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POLICY CONSIDERATIONS OF VOIP

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FOREWORD

This report was discussed by the Working Party on Telecommunication and Information Services Policies in December 2005. The Working Party agreed to recommend its declassification to the ICCP Committee. The Committee declassified the report in March 2006.

The report was prepared by Mr. Jaebum Lee of the ICCP secretariat. It is published under the responsibility of the Secretary-General.

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MAIN POINTS

This paper reviews the economic impact of Voice over Internet Protocol (VoIP) applications and provides policy recommendations for VoIP as a follow-up to the previous OECD paper on VoIP (DSTI/ICCP/TISP(2005)3/FINAL).

Economic impact: This paper employs a broad definition of VoIP when discussing the economic impact of VoIP. This definition includes the conveyance of voice, fax and related services partially or wholly over packet-switched IP-based networks, including peer-to-peer VoIP services and VoIP services connected to PSTN.

VoIP applications have the potential to reduce prices for voice communications and enhance competition in voice markets by lowering entry barriers to these markets. Some incumbent PSTN operators are responding to VoIP competition by transforming their networks into IP-based networks, offering new, additional services such as broadband Internet access, video, flat-rated call packages, and their own VOIP services. In some less competitive markets incumbents require consumers to buy a bundled service that include DSL Internet access service tied to analogue PSTN voice running over the same copper wire, raising fixed monthly charges for lines. A few cases have occurred where PSTN operators have used network management technology to block or slow data packets to and from competitors over their broadband access networks. In more competitive markets, market forces would preclude such behaviour. Even in less competitive areas, these strategies may not always be successful and will depend on the subscribers' price elasticity of demand, their perception of service quality and the level of competition in the market. Many customers are using VoIP services, often with no fixed monthly charges, while retaining their PSTN services.

In order to challenge VoIP providers unaffiliated with an operator, some PSTN operators are requiring customers to buy analogue voice service along with their DSL-based Internet access service. Customers in some markets are increasingly demanding DSL Internet access service alone, without analogue voice (often called naked DSL). Where other platforms for broadband access service (*e.g.*, cable modem or wireless) are available as a competitor to DSL, competition has required PSTN operators to introduce the naked DSL access. Where unbundling is available with regulated wholesale tariffs, competitive DSL offers consisting of broadband access, voice and video (TV) services exist.

Internet-related companies such as Microsoft, Yahoo, Google, AOL, and eBay have added VoIP capability into their existing software or hardware. Some Internet-focused companies started to make their instant messaging (IM) services interoperable to differentiate their service offerings, enlarge coverage, form strategic alliances with content providers (video or game) and broadband access providers. Network operators, in turn, are challenged to add differentiating features to their bundled offerings, leading to active competition between "centre" and "edge" providers.

Policy recommendations: In this section, VoIP is defined more narrowly as a voice application over IP-based networks that enables a VoIP subscriber to call and to be called by a party subscribed to a traditional PSTN service. This is done in order to focus on VoIP services which function most like the PSTN. It may take some time for consumers to perceive peer-to-peer VoIP service as PSTN replacements since they currently lack features such as the ability to make emergency calls. Therefore such applications are not discussed in this section. In the context of specific recommendations on economic regulation, this

paper does not recommend classifying VoIP services as a PSTN substitute. This market definition issue may be best dealt with on a case-by-case, empirical basis.

Some, but not all OECD members, have technologically neutral regulation as a goal. Technology neutral regulation implies that regulations neither impose nor discriminate in favour of a particular type of present or future technology. Technological neutrality does not necessarily imply that the existing set of regulations (economic and social) for PSTN voice services should be imposed automatically on VoIP services. When it comes to economic regulation, technology neutrality may mean that the same competition criteria, rather than same regulations, apply to VoIP and PSTN voice services. The social regulations applied to PSTN voice including emergency calls¹ may be generally applied to VoIP service if consumers begin to regard VoIP as a PSTN replacement. However, the idea of technology neutrality should not be used to suppress technological innovation. If the existing regulations crafted for PSTN are transposed directly to VoIP, VoIP services could become illegal or subject to onerous requirements that would not serve the public interest.

If competition is judged to be effective and sustainable, the current sector-specific, public utility-type of economic regulations should be rolled back in favour of general competition law. The availability of VoIP applications over broadband Internet access services may provide incentives to consider rolling back such *ex ante* regulations, when and where appropriate, at least for the retail voice communications market.

Consumers should be made aware of VoIP's distinct characteristics which may affect their safety. VoIP services that interoperate with the PSTN and therefore potentially the PSTN's emergency call service traditionally have had difficulty providing emergency capabilities. Dialling emergency numbers may not connect the VoIP callers to the nearest emergency call centre and many VoIP phones of this type may be unusable in the case of a power outage. Such distinctions, compared with traditional telephony, must be clearly recognised and understood by customers when entering into subscription contracts. However, it should also be noted that VoIP emergency services may result in superior emergency communications, providing greater information to emergency responders, providing greater resiliency in communications, and providing more features to the users of the system. As VoIP services continue to spread in the market, consumers are also becoming more vulnerable to security threats for VoIP services such as denial of service attacks, spam over Internet telephony (SPIT), viruses, eavesdropping and toll fraud.

This paper makes a number of policy recommendations² including:

- Ensuring that broadband Internet access operators allow consumers unrestricted access to and use of Internet applications and services including VoIP. Where broadband markets are competitive, market forces should produce this result without the need for regulation.
- Ensuring that outgoing calls from VoIP service providers are not subject to carrier selection and carrier pre-selection obligations, given that customers can easily change VoIP applications even on a call-by-call basis,
- Excluding VoIP applications from particular *ex-ante* regulation for the retail voice market, taking into account effectiveness and sustainability of VoIP service (or voice service in case VoIP can replace traditional voice) competition considering entry barriers to VoIP market, and the degree of platform competition (VoIP service is decoupled with its underlying network) and whether the underlying wholesale broadband Internet access market is competitive.
- Where numbering is regarded as a policy tool, either allocating numbers in the geographic range with restrictions compatible with the VoIP's nomadic nature or adding new number ranges for nomadic services;

- Where public safety considerations may make it necessary, mandating access to emergency services for VoIP calls, taking into account technical feasibility of implementing the service and allowing appropriate time for development and deployment of the technology.
- Where an individual licensing regime is being used, reviewing whether it is appropriate to differentiate voice and data or to classify³ communications services on a distance basis (*i.e.*, local, long distance, international calls).

I. PURPOSE, SCOPE, DEFINITION

This paper is a follow-up to the VoIP paper, “The Policy Implications of Voice over Internet Protocol,”(DSTI/ICCP/TISP(2005)3/FINAL) which reviewed the different regulatory treatment of VoIP services by member countries in comparison to traditional regulations for circuit-based voice. The purpose of this paper is to review the impacts of VoIP applications and provide some policy recommendations.

This paper does not necessarily provide an update of the status of regulations in OECD countries, but rather suggests some basic policy directions in order to pursue a certain level of harmonization while taking into account differences in the market and legal environments of member countries.

II. THE ECONOMIC IMPACT OF VOIP

1. The potential impact of VoIP application providers

This paper employs a broad definition of VoIP when reviewing the economic impact of VoIP technologies. This broader definition of VoIP⁴ includes the conveyance of voice, fax and related services partially or wholly over packet-switched IP-based networks including peer-to-peer VoIP services and VoIP services connected to PSTN. However, the section on policy recommendations takes a narrow view of VoIP defined as a voice application over IP-based broadband Internet networks. This is appropriate for the policy section because a VoIP is the most similar to traditional PSTN service when subscribers can make calls to and receive calls from the PSTN and also because these services are the closest substitutes to regulated PSTN voice services. Peer-to-peer VoIP services are therefore not included. In terms of social regulation, consumers are unlikely to perceive peer-to-peer VoIP service as PSTN replacements and may have no expectation of making emergency calls over these services.

