GSR 2009

Discussion Paper

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Work in progress, for discussion purposes

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Voice over Internet Protocol: Enemy or Ally?[1]

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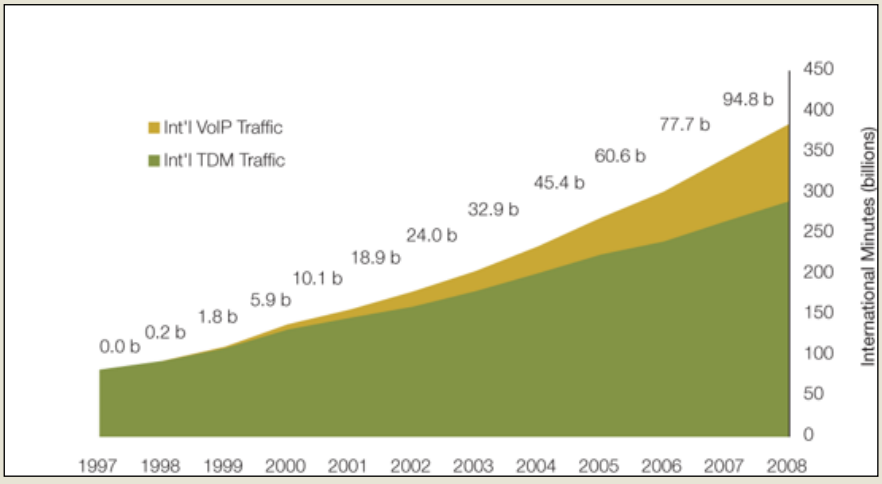
1 Introduction: VoIP Comes of Age

Voice over Internet Protocol (VoIP) is perhaps the best example of a converged technology to be found in today's telecommunication market.[2] Over the last decade, driven by growth in broadband networks and cost reductions, VoIP services have revolutionized the economics of voice service transmission and provision. Today, VoIP has become a classic "disruptive technology" that is transforming the entire telecommunication industry -- just as profoundly as the transition to mobile services did throughout the 1990s.[3]

After initial problems with quality of service (QoS) and availability, VoIP has now gained broad market acceptance among service providers, consumers and businesses alike. The traditional perception of VoIP has been as a vehicle for new market entrants to compete with traditional public telecommunication operators (PTOs). Increasingly, however, the reality is that most incumbent PTOs are now using wholesale VoIP to carry international traffic over their networks, as the transmission of traffic over IP-based networks can yield tangible cost savings. Many PTOs are also deploying VoIP in their access networks in ways that are not always evident to end-users. The consulting firm Wik Consult has observed that "large and small operators, incumbents and competitors, are converting their networks to next-generation networks (NGNs) and are betting their businesses on a successful migration to VoIP".[4]

Figure 1: International VoIP and Time Division Multiplexing (TDM) Traffic Growth, 1997-2008



Source: TeleGeography Inc. (2008). *Note:* VoIP traffic includes all cross-border voice calls over IP networks, but terminated on the PSTN. Personal computer-to-personal computer (PC-to-PC) and private network traffic are excluded, and 2008 figures are projections.

VoIP is now central to the business strategies of many operators and service providers in both developed and developing countries. For example, incumbent PTOs in Bangladesh, Fiji, Ghana, Sudan and Tunisia all use VoIP to transmit international traffic. By 2007, VoIP accounted for an estimated 23 per cent of international voice traffic (see Figure 1). This was projected to reach 25 per cent in 2008.[5] While the consulting firm Maravedis noted that "in the wired domain, the transition is nearly complete", networks based on public switched telephone network (PSTN) architecture and those based on IP will most likely continue to co-exist for some time yet.[6]

Whether incumbent operators choose to pass on the savings from IP-based transmission to customers in the form of lower retail prices is another issue. Dominant operators (and governments, where the incumbent is state-owned) may naturally try to protect and maintain their revenues. For some incumbent operators, this is a question of milking the "cash cow" of voice telephony while it lasts. For other incumbents with high, sunk network costs, their very survival may be at stake as they try to compete with VoIP companies whose main business asset may be a piece of software. The extent to which the cost benefits of VoIP are passed on to customers is partly dependent on the competitive and regulatory environment in each market.

Beyond the distinction between wholesale and retail operations, VoIP is not a single, uniform service. Rather, it comprises a range of services over different network platforms, including:

- Business VoIP;
- VoIP transit;
- VoIP over PSTN, cable, DSL or mobile; or
- VoIP embedded in web pages or online games.

Similarly, different VoIP service providers -- such as Vonage, Fastweb or Skype -- often have quite different business models and service portfolios. Defining VoIP in the context of the national ICT environment is one basic step every country can take in determining its national VoIP policies, which will influence the growth of nascent VoIP-based enterprises and determine how they will be regulated (see Section 3). This chapter reviews the growth of VoIP and examines its impact on regulatory practices and the future of voice services.

2 VoIP: Acceptance and Growth

What are the forces driving the transition to VoIP? In a few words, they are *cost* and *market liberalization*. This section explains how these powerful drivers have turned VoIP from a niche market to a newfound status of acceptance and growth in many economies.

2.1 The Cost Factor

The high costs of maintaining legacy networks are a key force driving the growing adoption of IP-based networks, alongside the need to upgrade to intelligent networks with inherent monitoring and adaptive capabilities. Transmission over IP-based networks can cost as little as a quarter of equivalent PSTN transmission.[7] Moreover, it can save 50-60 per cent in maintenance costs, because an IP call can require just 10 per cent of the bandwidth required for a PSTN call.[8]

As they review these cost advantages, many operators realize that they have to respond to competitors (domestic and foreign) and position themselves in a truly global communication industry. IP-based networks

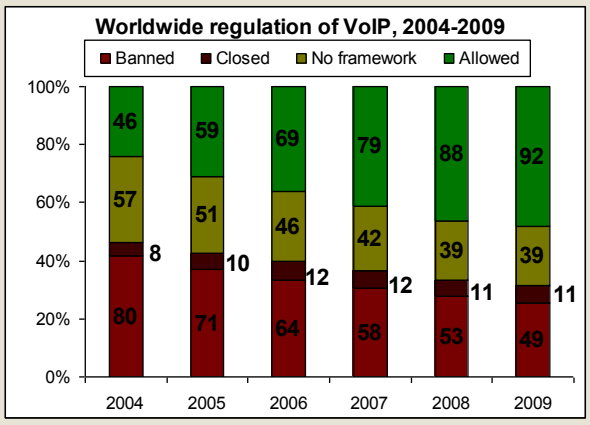
often appear to be the best foundations for business-critical applications, as operators integrate voice and data networks. Consumer VoIP applications can run over a range of devices, offering flexibility in the first step towards seamless communications. For some operators, IP-based transmission is the first step in implementing an NGN strategy, although true NGN is a broader concept that involves specific QoS guarantees and generalized mobility not offered by most types of VoIP.[9]

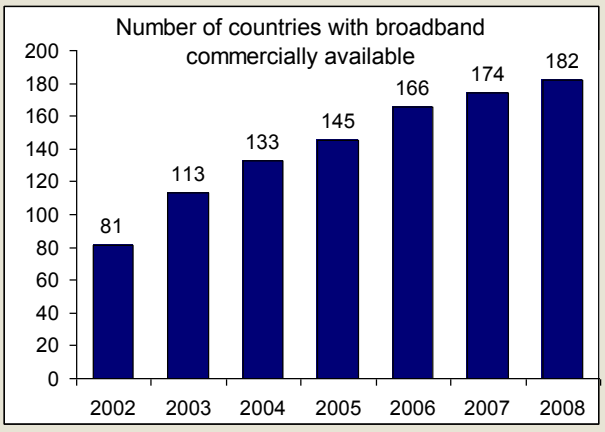
Still, some incumbent operators may be reluctant to introduce VoIP, because they already offer voice services over the PSTN. Perhaps understandably, they do not wish to cannibalize their higher-margin international service offerings (particularly if tariff rebalancing has not been fully implemented). They perceive a quandary: introducing VoIP could enhance their brand and portfolio of services, but it also could be interpreted as a concession to competitors. However, the reality is that convergence, in the form of VoIP services, is redefining markets and blurring boundaries between networks and content. VoIP is eliminating barriers to entry (because competitors no longer need to own a network) and bringing facilities-based providers under direct competition from service-based competitors. The market transition, meanwhile, is redefining the role of telecommunication regulators.

2.2 The Market Liberalization Factor

Progress in VoIP adoption and legalization is closely connected with market liberalization. VoIP can be seen as a technology for introducing competition -- and gaining a competitive advantage -- in liberalized national and international telecommunication markets. Ironically, this is not always welcome. Countries seeking to market second national operator licences may resist introducing VoIP in order to maintain the value and attractiveness of the second licence. This may be a contributing factor, for example, in Egypt's delay in fully legalizing VoIP for residential use – despite VoIP's growing popularity there.

Figure 2: The Global Growth of VoIP & Broadband





Source: ITU. This time series of data is available for 191 countries for 2004-2009.

Note: 'Closed' means countries where wholesale VoIP is permitted, but retail VoIP is banned, as well as those countries where only the incumbent is licensed to provide VoIP. Broadband services are defined as Internet access at speeds of 256 kbit/s or more.

Operators and policy-makers have generally been more receptive to broadband Internet services as the future direction of a modern communications industry (see Figure 2). According to ITU data, by 2008, the broadband Internet services on which retail VoIP depends were commercially available in 182 countries. However, the roll-out of broadband services also opens the door to "pure-play" or PC-to-PC VoIP offerings, about which some operators, governments and regulators may be decidedly less enthusiastic.

2.3 VoIP Growth Takes Off

In response to the drivers of cost and liberalization, VoIP has been gaining ground steadily. In 2004, VoIP was explicitly legalized in 46 countries (see Figure 2) – mainly in Europe, North America and Asia. VoIP was also broadly permitted in another 57 countries – for example, countries where there was no explicit regulatory framework or licensing for VoIP. Between these two categories, just over half of all countries permitted VoIP in 2004. By mid-2009, the proportion of countries where VoIP was tolerated had risen to two-thirds, with 92 countries having legalized VoIP and a further 39 countries tolerating it. Meanwhile, the number of countries where VoIP was banned shrank from 80 in 2004 to 49 in 2009, or about a quarter of all countries for which data exist.

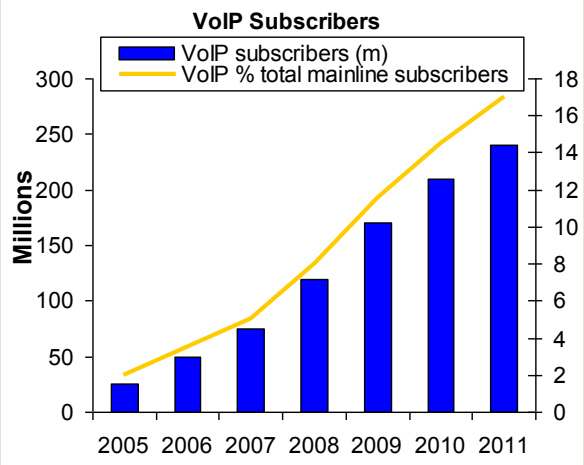
Estimates of global VoIP subscribership numbers are surprisingly rare, given the growth in the use of VoIP technologies. There are several reasons for this. The different definitions of VoIP in use across the world mean that countries report different numbers according to the methodology they use. It is also difficult to estimate the number of PC-to-PC or "pure" VoIP users, including regular Skype users, concurrent users, occasional users, or those using embedded VoIP in online game sessions. These difficulties mean that estimates of the total number of VoIP subscribers are almost always given as a range. For example, one estimate of the number of residential VoIP customers in the United States projected a range of between 12 million and 44 million subscribers by 2010.[10] This range may seem surprisingly broad, but it gives a fair idea of the high degree of uncertainty involved in estimates of VoIP subscribers and VoIP users.

