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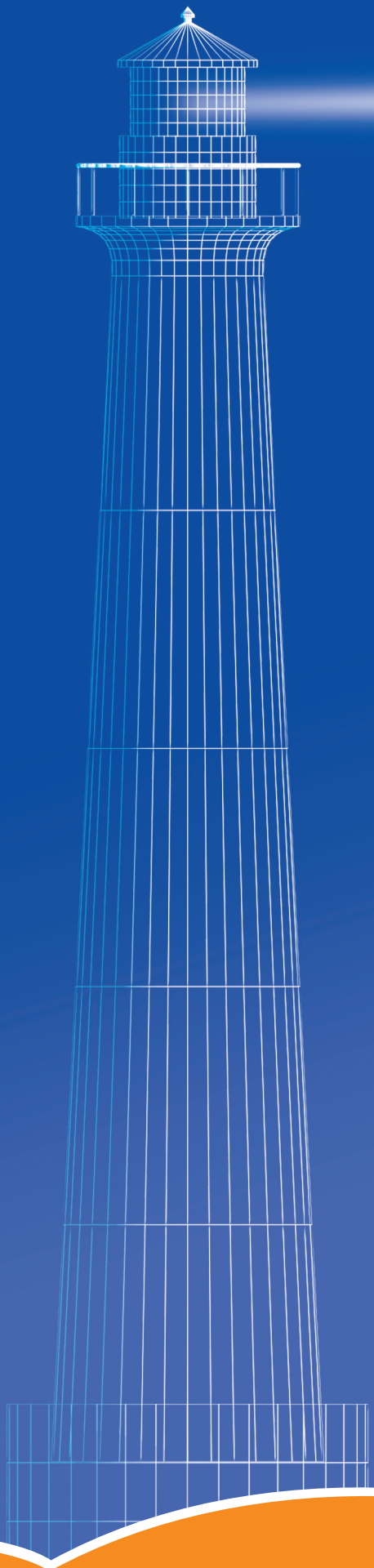

GSR 2005
DISCUSSION PAPER

VoIP AND REGULATION

Comments are welcome and should be sent by 5 December 2005 to GSR05@itu.int

International Telecommunication Union

GLOBAL SYMPOSIUM FOR REGULATORS

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VoIP and regulation

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GSR Discussion Paper*

VoIP AND REGULATION[1]

Voice over Internet Protocol (VoIP) is generally viewed as a "disruptive technology"[2]. All the current market indications show that IP networks and services like Voice over Internet Protocol (VoIP) will replace traditional PSTN networks and services. ITU estimates that by 2008, at least 50 percent of international minutes will be carried on IP networks and that many carriers will have all-IP networks. Recent trends are certainly headed in this direction. For example, in the United States, residential VoIP subscriber numbers have increased from 150,000 at the end of 2003 to over 2 million in March 2005. It is predicted that subscribers in the US will exceed 4.1 million by 2006, generating over USD 1 billion in gross revenues for the year[3]. In March 2005, the Chilean broadband operator VTR launched the first telecommunication network for residential services based on IP technology. The operator expects to expand its platform and reach 2 million customers in five years. There are approximately 35,000 residential telephones that use IP technology in Chile, either through Chilean operators or through Vonage.

Likewise, ITU expects that much of mobile traffic will become IP-based and that the introduction of mobile VoIP will influence the shape of the mobile business globally. Wireless-enabled mobile VoIP offers the potential for cheaper voice calling. Users of 3G networks can already use mobile phones to make VoIP calls such as Skype to other Skype subscribers at cheaper data rates. The growth of mobile VoIP will particularly affect the high-price international roaming business.

Today, however, VoIP services have been implemented unevenly around the world. Some countries have enabled many legal providers, whilst others have blocked the provision of VoIP providers and others only have grey market operators. These approaches reflect very different perceptions of VoIP in various parts of the world. In some countries, VoIP is seen as an exciting technological development that offers cheaper calling for consumers, whereas in others it is seen as a threat to the existing order. At an international level, VoIP traffic is often described as "by-pass" or "lost" traffic but this traffic has driven the development of new service providers both in the developed and developing world.

In both developed and developing countries however, the advent of VoIP has brought about new challenges for regulators. In developing countries where the entrenched rights of fixed line operators have been protected, the main question has been whether to legalize the introduction of VoIP. In more mature and competitive markets, VoIP has raised new questions for regulators over what aspects of the new services require regulation. Inevitably, it is those countries that have legalised VoIP as part of a broader liberalisation of their markets that have started to accumulate thinking, experience and precedent in this area. But even in these countries, VoIP is a relatively recent development and therefore there is often little consensus about how best it should be regulated.

This paper examines how VoIP services will affect future regulation. Due to the starkly contrasting global perceptions of VoIP however, it is difficult to present a unified approach to regulatory treatment of VoIP and this paper aims to reflect regulatory experiences from a wide range of countries that are grappling with the transition to VoIP. The three sections of this paper are structured to answer both the broad and specific questions raised by VoIP services, including the

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* This discussion paper has been prepared by *TRACY COHEN, OLLI MATTILA AND RUSSELL SOUTHWOOD* . The views are those of the authors and may not necessarily reflect the opinions of the ITU or its membership.

overall approach to regulating VoIP as a mainstream service; how VoIP has changed voice business models and the various ways of classifying the services it has created; and finally, other related issues frequently raised in connection with VoIP, such as quality of service; network integrity; emergency calling, numbering, communication security and lawful interception.

Box 1: VoIP – A Primer

"Voice over Internet Protocol" (VoIP) is a generic term referring to a technical standard that enables the transmission of voice traffic in whole or in part, over one or more networks, which use the Internet Protocol (IP).

Standards or **'protocols'** for VoIP are still evolving, but two main *open protocols* and proprietary *vendor protocols* enable VoIP: *"H. 323"*- the most widely adopted protocol for the transmission of VoIP. It is an International Telecommunication Union (ITU) legacy standard, which builds on earlier protocols for the transmission of voice and video over analogue PSTN, ISDN and ATM; and *"Session Initiation Protocol"* (SIP) is an application-layer control protocol, which is an end-to-end signalling protocol. SIP facilitates communication between two or more SIP supported devices, but it is not the only protocol required to make VoIP calls, which takes place via additional protocols.[4]

How VoIP technology works: Voice (or data) is compressed and converted into digital packets that travel over the Internet, or a private network utilizing VoIP and are then converted back at the other end compensating for echoes made audible due to the end-to-end delay, for jitter (variability) and for dropped packets. The data packets are non-isochronous and may take many different and independent paths to the intended destination, arriving out of sequence or with different end-to-end delays. VoIP technology makes much more efficient use of bandwidth and voice is transmitted on IP-based networks at considerably lower cost than circuit-switched networks which require a dedicated connection for the entire duration of a 'call'.

VoIP Applications: The first generation VoIP services only allow calls to people using the same service, (PC-to-PC, or Class 3, e.g. Yahoo! Instant Messenger). Here, voice signals transmitted are not switched across a PSTN at all. Second generation VoIP services allow calls to any regular (PSTN) telephone number (PC-to-Phone or Class 2, e.g. Dialpad, Net2Phone, Skype Out) including local, long distance, mobile, and international numbers. A third generation of VoIP services, enable use of a traditional phone (Phone-to-Phone, or Class 1[5], e.g. x-lite and Lipz through an adaptor, at both the originating and terminating ends of a call, but routing the call over an IP packet-switched, rather than traditional circuit switched network. [6]

1 VoIP: Evolution or Revolution in Regulatory approach

1.1 How VoIP is changing voice business models

In more liberalised telecoms environments, it is important to create regulatory frameworks that allow the market to produce sustainable business models. The industry continues to experience rapid change as the underlying business models change shape. A wide variety of technological and service innovations have already come from the introduction of IP networks. VoIP is a powerful service innovation that has the potential to change how existing voice markets operate. Since VoIP is largely enabled by the existence of IP networks, there is inevitably an overlap throughout this paper between these two key concepts which remain inextricably linked. It is not yet clear how IP networks will be implemented and at what speed but it is important to try and identify key elements of the changing business model as a basis for understanding the policy and regulatory dilemmas it poses. This discussion can also be extended to a broader one on Next Generation Networks (NGN) as many of the regulatory issues and challenges identified in this paper will arise as part of the move to NGNs.

Current regulatory practice for telephone service was devised at a time when circuit switched technology was dominant and is therefore historically based on this technology. This approach treats different types of networks differently. Future regulation should, however, be based on a fundamental recognition of the convergence of telecommunications, broadcasting, media and information technology sectors which means that all transmission networks and services should be addressed by a single regulatory framework model. For the remainder of this paper, the term Information and Communications Technologies (ICT) will be used to reflect this forward-looking approach.

For operators, VoIP represents three broad types of commercial opportunities emanating from the specific circumstances identified at the end of this section:

1.1.1 Price Arbitrage

Arbitrage is a term used to describe a situation where one buys at a cheaper price in one market to sell at a higher price in another. The growth of VoIP for international calling has been built on the wide gap between retail and wholesale calling prices in many parts of both the developed and developing world. These differences are a function of the uneven introduction of competition in voice markets around the globe.

In Africa for example, it may cost a caller (at the retail rate) between US50 cents and US$1 to call Washington DC but the same call is bought by the incumbent (at the wholesale rate) for between US1-3 cents. Where this circumstance exists, incumbent operators are able to maintain high margins because they either have monopolies or limited competition. What is often described as "bypass traffic" or the "grey market"– whether defined as illegal in some countries or in a genuinely grey area – is a proxy for competition, particularly on international voice calling. This has already forced incumbent telcos to cut their international rates and, as there is increasingly less regulatory protection of international voice markets, these rates will continue to decrease.[7]

Moreover, many incumbent operators are going through the process of "rebalancing" their tariffs in line with the costs of providing services. In the pre-competition days, high international rates were used to cross-subsidise rates on domestic networks. With competition in the largest voice markets having driven down international rates, and as various operators are mandated by law to ensure that tariffs are rebalanced within a given period, this business model is unlikely to be sustainable.[8]

Box 2: Examples of Grey Market revenues as a per cent of overall international call revenue

Africa	20-30%*
Asia	30%+
Brazil	36%**
Colombia	50%***
Costa Rica	20%****

* Source: Balancing Act
** Source: Abrafix
*** Source: V-P Technology, Orbitel
**** Source: Incumbent telco ICE

The VoIP service market has been fostered by the introduction of IP networks and the proliferation of web based transactions. Grey market operators can simply sign up on a web site and be offered international calling services that they can offer to users. As data, these calls are not recorded as minutes and need not use the international gateway of the historic or incumbent operator for outgoing calls. While quality of service issues do arise, many cost-conscious callers seem willing to make the trade-off between price and quality.

However, as a commercial opportunity this is entirely price dependent, so this arbitrage effect may change or disappear as prices are reduced. The legalisation of VoIP services to a wider range of operators is in effect the introduction of wider competition that will result in a lowering of this price arbitrage gap. Yet, whatever prices are chosen, the future of revenue in telephony, particularly in the international domain, appears to be "low-margin, high volume" rather than "high-margin-low volume" for this type of calling. Where VoIP has been legalised, VoIP providers appear content to work with lower margins than established operators.

1.1.2 Savings from New Network Topologies

Many of the world's larger carriers have been persuaded to consider VoIP because an IP-based network can carry both voice and data in one rather than two networks. In this way, operators will be investing a single network that can be used more efficiently for many different forms of traffic.

IP network deployment costs often come in smaller increments than those required for telco switching facilities and dedicated circuits. It is possible to add capacity incrementally in a manner that will realise return on investment more quickly than the traditional multi-million dollar telecom equipment investments, which require many years to produce the required return. For example, large numbers of traditional switches can be replaced by fewer "soft switches". Smaller investments can often be financed from cash flow rather than requiring major external borrowing. Moreover, some components for the new IP networks are items that can be found in retail electronics outlets rather than being sold as an "integrated solution" by a manufacturer. However, not surprisingly these arguments are hotly contested by some telco managements, traditional telephone network engineers and telephone equipment manufacturers.

The debate tends to centre on both the soundness or integrity and cost of the newer generation of network equipment - including Wi-Fi and Wi-MAX – as part of an IP network roll-out. These new wireless technologies can and are being deployed both to create local loop VoIP access and for backbone links. Again, it is argued that this is being done at prices that are much cheaper than

traditional copper or fibre networks. As with arguments about IP networks, the potential cost savings using wireless technologies are not without challenge. However, incumbents worldwide are both deploying these technologies and at the same time, are threatened by them.