It has been argued that VoIP has the potential to revolutionize the telecommunications industry. The forecast is based on the fact that some forms of VoIP technology enable voice communication over the Internet where end-to-end voice communication can be made by downloading VoIP applications at both intelligent end terminals. VoIP applications can be provided through free software and the marginal cost for making an additional call using such a VoIP application is almost zero because voice occupies relatively little space on the network compared to other applications such as video. Theoretically this means that the price of voice communication will fall as price approaches marginal cost, especially in case of peer-to-peer VoIP services⁵. The market for voice communication may become effectively competitive due to low barriers to market entry provided that the underlying market for broadband Internet access services is competitive. VoIP applications can also be integrated with other multimedia software⁶. One reason software providers have done this is because voice service is quickly becoming a marketing tool to keep customers loyal.⁷

2. Impact on telecommunication operators

According to a conservative estimate suggested by the UK-based market research group Point Topic⁸, more than 11 million people worldwide were using retail VoIP services for at least some of their telephone calls at the end of March 2005. The number climbs to just under 17.5 million users when PC-based VoIP

services like Skype are added and adjustments are made based on analysis of minutes served. That is an increase from just over 5 million users at mid-2004. VoIP take-up likely will erode circuit-based voice traffic, thus leading to a decrease in the voice revenues of traditional telecommunications operators. In addition, VoIP take-up likely will put downward pressure on the price of traditional voice services, resulting in additional reductions in revenue from traditional voice markets.

Quantifying the exact number of VoIP subscribers or minutes of traffic is difficult and to some extent meaningless since migration to VoIP will often take place within the context of a broader migration to IP. One way to follow this migration is to use a proxy to track VoIP diffusion country-by-country. The decrease of circuit-based access channels from the end of 2002 to the end of 2004 can be examined in conjunction with broadband subscribers per 100 inhabitants, and mobile cellular subscribers per 100 inhabitants. However, in countries where partial unbundling (line sharing) is a success, successful migration towards VoIP may not automatically translate into circuit-based access channels.

Of the 30 OECD countries, 13 countries have been losing more circuit-based voice access channels than the OECD average of CAGR -1.6% (compound annual growth rate) from the end of 2002 to the end of 2004. Fifteen countries have higher broadband subscribers per 100 inhabitants than the OECD average of 10.2 and 23 countries have higher mobile cellular subscribers per 100 inhabitants than the OECD average of 72. Of the 13 countries losing more access channels than the OECD average, 9 countries are also among the 15 countries with higher broadband penetration rates: Finland, the United States, Denmark, Norway, Netherlands, the United Kingdom, Canada, Japan and Sweden. Of these nine countries, three (Canada, Japan, the US) have lower mobile cellular penetration rates than the OECD average of 72. There are many possible explanations for the decline in circuit-based access channels: fixed-to-mobile substitution, consumers dropping a second telephone line that was used for dial-up access, or an increase in VoIP use. In addition, it should be noted that Canada and the United States are where cable modems are the most commonly adopted form of broadband Internet access. Thus, these two countries could be expected to lose more circuit-based access channels. The remaining four countries which show a high decrease in access channels but relatively low broadband access penetration compared with the OECD average have high mobile cellular penetration rates: Slovak Republic (79.4), Australia (82.5), the Czech Republic (105.6), and New Zealand (86.4).

Table 1: Changes in Access Channels*, Broadband and Mobile Penetration

Country	Decrease of access channels (CAGR 2002-2004, %)	Broadband penetration per 100 inhabitants (end of 2004)	Mobile cellular penetration per 100 inhabitants (end of 2004)
Finland	-5.5	15.0	95.6
Slovak Republic	-5.1	1.1	79.4
Australia	-4.7	7.7	82.5
United States	-3.5	10.5	62.0
Czech Republic	-3.4	1.6	105.6
Denmark	-2.8	18.8	95.7
Norway	-2.4	14.9	102.7
Netherlands	-2.2	19.0	98.1
New Zealand	-2.2	4.8	86.4
United Kingdom	-1.9	10.5	102.2
Canada	-1.9	17.8	46.7
Japan	-1.8	15.0	71.7
Sweden	-1.6	14.5	108.7
OECD average	-1.6	10.2	72

* **Access channels** = standard analogue access lines (analogue PSTN copper wire lines) + the number of equivalent 64 Kbps transmission paths enabled by ISDN lines (circuit-based digital voice channels) (Source: www.oecd.org/dsti/ICTindicators, refer to annex for more detailed numbers)

Many fixed incumbent PSTN operators are starting to change the underlying technology of their networks and shifting to IP-based networks mainly because IP-based networks are cost effective⁹ and allow for the development of new multimedia services which are expected to bring new revenue streams. This is also a defensive move in reaction to the competitive threat from VoIP providers and CATV operators with multi-play offerings. Second, some PSTN operators in less competitive markets are beginning to offer bundled services which largely require customers to buy DSL Internet access service tied to analogue PSTN voice services. Many customers will choose to use VoIP for some of their calling (for international calls, for example) while retaining their traditional fixed line for local calls, for emergency access, and for reliability (in case of power outages, for example.) However, for customers who would otherwise choose to substitute VoIP for all of their calling, tying high-speed DSL broadband access, which is required for many VoIP services, to legacy voice service subscriptions creates a strong financial incentive for consumers to continue making calls via their traditional phone lines. In addition, some bundled services have minimum contractual terms, keeping customers on a long-term basis while third party VoIP application providers cannot by themselves offer a corresponding bundled service to customers.

However, in countries such as the United States where cable modems are the most commonly adopted form of access, customers may be more attracted to bundled offers of video, voice and Internet access from cable providers if local PSTN operators do not offer similar services. In response, some incumbent local exchange carriers are preparing to launch comparable bundled services which include video.

Some fixed incumbent providers have responded to VoIP competition by raising fixed subscriber line prices while reducing call rates.¹⁰ Others have launched flat-rate charging to exploit their fixed line networks and help compensate for their investments in an IP network.¹¹ Flat-rate packages may have an advantage for incumbent operators in reducing the impact on revenues from a reduction in traffic.

Incumbent PSTN, CATV and mobile operators may be in a position to block or slow down access to specific applications or services using network management technology, called “deep packet inspection.”¹² The technology tells whether bits on their network are voice, e-mail, videos, etc. Broadband access providers have sought to justify the use of network traffic monitoring technology as a means of managing quality of service of the network and ensuring more fair distribution of network resources by restraining a small portion of heavy users from using most of the network resources. On the other hand, third party service providers using broadband may claim that the network management technology could be used for anti-competitive purposes to block or slow down packets generated by competitive VoIP applications.¹³

The competitive advantage of PSTN operators would include a brand name, long-term customer relationship (trust), billing, financial strength and economies of scale and scope in offering services to the public. The competition between PSTN and VoIP providers may also depend on the price elasticity of subscribers, their perception of the quality of VoIP, the speed of broadband take-up or the degree of customer apathy. In the EU, one survey undertaken in the second quarter of 2005 by Forrester Research found that only 1% of Europeans use VoIP frequently to make calls from home and 70% of consumers do not even know what VoIP is.¹⁴ However, it is noted that this survey is in contrast with figures observed by operators 6 months later. For example France Telecom reports that during the 4th quarter of 2005, approximately 14% of the voice traffic originated by their customers was through VoIP.

Mobile operators are providing mobile Internet access through their service package but in most cases prices are higher when compared with wired broadband Internet access. In cases where subscribers are billed by the minute or by traffic, customers may want to limit their data usage over mobile Internet access to their minimum level.¹⁵ This can be one explanation why voice revenues still constitute a substantial part of total revenues of mobile operators. If wireless access to the Internet through Wi-Fi, WiMax and 3G

mobile technologies becomes popular (likely in the form of dual mode handsets), it is expected that the use of VoIP over wireless Internet access would partially substitute for mobile voice minutes. In this respect, Korea's incumbent fixed operator KT is very active in deploying WiBro service (a mobile version of WiMax) in an effort to capture some of the mobile revenues.

3. The impact on non-telecommunication companies

Bundled multiple play (or triple play) offerings normally consist of voice, video and Internet access. In some cases, operators do not break down the prices of each of the services in the bundle when they are sold to consumers. This could have the effect of reducing customer churn in situations where the broadband Internet access market is not competitive. Unaffiliated VoIP providers may offer cheaper voice services but customers are not in a position to disaggregate the prices of bundled services in order to make valid comparisons.¹⁶ This could pose marketing problems to companies that only provide VoIP services.