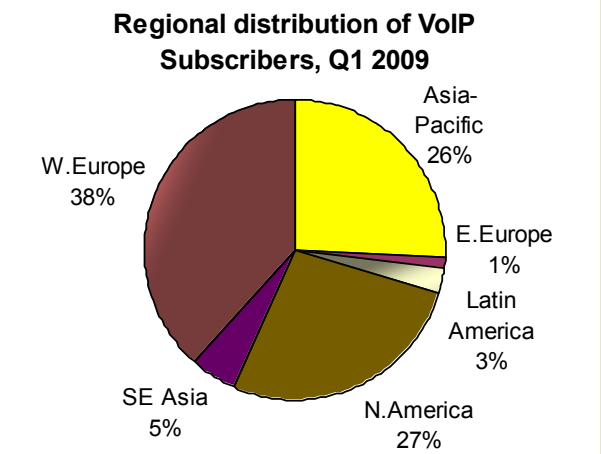
Nevertheless, some consultancies still produce estimates of VoIP subscribers. Infonetics Research estimated that there were some 80 million VoIP subscribers worldwide by the end of 2008.[11] Point Topic produced similar estimates of 87.8 million commercial VoIP subscribers by the fourth quarter of 2008, and 92.2 million by the first quarter of 2009. More recent projections of VoIP subscribers usually exceed earlier predictions by large margins.[12] One research consultancy estimated that there would be 200 million paying VoIP subscribers worldwide by 2012 (up from 70 million in mid-2008). Another analysis predicted 267 million residential VoIP subscribers globally by 2012.[13] iDATE projected 175 million VoIP subscribers by 2009, which would be equivalent to 10 per cent of the total number of main-line subscribers (see Figure 3).

According to Point Topic, Western Europe accounted for the majority (38 per cent) of all VoIP subscribers in the first quarter of 2009, although this share was declining as VoIP gained popularity in other regions. North America and the Asia-Pacific region are the next largest markets, accounting for just over a quarter of all VoIP subscribers each. South-East Asia, Latin America and Eastern Europe have a relatively small market share, but these markets are growing fast.

Figure 3: VoIP Subscribers Worldwide

Estimates of VoIP subscribers, as a total and as a proportion of main lines worldwide, 2005-2011 (left chart); and the distribution of VoIP subscribers worldwide, March 2009 (right chart).





Source: iDATE (left chart), Point Topic (right chart).

TeleGeography, Inc., estimated that international VoIP traffic reached 94.8 billion minutes in 2008, accounting for about a quarter of the world's international telecommunication traffic in that year.[14] A 2008 estimate projected that by the fourth quarter of 2009, there would be more than 135 million consumers using VoIP.[15] Meanwhile, the popularity of VoIP for business use continues to grow. Globally, AMI Research projected that revenues from IP private-branch exchanges (IP PBXs), VoIP gateways, soft switches, VoIP application services, IP phones and adapters will amount to USD 9.7 billion in 2010.[16]

In reality, the most remarkable thing about VoIP is not its growth, but the way it is transforming existing business models and rewriting the economics of providing telecommunication services. VoIP is changing the industry irrevocably by opening up new markets and bringing different players into competition. Converged technologies are boosting facilities-based competition. VoIP lets broadband, cable modem and wireless service providers compete directly with each other. It also promotes service-based competition by enabling new service providers to compete without owning their own network infrastructure. In many markets, Skype and Vonage are now competing directly with the incumbent operators. The entry of new service providers could result in new and improved services and greater incentives for domestic and foreign investment.

Some analysts have suggested that cable operators now have an advantage over PSTN operators, because they can more easily retrofit their networks for voice than traditional telephony carriers can. Such retro-fitting can enable operators to provide high-speed data, video and Internet services.[17] Video content can be provided in the same way as VoIP can – broken into small pieces, compressed using a CODEC into small packets and transmitted over the IP network. This means that video and other media content can be added onto VoIP offerings in a relatively simple way. However, it is usually more difficult and expensive to upgrade existing PSTN networks to accommodate such content, leaving traditional players hobbled in their ability to adapt to these technological changes.

The growth of VoIP, combined with the rise of mobile telephony, is challenging operators around the world. They are facing the need to re-write the business models they have relied on for the last three decades (see Box 1). In some cases, mobile telephony substitution is eroding fixed-line operators' revenues. The smart operators are offering both fixed and mobile services, relying on mobile service growth to offset their flagging fixed-line revenues (see Box 2).

Box 1: Coping with the Death of Traditional Telephony

If traditional telecommunication operators switch to delivering content and broadband Internet access (for example, using Fiber-To-The-Home or FTTH networks), they can be less concerned about losing their traditional voice telephony businesses. Most operators would rather have a single (fiber) line to the house, anyway, than pay to install maintain both a fiber line and a twisted pair line.

On the other hand, conventional telephones are now so cheap in terms of data-trafficking costs that they are a major "cash cow" that operators find hard to let go. Countries with strong, state-owned telephone companies may have even greater difficulty adapting, but countries with high Internet usage may not even need conventional landlines much longer. Telcos in industrialized countries might rather switch everybody over to fiber networks eventually, allowing the telcos to sell "land lines" that are actually boxes converting PSTN telephony into VoIP.

There is no "critical application" (such as voice) that is keeping conventional land lines rooted anymore. Land lines are simply a legacy of the PSTN. In industrialized countries, conventional land lines will fade away over the next 10-20 years as market penetration drops. But cellular phones will do the killing, not VoIP. More people have cell-phones than Internet connections.

Source: Adapted from The Future of Landline - http://news.slashdot.org/comments.pl?sid=1157677&cid=27163537.

Perhaps the greatest regulatory challenge is to promote the growth of a market for cheap VoIP services, rather than just leaving VoIP to develop of its own accord. In Australia, the size of the VoIP market is a major concern for the regulator, which regularly monitors and publishes market data estimates.[18] Regulators can adopt several measures to promote VoIP markets (see Box 2), starting with efforts to boost broadband take-up as a foundation for fixed access to VoIP services.

Box 2: So You Want To Grow Your VoIP Market?

Steps to promote the deployment of broadband networks are essential prerequisites to the development of any country's VoIP market. Steps to promote broadband include:

Developing a national broadband policy;

- Developing a national (fiber) backbone;
- Promoting alternative forms of competition (e.g. between DSL and cable);
- Instituting principles of technological neutrality for new technologies (e.g. WiMAX, NGN); and
- Liberalizing international gateway operations.

Want more details? Here are some concrete actions which regulators can take to implement a policy of promoting broadband network deployment and service growth:

1. Permit and promote unbundling and infrastructure-sharing.
2. Require the incumbent to offer a stand-alone DSL package for consumer use -- independently of, and in addition to, triple-play services -- to avoid consumer 'lock-in' to the incumbent's package.
3. Ensure seamless interconnection between networks.
4. Allow number portability between PSTN and VoIP services.
5. Simplify and ease licensing procedures (unified licenses, general authorization, etc.)
6. Develop "net neutrality" rules to prevent companies from blocking VoIP traffic. Setting clear QoS criteria can help promote the availability of reliable, secure VoIP services.
7. Clarify and simplify the rules for numbering, access to emergency numbers, consumer protection, etc.
8. Produce regular monitoring and policy statements to show clear regulatory commitment to the development of the VoIP market.

Source: ITU, adapted from Michael Kende's presentation at: http://www.osiptel.gob.pe/OsiptelDocs/GPR/el_sector/SEMINARIOS/files/Seminario% 20Internacional%2017%20de%20agosto/Files/Pres_Michael%20Kende.pdf

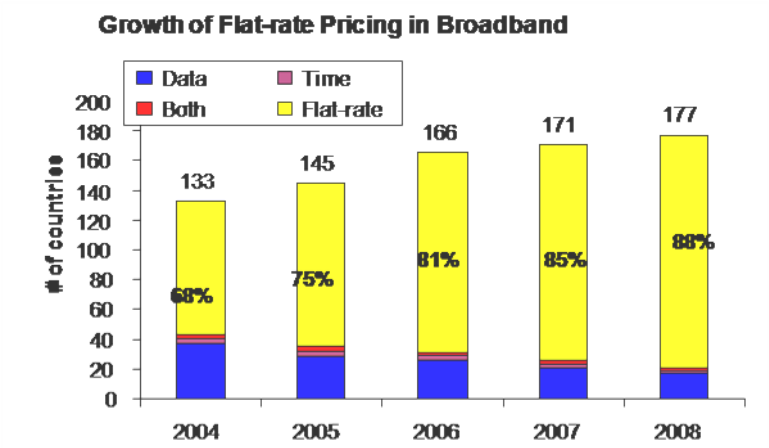
2.4 Harnessing VoIP's Potential

VoIP is intimately linked with changing business models in the telecommunication market. Incumbent operators have faced the impact of double-digit price declines for their services over the last four to five years, due to regulation, competition, technological advances and the introduction of bundled offers. Most notably, the transition to broadband Internet service has opened the door to flat-rate pricing that is independent of distance, time and call duration. Pricing models for broadband and VoIP services are increasingly detached from the amount or type of data that is downloaded, with prices now dependent on the speed and bandwidth of the connection.[19]

Currently, VoIP pricing models often mirror the flat-rate or monthly subscription pricing of the broadband services they ride on. VoIP also is available, however, on a time-metered basis in some countries – particularly in places such as the Pacific islands, where bandwidth is more limited. For example, in May 2008, Net2Phone dropped the price of its "VoiceLine" residential broadband voice service to USD 19 a month for unlimited local and long distance calling within the U.S., Canada and Puerto Rico. For an additional USD 15, customers could

make unlimited calls to more than 60 additional countries, including Argentina, Brazil, China, Ireland, Italy, Spain and the United Kingdom.

Figure 4: Growth of Flat-Rate Pricing Strategies for Broadband Internet, 2004-2008



Source: ITU

The VoIP industry is also notable for predominantly using a prepaid model that can give VoIP providers an advantage over conventional fixed-line incumbents, which historically have borne the risk of bad debt from non-paying customers (see Box 3).

Box 3: Advantages of the Prepaid VoIP Model

With VoIP becoming more available, some VoIP service providers are enjoying lower levels of delinquent and unpaid consumer bills. How do they do it? Apart from the fact that VoIP generally allows for cheaper calls (especially for long-distance and international calls), the VoIP industry has a different billing scheme from conventional telecommunication operators. Prepaid calling plans are the norm in the VoIP industry. Customers normally buy prepaid credits and then make calls, with the account remaining functional and active as long as there is still credit in the account. Once the account balance reaches zero, the customer can no longer make chargeable phone calls and has to purchase another set of credits in order to continue using the VoIP account. This is a very effective way to limit the amount of uncollectible payments. Conversely, conventional fixed-line companies usually offer post-paid plans, so customers can simply make all the phone calls they wish, and then pay when billed. This is convenient for consumers, but the telecommunication service provider bears all the risk of bad debt from non-paying customers. Some telcos are now offering pre-paid plans as a way to control the risk of uncollectible revenues from delinquent accounts.