Likewise, mobile operators that have invested considerable sums in 3G licences and need to make a return on their investment over five to ten years are also threatened by the potential of VoIP, in particular the effect substitution of mobile VoIP will have on operators' high-price international roaming business. This presents a recurring dilemma for the regulator: should the regulator protect the investment of the mobile operator and delay cost-saving innovations for consumers or should it allow wireless-enabled, mobile VoIP to flourish, which may have the effect of undercutting investment returns of the mobile operators?

These questions are particularly pertinent for regulators and policy-makers in developing countries where the choice is often between defending a government-owned telco incumbent (for financial and social reasons) and the distributive policy aspiration of making cheaper communications available to a wider number of people, particularly in rural areas.

1.1.3 New Products and Services

The convergence of voice, data and images on IP networks allows users to combine these different forms of traffic and significantly expand the range of product and service offerings. For example, call-centre software can include a range of features such as productivity management, real-time database access and cost-effective call routing. Convergence also blurs the line between voice, data and television programming. Many operators in the developed and developing world are now offering the so-called "triple-play" option that combines all three in a single service. Senegal's Sonatel has rolled out a "triple-play" service, offering voice, internet access and television programming and Brazil's TVA[9] is also offering the same service bundle.

This form of delivery has implications for competition as users increasingly seek a single provider and billing option. A single bill for all these services is undoubtedly convenient for consumers but the cost of each service is not transparent, making comparisons between services difficult for users. However, triple play, also has the potential to open up television as a delivery platform for a far wider range of rich, multimedia services, overcoming to some extent, the lack of installed, Internet-connected computers in developing countries. While this may be a solution for the urban poor, it still will not address lack of Internet access for those in rural areas without electricity or television coverage. Yet, while this may not be tomorrow's market, it is certainly going to be relevant in the medium-term.

In addition, there are now a number of VoIP crossover technologies for use with mobiles that are currently in a trial phase, or beginning rollout. For example, "Push-to-talk" is the term used to describe what most people would understand as "walkie-talkies": instantaneous, direct two-way conversations between two individuals based on IP software that sits on a mobile phone. US-based Nextel and others started offering the service in 2003. The product debuted in Europe with Orange's 'Talk Now' offering. Although it requires users to be subscribers to a data service from one of the major carriers and has a number of quality issues, there has been significant take-up. It is seen as sufficiently threatening to the traditional "walkie-talkie" market for Motorola to have produced at the beginning of 2005, specifically designed, rugged "push-to-talk" phones. Two of India's mobile providers – Hutchison Essar and Tata Indicom – also launched "push-to-talk" services in May 2004.

Another area of development will be the current testing of products that integrate cellular and WLAN networks and provide voice from a WLAN device. As with most technical advances, it can go in several directions: it is possible to use fibre and co-axial cable to distribute a wireless signal throughout a large area like a hospital, government ministry or a university. The wireless signal can then deliver VoIP calling and access to the Internet at broadband speeds without the same

interference problems that are usually caused by walls. It would then for example, allow doctors and nurses to have conference calls about patients and in more developed versions, offer the opportunity to show video or images for discussion. As part of the EU-project IPv6 Wireless Internet Initiative (6WINIT), Ericsson has trialled a health project, called Guardian Angel, using IPv6 and roaming between 2G, 3G and WLANs.

Mobile carriers in both the United States and Europe are already rolling out networks that offer 11-Mbit/second 802.11 WLAN access. Their fear is that it will eat into their existing data business (and perhaps even undercut the rationale for 3G) but at the same time, these operators are aware that they cannot be in a position where they fail to offer these advantages and they lose out to a competitor. One European UMTS mobile operator has been sufficiently worried by the impact of VoIP that it has threatened to block Skype calling to its subscribers.[10]

These three broad business opportunities have come from a number of key changes in the underlying business model for voice:

The impact of the features of IP networks

With traditional telephony, "intelligence" in the network is located centrally (in the functionalities of the switch) and usually controlled by one organisation. In its historic form, largely "dumb" devices (telephones) were attached to the network and these had a limited set of functions. The traditional telephone network's root and branch structure means that traffic flows to and from exchanges in ways that reinforce this pattern. For example, traffic for international destinations tends to go via a single international gateway. Telecoms carriers maintain bilateral relationships with other carriers and exchange revenue (to a much more limited extent than previously) through the Accounting Rate System.

By contrast, the IP network is one where no single entity has control, other than over the most basic transport to other networks. The service-providing "intelligence" is deliberately designed out of the network architecture. Indeed, put simply the network is "dumb" and intelligence is at the edge of the network. For example, a computer accessing the network has a far more complex range of service functionality in its application programmes which is not solely related to its size[11].

Traffic on the network is routed via the easiest route and therefore not always via central points. For example, international traffic can as easily flow from an ISP, a cyber-café or a telephone company: each has only to open a network connection and have the required capacity available. In this way, VoIP services do not necessarily need to go through an international gateway. The network design, where an important feature was a decentralised network without a central focus or control point, originated from United States military demands for redundancy and that the network withstand nuclear attack. Also, stemming from its university origins, it was designed to be open to users through publicly available standards, making it easy to access.

Due to their open nature, IP networks pose particular security challenges. The PTSN (and also a mobile network) is a closed network with controlled security and privacy. IP based VoIP is open architecture where vulnerabilities, threats and risks for communication security exist in various network elements. Special measures are required for ensuring communications security (see 5.2 and 5.3 below)

IP networks have introduced novel ways to do business. Broadly speaking, the telecoms sector charges each side of an international call, the cost of a full circuit. By contrast, ISPs bear the full cost of the circuit but have a well-developed set of industry practices known as 'peering' arrangements that allow ISPs to swap traffic at no cost. These practices will undoubtedly have an impact on existing interconnection models and this issue is discussed further in 4.7 below.

The separation of retail and wholesale

Historically, a vertically-integrated organization like the telco incumbent carried traffic and offered services, usually from a monopoly position. In a more liberalised market, the same telco incumbent sells international transmission to both external ISP customers and to its own ISP, leading to inevitable accusations of conflicts of interest. For VoIP service providers, the terms under which there is access to broadband therefore becomes a key question.

With liberalisation and more entrants in the market, there has been an emerging separation of retail (services) and wholesale (infrastructure) functions. Alternative infrastructure providers like utility companies have begun to wholesale bandwidth capacity and operators like ISPs, VoIP service providers and mobile virtual network operators (MVNOs) have begun to retail services to end users. The nature of IP networks has enabled this process and indeed encouraged changes in thinking about these two functions.

As a result, many telcos have separated out their wholesale and retail functions in order to better understand the underlying cost structure of different parts of the business. In some instances, this was prompted by regulators seeking to clarify terms of access to either the local loop or the network itself or by the companies themselves wanting answers to questions about costs of delivery.

Charging structures reflecting changes in geography, distance and services

Due to the broad similarity in wholesale rates between the more competitive markets in the world, several VoIP service operators offer the same or broadly similar rates between these countries. For example, Skype sells “Skype Out” minutes to enable its subscribers to call PSTN phones and at the time of publication, for less than two cents a minute, it was possible to call: Australia, Chile, Europe and North America.

Most telco transactions are based on knowing where a call originates and terminates. This is not however, the basis of many VoIP services. Charges per minute are based on where the call terminates. And charges in those countries with less competition reflect the higher international charges. However in a tacit acknowledgement of the impact of competition, even these countries can be called at cheaper rates than are offered directly by their incumbent telcos.

As we discuss in greater detail below (see 4.3), numbering once used be an indicator of geographic location but with VoIP, this is no longer the case and many VoIP service providers will offer users “virtual” numbers. For example, a user may live in London where her dialling code is 207. Her mother may live in Florida and has a 561 dialling code. The VoIP service provider can give the user a 561 dialling code that rings to her 207 line. In this way the user makes a “local” call to her mother. Argentina’s PVTEL offers its customers the choice of a Buenos Aires or Miami dialling code.

As fixed line and mobile phones (rather than SIP or soft phones) are still the dominant form of telephony, a hybrid model is emerging where operators offer consumers, part minutes, part bandwidth. The telco or ISP wanting to sell broadband connections will seek to offer an attractive combination of broadband and an adaptor or VoIP-enabled phone; free calling to their other subscribers as a sales incentive; and cheaper domestic and international calls. Again Argentina’s PVTEL allows users to make and receive calls using their broadband connection and an adaptor.

2 The Pace of VoIP Market Development

All current market indications show that IP networks and services will replace PSTN networks and services and influence the mobile business as well. Moreover, the introduction of IP networks will affect countries globally, but the timescale for its introduction will vary widely.

A number of major international carriers have committed themselves to making the transition to VoIP including, British Telecom (100% by 2009) MCI (100% of all traffic by the end of 2005); AT&T (100% by the end 2010); and Telecom Italia (80% of all traffic went by VoIP by the end of 2003).

In Europe, the number of market players offering VoIP has increased with astonishing speed during late 2004 and early 2005. According to rough estimates in March 2005, there were over ten VoIP service providers in most Western European countries and in some the number is in excess of 40. Yet, this growth is taking place across the globe. For example there are currently 11 companies in Pakistan using VoIP and more than 80 licensed in Malaysia[12]. Since 1 February 2005, all value added network service providers in South Africa are legally allowed to carry voice on their networks. While there are no specifically licensed VoIP providers, a number of companies are already offering various VoIP solutions.

In less liberalised markets, the impact of VoIP wholesale carriers gives some indication of how the market is changing. In 2004 between a fifth to a quarter of all historic operators in Africa were using VoIP to carry part of their international traffic. As these agreements are politically sensitive, establishing exact numbers is difficult. Telkom Kenya is about to offer a VoIP-based international service. Five African carriers – the Second National Operator (South Africa), BTC (Botswana), Mundo Startel (Angola), Telecom Namibia and UTL (Uganda) – have announced that they will introduce IP-based networks. Mexican incumbent Telmex has already implemented IP for the majority of its core network and various Mexican carriers (Alestra, Avantel, Axtel and Protel) have been conducting initial trials, whilst waiting for changes in legislation, and Marcatel is already offering long-distance services. Oman's incumbent Omantel, has committed itself to creating an end-to-end IP communications services network.

The transition to VoIP is so rapid and far-reaching that it is hard to make definitive statements about its progress. In some countries, legalised VoIP operators are already offering significant cost and service choices for both national and international calls. In others, the process of liberalisation has not yet begun and the only 'choice' for consumers are grey market operators. Irrespective of national regulation, there has been a very rapid growth in VoIP services over the Internet. Providers like Delta Three, Skype and Vonage have increased their subscriber base rapidly over the last three years globally.

Although there is no market data on the progress of this transition, it is useful to differentiate between the different types of VoIP services transitions that are occurring. At the wholesale level, there is a well-developed market for the carriage of international traffic over IP networks. Calls originate from a PSTN phone and are converted to data and then converted back to the PSTN format if required at the call's destination. National calls may even be carried over an IP backbone with the same conversion happening at either end of the call. Such calls may happen in parallel to existing PSTN networks.

At a local level, VoIP service provision is a much more substantial undertaking. Few users have IP-enabled phones or soft-phones[13] on their PCs or mobile phones. Also, the implementation of IP-enabled PABXs that can handle both TDM[14] and IP traffic in corporate markets varies enormously from sector to sector and country to country. Investment both at a personal level (by the individual user) and by the company (at a corporate level) will take time and as with the introduction of digital television, will be driven by an unpredictable mix of drivers including the speed of telco implementation, individual and company choice and government and regulatory policy. As with all technological transitions, the cost of the equipment needed – particularly at a local level – will only begin to come down once there is a sufficient volume of buyers.

The question posed by these developments is whether the transition to VoIP requires a revolution in regulatory thinking or whether it is more prudently handled in an evolutionary way? The best way

to approach this question is to differentiate between the short-term changes that are largely evolutionary and the long-term changes are more far-reaching. The transition from short-term to long-term changes is summarised in the box below. From the summary, regulators will be able to look at the different elements of change occurring and locate their market in the transition process. But the changes described in the long-term indicate that VoIP represents a major disruptive force for all telecom service providers and there will be a need for radical changes in all regulatory models when VoIP becomes the primary means of transmission for calls.

One clear certainty is that with the advent of next generation networks and the rapid rise of new technologies regulators will need new knowledge and expertise. The experience of almost all regulatory personnel is based upon knowledge of circuit switched technology and the services it offers. In the future, regulators will need to understand the new IP layered networks, the service concepts based upon them and the influence these will have on the future shape of the market. And because IP networks and VoIP services change rapidly, regulators are under greater pressure to make swift decisions and decide on a course of action.

