK the plans under discussion include 100 interconnection points or less, with Ethernet interconnection at 1,000 MSAN's.

Stakeholders' views:

This point is unclear for ECCA because it depends of the incumbent's strategy; however less POI (Points of Interconnection) than in PSTN networks should be implemented for better efficiency. ECTA expects that there will be less POI; all services should be using same POI but it is not yet the case everywhere (e.g. Germany).

According to respondents to the consultation traffic costs become less distance dependent (or even distance independent). Thus, bigger interconnection pipes are more efficient than smaller ones (e.g. using one single high bandwidth link instead of multiple E1 in PSTN/ISDN interconnection). Thus, a greater centralisation of interconnection points is considered appropriate. Moreover, Voice over Broadband is deemed more conducive to this centralisation of traffic. Others argue that reducing the number of interconnection points is justified due to the reduced number of switches. Considering that the final NGN architecture is not yet known the question of the appropriate number of interconnection points cannot be determined at this stage.

On the other hand some respondents do not necessarily expect the number of interconnection points to decrease. They refer to streaming services leading to interconnection points located more closer to the end user due to higher (IP) traffic demands.

Most of the illustration schemes point to an architecture based on an Ethernet carrier transport providing the possibility to interconnect at the backhaul Ethernet level with VLANs between MSAN and the service providers.

#### Definition of local interconnection (question 8)

NRA's views:

Local interconnection in NGNs has not yet been defined in any country. In IT, a specific definition will be given at the end of a formal proceeding on IP interconnection recently started by the regulator. In NO it is considered that it could vary in function of the service. In UK a virtual interconnection is under consideration as a possible solution.

Stakeholders' views:

For ECCA, this concept does not have sense anymore, because traffic handover at the last access switch or router in general is not efficient. For ECTA, this point requires a choice between definition in terms of either physical topology or commercial arrangement. It is not yet defined and, in any event, it would logically be referred to the geographical concept. ETP points out that the concept of hierarchy levels is no longer relevant in NGN. For EuroISPA, there will need to be a debate over the opportunity of switching to Bill and Keep from calling party pays.

With regard to the issue of local interconnection two categories of comments to the consultation can be distinguished each expecting different evolutions for the concept of local interconnection. Thus, they propose opposite approaches for dealing with this issue from a regulatory perspective.

One group is composed of incumbents and their respective associations. They do not find sufficient similarity between the local interconnection concepts of PSTN and NGNs to justify distinction between the economic terms of access and core in NGNs, which they say should not be set out by regulatory decisions. On the one hand, some of the incumbents indicate that it is not possible to precisely determine architectural issues at this early stage. On the other hand, all incumbents agree in their stated views that local interconnection in NGN will be superseded because of the following arguments:

- It is not economic for the incumbent neither for the competitive operator to connect at the lowest level (MSAN). Appropriate physical and service interconnection point is at the Metro node.
- Investment would be distorted if local interconnection was made mandatory. This would lead to non-efficient costs ultimately to be covered by the users.
- Services will be increasingly nomadic and customers will no longer be attached to the network nor driven by location. This increases the interconnection requirements and the need of interconnection agreements that do not exist today.
- The influence of distance on costs is less relevant in NGN than in PSTN. The transmission at lower costs and the possibility of choosing the location freely makes local interconnection unnecessary.
- The design of NGN could drive away from the idea of a unified network as understood in the context of PSTN, increasing national differences and growing complexity.
- Other technical reasons mentioned include the tendency to increase the level of routers in network architecture, the separation of signalling and data transport and integrated networks carrying more non-local traffic than PSTN.

The other group, the alternative operators, state that NGN allows for easier interconnection. They expect NRAs to regulate local interconnection in the context of NGN, The following arguments are put forward:

- A fully flexible system allowing investment up to the most efficient point would include options at the exchange or the street cabinet level for copper, or the optical distribution frame level for FTTB networks.
- Ethernet networks schemes allow concentrators to be replaced by switches thus allowing another network to interconnect easily.

However, they indicate that duplicating investment to higher-level points in the network is only economically rational in a model in which charges are distance and/or quality dependent so that there is some scarcity of bandwidth. In this circumstance, where it is not possible to give unrestricted bandwidth to all users at all times, specific channels should be paid for, thus creating a make-or-buy alternative for the originators of voice traffic.

They argue that if the network provides sufficient bandwidth that no QoS is needed, then it makes sense to have only one point of interconnection (or a small number to ensure resiliency of the interconnection) and to apply Bill & Keep (or peering). According to alternative operators providing appropriate incentives for assuring a guaranteed level of QoS is considered a major challenge when designing a Bill & Keep system. This is because Bill & Keep provides less incentives for operator to monitor inbound traffic as no payments are made for carrying this traffic.

### 3.4 Examples of NGN interconnection arrangements under discussion

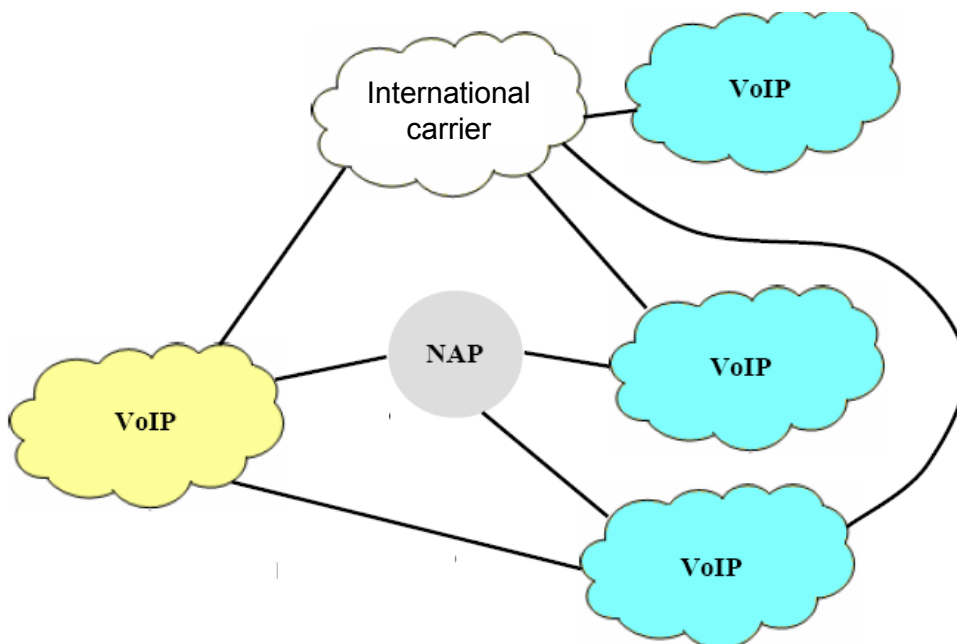
This section provides examples of some generalized models of “any-to-any” interconnection of IP services in NGN. “Any-to-any” interconnection is well established in TDM networks in member states, and is fundamental to the operation of competitive markets in telecommunications because it allows the customers of any network to communicate with those of any other network.

The presentation of the example models in this document is intended solely to aid understanding of some specific aspects of any-to-any interconnection of IP services in NGN core networks. The models are drawn from current negotiations of such interconnection arrangements in some member states, for example Italy, Germany and the UK, and represent neither a collectively exhaustive nor mutually exclusive set of options.

The examples in this section are confined to the interconnection of VoIP services. The NGN context suggests the use of common infrastructure to interconnect multiple services and this could be an efficient outcome in many cases. Such multi-service interconnection is therefore under discussion in some member states, for example in the UK. However, commonality of interconnection infrastructure across services could be limited for example by the extent to which traffic characteristics, geographical distribution of demand and technical requirements differ for different services.

The figure below shows a high-level view of the types of IP “any-to-any” interconnection (referred, as an example, to VoIP services) in which operators have expressed initial interest. These derive from configurations developed in the evolution of the public Internet, in which both bi-lateral interconnection between networks and interconnection between multiple operators at a neutral site (Network Access Point) occur.

Figure 5: Types of “any-to-any” interconnection in VoIP services. (Source: AGCOM)

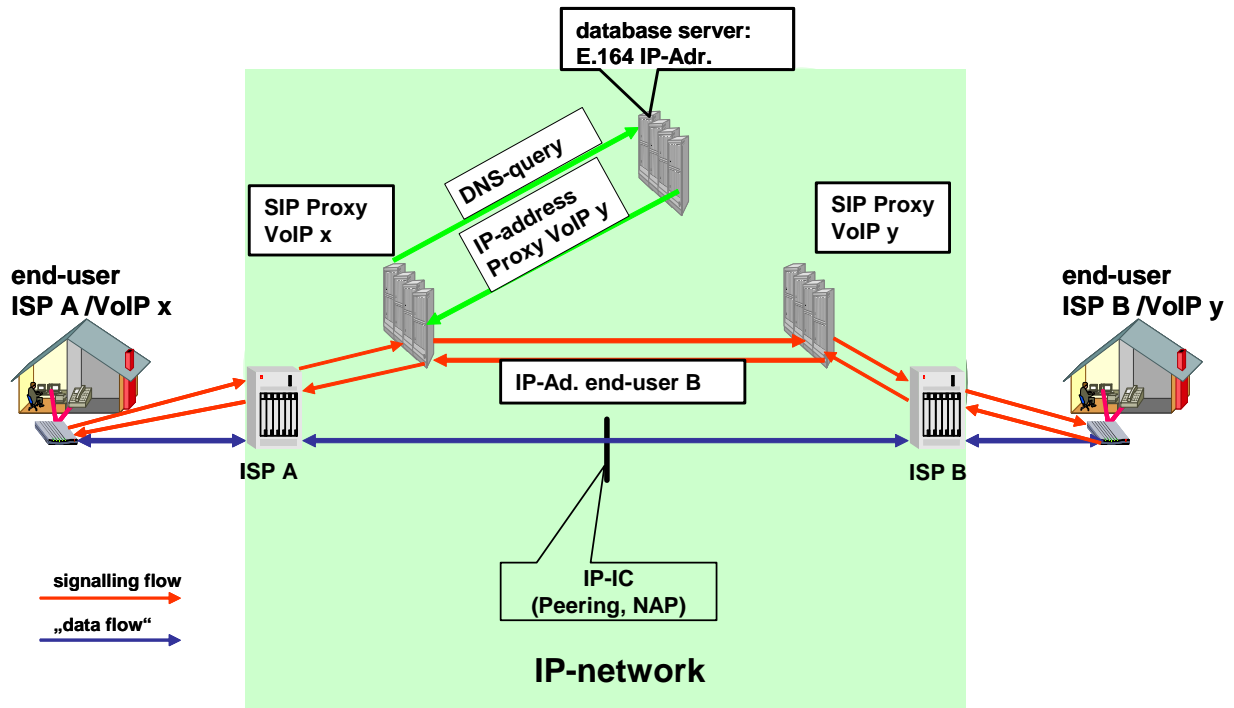


The signals that have to cross the interconnection point between two IP networks in order to allow any-to-any IP based services interoperability are shown in the following figure with reference to the specific example of VoIP applications:



The figure below illustrates the interconnection of two application providers who interconnect their services while making use of an IP infrastructure provided by other operators. An example of this could be some current VoIP operators, who provide best-effort voice services to customers of ISPs, making use of the public Internet for traffic transport.

Figure 6: IP Interconnection of application providers using others' infrastructure. (Source: Eickers)

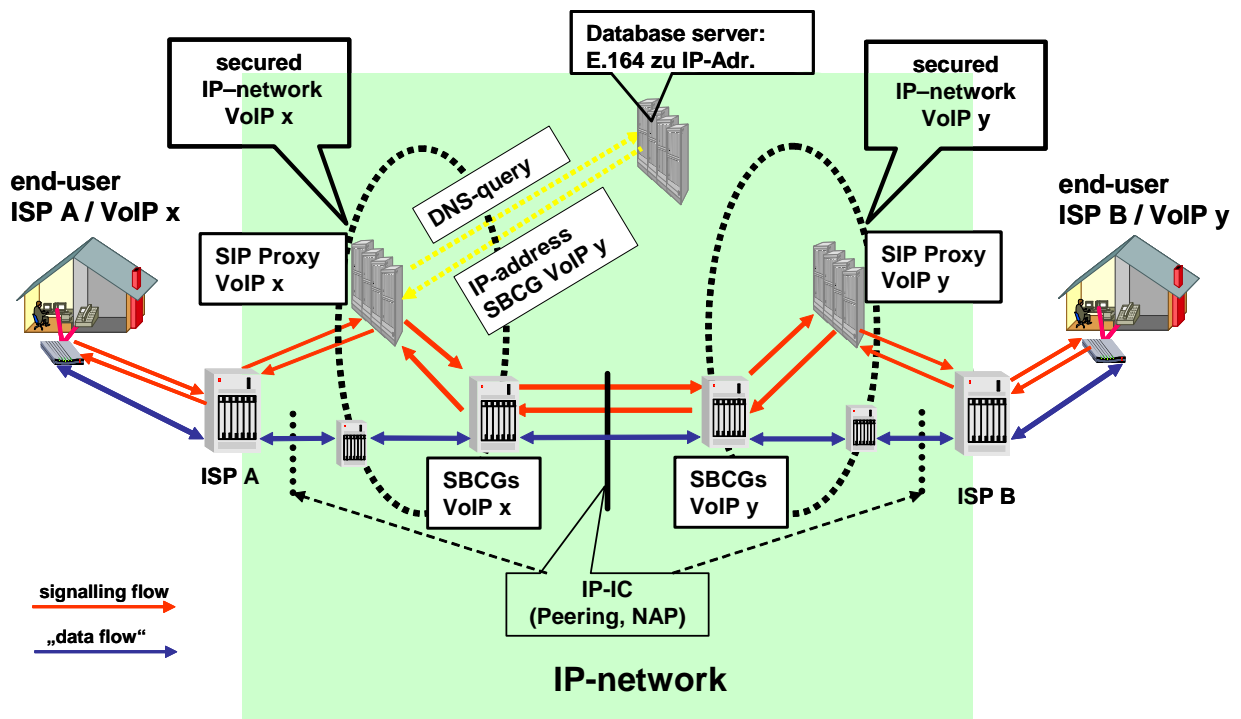


The functions required at the IP interconnection may in addition include the protection of the integrity of each network by logical and physical separation between operators' IP domains, translation of signalling protocols to allow the control functions to interoperate, voice transcoding to allow voice transport to interoperate, the enforcement of network security policies to avoid attack, and the recording of traffic volumes and other data for billing purposes.

A device that implements the functions described above is known as a Session Border Controller (SBC). Such a device can process both the IP packets carrying signalling messages, known as the "signalling flow", and the IP packets carrying the voice signals, which are known as the "media flow". These two flows can follow separate routes.

An example of interconnection using SBCs is shown in the next figure. In that case the VoIP provider can own the access and backhaul infrastructure (managed VoIP) and, as a specific case, may employ a NGN architecture.

Figure 7: Example of IP interconnection using Session Border Controllers. (Source: Eickers)



Besides the functionality of the SBC, an additional function may be needed in order to support call routing between the interconnected networks. This functionality is achieved by using an E.164 database server, as depicted in the figures above. The database server operates according to the ENUM protocol which converts the E.164 telephone number of the called party into appropriate routing information.<sup>41</sup>

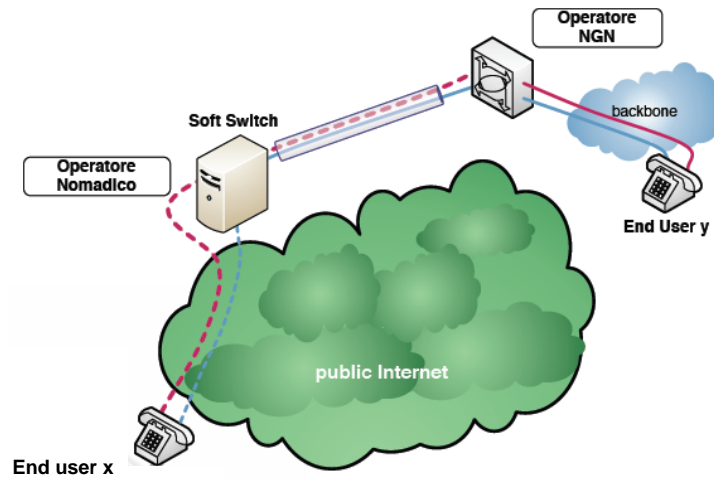
It should be noted that in particular cases some interconnection functions can be omitted by agreement, for example where operators agree common signalling protocols or voice coding standards and parameters the respective translation or transcoding functions could be omitted. Similarly, where a Bill & Keep arrangement is agreed between operators, billing data may not be required.

The commercial terms of interconnection could be regulated if either of the operators has SMP in the relevant market, or if the national regulatory authority is required to intervene in a particular circumstance.

In the following figure the bi-lateral example is extended to an interconnection between a VoIP application provider using the public Internet and an operator of a network infrastructure. This interconnection employs similar functions to the case where two infrastructure providers are involved.

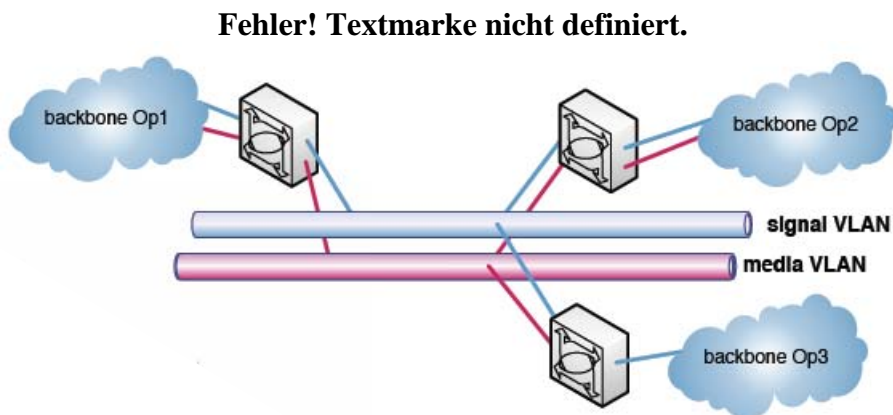
41 This can be the IP address of the VoIP SIP server or the IP address of the Session Border Controller of the called party's network, i.e. the network terminating the call. The functionality principle behind ENUM is the transformation of the E.164 telephone number into a domain name. A Domain Name Server (DNS) can then be used to convert the domain name to an IP address for routing the call, in much the same way that DNS is used in the world-wide web to convert a domain name such as www.erg.eu.int to an IP addresses.