Source: Adapted from http://www.asteriskblog.com/voip-industry-helping-eliminate-bad-debt/

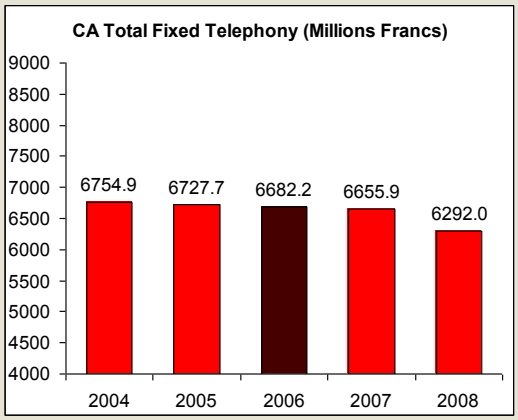
The roll-out of IP-based networks is essential for operators wishing to offer triple-play services. For example, despite delays in establishing a formal regulatory framework for VoIP in the United Arab Emirates, Etisalat rolled out its IP-based network during 2006-2007 as a way of offering voice, video and data over a single network.[20] Regulations facilitating or restricting entry into related markets can play a major role in influencing whether operators embrace IP and triple-play offers. For example, operators in Argentina are not allowed to enter the video distribution business, a restriction that industry analysts believe could lead them to delay the incorporation of IP into their networks.[21]

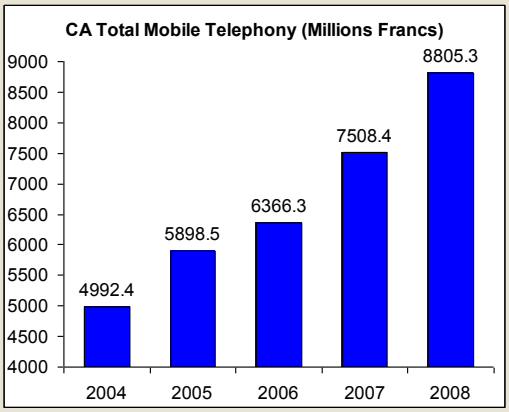
Greater use of VoIP has been associated with declining international call revenues in a number of countries. For example, Ghana Telecom's revenues from international calls dropped from USD 42 million in 1998 to USD 14.4 million in 2002, a decline some industry experts attributed to greater use of VoIP, email, international SMS and instant messaging.[22] In Bangladesh, the incumbent, BTTB, has seen sustained declines in revenues (see Box 5.5). FINTEL, the sole provider of telecommunication services to and from Fiji, saw its revenues decline from FJD 83 million (USD 43.13 million) in 2000 to FJD 50.1 million (USD 26.03 million) in 2004, as VoIP eroded its international business.

In New Caledonia, however, the introduction of VoIP had little immediate effect. In November 2006, the incumbent, OPT, introduced its "19" IP telephony service, after persistent legal challenges involving a leading ISP, Can'L. International revenue and overall fixed telephony revenue barely diminished in 2006 and 2007 (see Box 4). However, the financial crisis that erupted in 2008 has had a big impact, as consumers perceived VoIP services as cheaper. International revenues and fixed telephony revenues dropped significantly in October 2008, and OPT has responded to falling international tariffs by raising subscription rates for fixed line and VoIP service subscribers.

Box 4: The Introduction of VoIP in New Caledonia

New Caledonia's incumbent operator, OPT, introduced its "19" IP telephony service in mid-November 2006, and then reduced its tariffs for international calls in July 2007. Despite these tariff reductions and fixed mobile substitution, total fixed telephony revenues remained relatively stable until the financial crisis hit in October 2008, causing a drastic migration away from standard telephony to OPT's international IP telephony service.





In 2006, revenues from fixed telephony fell by 0.57 per cent compared with 2005. The losses observed at the international level from Internet telephony (the "19" service) were thus almost entirely offset by a growth in revenues from subscriptions and installation costs. Revenues from interior (domestic) traffic fell by 0.46 per cent in 2006, and external traffic revenues fell by 14.6 per cent over the same period. Sales of tele-cards fell by 6 per cent. The opening of the "19" service caused these reductions.

In 2008, there was a net reduction in domestic, circuit-switched traffic revenues of 5.3 per cent. There was an greater in external service revenues (11.7 per cent) following a drop of 20 per cent in external circuit-switched traffic in October 2008 – representing a shift towards the "19" VoIP service.

Source: Translated and abridged from the French text in the 2005, 2006, 2007 & 2008 OPT Annual Activities Reports, available at: http://institution.opt.nc/.

Box 5: The Introduction of VoIP in Bangladesh

In Bangladesh, extensive use of VoIP began some seven years ago. In January 2004, the Bangladesh Telecom Regulatory Commission (BTRC) announced the legalization of VoIP and an award of VoIP licences. However, technical problems caused some delays in rolling out services. The Bangladesh Telephone and Telegraph Board (BTTB) suggested that a strong monitoring system or "common platform" should be implemented for national security reasons and for monitoring revenues from VoIP service providers. The government decided to allow VoIP in four areas (Dhaka, Chittagong, Sylhet & Bogra) after introducing the common platform for channeling of Internet phone calls.

Meanwhile, interest groups used political influence to slow down BTTB's move to establish the common platform, forcing BTTB to re-work it. In October 2006, BTRC tried to issue VoIP licences without the common platform. The process of issuing licences was then halted, following a High Court stay order. This meant that within Bangladesh, there was no legal framework to provide VoIP, although BTTB was using VoIP for its international traffic.

Nevertheless, despite the legal ambiguity, VoIP operations were on the rise. At the start of 2009, they accounted for more than half of overseas traffic in Bangladesh. BTRC's newly appointed chairman, Zia Ahmed, assured gateway operators in 2009 that the Commission would crack down on illegal operators.[23] Meanwhile, a Parliamentary Committee recommended legalizing VoIP in order to increase the government's revenues from the telecommunication sector.[24] The Committee has asked BTRC to explore the technical and legal process for legalizing the use of VoIP.

Source: "VoIP and relevant Issues: Bangladesh's Context", by Md. Anwarul Kabir and Tamnun E Mursalin (2007) at: http://www.ict.developmentgateway.org/uploads/media/ict/Voice%20over%20Internet%20Protocol(Article).doc supplemented by additional update for the situation in 2009.

The impact of VoIP on an incumbent's revenues depends on its traffic structure. The CEO of Etisalat is on record as commenting in January 2008 that Etisalat did not expect a huge net effect from any future roll-out of VoIP, given the scale of its business in its 16 markets. The introduction of VoIP, however, could be "ultimately good for the economy, because we have to adjust tariffs and fees".[25] Growth in the use of VoIP does not always mean that a country's incumbent operator will lose revenue. The new traffic volumes VoIP generates can compensate for the loss in circuited-switched telephony revenues (see Box 6), especially if countries take active steps to promote growth in their VoIP market shares.

Box 6: The Impact of VoIP in Bahrain

The impact of VoIP on the telecom revenues of a country depends on traffic volumes and the balance of traffic among national and international destinations. In Bahrain, during a 54-month period prior to July 2008, VoIP captured 60 per cent of all international minutes, and about 40 per cent of revenues. Even though Batelco lost international traffic market share, the overall market in Bahrain was still growing and there was still revenue to be made.

In response, Batelco launched its VoIP service for International Direct Dial (IDD) in October 2008. Batelco customers now can make IDD calls to worldwide destinations at reduced rates through VoIP fixed and mobile services. The VoIP service is accessed by dialing "122," followed by the country code (without 00) and then

the desired number.[26]

Fixed-line operators wishing to offer VoIP services hope that the resulting rise in traffic volumes – both from increased subscribership and more minutes of use – will compensate for any loss in margins. In developing markets, where there is still significant untapped demand, it is likely that growth in volumes from winning new subscribers and reducing consumer prices may help compensate incumbent operators for the loss of higher-margin, circuit-switched international voice revenues.

By offering VoIP services, moreover, incumbents can save operational costs, as VoIP is a less labour-intensive technology. Incumbents also can leverage the advantages of their brand names and existing customer bases. Operational costs of legacy circuit-switched equipment can be high, at around 20 per cent of the original capital value of the systems. IP can reduce operational costs, and incumbents can compete against newcomers by leveraging their cash resources and customer bases, reyling on key differentiators such as QoS and customer service. Incumbents can also introduce value-added services and content. As VoIP continues to evolve, and its quality approaches what consumers expect from traditional telephone, more established carriers will be able to reach out with advanced IP-based solutions for the most demanding corporate customers.

Source: Adapted from "Living With VoIP", available at: http://www.itp.net/news/523624-living-with-voip?start=1.

As VoIP blurs boundaries between voice service and content, PSTN operators concerned about the impact of VoIP on their revenues could consider enhancing their revenues through value-added services, which IP networks can provide. Internet industry players such as Google and eBay have been quick to exploit and adapt advertising models to their needs (indeed, advertising accounted for nearly 97 per cent of Google's revenues in 2008).[27] VoIP providers -- or PSTN incumbents diversifying into consumer VoIP markets -- could consider how value-added services and advertising could enhance their offerings and supplement their revenues.

VoIP providers are often also ISPs, or can become ISPs, so they can expect revenue not only from VoIP telephony, but also from other cash-flow sources, including product support and telemarketing. VoIP telephony can facilitate call-center and outsourcing support businesses. Besides these, Internet Protocol Television (IPTV) or digital television services, delivered over the Internet, can be sources of income for the Internet industry, including VoIP providers. One example of such a service is Skype's video distribution platform, dubbed "Joost."

Existing VoIP providers are already exploring other sources of income. For example, users of Vonage's enhanced "411" information service can find out about weather, horoscope and other regularly updated services. They can also find out about virtual numbers, number portability, "Numbers for Life" and voicemail messages that are automatically transcribed into text messages and forwarded to their mobile phones. As VoIP protocols are compatible with other existing Internet protocols, VoIP providers can enhance their telephony offers with Internet services (see Box 7). Advertising is another major potential source of additional revenue for VoIP providers.[28]

Box 7: VoIP, Broadband, New Services and Applications

The IP-enabled world allows service providers to package and integrate voice service with numerous applications, including:

- Presence detection (instant messaging, "find me" services);
- One number/"follow me" services;
- Universal messaging;
- Virtual meetings/collaboration at the individual and enterprise levels;
- Real-time language translation;
- Multipoint video-conferencing;
- Push-to-talk cellular;
- Voice chat;
- Gaming;
- E-health applications; and
- E-education.

Now that voice can be just one more application in an IP network, innovation is occurring rapidly. Users are finding VoIP services attractive, regardless of which country or region they live in. The first benefit users often experience is reduced costs. So naturally, some users see VoIP as merely a way to avoid the high cost of some telephony offerings. But the greatest benefits occur when there is a broadband architecture at both ends of the network — the so-called "last mile" segments that reach the customers' premises. Users who already have high-speed Internet — whether broadband wireless, DSL or cable — can subscribe to a high-quality VoIP service and get the benefits of "all distance" calling, including integrated features that formerly were reserved for business enterprises. Examples of these features are personal tele-conference bridge services and "follow me" services.

For some broadband users, then, VoIP is driving the roll-out of residential and enterprise broadband services. At the same time, growth of broadband deployment is encouraging the adoption of VoIP.