One new trend in VoIP is that companies that have never been in the telecommunication service business before have begun adding VoIP capability into their existing hardware or software. In some cases these new products do allow users to make calls to and receive calls from the PSTN. Microsoft inserted voice capability into its MSN Messenger after purchasing a VoIP company named Telio and embedded voice chat function into its online game console.¹⁷ Internet portal and search companies such as Yahoo (Yahoo! Messenger) and Google (Google Talk) blended voice capability into their Instant Messenger (IM). AOL, which has the leading IM platform, introduced TotalTalk which unifies voice, instant messaging, e-mail, enhanced voicemail and call management capabilities, and the ability to make and receive calls using a traditional phone without a computer turned on. Cyber auction company eBay purchased Skype Technologies to strengthen eBay's global marketplace and payments platform, while opening several new lines of business.¹⁸ Some Internet-focused companies have started to make their IM services interoperable to enlarge coverage and form strategic alliances with content providers (video or game) and broadband access providers. Examples include Microsoft and Yahoo¹⁹ and deals between Google and Time Warner's America Online²⁰ as one way to differentiate their service offerings and also cope with strategic challenges from traditional telecommunications operators.

4. The impact on consumers

VoIP services that interoperate with the PSTN and therefore potentially the PSTN's emergency call service traditionally have had difficulty providing emergency capabilities. Dialling emergency numbers may not connect the VoIP callers to the nearest emergency call centre and many VoIP phones of this type may be unusable in the case of a power outage. Such distinctions, compared with traditional telephony, must be clearly recognised and understood by customers when entering into subscription contracts. However, it should be noted that VoIP providers are providing and developing backup power supply abilities and that VoIP emergency services may result in superior emergency communications to emergency responders, increased resiliency in communications and more features to the users of the system.

As VoIP services begin to spread in the market, consumers are becoming more vulnerable to security threats for VoIP services. According to research which listed the top five security threats for VoIP, first threat is denial of service attacks (DoS).²¹ Real time network solutions such as VoIP and video conferencing are particularly vulnerable to denial of service attacks because they rely heavily on efficient routing and switching in a time sensitive quality of service environment. The second threat for VoIP security is the likely growth of spam over Internet Telephony (SPIT). The third threat is viruses which may spread in real time on voice data traffic. Fourth is the potential for eavesdropping and fifth is the threat of toll fraud.²²

In the competition between Internet and traditional telecommunication companies, consumers in many cases may be faced with varied options of tied services offered by high-speed Internet access service providers. The broadband access providers are tying high speed Internet service with, in many cases, voice service and video (TV) services and have structured their pricing and contracts so as to lock in customers for long periods. When it comes to DSL-based Internet access services, many fixed incumbent PSTN operators require customers to subscribe to their analogue PSTN voice services as a prerequisite for obtaining DSL service. This is despite the fact that many consumers may want to subscribe only to the broadband component, sometimes referred to as “naked DSL”. Where other forms of broadband access are available, such as cable modem or unbundled local loops, customers could defect to cable modem-based access providers (typically cable TV operators) or alternative DSL operators that commonly sell broadband and voice services separately. However, it is worth noting that cable firms may bundle television and Internet services together or make purchasing the bundle the only cost-effective solution.

Cable modem access is the most commonly adopted form of broadband access to Internet in the United States and some incumbent local exchange carriers such as Qwest have begun offering “naked DSL” in certain areas as an attempt to retain customers who would otherwise migrate to CATV operators. Verizon and AT&T also voluntarily committed to offer “naked DSL” in conjunction with their recent merger. The existence of naked DSL would give consumers more options, including the option of abandoning their fixed line phone.

III. POLICY RECOMMENDATIONS FOR VOIP SERVICES

In this section on policy recommendations, VoIP is defined more narrowly as a voice application over IP-based broadband Internet networks that enables a VoIP subscriber to call and to be called by a party subscribed to a traditional PSTN service. This allows the analysis to focus on the type of VoIP service which may look and feel like PSTN voice in terms of its functionality and usability. Peer-to-peer VoIP service is out of scope in this section as noted earlier.

Considering specific recommendations on economic regulation,²³ this paper does not intend to imply that VoIP service is a PSTN replacement nor a different service. Such market definition issues may be best dealt with on a case-by-case and empirical basis. Nevertheless, this paper conceptually deals with VoIP services as distinct from PSTN voice when it looks into the impact of VoIP technology on the state of competition of the VoIP service market with regard to economic regulation. This approach may be helpful in identifying what elements of traditional economic regulations would be improper for VoIP services and potential bottlenecks in the provision of VoIP service offerings. It will also highlight what should be considered or monitored to ensure effective competition in VoIP service markets.²⁴

1. General recommendations

Application of technology neutrality concept to VoIP

Technologically neutral regulations imply that regulations neither impose on nor discriminate in favour of a particular type of technology.²⁵ This can be interpreted as requiring that the same regulation should be applied to services that consumers view as being the same or similar regardless of the underlying technology. In terms of economic regulation, the technology neutrality concept may merely mean that the same competition criteria apply to VoIP and PSTN voice services. The competition criteria may include elements used to decide if a market should be defined for *ex ante* regulation,²⁶ those used for market definition²⁷ or those that designate a dominant supplier(s).²⁸ The competition policy applicable to VoIP could differ compared to PSTN voice in that a technology has the ability to impact and alter the state of market competition, thereby altering the appropriate competition policy. For example, VoIP packets can be delivered over any type of broadband Internet access infrastructure. Entry barriers for VoIP providers

may be considered low if providers can run their applications and consumers can access these services without suffering unreasonable discrimination by broadband Internet access providers. This will likely be the case in markets with sufficient broadband choices for consumers.

The social regulations applied to PSTN voice including emergency call handling and lawful interception²⁹ may be generally applied to VoIP service in situations where consumers are proven to view VoIP as a PSTN replacement. However, technologically neutral regulation should be interpreted so as not to suppress technological innovation, particularly with respect to nurturing future technologies. If the existing regulations crafted for PSTN voice services are simply transposed to VoIP services, there may be cases where VoIP services could be considered illegal or subject to onerous requirements which would inhibit the diffusion of the new technology. In this sense, technology-neutrality in terms of social regulation may require changing existing regulations, or developing a different version of social regulations to achieve the same goals as the regulations applied to PSTN voice operators.

Light regulation

If competition is judged to be effective and sustainable, the current sector-specific, public utility-type economic regulations should be lifted. The potential of VoIP services to enhance competition in the voice market and the characteristics of VoIP decoupled with its underlying network may give an opportunity to deregulate and streamline sector-specific regulation, when and where appropriate. Each component of a regulatory framework for voice including market entry, numbering (including number portability) and carrier selection needs to be examined to ensure that competition remains effective.

Consumer protection for informed and free choice

VoIP services that interoperate with the PSTN and therefore potentially the PSTN's emergency call service traditionally have had problems with providing emergency capabilities. VoIP users may dial emergency numbers but may not connect to the nearest emergency call centre. Such distinctions, compared with traditional PSTN voice services must be clearly noted and expressly recognized and understood by customers when entering into subscription contracts. However, it should be noted that VoIP emergency services may also result in superior emergency communication by providing greater information to emergency responders, improving resiliency in communications, and providing more features to the users of the system. The responsibility that governments have for the safety of citizens may require that emergency services obtain a minimum level of information during emergency calls which will need to be provided either through end-user devices, the services being used, or both, and/or that an on-going monitoring framework be set up.

Consumers should be allowed free choice to the extent reasonable to reap consumer benefits and promote competition. More and more intelligence resides at the end-use devices instead of networks in the IP-based packet networks. Voice services can be made possible in the form of home gateways or software applications downloadable onto the end-user devices. This implies that consumers can benefit from various service offerings of their choice when they are allowed free choice of network access providers and free independent choice of voice service provider.

2. Specific policy recommendations for VoIP

Ensuring impartial management of Internet access and use

Broadband Internet access services should be provided in a way that consumers can have unrestricted access to and use of applications and services of their choice, including VoIP services with a preposition that the bandwidth of broadband Internet access network can be widened commercially as bandwidth demand increases. Giving equal treatment to any kind of data over broadband networks would maximize

competition among data and applications over broadband access networks and facilitate broadband deployment in that demand for applications and content over Internet would stimulate the supply of more bandwidth.³⁰

However, it should be acknowledged that more services and applications including VoIP services on the network with a limited bandwidth may lead to decreases in quality of service. VoIP subscribers may experience low voice quality or delay of voice signals on broadband networks during periods of high traffic. One solution is to give prioritised bandwidth to VoIP packets on the network, although this may run counter to the equal treatment of data on the broadband access network.