Box 3: VoIP Transition

Short to medium-term evolution (evolution from PSTN to IP networks)

Technical concepts

- PSTN phone services and VoIP services exist in parallel.
- PSTN – IP network gateways are needed in most cases.
- E.164 numbers are (mainly) used, additionally ENUM use of E.164 numbers is increasing.
- Terminals: Adapter + regular phone, IP-phone or a soft phone.

Transition period for the market

- New type of competition with possible advantages of cost structures and with new innovative services (in particular nomadic use of IP/Internet telephony) and possibly lower level charging models.
- Voice traffic is shifting to IP based traffic and revenues from traditional phone services are decreasing.

Regulatory model

- Changes are required to the current regulatory regimes, need to take into account long-term influences.
- Should balance basic main objectives:
  - to enable the development of new innovative services.
  - to ensure acceptable social and consumer protection.

Long-term change (towards all IP)

Technical concepts

- IP/NGN networks and VoIP services are prevalent.
- Subscribers and services are addressed mainly by different types of Internet addresses;
- however, E.164 numbers are likely to prevail at least in the global context.
- New terminals e.g. combined GSM/UMTS/WLAN phones supporting IP/Internet telephony at home and other WLAN coverage areas.
- VoIP is normally one service inside a large service set.

Market and competition structure is changing:

- Integrated, innovative and personalized services.
- Nomadic use is important, increasing the amount of cross border services.
- Cost and revenue model of service providers has changed radically.
- The separation of the transport network and the services delivered on top of that network.

Regulatory model:

- New legal framework/regulatory model is needed.

3 Regulatory Responses to VoIP – Grappling with Change

Before looking at the detailed issues that VoIP raises for regulators, it is worth looking at the overall policy and regulatory responses of different countries. As regulatory responses are extremely varied, this section groups countries under a series of headings, corresponding to their approach to VoIP as part of their broader liberalisation process, or lack thereof.

It is these countries, both developed and developing, that have started to accumulate thinking, experience and precedent in this area. The outlines of regulatory approaches below concentrate on what might be described as the core philosophy of the regulators involved. Yet even in these countries, VoIP is a relatively recent development and there is not often a consensus about how it should be regulated. Some countries have adopted an incremental, evolutionary approach to VoIP regulatory issues and sought to make modest adjustments to their regulatory frameworks that allow them to grapple with the scale of changes they are facing. For others, VoIP (particularly the impact of the international price arbitrage business) represents a considerable threat to the established order and remains illegal.

In China for example, the deployment of IP technology has been driven by the basic services operators (China Unicom, China Telecom and China TieTong). There is currently no specific VoIP regulation, and VoIP has not been classified as either a value-added network service, or as a basic service. At the present time, basic telecommunications licensees are allowed to offer VoIP services and use IP technology in their core networks. The government is considering whether to ban the use of VoIP services provided by those other than licensed operators.[15] Currently, ISPs can only offer PC-to-PC VoIP services.

3.1 A Liberalised Policy Approach to VoIP

Various countries have legalised VoIP services at different levels. For example, all forms of VoIP service are legal in Canada, the European Union, India and Korea. The following details some specific examples:

Europe: The European Regulators Group (representing regulators from 27 European countries) has agreed a common statement on the regulatory approach to VoIP in their countries. According to the Group, VoIP should be used to enable (for the benefit of consumers) the greatest possible level of innovation and competitive entry in the market, whilst ensuring that consumers are adequately protected. Application and interpretation of rights and obligations in relation to VoIP should be in accordance with the European regulatory framework including the policy goals and regulatory principles existing today. Consumers and service providers should be provided with adequate information and be empowered to make informed choices about services and service provision.

United States: The 1996 Telecommunication Act separates telecommunication services and information services. The FCC has formalised the policy of not imposing traditional telecommunications rules on new Internet applications (information services). Currently the FCC is running proceedings to examine issues for "IP enabled services", including VoIP. These proceedings are examining various social issues (e.g. Universal Service) and the classification of services for regulatory purposes.[16]

Japan: VoIP is permitted and is subject to minimal regulation. The legal framework distinguishes three types of VoIP services based on the quality of the service. Providers that do not need numbers for their operation (e.g. PC-to-PC communications) do not have to comply with QoS requirements. If the provider can ensure a minimum QoS (in terms of end-to-end voice quality and end-to-end voice delay), the authority can assign it 050-prefix numbers. Only if the quality is as good as traditional telephony, providers can use the same numbers as the PSTN. Tariffs and access charges for VoIP services are not regulated. Only if the VoIP provider is a facility-based operator is

interconnection required. VoIP providers have to pay access charges to the PSTN operators when calls are terminated on their networks. It is also worth noting that South Korea adopted a broadly similar approach to VoIP in September 2004.

The allocation of 050-prefix numbers started in September 2002. 050-prefix numbers enable subscribers to receive calls from the PSTN, and they allow the provision of location-free services. In 2003, common PSTN numbers were allocated to VoIP services that offer a quality equivalent to that of the traditional voice services. In addition, emergency calls and direct access must be available from these lines, and numbers must observe location correspondence.

Canada: Following a public consultation process, the Canadian Radio-television and Telecommunications Commission (CRTC), published a decision in May 2005 that it would only regulate VoIP service when it is provided and used as a local telephone service[17]. The CRTC reached its decision based on service neutrality, namely that subscribers use VoIP primarily as a local service and that providers offering VoIP do so with the same core attributes as local exchange services[18].

In subjecting local VoIP services to the same regulatory framework applicable to local competition[19], the CRTC's decision provides for the registration of VoIP resellers; access to numbers and local number portability; directory listings; equal access to interexchange carriers; winback rules; comprehensive assessment by VoIP operators of access for the disabled; message relay service; privacy safeguards; tariff filing requirements; contribution to the national service fund; regulation of non-dominant carriers; the development of IP interconnection interface guidelines and the regulation of VoIP in areas where local competition is not permitted (areas served by small ILECs and the far north of Canada).

In line with its approach to retail Internet services, the CRTC will not regulate computer to computer (peer to peer) VoIP services which reside solely on the Internet.

Tariffs are therefore regulated and incumbent local exchange carriers with market power cannot price their local VoIP services below cost in order to facilitate sustainable competition in local telephone markets- one of the few remaining telecoms markets in Canada that is still regulated.

Singapore: In June 2005, Singapore announced the introduction of a new policy framework for Internet Protocol (IP) Telephony to address the growing trend of consumers increasingly using the Internet and other Internet Protocol (IP)-based networks to make local and international voice calls, together with, or as alternatives to traditional fixed-line telephony. In Singapore, IP Telephony is a form of Voice over IP (VoIP) service, whereby a user's voice during an IP telephony call is digitized, carried over public Internet or private IP networks in IP data packets, then de-digitized back into 'voice' at its destination. With IP Telephony, a user can potentially use any broadband Internet access connection to make and receive local or international voice, data and video calls with a phone number.

The InfoComm Development Authority of Singapore (IDA) will issue licences and phone numbers for the provision of IP telephony services to facilitate the entry of companies interested in offering IP Telephony services in Singapore.

Under the new IP telephony framework, facilities-based operators (FBOs) and services-based operators (SBOs) can be licensed. For the provision of IP Telephony services, FBOs can use 8-digit level "6" numbers. In addition, IDA will issue a new 8-digit number level "3" to both FBOs and SBOs. To encourage adoption in this emerging technology, IDA's framework includes minimal regulatory obligations to address certain public and regulatory concerns. For instance, operators providing IP Telephony services using level '3' numbers, are not required to provide number portability, emergency service connection, directory enquiry and printed directory services, or conform to QoS levels set by IDA. However, operators must provide clear information to their

subscribers, for example, whether their service allows access to emergency services and whether it meets the minimum QoS levels set by IDA for local fixed-line services. Also, FBOs are only to assign level '6' numbers to users with valid Singapore addresses. This ensures that Singapore's national numbering plan resources continue to benefit users in Singapore.

IDA's view is that a proper framework that provides phone numbers for VoIP brings convenience to consumers. Singapore's regulator expects that the growth in IP Telephony will bring about reduced costs in providing telephone services, and in turn, translate to reduced prices and more service choices for businesses and consumers.

South Africa: As of 1 February 2005, any holder of a value-added network service, or enhanced service licence is allowed to carry voice on their networks. Until this date, all VANS providers were prohibited by legislation from allowing their networks to carry voice. This restriction formed the basis of various regulatory complaints by Telkom, the incumbent operator during its period of exclusivity. In recognition of the removal of the restriction on voice, the terms and conditions for VANS licensees were revised and now include the right of a VANS provider to apply for numbering resources, spectrum and interconnection with any operator. Other restrictions lifted on 1 February 2005, suggest that VANS may also self-provide telecommunications facilities and no longer have to obtain them solely from Telkom and the Second Network Operator, when licensed. However, a media statement by the Minister of Communications in late January 2005, has noted that VANS are still required to obtain facilities from any licensed telecoms operator, including mobile operators, but cannot self-provide such facilities. While some VANS providers and market analysts disagree, to date, the media statement has not been challenged.

Various Internet Service Providers and VANS operators have begun to offer VoIP services on a retail basis and have also begun to advertise aggressively. Internet Solutions, a subsidiary of Dimension Data is offering a "Voice over Internet Solutions (VoIS) over their MPLS[20]network billed as a full portfolio of converged voice and data services, including calling between branches of the same company; calls to customers of other ISPs; national long distance calls; call to cellular phones; and International calling. There is no regulation of rates and tariffs for VoIP services directly, but the regulator is considering quality of service issues and access to emergency services on VoIP networks. It is worth noting that all the Second Network Operator's traffic will be IP based by virtue of its deployment of a Next Generation Network.

Philippines: In August 2005, the National Telecommunications Commission issued new regulations, treating VoIP as a value-added service, for which only registration, not authorization, is required. Commercial VoIP providers with no network of their own are required to enter into interconnection agreements with network operators. Although such interconnection agreements are to be negotiated between the parties, the NTC will intervene where necessary to ensure interconnection is provided under fair terms. Local exchange and inter-exchange operators and overseas carriers who have previously received authorization, are not required to register with the NTC when providing VoIP services[21].

3.2 An Incremental Approach to VoIP

India has offered Internet telephony legally since April 2002. Internet telephony covers the "following types of connections using the public Internet: (i) PC to PC (both within the country as well as abroad), (ii) PC to Phone (PC in India, Phone abroad), and (iii) IP based H.323/SIP Terminals in India to similar Terminals both in India and abroad, employing IP addressing scheme of the Internet Assigned Numbers Authority (IANA)"

Internet Telephony through PCs or IP based terminals should be available also through India's Public Tele-Info Centers & Internet Kiosks. Facility based operators can provide Internet telephony and use VoIP technology to manage their networks. Furthermore, the regulator TRAI, has issued

regulations on quality for VoIP international long distance calls, differentiating between two quality levels: toll quality and below toll quality. Tariffs of VoIP services offered by ISPs are not regulated.

In *Bolivia*, VoIP is considered to be a telephony service as the Telecommunications Regulations define a telephony service as every real-time voice communication, irrespective of how it is transmitted. In January 2005, a Bolivian ISP (Unete) announced that it was investing US$5 million to launch a national and international long distance voice service.

In *Ecuador*, telephony providers are either required to have a licence for local and long-distance public telephony or to establish resale agreements with licensed operators. In February 2005, the regulator CONATEL published regulations covering cyber-cafes and telecentres. The regulations limit the number of terminals assigned for VoIP services: up to 25 per cent of the total, or one if the cyber-café accommodates only two or three terminals.

In *Honduras*, the regulator has allowed VoIP services provided that operators contract with the monopoly incumbent Hondutel. The organisations doing this are described as "sub-operators" and can have their own networks and use them to sell other licensed services. However, the international traffic must be conveyed through Hondutel, the incumbent operator until 24 December 2005.

3.3 VoIP out to Consultation

Chile: In July 2004 the Chilean regulator SUBTEL launched a public consultation on VoIP that stressed the need to increase the development of new technologies that will allow more and better services for consumers and promote network and infrastructure deployment. According to the consultation document, if voice services are offered through the existing PSTN network, the operator is required to comply with the regulations that apply to PSTN services. Within the framework of technological neutrality and non-discrimination, service providers offering VoIP calling through direct access are subject to the same conditions as for PSTN services. But if services are provided over the Internet, they are not subject to the same conditions. The regulator is suggesting a broadband voice licence (Servicio Público de telecommunicaciones de voz sobre banda ancha – SPTVBA) that allows the provision of voice using the IP protocol. Some operators responding to the consultation document have indicated that the classification is too rigid and potentially problematic in an increasingly converged environment. The Chilean incumbent argued that the introduction of IP telephony will only positively affect a small group of the population but will take income from it, thus reducing the financing of current networks, discouraging investment and therefore harming the access to services for the less well off.