Source: "VoIP Deployment and Regulation in Asia", Konrad L. Trope, available at: http://www.abanet.org/scitech/annual/2006/pdf/6.pdf.

3 Regulatory Approaches to VoIP

The global growth of VoIP raises a host of issues for regulatory frameworks that were, after all, designed mainly for the PSTN world (see Table 1). Some of these issues impact all markets -- for example, QoS concerns -- while other issues vary and evolve with the level of market maturity. These variable issues may relate initially to universal service, licensing, numbering and access to emergency services. Later on, net neutrality, market size, and pro-competition concerns come to the fore. This section explores the regulatory issues raised by VoIP around the world, as of mid-2009.

The main regulatory issues involve whether or not to regulate VoIP as a substitute for PSTN telephony, and whether VoIP regulation should differ from regulation of traditional telephone services. Regulators may want to ensure a "level playing field" between existing operators and new VoIP market entrants in the areas of

universal service, access to emergency services, and numbering portability. At the same time, however, many regulators are anxious to avoid disproportionate regulatory interventions that could stifle innovation, dissuade entry by new competitors, or dampen investment in new services and networks.

Table 1: VoIP Regulatory Issues

Early VoIP Market	Maturing VoIP Market	Mature VoIP market
Defining VoIP & considering its legality Issues of illegal termination & "grey market" bypass Licensing Numbering Quality of Service (QoS) Universal Service Promoting competition, innovation, investment.	Illegal termination & grey market bypass Regulatory capture Universal service QoS Access to emergency service numbers Number portability.	Illegal termination & grey market bypass Location correspondence Security of transmissions Net neutrality & blocking Consumer protection Concerns with market size & how to grow the market. (Anti-)competitive issues.

Source: ITU.

Many developing countries retain telecommunication laws and regulations that pre-date the explosion of VoIP services. Indeed, the PSTN and IP worlds will continue to co-exist for some time yet. Legacy obligations that worked well for the PSTN and competitive mobile networks can coexist with growth in VoIP services, but it is difficult to apply them directly to VoIP services. Obligations that were appropriate for PSTN operators are not automatically proportionate for VoIP-based service providers. For example, access to emergency service numbers and lawful intercept mechanisms are both more problematic to achieve in a packet-switched VoIP environment. VoIP service providers argue that requirements to provide these services constitute a competitive barrier to entry into certain markets or for certain services.

Recognizing the difficulties of translating existing regulatory frameworks into the IP world, the European Commission advocated a "light regulatory touch" when it first examined VoIP regulation in 2004. The United States took a similar initial approach, but VoIP is becoming more regulated over time in the United States, especially in the context of security concerns (whether and how VoIP traffic can be monitored) and access to emergency call services.

Incumbents argue that if regulators fail to impose the same or similar regulations or licensing requirements on VoIP providers, incumbents will have fewer incentives to invest in the underlying network infrastructures that everyone needs -- including VoIP providers.[29] It is not always clear how the "level playing-field" concept applies to incumbents that own networks, as well as the VoIP service and application providers that use those networks. Indeed, competition between facilities-based and service-based competitors is taking on new importance in debates over QoS, "net shaping" and traffic blocking.

For the future of their telecommunication markets and their country's economic competitiveness, regulators have to tackle the IP transition head-on. If they fail to do so, they risk tying their countries to networks that are increasingly obsolete, condemning consumers to a future of higher costs in exchange for fewer or reduced capabilities. Countries that do not take action risk being left behind in everything from broadband access to cheaper phone calls in the new information economy.

3.1 Defining VoIP

Defining VoIP is central to any regulatory approach, as well as to measuring the growth of the service in any given market. The basic question for regulators is whether VoIP can be viewed as an alternative to PSTN telephony or not. The service is the same (voice transmission), but the method of transmission (the technology) is different. All forms of VoIP involve the digitalization, conversion, and compression of recorded voice signals into data packets, which are transmitted over an IP-based network, to be reassembled and converted back into audio communications at the other end of the network. The packets may then be transmitted over either the public Internet or a private network, or both.

For regulators concerned with the quality and content of services, the tough questions they must ask themselves are, "Which services must be regulated and to what extent – and should any services be exempt?" Even in countries with well-defined regulatory frameworks, discrepancies are apparent. For example, in the United States, Skype is not required to provide access to emergency calling services (and does not provide access), but Vonage is required to (and does).

It is not necessary to tailor regulations for VoIP to enjoy the benefits of a strong retail VoIP market. In New Zealand, for instance, VoIP services are viewed as fully equivalent to PSTN voice telephony, and identical regulatory treatment applies to both. The VoIP market has grown rapidly in New Zealand. In Brazil, regulatory frameworks for the provision of telecommunication services have not been tailored to accommodate VoIP, yet Brazil also enjoys a vibrant consumer VoIP market. Some countries get by with telecommunication laws that have not changed at all over the last decade, despite the rise of IP-based networks. Indeed, under a technology-neutral licensing approach, it may not even be necessary to denote individual technologies in licences -- the market decides how best to meet the licence obligations.

In practice, a broad range of regulatory definitions is used for VoIP (see Table 2). A vital part of regulators' work is to establish a relevant definition of VoIP, as it applies to their market. Regulatory definitions of VoIP and VoIP providers have major implications, not only for regulation, but also for the development of the market, as well as competition and innovation. Common regulatory criteria that define VoIP (often used interchangeably with *Internet telephony*, *IP telephony* or v*oice over broadband*[30]) include:

- ***Degree of transmission over the PSTN*** – This is one of the most commonly used criteria to define VoIP. That is, definitions may vary according to whether the service is a phone-to-phone, PC-to-phone (or vice versa), or PC-to-PC offering. This can also be expressed as a service that is either "on-net," "inbound," "outbound" or bi-directional. Countries using variations of these criteria include Barbados, Brazil, Chile, Israel, Jordan, Norway and the UK.

- ***VoIP as a voice or data service*** – Some countries view VoIP as a voice service, while others view it as a data, "value-added" or "information" service. For example, Bolivia, Czech Republic, Egypt, Jordan and the United States view VoIP as data, while Dominica calls it voice.

- ***Nomadic or non-nomadic services*** – This establishes whether the service can be accessed in more than one fixed location. This definition implicates geographic numbering allocation and is applied in some European countries (see Table 2);
- ***"Technology" or "Service"***-- Whether VoIP is viewed as a technology or service has implications for technology-neutral licensing and regulatory frameworks.
- ***"Telephone" or "electronic communication" service*** – In Europe, where regulatory frameworks for VoIP are well advanced, countries have widely differed in their classification of VoIP (see Table 3), with significant consequences for regulation.

Table 2: Main Categories of Definitions or Distinguishing Features*

Definition	Examples (among others)
Quality of service (*now obsolete*)	Japan, India
Equipment & architecture, *and/or*	India, Israel, Japan, Malaysia, Saudi Arabia, Spain
Functionality	Hong Kong (China)
Numbering system	Japan, Taiwan (China)
Voice over Broadband	Austria, France, The Netherlands
Whole or part-provision of service over IP/PSTN	Bahrain, Barbados, Brazil, Chile, Israel, Jordan, Kenya, Norway, UK, ITU. Canada does not regulate PC-to-PC.
Technology or service	Saint Lucia, most of Africa.
PSTN, inbound and outbound	Australia, UK.
By service	Some countries distinguish between VoIP services in whether: VoIP is viewed as voice or value-added service (Bolivia); VoIP is viewed as a data or information service, as opposed to a voice service (Czech Rep., Egypt, Ghana, Jordan, US); Nomadic or non-nomadic services (Iceland, Italy, Portugal, Spain).
Users/usage	Some countries distinguish VoIP according to its users: Public or closed group of end-users (e.g. Chile); Corporate/residential use (e.g. Ghana, Tunisia, formerly Australia).

Source: ITU research.

Some regulators are now revising their definitions. By 2006, Japan and India both had revised their initial definitions of VoIP (which had been based on QoS) in favour of definitions based on infrastructure. QoS is less relevant today from a technological perspective, but some jurisdictions (Hong Kong, China, for example) consider which services are available over VoIP (e.g., emergency calling or directory services) as criteria to classify their VoIP services.

In April 2008, Australia updated its first definition of VoIP (based on peer-to-peer, corporate or residential usage categories) in favour of a definition based on on-net VoIP service, inbound or outbound or two-way communication service. Barbados also replaced its original definition of VoIP as a data service, with one based on the degree of provision over the PSTN. In 2007, Jordan adapted its definition, which had been based on degree of service over the PSTN, to one based on "primary and secondary line services."[31] Definitions of VoIP need to be flexible and may need to be revised regularly to reflect market developments and changing regulatory objectives.

Table 3: Different Classifications of VoIP Services in Selected European Countries

Country	Classification
Austria	Class A is a Publicly Available Telephony Service (PATS). Class B is not regulated.
Belgium	Electronic Communication Service (ECS) offered to the public for the purposes of conveying speech wholly or partly over an IP network, with at least one network connection point connected to an IP network.
Bulgaria	ECS
Czech Republic	ECS
Denmark	Five categories of VoIP identified in March 2005 after public consultation, of which four are viewed as ECS services and regulated. Peer-to-peer communication without possibility to make/receive calls over PSTN is not ECS and is not regulated.
Estonia	PATS
France	ECS and PATS possible; recommendation to register as PATS. France distinguishes between Voice over Internet (VoI) and Voice over Broadband (VoB).
Germany	ECS; no statement as to whether PATS or not by 2007.
Italy	PATS or nomadic voice communications service.
Latvia	ECS
Malta	VoIP software, which do not offer access to/from PSTN and are not ECS. (2) Services which qualify as ECS, but not as PATS (e.g., where service excludes

	national, international, incoming & outgoing calls). (3) ECS also qualifying as PATS.
The Netherlands	PATS and ECS.
Norway	(1) VoB offerings unable to make/receive calls from the POTS. E.g. plain Skype. (2) VoB offerings for either making or receiving calls from POTS (not both). E.g. SkypeOut. (3) Any-to-any communications for both calling & receiving calls to POTS.
Poland	Telecommunications service (no PATS)
Portugal	In February 2006, ANACOM distinguished between: (1) services from single fixed location and perceived by users as equivalent to traditional PSTN and regulated as a regular PSTN service; and (2) nomadic services.
Spain	ECS (PATS if service meets all requirements); nomadic communications (ECS).
UK	Peer-to-peer (not ECS); VoIP In, VoIP Out (PECS); VoIP In & Out (PECS or PATS).

Source: WIK/Cullen International (2007) and ITU research.

Notes: PATS – Publicly Available Telephony Service. (P)ECS – (Public) Electronic Communications Service. PSTN – Public Switched Telephone Network; POTS – Plain Old Telephony Service; VoB – Voice over Broadband; VoI – Voice over Internet; IP – Internet Protocol.

3.2. Quality of Service (QoS)

QoS, or rather the lack of it, has historically been one of the chief concerns surrounding VoIP, both for operators and for regulators and consumer associations. With PSTN telephony, the operator has a high level of control over call quality -- either the call goes through or it fails to connect. In contrast, VoIP is subject to variable quality, with packets delivered on a "best-effort" basis. Indeed, QoS metrics are sometimes used to define VoIP, as was the case in Hungary, where calls below certain quality threshold levels (e.g., a 150 millisecond delay) were defined as VoIP and therefore outside the then-monopoly purview of the incumbent operator.[32]

Packet loss during transmission can be compensated for technologically by filling in gaps in data delivery, a process called *packet-loss concealment* (PLC). Other methods to ensure completeness of packet transmissions include: (1) sending duplicate packets multiple times (*redundancy*), and (2) including some overlap of data within packets to allow reconstruction of lost packets (*forward-error correction*). Packets can also be delayed through jitter (which is a particular problem for voice). Jitter can result in choppy audio or temporary glitches, so VoIP devices must implement buffer algorithms to compensate for the problem. PLC algorithms can also smooth the audio and compensate for late arrival of packets (which are then discarded).