Preferential treatment by broadband access providers would not be a problem when consumers have a sufficient number of alternative broadband access providers. Unsatisfied consumers could then switch to alternative broadband access providers who allow their subscribers equal access to third party applications and services. Likewise, consumers could switch to providers offering enhanced quality of service VoIP services bundled with broadband access but at a lower price. Customers may have more options when there is effective competition among multiple platforms (e.g. DSL and cable). Broadband access providers may implement network management technology to prohibit some users from occupying a large percentage of network resources or to prioritise the traffic from heavy users in return for additional payment.

Local loop unbundling (LLU) would be an effective tool to provide cost-based wholesale broadband access networks for alternative service providers in cases where intermodal competition is not available or efficient. In some cases existing fixed PSTN operators offer bundled services requiring consumers to buy DSL access services and analogue PSTN voice running over the same copper wire. This can discourage consumers from using other VoIP applications. However, competitive operators using full LLU products from the incumbent may be more likely to allow consumers to opt for DSL Internet access service without analogue voice (naked DSL). This could be one way to attract consumers. Another risk is that operators may try to control customers by promoting bundled services through home gateways or set-top boxes for example.³¹ Therefore, the solution to ensure consumer choice in tied services may not simply be to mandate the unbundling of DSL access from analogue voice service by incumbent operators. This may be used as a last resort. It may be better to make the broadband access market more competitive via local loop unbundling so that broadband access providers voluntarily offer naked DSL.

Carrier selection (CS) and Carrier pre-selection (CPS)

Some of the existing regulatory requirements for PSTN voice services, such as carrier selection and carrier pre-selection, are inappropriate for VoIP service providers as long as customers have unrestricted access to and use of Internet applications and services. This is because customers can simply change and use another VoIP application of their choice when they choose, even on a call-by-call basis.

Both carrier selection (CS) and carrier pre-selection (CPS) were crafted with the characteristics of circuit-switched networks in mind. In these circuit-switched networks the voice service was thoroughly integrated with the underlying network (PSTN), constituting a high and non-transient barrier for the service market. The use of CS and CPS in the residential voice services market has helped to create competition in the PSTN voice market. However, VoIP services that are decoupled from the underlying platform allow consumers to change service providers easily, provided that the underlying broadband Internet access services are competitive and allow consumers full access to Internet applications and services.

Relevant markets for ex-ante regulation

This paper does not try to define whether VoIP is a substitute or not for PSTN services. This market definition issue may be best dealt with on a case-by-case and empirical basis. Nevertheless, this paper

conceptually deals with VoIP services separately from PSTN voice when it looks into the impact of VoIP technology on the state of competition of the VoIP service market itself.

If necessary and applicable, VoIP could be excluded from market definitions when determining the relevant market for *ex-ante* regulations³² of retail voice markets.³³ VoIP services increasingly compete directly with PSTN voice and entry barriers may be low or transitory if the broadband access market is competitive and users have full access to Internet services and applications. Entry barriers may remain high in respect to the circuit-based fixed PSTN voice market in areas where PSTN voice service is still tied with the underlying network and the circuit-based voice is still the dominant mode of voice communication.

Even with the existence of entry barriers the PSTN voice market could likely tend towards effective competition as VoIP service increases its market penetration, provided that the broadband Internet access market is competitive. This is because an increase in the price of PSTN voice services by a dominant PSTN provider is likely to induce customers to migrate to VoIP application providers and could encourage new entrepreneurs to enter the VoIP market. These would both add pressure on PSTN operators. This could mean that as the market penetration of VoIP services increases and broadband access networks spread, there may be less need to define relevant retail markets for voice for *ex ante* regulation.

The European Commission has used three cumulative criteria in identifying relevant markets susceptible to *ex ante* regulation,³⁴ which may have general implications for other member countries. The first is whether a market is subject to high and non-transitory entry barriers. If entry barriers to a market are low and non-transitory then a relevant market need not be defined for *ex ante* regulation. Given the first criterion, the second is whether a market will tend over time towards effective competition. In cases where entry barriers are high the relevant market is not defined if the market is assessed as moving toward effective competition over time. The third criterion considers whether competition law is sufficient by itself (absent *ex ante* regulation), taking account of the particular characteristics of the electronic communications sector. Even though the first and second criteria are met, if market failures in a market are judged to be redressed by general competition law by itself, a relevant market does not need to be defined.³⁵ The entry barriers to VoIP services (as a software application) are low and do not require *ex ante* regulation. As such the definition of a relevant market for this service is not necessary. In this sense, defining a relevant market for the purpose of determining the necessity of *ex ante* regulations is, in itself, an asymmetric measure to separate out certain services from effective competitive services.³⁶

With the take-up of VoIP over broadband access networks,³⁷ the segmentation of retail outgoing calls into local, national and international telephone services, where applicable, may become less relevant. An increase in the price of a national call by a supplier in a dominant position may give customers an incentive to turn to VoIP service providers located outside a country to make national calls.

Numbering policy

VoIP services need telephone numbers (E.164 numbers³⁸) to be interoperable with traditional PSTN voice services, which currently limits numbering policy to E.164 numbering plans. Peer-to-peer VoIP calls do not necessarily involve E.164 numbers. Use of IP technology only within the transmission network also does not affect the E.164 numbering plan.

It is noted that the telephone numbers by which PSTN subscribers are identified may gradually evolve into alternative forms of name and address such as IP, SIP, H.323 or e-mail address in the future as communications converge over the data network. With this in mind, some modifications may be made to current geographical numbering plans to accommodate VoIP services so they do not necessarily result in problems or create consumer confusion.

National regulatory authorities should consider two main options for numbering: allocating numbers in the geographic range with restrictions compatible with the nomadic nature of VoIP or modifying the numbering plan by adding a new number range for services with nomadic features. However, in the long run, numbering policy may eventually move toward portability in all respects – across technologies and geography. In the United States, for example, where in numbering policy, competition and customer convenience are given great priority, the geographic meaning of numbers is declining as more and more numbers are ported.³⁹

First, the allocation of numbers for VoIP should enable competition with traditional voice services. The allocation of a geographic number range would appear to support competition best. End-users are familiar with geographic number ranges and associate them with low prices. A geographic number range is easily portable with other geographic numbers and easily interoperable with existing networks nationally or internationally. Allocation of a geographic number range might, in many countries, require a modification of the allocation criteria for the geographic range.

The nomadic nature of some VoIP applications may be viewed as improper for geographic numbers. However, if a numbering resource is allocated based on criteria tailored for PSTN voice, the effect of the numbering policy would be to give preferential treatment to PSTN operators. However, it is noted that a premature relaxation of current requirements for geographic numbers may compromise consumer safety in terms of access to emergency services by giving a false geographic impression that may come from geographic numbering used by nomadic VoIP users. The current requirements for the use of the geographic number range, in this sense, may need to be reviewed to accommodate the nomadic nature of some VoIP services⁴⁰ in relation to emergency services.

The downside of technology-neutral allocation of the geographic number range to VoIP providers would be the potential early exhaustion of geographic numbering resources. However, the issue of number exhaust should be fully explored before recommending exclusive non-geographic numbers for VoIP services. Incumbent providers often have an appallingly low efficiency ratio of working versus allocated numbers. An analysis of traditional carriers' inventory of unused numbers should be undertaken before concluding that VoIP is a major threat to numbering resources. Incumbents have also used the threat of number exhaust to try to force new entrants to use only non-geographic numbers. One response to the possibility of exhaust, however, is number portability between geographic numbers used by PSTN operators and VoIP service providers and between fixed and mobile operators although, in some countries, number portability may be limited to substitutable services. Number portability allows numbers to be used more effectively in case a subscriber replaces PSTN voice with VoIP service. Number portability allows subscribers' numbers to be transferred from one service provider to another, instead of creating new numbers and also allows blocks of unassigned numbers allocated to service providers to be transferred either between service providers or between the numbering administrator and a service provider.⁴¹ Another way to conserve geographic numbers would be to allocate new non-geographic numbers only for VoIP type services where numbering is regarded as a policy tool.

Second, national regulatory authorities may also open new number ranges for nomadic VoIP services. The new number ranges could allow VoIP providers to create their own service descriptions that emphasise the nomadic features of VoIP service. However, forcing new entrants such as VoIP providers to use non-geographic numbers can be anti-competitive for two reasons. First, incumbents often charge higher termination rates for calls placed to non-geographic numbers as these types of calls can be classified as 'premium services.' Second, if incumbents do not charge callers higher rates than they would for geographic numbers, there is a widespread consumer perception that such discriminatory charges will apply, creating a wariness among users to call these numbers. Regulators that decide to allocate non-geographic numbers for VoIP should make them optional and non-exclusive (*i.e.* VoIP providers must have access to geographic numbers as well). Such decisions should also be accompanied by a requirement

that termination charges are not discriminatory compared to geographic numbers and consumers should be educated that calls to VoIP numbers are no more expensive than calls to geographic numbers.