Colombia: In June 2004, the Ministry of Communications issued a consultation document on VoIP services. The consultation has been completed but no action had been taken by August 2005. At present operators require a basic PSTN licence (Telefonia Pública Básica Conmutada – TPBC). The use of a PC to make calls over the Internet is not restricted. The Ministry of Communications is seeking to classify VoIP in the existing telecommunications service categories of public telephony but a number of consultees have suggested that VoIP needs a new service category because it will not fit the old ones. The consultation addressed the following issues: emergency calling; numbering; network availability in event of disaster; services provided from other countries; market definition; the treatment of access to free services and lawful interception.

Some of the stakeholders that have responded to the consultation see the introduction of VoIP services as market skimming and argue that it will be to the detriment of contributions to the Universal Service Fund. The incumbent has argued that VoIP service providers should bear the same regulatory burdens as the existing TPBC operators.

Jordan: In May 2005, the Jordanian regulator issued a consultation document on the delivery of voice services using Internet protocol. This raised a number of issues on which it sought comment including: distinctions between different types of voice services, particularly when they are seen as identical by the consumer; the provision of information to equipment purchasers and potential users; the role of network and service providers in relation to network integrity; geographic and non-geographic numbering; emergency service requirements; interconnection; the requirement for a class licence for VoIP service providers, even if the operator is off-shore, and quality of service issues.

Hong Kong, China: In June 2005, Hong Kong's regulator (OFTA) published its statement on the "Regulation of Internet Protocol (IP) Telephony"[22]. This statement outlines the position of OFTA after having evaluated the comments on a consultation document released in October 2004.

According to the statement, service-based providers should be allowed to compete with facility-based operators (Fixed Telecommunications Network Service (FTNS)/Fixed Carrier (FC) licensees). Moreover, the principle of technological neutrality has to be upheld. Therefore, OFTA decided to introduce two different licenses for VoIP providers: Class 1 services – IP telephony service providers who market their local voice telephony services to customers with service attributes similar to those of conventional telephone services; and Class 2 services - those that do not have the same attributes as conventional telephony. Class 2 services are subject to minimum regulation, although services providers are however, required to inform customers about the limitations of their services. Class 1 services must fulfil FTNS/FC licensing conditions.

In recognizing the multiple modes of IP service provision in the scope of Hong Kong's regulations, OFTA states that "the provision of IP Telephone services by overseas websites will be outside the jurisdiction of the TA (…) unless the provision involving the establishment or maintenance of means of telecommunications, or offering of telecommunications services, takes place within the territory of Hong Kong."

Algeria; Israel; Taiwan, China; and Trinidad and Tobago have all gone out to consultation on VoIP, while Kenya has issued guidelines legalising various categories of VoIP, following public consultation.

3.4 Where VoIP is illegal

There are a considerable number of countries where VoIP remains illegal[23]. Governments and regulators in these countries adopt a number of different strategies to try and eliminate grey market operators. Some countries seek to ban websites that allow users to make international calls. Others periodically confiscate or seize the equipment of grey market operators. Some jurisdictions back up these sanctions with severe jail sentences and in one instance, the owners of several ISPs were jailed for a short period.

Before the ending of the monopoly in Panama in 2003, the Public Services Regulator mandated all ISPs to block IP ports identified with VoIP services. In addition, sometimes telcos filter (stop) VoIP service providers on their own. For example, an ISP in Mexico filters VoIP service providers including Skype and operators in Kenya have also filtered VoIP traffic. Unfortunately such filtering also affects the business of those using the Internet for video conference calls and instant messaging.

In almost all those countries where estimates of the grey market are given by the incumbent operator, the amount of "lost" traffic" is on a scale that would indicate that few of these strategies are successful at completely closing down grey market operators and preventing access by users to some form of VoIP service.

3.5 Classifying VoIP Services for Regulation

As can be seen from examining the current state of VoIP regulation, a key question for regulators is to examine how, if at all, these kinds of services are or should be classified. VoIP technology is being used to provide a variety of market offerings. Any rigid classification is unlikely to be stable given the pace of technological and market-driven change. Any classification used also depends on national policies and legislation. However, the VoIP offerings in the box below roughly divide into three categories, depending on which regulatory regime they fall under:

Box 4: Classification of VoIP Services

Category I

VoIP offerings that do not really require regulation because there is no provision of service. This would cover VoIP communication that is self-provided, such as a software programme downloaded to run on a personal computer (Examples include GIZMO, Yahoo instant messenger and Skype).

Category II

VoIP offerings which are outside the scope of regulation in that there are normally no specific public obligations:

- Corporate private networks, where VoIP is used to provide communications inside companies
- IP technologies used within a public operator's core network, but which do not impinge on the retail services offered to the end-user.

Category III

This category covers publicly available services provided to the end-user using VoIP technology in which the service consists of signals in an electronic communications network. These services do fall into a category of legitimate regulatory concern. However, there are many different kinds of publicly available VoIP service offerings, and the regulatory treatment depends on the nature of the service being offered and relevant national legislation.

Publicly available VoIP services belong in this category, where there is access to and/or from the PSTN (i.e. use of a PSTN-gateway. The services can either be offered by a broadband access provider or by an independent ISP.

This type of service can be divided into at least into three types:

- VoIP services, where there is access to and from PSTN (i.e. use of a PSTN-gateway).
- VoIP services, where there is access to the PSTN, (i.e. use of a PSTN-gateway).
- VoIP services, where there is access from the PSTN, (i.e. use of a PSTN-gateway).

A large number of national regulatory agencies have carried out consultations on VoIP issues but have not reached any final decisions. Many are trying to adapt existing service classifications under existing telecommunications legislation for VoIP services. There appears to be a consensus that VoIP services residing solely on the Internet (PC-to-PC calling) should not be regulated. Global discussion of these issues focuses on approaches to VoIP services that are similar to those described in category III above. The basic regulatory question that hovers over the whole discussion is whether or not VoIP can be regarded as a substitute for PSTN-telephony?

Below are various examples of how different countries have treated these issues:

European Union: the regulatory framework addresses the question of how communication services should be regulated in two ways. The Universal Service Directive defines service classification for purpose of consumer and social protection. For market and competition control purposes the need for regulation is to be assessed through analysing if VoIP services have "Significant Market Power" (dominance) in one or more of the “Relevant Markets” (See section 4.6 below for full explanation).

The services covered by the Universal Service Directive are divided into two categories:

- **Electronic Communication Service (ECS):** If a service is provided for remuneration and consists wholly or mainly in the conveyance of signals on Electronic Communications Networks. ECS is treated with lighter regulation.
- **Publicly Available Telephone Service (PATS)**: If a service includes all the following functions: available to the public; for originating and receiving national and international calls; access to emergency services, through a number or numbers in a national or international telephone numbering plan. PATS attracts more regulation and obligations. The main obligation compared with ECS is the provision of emergency calls.

The EU regulatory framework seeks to be technology-neutral, though some of its rules are built upon traditional telephony technologies. Debate on the classification of VoIP services is still ongoing but as a result, different European countries seem to interpret the regulatory framework for VoIP services in different ways. These vary from a flexible reading of the rules to a strict interpretation of the framework's wording. The following examples reflect these differences:

- There is a flexible classification where providers of communications services or of publicly available telephone services can decide in which regulatory category they want to be classified, rather than a decision being made by the regulator (for example, the UK);
- There is an approach where distinguishing different types of services strictly follows the wording of the PATS definition. PATS obligations are imposed on a voice telephony service only if all four parts of the PATS definition are fulfilled.
- The compromise approach is to apply criteria according to which a service is qualified as PATS if it is available to the public for originating and/or receiving national and/or international calls through an E.164 number. Access to emergency services is then not regarded as being part of the PATS definition and its regulation can be decided separately.

For market control purposes, each national regulator assesses how different VoIP services fit into the EU's Relevant Markets categories. At present, there is very limited practical experience and precedents set from that experience. The EU is currently discussing market analyses that include VoIP services.

Canada: the classification of VoIP services has come out of a discussion of emergency call services. From this perspective, there are currently three different types of VoIP service offered to customers: fixed, nomadic and foreign exchange. Users of **fixed** VoIP service can only place a telephone call from the location where their service is being provided. Users of **nomadic** VoIP service can make calls from any location where users can get access to Internet service. **Foreign exchange** VoIP service allows users in one exchange to receive telephone calls dialed as local calls in another exchange that they have selected (e.g. a customer located in Ottawa with a Halifax local telephone number). These different types of VoIP services have different requirements in respect of emergency calls (see section 4.4).

United States: in the United States there has been substantial debate about how VoIP services should be seen from the regulatory point of view: are they so called 'information services' with no regulation or regulated telecommunication services or are they simply a substitute for traditional telephony services? From the FCC perspective, services that are only provided over the Internet (like MSN Messenger and Skype) are classified as information services. If VoIP services have a gateway to the PSTN, then they should not be regulated except in relation to emergency calls and lawful interception.

4 Regulatory Responses to VoIP

4.1 Balancing different policy needs

The transition to IP networks and VoIP services tends to produce conflicting policy approaches in different countries. The following defines some of these conflicts which tend to emanate from opposing policy goals and sector objectives.

The main challenge is to balance short and long-term policy and regulatory approaches. In some countries VoIP is seen as a major threat to established operators because it undercuts their domestic and international long distance rates and radically reduces their revenues. However, strict regulation in the short-term to protect these revenues (forbidding VoIP usage, strict licensing conditions or heavy obligations for new services/market entrants) may harm the development of the sector in the longer term. Often, this drive to protect the national incumbent may stem from a particular social policy, such as extending universal service. However, regulators need to weigh the impact of short and long-term policy and regulatory approaches not only from the established operator's point of view but from the perspective of end users and potential new market entrants as well. The impact of lower prices brought about by VoIP may benefit users directly and help to increase the number of users and the volume of usage. In these circumstances, it is important that policy decisions are based on trend data and that the regulator analyses different market scenarios.

The regulatory model for VoIP should create a justifiable balance between partly conflicting objectives: regulation is needed but the shape of new markets is far from clear. Therefore regulation may struggle to keep up with new developments. It is a commonly expressed truth among regulators that, "one can establish a regulation in a year but it takes ten years to remove it." Regulation needs to guarantee regulatory certainty for investors but the period over which a rate of return is realised is getting increasingly shorter. Therefore, the tension that emerges is whether to protect those with longer historic investments or encourage newer, cheaper technologies that benefit users. In an ideal world, the regulator should be in a position to protect past operators' investments but as newer technologies become more widespread as part of IP networks, this may become harder to achieve in reality.

New policy and regulation needs to promote competition through innovative, cheaper services in the interest of users, however it also needs to ensure consumer protection and take social concerns into account, including through universal access and service objectives. Regulators may find themselves torn between the need to react quickly to new concerns and stepping back to see the shape and dynamics of the emerging market.

A basic objective of regulation in promoting competition is to ensure a level playing field for similar services. One emerging challenge is how to interpret technological neutrality between services based on technologies with very different attributes. One example is the difficulty in comparing copper cable-based, local loop with a Wi-Fi-based local loop. The former is not designed to promote mobility, whilst the latter has a form of mobility as a primary functional attribute.

Many regulators are guided by the principle of limiting regulatory obligations so they are not so onerous as to discourage market entry or the creation of innovative new services. Thus regulators have adopted "light-touch" regulation particularly in respect of newer technologies so that suppliers are encouraged to find technical solutions. A number of developing country regulators have encouraged the use of free or low-cost spectrum and low or no licence fees for areas where there are little or no voice or data services.

A vital task for regulators and policy makers is to manage the transition to the new world of IP networks. These include:

- how long a PSTN network should be maintained;

- assessing how much time is needed to make changes to existing legislation or rulings to provide legal stability in a time of flux;
- how quickly competition policy should change or adjust to reflect an IP based network rather than a PSTN era;

The pace at which these issues are decided may not necessarily be determined by government or the regulator as the market changes are already underway in many different forms, both for legal operators and currently illegal or grey market service providers.

Moreover, there is no consensus on these issues amongst policy makers and regulators, either at a global or a national level. National approaches vary from fully liberalised policy and regulatory frameworks supporting VoIP services to countries where VoIP is illegal or prohibited. What follows is an examination of a number of these different responses. These are not grouped geographically but according to topic headings that identify key issues.