QoS remains a major issue but it has improved, mainly due to the greater availability of bandwidth and faster connection speeds of broadband. The major prerequisite of modern VoIP is a broadband connection, with different speeds for different types of usage (see Box 8). When the Internet first became widespread in the mid-1990s, most end users had a 56 Kbit/s modem. Had VoIP been available then, it easily would have consumed 32 Kbit/s of the bandwidth available at any given point in time. Today, connections measured in Mbits/s are common in industrialized countries, with VoIP still only consuming the same 32 Kbit/s of

bandwidth. Technological developments such as *meta-tagging* (the use of additional data or "meta elements" to define and locate content such as web pages more efficiently) and *tunneling protocols* (enabling delivery of packets over otherwise incompatible protocols) also make QoS less of an issue.

Box 8: VoIP Quality and Bandwidth Issues

Customers need to have broadband access, because the bandwidth required for VoIP services can vary, according to their desired usage:

- A speed of 256/64 Kbit/s is adequate for one phone call if the connection is not being used for any other applications.
- A speed of 512/256 Kbit/s is suitable for residential use.
- A speed of 512/512 Kbit/s would suit a small office.
- Dial-up Internet connections with maximum speeds of less than 56 kbit/s can be used for VoIP calls, but they will be of significantly poorer quality.

Download limits are also important. Light VoIP usage consumes around 200 MB a month. Medium usage is about 600 MB, and heavy usage averages around 20 GB per month.

Source: Adapted from ACMA, "Introduction to VoIP" and "VoIP Quality", available at: http://www.acma.gov.au/WEB/STANDARD/pc=PC_310763 and Australian Communications Alliance, "So you want to have a VoIP service?" 2nd edition, June 2007, p. 14, http://www.commsalliance.com.au/Activities/ngn_voip

While the quality of VoIP may be improving for most consumers due to greater bandwidth, users are now consuming much more bandwidth through applications such as video streaming and music downloads. This is starting to cause significant bandwidth problems in some countries, such as the UK.[33] QoS, therefore, remains very important at the end-user level.

In the core of the network, service providers usually have far more bandwidth than they need to transmit voice packets successfully, although concerns have already been expressed about the levels of investment needed to meet growing demand for bandwidth. The global cost of upgrading the Internet to keep pace with demand has been estimated at USD 137 billion over the next five years, with network operators in North America spending 60-70 per cent less than they should be.[34] Analysts project that demand will exceed total broadband capacity at the access layer of the Internet by 2012, and an additional USD 42-55 billion will be needed to upgrade infrastructure.[35]

3.3 Network Management and `Net Neutrality'

QoS is now taking on new meaning in network management and what is known as *network neutrality* – often shortened to "net neutrality." That is the term used by content or VoIP providers and others who favour equal treatment of content and access to operators' networks. Operators are increasingly attempting to block, limit or even degrade certain kinds of traffic, arguing that bandwidth limitations require them to set priorities over use of their own networks. This has immediate implications for prioritization of traffic and for the quality (or degradation) of VoIP that service providers offer over other operators' networks.

At present, there is little clear regulatory guidance in most countries on this issue, although the experiences of Canada and the United States offer some insights into how these issues are evolving. The Canadian

Association of ISPs has filed a complaint with the Canadian Radio-television and Communications Commission (CRTC) against Bell Canada's traffic management practices, alleging that the operator engaged in "application-based throttling" of other providers' content. In the United States, meanwhile, consumers have been increasingly concerned by allegations that AT&T and Verizon had begun treating VoIP and IPTV traffic differently from other types of traffic, in order to maximize their networks' efficiency. Consumer groups feared that other ISPs would follow the operators' lead by creating "tiered service levels" that would favour some types of traffic over others. AT&T's purchase of BellSouth in December 2006 was only given regulatory clearance after AT&T committed to "net-neutral" behavior – at least for the first 24 months after the merger. The net neutrality debate has also surfaced in discussions of broadband network funding included in the U.S. economic stimulus package enacted in early 2009.[36]

Meanwhile, Bahrain's Telecommunications Regulatory Authority (TRA) was concerned about possible degradations in service due to network management. As Rob Middlehurst, director of market and competition at Bahrain's TRA, noted:

There is a quality impact, which we have to consider. Providing traffic is sent out on routes that are recognized, then quality at a certain level is maintained and there are international standards for a 150 millisecond delay in VoIP on international calls, which is acceptable. But if providers start using grey or black routes (the public Internet, for example) as a means to cuts costs, then that does create problems. We've got to migrate consumer services and inter-operator services into an IP world, and that comes down to the quality measures required. If VoIP is voice and technology-neutral, then there are existing quality measures in place regarding delay [and] echo, and they have to be managed the same in the IP world as they are in the PSTN world. From a consumer perspective, we would not want to see a degradation in service.[37]

The Jordanian Telecommunications Regulatory Commission (TRC) has recognized that as long as Jordan Telecom retained a *de facto* monopoly over the physical provision of local loops, regulatory oversight was needed to protect QoS for DSL providers, which lacked end-to-end network control.[38]

Box 9 Network Blocking – VoIP, But Only on My Terms

VoIP is clearly a disruptive technology. It has the power to topple traditional technical, business and regulatory models. Having that power and using it, though, are two different things. VoIP could just as easily become a tool of entrenched telcos, part of the *status quo* the telcos are trying to protect, rather than the competitive turmoil which they are trying to prevent.

The front line in this epic struggle between the incumbents and the insurgents for control of a rapidly evolving technology is the effort by telcos to block competitors' access to provide VoIP on their networks. VoIP blocking actually has a long and colourful history in much of the world. Blocking can be as blatant as closing a router port or as subtle as forgetting to follow up on certain kinds of incident reports.[39] It can be either regulatory or technical (although regulatory blocking usually requires technical enforcement). In both cases, it has long been a means for established telecom companies to try to cripple VoIP's potential to bring revolutionary changes to their markets.

Skype's traffic is harder to identify than most VoIP traffic, because (1) Skype uses proprietary protocols, (2) its traffic is encrypted and (3) the traffic is routed from peer to peer (P2P) using a random combination of IP addresses and ports that defeats traditional port-blocking filters. That means Skype's traffic can be blocked

only by investigating the headers of every Internet packet crossing the network in order to find the "Skype" ones. The challenge is to do this quickly enough so that other services are not degraded. Narus claims its software can do this, and a major European customer has confirmed this. A proxy appliance, widely used to apply controls to web traffic, can also be used to block specified unwanted traffic (including voice calls) if necessary.

If blocking is defined as "inadvertently" making it hard for someone else's VoIP traffic to get through with good voice quality -- or even failing to make VoIP transmission easy -- it will be hard to stop blocking entirely. One analyst suggests that the question ultimately is whether the network operator, or the service provider, is responsible for figuring out why the service is performing poorly. As long as a VoIP service performs poorly, it opens up opportunities for network operators to offer their own VoIP services. The incumbents' QoS is guaranteed to be high, but the potential for revolutionary effects on competition will be low. That may be effective as a way of protecting big-carrier VoIP services -- and traditional telco models.

Source: Adapted from "Will VoIP Join the Telco Counter-revolution?" by Robert Poe at: http://www.voip-news.com/feature/voip-telco-blocking-071406/, supplemented from http://www.guardian.co.uk/technology/2006/apr/06/voip.telephony.

3.4 Universal Service

Universal service issues are a concern for both developing and industrialized countries. In the United States, lobbyists have sought to persuade the FCC to apply a Universal Service Fund (USF) surcharge to all VoIP providers, and popular VoIP providers (such as Net2Phone) have to include a universal service surcharge in their pricing. Issues of universal service are again coming to the fore in the allocation of federal broadband stimulus funds, in the definitions of 'unserved' and 'underserved' areas.

Proponents argue that universal service obligations (USOs) -- i.e., requirements to provide for or financially support universal service -- are badly needed and essential to ensuring greater broadband service. Similar arguments may apply to VoIP services, in the view of some regulators. For VoIP services, which may be provided within the content layer, it is unclear whether USOs should apply and how they would affect competition between existing operators and new entrants. If USOs only apply to incumbents, those incumbents will argue that they face unfair burdens and discrimination. Conversely, where USOs apply to all VoIP providers, they may be viewed as a potential barrier to entry, eating into profits of new entrants and discouraging market entry.

According to ITU's latest data for 2007/2008, 77 per cent of countries for which data are available have defined universal service policies. In comparison, 43 of 98 countries (43 per cent) have required VoIP providers to contribute to universal service. Some of these obligations relate to USOs imposed on incumbent operators, which now provide VoIP services. This suggests that universal service is not a major issue in the regulation of VoIP.

3.5 Access to Emergency Service Numbers

Access to emergency service numbers, however, has proved more of an issue in some countries. It is one of the major obligations of Publicly Available Telephone Service (PATS) in Europe. The UK and Irish regulators have had extensive consultations on this subject, as has Hong Kong (China), which has defined two different categories of VoIP service providers (Class 1 and Class 2). Both classes of service provider must provide access to emergency services and to reserve power, but they differ in the requirements they face for number

portability and numbering. Class 1 is equivalent to PSTN voice service with number portability, but Class 2 lacks numbering rights.[40]

Many regulators continue to be concerned about VoIP custmers' ability to access emergency service numbers, as well as location correspondence (and, implicitly, the use of geographic or non-geographic numbering). Issues with QoS mean that VoIP emergency calls may not always connect, while power outages could render VoIP phones useless.

There is also a related issue of customer education. VoIP customers may not always be informed in advance that their access to emergency services may be abridged, and they may not understand these risks fully. Furthermore, VoIP telephone numbers are not necessarily associated with a fixed physical address or geographical location as traditional PSTN numbers are, so a VoIP caller's location cannot always be automatically determined. Major consumer protection issues arise -- not only whether emergency services can locate VoIP callers, but also whether ISPs and VoIP providers are required to inform users clearly about the limitations of VoIP services.

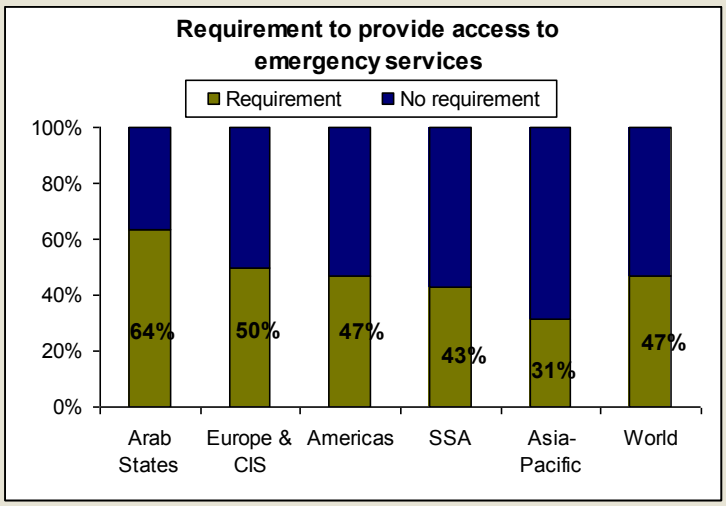
In the United States, the FCC required in 2005 that interconnected VoIP providers must provide access to enhanced 911 (E911) services.[41] That would enable VoIP callers to reach local 911 services from wherever they were. However, VoIP providers objected to the expense and technical difficulty of creating a comprehensive capacity for access to emergency services. Eventually, the FCC negotiated a compromise, whereby consumers were required to inform VoIP providers of their fixed addresses. The order also stated an intention eventually to adopt an advanced E911 solution that could determine customer locations without requiring the customer to provide and update the information. VoIP providers have been directed to build automatic location awareness into their VoIP services over time.