Figure 8: IP Voice interconnection between a VoIP operator using the public Internet and a VoIP operator using its own infrastructure. (Source: AGCOM)



The following figure shows the interconnection of multiple networks by co-location at a neutral site, described as a neutral access point or NAP.

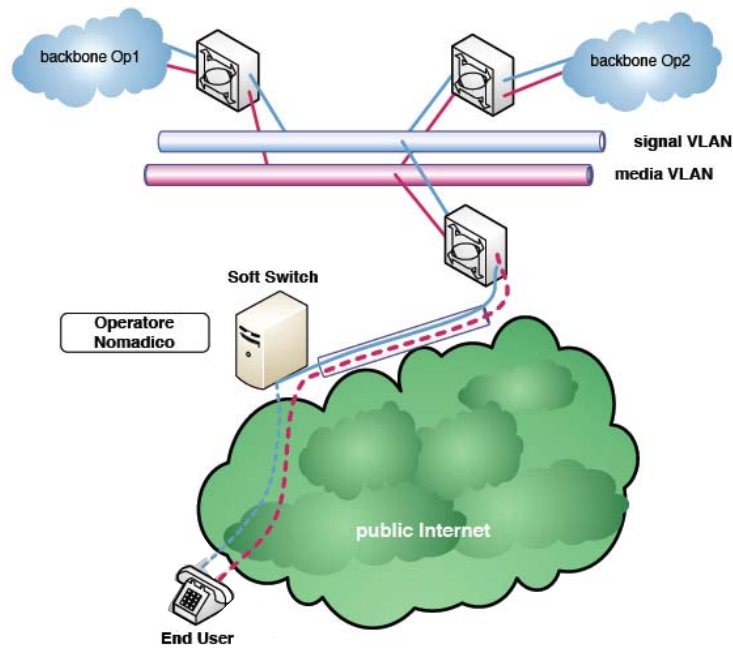
Figure 9: IP Interconnection of multiple networks at a neutral access point (NAP). (Source: AGCOM)



The SBC could be shared by multiple operators by logical partitioning, or dedicated to a single operator.

As a final example in the following figure shows the interconnection between a pure VoIP application provider and multiple operators' infrastructures at a NAP:

Figure 10: IP Interconnection of VoIP application providers at a neutral access point (NAP).  
(Source: AGCOM).



### 3.5 Implications for interconnection products and network/service provision

The changes which are taking place in technology affect the whole set of interconnection products, but also the provision of networks and services in general. The correct estimation of the impact on competition brought by changes in interconnection products will be one of the most relevant task for NRAs in the near future.

In particular when considering bottlenecks and the evolution of SMP products, respondents to the consultation outlined different views, with opinions falling into two main groups. Members of the first group, incumbents and its associations pointed out that the introduction of NGN should not be seen as detrimental to competition:

- Some operators do not perceive bottlenecks emerging in NGN due to lower entry barriers and an increased number of players such as ISPs, DRM providers, ASP and content aggregators, potentially neutralising legacy market power.
- For some, NGN could even offer a chance for preparing a level playing field for offering voice services.
- In addition, NGN could offer a potential for reducing existing bottlenecks at the core level for some, while with regard to access this evolution will depend on the access solutions adopted, on the level of competition in specific geographic areas and on local authorisation systems (i.e. access to street cabinets and ducts, etc.)
- Finally, some deemed that some SMP products, like carrier preselection, may no longer be necessary as competition becomes effective at access or infrastructure level.

On the other hand, members of the second group (alternative operators) noted that the migration towards NGN ought to be assessed considering issues such as:

- Advanced features such as improved control over signalling information and intelligent features (e.g. presence information) could reinforce market power and allow leveraging towards adjacent sectors. Content aggregators and DR (Digital Rights) owners might become bottlenecks.
- There is a risk of emergence of walled garden systems, reducing interoperability unless assured by regulation.
- the last mile remain an essential facility; also depending on replicability of infrastructure
- Access obligations might be insufficient, if not supplemented with proper interconnection and interoperability obligations.
- NGN should not provide an opportunity to roll back regulation and conditions for market analysis should remain unchanged.
- Finally it was noted that stable IP-IP Interconnection standards are seen as a pre-requisite for the reduction of entry barriers.

Incentives to upgrade the network can be attributed to cost savings or to the need to be able to provide advanced services as voice revenues decline, but the use of more efficient technology to provide existing regulated services does not alter the justification for that regulation; the move to NGNs does not provide an opportunity to roll back regulation on existing services if the competitive conditions have not changed.

At the same time, as pointed out by the Commission in the Draft Recommendation on relevant market<sup>42</sup> it is recognised that some market definitions may change in the light of the new service offerings that NGNs could bring. More particularly markets 8-10 so far only include narrowband interconnection. A broadening of these markets should be allowed to include IP-interconnection by defining the markets more generally in those countries, where NGN related services already play a more important role. Also, the introduction of a Bill & Keep model for interconnection of voice calls on IP networks would have a major impact on the market for call termination.

With reference to SMP notifications, some elements of the analysis performed by NRAs will be NGN specific. For instance, control over architectural functions that constitute “control points” – i.e. functions that are necessary for service provision to end users – can result in market power. As long as control points might reside in any layer of the network hierarchy, this might increase the complexity of the competitive assessment. There might be cases where this control provides only a temporary advantage, while in other cases it may trigger abuses of dominant positions which could call for regulatory intervention.

The NRAs will therefore need to address in particular the following issues:

- develop some guiding principles in order to clearly identify the regulatory challenges and evaluate regulatory options;<sup>43</sup>
- define appropriate areas for regulatory intervention, based on the existing list of relevant markets and identify, if needs so require, further markets for regulation and de-regulation;

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42 See [http://europa.eu.int/information\\_society/policy/ecommm/doc/info\\_centre/public\\_consult/review/recommendation\\_final.pdf](http://europa.eu.int/information_society/policy/ecommm/doc/info_centre/public_consult/review/recommendation_final.pdf).

43 See section 1.2.

- anticipate the significant issues due to arise in the area of geographical location, national market definitions and country of origin. Concerns arise as to the possibility of applying and enforcing national legislation across borders, and as to the need to geographically locate calls, which is essential for the provision of services such as emergency calls;
- the imposition of ex-ante regulation should follow a strict application of community legislation in this regard, and produce a harmonized result at EU level. Harmonisation is particularly important in case NGNs lead to an increased number of transnational markets. However given the different stage of migration towards NGN in member states, this may be a longer term issue;
- adapt existing SMP products in the light of changes, such as: the potential for call control elements of call origination, which is currently a 'bottleneck' service, to become replicable by alternative providers; the possible (commercial) evolution of call termination arrangements; and the emergence of broadband applications (e.g. voice over broadband) having identical (i.e. substitutable) quality of service characteristics to PSTN emulation services;
- the availability of future narrowband access products, in particular a 'MSAN (voice) access' product;
- changes in the IP interconnection product and of point of handover. As the network converges, backhaul requirements for narrowband calls are likely to look very similar to backhaul for any other type of downstream service. IP interconnection may be differentiated along the lines of services, according to quality of service classes or not differentiated at all. Hence, next generation voice interconnect may not require a voice specific backhaul product and instead may rely on a converged backhaul product;
- determine the cost of regulated interconnection products in a multi-service environment;
- preserve the interest of consumers and competition taking account of the need for interoperability and quality of service at all levels of the value chain, also closely monitoring vertical integration which may result in the control of one or more markets by the same commercial company or companies. If such integration occurs, it may limit the choice or quality of services and availability of information for users. A more ubiquitous application of Article 5 of the Access Directive may be needed to ensure end-to-end connectivity and accessibility for end-users (including disabled users) as well as allowing users to access services provided by another undertaking;

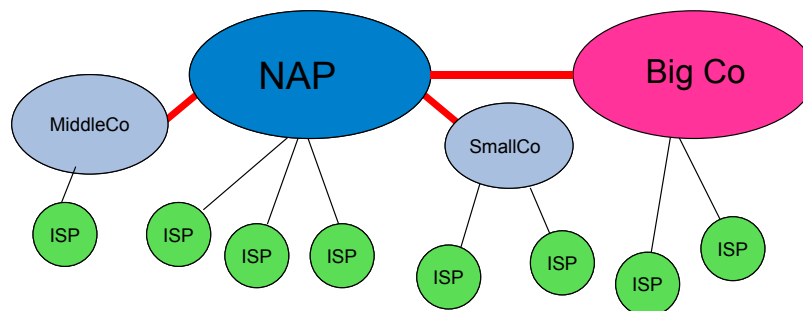
Developing an interconnection regime for an NGN environment also requires addressing the issue of charging principles. In the migration process towards NGNs different charging principles (like Calling Party's Network Pays versus Bill & Keep) are used for the interconnection of different networks. This has raised a discussion on the appropriate charging principle for IP-interconnection, as presented in the next chapter.

## 4 Principles of billing at the wholesale and retail level in an IP-enabled NGN

The economic principles for NGN interconnection include the charging principles (for example Calling Party's Network Pays, Bill & Keep) pricing principles (for example element-based, capacity based or based on quality of service) and contractual terms and conditions. Where commercial agreement cannot be reached, or where the relevant market is susceptible to *ex-ante* regulation, NRAs will be involved in setting charges, charging principles and resolving disputes.

The Internet "world" has historically adopted an interconnection model based on neutral centralised NAP (Network Access Point) where many Internet service providers converge to exchange IP traffic. Each provider bears the cost to transport the IP traffic to the NAP.

Figure 6: Interconnection in the Internet world (figure derived from Marcus, 2006a)



On the other side, traditional incumbent telephone operators tend to replicate the PSTN approach in the NGN environment by transforming the previous TDM interconnection points (area gateways) into IP interconnection points. This means that other operators will have to bear the cost of transport of their traffic to the (new) interconnection points established by the incumbent. This system tends to maintain and enhance an asymmetrical condition in favour of the incumbent which could be less interested to reach the neutral interconnection points (like the NAP).

The NRAs may need to intervene in the definition of (new) IP interconnection points if the operators' cost for IP traffic transport increases beyond an acceptable level, especially if due to changes in the incumbent's networks.

### 4.1 Retail billing regimes currently used

For categorizing retail billing principles two aspects are relevant:

- 1) Who pays?
- 2) What is paid for (tariff structure)?

#### 4.1.1 Retail billing in the PSTN

- 1) Who pays?

The most common principle for charging for voice calls is that the party that originates (initiates) a call pays a fee for the call, usually as a function of the duration of the call in minutes, and often also as a function of the distance from the originator to the point at which the call terminates (is received). In this case, the party that receives the call typically is not charged. These arrangements are referred to as Calling Party Pays (CPP). The rationale

underlying this charging principle is that the party that originated a call presumably wanted the call to complete, and that the originating party can therefore be considered to be both the prime beneficiary and the cost-causer of the call. Similarly the receiving party has been thought of as a passive party, involuntarily receiving a call from the originator.

Further points to consider:

- (-) Positive usage externalities are not internalized leading to suboptimal usage;
- (+) End-customers are familiar with CPP → CPP has a high acceptance in Europe;
- (+) Since fixed charges can be kept low, penetration is encouraged and the associated network externalities accordingly internalised;
- (+) There may be fewer problems with SPAM and SPIT<sup>44</sup>.

On the other hand, receiving party pays (RPP) is a mixed system where the called and the calling party share the cost of the call. This principle has been employed in the North American mobile markets.

Further points to consider:

- (+) Positive usage externalities are internalized;
- (+) The termination monopoly problem is avoided;
- (-) End-customers are less familiar with RPP in Europe;<sup>45</sup>
- (-) There is less internalisation of network externalities;<sup>46</sup>
- (-) More problems with SPAM and SPIT may occur.

## 2) What is paid for?

Usage based pricing on a per minute basis have long been the norm for voice calls. They are increasingly being supplemented by a range of non-linear tariffs. Flat rate arrangements are becoming increasingly popular, as they allow elimination of uncertainty of what the consumer has to pay.

### 4.1.2 Retail billing in the Internet

#### 1) Who pays?

Retail billing regimes in the Internet usually follow the principle of RPP. In this respect, the retail billing principle in the Internet is different from the principle usually applied in the PSTN (→ CPP). Tariffs for internet connectivity involve paying for access and for the potential of sending and receiving data. Consumers tended to historically receive more traffic than they send primarily due to downloads they request. Historically, most Internet traffic used to flow downstream as consumers received more traffic as downloads than they sent. Increasingly use of peer-to-peer,, instant messaging and other applications tend to balance downloads with uploads.

#### 2) What is paid for?

Tariffs for internet connectivity involve paying for access and for the potential of sending and receiving data. This broad description encompasses a significant number of possible offers or billing solutions.

<sup>44</sup> SPIT – SPAM over Internet Telephony.

<sup>45</sup> The acceptance of RPP might change with the increasing relevance of flat rates.

<sup>46</sup> End-customers may refrain from accessing a network or a specific operator if they have to pay for receiving calls. In this case positive network externalities are not internalised.



Tariffs can be based for example on connection time, volumes (actual amount of data transferred); users may also buy a certain capacity upfront, e.g. 10 hours of usage or 1 Gbyte with any traffic exceeding this being paid for in addition on a usage-related basis. Increasingly, flat rates are used. Such tariff schemes are often differentiated according to the speed of the customer's Internet access.

## 4.2 Wholesale pricing regimes

### 4.2.1 Wholesale pricing - Current situation

#### 4.2.1.1 PSTN

On the wholesale level a distinction can be made between "Calling Party's Network Pays" (CPNP) and Bill & Keep.

Under CPNP the network of the caller pays for the whole call. The pricing within a CPNP regime can be either Element Based Charging (EBC) or Capacity Based Charging (CBC), depending on how usage is billed, and has been commonly used in the PSTN as the basis for regulated interconnection rates. The rationale for CPNP is to a certain extent similar to that of CPP (cost causation: calling party's network / calling party).

CPNP termination leads to a problem that is known as the termination monopoly. In general, a network operator has no control over how the call is to be terminated – a single operator is able to terminate calls to any given telephone number. This confers a special form of market power on the terminating operator – hence, the term termination monopoly. The termination monopoly operates even in markets where competition for call origination is effective, and is by no means limited to large players that have significant market power (SMP) on the call origination market. This leads to extensive regulation of even small network operators without SMP in the retail markets.<sup>47</sup>

#### 4.2.1.2 Internet

In the Internet peering and transit arrangements are widely applied. In peering contracts parties agree to exchange traffic without a payment flow subject to their peering policy (which may entail conditions such as some degree of symmetry of traffic). The rationale of transit agreements is "bill your customer & pay your upstream-provider". Providers may have peering arrangements with some providers and buy transit from others. These arrangements come about as the result of bilateral negotiations and no regulation is involved.

Bill & Keep and peering are both arrangements without payment flows but may differ with regard to the prerequisites required for participation. Participation in a Bill & Keep system for termination does not strictly require traffic symmetry but may e.g. rather be made contingent on a minimum number of interconnection points (see 4.2.4 c).

Under Bill & Keep the network provider of the user requesting to receive data carries the cost for terminating this data flow on his network. If the same user uploads data, this origination cost is also carried by his network provider. Thus the network covers its own costs for traffic in both directions. In this respect Bill & Keep is related to the retail principle of RPP.

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<sup>47</sup> This holds, if there is CPNP on the wholesale level and unless there are different access ways for reaching the called customer.

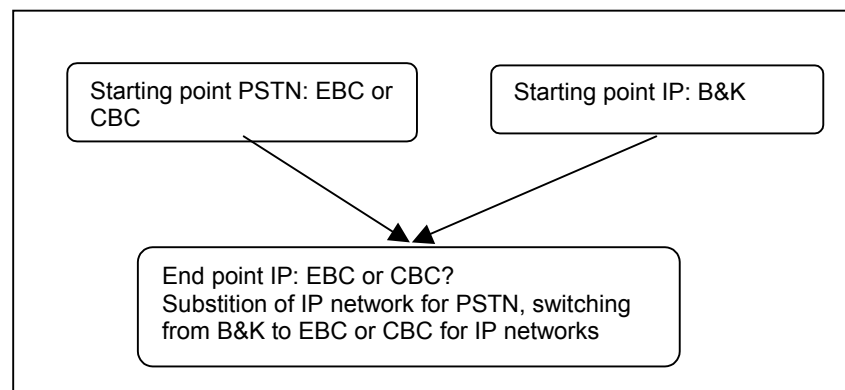
#### 4.2.2 Calling Party's Network Pays in an all-IP NGN: EBC or CBC

Wholesale charges in a CPNP model can either take the form of Element Based Charging (EBC) or Capacity Based Charging (CBC). Both systems constitute cost-based systems in the sense that NRAs refer to specific efficient cost standards when they determine wholesale rates thereby assuring efficient incentives for investment.<sup>48</sup> Usually, the efficient costs consist of LRAIC plus a mark-up for common costs including an appropriate rate of return on capital employed.

At this point it is only intended here to briefly illustrate the rationale of EBC/CBC. Under EBC the interconnection rates depend on the number of network elements as well as distance whereas in the past they were often only distance based. By changing to EBC it was intended to better reflect the underlying costs. For the PSTN it can be assumed that transaction costs of changing to EBC (or to CBC where this happened) have been significant. But these transaction costs can be considered sunk costs in the PSTN. If one decided for implementing EBC (or CBC) for IP networks this would obviously cause transaction costs (e.g. for determining IP points of interconnection). The central feature distinguishing EBC from CBC is that, under the latter, system bandwidth (channels or bit/s) is being bought in advance by competitors. This leads to a more adequate risk sharing between incumbent and competitor.<sup>49</sup>

The following figure schematically presents billing systems used for different *networks* as starting point and a target regime for an integrated IP-network, in this case EBC/CBC. Having different regimes in different networks may imply inconsistencies and arbitrage problems. The shift from Bill & Keep to EBC or CBC for IP networks could either be done before or after operation of the PSTN network is terminated.