4.2 Examining the Best Regulatory Approach to Encourage Market Entry

Regulators will face different challenges depending on how advanced the liberalization process in their country is. Regulators in more liberalized countries will simply manage the range of issues that flow directly from the transition of services to an IP network. In countries where the historic operator still has exclusive rights, the task of the regulator is both more complex and challenging. These regulators have to manage two processes in parallel: the transition from a monopoly to liberalized markets and the transition from existing technology to the new IP based technology. So in addition to preparing revised legislation and new regulatory measures that deal with IP-based networks, the regulator will also have to prime the historic operator with exclusive rights to prepare itself for wider competition.

VoIP's innovative services and special characteristics create new types of challenges for regulating markets. In the past, regulators have been used to slower moving and more predictable national telecommunications markets: initially rules were set without reference to experience but were changed slowly, setting precedents for further future rule changes. In the future, regulators will face a rapidly changing market based on a new type of infrastructure. They will need to deal with a large number of new services entering the market that may never have existed before. The policy and regulatory framework may be influenced or changed by international market developments over which they have little or no control. It is therefore becoming increasingly difficult to lay out detailed conditions in advance about how regulation might function and how market entry will be governed.

As stated above, many countries have carried out or are in the process of carrying out national consultations on how VoIP regulation might best be approached. Therefore as with the overall approaches to VoIP regulation, there are widely differing strategies for addressing new market entry.

The approach of the European Union is to facilitate "easy" market entry by only requiring individual licenses for scarce resources like spectrum frequency. For other network or service developments, only a notification or registration is required. It also adopts a "technology-neutral" approach, leaving market players to decide for themselves what technology they use.

South Africa has enhanced the business case and created conditions for easier market entry in value-added (VANS) or enhanced services, but still retains control over the market structure for fixed, mobile and satellite services. Under the current Telecommunications Act, only VANS and Private Telecommunications Network service licenses may be issued on a non-exclusive basis. Fixed line service has been dominated by one incumbent, with a second entrant set to commence operations by 2006. Mobile voice and data services are supplied by three operators.

Until 1 February 2005, the fixed line incumbent, Telkom had a full monopoly on facilities provisioning, and the resale of spare capacity for VANS and PTNs was prohibited. Since then, VANS may obtain alternative facilities supply from other operators. There is some debate about whether the lifting of restrictions on facilities supply has given VANS the right to self-provide facilities or whether they must obtain them solely from other fixed and mobile licensed operators. The resale market has been opened along with the market for providing public pay telephone services.

These policy developments took place in the context of a markedly delayed entry of a second fixed line network operator. In effect, these determinations lifted a number of legislative restrictions in the law and were intended to facilitate growth and competition in the communications sector; create greater choice for operators and service providers in acquiring facilities and managing spare capacity on their networks; liberalize the public payphone market segment and enhance Internet connectivity in schools and tertiary educational institutions across South Africa by mandating a discounted fee for service and connectivity. New regulations for VANS give providers the right to access spectrum, apply for numbering allocations and interconnect with other operators. Numerous VoIP providers are emerging in the South African market as a result, although the regulator has not yet finalized a policy on numbering and spectrum access for VANS.

Other countries restrict entry to the market for new VoIP operators through the use of different approaches to licensing. In many countries, much depends on whether VoIP is defined as a voice or information data service. Where VoIP has not yet been categorized, the issue often leads to extended debate.

ANATEL, the Brazilian regulator, for example, has not defined VoIP as telecommunication service, a value-added-service or a technology. If VoIP is considered a data service, operators need a license for multimedia communication services. However, in order to initiate and terminate calls outside of a private network, operators need a license for public switched fixed telephony. The latter type of license requires certain goals on coverage and QoS, and the application process is more complex.

Some countries, like Colombia, Egypt and Nigeria are pragmatic about certain aspects of VoIP (like PC-to-PC telephony) which is regarded as personal use and would almost certainly be impossible to control. Others, such as Guinea have made legal the use of VoIP over Virtual Private Networks (VPN), something which again is hard to detect and therefore equally hard to control. However, only VPN VoIP could easily be described as a field for new service providers.

In Nigeria, the regulator has stated that VoIP is legal provided operators obtain the appropriate licences. Thus one satellite operator with an international licence is offering a VoIP service to its customers. Yet, other countries completely restrict any form of VoIP market entry and seek to control grey market operators through a variety of strategies.

4.3 Numbering for VoIP Services

Numbers can be used for several different purposes. They can be used to differentiate between services and inform users of tariff categories like premium call services. Numbers can also be used as a tool to control markets by setting restrictions on the use of certain numbers. Thus access to numbers and the use of them potentially becomes a barrier to market entry.

VoIP services can be routed to the user in a number of different ways: IP addresses; SIP addresses; H.323 addresses or E.164 numbers. Traditionally E.164 numbers have been needed to originate and receive voice calls but it may lose its dominant position in the future and become just one of many options.

E.164 numbering ranges are usually divided into several generic types indicating the services that may be offered using these numbers. Geographic numbers or some special number series are regarded as most relevant for VoIP services. Also mobile, personal and corporate numbers can be used to address VoIP subscribers. These are, however, seen as less attractive in many countries because users will associate them with high retail calling prices.

The current position on the availability of geographic numbers for VoIP services varies between countries. The main argument in favour of allocating geographic numbers to VoIP services is that they offer the best support for competition, especially when combined with number portability. The main arguments against this approach have been the need for nomadic use of VoIP and exhaustion of geographic numbering resources. There are three ways to allocate geographic numbers in order to support VoIP services:

- allowing nomadicity in a limited area;
- allowing nomadicity countrywide but requiring some relationship with the geographic area of the number, or
- removing any requirement for a relationship to a geographic location.

Regulators may also open new number ranges for nomadic VoIP services, whether or not existing number ranges are changed. Broadly speaking, there are three types of possible new number ranges: a general-purpose number range; a number range for nomadic services and a number range for ENUM-based or similar software based services. Creating new number ranges seems to have mainly been motivated by a number of factors including the need to avoid giving the impression that these are high tariff numbers like those for mobiles; the need to keep existing number ranges intact and a desire to give service providers the freedom to create their own service description.

In Europe for example, the number ranges open for VoIP use varies due to different numbering policies and the regulations related to them. The geographic number ranges are open for VoIP services in most countries. However, some countries list a number of requirements that have to be fulfilled by VoIP services.

Cost of Numbers: The cost of numbers (national numbering fees) can be a significant barrier to market entry in some countries. Geographical numbers are typically allocated in blocks (normally blocks of 1000 or 10,000) for a certain national geographical area. A country can have a large number of geographic areas. Where geographic numbers are sold with limited nomadicity, VoIP service providers need to get number blocks that cover the whole country. The costs of doing so can be high and act as a market entry barrier for small providers. In Europe, numbering market entry costs vary greatly.

Number Portability: This is a key enabler of competition because it allows users to retain their telephone number when they change service providers. While the implementation of number portability can also be an onerous cost to new entrants and existing market players, it is essential to facilitate a truly competitive arena in both mobile and fixed line markets. Generally, a reasonable implementation period can address some of the cost concerns associated with porting from one network to another.

Call routing: There are various ways to find the IP address when routing a call based on an E.164 number but at the moment ENUM (Electronic Number Mapping) seems to be most practical tool, although there are other software solutions, such as the peer to peer Distributed Universal Number Discovery (DUNDi) system.. ENUM is a protocol developed by the Internet Engineering Taskforce (IETF) that defines a DNS based architecture and protocol aimed at using a telephone number to look up a list of IP based service addresses (e-mail, IP phone address, URL, SMS, etc). The idea of ENUM is to use an E.164 number as the key to identify the available communication services to contact a person. For VoIP, it is used to route a VoIP call to an IP network based on the receiver's

E.164 number. There are different ENUM systems for public service and for operators' internal use. For regulators, the issue is to provide the necessary rulings for the use of ENUM or other solutions that cover as a minimum, non-discriminatory use and protection of privacy issues.

4.4 VoIP and Emergency Calling

The nomadic nature of VoIP services poses a problem for the provision of emergency calls as it creates uncertainties about location informationThe location information from a geographic number of the user calling is used for routing such calls to the nearest "Emergency Centre". With VoIP there may well be a complete separation between the provision of the voice service and the transport of the voice data. There is – at least currently - no way of conveying location information about the user calling an emergency service between ISPs and VoIP providers. However in the future, technical solutions are expected to come out of the current standardisation work that is being undertaken.[24] .

National and International Challenges: The problems of handling emergency calls from VoIP users can be divided into two categories: emergency calls phoned from within a country and cross border emergency calls. The first category is likely to be less problematic due to the likelihood of increased co-operation between service providers covered by national regulation in a single country.

Cross border VoIP emergency calls raise more difficult issues because an emergency call needs to be identified as such. Globally there are more than 60 national emergency call numbers (e.g. 911 in the US; 112 in Europe). For an emergency call to be routed to the right country and the correct emergency centre, intensive international agreement, cooperation and arrangements will be required.

Consumer Issues: From a consumer point of view, the best possible solution would be the possibility of an emergency call from any VoIP device as the very nature of emergencies is likely to preclude a caller from stopping to assess whether the device they are using supports calls to emergency centres. It needs to be recognised that a user making an emergency call is often under severe stress, and it is possible that he or she may attempt to make an emergency call via whatever method appears to be most accessible, even if this would not normally be a natural choice. While various solutions will be required to overcome any technical limitations to the provision of data so as to ensure the adequate routing of emergency calls, two likely scenarios emerge:

1) In the short to medium term, a VoIP service may be the only option for making an emergency call if it is implemented as a primary line residential service or operates across a corporate network. A VoIP service is less likely to be regarded as the only choice for making an emergency call if it is used in a home or office environment in which a PSTN-connected phone or a mobile phone is readily available. Additionally, some industry observers are predicting that VoIP services running over Wi-Fi or Wi-Max, may become a replacement for existing mobile services: in other words, mobile calls will become VoIP-enabled. A key question is what will happen with VoIP connections during electricity outages, especially where VoIP is the only option for making a call in an emergency situation.

2) A VoIP service will, in the short- to medium-term, be a natural choice for making an emergency call if it appears to be identical to a PSTN (or mobile) service, or is used in a similar way to a PSTN (or mobile) service. This would appear to rule out the likelihood of devices such as gaming consoles or applications such as MSN Messenger or Skype being used to make emergency calls.

   Various principles may be considered to address these problems:

- If VoIP terminals are likely to be used for making emergency calls, they should have the capacity to be able to do so;
- An emergency call from a VoIP terminal should reach an emergency centre in the country in which it the call originates;
- Where possible, an emergency call from a VoIP terminal should reach the specific emergency call centre that is responsible for receiving emergency calls for the area in which the caller is located;
- The VoIP call made to an emergency centre should carry Calling Line Identification (CLI) which can be used to call back the person reporting the emergency if the person is cut off or rings off before full information has been provided;
- Where possible, the number provided by CLI for an emergency call from a VoIP terminal should not be linked to location information that is incorrect or misleading.

The following examples of VoIP emergency calling suggest various approaches:

European Union: The EU's Universal Service Directive leaves room for technical feasibility when imposing obligations relating to the provision of location information. It says it must be "*handled in a manner best suited to the national organization of emergency systems and within the technological possibilities of the networks" and "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"*.

How the Directive is actually applied varies depending on the national organisation of its emergency systems and the capabilities of the networks involved. Similarly, related legal requirements - like providing caller location information, routing calls to an appropriate emergency centre and providing Calling Line Identification – varies a great deal between countries. Where VoIP services are regulated, some countries have set the same legal requirements for both VoIP and PSTN calls, whilst providing a temporary reprieve from these requirements to VoIP calls. Currently, it seems that nomadic VoIP service providers can only meet national legal requirements for emergency services in a few countries and there are still outstanding issues in the majority of countries. In Gabon, Pakistan and Romania however, VoIP operators have regulatory obligations to provide access to emergency services.

Canada: The Canadian Radio-television and Telecommunications Commission (CRTC) made a decision in April 2005 that requires VoIP service providers who provide fixed VoIP service (users of fixed VoIP service can only place a telephone call from the location where their service is being provided) to provide the same level of 911 emergency service that is provided by the incumbent telephone companies to their existing customers (either Enhanced 911 or Basic 911 service). Implementation was made mandatory 90 days after the decision was made[25].

The CRTC placed obligations on two other types of VoIP service providers: **Nomadic** VoIP services where users can make calls from anywhere they can get access to the Internet or **foreign exchange** VoIP services which allow users in one exchange to receive phone calls dialed as local calls in another exchange. So in the case of the latter it might refer to a user with a Halifax local number receiving calls in Ottawa. The Commission has imposed the obligation to provide an interim solution, the equivalent of a basic 911 service, and that providers in these categories do so within 90 days of the decision.