It should be mentioned that the numbering policy which segments services by number ranges would not be valid when number portability is implemented between different kind of services (e.g., between geographic numbers and mobile numbers as in the United States). Number portability can be possible between any kinds of numbers, in some cases, by using intelligent network functionality. Using intelligent network functionality, the dialled number does not directly determine the network routing. Instead, it specifies where in a database to look for the network routing details. This arrangement is flexible because the database entry can be changed without changing the dialled number.⁴² If regulators decide that number portability should be implemented between different kinds of services, the policy of allocating numbers to classified services would become meaningless.

Access to emergency services

If it is necessary for public safety to mandate access to emergency services for VoIP service providers, then regulators need to take into account the technical feasibility of implementing such a requirement and allow time for development and deployment of the technology in a phased approach. Developing capability to access emergency services may need to involve not only VoIP application providers but also other entities including device manufacturers, access providers, and operating system manufacturers.⁴³

The capability of access to emergency services (police, fire, ambulance) in voice communications is extremely important. Problems in providing access to emergency services by some VoIP service providers stem from the nomadic nature of their services. Subscribers can typically connect to any VoIP provider from most access points around the world and in any country. This feature of VoIP service raises practical questions on how to route an emergency call to the nearest emergency centre (or public safety answering point) and how to get caller location information.⁴⁴

With regard to routing an emergency call to the nearest emergency centre, in the United States VoIP service providers use a database and special physical connection to the selective router in each area that routes VoIP calls to the Public Safety Answering Point (PSAP) in order to provide emergency services to their customers. The database that tells which PSAP to route to is provided by the public authorities. A VoIP provider would need to obtain and maintain that database and have the software to access it. Some network operators such as Level3 and Intrado have entered the market as intermediaries who are setting up trunking to each selective router in the United States, and will sell access to those trunking arrangements on a wholesale basis to VoIP service providers. The issue of providing accurate location information is a separate one from access to emergency services. VoIP service providers can allow customers to manually type in their exact location before initial use of VoIP phones. Mobile operators have faced the same problem, and developed new technology (either GPS capability in the phone, or triangulation⁴⁵ among cell sites).

The requirement to route calls to the nearest emergency call centre with caller location information or caller identity originates from the fixed PSTN network where a network termination point is matched with the location of a caller. Similar obligations continue to be imposed on mobile operators but with a phased approach taking account of the time for development and deployment of the technology.

The United States Federal Communications Commission (FCC) adopted an order (FCC96-264) in 1996 that required mobile operators to provide 911 calls delivered to Public Safety Answering Points (PSAPs) with call back number and location data.⁴⁶ Nine years later in May 2005 the FCC adopted an order (FCC05-116) that required “interconnected” VoIP providers⁴⁷ to provide their new and existing subscribers with 911 service no later than 28 November 2005. The European Commission’s Universal

Service Directive also states that “Member States shall ensure that undertakings which operate public telephone networks make caller location information available to authorities handling emergencies, *to the extent technically feasible*, for all calls to the single European emergency call number 112.”⁴⁸

The development of VoIP emergency capability needs to involve VoIP application providers as well as device manufacturers, access providers and operating system manufacturers since there is not necessarily a centralised service provider controlling calls. Instead, application developers may simply provide downloadable VoIP clients that allow end users to communicate directly through the Internet.⁴⁹ Policy makers also need to consider the distinction between VoIP services that interoperate with the PSTN and therefore potentially the PSTN's emergency call service and those VoIP services that do not. They must ensure that certain services are not marketed as PSTN replacements so that individuals have no expectation of making emergency calls over this service (for example, the VoIP capability of a game console, connecting different gamers).

Market entry

VoIP services increasingly compete directly with PSTN voice and where an individual licensing regime is being used it may be inappropriate to classify voice service offered by some VoIP providers on a distance basis (*i.e.*, local, long-distance, international calls) or to differentiate voice and data or to even classify⁵⁰ communications services for the purpose of market entry. However, it is noted that mandatory enforcement of access to emergency services by VoIP providers may require such a licensing regime to ensure connection to critical infrastructure where VoIP providers are mandated to provide access to emergency services.⁵¹

The distance-based sub-categories may be difficult to apply to VoIP service because the routed packets may take different paths around the world. The distinction between voice and data may become irrelevant as voice traffic is increasingly transmitted over IP networks as data packets.⁵² The service classification for the purpose of market entry, where appropriate, may not seem to be sustainable in dealing with various possible new various services having similarities with traditional services (*e.g.*, nomadic VoIP services), or fixed-to-mobile substitution. In addition, there may be no need to maintain individual licensing regimes via service classification since there are, arguably, no scarce resources involved which can block market entry, at least, in the fixed communications market.⁵³

REFERENCES

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(http://www.soumu.go.jp/joho_tsusin/eng/Statistics/yellowbook/YB0304.pdf)

ANNEX

	Circuit-based Access Channels							
Hungary	3,666,443	3,602,912	3,577,273	-63,531	-25,639	-1.2	-0.7	
Iceland	191,528	192,552	190,478	1,024	-2,074	-0.3	-1.1	
Ireland	1,954,448	1,935,860	1,921,630	-18,588	-14,230	-0.8	-0.7	
Italy	28,587,000	28,315,462	28,805,452	-271,538	489,990	0.4	1.7	
Japan	72,142,563	70,657,989	69,591,056	-1,484,574	-1,066,933	-1.8	-1.5	
Korea	27,819,163	27,983,892	27,619,254	164,729	-364,638	-0.4	-1.3	
Luxembourg	346,753	434,500	434,500	87,747	0	11.9	0.0	
Mexico	15,000,492	16,351,284	18,091,829	1,350,792	1,740,545	9.8	10.6	
Netherlands	10,004,000	9,906,000	9,562,000	-98,000	-344,000	-2.2	-3.5	
New Zealand	1,801,000	1,798,000	1,722,000	-3,000	-76,000	-2.2	-4.2	
Norway	3,356,546	3,244,492	3,197,934	-112,054	-46,558	-2.4	-1.4	
Poland	12,319,579	12,578,054	12,545,912	258,476	-32,142	0.9	-0.3	
Portugal	4,262,086	4,194,296	4,142,727	-67,790	-51,569	-1.4	-1.2	
Slovak Republic	1,479,073	1,369,613	1,331,521	-109,460	-38,092	-5.1	-2.8	
Spain	17,427,000	17,608,591	17,157,405	181,591	-451,186	-0.8	-2.6	
Sweden	6,576,000	6,504,000	6,367,000	-72,000	-137,000	-1.6	-2.1	
Switzerland	5,387,568	5,323,507	5,262,558	-64,061	-60,949	-1.2	-1.1	
Turkey	19,137,903	19,133,555	19,303,001	-4,348	169,446	0.4	0.9	
United Kingdom	35,043,000	34,591,000	33,700,000	-452,000	-891,000	-1.9	-2.6	
United States	200,518,209	191,741,117	186,645,726	-8,777,092	-5,095,391	-3.5	-2.7	
OECD	607,890,551	598,360,756	589,016,242	-9,529,794	-9,344,514	-1.6	-1.6	

* Access channels refer to the sum of the standard analog access lines and the number of equivalent 64 Kbps transmission paths enabled by ISDN Lines

Source (OECD Communication Outlook 2005, Table 4.2., page 102).