Figure 7: EBC or CBC as target regime:



#### 4.2.3 Bill & Keep in an NGN

In contrast to traditional voice services, where at the wholesale level termination is being paid for, the Bill & Keep principle is widely applied for Internet traffic. Nevertheless, Bill & Keep is not only applied in the Internet. The Commerce Commission in New Zealand recently published a Draft Determination<sup>50</sup> ordering a Bill & Keep model for local interconnection

48 Saying that CPNP regimes like EBC and CBC are cost-based does not mean that for Bill & Keep cost-orientation is of no relevance. The difference is that under EBC/CBC it is the NRA that determines the rate for wholesale services, whereas under Bill & Keep there is - by definition - no such decision to be taken.

49 Such a risk distribution between incumbent and competitors might lead to a higher degree of market concentration.

50 Commerce Commission (2006).

between Vodafone and Telecom's fixed PSTN.<sup>51</sup> Bill & Keep is also used in the mobile sector in the USA.

With this regime there are no charges for termination. This approach *can* additionally also be applied to origination services.

Bill & Keep can be understood as a barter exchange under which the network carriers involved make transport available to other providers via their own network. Each network bears the costs for the network service. The costs for terminating the traffic from network carrier A in the network of carrier B consist of the provision of network capacities for termination in B's traffic in the network of A. Thus, the impression is wrong that the interconnection services are rendered *at no cost*, even if no interconnection services are paid for in financial terms.

According to the IRG/ERG symmetry of traffic flows is not considered a strict requirement for the applicability of Bill & Keep. This is also explicitly acknowledged by one respondent. On the other hand other respondents consider traffic symmetry a decisive requirement for the applicability of Bill & Keep. They also refer to differences with regard to costs or network depths. Moreover, in case of different QoS classes this symmetry requirement is to be met for each QoS class.

According to some statements doubts are expressed whether costs can be recovered under a Bill & Keep regime. According to this line of argument recovering costs from end users is not possible for two reasons: fierce retail competition and lack of acceptance among end users of a retail system of receiving party pays. Thus, investments in higher quality would not be rewarded with the adoption of a Bill & Keep regime.

With Bill & Keep transaction costs can be reduced, for example those of determining the "right" termination rates,<sup>52</sup> help to reduce the need for regulatory intervention. Furthermore, there is no termination monopoly problem under Bill & Keep and positive network externalities are internalized.<sup>53</sup> Without payments for termination services the problem of arbitrage is avoided.

Like every other system Bill & Keep also has its shortcomings. For example it, can lead to a "hot potato" problem because providers have an incentive to hand over their traffic into another network for termination as close to the point of origination as possible. The "hot potato" problem is the reason why Bill & Keep could possibly lead to underinvestment. To counter this problem it may be reasonable to require a minimum number and location of interconnection points for Bill & Keep to be applicable for a specific network operator. The closer the point of interconnection is located to the called customer, the smaller is the "hot potato" problem (and vice versa). Therefore to reduce "hot potato" problems the application of Bill & Keep may essentially require a determination of the topology of points of interconnection.

Assuming that competitors have to increase their network investment in order to be a potential Bill & Keep partner for other providers, this investment may be economically inefficient (duplicating infrastructures). As a closely related effect there may be a greater concentration in the market.

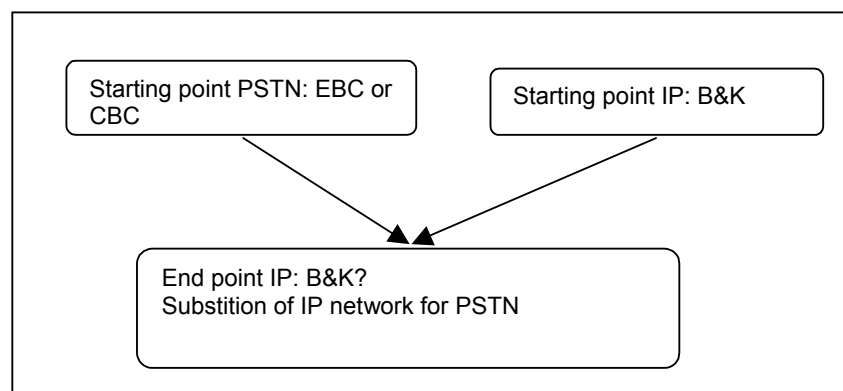
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51 The determination relates to local calls to and from Vodafone's local numbers but not calls to and from Vodafone' mobile numbers.

52 Nevertheless, there may be transaction costs for measuring traffic flows in order to determine whether traffic flows balance out or whether any differences in traffic flows exist that need to be paid for. It might be that these costs of measuring traffic would have occurred anyway, e.g. for billing their retail customers and for planning network capacities.

53 Positive network externalities occur when the attractiveness of a network increases due to new end-customers or the integration of other networks. Internalising such an effects means that those who benefit pay for the utility they receive.

Figure 8: Bill &amp; Keep as target regime



#### 4.2.4. Dual Regimes

Currently, different networks prevail that are still predominantly governed by different charging principles. Therefore we have a duality of charging systems across network infrastructures, that are discussed under a) below.

Also in a unified multi-service all-IP network there may be a rationale for a number of different charging schemes. They could be differentiated along the lines of service or QoS classes on the one hand (see b)) or depending on the level of network (access vs. core network – see c)).<sup>54</sup>

Furthermore combinations of these approaches are conceivable.

- a) Different regimes for different types of networks (PSTN or IP) – independent of network level and service

This approach essentially represents the current situation where there is CPNP (either EBC or CBC) for the PSTN and Bill & Keep for the IP network. Such a dualism might work well as long as traffic flows exclusively in PSTN or IP networks. But as the example of VoIP calls shows, calls will often pass through different types of networks. This gives rise to arbitrage opportunities. As the separate network infrastructures are expected to converge to an all IP network this regime does not seem viable in the long run.

- b) Different regimes for *different services* – independent of network type and level

This approach requires that it is possible to clearly distinguish between different services and that usage of services can be measured. Thus, it is necessary to mark different services or to transport them separately. Unless these preconditions are met there is a high risk of adverse selection, moral hazard and arbitrage problems.

Instead of differentiating regimes according to services one might also envisage differentiation of different QoS classes (best effort vs. QoS level specified).<sup>55</sup> Applying such an approach could be done by assigning different services to different QoS classes.

<sup>54</sup> Vogelsang (2006).

<sup>55</sup> See also ECC Report 75 (2005).

Some comments mentioned that NGN interconnection could not be assimilated to simple IP traffic exchange since each end-to-end NGN service used different control and network resources depending on the peculiar characteristics of the specific service provided.

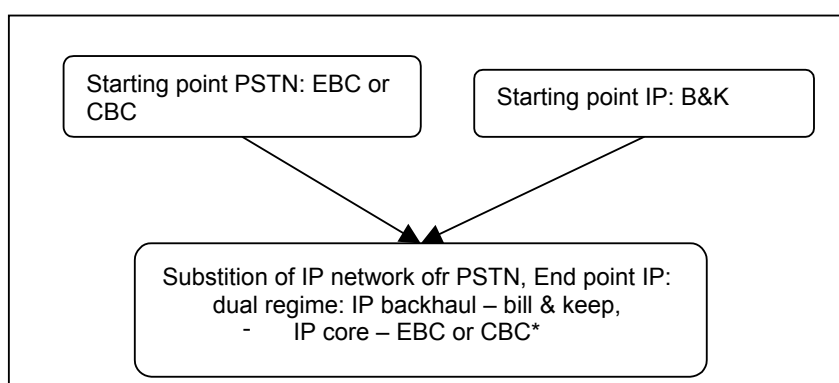
- c) Different regimes for *different network levels* – independent of network type and services

Such a “two-level” regime could be implemented as follows: Bill & Keep on the access/backhaul level (between customer and point of interconnection), and EBC (or CBC) for transit in the core network.

The determination of the minimum number of interconnection points required to take part in the Bill & Keep regime at the access/backhaul level is a crucial ingredient of this approach. The number of network nodes at the boundary between backhaul and core network represents the maximum number of interconnection points possible. Therefore this boundary plays a crucial role here.

The “two-level” regime helps to minimize the “hot potato” problem (see above). It is advocated by a considerable number of authors.<sup>56,57</sup>

Figure 9: Dual regime with Bill & Keep in the backhaul network and EBE/CBC in the core network as target regime



\* For the IP core EBC or CBC would be applied unless peering agreements apply.

One respondent explicitly considered the dual approach to be the best compromise (e.g. with regard to investment incentives, minimizing the hot potato problem, smooth transition) but further clarification was required concerning for example QoS, number of interconnection points and boundaries.

A number of respondents opposed mandating Bill & Keep, stating that priority should be given to market solutions instead. These respondents do not consider a decision on a future interconnection regime possible today as the structure of future networks is not known.

56 A similar system with Bill & Keep on the access level is also advocated in ECC Report 75 (2005), Horrocks (2006) and DeGraba (2000). Very generally, the Bill & Keep seems to have widespread support from economists (see also Littlechild, 2005, Marcus, 2006). Wright (2003) holds a more sceptical view on Bill & Keep.

57 Theoretically, the very opposite would also be possible: i.e. Bill & Keep for transit and EBC (or CBC) on access level (i.e. between access providers (TNB) or between access providers and backbone providers. But this option does not seem to be advocated in the literature.

#### 4.2.5 Options for Managing the Migration Period towards all-IP Infrastructures

Tackling the problem of developing an interconnection regime that meets the demand of future IP networks *and* – at the same time – the challenges resulting from the migration period is quite complicated.

Assuming that the long-run target option is a “pure” Bill & Keep regime,<sup>58</sup> then the question is whether there are options that help to soften the transition process towards this regime and avoid disruptive changes without inducing prohibitive transaction costs. Two options are at hand:

- 1) IP-based networks simply substitute for the PSTN network; or
- 2) As an intermediate step the interconnection regime is adapted to Bill & Keep for the PSTN.

Option 1) implies parallel existence of different interconnection regimes for PSTN and IP networks as long as there is parallel operation of both types of networks. Inconsistencies and arbitrage opportunities resulting from this situation may be outweighed by saving transactions costs (of *not* taking the intermediate step as in 2). Option 1) may be preferable if the transition to all-IP networks comes quickly.

In order to have a smooth transition towards a Bill & Keep regime one could gradually decrease over time EBC thereby approaching EBC to Bill & Keep. This may allow a gradual transition avoiding disruptive change and avoid structural adjustments in the PSTN (network structure, points of interconnection). The lowering of tariffs might be justified by the fact that, under a LRAIC approach, replacement investments do not (necessarily) have to be taken into account if a phasing out of PSTN network operation is foreseeable because the PSTN is replaced by NGN networks.

Option 2) involves high transaction costs that might be worth incurring if the envisaged period for parallel running is long, avoiding inconsistencies and arbitrage opportunities. It should be noted that it seems preferable to keep the period of parallel running as short as possible. This would a) help to minimize the period of time where inconsistencies and arbitrage problems may occur due to different regimes for different networks, b) avoid transaction costs of implementing the intermediate step mentioned and c) enable operators to benefit as early as possible from the efficiency gains of a having an all-IP network.

A general statement on whether such an intermediate step is reasonable is not possible. This depends on the duration of the migration process with parallel operation of PSTN and IP networks. This period may differ between countries due to different migration strategies chosen by incumbents and competitors (overlay vs. substitution).<sup>59</sup>

If the long run target is the EBC/CBC regime for an all-IP network, one would have to think about migration steps easing the transition from Bill & Keep in IP networks towards EBC/CBC regimes. Elements of these regimes are present in transit agreements. Furthermore, the assurance of QoS might increase willingness to pay for network usage.

### 4.3 Relationship between Retail Billing Principles and Interconnection Regimes

Interconnection regimes and end-user payment systems are closely interrelated. It is evident that the interconnection regime influences the providers' costs. Although it may not be

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58 Referring to “pure” Bill & Keep here is done *only* for reasons of simplicity. It is intended here to illustrate the possibility of implementing an intermediate step.

59 Even two countries where the incumbents follow the same strategy (e.g. both overlay and substitution) the migration period will probably not be the same.

possible to establish clear-cut causalities between interconnection regimes and end-user payment systems, it is possible to make some statements on compatibility between them.

Marcus summarizes the relation between wholesale and retail level as follows:<sup>60</sup>

- “Bill & Keep wholesale arrangements enable low or zero retail per-minute usage fees, but higher initial and fixed per-month fees;
- CPNP wholesale arrangements tend conversely to preclude flat rate or buckets of minutes retail arrangements, leading instead to low initial and per-month fees but high per-minute usage fees;
- Countries with buckets of minutes retail arrangements tend to experience high and efficient utilization, but slower adoption of mobile services;
- Countries with conventional CPNP/ CPP arrangements tend to experience lower utilization, but faster adoption of mobile services.”

Bill & Keep is compatible with a receiving party pays regime as billing for classical Internet usage shows. However, it is not clear whether end-customers would accept a system where they have to pay for incoming calls.

Some respondents to the consultation held the view that implementing Bill & Keep at the wholesale level would necessarily imply switching from CPP to RPP at the retail level which according to their view might lack acceptance by consumers.

Such a shift to RPP cannot be considered strictly linked to the introduction of Bill & Keep (see Vogelsang<sup>61</sup>) but seems to be likely. However, end-users seem to have a relatively strong preference for flat rates<sup>62</sup>, thus, shifting to RPP may not cause insurmountable acceptance problems. With flat rates, it is not clear *a priori* whether the consumer pays the fixed monthly fee for outgoing calls only or whether the fee is also intended to cover a share of the cost of incoming calls. The consumers will mainly care about the level (price) of the flat rate. Therefore the trend towards end-user flat rates would also alleviate a possible change to Bill & Keep on the wholesale level.

However (regulatory) intervention may be necessary either if the matter is referred to NRAs by market players through complaints or if competition problems such as margin squeeze persist or emerge.

When criticizing a Bill & Keep regime, some comments also referred to the differences of mobile networks as opposed to fixed networks. It should be noted that Bill & Keep is used in the field of mobile communications in the USA.

## 5. Conclusions

### Conclusions

The changes which are taking place in technology affect not only the whole set of interconnection products, but also the provision of networks and services in general. The correct estimation of the impact on competition brought by changes in interconnection products will be one of the most relevant tasks for NRAs in the near future. Incentives to upgrade the network can be attributed to cost savings or to the need to be able to provide advanced services as voice revenues decline, but the use of more efficient technology to

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60 Ibid. p. 13.

61 Vogelsang (2006), slide 8.

62 See. Marcus (2006), p. 8.

provide existing regulated services does not alter the justification for that regulation; the move to NGNs does not provide an opportunity to roll back regulation on existing services if the competitive conditions have not changed.

A crucial feature of IP-architecture having implications for interconnection is the possibility to separate the main functional levels of the network. NGN strategy of implementation typically is based on a horizontal platform that allows for a technical and commercial separation of service, transport and control layers, which may be provided by different market players. This may require defining additional interconnection services accordingly.

The NRAs will therefore need to address several issues:

- Develop some guiding principles in order to clearly identify the regulatory challenges and evaluate regulatory options.
- NRAs may have to ensure that all types of interconnection which are technically feasible are possible, ensuring end-to-end connectivity and allowing for full interoperability of the IP based services offered to the customers of the interconnecting networks; for this reason, operators should be encouraged to give access to the technical interfaces, protocols and all other technologies necessary for the interoperability of IP based services, and to use standard interfaces and protocols.
- Regulators should take account of the need for interoperability and quality of service at all levels of the value chain. A more ubiquitous application of Article 5 of the Access Directive may be needed to ensure end-to-end connectivity as well as allowing users to access services provided by another undertaking.
- The transition towards NGNs entails several structural changes such as rearrangement of core network nodes and points of interconnection, number of points of interconnection or changes in the number of network hierarchy levels, as well as the question of interconnection tariffs. Furthermore IP-interconnection may be differentiated along the lines of services, according to quality of service classes or not differentiated at all.
- Besides regulation such as Article 5, appropriate areas for regulatory intervention have to be defined, building on the existing list of relevant markets and findings of SMP. These changes may require the adaptation of existing SMP products for interconnection. More particularly markets 8-10 so far only include narrowband interconnection services. A broadening of these markets should be allowed to include IP-interconnection by defining the markets more generally in those countries, where NGN related services already play a more important role. Also, the introduction of a Bill & Keep model for interconnection of voice calls on IP networks would have a major impact on the market for call termination. If needed, further markets for regulation and de-regulation may have to be identified.
- Adaptation of existing SMP products in the light of changes. With reference to SMP notifications, some elements of the analysis performed by NRAs will be NGN specific. For instance, control over architectural functions that constitute “control points” – i.e. functions that are necessary for service provision to end users – can result in market power. As long as control points might reside in any layer of the network hierarchy, this might increase the complexity of the competitive assessment. There might be cases where this control provides only a temporary advantage, while in other cases it may trigger abuses of dominant positions which could call for regulatory intervention.



- Determination of the cost of regulated interconnection products in a multi-service environment.

In the migration process towards NGNs, different charging principles (like Calling Party's Network Pays versus Bill & Keep) are currently being used for the interconnection of different networks. Therefore a discussion on the appropriate charging principle for IP-interconnection has begun, considering the following key factors: termination monopoly at the wholesale level, familiarity of end-users with CPP and RPP, relationship between wholesale and retail pricing, compatibility with retail tariff schemes (e.g. flat rates) and network and usage externalities.

This paper reviews options for wholesale arrangements in an all-IP world also considering problems during the transition phase. Bill & Keep and CPNP differ with regard to their relevance to the termination monopoly problem. IRG/ERG do not consider traffic symmetry a strict requirement for the applicability of Bill & Keep. Bill & Keep may lead to Receiving Party Pays (RPP) at the retail level. Possible acceptance problems of this shift might be alleviated by the trend towards end-user flat rates.