Wireless VoIP customers are especially susceptible to gaps in their access to emergency service numbers. While emergency calls from VoIP customers with a fixed service address can be handled in a way similar to landline calls, the process is quite different for nomadic VoIP calls, which can originate from pretty much anywhere.

According to ITU's annual survey of ICT regulatory agencies, nearly 47 per cent of all countries with VoIP regulations required VoIP providers to provide access to emergency services in 2008 (see Figure 5). However, some regional differences were apparent. Nearly two-thirds of all Arab states and half of all European countries required VoIP service providers to provide access to emergency services. Alarmingly, there was no consistent European policy requiring VoIP operators to inform end-users about limitations to their service.[42] Some Member States had such a requirement, while other did not. In addition, as of 2008, requirements for routing VoIP calls to local emergency call centres varied across the European Member States.

In Africa, 43 per cent of sub-Saharan African countries where retail VoIP was legal or tolerated required VoIP service providers to provide access to emergency services – mostly due to requirements imposed on incumbents, which were often the only VoIP service providers in these countries. Intriguingly, Asia-Pacific is the region where the lowest proportion of countries has imposed emergency access requirements (only a third). The low regulatory priority given to emergency access may reflect a desire to encourage market entry by new and innovative service providers.

Figure 5: Requirements to Provide Access to Emergency Services, 2008



Source: ITU.

Note: ERG (2005) and Wik Consult (2008) proportions for Europe are considerably higher, as they have omitted countries where data was not readily available. The ITU Annual Regulatory Questionnaire was answered by a much higher proportion of Eastern & Southern European countries, giving a lower overall proportion.

3.6 Numbering

Issues related to numbering include:

- **Whether separate numbers should be allocated to VoIP providers**. Should existing fixed telephony (E.164 numbers) be permitted for VoIP services, or should an entirely new number system be developed? Using the same system may be simpler, more consistent for consumers, and more interoperable. On the other hand, using clearly defined VoIP numbers would enable consumers to recognize VoIP offerings and understand any potential service limitations (such as for QoS or emergency calling services) more easily. One solution: Hong Kong (China) uses prefixes to distinguish between the different classes of VoIP numbers.

- **Whether VoIP numbers should be geographical and/or non-geographical**. Should numbering for nomadic or non-nomadic VoIP services be based on a geographical allocation? In Italy, both geographical and non-geographical numbering systems are possible. This issue is linked to location correspondence and increasing consumer demand for numbers decoupled from locations. For example, UK residents may wish to take a geographic phone number to Greece or a Canadian may wish to transfer a phone number to Florida. These services are now regularly offered by VoIP service providers in some countries, but they are prohibited in others. This gives some VoIP providers a competitive edge across certain regional markets. European directives do not specifically indicate the criteria for assigning geographic or non-geographic numbers, or to whom they should be assigned.

- **Whether numbers should be "portable."** Can consumers keep the same phone numbers when changing services? If not, many consumers may hesitate to switch to VoIP providers, putting them at a competitive disadvantage to traditional telcos.

According to ITU's most recent data, just over half (55 per cent) of all countries with a VoIP regulatory framework permitted the allocation of PSTN numbers to VoIP service providers in 2009. European regulators tackled numbering issues early on, and issues of numbering and number portability continue to feature high on the regulatory agenda. A 2005 European Regulators Group (ERG) common position document summarized the problem in Europe:

> "In this area, the result of current regulation is a disharmonised allocation and use of geographic numbers, against the increasing demand amongst consumers to use geographic numbers out of area (nomadic use). Some Member States permit out-of-area use and allocation of geographic numbers, while others do not".

The ERG has argued that numbering plans should be technologically neutral and based on service descriptions. Further, the same number ranges should be available to all providers of each described service category, so that geographic numbers for both traditional telephony and VoIP services could share the same number range and come from a common "number pool". For number portability, ERG suggested requiring numbers to be ported to any service provider in the same defined service category.

In some European countries, number portability remained limited only to PSTN operators in 2008 (for example, Austria, Estonia, Italy and Spain). In others, however, number portability was also possible for *electronic communications service* (ECS) operators (for example, Denmark, the Netherlands and Germany). Given that classifications of VoIP as either *publicly available telephony service* (PATS) or ECS differ markedly among European countries (see Table 3), number portability is still a tricky issue for European regulators, with implications for consumer protection and competitive advantage.

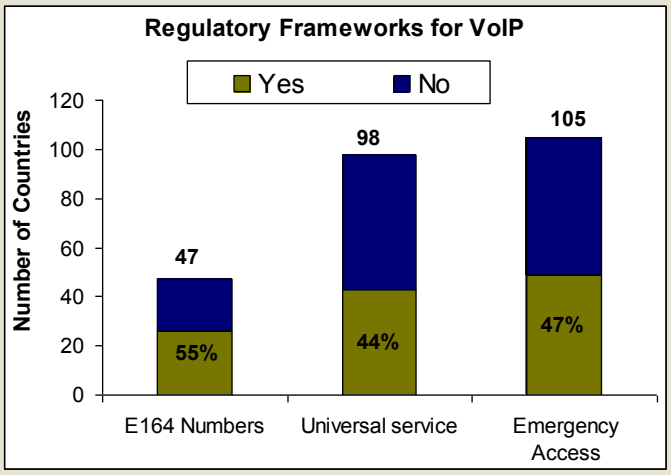
4 Adapting Regulatory Frameworks for VoIP

4.1 Adapting to the VoIP Transition

Adapting regulatory frameworks to accommodate the transition to IP-based networks takes time, considerable resources and, quite often, repeated attempts. The countries where a clear and well-established framework exists for the provision of VoIP services have only achieved this through a process of regular and repeated consultation. And even when such a framework is in place, the difficulties may only be starting. As the discussion in the previous section indicated, network management and anti-competitive practices are emerging as issues even in countries with established regulatory models. The regulation of VoIP is an ongoing process that requires regular attention as new issues emerge.

According to ITU's latest data, countries' VoIP regulations differ widely (see Figure 6). As discussed in Section 3.5, the requirement to provide access to emergency services is a key consideration, as are universal service obligations and numbering allocations. More than half of all countries responding to ITU's survey question on numbering indicated that they had allocated E164 numbers to VoIP providers.

Figure 6: Regulatory Frameworks for VoIP around the World, 2008



Source: ITU.

Note: These totals include the 81 countries which had explicitly legalized VoIP in 2008 and the 31 countries which tolerated VoIP, despite having no specific framework for it yet. In some cases, survey questions have been interpreted by respondents to include PSTN requirements which are automatically transposed to VoIP.

Meanwhile, questions of whether and how to apply and interpret pro-competition policy for the VoIP market remains largely unresolved. If regulators find it difficult even to define VoIP as a service, technology or application, how much harder is it for them to accommodate VoIP within their competition rules? This would require redefining competition between relevant markets and describing the substitutability of services. Then, regulators could begin to target anti-competitive practices by new market entrants as well as incumbents seeking to maximize returns on their network investments. The ability of regulators to regulate effectively in this area has major implications for investment, innovation and a country's long-term competitiveness.

So, what would a comprehensive regulatory framework for VoIP providers look like? It is not necessary to design a completely new regulatory regime to accommodate VoIP. In fact, while the transition to IP is ongoing, regulatory regimes for PSTN and IP-based networks are likely to co-exist for some time yet. Regulators must decide which regulations and requirements are important to retain, transfer or replace in the transition. As an example, Box 10 details the regulatory obligations of VoIP providers in Australia -- the result of ongoing consultations since at least 2004. The Australian Communications and Media Authority remains concerned that the VoIP market is lagging behind its potential, and it continues to monitor and publish regular analytical reports on VoIP growth.

Box 10: The Australian Experience - Obligations of VoIP Providers

Australian VoIP service providers are generally categorized as *carriage service providers* (CSPs), which are subject to provisions of the *Telecommunications Act 1997,* the *Telecommunications (Consumer Protection and Service Standards) Act 1999*, and related legislation and standards. These include:

- Participation in a dispute-resolution programme known as the Telecommunications Industry Ombudsman (TIO) scheme
- Provision of free access to "000" emergency numbers

- The Numbering Plan – Telecommunications Numbering Plan 1997
- Integrated Public Number Database (IPND) notification
- Number portability
- Privacy of customer information
- Calling line identification
- Conformance with industry codes and standards
- A range of public interest obligations including:
- Law enforcement (for interception and national interests)
- Defense and natural disaster assistance

VoIP Providers offering a "Type 4" two-way service enabling customers to make calls to (and receive calls from) users of the PSTN may be considered to be providing a *standard telephone service* as defined by section 6 of the *Telecommunications (Consumer Protection and Service Standards) Act 1999*. This necessitates several further obligations, including:

- Adherence to a customer service guarantee (CSG) known as the Telecommunications Customer Service Guarantee Standard 2000.
- Operator services
- Directory assistance
- Access to the National Relay Service
- Itemized Billing.

Source: VoIP and Legislation, Codes & Standards at: http://www.acma.gov.au/WEB/STANDARD/pc=PC_311047

4.2 VoIP over Wireless Networks

There are increasing issues stemming from the provision of VoIP over mobile and other wireless communication systems. The ability of mobile broadband users to access Skype using iPhones in Europe has led certain operators to block Skype access over their networks to prevent loss of revenues. VoIP over 4G networks ("Vo4G"), including the provision of voice over WiMAX or LTE, is another potential growth market. One analyst notes that the technological challenges in guaranteeing QoS for IP voice delivery over wireless are still significant, and delays are longer than for wired networks.[43] This is a natural result of the fact that wireless bandwidth is generally lower at around one-tenth of that of the lowest-bandwidth wireline technologies. However, these challenges should diminish over time, as technological advances make QoS less of an issue, even for wireless technologies.

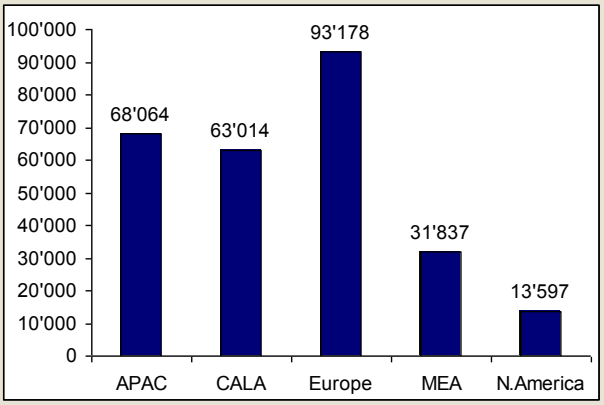
Due to limited spectrum allocations, wireless systems are nearly always bandwidth-constrained and spend a large proportion of time at or near full capacity and at risk from interference by other spectrum uses. Voice transmission requires packets to arrive in a timely, continuous, bidirectional stream, with end-to-end QoS. VoIP over wireless networks therefore demands particular attention. According to the consulting firm Maravedis, this means that "the majority of wireless networks today still continue to deliver voice in the traditional manner, over a completely separate TDM network". This will likely change, however, as the technical challenges of delivering VoIP over WiMAX and LTE are gradually overcome.