Broadband Access Lines

Broadband Access Lines (DSL+Cable modem+Other*)

	2,002	2,003	2004	2003-2002	2004-2003	CAGR (02-04)	CAGR (03-04)	Penetration rate per 100 ('04)
Australia	363,500	698,700	1,548,300	335,200	849,600	106.4	121.6	7.7
Austria	451,571	618,500	827,675	166,929	209,175	35.4	33.8	10.2
Belgium	895,671	1,213,304	1,618,944	317,633	405,640	34.4	33.4	15.6
Canada	3,558,923	4,554,545	5,631,714	995,622	1,077,169	25.8	23.7	17.8
Czech Republic	16,900	48,498	168,200	31,598	119,702	215.5	246.8	1.6
Denmark	446,276	702,200	1,024,160	255,924	321,960	51.5	45.9	18.8
Finland	283,500	494,300	779,929	210,800	285,629	65.9	57.8	15.0
France	1,691,992	3,656,654	6,529,997	1,964,662	2,873,343	96.5	78.6	10.6
Germany	3,308,900	4,611,086	6,905,159	1,302,186	2,294,073	44.5	49.8	8.4
Greece	1,953	10,476	48,435	8,523	37,959	398.0	362.3	0.4
Hungary	83,834	282,334	360,741	198,500	78,407	107.4	27.8	3.6
Iceland	24,285	41,406	53,264	17,121	11,858	48.1	28.6	18.3
Ireland	10,600	33,050	134,848	22,450	101,798	256.7	308.0	3.4
Italy	976,019	2,401,939	4,701,252	1,425,920	2,299,313	119.5	95.7	8.1
Japan	7,805,917	13,641,311	19,097,172	5,835,394	5,455,861	56.4	40.0	15.0
Korea	10,400,097	11,608,901	11,921,439	1,208,804	312,538	7.1	2.7	24.9
Luxembourg	6,861	15,571	44,145	8,710	28,574	153.7	183.5	9.8
Mexico	261,420	374,147	840,147	112,727	466,000	79.3	124.5	0.8
Netherlands	1,136,200	1,913,200	3,048,561	777,000	1,135,361	63.8	59.3	19.0
New Zealand	64,100	103,776	191,695	39,676	87,919	72.9	84.7	4.8
Norway	190,544	364,104	680,000	173,560	315,896	88.9	86.8	14.9
Poland	47,900	297,291	811,796	249,391	514,505	311.7	173.1	2.1
Portugal	262,789	503,119	858,418	240,330	355,299	80.7	70.6	8.2
Slovak Republic	420	18,677	51,669	18,257	32,992	1009.2	176.6	1.1
Spain	1,209,969	2,207,008	3,441,630	997,039	1,234,622	68.7	55.9	8.4
Sweden	720,000	959,000	1,302,861	239,000	343,861	34.5	35.9	14.5
Switzerland	395,884	748,598	1,309,446	352,714	560,848	81.9	74.9	17.3
Turkey	25,531	99,324	506,452	73,793	407,128	345.4	409.9	0.7
United Kingdom	1,719,319	3,200,600	6,256,300	1,481,281	3,055,700	90.8	95.5	10.5
United States	19,881,549	28,230,149	37,900,000	8,348,600	9,669,851	38.1	34.3	12.8
OECD	56,242,424	83,651,768	118,630,349	27,409,344	34,978,581	45.2	41.8	10.2

* "other" broadband technologies include satellite broadband Internet, fibre-to-the-home Internet access, Ethernet LANs, and fixed wireless subscribers (at downstream speeds greater than 256 kbps).

Source: (OECD Communication Outlook 2005, Table 5.6., page 153)

Total mobile cellular subscribers per 100 inhabitants
(OECD Communication Outlook 2005, Table 4.8., page 109)

Total mobile cellular subscribers per 100 inhabitants			
year-end	2002	2003	2004
Australia	63.7	71.7	82.5
Austria	83.3	87.4	97.7
Belgium	78.4	83.0	87.7
Canada	37.8	41.9	46.7
Czech Republic	84.4	95.2	105.6
Denmark	83.3	88.4	95.7
Finland	86.8	91.1	95.6
France	62.8	67.4	71.7
Germany	71.7	78.5	86.4
Greece	84.8	93.8	99.9
Hungary	67.8	78.4	86.3
Iceland	90.7	96.7	99.1
Ireland	78.4	85.7	93.1
Italy	91.6	97.6	107.9
Japan	63.7	67.9	71.7
Korea	67.9	70.2	76.1
Luxembourg	106.0	119.8	119.8
Mexico	25.6	29.3	37.4
Netherlands	73.1	80.7	98.1
New Zealand	63.9	73.3	86.4
Norway	86.2	91.2	102.7
<u>OECD</u>	58.9	64.3	72.0
Poland	36.4	45.6	60.5
Portugal	82.3	96.1	99.2
Slovak Republic	54.4	68.4	79.4
Spain	90.1	91.9	90.6
Sweden	89.1	98.2	108.7
Switzerland	78.1	83.6	83.9
Turkey	33.5	39.4	48.3

NOTES

¹ Numbering policy, where applicable, may be either an economic regulation or a social regulation. It may be used to enhance competition by using geographic numbers for VoIP service or to protect consumers from potential mishaps by differentiating VoIP service from PSTN voice using a new number range for VoIP service.

² The issues of interconnection and universal service are not covered in this paper since the complexity and general nature of the issues, at this stage, make it difficult to draw some policy directions related to VoIP.

³ For example, EU member states have only the broadest category of “electronic communications service” for the purpose of market entry. In doing so, EU states abolished prior individual licensing regime substituting a general authorisation regimes where communications service providers are not required to get prior licensing from regulators before they start a communications business. In Japan, the classification of “Type 1 carrier” (carrier which installs its own infrastructure) and “Type 2 carrier” (carrier who borrows infrastructure from other carriers) was abolished and unified in July 2003, into “Telecommunications carrier” which needs registration or notification instead of permission to do its business.

⁴ The French regulator, the *Autorité de Régulation des Communication et des Postes* (ARCEP), divided VoIP definition into Voice over Broadband (VoB; managed VoB provided by broadband access provider) and Voice over Internet (VoI; unmanaged VoB such as Skype). VoB is regarded as a substitute for PSTN voice in terms of call quality, security and usage of the same handset.

⁵ In the case of VoIP calls interconnected to PSTN, making an additional call may incur interconnection charge payable to PSTN operators.

⁶ Voice over Internet Protocol (VoIP) is, in part, driving a shift away from circuit switched networks to IP networks mainly because of the ability to integrate a range of features and provide these at low cost. VoIP can be easily integrated with other functionalities thanks to the layered approach which VoIP adopts. The beauty of the layering model is that each layered protocol can be developed independently of the other layers. This means that VoIP providers can be independent of the lower underlying infrastructures such as DSL-based or cable modem-based networks. Similarly, at the higher layer, voice-enabled software applications can be developed independently from the VoIP protocol used. Developing applications to improve telephony generally is much easier than developing new hardware. Thus voice communication capability can be easily unified with other multi-functionalities and multimedia in the IP world. In contrast, in a circuit-switched Public Service Telephone Network (PSTN), adding even a simple new service can be complicated and expensive. (Bert Sadowski and Bas Straathof, 2005).

⁷ *Economist*, “The meaning of free speech” (September 15 2005) (http://www.economist.com/displaystory.cfm?story_id=4400704)

⁸ <http://www.point-topic.com/content/dslanalysis/voipana050706.htm> (6 July 2005). The study suggests residential VoIP users as of March 2005; North America (1.8 million), Japan (7.2 million), France (1.3 million), Europe (2.3 million), PC-based VoIP users (5.9 million).

⁹ VoIP is in most cases cheaper when compared with circuit-based voice. VoIP does not require a dedicated time slot on a wire. Instead, VoIP allows voice packets belonging to the same call to be sent over different routes through a network and at irregular time intervals⁹. The absence of a need for fixed routes

substantially reduces the complexity of extending a network. The absence of fixed timeslots also implies that silences no longer have to be transmitted. In addition, maintaining only one network for both data and voice makes the use of network resources more efficient and reduces operational costs.

¹⁰ Price rebalancing (raising line rental charge and reducing call charge) is linked to three regulatory objective of enhancing competition in the broadband and local voice market in order to ensure a greater gap between the price of the line rental and the wholesale access copper line offered to competitive fixed operators.

¹¹ <http://www.forrester.com/ER/Press/Release/0,1769,1037,00.html> According to a survey undertaken in the 2nd quarter of 2005 by a market research firm, Forrester, proactive incumbents like Telecom Italia, France Telecom, and Portugal Telecom launched flat-rate PSTN calling even before independent VoIP providers became a threat, reducing VoIP's threat to their core PSTN business. Since then, a majority of incumbents have introduced various flat-rate pricing plans, further reducing their vulnerability to VoIP. A number of incumbents are also launching their own VoIP services, ADSL bundles, and enhanced functionality services, challenging the third party VoIP offers directly.