Apart from devising an appropriate interconnection regime including charging principles for an all-IP world, regulatory work will have to focus on the migration period towards NGNs, where different network and charging principles are used in parallel. Currently, this particularly applies to the provision of voice services.

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## Annex 1 Examples for NGN architectures

### A1.1 ITU architecture

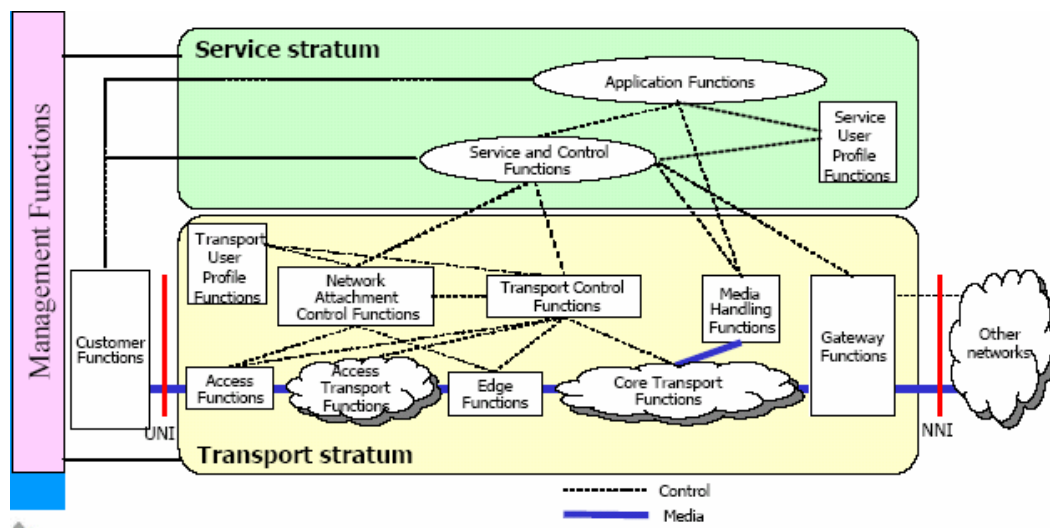
According to ITU-T definition “a Next Generation Network (NGN) is a packet-based network able to provide services including Telecommunication Services and able to make use of multiple broadband, QoS-enabled transport technologies and in which service-related functions are independent from underlying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

Since NGN's architecture allows decoupling the network's transport and service layers, whenever a provider wants to enable a new service, they can do so by defining it directly at the service layer without considering the transport layer - i.e. services are independent of transport details.

The transport plane provides a core QoS-enabled IP network with access from User Equipment (UE) over mobile, WiFi and broadband networks. This infrastructure is designed to provide a wide range of IP multimedia server-based and P2P services.

The following figure shows the overall general NGN architecture.

Figure 1: ITU NGN Architecture (picture source: ITU presentation ITU-T Workshop on NGN jointly organized with IETF Geneva, 1-2 May 2005.)



#### a) Transport functions include:

##### Access network functions

- Cable access.
- XDSL access.
- Wireless access (e.g. IEEE 802.11 and 802.16 technologies, and 3G RAN access).
- Optical access.

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##### Edge functions

- Used to aggregate, using specific Edge nodes, traffic coming from different access networks.

**Core transport functions**

- Provide QoS mechanisms, including buffer management, queuing and scheduling, packet filtering, traffic classification, marking, policing, shaping, admission and gate control, and firewall capability.

**Gateway functions**

- *Border gateways/session border controllers* are required for Interconnection between different peering domains (Carrier to Enterprise, Access to Core, Carrier to Carrier). Their main functions are: dynamic session management, media firewall, dynamic translation of IP addresses and UDP ports and QoS management through, e.g., DiffServ technique.

**Media handling functions**

- *Media Gateways* carry out media level interworking with other networks (including IP-TDM transcoding). They may be controlled by *Media gateway controllers* (e.g. through MGCP/MeGaCo protocols) and are equipped with voice coders such as G.711, G.729, G.723.1, and video coders such as H.261, H.263, H.264.

**b) Transport control functions include:****Resource and Admission Control Functions (RACF)**

- Provide QoS control (including resource reservation, admission control and gate control), NATP (Network Address Port Translator) and/or FW (Firewall) traversal control functions over access and core transport networks.
- Check authorisation based on user profiles, SLAs, operator specific policy rules, service priority, and resource availability within access and core transport.
- Act as the arbitrator for resource negotiation and allocation between Service Control Functions and Transport Functions.

**Network Attachment Control Functions (NACF)**

- Provide registration at the access level and initialisation of end-user functions for accessing NGN services.
- Provide network-level identification/authentication, manage the IP address space of the access network, and authenticate access sessions.

**Transport user profile functions**

- Provides network-level identification and authentication.

**c) Service and Control functions**

- Include resource control, registration, and authentication and authorization functions at the service level for both mediated and non-mediated services. Specific *Servers* for registration, localization, call control, AAA<sup>63</sup> are adopted.

**d) Application functions**

- Include functions such as the gateway, registration, authentication and authorization functions at the application level.
- Work in conjunction with the Service control functions to provide end-users and applications with the value added services they request. Generally specific *application servers* are utilized for the development of multimedia applications. These may be based on standard APIs (Application Programming Interface) such as OSA/Partlay.

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63 Authentication, Authorization and Accounting.

### e) Service user profile functions

- Combine user information and other control data into a single user profile function in the service stratum, in the form of a functional database.

Some NGNs implementations realize many of the control functions through *Softswitches* that are in charge of *Call Control*, *Media Gateways* control, *Border Gateways* control, *Signalling Gateway* with other network (e.g. H323 and ISUP). *Softswitches* also act as Signalling Switching Point to provide access to IN services to H323/SIP users.

As shown above, NGN implementation's strategy is typically based on a separation of service, transport and control layers. Another critical aspect is related to the adoption of standard interfaces/protocols and centralized DataBase for user's data and service profiles. Transport/control/services layers can thus be technically and commercially separated and provided by different market players.<sup>64</sup> Therefore NGN infrastructures potentially allow a greater division of labour.

## A1.2 IMS architecture

The IP Multimedia Subsystem (IMS) is a standardised NGN architecture for telecom operators that want to provide mobile and fixed multimedia services. It uses a VoIP implementation based on a 3GPP standardised implementation of SIP<sup>65</sup>, and runs over the standard Internet Protocol. Existing phone systems (both packet-switched and circuit-switched) are supported.

IP Multimedia Subsystem (IMS) framework, developed by the 3rd Generation Partnership Project (3GPP)/3GPP2 for 3G/UMTS and CDMA mobile networks, has been subsequently extended by other standards bodies, such as ETSI/TISPAN, to cover wireline facilities thus creating a converged, seamless mobile user experience.

Just as with cellular networks, IMS assumes each user is associated with a home network, and supports the concept of roaming across other wired or wireless nets. IMS also includes a policy engine and authentication, authorization and accounting (AAA) server for operator control and security.

IMS decomposes the network infrastructure into separate functions with standardized interfaces between them. Each interface is specified as a "reference point", which defines both the protocol over the interface and the functions between which it operates. The standards do not mandate which functions should be co-located, as this depends on the scale of the application, and a single device may contain several functions.

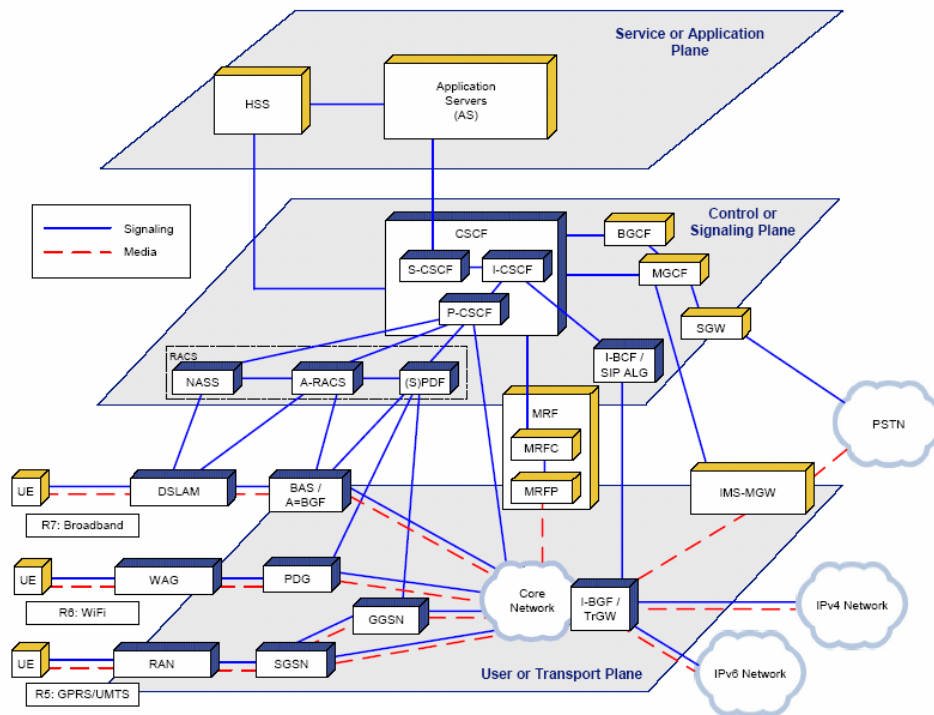
The IMS architecture is split into three main planes or layers, each of which is described by a number of equivalent names: Service or Application Plane, Control or Signalling Plane, and User or Transport Plane.

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<sup>64</sup> See also Langmantel (2006).

<sup>65</sup> See 3GPP specs in <http://www.3gpp.org/specs/specs.htm>.

Figure 2: IMS architecture (source “White paper” on IMS: www.dataconnection.com)



**Application plane**

The application plane provides an infrastructure for the provision and management of services, and defines standard interfaces to common functionality including:

- configuration storage, identity management, user status (such as presence and location), which is held by the Home Subscriber Server (HSS);
- billing services, provided by a Charging Gateway Function (CGF) (not shown);
- control of voice and video calls and messaging, provided by the control plane.

Application servers (AS) host and execute services, and interfaces with the S-CSCF using SIP. This allows third party providers an easy integration and deployment of their value added services to the IMS infrastructure. Examples of services are:

- Caller ID related services (CLIP, CLIR, ...);
- Call waiting, Call holding, Push to talk;
- Call forwarding, Call transfer;
- Call blocking services, Malicious Caller Identification;
- Lawful interception;
- Announcement services;
- Conference call services;
- Voicemail, Text-to-speech, Speech-to-text;
- Location based services;
- SMS, MMS;
- Presence information, Instant messaging.

## Control plane

The control plane is placed between the application and transport planes. It routes the call signalling, tells the transport plane what traffic to allow, and generates billing information for the use of the network, carries the gateway functions towards different networks, the admission control, network-level user identification and authentication.

At the core of this plane is the Call Session Control Function (CSCF), which comprises the following functions.

- The Proxy-CSCF (P-CSCF) is the first point of contact for users with the IMS. The P-CSCF is responsible for security of the messages between the network and the user and allocating resources for the media flows.
- The Interrogating-CSCF (I-CSCF) is the first point of contact from peered networks. The I-CSCF is responsible for querying the HSS to determine the S-CSCF for a user and may also hide the operator's topology from peer networks (Topology Hiding Inter-network Gateway, or THIG).
- The Serving-CSCF (S-CSCF) is the central brain. The S-CSCF is responsible for processing registrations to record the location of each user, user authentication, and call processing (including routing of calls to applications). The operation of the S-CSCF is controlled by policy stored in the HSS.

The Breakout Gateway functions are carried out by the following elements:

- The BGCF (Breakout Gateway Control Function) is a SIP server that includes routing functionality based on telephone numbers. It's only used when calling from the IMS to a phone in a circuit switched network, such as the PSTN or the PLMN.
- The SGW (Signalling Gateway) provides conversion between SS7 signalling used in the PSTN and IP signalling used in the NGN.
- The MGCF (Media Gateway Controller Function) carries out call control protocol conversion between SIP and ISUP and interfaces with the SGW over SCTP. It also controls the resources in an MGW with a H.248 interface.
- An MGW (Media Gateway) interfaces with the media plane of the CS network, by converting between RTP and PCM. It can also carry out transcoding when the codecs are different (e.g. IMS might use AMR, PSTN might use G.711).
- The Interconnect Border Control Function (I-BCF) controls transport level security and tells the RACS what resources are required for a call.

The Control Plane also controls User Plane traffic through the Resource and Admission Control Subsystem (RACS). This consists of the Policy Decision Function (PDF), which implements local policy on resource usage, for example to prevent overload of particular access links, and Access-RAC Function (A-RACF), which controls QoS within the access network.

The NASS module provides registration and (potentially) initialization of user equipment so that the subscriber can access the services provided in the Service Layer. From a network perspective, NASS provides network-level identification and authentication. This module is also responsible for managing the IP address space within the Access Network and providing authentication to service sessions. Network attachment is provided based on either implicit or explicit user identification credentials stored in its database (respectively, physical or logical Layer 2 addresses, or user name and password). This subsystem provides five essential functions<sup>3</sup>: Dynamic provisioning of IP addresses and other terminal-configuration parameters; Authentication at the IP layer prior to or during the address-allocation procedure; Authorization of network access based on user profiles; Access network configuration based on user profiles and Location management at the IP layer.



## User plane

The User plane provides a core QoS-enabled IPv6 network with access from User Equipment (UE) over mobile, WiFi and fixed broadband networks. This infrastructure is designed to provide a wide range of IP multimedia server-based and P2P services.

Access into the core network is through Border Gateways (GGSN/PDG/BAS). These enforce policy provided by the IMS core, controlling traffic flows between the access and core networks.

Within the User Plane the I-BGF, A-BGF Border Gateway Functions act as a gateway between two IP transport domains. Gateway functions are realized in one of three ways: between the CPE and the access node; between the access node and the core network; or between two core networks.

The BGF can provide many capabilities: Packet filtering based on IP address or port (gate control function); Marking of outgoing packets and policing of incoming traffic; Resource allocation; IP address and port number allocation (NAPT); Hosted NAT traversal; Usage metering; Topology hiding and Interconnection between IPv4 and IPv6 networks.

## Media Servers

An MRF (Media Resource Function) provides a source of media in the home network. It's used for:

- Playing of announcements (audio/video);
- Multimedia conferencing (e.g. mixing of audio streams);
- Text-to-speech conversation (TTS) and speech recognition;
- Realtime transcoding of multimedia data (i.e. conversion between different codecs).

## A1.3 ETSI TISPAN Architecture

ETSI, the EU standardization body for (tele)communications, published the first "stabilised" NGN standards and specifications release in December 2005 (Release 1) and it is currently expanding the scope and the stability of the published document for a second release scheduled for the second half of 2007 (Release 2). The Telecoms & Internet converged Services & Protocols for Advanced Networks (TISPAN) committee is the ETSI core competence centre for the migration from switched circuit networks to packet-based networks with an architecture that can serve for both networks.

Release 1 is derived from the mobile network community (3GPP) and covers:

- Terminology, Strategy, QoS, Security, NNA & Identification, ENUM;
- Requirements, General architecture, Early services and protocols;
- Detailed architecture, Base services/protocols, 3GPP endorsements;
- Operations Support Systems, Congestion control, NGN user data, PSTN/ISDN emulation.

Release 2 will cover:

- Content delivery: Streaming, IP-TV, VoD;
- Optimized resource usage;
- Corporate users specific requirements.

Work for Release 3:

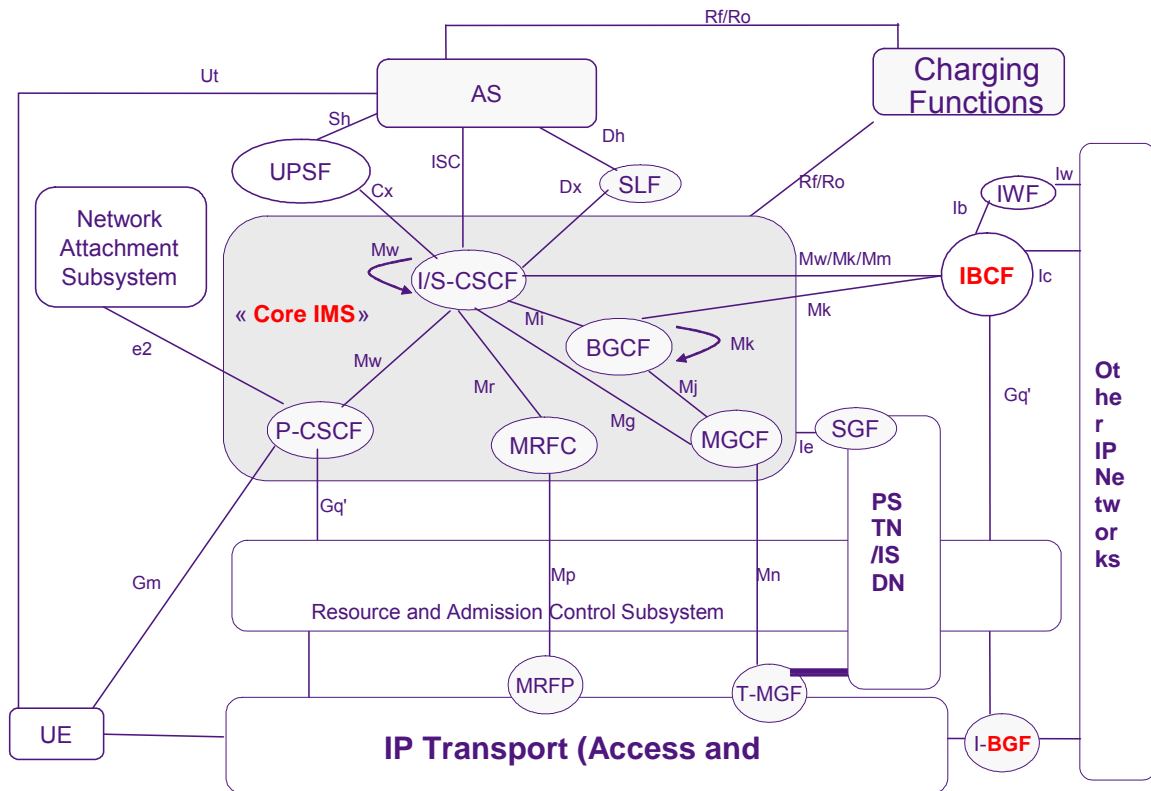
- Generalized mobility, and more ...?