Considerable care was taken in the development of WiMAX specifications to ensure that it could support VoIP gracefully. However, since there are several QoS types offered by WiMAX (with both fixed and variable

bandwidth allocations possible), it is largely up to equipment vendors to decide how to classify VoIP packets and apply QoS standards. So vendor selection has proved pivotal -- and VoIP performance over WiMAX can vary considerably. LTE has only two QoS types (non- and Guaranteed Bit-Rate) and can leverage off existing networks to ensure a more uniform transition to VoIP. Nevertheless, QoS concerns will be paramount for regulators with all of the wireless forms of VoIP.

Maravedis has estimated that the cumulative numbers of voice-over-WiMAX subscribers remain low worldwide, at less than 300,000 or about 20 per cent of the total WiMAX subscriber base. Europe leads the way with a 35 per cent market share of voice-over-WiMAX subscribers, while Asia-Pacific accounts for a further 25 per cent of all subscribers (see Figure 7). In terms of revenues, voice does not make up a large component of total revenues for most WiMAX service providers.

Figure 7: The WiMAX Voice Subscriber Base (Cumulative), by Region, 2008

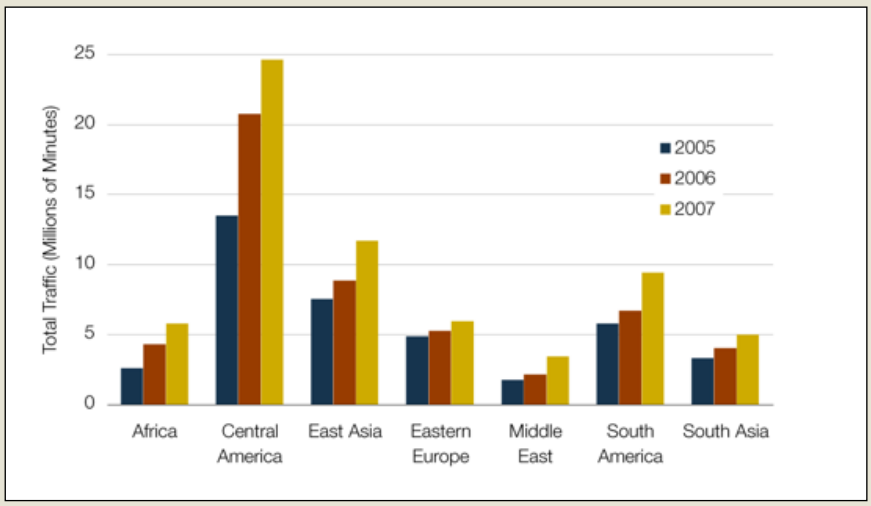


Source: Maravedis Research

5 Regional Perspectives on VoIP Regulation

The regulatory challenges posed by the advent of VoIP are significant. VoIP is growing in a complex context that includes incumbents, competitors, government ministries, and regulatory agencies. Examples of regulatory capture may arise. In some countries, the growth of VoIP has led to clashes between new entrants and incumbents. In other countries, service-based entrants are being brought into conflict with facilities-based competition.

Figure 8: Inbound International VoIP Traffic, Selected Regions, 2005-2007



Source: TeleGeography Inc. (2008).

Some of the fastest-growing regions for international VoIP traffic are Central America and South America (see Figure 8). More restrictive regulatory frameworks in some Middle East countries, however, have tended to stifle growth in VoIP traffic in that region. South Asia also includes some countries (such as Pakistan or Bangladesh) that have historically had a difficult process with the regulation of VoIP (in common with other countries). This section examines regional approaches to the regulation of VoIP.

The following sections review how VoIP is regulated in various regions.

5.1 Africa

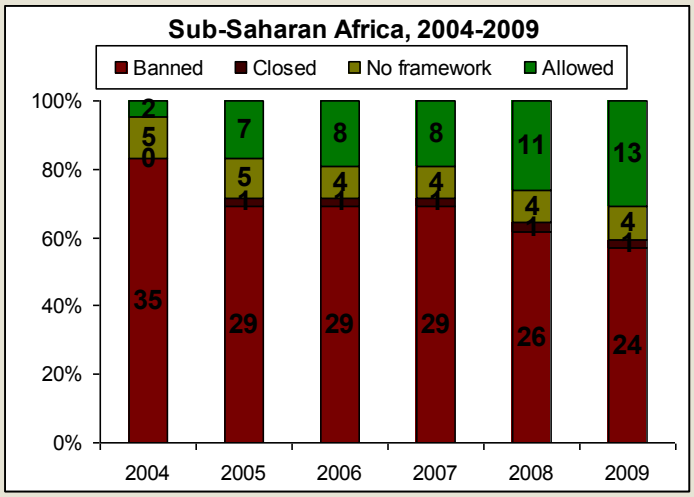
Africa has had a long and sometimes difficult experience with regulation of VoIP. ITU's *Trends in Telecommunication Reform 2005* noted that even as early as 2004, 20-25 per cent of all incumbent operators in Africa were using VoIP to carry at least part of their international traffic. Today, although most incumbents have adopted VoIP for international traffic, Africa remains more conservative in its regulation of commercial and residential uses of VoIP (see Figure 9). In Ghana, wholesale VoIP for corporate use is legal. However, in many African countries, VoIP services are not yet widely available as commercial services on the residential market. South Africa legalized VoIP as recently as 2005, as part of its broader market liberalization, while Nigeria's NCC announced its intentions to issue guidelines on VoIP the same year. Lesotho introduced ADSL in 2007, but has not yet legalized VoIP.

In 2006, some 30 out of 42 African countries forbade the widespread use of VoIP by regulation or by law. Eight countries permitted VoIP in various degrees (including Kenya, Mauritius, South Africa, Tanzania, and Uganda), with another four planning to legalize VoIP.[44] In practice, VoIP was tolerated in several additional countries, including Angola, Nigeria, Reunion, Seychelles, and Togo.

By mid-2009, VoIP had been legalized in 13 Sub-Saharan African countries, with a further four countries (Angola, Benin, Guinea and Sao Tome & Principé) tolerating VoIP. Ghana permitted limited use of VoIP for wholesale voice carriage over IP networks, but only for international traffic. The number of African countries

where VoIP could be regarded as "open to private operators" had nearly doubled, rising to about 20 (including North African countries).[45]

Figure 9: Regulatory Treatment of VoIP in Sub-Saharan Africa, 2004-2009



Source: ITU.

Note: Data cover 42 sub-Saharan African economies; no data available for the Central African Republic.

There is also evidence of substantial "grey market" activity. Budde Research estimated in 2007 that at least 10 per cent of international calls in virtually every country in Africa were still carried by unlicensed grey market players, because "many operators are not yet passing on the full cost savings from VoIP to their customers" -- allowing arbitrage opportunities to persist.[46] For example, in Sudan, the operator Canar reported that incoming international calls using grey-market VoIP represented a significant percentage of total incoming international traffic.[47] According to Balancing Act Africa, in those countries where VoIP was illegal, grey market operators were subject to varied enforcement treatment, from raids on their premises and the confiscation of equipment, to the filtering of traffic for VoIP calls.[48] In some countries, jail penalties even applied for making VoIP calls. Even so, the grey market continued to flourish in many countries -- to different degrees, depending on the severity of legal sanctions.

5.2 Arab States

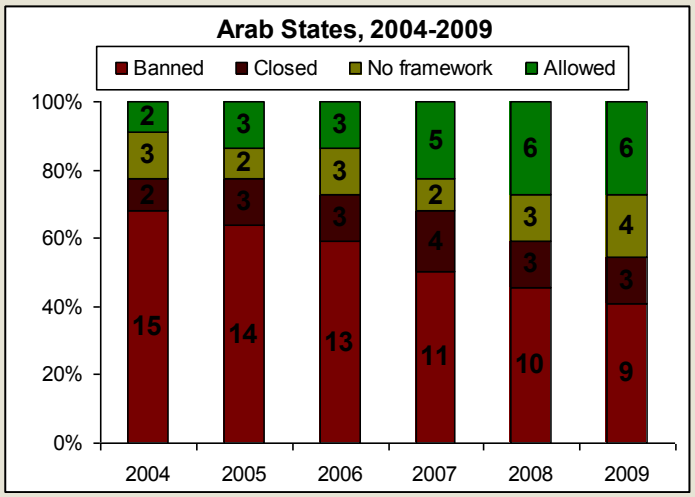
After Sub-Saharan Africa, Arab states are the second-least liberalized region in their approach towards VoIP, despite a few early initiatives. For example, Tunisie Telecom introduced VoIP transmission for international traffic in 2004 and started rolling out an IP-enabled, multi-protocol label switching (MPLS) backbone network in 2005.[49] In Sudan, although VoIP is not authorized for consumer use, licensed operators can use VoIP technology to send and receive international traffic. By 2009, six countries (one quarter of all Arab countries) had conducted or begun public consultations on the issue of VoIP telephony. This included some of the earliest work on VoIP regulation, dating back to 2004 (when Algeria legalized VoIP after a consultation) and Jordan's consultation to formalize its regulatory framework in May 2005. Saudi Arabia has held repeated consultations -- in 2006 and again in 2007 -- while the United Arab Emirates was still engaged in ongoing consultations with the industry in 2009.

By mid-2009, in fact, VoIP had been explicitly legalized in six economies – including:

- Algeria, since 2004;
- Bahrain, where Batelco launched its VoIP service in October 2008;
- Egypt;
- Palestine; and
- Jordan.

Moreover, VoIP is tolerated in a further four economies (Qatar, Lebanon, Mauritania and Saudi Arabia). However, 12 countries were still not fully open to the use of VoIP. Even where licences for VoIP have been issued, the licensees may not have launched VoIP services. Or, if they were incumbents, they may have been reluctant to launch VoIP services for fear of cannibalizing their international voice revenues. This was the case in Mauritania, where licences authorizing VoIP were first issued in 2006. Today, Mauritel, Mattel and Chinguitel possess global licences and are authorized to offer VoIP. To date, however, no operator has yet begun offering VoIP services.

Figure 10: Regulatory Treatment of VoIP in Arab States, 2004-2009



Source: ITU. Note: Data cover 22 Arab economies.