¹² This is referred to as session border controller (SBC). SBCs are put into the signaling and media path between calling and called party. The SBC acts as if it were the called VoIP phone and places a second call to the called party. The effect of this behaviour is that not only the signaling traffic, but also the media traffic (voice, video etc) crosses the SBC. Without a SBC, the media traffic travels directly between the VoIP phones. Private SBCs are used along with firewalls to enable VoIP calls to and from a protected enterprise network. Public VoIP service providers use SBCs to allow the use of VoIP protocols from private networks with Internet connections using NAT. Additionally, some SBCs can also allow VoIP calls to be set up between two phones using different VoIP signaling protocols (SIP, H.323, Megaco/MGCP, etc...) as well as performing transcoding of the media stream when different codecs are in use. Many SBCs also provide firewall features for VoIP traffic (denial of service protection, call filtering, bandwidth management, etc...). (http://en.wikipedia.org/wiki/Session_Border_Controller)

¹³ *The Wall Street Journal*, A1, "Phone, Cable Firms Rein In Consumers' Internet Use" (October 21, 2005) (<http://webreprints.djreprints.com/1341970908457.html>) The article points out that some mobile operators stipulate in their subscription contracts that customers cannot use the company's high-speed Web-access networks for Internet calling.

¹⁴ <http://www.forrester.com/ER/Press/Release/0,1769,1037,00.html>; Forrester Research, a market research company, surveyed more than 25 000 consumers across Europe – including France, Germany, Italy, the Netherlands, Spain, Sweden, and the United Kingdom- about the use and knowledge of VoIP and triple-play technologies.

¹⁵ Given the limited spectrum bandwidth for mobile communications, mobile operators may think that if data usage becomes more popular, the data demand for spectrum cannot be met while accommodating voice demand for spectrum. However, the high pricing policy for mobile Internet access could be changed according to availability of new technology or more spectrum bandwidth.

¹⁶ Research shows that consumers sometimes make irrational choices when confronted with complex service offers. (Wilson, Chris and Catherine Waddams, "Irrationality in Consumers' Switching Decisions: when more firms may mean less benefit", as presented to the OECD Committee on Consumer Policy Roundtable on Demand-Side Economics for Consumer Policy" 24 October 2005 in Paris, France).

¹⁷ Microsoft's Xbox360 game console and Sony's PlayStation2 have a VoIP-based voice chat function.

¹⁸ <http://news.bbc.co.uk/go/pr/fr/-/1/hi/business/4237338.stm>

¹⁹ Yahoo and Microsoft announced, in October 2005, plans to make their instant-messaging services interoperable in what analysts called a shot at the market leader America Online's AOL Instant Messenger and a defensive measure against Google

- 20 On 3 January 2006 Google and AOL announced that Google would invest USD 1 billion for a 5 % stake in Time Warner's America Online unit as part of a partnership that expands their existing search engine deal to include collaboration on advertising, instant messaging and video. Google also is offering a USD 300 million credit that AOL can use to buy keyword-based ads from Google. The companies commented that a critical piece of the strategic alliance would be to connect Google users worldwide to a wealth of AOL's content and for AOL to sell all types of ads, including search, banner and display, across Google's network. (<http://www.vanguardngr.com/articles/2002/features/technology/tec804012006.html>)
- 21 Denial of service attacks prevents a target machine from accessing a network resource. A simple form of DoS attack is by sending large packets of data to a single machine thereby making it unstable or even crashing it.
- 22 Toll fraud is a specific criminal act that occurs when a hacker dials into an agency's PBX, key system or other managed telephone equipment and then probes the system for a weakness that will provide an outside telephone line. Once the outside line is obtained, calls may be made anywhere in the world and toll fees will be charged to the owner/operator of the switch.
- 23 There is a need to differentiate between social regulation and economic regulation. The former is focused on social demands like access to emergency services and is strongly influenced at the political level. The latter is about competition on defined markets with a clearly specified process of market definition and market analysis and is affected strongly by new technology. In this paper, economic regulation is defined as government interventions designed to affect the price or availability of goods or services while leaving the production itself in private hands in order to enhance competition such as price control, carrier (pre-selection or network unbundling) (<http://www.politicalscience.utoledo.edu/faculty/lindeen/glos3260.htm>). Social regulation is defined as government-imposed restrictions designed to discourage or prohibit socially harmful behaviour or to encourage behaviour deemed socially desirable such as regulations for access to emergency call services, access by individuals with disabilities with disabilities or lawful interception (<http://countrystudies.us/united-states/economy-12.htm>).
- 24 A more detailed explanation is made at "Relevant Markets for Ex-ante Regulation" on page 12.
- 25 EC Framework Directive (2002/21/EC) recital 18.
- 26 For example, European Commission considers three cumulative criteria to decide whether a market should condition to warrant inclusion of a given defined market. Given the dynamic character of electronic communications markets, possibilities for the market to tend towards a competitive outcome, in spite of high and non-transitory barriers to entry, need also to be taken into consideration. The second criterion, therefore, is whether a market has characteristics such that it will tend over time towards effective competition. This criterion is a dynamic one and takes into account a number of structural and behavioural aspects which on balance indicate whether or not, over the time period considered, the market has characteristics which may be such as be defined. The first criterion is whether a market is subject to high and non-transitory entry barriers. The presence of high and non-transitory entry barriers, although a necessary condition, is not of itself a sufficient to justify the imposition of regulatory obligations as set out in the specific directives of the new regulatory framework. The third criterion considers the sufficiency of competition law by itself (absent *ex ante* regulation), taking account of the particular characteristics of the electronic communications sector.
(http://europa.eu.int/information_society/policy/ecomm/doc/info_centre/recomm_guidelines/relevant_markets/en1_2003_497.pdf page 10).
- 27 A market is defined as a (group of) product/service and a geographic area in which a hypothetical profit maximising firm, a sole firm not subject to price regulation, can impose a 'small but significant and non-transitory' increase in price. The concept of a 'hypothetical monopolist' can be a useful analytical tool in finding close demand and supply-side substitutes, which sets the boundary to the relevant market. Many competition authorities in the United States, United Kingdom and other countries use the prevailing prices of the products as a benchmark and regard price increases of 5-10% lasting for the foreseeable future as a small but significant and non-transitory price increase. Most economists agree that an ideal market definition considers possibilities in both consumption and supply substitution.

The hypothetical monopolist should consider the likely demand responses from consumers to a price increase. If the reduction in sales of services were large enough, such a price increase is not profitable for the hypothetical monopolist because of demand substitution. The nature and magnitude of this response from consumers determines the scope of the product/service market and the geographic market. A relevant market measures responses from firms selling similar types of products/services to a price increase by the hypothetical monopolist firm. Without significant sunk costs of entry or exit, new entrants would enter existing markets to produce or sell products/services alternatives to the incumbents if they view a small but significant and non-transitory price increase as giving them profits higher than normal. (DSTI/ICCP/TISP(2001)6, para.20-23, Secretariat Working document).

28 For example, market structures (market share and its trends, entry barrier), supplier behaviour (active competition in price and rivalries, absence of anti-competitive behaviour and collusion, etc), consumers behaviour (access to information, ability to use information and market opportunities, costs and barriers to switching suppliers, etc), consumer benefits (a wide range of competitive service offer, consumer satisfaction with price and affordability, etc) (DSTI/ICCP/TISP(2001)6, page 14).

29 Numbering policy, where applicable, may be either an economic regulation or a social regulation. It may be used to enhance competition by using geographic numbers for VoIP service or to protect consumers from potential mishaps by differentiating VoIP service from PSTN voice using a new number range for VoIP service.

30 In the United States, the FCC adopted on 5 August 2005 a policy statement on broadband Internet access. The principles which will be incorporated into the FCC's policy-making activities are, first, that consumers are entitled to access the lawful Internet content of their choice. Second, consumers are entitled to run applications and use services of their choice, subject to the needs of law enforcement. Third, consumers are entitled to connect their choice of legal devices that do not harm the network. Fourth, consumers are entitled to competition among network providers, application and service providers, and content providers. (http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-05-151A1.pdf)

31 For example, a competitive VoIP provider in France, Free, provides subscribers with naked DSL using a fully unbundled telephone line rented from France Telecom, but mainly promotes its 'Freebox' bundled offer which includes broadband access, VoIP and TV services.

32 Such as price control, carrier (pre-) selection.

33 The term, 'retail voice markets' is used to imply VoIP service and PSTN voice without any competition-related assumption or analysis.

34 Explanatory Memorandum to Commission Recommendation on Relevant Product and Service Markets within the electronic communications sector susceptible to *ex ante* regulation. P.9.