### Network structure (architecture and topology)

The TISPAN NGN architecture allows for peering points towards PSTN and with other IP networks:

- Interconnection to PSTN happens through media gateways controlled by MGCF (Media Gateway Control Function).
- Interconnection to other IP networks happens to border gates controlled by IBCF (Interconnection Border Control Function).

Figure 3: ETSI/TISPAN architecture (source: ETSI).



It must be noted that the interconnection to other IP networks may also carry PSTN traffic that could be handed over to the PSTN after transiting via one or several IP networks. More generally, IMS can also be used as a transit network for its own non-IMS users, for interconnecting enterprises and for other network operators providing connectivity to both PSTN and IP endpoints. It can be anticipated that gradually interconnection with PSTN will fade out to the benefit of full IP connectivity.

The TISPAN NGN supporting IMS today and IPTV tomorrow is by definition “access agnostic”. TISPAN Release 1 focused on DSL access but Release 2 will definitely extend to other access technologies. 3GPP defined IMS with the requirement of agnostic access in mind. 3GPP has defined the specific features for control of the mobile access network, whereas TISPAN Release 1 has defined the DSL access specific control with NASS and RACS.

### IP Interconnection

ETSI TISPAN definition of two distinct interconnection models:

- Service-oriented Interconnection (Solx): the physical and logical linking of NGN domains that allows carriers and service providers to offer services over NGN platforms with control, signalling (i.e. session-based), which provides defined levels of interoperability.
- Connectivity-oriented Interconnection (Colx): the physical and logical linking of carriers and service providers based on simple IP connectivity irrespective of the levels of interoperability.

Solx interconnection is typically characterised by the presence of two types of information exchanged between the two interconnected domains:

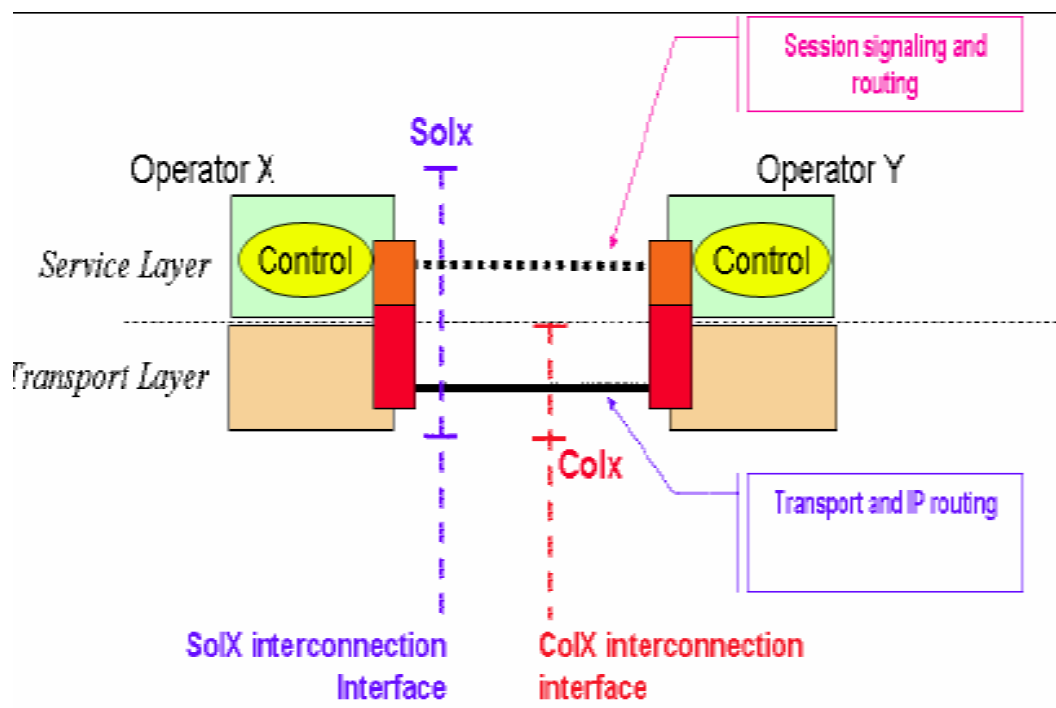
- Service-related signalling information that allows to identify the end-to-end service that has been requested
- Transport information, that carries the bearer traffic

Colx interconnection is characterised by the absence of the service-related signalling. This implies that there is no end-to-end service awareness in Colx interconnection. Two cases can be occurring:

- Only transport information, carrying the bearer traffic, is exchanged at the interconnection point
- Two types of information are exchanged between the two interconnected domains through the NNI:
  - Transport-related signalling that does not carry any service-related signalling information
  - Transport information, that carries the bearer traffic

The Colx interconnection does not invoke any functionality in the service layer, and even in those case where some signalling is exchanged at the interconnection point, no end-to-end service information is present in that signalling.

Figure 4: Simplified model of Solx and Colx interconnection (source: TISPAN WG4).



On this basis ETSI identifies the minimal requirements and functionalities that operators and providers have to assure in their NGN for service “aware” interconnection. Main requirements include the followings:

- IBCF (application level functional entity, which provides interconnect functions at the boundary between two operators) and I-BGF (packet-to-packet gateway for user plane media traffic) functionalities are the only elements acting as a interconnection boundary between operators/providers network domains (see figure 3 where IWF means Inter-Working Functions);

- operators and service providers shall control the flow of service request through the signalling protocol which is used to control the set-up of the communication;
- ETSI has adopted SIP signalling protocol (the references are ETSI ES 283003/TS 124229 standards) as the unique protocol for NGN interoperability. Besides the specification of interworking function between SIP-based networks and traditional circuit-based telephony network is defined in ETSI ES 283027/TS 129163 standards.

## Annex 2 : Summary of Comments

**Draft Summary of inputs received under the consultation**  
**“ERG Project Team IP-Interconnection and NGN – ERG (06) 42 rev1**  
**Consultation document on IP interconnection”**

December 2006

### Executive summary: key points

A total of 14 responses to the consultation were received by the ERG and published on the ERG website (erg.eu.int)

*Consultation questions:*

- 1) How should the transition from the PSTN number of interconnection points to the probably reduced number of interconnection points in NGNs look like? Which are the implications for the price structure and price level of interconnection rates?
- 2) What is the equivalent to “local” interconnection in NGNs?
- 3) Reflecting the transition towards NGNs what are the implications for existing SMP products and bottleneck facilities? Does this technological change remove existing SMP positions or bottlenecks or could new ones emerge in NGNs?
- 4) How do you evaluate the advantages and disadvantages of different charging principles discussed in the paper?

In the following the comments received to these questions are summarized, beginning with the answers of associations followed by companies’ answers. As some answers also covered aspects going beyond these questions this summary also addresses the issues of “Quality of service”.

***Question 1: How should the transition from the PSTN number of interconnection points to the probably reduced number of interconnection points in NGNs look like? Which are the implications for the price structure and price level of interconnection rates?***

Several comments indicated that the number of interconnection points would diminish in an NGN context. Fewer comments did not agree with this view, noting that streaming services could actually lead to more POIs. Others thought it is too early to answer these questions. Some stressed that cost savings of NGN need to be passed on to competitors. More generally, transparency about incumbents' plans and their networks is considered crucial by some.

#### **ECTA**

Strongly advocated transparency of topology evolution and investment plans to allow for an informed impact assessment by regulators and competitive operators. Noted it was impossible to predict on a pan-European scale how the transition would look like, also because the number of points of interconnection would likely vary significantly from country to country. NGNs should in general lend themselves to flatter charging regimes (whether based on QoS, element or capacity or Bill & Keep). The expected cost savings of NGNs are expected to be reflected in prices charged to external wholesale customers on a non-discriminatory basis. In case of fewer interconnection points, fewer charging 'bands' are expected.

#### **ETNO**

Considered that the development of NGNs has only started, thus the final network architecture and network structure were not known today. It is claimed that no definitive statements about the future network structure and regime, particularly about the amount of interconnection points and hierarchy levels, could currently be made. The deployment of NGN depends on factors like the strategy of operators, regulatory certainty, maturity of the markets, depreciation and amortization of the existing interconnection infrastructure. It was premature to predict how interconnection rates could be affected by the future NGN interconnection structure. A well-functioning interconnection market will lead to an adequate number of interconnection points and find its own price points.

#### **ETP**

NGNs would not necessarily lead to a reduction of interconnection points. The number of interconnection points depends on the operators deployment plans and could differ per country. Market forces would be sufficient to deal with the transition to IP-based networks. NRAs should focus on transport interconnection while service interconnection and interoperability issues should be left to the market. It is premature for NRAs to define areas for regulatory intervention.

#### **GSME**

The move to all-IP networks should not be considered an opportunity change existing business and charging models through regulatory intervention. It is essential that networks will not be constrained to apply a particular interconnection model, economically efficient only in conjunction with a specific retail model. It is expected that NGNs and the public Internet will run in parallel. There is no reason why they should not follow separate interconnection regimes. Market solutions are considered to be superiors as they suit the particular circumstances.

#### **IPsphereForum**

In order to realise the economic benefits of NGNs the number of physical points of interconnect should be reduced as much as possible. Therefore, the most appropriate point of (physical and service) interconnect in the BT 21C network example was at the Metro node.

It is argued that in NGN, the price structure would reflect the number of Points of Service Interconnect (PoSI). A smaller number of PoSIs would result in lower costs and hence lower charges to customers. Regardless of how many PoSIs there are, there would still be a significant cost difference in delivering calls to customers in heavily populated as opposed to those in lightly populated areas. This would need to be reflected in any pricing structure.

#### **Alcatel**

Structured and managed SS7 interconnection will evolve into bulk IP handover/peering based on QoS /SLA (Service Level Agreement) arrangements located either at edge or core nodes. . Policy needs to account for the multiple facets of competitive IP interconnection: PSTN-NGN Core, NGN Core – NGN Core, PSTN-NGAs (Next Generation Access), NGN-NGAs, as well as Vertical vs Horizontal IP interconnection within multi-platform networks owned by an integrated player.

#### **Arcor**

Noted that the number of interconnection points is not necessarily lower for IP-interconnection than for PSTN-interconnection. Streaming services can lead to a high number of interconnection points.

#### **DTAG**

Two different kinds of parallel IP-based networks would exist in the future: managed NGNs and the unmanaged public Internet. Two different kinds of IP-interconnection would result hereof (managed / unmanaged). IP-interconnection during the migration period should follow two principles: a) Implementation of the same kind of interconnection regime in parallel networks (e.g. CPNP in both PSTN and NGN), b) uniform pricing level of the interconnection services.

#### **France Telecom**

Voice over Broadband would be conducive to a greater centralisation of the traffic delivered by both France Telecom and competing operators. Distinguishing between Pops for signalling flows from Pops for media flows it is expected that the number of Pops will be reduced for both flows. The impact of this transition on the price structure and level would depend on various issues such as the technical architecture. Future pricing structures should be driven by principles of symmetry.

#### **Telecom Italia**

It is argued that the evolutionary NGN scenario would depend on the progressive deployment strategy followed by each operator. Since the NGN deployment strategy was market driven it would not be possible gauge network topology issues such as the number and the points of interconnection.

#### **Telefónica**

The transition would depend heavily on the operators' strategy to migrate to NGN. Different interconnection schemes for different services, and in different countries could arise. NGN all IP networks would show different hierarchical levels than existing PSTN networks. The number of point of interconnection with economic and businesses sense may tend to diminish. Although NGN might reduce operation costs, it is not clear if the mere transition to NGN will reduce the costs if not accompanied by a new panoply of services accepted by the market.

#### **Tiscali**

In the early stage towards NGNs the primary interest for NRAs would be to track carefully the technological and market developments taking place. The regulatory structure needs to be as stable as possible. Due to the different solutions followed by different countries, it is not possible to envisage a unique model of NGN structural development. If the purpose was to reduce the number of nodes geographically (due to an old infrastructure based on high

capability services and customer), the trend would be towards the reduction of nodes. However, if the introduction of NGN was to push IP at access level, the hierarchy levels could reduce so that the number of transport nodes could also increase.

### **Vodafone**

Operators moving to more efficient networks should have the ability to rearrange network hierarchies and to reduce the number of nodes. This *may* lead to geographic rearrangement and also to an overall reduction in the number of interconnection points offered by incumbents. If IP-based access networks would lead to reduced costs, these lower costs should be available to competitive access providers using fixed incumbents' networks. In the case of regulated interconnection rates price structures and levels should also reflect new, presumably lower costs.

### **Question 2: What is the equivalent to "local" interconnection in NGNs?**

Several comments consider the existing concept of local interconnection to be overcome in NGNs. This is due to the following aspects (inter alia):

- nomadic and mobile uses,
- number portability (customer location and number are not as closely related as in the past)
- the tendency to increase the level of routers in network architecture
- the fact that integrated networks carry more non-local traffic than pure voice networks.

Others argue that this question cannot be answered at this early stage of NGN deployment.

### **ECTA**

NGNs should in theory allow for easier interconnect. It should be technically possible to open the concentrator and convert it to a switch into which another network provider can plug his interconnect wire. A fully flexible system would include options at the central office or the street cabinet level for copper, or the optical distribution frame level for FTTB networks. Duplicating investment to higher-level points in the network was only economically rational in a model in which charges are distance and/or quality dependent – i.e. there was some scarcity of bandwidth and specific channels should be paid for. If, however, the network provided so much bandwidth that no QoS is provided for, then it would make sense to have only one point of interconnect (or a small number to ensure resiliency of the interconnect network) using Bill & Keep (or peering).

### **ETNO**

Current models for interconnection including local, single and double tandem price levels may be less relevant as the importance of distance is decreasing. Elements related to quality or service elements may play a role. However, it is too early to know if local interconnection points will disappear for all services.

### **ETP**

Local interconnection is considered an intrinsic part of the PSTN/ISDN architecture and based on the assumption that costs depend on the amount of network used. In an IP network the location of control and applications can be chosen freely and the length of the path within a network becomes less relevant. Furthermore the signalling path and the data transport become detached. The concept of local interconnection should be revisited bearing in mind the technological characteristics and actual cost structure in an IP based NGN.

### **GSME**

It is pointed out that the mobile network structure differed from fixed networks.



**IPsphereForum**

IPSPF provided an example of the "local" equivalent of NGN interconnect could be either interconnect at the MSAN (Multi-Service Access Node) level or at the MDF (Main Distribution Frame). Interconnect at the MSAN is not recommended because it would be uneconomic to provide physical interconnect at over 10,000 points in the network. Interconnect at the MDF is equivalent to LLU.

**Alcatel**

In the context of the consultation local interconnection was considered "a service provided by an access asset owner who supports some type of first mile providing access to service applications provided by his own organization or by competitive players who do not own access assets in the access area". In traditional local interconnection regimes (based on TDM), one of the main ambitions of the access owner is to get rid of the "foreign" service traffic at the earliest point possible, with the objective to offload such traffic at the access level of the network. As regards basic services, this trend would persist in the VoIP space. The nature of VoIP and growing competition naturally tended towards developing more complex communication services. In the wider Internet context, existing SMPs and other facilities-based players are increasingly motivated to act as "capability" providers for the web community. The new capability wholesale regime could be either an evolution of the existing "local interconnection" regime of the incumbent, or offered by larger ISPs as a set of capabilities relying on their existing "local interconnection" regime with the incumbent.

**France Telecom**

As services will be more and more nomadic and fixed number portability develops driven by multiplay competition, "local" interconnection would make much less sense in the context of wide scale NGN deployments. "Local" interconnection was mainly justified on PSTN by the influence of distance on the costs in the context of a TDM architecture and the direct link between customers location and numbering allocations. In a NGN architecture, attaching a customer to a NGN platform is not driven by location - neither of the customer nor of the platform. A NGN platform can manage customers located anywhere on the national territory, so that the case for "local" level of interconnection as known today is not strong anymore.

**Telecom Italia**

The existing concept of local interconnection for end-to-end service communications was likely to be overcome in NGN context as a consequence of technological evolution: a trend towards a coexistence of pure IP connectivity interconnection at access/edge network level (CoIX) and a service aware interconnection at core network level (SoIX) could be foreseeable. It is not possible to gauge network topology issues such as the number and the location of points of interconnection.

**Telefónica**

It was not clear if the local interconnection level will make sense in the future in NGN. There would be a number of factors that tended to increase the level in the architecture of the interconnection points, such as:

- The percentage of local traffic in an integrated network that carries all kind of services (voice, data, video, ...) is much lower than in specialised networks (for example voice network has much more local traffic than P2P networks).
- The increase use of mobile and nomadic services.
- The reduction in the cost of the transmission.
- The tendency to increase the level in the network architecture of the router.

However; it was still too early to know, especially for new services requiring high bandwidth, if the local interconnection points will completely disappear.

**Tiscali**

If the purpose was to reduce the number of nodes geographically (due to an old infrastructure based on high capability services and customer), the trend would be towards the reduction of nodes. However, if the introduction of NGN was to push IP at access level, the hierarchy levels could reduce so that the number of transport nodes could also increase.

**Vodafone**

Local interconnection in an NGN environment should reflect the lowest practical value added interconnection service offered.

***Question 3: Reflecting the transition towards NGNs what are the implications for existing SMP products and bottleneck facilities? Does this technological change remove existing SMP positions or bottlenecks or could new ones emerge in NGNs?***

The EC and NRAs will be most interested in understanding the regulatory implications of technological change. In particular, the evolution of existing SMP products and the emergence of new ones in the context of NGN implementation will reflect on the EC Recommendation on relevant markets. To this end, several inputs addressed this issue. Some purported the maintenance of existing markets, providing input on their possible evolution. Others noted that bottlenecks will appear according to specific architectural design of NGNs.