In addition to the above service requirements, the Commission also required all VoIP service providers to provide customers with notification, both before service commencement and during service provision, regarding any limitations associated with their emergency 911 service. The VoIP service providers must also secure the customer's express acknowledgement that they are aware of

these limitations, prior to providing this type of service. VoIP service providers must also notify customers of all limitations on emergency services before commencement of service to them.

Box 5: Existing Enhanced and Basic 911 Services

In Canada and the United States, the existing local telephone networks currently provide two types of 911 service: Enhanced 911 service and Basic 911 service. Enhanced 911 service automatically sends customer location information to an emergency centre where an operator dispatches a response service. Basic 911 service connects the caller to a central call centre which then connects the call to the correct emergency response centre, at which point the caller must identify his or her location in order for an emergency response service to be dispatched.

United States: In May 2005, the Federal Communications Commission (FCC) issued an Order requiring interconnected VoIP providers to provide Enhanced 911 Service. The Order places obligations on interconnected VoIP service providers that are similar to traditional telephone providers. For example, according to the FCC's interpretation, service provider Vonage falls into this category in that they enable customers to receive calls from and terminate calls to the PSTN. It does not place obligations on other IP-based service providers, such as those that provide instant messaging or Internet gaming services, because although these services may contain a voice component, customers of these services cannot receive calls from and place calls to the PSTN. The FCC has also stated its intention to adopt, in a future order, an advanced E911 solution that includes a method for determining the customer's location without the customer having to self-report this information.

Box 6: FCC Enhanced 911 Service Order (FCC 05-116[26])

- Interconnected VoIP providers must deliver all 911 calls to the customer's local emergency operator. This must be a standard, rather than an optional feature of the service.
- Interconnected VoIP providers must provide emergency operators with Calling Line Identification and location information for their customers (an Enhanced 911 service) where the emergency operator is capable of receiving it. Although the customer must provide the location information, the VoIP provider must provide the customer a means of updating this information, whether he or she is at home or away from home.
- Interconnected VoIP providers must inform their customers, both new and existing, of the Enhanced 911 capabilities and limitations of their service.
- The incumbent LECs are required to provide access to their Enhanced 911 networks to any requesting telecommunications carrier. They must continue to provide access to trunks, selective routers, and E911 databases to competing carriers. The Commission will closely monitor this obligation. Interconnected VoIP providers must comply with these requirements, and submit to the Commission a letter detailing such compliance, no later than 120 days after the effective date of the Order.

4.5 VoIP and Universal Service/Access

In developing countries, the term 'universal service' is often used to describe the widespread provision of identified services at affordable rates to users in every part of a country. The concept

has two main elements: affordability and accessibility. In developing countries, the term ‘universal access’ is subsumed by the broader concept of universal service and as a medium term policy option, refers to public access to identified services, which may be defined in terms of distance or time to reach access or the size of communities with access. Funding has traditionally been raised to achieve universal access and service goals through a percentage or specified amount of revenues from traditional telephony providers. With more users switching to VoIP, there is fear that a loss in telecommunications revenues could lead to a subsequent loss in funding for universal service/access. This raises the inevitable question as to whether VoIP providers should be included in universal service/access arrangements and contribute to a national universal service/access fund?

There are two regulatory and policy issues at stake here: the financial contribution VoIP service providers might make to universal service/access funding and the use of VoIP as a tool to deliver cheaper calling to a wider number of consumers. Universal service/access contributions are in effect a form of taxation. Providers are usually charged a percentage of their turnover, paid to the regulator, and in some cases paid over to the national fiscal authority. The regulator may pass the money on to an agency or agencies charged with the task of meeting universal service/access objectives. The difficulty posed by VoIP service providers in this context--and particularly where VoIP is not a formally licensed service--is that they do not usually make contributions of this kind to the regulator and that as VoIP calling increases, the amount of turnover subject to such funding will reduce.

The FCC has issued a public notice that states that the "dramatic decrease in traditional long-distance wireline traffic and the increase in the use of VoIP and the deployment of IP networks has changed the dynamics of USF so irrevocably that immediate attention to the issue is required." If approved, this would mean new taxes on VoIP customers that do not currently pay into the universal service fund. Companies that already pay into the fund indirectly may have to raise their rates because their contribution would likely have to increase. The FCC has suggested that any new regulations should require anyone with a phone number to pay into the fund at the same rate, regardless of whether their phone service comes from a cable provider, VoIP provider, or a wireless or wireline provider. Some VoIP customers already see charges linked to the USF on their bills, because many providers have to pay fees to the telephone companies whose wires they use. Vonage, for instance, imposes what it calls a "regulatory recovery fee" of $1.50 on each phone number it distributes[27].

However, if all calls (or just international calls) are subject to tax, irrespective of what technology they were carried by, government can collect funds to be used to meet its universal service/access objectives. Clearly there is concern that as the cost of calling is reduced, the amount of traffic revenue will also decrease, reducing the amount that can be raised by taxes. However, this concern may well be balanced by greater levels of uptake as call costs become cheaper, thus reducing the scale of any overall universal service/access burden. And there is also a wider market entry point to consider: if the burden of this universal service/access “tax” is too high, it may put off the very innovators who might be able to deliver low-cost, calling services for the less well-off.

As IP delivery of services is arguably cheaper than traditional PSTN services, VoIP can also be seen as a way of encouraging precisely this kind of low-cost innovation. Using the same bandwidth, a VoIP network can carry many times the number of voice calls as a switched circuit network. Therefore transport cost per bit of information is lower on packet switched networks. As such, VoIP can be supported by regulators in developing countries as a means to enhance at least the affordability aspect of universal service/access. The Association of Infocentres of El Salvador (Infotel), for example, is launching a VoIP service for international calls using pre-paid call cards. The service will be available in 41 of the Association’s centres and the initiative is supported by the Salvadorian regulator as a means of reducing international call costs. Similarly, state-owned

Telecommunications Office (Telof) in the Philippines plans to launch VoIP services in un-served rural areas.[28]

To address poor teledensity in rural areas, the South African government amended the Telecommunications Act in 2001 to create a class of service licences to provide telecoms service in geographical locations where teledensity is less than 5 per cent. These "under-serviced area licensees" (USALs) are comprised of small businesses and their licences specifically mandate the provision of service using VoIP, fixed mobile services and public pay phones. The first group of USALs were licensed in 2004 and the regulator began the second round of licensing in 2005.

However, VoIP is likely to remain a small percentage of overall voice revenues in South Africa for many years. Analysts predict growth from ZAR 30 million in 2005 to ZAR 630 million in 2009, representing 3 per cent of all fixed line voice revenues or, only 0.8 per cent of total voice, fixed and mobile combined. Moreover, growth patterns are expected to follow that in Australia, where the majority of VoIP services are expected to be in the corporate sector. The low penetration rate of broadband in homes and the high cost of VoIP terminals, may be one of the main drivers of this skewed take up[29].

The European Union's Universal Service Directive defines universal service as "*the provision of a defined minimum set of services to all end-users at an affordable price*". The Universal Service Directive states that there are no constraints on the technical means by which the connection is to be provided to the user and therefore there is no reason to exclude VoIP technologies from the set of technologies by which universal service can be provided. However, the Directive does not specify to what level a connection needs to be provided. Indeed, the recent EU Commission Communication on the scope of Universal Service suggests that broadband access need not be included.

Similarly, on the grounds of technological neutrality, non-discrimination and especially proportionality considerations, the Directive propose to exclude service providers (including VoIP) from contributing to any national Universal Access Fund unless they are of a sufficient scale to do so. Therefore the question of VoIP providers making a universal service contribution in European countries is at the moment an open one.

Various other countries that allow VoIP, including the Czech Republic, Mauritius, the Slovak Republic and Venezuela subject operators to universal service/access contributions. In Canada, the CRTC has ruled that if the VoIP service provided allows for access to and/or from the PSTN, the service is considered eligible to make contributions to the national contribution fund, even if the customer uses the service to make peer-to-peer (computer) calls. In South Africa, VoIP providers who offer service by virtue of their VANS license are required to contribute to the universal service fund as a general telecommunications licence holder.

4.6 Competition and VoIP

The question of how to regulate the VoIP service market raises the question of what kind of competition issues might arise specifically in relation to VoIP. A number of issues come to the fore in this regard. For example, the development of VoIP services depends greatly on the availability of broadband access. In order to support greater broadband availability, the challenge for the regulator is to ensure open, non-discriminatory and fair-priced access for ISPs wanting to resell broadband access.

Another challenge experienced by regulators is how to prevent the incumbent operator from stopping or blocking VoIP services, for example, by closing the ports used by VoIP services or refusing facilities to downstream providers dependent on infrastructure. Another concern arises out of whether VoIP services can be regarded as a substitute for traditional telephony, sharing similar

product features. As described earlier, regulators in most countries have not yet expressed an opinion on this and where opinion has been expressed, it varies considerably. There is also no consensus about which regulatory tools might be best used to ensure fair competition. It is important that a regulator with oversight on competition issues is effective in preventing anti-competitive behavior emerging with respect to VoIP providers as they apply downward pressure on tariffs.

In the European Union, market control is based on principles of competition law that respond to practical definitions of different markets. Regulation is therefore relative to the level of competition in the market described. The telecommunications market is divided into 18 "Relevant Markets"[30] which can be analyzed by the national regulator in each member country. If robust competition is present, no regulation is applied. If the regulator finds an operator with "significant market power" it will set one or more regulatory requirements (remedies) to that operator in the market concerned.

Several European countries are in process of considering whether VoIP should be seen as part of the services to be included in the "fixed telephony relevant market". Again results vary considerably but in some countries, those VoIP services with a gateway to the PSTN will be considered part of the fixed telephony market for the purposes of competition analysis. The whole question of where VoIP services will be placed in terms of "relevant markets" will shortly be considered by the European Commission (working with European regulators) in the near future. This discussion underlines the main question posed at various points in this paper as to whether VoIP services are equivalent and equal to, and hence substitutable PSTN voice services?

The Canadian Radio-television and Telecommunications Commission has decided that VoIP should be seen as part of fixed telephony market. However it will only regulate VoIP services when they are provided and used as a local telephone service. The decision is aimed at building sustainable competition in the local telephone market. Under this decision, incumbent local loop carriers – those with market power- cannot price their local services below cost to themselves in order to stifle competition.

4.7 VoIP and Interconnection Models

VoIP services challenge current interconnection models in several respects, both from an economic and structural perspective. Again it is helpful to separate what may happen in the short-term during the transition period and in the longer-term when most networks are IP-based. In the short-term, the main interconnections will be between IP networks and the PSTN. In the long run, the interconnections will mainly occur directly between IP networks.

As already mentioned, VoIP has a number of characteristics that will affect basic interconnection. As an IP-based network service, it can be provided directly with the cheapest provider irrespective of national boundaries. VoIP service provider Skype, for example, allows callers to call PSTN numbers and other Skype customers using its 'Skype In' and 'Skype Out' features. Calls between competitive, developed countries are charged almost at a flat rate and calls elsewhere to PSTN numbers are charged solely on the basis of where the call terminates, not where it originates.

For developing countries, changes in the interconnection model will be driven by the speed at which they make the transition to VoIP and IP-based network services. The more that transition is accomplished, the greater will be the need to consider the issues raised in this section. Regulators from developing countries can assess where they are in the transition process by referring back to Box 3, VoIP Transition, above.

Short-term interconnection issues: Current interconnection models are increasingly based on cost-based charges. The disruptive factor for current interconnection arrangements introduced by VoIP services is the likely difference of investment scale between IP-based networks and PSTN

networks. Although views differ as to the exact scale of difference, the cost of IP networks is significantly lower. There is not likely to be any major conflict when the call comes from an IP-based network to the PSTN as the receiving PSTN operators normally charge the same termination fee regardless of which network the call is coming from. However, when the call originates on the PSTN network and terminates on the IP network, the termination cost is difficult to determine. The relevant elements to assess the actual costs are unclear. Thus PSTN to IP interconnection is likely to create a difficult debate between the different players and may require greater regulatory oversight and intervention.

The cost calculation to define the cost based interconnection pricing is usually based on various FDC (Fully Distributed Cost) or LRIC (Long Run Incremental Model) calculation concepts.

Some countries are planning on using LRIC as a tool to define network termination prices, which usually requires significant resources from regulators, their consultants and industry. Today`s LRIC models are developed for circuit switched networks and their applications to IP networks is not known. With the rapid development of network concepts towards IP, caution about LRIC modelling may be warranted. This depends, however, on the state of transition to IP-based network services a country has reached.