35 According to the criteria, the EC recommended six fixed voice markets: (markets 1 through 6) out of seven retail markets; access to the public telephone network (for residential or non-residential customers); publicly available local and/or national telephone services (for residential or non-residential customers); publicly available international telephone services (for residential or non-residential customers). The EC also identified two access markets out of 11 wholesale markets: wholesale unbundled access to metallic loops and sub-loops for the purpose of providing broadband and voice services, wholesale broadband access. If one (or more) company is designated as having Significant Market Power (SMP) in one of the six fixed voice markets, a National Regulatory Authority must impose carrier selection and carrier pre-selection and can choose a range of *ex ante* regulations such as price control and cost accounting obligations, obligation of transparency, obligation of non-discrimination, obligation of accounting separation, and obligation of access to, and use of, specific network facilities upon the SMP company.

36 Although underlying reasoning is different, the French regulator, the *Autorité de Régulation des Communication et des Postes* (ARCEP), made a similar conclusion when it submitted its analysis on VoIP markets in the context of *ex ante* regulation to the EC. ARCEP divided VoIP into Voice over Broadband (VoB; managed VoB provided by broadband access provider) and Voice over Internet (VoI; unmanaged VoB such as Skype). VoB is regarded as a substitute for PSTN voice in terms of call quality, security and usage of the same handset. Regarding the treatment of VoIP in the retail access markets (markets 1 and 2; Access to the public telephone network at a fixed location for residential or non-residential customers), ARCEP decided that VoB access offers for only or mainly speech communication (*i.e.* ISDN) are included in the relevant markets of the access to public telephone network. ARCEP found that until now broadband access offers such as ADSL or bitstream are bundled with VoB and video services. Thus, the tied broadband access offers are not included in the two relevant retail access markets at a fixed location (markets 1 and 2).

As a result, broadband access providers, who provide bundled service offerings including VoB service, are not regulated.

Regarding the treatment of VoIP relative to publicly available telephone services at fixed locations (publicly available local and/or national telephone services provided at a fixed location for residential customers, publicly available international telephone services provided at a fixed location for residential customers publicly available local and/or national telephone services provided at a fixed location for non-residential customers publicly available international telephone services provided at a fixed location for non-residential customers), ARCEP included VoB in these relevant markets but only VoB services using an access offer within the existing relevant retail access market (*i.e.*, broadband access over ISDN). The VoB services using broadband access providers, who provide bundled service offerings including VoB, are excluded from the retail fixed markets for publicly available telephone services (markets 3 through 6). This decision is based on a finding that VoB bundled with other services is based on the broadband access service market, excluded from the relevant access market 1 and 2, which ARCEP considers competitive. As a result, VoB providers, who bundle VoB with other services (*i.e.* broadband access service, video, etc), are not regulated with *ex ante* regulation. ARCEP also concluded that in each of the six retail relevant markets (markets 1 through 6), France Telecom was dominant, thus, justifying *ex ante* regulation.

The European Commission has backed this approach in its decision on the respective notification (case FR/2005/0221 to 226: retail access services markets: narrowband and fixed calls). The comment by the Commission pointed out that, *“lorsqu'elle envisage l'inclusion de la téléphonie IP dans les marchés des appels au détail, l'autorité réglementaire nationale doit prendre attentivement en compte des indicateurs tels que la pénétration du haut débit, l'élasticité des prix des appels, la pénétration de la téléphonie IP sur le marché de détail de la large bande, le coût de connexion de la téléphonie IP, la position de l'opérateur historique dans la fourniture des services de téléphonie IP, la capacité de discrimination entre les tarifs d'appels suivant le type d'accès (à savoir bande étroite ou large bande) et la contrainte en termes de prix de la téléphonie IP sur les services RTC. (When the national regulatory authority plans to include IP telephony in markets of retail calls, it must carefully take into account indicators such as broadband penetration, the elasticity of the prices of the calls, the penetration of IP telephony on the retail market of broadband, the connection cost of IP telephony, the position of the traditional operator regarding the provision of IP telephony services, the capacity to discriminate tariffs of calls depending on the type of access (i.e narrowband or broadband), and the constraint of IP telephony on PSTN services in terms of price. - unofficial translation -)”*

37 It is assumed that if wider broadband capability is provided, the customers would regard the quality of service of VoIP more indistinguishable from PSTN voice.

38 E.164 is an ITU-T recommendation which defines the international public telecommunication numbering plan used in the PSTN and some other data networks. It also defines the format of telephone numbers. E.164 numbers can have a maximum of 15 digits and are usually written with a + prefix. To actually dial such numbers from a normal fixed line phone the appropriate international call prefix must be used. (<http://en.wikipedia.org/wiki/E.164>).

39 In the United States, most VoIP providers allow customers to choose the area code they want. So the number is chosen by the customer to suit the customer's convenience, but may not indicate where the customer lives.

40 Regulators may allow nomadicity in a limited area or allow nomadicity countrywide but requiring with geographical area of the number or removing requirements for relationship to geographical location. According to the ECC report (ECC/REC/(05)03), each option to adapt criteria for geographic numbers in order to support VoIP services removes to some degree the geographic nature of the range, which could have an impact on other national regulatory issues (*e.g.* number shortage, tariff models of SMP operator, business cases of carrier pre-selection providers, the way of handling location information by emergency centres). This impact will have to be weighted against the benefits of using the geographic number range (<http://www.ero.dk/documentation/docs/doc98/official/pdf/REC0503.PDF>). It implies that the definition of 'geographic' number could lose ground as VoIP service, which is not distance-based, takes up. In the future the geographic number range may no longer qualify as geographic number.

41 <http://www.teleconsultingroup.com/PDF/Num.pdf>, p.18-21.

42 John G. Williams, Numbering Plan Development and Administration (Feb 2004), p. 19-20.

43 http://enum.nic.at/documents/AETP/Presentations/Austria/0053-2005-05_VON_Europe/200505_VON_Europe_Emergency_Services_R_Stastny.ppt

44 ERG Common Statement for VoIP regulatory approaches, p.9.

45 Triangulation is the process of finding a distance to a point by calculating the length of one side of a triangle, given measurements of angles and sides of the triangle formed by that point and two other reference points.

46 http://www.mobilein.com/wireless_emergency_services.html18-21.

46 John G. Williams, Numbering Plan Development and Administration (Feb 2004), p. 19-20.

46 http://enum.nic.at/documents/AETP/Presentations/Austria/0053-2005-05_VON_Europe/200505_VON_Europe_Emergency_Services_R

47 http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-05-116A1.pdf. “Interconnected VoIP service” means an interconnected voice over Internet Protocol service that: 1) enables real-time, two-way voice communications; 2) requires a broadband connection from the user’s location; 3) requires Internet protocol-compatible customer premises equipment (CPE); and 4) permits users generally to receive calls that originate on the public switched telephone network and to terminate calls to the public switched telephone network.

48 Universal Service Directive, Art 26 (3); Public telephone networks include fixed and mobile networks which are used to provide publicly available telephone services.

49 http://enum.nic.at/documents/AETP/Presentations/Austria/0053-2005-05_VON_Europe/200505_VON_Europe_Emergency_Services_RStastny.ppt

50 For example, EU member states have only the broadest category of “electronic communications service” for the purpose of market entry. In doing so, EU states abolished the prior individual licensing regime for the general authorisation regime where communications service providers are not required to get prior licensing from regulators before they start communications business. In Japan, the classification of “Type 1 carrier” (carrier which installs its own infrastructure) and “Type 2 carrier” (carrier which borrows infrastructure from other carriers) was abolished and unified, in July 2003, into “Telecommunications carrier” which needs registration or notification instead of permission to do business.

51 For example, in the United States, the 911 system routes emergency calls on special trunks, through selective routers, to calling centres. Carriers cooperate with one other to ensure that the routing and trunking arrangements are set up properly. Each carrier is responsible for providing its own trunking. The concern of VoIP providers has been the cost of establishing physical trunking arrangements to get their traffic to the calling centres (PSAPs). There are many of these calling centres in different parts of the United States. Therefore, in order for anyone providing a national service to ensure that its emergency calls will be routed properly, physical trunking arrangements must be set up in all of these different areas. (DSTI/ICCP/TISP(2005)3/FINAL).

52 In IP networks, the distinction between real-time and non real-time would be more relevant, if necessary.

53 In mobile markets, spectrum resources are scarce, thus limiting the number of player. However, in most OECD countries, MVNO is allowed to overcome the technological entry barrier to the mobile market, resulting in many more mobile operators.