Access is clearly a more controversial issue than core network. In particular when considering bottlenecks and the evolution of SMP products, respondents to the consultation outlined different views. Members of the first group pointed out that the introduction of NGN should not be seen as detrimental to competition:

- a) Some operators do not perceive bottlenecks emerging in NGN due to lower entry barriers and an increased number of players such as ISPs, DRM providers, ASP and content aggregators, potentially neutralising legacy market power.
- b) For some, NGN could even offer a chance for preparing a level playing field for offering voice services.
- c) In addition, NGN could offer a potential for reducing existing bottlenecks at the core level for some, while with regard to access this evolution will depend on the access solutions adopted, on the level of competition in specific geographic areas, on local authorisation systems (i.e. Access to street cabinets and ducts, etc.)
- d) Finally, some deemed that some SMP products, like carrier preselection, may no longer be necessary as competition becomes effective at access or infrastructure level.

On the other hand, members of the second group noted that the migration towards NGN ought to be assessed considering issues such as:

- a) Advanced features such as improved control over signalling information and intelligent features (e.g. presence information) could reinforce market power and allow leveraging towards adjacent sectors
- b) There is a risk of emergence of walled garden systems, reducing interoperability unless assured by regulation.
- c) the Last mile remain an essential facility; also depending on replicability of infrastructure
- d) Access obligations might be insufficient, if not supplemented with proper interconnection and interoperability obligations.

- e) NGN should not provide an opportunity to roll back regulation and conditions for market analysis should remain unchanged.
- f) new bottlenecks could emerge due to the centralised provision of intelligence functions that all services are dependent on, e.g. IMS, number translation and DNS, this can be alleviated by appropriate dimensioning of these functions as well as for the opportunities to invest and participate in the new services markets

Eventual regulatory remedies should take into account a necessary revision on the real bottlenecks remaining in an NGN environment. The opportunity and willingness to invest by service providers shall not be conditioned by similar obstacles as could be the case in the former PSTN environment, which dictated the existing regulatory policy. Therefore, such a policy should be fully revisited, specially when referring to the core NGN investment and deployment and, consequently, related services. Existing bottleneck to the participation of services providers in a much more open value chain should allow to remove currently identified bottlenecks.

Finally it was noted that stable IP-IP Interconnection standards are seen as a pre-requisite for the reduction of entry barriers.

### **ECTA**

ECTA noted that the technological change is unlikely to reduce existing bottlenecks where replicability is an issue. Where existing bottlenecks depend on pricing principles, these could change. New bottlenecks may also emerge for intelligent features associated with NGNs.

A summary market by market assessment followed, suggesting that Market 8 is justified because 1) in the PSTN, if an operator is not the provider of the access segment, a wholesale call origination service is the only way to be able to offer a retail voice service; in an NGN, where in theory any voice provider could provide its service on the top of the broadband solution used by the customer, transparent emulation of voice services could reduce incentive to provide the service on a voice-only base, 2) in some countries the wholesale call origination service is also the basis of the Intelligent Network services (free calls, shared cost, shared revenue services). This remains valid in an NGN environment.

Market 9 is purely justified by QoS: while Voice over Internet comes without QoS guarantee and does not justify any termination monopoly; Voice over Broadband, if linked to a guaranteed QoS, justifies a termination charge. In other words if the broadband user has many voice over internet addresses over the same broadband link and uses them without any priority, the broadband provider should not get a significant termination charge for this. By contrast, if the broadband supplier had built a guaranteed bandwidth tunnel on to the user broadband link, to ensure that a voice conversation does not get hampered by the simultaneous download of a HDTV movie, then the broadband provider should be rewarded with a termination charge. Market 10 is useful in case there is a need to transit traffic with given parameters such as quality. Bottleneck characteristics are likely to remain unchanged from the present situation, with thin or thick routes having different prospects for competition. Providing any single route is uncompetitive however, it will be necessary to maintain this market to ensure a possibility for full geographic coverage. Also, it was suggested that Market 11 (ULL) in particular will remain as a separate SMP building block; distinction between market 12 (WBA) and market 13 / 14 may start to blur, but should remain separated, partly due to the different treatment of QoS and service issues in these markets.

Further into the future, additional bottlenecks could emerge around control over network signalling information (sometime referred to as 'network hooks'). It may be necessary to share certain information over interconnects in order to be able to set up end-to-end services, for example, information about QoS parameters, or end-user location data (not only for voice, but also for video, data and access to content). The network operator necessarily

has a monopoly over this information, and this could create new competition issues. It should be clarified how, in the context of the market analysis process, these would be addressed.

### **ETNO**

ETNO does not see any bottleneck emerging in the near future. In this area, regulatory intervention is therefore impossible to justify at this stage. The move towards NGN has the potential to remove existing bottlenecks. NRA should take into account that the NGN functional architecture could lead to network operators being challenged by new market players: for instance, application providers and premium content providers could neutralise and challenge the legacy market power over the physical network. Service providers could become strong competitors which do not invest in the network infrastructures themselves.

In case an incumbent operator chooses to discontinue supplying legacy wholesale products, this should be allowed provided:

- It no longer has SMP or;
- There is no longer reasonable demand for existing SMP products. It would be disproportionate to continue SMP-driven obligations related to wholesale products offered to by a small number of alternative operators, for a small absolute level of demand, or where demand is in rapid decline or;
- It is reasonable to move to NGN products: an operator's wholesale customers will have a greater incentive to shift to NGN platforms, if there is a reasonable prospect of timely market reviews leading to a transparent mechanism for withdrawal of legacy products.

### **ETP**

It seems to be too early to answer this question. Of course the move towards NGN may have the potential to remove some existing bottlenecks but it is pre-mature to define hypothetical future bottlenecks.

### **GSME**

Indeed given the adoption of a technologically neutral regulatory framework EU regulators first response to a new technology should be an assumption of consistency and that the current regulatory approach: definition of relevant markets based on the three criteria test, market analysis, the determination of Significant Market Power and application of proportionate remedies where it exists will remain valid.

### **IPsphereForum**

Access bottlenecks in the NGN environment have the potential to be much reduced compared to legacy networks because of the many different access technologies available, e.g. DSL, Ethernet, 2G, 3G, WiFi, WiMAX, etc. Although it could be argued that new bottlenecks could emerge due to the centralised provision of intelligence functions that all services are dependent on, e.g. IMS, number translation and DNS, this can be alleviated by appropriate dimensioning of these functions as well as for the opportunities to invest and participate in the new services markets

Regulatory remedies should take into account a necessary revision on the real bottlenecks remaining in an NGN environment. The opportunity and willingness to invest by service providers shall not be conditioned by similar obstacles as could be the case in the former PSTN environment, which dictated the existing regulatory policy. Therefore, such a policy should be fully revisited, specially when referring to the core NGN investment and deployment and, consequently, related services. Existing bottleneck to the participation of services providers in a much more open value chain should allow to remove currently identified bottlenecks.

### **Alcatel**

ALCATEL noted that the model where the incumbent as SMP dominates the emerging world of IP-based communications is becoming more and more questionable. In a context limited

to electronic communications, the role of the SMP would probably remain, but in this wider Internet context, existing SMPs and other facilities-based players are increasingly motivated to act as “capability” providers for the web community. Clearly the owner of communication assets can offer specific capabilities, which bring value to the web community, for example, the ability to:

- Easily establish different forms of communication to any user,
- Determine location (e.g. for emergency services),
- Control the quality of the service provided over the assets.

Additionally, the SMP owns feature-rich payment assets, which could enable existing Internet players to more effectively price, their services. The most advanced SMPs realize that they can set up new wholesale regimes whereby they evolve their access interconnection offering into a capability-sharing offering. This capability sharing will be done relying on technologies such as SOAP/XML, EJBs and SIP servlets.

The new capability wholesale regime could be either an evolution of the existing “local interconnection” regime of the incumbent, or offered by larger ISPs as a set of capabilities relying on their existing “local interconnection” regime with the incumbent.

### **DTAG**

Deutsche Telekom is of the opinion that NGNs will significantly reduce barriers to entry and thus will further enhance competitive pressures, especially on already competitive core network markets.

### **France Telecom**

France Telecom sees no bottleneck emerging in a NGN context as competition would essentially rely either on alternative infrastructures or regulated accesses of markets 11 and 12 of the Recommendation on relevant markets. Generalisation of broadband capabilities would further lower entry barriers on services markets, stressing even more - if needed - the merit of full de-regulation at retail level. As traffic was aggregated and delivered higher in the network, current CS and CPS did not make technical sense anymore in a NGN context. CS and CPS did not have any regulatory merit anymore as competition was effective at access or infrastructure level. Adopting symmetric rules could constitute a promising alternative to the SMP-driven regulation of termination markets, especially in the context of generalised fixed number portability, which significantly reduces the ability of wholesale and retail customers to use E.164 numbers in order to identify access operators.

### **Telecom Italia**

While the existing regulatory approach was suited for traditional technologies, NRAs should define remedies taking into account the level of maturity and stability of the new platform, the initial phase of investments by all the operators and the specific technology and infrastructure features. NGNs are considered new infrastructures that all operators, both incumbent and alternative, have to deploy facing a similar starting point when to decide to make the investment. As a consequence, asymmetric regulation as that applied to legacy networks is not justified in the context of NGN.

In relation to issues addressed in the Recommendation of relevant market appropriate substitutability analysis should be conducted with regard to wholesale broadband access, to assess whether a specific NGN service falls within the definition of a market susceptible of ex-ante regulation.

Telecom Italia is of the view that at this stage there is no evidence of emergence of NGN generated market failure that would justify a regulatory intervention aimed at mandating a single IP interconnection model. Moreover Telecom Italia believes that structural intervention on NGN interconnection issues (charging model included) envisaged by ERG can not be enforced either on the basis of an SMP position either on the basis of a more general

requirement of interconnection applicable to all telecommunication operators (article 5 of the Access directive).

When outlining the implications for SMP products and bottleneck facilities Telecom distinguishes between 1) NGN core network, 2) NGN access network:

Ad 1) Considering that competitors in the fixed and mobile telephony already been able to develop, deploy and manage their own core networks without the need to make use of any Telecom Italia's network facility Telecom Italia sees no bottlenecks in the deployment of NG core network.

Ad 2) In the deployment of NG access network operators can adopt different architectural solutions, which implies that NGN functionalities can be located either in the exchange or in a downstream network point. Different technical solutions will have different implications in terms of the location and the architecture of the interconnection and in terms of the identification of enduring economic bottlenecks, if any. As a consequence, since no firm decision has yet been taken on NG access architecture, it is far too early to assess which economic bottleneck will emerge or fade away due to the deployment of NG access. Telecom Italia believes that the main point to retain is that in NGN context the existence of bottlenecks will be highly dependent on both the technical NG access solution adopted and on the competitiveness of the specific geographical area. Even the permanency of the bottleneck characteristics of the legacy network elements may substantially differ across geographical areas.

Street cabinets are a critical issue not for the scarcity or the affordability of the product itself but rather for the difficulties that might arise in order to obtain the authorisations required to install them. Access conditions to ducts and sub-loop unbundling could also be included in the market analyses by NRAs, depending on the adopted NG solution. Hence for instance in areas where Wi-Fi and Wi-Max are deployed there are no enduring bottleneck left.

### **Telefónica**

NGN could lead to an enhance competition between an increasing number of different market players in the new value chain of convergent services. The deployment of new networks, the use of new technologies, and the introduction of new services would tend to reduce the present bottlenecks but may allow the emergence of new ones controlled by other agents besides traditional telecommunication operators that are already well positioned (internet service providers, contents aggregators, DRM providers, etc). SMP and bottlenecks would be co-mingled in a common competitive space were rule governing competition should reach similar levels.

### **Tiscali**

The statement that "the move to NGNs does not provide an opportunity to roll back regulation on existing services if the competitive conditions have not changed" is strongly agreed to. Even after the complete deployment of the NGNs, national incumbents would continue to controll the "last mile" (i.e. the access network). Furthermore, because of NGN structure - i.e. the "more defined separation between the transport (connectivity) portion of the network and the services thatrun on top of that transport"- access obligations may not ensure the possibility toprovide any kind of products and services if not linked to interoperability and IP interconnection obligations.

If the transition towards NGNs is carried out according to interoperability and interconnection principles, could offer the occasion to overcome some market failures. In fact, all-IP networks, through strong reduction in network costs, contribute to lower some entry barriers.

## Vodafone

It is assumed that the widespread development of IP-based access due to a combination of competition and regulation may be rendering past interventions obsolete. It was hard to justify a continued wholesale requirement to support complex interventions in the wholesale market such as indirect access or carrier pre-selection where there is widespread commercial availability of voice over broadband access to the home and office.

### ***Question 4: How do you evaluate the advantages and disadvantages of different charging principles discussed in the paper?***

In general, respondents noted that even in an NGN environment (or because of the transition to it), many different models of interconnection shall be present, and more efficiently than otherwise they should be left to markets. A few contested that the bill and keep model indicated in the ERG document represent real life situations. For instance, the mechanics of peering arrangements with reciprocal charging, no interpayment model and transit (interconnection) models were singled out to illustrate differences. It was noted that multiple solutions need to be available to account for the many different possible evolutions. Also, distance-based charging models were presented – with different notion of distance being examined, as well as class of service charging models.

## ECTA

ECTA noted that in the future, it may be appropriate to have different charging principles to apply depending on whether a QoS-guaranteed service or 'best-efforts' service is envisaged:

- For QoS guaranteed service, interconnect prices on a combination of QoS-based and Element- or Capacity based items are likely to be most appropriate.
- For best effort service, 'bill and keep', may be the most logical solution, although, to deliver PSTN-like quality a 'best effort' environment would require sufficient unrestricted bandwidth to all users, which may not be available in all networks at all times.

ECTA noted that SMP positions & bottlenecks may exist because given charging principles are in place. Firstly for communications between identified individuals, a bottleneck will apply for termination wherever there is a "Calling Party Network Pays" (CPNP) charging scheme, and this will apply in a PSTN or IP environment. Secondly, the extent to which investments are encouraged on an efficient basis (but not otherwise) depends on regulators making an accurate assessment on the cost-drivers for services and what are therefore the appropriate prices for both access and interconnect. Considerable care will thus be needed in the assumptions used for pricing services, particularly where these involve any 'value add' to the basic underlying infrastructure.

Whilst the first consideration would tend to favour bill and keep as a mechanism which could over-come the CPP termination bottleneck, the second highlights the need to make sure that the mechanism used really does reflect the 'real' value of bandwidth and any costs incurred in maintaining QoS levels. Using a bill and keep model in circumstances where one or more parties did not recover their costs may tend to lead to under-investment. The conclusion may be that different models are appropriate in different circumstances – and possibly for different aspects of the network.

ECTA favours pricing mechanisms for IP Interconnect that facilitate flatter charging models, rather than time-based which becomes increasingly removed from the underlying cost-base in an NGN world. Implications for charging for particular end-user services should nonetheless be considered, as the current charging system (including the potential for time-based charging) has proved useful in enabling the development of services such as directory enquiry and other premium services.

In selecting between a port-based, capacity-based and/or QoS based charging system and bill and keep it is necessary to weigh the benefits of bill and keep (no termination bottleneck) against the need to ensure that costs are properly assessed and covered, so as to encourage efficient investment – but without allowing over-recovery or inefficient investments. It is possible that multiple solutions could be adopted for different elements, or in parallel, depending on the circumstances.

In setting prices, it is also vital for regulators to ensure that cost-savings are passed on in a non-discriminatory manner and that costs in establishing interconnect and access are not loaded onto entrants. Likewise entrants' investments made necessary as a result of the incumbent's migration (eg in moving the points of interconnect) should be appropriately compensated.

### **ETNO**

ETNO noted that business models developed in each system (Internet and proprietary networks) have evolved independently. The common use of the Internet Protocol (IP) should not command an identical interconnection and billing regime. Customers could benefit from different interconnection regimes fostering an enhanced competition. Different retail charging principles will coexist in NGN. If peering arrangements can take place, then within those agreements a Bill and Keep billing regime might be chosen.

ETNO refers to two kinds of relations: client to provider and peering relations. Only peering relations are Bill and Keep relations and they are grounded in the symmetry between players (in the core network); to peer or not to peer is a typical bilateral decision. Otherwise the most frequent relation is the client-to-provider relation. With the emergence of various markets players in the future NGN context, it is very doubtful that all service providers and network operators will find identical symmetry of traffic between each other. In that case, an interconnection arrangement similar to today's IP-Transit would be necessary, but this will also have to be market driven. Symmetric exchange of traffic is almost non-existent. A Bill & Keep billing regime can hardly deal with traffic asymmetries; this model should therefore not be imposed by NRAs as it could result in delaying the development of NGN networks. An artificially mandated Bill & Keep-Regime, like the [ERG] proposed Dual Regime, would lead to technical inefficiencies with regard to an artificial set of points of interconnection as well as to a cost recovery problem: relying on customers' acceptance of a reversal of the charging principle as a result of the technological change. Besides this acceptance problem of Receiving Party Pays (RPP), the costs for network usage risk can not be recovered by charging the operator's own customers because of fierce competition on the retail market, particularly in the case of a flat rate retail price offering. Therefore, the most important objectives of the future charging principle for IP-interconnection has to be the possibility to recover costs as well as incentives for investments. These objectives are best fulfilled by Interconnection arrangements developed in the market.

### **ETP**

Although Bill & Keep seemed to have theoretical value it is considered that a transition to this approach would imply several problems: Covering the costs of termination would be difficult as RPP would be hard to implement on the retail level. The customer was not familiar with paying for incoming calls. The question is asked whether those who would not interconnect to the required points of interconnection had to pay or not. And what about traffic to free phone numbers or other services with online and offline billing? If implemented only in some countries Bill & Keep would lead to arbitrage problems. More generally, it was not yet possible to decide about a future IP-interconnection regime today.