Long-term interconnection issues: In the long term, when IP to IP interconnection is dominant, the application of current telephony interconnection models will create a number of problem areas. These are commented on below, but it should be noted that these comments could apply to all IP services and not just to voice calls.

- **Support of new IP based services:** IP based networks are expected to support new services including third party services over network boundaries. The existing usage-based charging for interconnection would mean that there would need to be interconnection agreements and charging arrangements at each interconnection point for each service carried over that point. However, there is a basic technical problem in that there is no way (at least in the near future) to transmit the charging information between IP networks. These practical problems could constitute a barrier to the roll-out of new services if changes are not made to the interconnection model.
- **Changes to cost structures:** Developments in technology and huge economies of scale have resulted in the costs of core or backbone networks dropping substantially. The existing regulatory and commercial models are built on the assumption of an expensive core or backbone network, hence the focus on competition in long distance and international calls through carrier selection and the development of services such as ‘freephone’. As a new cost model has developed, there is need to consider changing charging to capacity instead of usage for basic connectivity. The reduction in core or backbone network costs means that a complex interconnection charging model is no longer justified and that a simpler approach should be sought. A simpler approach could come from a combination of two changes, either the separation of services and connectivity, or the adoption of “bill and keep” for services.
- **Changes to the retail market:** The existing retail market is changing with call prices dropping and some operators starting to offer flat rate tariffs where unlimited call volumes are offered for a fixed subscription. This generates the risk of arbitrage and the operators would benefit from having interconnection arrangements that better match the structure of the retail charges. This change is causing many commentators to say that the days of time-based call charges are rapidly disappearing. However, there are still a number of high price, time-based charging structures (for mobile calls and premium rate services) and these providers will likely seek to continue these revenue streams or find substitutes, such as charges for video or music downloads.

4.8 Possible Approaches for Interconnection for IP Based Networks and Services

These developments suggest that there is need to look for new approaches to interconnection. A variety of ideas are under discussion about how to approach IP/NGN interconnection models. There is lively debate between the "telecom world" and the "internet world" on two basic approaches:

a) an open internet type approach where the separation of service provision and connectivity occurs as it does on the internet. This would require separate consideration of:
   - Interconnection (interoperability) at the service level, where services are charged on the "bill and keep" principle (peer to peer), and
   - Interconnection at the connectivity level, where charging between networks is based on capacity charging or another similar method

b) an NGN architecture approach through which network operators have more control over new services, for example service quality (such as providing different categories of guaranteed bandwidth), security (such as customer ID, authentication and security tunneling) and charging for services by third parties. NGN architecture includes additional software, which is not present on the basic internet network, such as IMS (IP Multimedia Subsystem), which controls the interconnection of services to networks. This means that in NGN architecture, since network and application services are separate, network operators can get a share of revenues from application services.

It is likely that in the future there may be more than one interconnection model and that market players should be able to choose the one that best fits their situation. During the transition period to NGN networks, new interconnection models will naturally work in parallel with existing models as the Internet's current charging models work alongside those of telephony.

5 Other VoIP Regulatory Issues

5.1 Quality of Service

One of the requirements for the deployment of voice over IP networks is the ability to offer toll-quality service equivalent to the existing PSTN. The quality of service (QoS) for voice transmission over IP can be defined in a number of different ways, depending on whether it is considered from a user or a technical perspective. The users' perceptions of service quality can be measured through subjective quality assessment. The most common consumer-based method to quantify QoS in telecom services is the Mean Opinion Score (MOS) described by the E-model from ITU-T. It is based on a variety of statistical tools and aims to represent the user perceptions of service quality.

5.1.1 End to end quality

Discussions of QoS in relation to VoIP typically highlight the issue of increased end-to-end delay and discuss the effects of this delay in terms of its potential for interfering with the normal cadence of voice conversations. A real-time expectation guides our conversation behaviour and, where this expectation is violated, the back-and-forth nature of the conversation begins to break down as we start to talk over each other (double talk) and consequently become more hesitant about switching between the role of listener and talker. However, this problem is not a new one and has appeared with both satellite latency on international calls and mobile telephony.

The delays that come with the use of mobile technology can be more marked than those of VoIP technology and are apparently well accepted by mobile users. Furthermore, for most developing countries, mobile phones set the level of quality expectation, since the majority of voice subscribers use mobile phones. This may be particularly true for Africa. While VoIP call quality is still inferior to analogue or circuit switched systems, many PSTNs in developing countries offer call

quality below that experienced in developed countries. In this light, 'quality' must be seen as a relative concept.

Delay is still a major issue for digital voice transmission, but other parameters need to be included in QoS for voice transmission evaluation. The combination of these parameters will therefore define the end-to-end quality:

– jitter, which is the variation in the time between packets arriving, caused by network congestion, timing drift, or route changes. A jitter buffer can be used to address this;

– packet loss, which introduces audio distortions;

– speech coding and decoding, which generates an approximation of the original signal.

5.1.2 QoS for VoIP in Practice

QoS issues for VoIP seen from the consumer perspective are really about a series of trade-offs between costs and other advantages. If we make the comparison with mobile phones, consumers appear willing to pay more for this service than fixed lines because it offers mobility. Likewise, a consumer using VoIP services are willing to trade call-quality for free or low-cost calls. In developing countries, users in the grey market are making exactly the same trade-off: they want to speak to their relatives or friends overseas as cheaply as possible whilst at the same time still being able to make themselves heard and hold a conversation.

On this basis, quality of service for VoIP seems to self-regulate itself and many operators make great efforts to maintain the QoS at the highest possible level. If consumers are not happy with a service's quality, they will cease to use it. Mission critical voice as required by corporate clients is generally not reliant on VoIP unless service level agreements are in place ensuring the integrity of the network for a percentage of service time. While it does seem unlikely then that QoS questions will be a major problem with VoIP, it still remains an issue that regulators are examining. This is particularly true in developing countries where VoIP is emerging as a low-cost communication solution.

5.2 Regulating Network Integrity

The term 'network integrity' is used to refer to the inherent reliability of a network and its resilience to threats (for example, natural disaster or malicious acts) and measures that might be taken to mitigate threats to the normal operation of the network.

The main regulatory problem in this arises from the fact that a VoIP service can be provided independently of the underlying network access ('network/service independence'). This has a number of implications which include:

- Voice over IP services can be provided over an access network without the provider of that network being aware or having any control over the voice service provided;
- Voice over IP services can be provided over an IP network using any access technology;
- Voice over IP services can be provided over an IP network at any location.

This fundamental change has the potential to raise more complicated issues for regulators. This is because existing network integrity requirements have generally been developed with the assumption that the network and the service are *not* independent. In the case of the PSTN, the access network provider is always the provider of calls over that access network (even if at the retail level those calls are resold by another provider), and would always have direct control over the integrity of the access network used. However, VoIP services have introduced the possibility that calls can be provided independently of the access network provider.

In the EU, the requirements relating to network integrity are set out in the EU's Universal Service Directive. It states that "Member States shall take all necessary steps to ensure the integrity of the public telephone network at fixed locations and, in the event of catastrophic network breakdown or in cases of force majeure, the availability of the public telephone network and publicly available telephone services at fixed locations. Member States shall ensure that undertakings providing publicly available telephone services at fixed locations take all reasonable steps to ensure uninterrupted access to emergency services."

This raises a number of questions in relation to VoIP services. For example, are 'nomadic' VoIP services (ones that can be used over any IP access network) provided at a fixed location? What are the implications of network/service independence? What are "all necessary steps" to ensure the integrity of the public telephone network at fixed locations in a VoIP context? These are all issues that are under discussion in European countries. Thus far there is no common European regulatory approach covering VoIP and network integrity.

Box 7: SPIT: A future issue

An issue that has recently begun to emerge and may require further consideration is "Spam over Internet Telephony, or "SPIT". This is part of the general problem of SPAM and SPIM (Spam over Instant Messenger). SPIT is essentially junk mail in voice form, unsolicited voice messages and unwanted advertising or marketing. This problem has a unique element in that VoIP does have elements of broadcast capability. Views differ on the future potential of the problem: while some security products are being developed to incorporate SPIT-blocking technology in future releases, some operators and analysts are less concerned about such threats as messages would have to be streamed to a network, as opposed to simply being mass emailed. At the same time, others have noted that standard content filters used for spam would be very difficult to implement with voice data because of the variability of phrases and pronunciation, making algorithms difficult to write and that the technology lends itself to extremely cost effective solutions for telemarketers. While SPIT is just barely emerging, it is not in itself a new problem, and needs to be addressed as part of a general approach to voice security in the IP space, including Viruses and Denial of Service attacks (DoS) and vulnerabilities to hackers that have been identified with Session Internet Protocol (SIP).

5.3 Communication Security and VoIP: the Role of the Regulator

Electronic communication security is a broad subject that can be used to address a large variety of issues. It is normally understood (for example, in the ITU X.805 framework) that there are eight dimensions that are designed to address network security:

- Access control;
- User authentication;
- Non repudiation;
- Confidentiality;
- Communication security;
- Data integrity;
- Availability;
- Privacy.

For example on application layers of an IP network, the operation of each application (web browsing, e-mail, domain names, real time communication including VoIP services) brings with it its own security questions and in each case specific actions are taken to minimize risks (like filtering in e-mail services).

Box 8: Current Threats to VoIP Networks and Publicly Available Services

- Distributed Denial of Service (DDoS) attacks against the availability of the VoIP network by flooding the network with unnecessary data or attacking the key network elements of the VoIP network. DDoS attacks are typically launched from a large number of compromised client machines and are difficult to defend against in the light of VOIP QoS requirements;
- Thefts of call information by breaching vulnerable VoIP signalling servers. The call information can be as valuable as the content so it is likely to be a target for attackers;
- Conversation eavesdropping or recording by breaching VoIP network gateways or other key points of the infrastructure. Plug-ins needed for sniffing VoIP traffic are available on many open source web sites for free;
- Call hijacking or man-in-the-middle attacks. These scenarios involve rerouting the connection and modifying call parameters;
- Identity spoofing by caller id manipulation;
- Attacks against the terminal equipment software, devices or network servers themselves. The software on these devices can be vulnerable to same types of vulnerabilities that affect all operating systems software.
- A new issue that has recently developed is “Spam over IP” or “SPIT” (see Box 7 above)

5.3.1 The Nature of VoIP services

The communication security of an IP-based phone service and PSTN phone service differs significantly due to differences in the concepts that underpin how each network operates. The PSTN is by nature a closed network with controlled security and privacy. The IP network is based on open network architecture where vulnerabilities, threats and risks for communication security are present in various network elements.

VoIP services are a specific set of services among a larger set of possible services on IP based networks. Thus VoIP services are largely under the general communication security questions that are common to all IP based communication /application services. The following therefore addresses some basic concerns about IP network communication security, which includes VoIP services:

5.3.2 User provided security/privacy - network provided security/privacy

In traditional PSTN networks, privacy and security have been mainly guaranteed by the network’s operator, whereas in IP networks these have been guaranteed end-to-end by the terminals/users. With the wider use of IP networks, it is clear that there needs to be a greater emphasis on privacy and security before VoIP services can be called “carrier-grade”, particularly with the implementation of Next Generation Networks.[31]

Work is already being done to try and address these privacy and security issues in some of the Internet Engineering Task Force’s specification work. It uses the term ‘trust domain’ (and other trusted entities) which can be used in connection with network asserted identities and their privacy.

5.3.3 Regulatory Authorities

Electronic communication security is managed by various organizations on various levels.

However, it is particularly important that telecommunications regulators follow the development of communication security in IP based services, particularly through organizations like the Internet Engineering Task Force.

In the meantime, regulators and governments can inform consumers of the security and privacy risks related to different types of IP based electronic communication and provide education information on the available protection methods and their effectiveness. Regulators and governments can also help highlight the importance of the issue by requiring reports from relevant service providers on the security incidents and failures.

Box 9: Defense Mechanisms Against Security Attacks Services

The protection of communication security is dependent on both the actions of the terminal equipment user and the security practices of the VoIP service provider/operator. Security is always a compromise between the usability/cost of the services and the protection mechanisms provided. The VoIP operator/service provider needs to consider at least the following points to mitigate security risks:

- VoIP networks should be logically separated from other IP networks of the organization;
- VoIP servers should be hardened and treated using the same security precautions as any other servers that contain confidential information and offer network services;
- VoIP networks should be redundant to ensure the availability of the service. The VoIP network has to be resistant to DoS attacks. This is especially essential for emergency services;
- Encryption of VoIP traffic can be used whenever reasonable. Encryption can be implemented on the application, transport or network level;
- Network devices should be configured properly to restrict unnecessary traffic toward VoIP systems and to ensure the operation of VoIP services.

5.4 Regulation and Lawful Interception

The regulatory aspects of lawful interception in terms of VoIP services are complex. In the future it will be vital for law enforcement agencies to be able to monitor and intercept Internet-based voice traffic. However, because of the way in which VoIP services are provided, the sector is much more fragmented than the large telephony operators. Also, traditional carriers are clearly signalling their intent to move to Next Generation Network architectures.

Several countries are examining the possibility of providing their security services with the necessary powers to intercept e-mails and monitor traffic on the Internet. If this comes about, Internet service providers will be required to install a link to the security services. The security services will then be able to monitor Internet traffic or equipment within their network. Increasing pressure is being placed on national regulatory bodies to ensure that operators are obligated to have surveillance-enabled networks and retain call and traffic information. As more voice traffic moves to IP-based networks, the same pressures will be brought to bear on VoIP operators.

For example, in August 2005, the United States FCC ruled that that providers of certain broadband and interconnected VoIP services must be prepared within 18 months, to accommodate law enforcement wiretaps and are thus subject to the Communications Assistance for Law Enforcement Act, or CALEA. The FCC has determined that VoIP services can essentially replace conventional telecoms services currently subject to wiretap rules, including circuit-switched voice service and dial-up Internet access. As such, any voice over Internet Protocol, or VoIP, provider linking with

the public telephone network must be wiretap-ready by early 2007[32]. CALEA requires the Commission to preserve the ability of law enforcement agencies to conduct court-ordered wiretaps in the face of technological change.

The FCC Order is limited to facilities-based broadband Internet access service providers and VoIP providers that offer services permitting users to receive calls from, and place calls to, the public switched telephone network.

However, as with other media, there are other pressing and sometimes conflicting concerns to consider with respect to the individual right to privacy. In terms of lawful interception, regulators might play a useful role in helping to determine the balance between the rights of the individual citizen and the requirements of government to monitor this kind of traffic. At a practical level, regulators can also help find a balance between the obligations and requirements of law enforcement agencies and the needs of service providers.

Lawful interception raises a number of difficult issues that are not always easily balanced including: data protection, user privacy and public interest. Therefore it is probably easier to use general authorization regimes and ensure that these are compliant with any lawful interception obligations. A further complicating factor is that VoIP services are frequently provided across borders.

Below are some of the issues that are raised by lawful interception obligations:

Costs: the cost of compliance with such obligations can be significant. In some countries, law enforcement agencies or the government share the costs of lawful interception with smaller operators or service providers. However, where these arrangements are absent, regulators need to be sensitive to the fact that for smaller ISPs or VoIP service providers, the cost of purchasing the necessary equipment to be able to provide access to law enforcement agencies can be prohibitive.

Area of Responsibility: another potential problem area is that of delineation of responsibilities for implementation and compliance between the national regulatory authority and the law enforcement agencies. This can lead to difficulties in establishing technical specifications, determining service provider responsibilities and applying remedies that can be imposed in cases of non-compliance.

Standards: lawful interception, especially of cross-border services, is highly dependent on standardization bodies such as the European Telecommunications Standards Institute. Unfortunately, although standards for Lawful Interception in traditional circuit switched networks are well defined and now becoming mature, there is still a long way to go before interception standards for VoIP are standardized.

Privacy: there is no question that lawful interception plays a crucial role in helping law enforcement agencies combat criminal activity. Lawful interception of public telecommunications systems in each country is based on the national legislation in that country. Regulators may have differing ranges of powers that can be applied when dealing with lawful interception issues. Although it is difficult, it is important to balance the data protection, user privacy and public interest aspects.

6 Conclusion

This paper has attempted to outline the regulatory challenges posed by VoIP technology and uptake. It has highlighted the various different approaches currently being taken globally, informed by different levels of market maturity, competition and social objectives of regulation. While the implementation of regulatory approaches will remain highly uneven for many years, and may in fact, never standardize, there is at least consensus on the fact that IP based technology and networks need to be addressed from a regulatory point of view.

The countries that have begun to address regulation on VoIP are generating precedent and learning opportunities for other countries that are not yet in a position to do so. It appears that minimal

additional regulation of VoIP is required, to ensure quality, security, network integrity, interconnection, access to emergency services and further competition in global telecoms markets. VoIP services offer a truly exciting technological development that may yet unlock affordable communication solutions for much of the developing world. Regulators can act to ensure that they assist in this common goal.

VoIP is a particularly important opportunity for developing countries to enable voice and other services more cheaply than over traditional PSTN networks. The increased availability of cheaper services will widen access to a larger number of citizens, providing another avenue for closing the digital divide. VoIP also highlights the powerful role of technology and change in communications and its benefits overall, for incumbent operators and new entrants alike who can harness new business opportunities technological change brings.

References

The views in this discussion paper are based on a wide range of information including: recent VoIP conference papers, internal discussion among various national telecoms regulators and from co-operation work, especially among European regulators. Further information is available for example in the following documents (listed alphabetically by title):

ERG Common Statement for VoIP regulatory approaches, includes a common approach by 27 European regulators, especially for VoIP numbering and emergency services. Annexes include summary of some European countries' current regulations related to these issues.

www.erg.eu.org.int

The Essential Report on IP Telephony by the group of experts on IP telephony / ITU-D

http://web/ITU-D/e-strategy/publications-articles/pdf/IP-tel_report.pdf

Impact of Skype on Telecom Service Providers, an Evalueserve report

A Model for Interconnection in IP-based Networks, ECC draft report, including reasons to move to a new interconnection model and presentation on the new model concept.

www.ero.dk

An Overview of VoIP regulation in Africa: policy responses and proposals by Tracy Cohen and Russell Southwood for the CTO

The policy implications of Voice over Internet protocol, report by OECD DSTI/ICCP/TISP (2005)

Skype-VoIP Win-Win, harnessing the value creating power of Skype while avoiding the value destruction by Merlin Consulting and by Fornebu consulting

World numbering developments by Antelope Consulting

www.antelope.org.uk

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[1] The authors wish to thank Susan Schorr for bringing them together as co-authors and for her helpful comments in writing this paper, and Tania Begazo for her research support that has enabled us to reflect a wide range of regulatory experiences. Views expressed by the authors are in a personal capacity and in no way reflect the organizations they represent.

[2] Clayton Christensen, *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail* (New York: Harper Business, 1997), coined the term "Disruptive technologies". These technologies are said to satisfy existing

customer needs at a drastically lower cost and are simpler and easier to use than previous ones. Disruptive technologies cannot at the point they are introduced into the market, compete against the traditional products such that they can acquire a large market share.

[3] See http://www.telegeography.com/press/releases/2005-05-31.php

[4] See *Webopedia* at http://www.webopedia.com/TERM/I/Internet_telephony.html

[5] Class 0 is phone-to-phone over the PSTN. This is David Clarke's classification system (MIT).

[6] A VoIP network requires a terminal or communication end-point, which can be a phone, PC or even a software programme. Terminals are identified by at least one IP address (e.g. user101@196.71.47.103) and are registered with a server, which stores IP addresses and can map an address to a terminal. The server might also store locational, identifying and traffic data. Finally, gateways act as bridges between the local PSTN and IP network to allow calls between different networks so that the signalling protocol can be understood between networks and so that IP addresses and regular PSTN numbers are recognizable between networks. Signalling data is exchanged between switched circuit telephone networks and VoIP networks. This information is used to setup, manage and release voice calls, and support telephony services such as caller ID, toll-free calling, and mobile authentication and roaming services.

[7] For example, from May 2005, Senegal's incumbent operator Sonatel cut its international call rates to US19 cents a minute at weekends and US31 cents during office hours. Sonatel was one of early adopters of VoIP for international calling.

[8] In South Africa, as part of its tariff rebalancing licence requirement, the monopoly operator, Telkom, reduced international calls overall by approximately 36% over 2004-2005.

[9] A privately owned Pay TV company.

[10] See http://www.20min.ch/tools/suchen/story/27383201.

[11] It is also noteworthy that the establishment of the World Trade Organization (WTO) and the GATS Framework Agreement, has facilitated a much wider and more complex exchange process, and facilitated a regime change from one typified by a exchange of traffic, to one characterized by (multilateral) trade in services, and a consequent shift away from individual, bilateral country negotiations for market access and network interconnection.

[12] The Pakistan carriers use VoIP as licensed long-distance or local loop carriers.

[13] A soft-phone is a piece of software that sits on the desktop of a computer and mimics the functions of a physical phone.

[14] Time Division Multiplexing, a type of multiplexing that combines data streams by assigning each stream a different time slot in a set. TDM repeatedly transmits a fixed sequence of time slots over a single transmission channel. Within T-Carrier systems, such as T-1 and T-3, TDM combines Pulse Code Modulated (PCM) streams created for each conversation or data stream.

[15] Chinatechnews, "MII: No Plans Soon To Lift Ban Over VoIP", July 22, 2005, online at http://www.chinatechnews.com/index.php?action=show&type=news&id=2813; Chinatechnews, "China Netcom Prepares To Crackdown On Illegal Phone Kiosks", June 20, 2005, online at http://www.chinatechnews.com/index.php?action=show&type=news&id=2716

[16] IP-Enabled Services , WC Docket No. 04-36, Notice of Proposed Rulemaking, 19 FCC Rcd 4863 (2004).

[17] "Regulatory framework for voice communication services using Internet Protocol", Telecom Decision CRTC 2005-28, 12 May 2005.

[18] Local VoIP services are defined as those which use telephone numbers that conform to the North American Numbering Plan and provide universal access to and/or from the Public Switched Telephone Network (PSTN), along with the ability to make or receive calls that originate and terminate within an exchange or local calling area.

[19] "Local Competition", Telecom Decision CRTC 97-8, 1 May 1997.

[20] Multiprotocol Label Switching, an IETF initiative that integrates Layer 2 information about network links (bandwidth, latency, utilization) into Layer 3 (IP) within a particular autonomous system--or ISP--in order to simplify and improve IP-packet exchange. MPLS gives network operators a great deal of flexibility to divert and route traffic around link failures, congestion, and bottlenecks.

[21] Memorandum Circular, No. 05-08-2005, Subject: VOICE OVER INTERNET PROTOCOL (VOIP), National Telecommunications Commission of the Philippines (last visited at http://www.ntc.gov.ph/whatsnew-frame.html).

[22] REGULATION OF INTERNET PROTOCOL (IP) TELEPHONY, Statement of the Telecommunications Authority, 20 June 2005, OFTA http://www.ofta.gov.hk/en/tas/ftn/tas20050620.pdf

[23] China's government is considering banning the use of unregulated VoIP services. Report in Fierce VoIP, 13 September 2005.

[24] Intrado has introduced a new service that will enable wVoIP providers to offer 911 services in compliance with the recent FCC mandate. The company claims that its V911 Mobility Service will let wVoIP providers nationwide position their services as primary line replacements. The solution is designed to accommodate each jurisdiction's 911 regulations while supporting static, mobile and out-of-area phone numbers. Intrado supplies 911 integration by transmitting routing instructions for the local 911 service through the wireless VoIP provider's modem. The service redirects VoIP 911 calls

over the existing wireline service and offers live call-center support 24 hours a day. See http://lists.fiercemarkets.com/c.html?rtr=on&s=69l,f8zf,lcs,bhks,bxd0,jti9,1419

[25] "Decision on 9-1-1 Emergency Services for VoIP Service Providers", Telecom Decision CRTC 2005-21.

[26] Federal Communications Commission, 911 Services, at http://www.fcc.gov/911/enhanced/

[27] Federal Communications Commission, Federal-State Joint Board on Universal Service Seeks Comment on Proposals to modify the Commission's Rules relating to High Cost Universal Service Support", FCC 05J-1, CC Docket No. 96-45, 17 August 2005.

[28] Telegeography, "Telof to launch VoIP in unserved areas", May 16, 2005. Available at http://www.telegeography.com/cu/article.php?article_id=7203

[29] ITWeb Market Monitor with BMI-TechKnowledge, July 2005.

[30] The list is provided in the European Commission's recommendations.

[31] For a description of Next Generation Networks, see Keith G. Knightson's presentation of Basic NGN Architecture and Principles: http://www.itu.int/ITU-T/worksem/ngntech/presentations/s1-knightson.pdf

[32] Federal Communications Commission, First Report and Order and Further Notice of Proposed Rulemaking, FCC 05-153, ET Docket No. 04-295 RM-10865, 23 September 2005. Available at http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-05-153A1.pdf

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