### **GSME**

It is stated that not one charging model best suites all circumstances. The efficiency characteristics of different IC charging approaches would depend in part on the efficiency



properties of the retail charging models they induce. The economic performance of any particular IC charging model that might be imposed on a network would also be affected by the ability of the network operator to strategically (re-)design its networks and/or to (re-)focus its business in response to the imposed charging model

Bill & Keep is not considered the predominant IC charging model in the Internet. Where applied, Bill & Keep has often been adopted on the basis of technical necessity rather than economic merit. Limitation to identify the origin of traffic would no longer apply in NGN. Even if attractive and voluntarily agreed upon under certain circumstances Bill & Keep would not generally be the sound choice as the mandated regulatory fallback arrangement in all circumstances.

Bill & Keep would require approximately balanced traffic. The required balance was not limited to traffic volumes but has also a time dimension, a network component and quality dimensions. If BAK is used as an interconnection model when traffic is unbalanced, or may become unbalanced (because of actions taken by one or more of the operators involved), then the economic efficiency of the BAK model hinges critically on each network being able to generate returns from incremental originating/terminating traffic. With regard to termination, by definition, under BAK these profits can only be generated from the terminating network's retail customers.

The question is how well Bill & Keep performs with specific retail models. A retail model working well with Bill & Keep would not be the economically efficient retail model in all situations. Multiple retail charging models are expected to emerge in NGNs. It is doubted whether consumers accept a fundamental reversal of retail systems.

The geographic rigidity needed by a COBAK system did not correspond to the reality of the current industry structure of circuit switched networks, let alone mobile. The mobile network structure differed from fixed network. The discussion surrounding COBAK was very much fixed network specific as in the mobile world it was unclear what would constitute a 'central office'. Mobile networks were more costly than fixed networks in the access party which under COBAK would be part of the 'central office'.

### **IPsphereForum**

IPSF noted that the current retail charging models for PSTN Voice are likely to remain appropriate in an NGN world, at least in the short term. The alternatives have significant downside impacts on end-users, who understand current "Caller Pays", and on network operators, whose business models are reliant on a stable model that does not result in imbalances in cost recovery between unequal operators. "Bill and Keep" or peering arrangements for Voice would be too radical a change for most, if not all, operators in Europe, and would result in unpredictable changes in business models and cash flows.

While the "currency" of traffic will become packets (and associated quality attributes), the use of minutes is likely to be retained at least in relation to voice calls originated on handsets connected to the fixed network. Customers need metrics that they can relate to and that result in charges that relate to apparent cost causality.

Just as with current networks, geographic differentiation in costs will result in more pressure for geographic wholesale pricing, but the extent to which this results in geographic pricing for end users will depend on the nature of the services provided and the degree to which national "postage stamp" pricing structures are preferable from a marketing and customer service perspective. IP interconnections should migrate into relationships where parties are being compensated for usage of their network resources.

To avoid "hot potato" routing, the best business model for IP traffic exchange is considered to be distance related, where compensation is based on the distance IP packets travel on a

carrier's network. This model is also service independent. It can be used for both existing Internet traffic in one class, as well as for IP-based traffic in different quality classes.

### **Alcatel**

ALCATEL pointed out that current per minute/distance dependent pricing in the traditional PSTN context, compared to distance-independent IP Pricing, will lead to a market driven, optimized and distributed interconnection model connecting with incumbent legacy resources. This will encourage the emergence of dedicated market players (access and traffic carriers, end-user service providers). Moreover, it should be noted that the existing revenue sources of ISPs, would not be able to generate the funds required for infrastructure renovation required by the migration to NGN.

### **Arcor**

Arcor stresses that Bill & Keep is not an exchange of balanced traffic between network operators. Thus, balanced traffic is not a condition for a Bill & Keep system. It is noted that different billing regimes lead to arbitrage problems.

It is pointed out that web-based IP providers collected interconnection termination charges for QoS-services, although they did not offer QoS and the termination service was already paid by called party via DSL flatrate.

### **DTAG**

It is stressed that NGN and the Internet will coexist. Any discussion on IP-interconnection should also differentiate between IP-Interconnection in an All-IP-World and IP-interconnection in a migration period with parallel existing networks (e.g. PSTN and NGN). CPNP is considered a well-established approach enabling operators to recoup their costs and induces efficient network usage. The corresponding retail system CPP is considered efficient since the calling party has the greater benefit from the call.

Bill & Keep is only one of several forms of interconnection billing schemes used by Internet providers. In so-called peering arrangements, Bill & Keep is the efficient result of the negotiations of two network operators which regard each others traffic as symmetric. If symmetry is not fulfilled in a Bill & Keep relationship, larger networks are disadvantaged because they bear higher network costs than small networks. Furthermore, it is argued that consumers are familiar with the CPP-principle. Bill & Keep would lead to a hot potatoe problem and it would not lead to a significant minimization of transaction costs. The existing billing systems would be needed to bill traffic to specific service numbers. Moreover, adverse selection problems would occur with regard to QoS as networks operators would not be paid for network usage, thus, higher costs for better QoS could not be recovered.

The interconnection systems during the migration period should meet the following principles:

- Implementation of the same kind of interconnection regime in parallel networks (e.g. CPNP in both PSTN and NGN)
- Uniform pricing level of the interconnection services.

### **France Telecom**

It is argued that private arrangements at the IP-IP level would be clearly preferable to ex-ante regulations. Various interconnection models are expected to develop.

The co-existence amongst others of NGNs, transit operators and TDM CPS-based providers could stimulate forms of undesirable free-riding and regulatory-based arbitrage, if operators could not limit the benefit of B&K to symmetrical traffic. France Telecom considers that the risk of free-riding - and also spamming - will limit the scope of B&K in the short and middle term.

Inter-operator relationships in the internet world would either be client-to-provider relations or peering relations. Only the latter would be Bill & Keep relations. Peering required “equivalent” partner (same size, volume of traffic exchange, kind of business). Each network operator would ask for minimal conditions before entering in a peering relation. It is argued that client-to-provider not Bill & Keep was the most frequent relation in the Internet.

### **Telecom Italia**

TI refers to two different notions of Bill & Keep, the first relating to Internet traffic charging models (peering, transit) and the second to a “no-interpayment” model of interconnection. According to TI, the no-interpayment charging model was adopted in the Internet environment only if traffic is roughly balanced in the two directions or where there is a lack of evidence of traffic imbalance. Unbalanced traffic leads to a “transit agreement” which entails the payment of an interconnection fee. Moreover, traffic needed to balance out at each QoS level, symmetry of the total traffic volume alone would be insufficient for peering to hold.

Overcoming the termination problem would be the main reason for adopting Bill & Keep but this problem would cause less concerns in the VoIP context with continuously growing penetration rates. TI argues that asymmetries in termination rates reflecting different costs (e.g. of mobile and fixed operators) of providing the service would be eliminated with Bill & Keep. Moreover, Bill & Keep would not allow an internalisation of network externalities. TI considers RPP on the retail level to follow inevitably from Bill & Keep on the wholesale level.

TI stresses superiority of market driven interconnection models. A regime foreseeing a differentiation of interconnection tariffs (according to network hierarchy and QoS) is considered most promising. In any case it was crucial that the regime allows remuneration of the resources employed.

### **Telefónica**

It is expected that several billing systems will coexist in the future. Bill and Keep could be one of the billing systems used that could be appropriate for some types of services and networks. A general trend to use it in all cases is not seen. NGN interconnection would be based on much more complex business models and service scenarios.

Bill & Keep was not necessarily the most convenient model when competition is present, because it did not incentive competition, p.e. through the reduction of termination costs in other networks through licit commercial practices. Therefore, it did not promote maximum efficiency. The inefficiencies of the “Hot potato” scenario would be the most probable reaction to its application.

### **Tiscali**

It is assumed that there is no first best solution for a pricing regime for IP interconnection. Adopting a “PSTN model” (i.e. CPNP) risks to annul any cost saving incentives for incumbents as by favouring an interconnection costs reduction they would significantly reduce their revenues. Conversely, in a pure “internet model” (i.e. Bill & Keep) AltNet infrastructures investments are sunk costs: the price competition by an operator without substantial network infrastructures would not be sustainable for an AltNet that has to recover its investments.

If an IP pricing regime had to protect and favour (efficient) network investments B&K is not seem to be the correct choice. Pure B&K did not address the principal issues linked with investments, i.e. promoting (i) new and innovative infrastructures’ deployment, and (ii) the maintenance of the existing ones.

Tiscali thinks that a “two-level” regime (see paragraph 4.2.4, option c)) should be the best compromise if it is associated with a minimum (i) number of interconnection points and (ii) level of QoS as prerequisites for participating in B&K.

## Vodafone

It is argued that internet connectivity did not simply use Bill & Keep. Top-tier companies would require low-tier companies to pay for interconnection. Even where connectivity is in place between providers within the same tier the underlying billing mechanism is settlement-based rather than bill and keep and requires traffic to be in balance

However, it was a substantial regulatory misunderstanding to go from a rather academic concern about arbitrage to define a series of interconnection “*options for the billing regime in future all-IP networks*” – substantially in advance of their deployment in the market.

A clear interrelationship between interconnection and retail billing is seen. It is argued that different retail pricing schemes would emerge in the market (e.g pre-pay services with no-periodic charge) not only flat rates.

## Quality of service

Several respondents advocated or considered appropriate to have different classes of service quality, and thus corresponding differentiated price levels, considered more efficient. It was noted that from a commercial perspective it makes sense to treat traffic from paid content differently to traffic of free content. Accordingly, it was pointed out that introduction of more quality classes would greatly improve the capabilities of IP-based services compared to the Internet.

IPsphere Forum recalled that certain types of applications more than others require defined QoS parameters in order to function properly, for example:

- Streaming multimedia (e.g. Video on Demand (VoD), Internet Television (IPTV)) may require guaranteed throughput with low jitter and low packet loss.
- IP telephony or Voice over IP (VoIP) will require strict limits on jitter and delay (voice/video quality seriously declines when the underlying bearer performance degrades; i.e., when connecting to the 'delay challenged' mobile network).
- Video Conferencing (VTC) requires low jitter and low round trip delay.
- Dedicated link emulation requires both guaranteed throughput and imposes limits on maximum delay and jitter.

In general, these types of services are called unelastic, meaning they require a certain level of bandwidth with quality requirements to function properly. By contrast, elastic applications can take advantage of however much or little bandwidth is available. The breakdown of service categories is possible, such as Conversational (very low round trip delay), Streaming (low jitter), Priority data, Best effort

With a QoS based compensation model, carriers could get a portion of the revenue either directly from the end-user or the content provider when the business model and value chain roles allow carrier application “awareness”, once the QoS based bearer supports the requested application QoS parameters. It needs to be discussed how this can be translated into agreements among interconnecting networks.

From a carrier’s perspective, the implementation and support of QoS require network designs which allow marking and prioritising of IP packets according to the type of service. Many Tier 1 and Tier 2 carriers already have such functionality in place. However, the challenge will be the implementation of interconnects among carriers that support QoS.

## **Annex 3: Glossary**

### **3G Third Generation**

The next generation of Cellular Radio for mobile telephony. 3G is the first cellular radio technology designed from the outset to support wideband data communications just as well as it supports voice communications. It will be the basis for a wireless information society where access to information and information services such as electronic commerce is available anytime, anyplace and anywhere to anybody. 3G's technical framework is being defined by the ITU with its International Mobile Telecommunications 2000 (IMT-2000) programme.

### **3GPP Third Generation Partnership Project**

The 3GPP was formed in December 1998 as a collaboration agreement bringing together a number of telecommunication standards bodies. These standards bodies are referred to as Organizational Partners. The original aim of the 3GPP was to produce globally applicable technical specifications for third generation mobile systems based on evolved GSM core networks and the radio access technology UTRA (Universal Terrestrial Radio Access).

### **AAA**

In computer security, AAA stands for "authentication, authorization and accounting".

### **AMR Adaptive Multi Rate**

A codec offering a wide range of data rates. The philosophy behind AMR is to lower the codec rate as the interference increases and thus enabling more error correction to be applied. The AMR codec is also used to harmonize the codec standards amongst different cellular systems.

### **ASP Application Service Providers**

#### **ATM Asynchronous Transfer Mode**

Broadband transmission technology which provides the backbone of the world's telecommunications network. ATM breaks information flows into small fixed-length cells of 53 bytes. Cells of any type of traffic – voice, multimedia, data or video – can be interspersed with each other. ATM operates at speeds of 25, 155 and 622 Mbps.

### **BGP Border Gateway Protocol**

The Border Gateway Protocol (BGP) is the core routing protocol of the Internet. It works by maintaining a table of IP networks or 'prefixes' which designate network reachability between autonomous systems (AS). It is described as a path vector protocol. BGP does not use traditional IGP metrics, but makes routing decisions based on path, network policies and/or rulesets. As of January 2006, the current version of BGP, version 4, is codified in RFC 4271.

### **Bill & Keep**

Bill & Keep is a wholesale billing regime under which the network carriers involved make available the transport to other providers via the own network. Each network bears the costs of terminating traffic coming from other carriers.

## **Broadband**

A term applied to telecommunications systems capable of simultaneously supporting multiple information formats at relatively high speeds such as voice, high-speed data services and video services on demand. Overall transmission speeds are typically hundreds to thousands of times faster than those of Narrowband systems.

## **Circuit-switching**

Means of creating telecoms connections by setting up an end-to-end circuit. The circuit remains open for the duration of the communication and a fixed share of network resources is tied up with no one else able to make use of them until the connection is closed. The main advantage of circuit-switching is that it enables performance guarantees to be offered. See also Packet Switching.

## **CGF Charging Gateway Function**

Element with a GPRS network that consolidates, filters and optimizes CDR (Call Detail Record) prior to their transmission to the Billing Platform.

## **CPE Customer Premises Equipment.**

Telephone equipment, such as key systems, PABX (Private Automatic Branch Exchanges), answering machines, etc., that reside on the customer's premises (e.g., office building, home office, or factory). They are also called customer provided equipment.

## **CPP**

In most countries, the party that originates (initiates) a call pays a fee for the call, usually as a function of the duration of the call in minutes, and often also as a function of the distance from the originator to the point at which the call terminates (is received). In these same countries, the party that receives the call typically is not charged. These arrangements are collectively referred to as Calling Party Pays (CPP).

## **CPNP**

In a CPNP regime, the call receiver's operator assesses some predefined charge per minute to the caller's operator for termination. The call receiver's operator pays nothing.

## **DiffServ Differentiated services**

DiffServ or Differentiated Services is a computer networking architecture that specifies a simple, scalable and coarse-grained mechanism for classifying, managing network traffic and providing quality of service (QoS) guarantees on modern IP networks. DiffServ can, for example, be used to provide low-latency, guaranteed service (GS) to critical network traffic such as voice or video while providing simple best-effort traffic guarantees to non-critical services such as web traffic or file transfers.

## **DNS Domain Name Server**

A Domain Name Server maintains a database for resolving host names and IP addresses. Network devices query the DNS server by specifying a remote computers host name and receives in return, the hosts IP addresses.

## **DRM Digital Rights Management**

DRM is an umbrella term that refers to any of several technologies used by publishers or copyright owners to control access to and usage of digital data or hardware, and to restrictions associated with a specific instance of a digital work or device. The term is often confused with copy protection and technical protection measures; these two terms refer to technologies that control or restrict the use and access of digital content on electronic devices with such technologies installed, acting as components of a DRM design.

## **xDSL xDigital Subscriber Line**

Collective description for a range of Digital Subscriber Line technologies designed to provide high speed data links over ordinary copper telephone lines. Asynchronous DSL (ADSL), for example, is called asynchronous because the downstream (to the customer) speed is faster than the upstream (to the telco) speed. ADSL speeds are typically 1.5 – 6 Mbps downstream and 64 kbps upstream. Very high data rate DSL (VDSL) is similar to ADSL, but operates at 12 – 51 Mbps downstream and 1.6 – 2.3 Mbps upstream. Rate Adaptive DSL (RADSL) is also similar to ADSL but the transfer rate can be altered allowing it to work over poorer quality lines or over longer distances, albeit at lower speeds. High Bit Rate Digital Subscriber Line (HDSL) uses the same modulation as ISDN on a wider bandwidth and with more sophisticated processing. It operates at speeds of up to 2 Mbps at distances up to 4 km.

## **ECC Electronic Communications Committee**

Considers and develops policies on electronic communications activities in CEPT member countries, taking account of European and international legislation and regulations and establishing close cooperation and consultation with relevant European bodies, in particular with the European Commission and the European Free Trade Association, as well as with some major industry associations.

## **ENUM Telephone Number Mapping**

Telephone Number Mapping (ENUM or Enum, from TELEphone NUmber Mapping) is a suite of protocols to unify the telephone numbering system E.164 with the Internet addressing system DNS by using an indirect lookup method, to obtain NAPTR records. The records are stored at a DNS database.

Although it facilitates calling VoIP users from IP and PSTN networks, ENUM is not a VoIP function and should not be confused with common VoIP routing based on SIP and H.323 protocols with a Uniform Resource Identifier (URI).

## **ETSI European Telecomm-unications Standards Institute**

A pan-European standards-making body based in France. Many ETSI standards are now being adopted world-wide.

## **Ethernet**

The most widely-installed LAN technology. Standardised as IEEE 802.3, an Ethernet LAN uses Carrier Sense Multiple Access with Collision Detection (CSMA/CD) protocol (originally developed to manage radio based data communications - hence the name Ethernet) running over a coaxial cable or twisted pair wires. The most commonly installed Ethernet systems are called 10BASE-T and provide transmission speeds up to 10 Mbps. Fast Ethernet, or 100BASE-T10, provides transmission speeds of up to 100 Mbps and is typically used for LAN backbone systems, supporting workstations with 10BASE-T cards. Gigabit Ethernet provides an even higher level of backbone support at 1 Gbps.

**FTTx**

Fiber to the Premises (FTTP), Fiber to the Home (FTTH), or fiber to the building (FTTB) is a broadband telecommunications system based on fibre-optic cables and associated optical electronics for delivery of multiple advanced services such as of telephone, broadband Internet and television across one link (triple play) all the way to the home or business.

**GSM Global System for Mobile communications**

TDMA-based second generation mobile Cellular Radio technology, originated in Europe but now used in over 100 countries around the world. GSM supports voice, data and text messaging and allows roaming between different networks – which means that GSM users can take their phones with them to many parts of the world. GSM systems currently operate at 800 MHz, 900 MHz, 1800 MHz or 1900 MHz.

**H.323**

H.323 is the standard for interoperability in audio, video, and data transmissions, as well as Internet phone and Voice over IP. The standard addresses call control and management for point-to-point and multipoint conferences, as well as gateway administration of media traffic, bandwidth, and user participation.

**HSS Home Subscriber Server**

The Home Subscriber Server describes the many database functions that are required in next generation mobile networks. These functions will include the HLR (Home Location Register), DNS (Domain Name Servers) and security and network access databases.

**IETF Internet Engineering Task Force**

International community of network designers, operators, vendors and researchers whose purpose it is to co-ordinate the operation, management and evolution of the Internet.

**IMS IP Multimedia Subsystem**

A standard specified by the 3GPP organization and embraced by others, which defines a generic architecture for offering VoIP, and multimedia services in both wireless and wireline networks. An example service provided by the IMS architecture includes voice, picture, text and video messaging.

**IN Intelligent Network**

A telephone network architecture where the switching and service functions are separated. This adds great flexibility to the design of telephone networks by allowing services to be added or changed without having to redesign switching equipment. A certain portion of a dialled number can trigger a request for a specific service which can then be dealt with by equipment other than the telephone switch itself.

**Interconnection**

1. The linking together of interoperable systems. 2. The linkage used to join two or more communications units, such as systems, networks, links, nodes, equipment, circuits, and devices.



## **Internet**

A world-wide network of computer networks in which users at any one computer can, if they have permission, get information from any other computer. The idea was conceived by the Advanced Research Projects Agency (ARPA) of the US government in 1969 and was first known as Arpanet. Since then it has been demilitarised and commercialised and augmented by a series of inventions and innovations, not least of which is the web browser invented by a team led by Tim Berners-Lee in 1991 at CERN, the European Laboratory for Particle Physics. This is the basis for the World Wide Web which has been so successful that it is now often confused in popular conversation with the Internet itself.

## **IP Telephony / VoIP**

Also known as Internet Telephony or Voice over IP (VoIP). Use of Internet Protocol (IP, see TCP/IP) to carry and route two-way voice communications. IP Telephony can support telephone to telephone links through suitable adapters but also voice communications from telephone to IP terminal (such as a PC with sound card) or from IP terminal to IP terminal. The technique promises reduced costs to carriers and therefore prices to end users – but it still suffers problems with quality assurance.

## **IP**

The Internet Protocol (IP) is a data-oriented protocol used for communicating data across a packet-switched network. IP is a network layer protocol in the internet protocol suite and is encapsulated in a data link layer protocol (e.g., Ethernet). As a lower layer protocol, IP provides the service of communicable unique global addressing amongst computers.

## **IPv6 Internet Protocol version 6**

IPv6 provides a replacement for IPv4. IPv6 includes support for flow Identity in the packet header, which can be used to identify flows and improve QoS (Quality of Service). IPv6 was formerly known as IPng (next generation).

## **ISP Internet Service Provider**

Point of access to the Internet for small business and individual users. The ISP provides its customers with dial-up access to its router which relays traffic to web servers on the Internet.

## **ITP Internet Transport Provider**

The ITP provides its customers (ISP) with access to transport networks, which relays traffic on the Internet.

## **ITU-T International Telecommunication Union—Telecommunication Standardization**

The Telecommunications Standardization Sector of the International Telecommunication Union. Note 1- ITU-T is responsible for studying technical, operating, and tariff Questions and issuing Recommendations on them, with the goal of standardizing telecommunications worldwide. Note 2- In principle, the ITU-T combines the standards-setting activities of the predecessor organizations formerly called the International Telegraph and Telephone Consultative Committee (CCITT) and the International Radio Consultative Committee (CCIR).

## **Jitter**

Jitter is the variation (statistical dispersion) in the packet transfer delay, e.g. packet delay variation in IP networks or cell delay variation in ATM networks.

## **LAN Local Area Network**

A LAN is a means of interconnecting computers at relatively high speed within a relatively small geographic area. Peer-to-peer LANs assign equal status to all the computers connected to them. A server-based LAN runs applications and stores data on a computer designated as the server with the other computers acting as workstations. A LAN may serve as few as a handful of users or as many as several thousand.

## **Latency**

Latency is the time it takes for a packet of data to travel from one point on a network to another, e.g. packet transfer delay in IP networks or cell transfer delay in ATM networks.

## **Media gateway**

A Media Gateway acts as a translation unit between disparate telecommunications networks such as PSTN; Next Generation Networks; 2G, 2.5G and 3G radio access networks or PBX. Media Gateways enable multimedia communications across Next Generation Networks over multiple transport protocols such as ATM and IP. Because the MG connects different types of networks, one of its main functions is to convert between the different transmission and coding techniques. Media streaming functions such as echo cancellation, DTMF, and tone sender are also located in the MG. Media Gateways are controlled by a Media Gateway Controller (also known as a Call Agent or a Soft Switch) which provides the call control and signaling functionality. Communication between Media Gateways and Call Agents is achieved by means of protocols such as MGCP or Megaco or H.248 or SIP. VoIP Media Gateways perform the conversion between TDM voice to Voice over Internet Protocol (VoIP).

## **MGCP Media Gateway Control Protocol**

In computing, MGCP is a protocol used within a distributed Voice over IP system that can appear to the outside world as a single VoIP gateway. MGCP is a client-server protocol, used by telephony providers in order to have more control over subscribers, contrary to the Session Initiation Protocol (SIP) or H.323 that are peer-to-peer protocols. However, MGCP and SIP can be combined in some cases. MGCP is defined in an informational (non-standard) IETF document.

## **Modem MODulator/DEModulator**

Device which converts the digital signals from a computer into the analogue tones which are compatible with all telephone networks, and back again. It effectively allows computers to use telephone networks for communication with other computers. The term ISDN modem which is in current usage is strictly speaking incorrect as the signal at both ends of an ISDN modem is in fact digital. The correct term should be ISDN terminal adapter.

## **MPLS MultiProtocol Label Switching**

A set of IETF (Internet Engineering Task Force) specifications describing a label-swapping forwarding algorithm. The algorithm makes forwarding decisions based on the contents of a label inserted by an LSR (label-switching router) in each frame's link-layer header.

### **MRF Multimedia Resource Function**

Conferencing within the IMS (IP Multimedia Subsystem) will be coordinated by the S-CSCF (Serving - Call Session Control Function), in conjunction with an AS (Application Server). The mixing of the various conference participants' media streams is then performed by the MRF which comprises of the MRFC (MRF Controller) and the MRFP (Media Resource Function Processor). These are very similar in function to a MGCF (Media Gateway Control Function) and a MGW (Media Gateway) using H.248/MEGACO in order to establish suitable IP and, if required, SS7 bearers to support the mixed media streams.

### **MSAN MultiService Access Node**

A MSAN is a device typically installed in a telephone exchange (although sometimes in a street cabinet) which connects customers' telephone lines to the core network and is able to provide telephony, ISDN, and broadband such as DSL all from a single platform.

### **NAP Network Access Point**

A physical entity that provides network access for users. It contains the call-control agent function and may include the call-control function. The Internet "world" has historically adopted an interconnection model based on neutral centralised NAP where many Internet service providers converge to exchange IP traffic.

### **NGN**

A packet-based network able to provide telecommunication services and able to make use of multiple broadband, QoS-enabled transport technologies and in which service-related functions are independent from underlying transport-related technologies. It offers unrestricted access by users to different service providers. It supports generalized mobility which will allow consistent and ubiquitous provision of services to users.

*(ITU-T Recommendation Y.2001)*

### **NNI Network to Network Interface**

Network to Network Interface, or NNI for short, is an interface which specifies signalling and management functions between two networks. NNI circuit can be used for interconnection of either signalling (e.g. SS7) or IP (e.g. MPLS) networks. Basically NNI is used for interconnection of P (class 4 or higher provider core) routers in signalling or MPLS networks. NNI can be used for interconnection of two VoIP nodes.

### **QoS Quality of Service**

1. The performance specification of a communications channel or system. Note: QoS may be quantitatively indicated by channel or system performance parameters, such as signal-to-noise ratio (S/N), bit error ratio (BER), message throughput rate, call blocking probability, jitter and delay. 2. A subjective rating of telephone communications quality in which listeners judge transmissions by qualifiers, such as excellent, good, fair, poor, or unsatisfactory.

In the fields of packet-switched networks and computer networking, the traffic engineering term QoS refers to control mechanisms that can provide different priority to different users or data flows, or guarantee a certain level of performance to a data flow in accordance with requests from the application program. Quality of Service guarantees are important if the network capacity is limited, especially for real-time streaming multimedia applications, for example voice over IP and IP-TV, since these often require fixed bit rate and may be delay sensitive.

## **Packet Switching**

Means of creating connections by breaking up the information to be sent into packets of bytes, sending them along a network with other information streams and reassembling the original information flow at the other end. The main advantage of packet-switching is that it makes very efficient use of fixed capacity. The disadvantage is that the quality of service of an information channel cannot be guaranteed. See also Circuit Switching.

## **Packet loss**

Packet loss occurs when one or more packets of data travelling across a computer networking fail to reach their destination. Packet loss can be caused by a number of factors, including signal degradation over the network medium, oversaturated network links, corrupted packets rejected in-transit or faulty networking hardware.

Lost or dropped packets can result in highly noticeable performance issues or jitter with Streaming Technologies, Voice over IP, Online Gaming and Videoconferencing, and will affect all other network applications to a degree.

## **Peering**

Peering is an agreement between ISPs to carry traffic for each other and for their respective customers. Peering does not include the obligation to carry traffic to third parties. Peering is usually a bilateral business and technical arrangement, where two providers agree to accept traffic from one another, and from one another's customers (and thus from their customers' customers).

*(Network Reliability and Interoperability Council, an industry advisory panel to the U.S. FCC)*

## **PLMN Public Land Mobile Network**

A PLMN is a generic name for all mobile wireless networks that use land based radio transmitters or base stations.

## **PoI Point Of Interconnection**

The geographical location where two networks interconnect and exchange traffic.

## **PSTN**

The public switched telephone network (PSTN) is the network of the world's public circuit-switched telephone networks, in much the same way that the Internet is the network of the world's public IP-based packet-switched networks. Originally a network of fixed-line analog telephone systems, the PSTN is now almost entirely digital, and now includes mobile as well as fixed telephones.

The PSTN is largely governed by technical standards created by the ITU-T, and uses E.163/E.164 addresses (known more commonly as telephone numbers) for addressing.

## **Router**

A device, or in some cases software in a computer, that determines the next network point to which a packet should be forwarded on its way to its destination. Typically, a packet will travel through a number of network points with routers before arriving at its destination.

## **RPP**

Under RPP, the originating party and the terminating party can each be charged by their respective service providers.

## **RTP Real time Transport Protocol**

The Real time Transport Protocol is an Internet protocol standard that defines a way for applications to manage the real-time transmission of multimedia data. RTP is used for Internet telephony applications, it does not guarantee real-time delivery of multimedia data, since this is dependent on the actual network characteristics. RTP provides the functionality to manage the data as it arrives to best effect.

## **Transit**

Transit is an agreement where an ISP agrees to carry traffic on behalf of another ISP or end user. In most cases transit will include an obligation to carry traffic to third parties. Transit is usually a bilateral business and technical arrangement, where one provider (the transit provider) agrees to carry traffic to third parties on behalf of another provider or an end user (the customer). In most cases, the transit provider carries traffic to and from its other customers, and to and from every destination on the Internet, as part of the transit arrangement. In a transit agreement, the ISP often also provides ancillary services, such as Service Level Agreements, installation support, local telecom provisioning, and Network Operations Centre (NOC) support.

*(Network Reliability and Interoperability Council, an industry advisory panel to the U.S. FCC)*

## **TCP/IP Transmission Control Protocol/Internet Protocol**

Collective name for the set of protocols on which the Internet is based. TCP and IP are the best known of this set, but they are by no means the only ones. TCP guarantees that every byte sent from one port arrives at the other in the same order and without duplication or loss. IP assigns local IP addresses to physical network addresses providing a structure which can be recognised by Routers. Other members of the TCP/IP family include the Telnet protocol which allows a remote terminal to log in to another host, the Domain Name System (DNS) which allows users to refer to hosts by name rather than having to know their numeric IP addresses, the File Transfer Protocol (FTP) which defines a mechanism for storing and retrieving files, and HyperText Transfer Protocol (HTTP) which allows information to be transferred from host computers to computers equipped with web browsers.

## **SDH Synchronous Digital Hierarchy**

Before SDH, networks were extremely rigid and creating a new link between two points was time consuming. It could take months to set up new services. In the late 1980s operators and suppliers standardized first on SONET and then SDH standards for optical transmission. By using add/drop multiplexers new signals can be added to or dropped from the network quickly and easily. The network can then be monitored centrally, adding to both flexibility and reliability. When a fault does occur, the traffic can be re-routed so quickly that the user does not even realise there was anything wrong.

## **SGW Signalling Gateway**

Signalling interworking between SS7 (Signalling System No 7) and IP based networks is achieved by the use of a SGW. These functions strip off the traditional transport protocols such as MTP (Message Transfer Part) employed in circuit switched networks and replace them with a transport mechanism based on IP.

## **SIP Session Initiation Protocol**

SIP is the real-time communication protocol for Voice over IP (VoIP), and it has been expanded to support video and instant-messaging applications. SIP performs basic call-

control tasks, such as session set up and tear down and signalling for features such as hold, caller ID and call transferring. Its functions are similar to Signalling System 7 (SS7) in standard telephony and H.323 or Media Gateway Control Protocol in IP telephony.

With SIP, most of the intelligence for call setup and features resides on the SIP device or user agent, such as an IP phone or a PC with voice or instant-messaging software. In contrast, traditional telephony or H.323-based telephony uses a model of intelligent, centralized phone switches with “dumb” phones.

### **SLA Service Level Agreement**

Contractual service commitment. An SLA is a document that describes the minimum performance criteria a provider promises to meet while delivering a service. It typically also sets out the remedial action and any penalties that will take effect if performance falls below the promised standard. It is an essential component of the legal contract between a service consumer and the provider.

### **SMP Significant Market Power**

The Significant Market Power test is set out in various European Directives. It is used by the National Regulatory Authorities to identify those operators who must meet additional obligations under the relevant directive. It is not an economic test as it requires a consideration of the factors set out in the test within a specified market.

### **Softswitch**

A softswitch is a central device in a telephone network which connects calls from one phone line to another, entirely by means of software running on a computer system. This work was formerly carried out by hardware, with physical switchboards to route the calls.

A softswitch is typically used to control connections at the junction point between circuit and packet networks. A single device containing both the switching logic and the switching fabric can be used for this purpose; however, modern technology has led to a preference for decomposing this device into a Call Agent and a Media Gateway.

### **SPAM**

Spamming is the abuse of electronic messaging systems to send unsolicited, undesired bulk messages. While the most widely recognized form of spam is e-mail spam, the term is applied to similar abuses in other media: instant messaging spam, Usenet newsgroup spam, Web search engine spam, spam in blogs, and mobile phone messaging spam.

### **SPIT Spam over Internet Telephony**

Voice over IP systems, like e-mail and other Internet applications, are susceptible to abuse by malicious parties who initiate unsolicited and unwanted communications. Telemarketers, prank callers, and other telephone system abusers are likely to target VoIP systems increasingly, particularly if VoIP tends to supplant conventional telephony.

### **SS7 Signaling System No.7 Signaling System 7**

SS7 is an architecture for performing out-of-band signaling in support of the call-establishment, billing, routing, and information-exchange functions of the public switched telephone network (PSTN). It identifies functions to be performed by a signaling-system network and a protocol to enable their performance.

### **TDM Time-Division Multiplexing**

TDM is a type of digital or (rarely) analog multiplexing in which two or more signals or bit streams are transferred apparently simultaneously as sub-channels in one communication channel, but physically are taking turns on the channel. The time domain is divided into several recurrent timeslots of fixed length, one for each sub-channel. In its primary form, TDM is used for circuit mode communication with a fixed number of channels and constant bandwidth per channel. In European systems, TDM frames contain 30 digital voice frames.

### **UNI User-Network Interface**

The reference point where the protocols for compatibility between customer premises equipment (CPE) and a carrier network must be defined. A UNI specification defines in detail the Layer 1 and Layer 2 and perhaps Layer 3 protocols that are required for CPE and carrier equipment to interoperate. Note: The User Network Interface was defined by the ATM forum for public and private ATM network access.

### **VPN Virtual Private Network**

Looks for all intents and purposes like a private network but is actually just access to a shared network. Careful management and guarantees of quality of service levels ensure that corporate customers get the privacy and facilities they want but at a lower cost.

**Annex 4: Member States and Country “Codes”***European Union*

Austria (AT)  
Belgium (BE)  
Bulgaria (BU)  
Cyprus (CY)  
Czech Republic (CZ)  
Denmark (DK)  
Estonia (EE)  
Finland (FI)  
France (FR)  
Germany (DE)  
Greece (GR)  
Hungary (HU)  
Ireland (IE)  
Italy (IT)  
Latvia (LV)  
Lithuania (LT)  
Luxembourg (LU)  
Malta (MT)  
Netherlands (NL)  
Poland (PL)  
Portugal (PT)  
Romania (RO)  
Slovakia (SK)  
Slovenia (SI)  
Spain (ES)  
Sweden (SE)  
United Kingdom (UK)

*EFTA*

Iceland (IS)  
Norway (NO)  
Switzerland (CH)

*Other*

Turkey (TR)