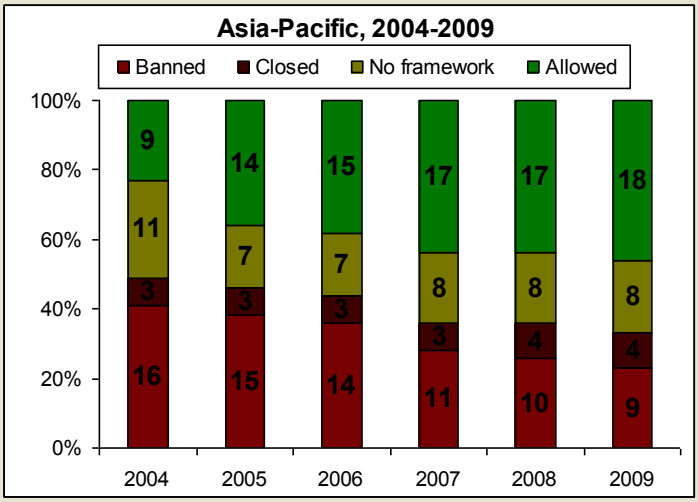
5.3. Asia-Pacific

The diverse Asia-Pacific region is home to some of the most well-developed VoIP markets, as well as some of the least developed ones. In developed markets, the expansion of IP-based networks and services continues rapidly, partly due to the early establishment of clear regulatory guidelines. This was the case in Australia, Hong Kong (China), Japan, Malaysia, and Singapore. In some cases, direct government assistance -- for example, the Republic of Korea's National Broadband Development Plan -- was brought to bear to promote growth.

By mid-2009, two-thirds of Asia-Pacific economies permitted or tolerated VoIP. Eighteen countries had explicitly legalized the use of VoIP, with a further eight tolerating its use outside of their regulatory frameworks. Conversely, nine economies maintained outright bans on VoIP, with another four markets remaining closed to the use of VoIP (China, Myanmar, Nepal and Tonga). After a long transition, Bangladesh revised its guidelines for the use of IP telephony in June 2009. To some extent, these differences in regulatory

treatment reflect the underlying broadband digital divide in the region, emphasizing the number of economies with comparatively low broadband penetration rates.

Figure 11: Regulatory Treatment of VoIP in Asia-Pacific, 2004-2009



Source: ITU.

Note: Data cover thirty-nine economies.

The VoIP experience in Pacific island economies is interesting, because of their strong reliance on international voice revenues, submarine cables and satellite systems for their communication needs. In 2009, many incumbents in the region remained state-owned, and licences tended to be service-specific, covering either mobile service, fixed service or international services. There were widespread concerns over VoIP and its impact on existing revenues.[50] With the prevalence of both callback and VoIP services, international telephone calls were increasingly being carried as data over IP-based networks.

The introduction of high-speed broadband Internet to Fiji in 2005 accelerated growth in VoIP traffic, resulting in a statement by the Fijian Government calling for a clear policy direction on VoIP.[51] Fiji thereafter published its VoIP policy in June 2007.[52] It followed up by issuing its first specific license for the provision of VoIP services, to VoiceNetIP, in November 2007.[53]

In Papua New Guinea, the Independent Consumer and Competition Commission (ICCC) noted that "VoIP is not illegal" in its 2005 ISPs' Code of Practice. The Commission turned back arguments by Telikom PNG that ISPs should not be allowed to carry VoIP traffic. The ICCC concluded that carriers will not be permitted to monitor Internet traffic carried by ISPs to detect VoIP for any reason, except in limited circumstances of illegal use.[54] New Caledonia also moved to legalize VoIP services, with the incumbent OPT launching VoIP services in November 2006 (see Box 4). VoIP remained illegal in Samoa and the Marshall Islands. It was outside the regulatory framework in Tonga (where it is not readily available) and the Federal States of Micronesia and Vanuatu (where it is).

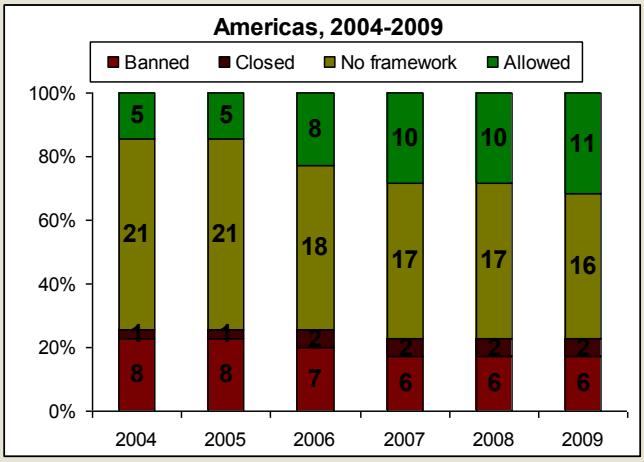
5.4 The Americas

Adoption of VoIP has historically varied considerably across Latin America and the Caribbean, with governments and operators concerned about the potential loss of revenues, profits and taxes. Several VoIP operators had introduced retail VoIP services in Latin America by 2007. Retail VoIP services were not yet common by that year, although it was clear that most carriers were already using it for their long-haul transmissions.[55]

By 2009, VoIP had been legalized in many Latin American countries. Mexico was "by far the largest destination for VoIP traffic in both Latin America and the world," with 19 billion minutes or one quarter of all international VoIP traffic.[56] Brazil was the second-largest VoIP destination in Latin America (and fourth-largest globally). Indeed, in terms of VoIP traffic, Central and South America remained among the fastest-growing regions (see Figure 12). By 2009, eleven countries had explicitly legalized VoIP services, up from just five in 2004. However, this number excluded the flourishing VoIP markets of Brazil and Argentina, where VoIP services still remained outside the regulatory framework. There was a loosening of the regulatory approach to VoIP in Honduras and Bolivia, where most cybercafés offered VoIP services.[57] Licensing requirements restricted which operators could offer VoIP in Colombia, the Dominican Republic, Ecuador, Mexico, Peru and Venezuela, although those licensing restrictions were not enforced in many countries.[58]

VoIP was legal or tolerated in other three-quarters of all countries in the Americas in 2009, but consumer use of VoIP remained officially illegal in six countries: Antigua and Barbuda, Costa Rica, Cuba, Paraguay, Guyana and Nicaragua. Both Costa Rica and Paraguay had initiated proceedings to regulate VoIP, but they experienced immense difficulties and maneuvering by all stakeholders involved.[59] Incumbents reportedly were blocking VoIP services in Belize[60] and Guyana.[61] In October 2006, even after deregulation, Telefónica Chile, one of the major operators, was fined nearly USD 1 million anti-trust violations in blocking VoIP calls.[62]

Figure 12: Regulatory Status of VoIP in the Americas



Source: ITU. Note: Data are available for 35 economies in North America, Latin America and the Caribbean.

Some countries had legalized VoIP, but then ran into implementation problems. Colombia and Mexico both allowed VoIP services and treated them as voice telephony -- subject to licensing requirements. The high cost of licences in Colombia, however, meant that there were few market entrants.[63] The Bahamas and Belize had both officially legalized VoIP, but in practical terms restricted VoIP to the incumbents, which maintained monopolies over international services. Bolivia and Ecuador are other examples of countries where only licensed voice providers were permitted to provide VoIP. Many governments committed to investing in public

access points and community tele-centres or cybercafés, where many users in the region access the Internet and VoIP services.[64]

Developments in the Caribbean are especially interesting, owing to the triangle of relationships between government ministries, regulatory agencies and incumbents that characterizes many countries in the region. Many governments acknowledge that cheap communication services are vital to their economic competitiveness as destinations for tourism and banking.[65] However, they have been hampered in their liberalization efforts, in some cases, by exclusivity contracts they signed with monopoly operators.

Throughout the Caribbean, Cable & Wireless (C&W) initially resisted the introduction of VoIP -- for example, in June 2008, C&W warned that if the government of Antigua and Barbuda ended a restriction on VoIP prior to enacting a new Telecommunications Act, C&W would consider that action a violation of its exclusivity clause.[66] There have also been some reports of the operator challenging governments and regulators in Barbados and Dominica.[67] Market liberalization, the growth of mobile services, and the market entry of competitors with deep pockets and aggressive roll-out plans, have transformed the situation in the Caribbean.[68] After years of resisting the growth of VoIP services, Cable & Wireless has now embraced the inevitable and introduced its own IP-based "Netspeak" service.

5.5 Europe and the Commonwealth of Independent States (CIS)

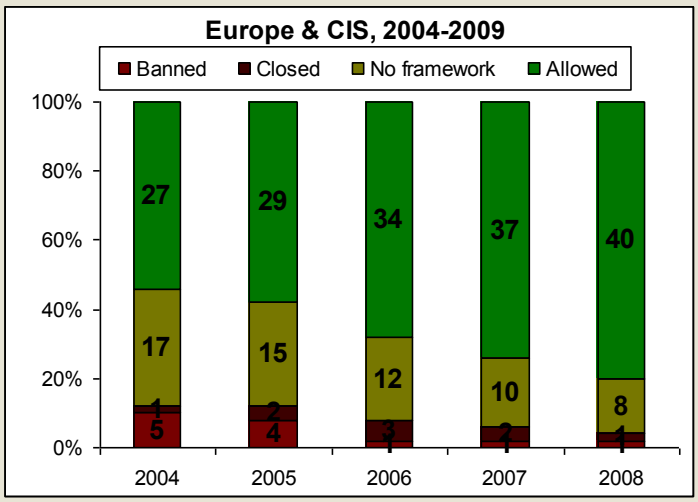
VoIP has been widely available and well used in Europe from the start. The Finnish regulator, Ficora, was among the first to state a clear policy on VoIP when, in 2003, it directed that the VoIP service of the then-incumbent, SoneraTelia, be subject to the same regulations as standard public telephone services. Many European countries acted early, carrying out public consultations during the period from 2003-2006. At least 16 consultations were conducted in countries such as France, Germany, Ireland, Poland and the UK.

European Union (EU) countries have also benefited from a body of pan-European legislation from the European Commission. The European Regulators' Group (ERG) held public consultations on VoIP in 2004 and 2005, noting that VoIP service was available at that time (at least on a trial basis) in many European countries.[69] The European Commission, meanwhile, had amended the regulatory framework for electronic communications in 2002, in an attempt to lower entry barriers and encourage new operators to enter the market. The *Authorisation Directive* defined rights and obligations connected with the provision of ECS and networks, while the *Framework Directive* established a single, over-arching regulatory structure for the range of electronic communications. Finally, the *Universal Service Directive* established obligations for PATS.

Despite this common framework, European countries have differed widely in their classifications of VoIP services (see Table 3) and the regulatory requirements placed upon them. ERG (2005) highlighted differences in the regulatory treatment of VoIP in numbering, number portability and access to emergency services across the Member States, a conclusion reaffirmed by Wik Consult in 2008 in its study of VoIP regulation. European regulators are now moving to address geographic numbering, the regulation of nomadic services and caller location, interconnection issues and, in particular, lawful intercept.[70]

Despite the different definitions and regulatory treatments applied to VoIP, European countries were united in their tolerance of VoIP services (see Figure 13). By 2009, Europe was moving ahead with a pro-VoIP stance. The few countries that had banned VoIP in 2004 (including Armenia, Belarus, Bosnia and Herzegovina, Serbia and Turkmenistan) were moving slowly towards accepting VoIP five years later, apparently converted to the idea that VoIP was integral to economic competitiveness and the future of the industry. Only in Belarus did VoIP continue to remain forbidden for in-country traffic).

Figure 13: Regulatory Treatment of VoIP in Europe, 2004-2009



Source: ITU.

Governments and regulators in CIS countries, however, remained sharply divided in their treatment of VoIP. Some CIS economies, such as Georgia and Kazakhstan, have allowed VoIP operators to flourish. By contrast, Turkmenistan applies a strict licensing regime, comprising about 30 different telecom licences.

6 Conclusions

This chapter has sought to map the rise of VoIP through expanding broadband networks, as well as some of the most salient regulatory issues that are emerging from VoIP's rapid spread throughout the global marketplace. The growth of VoIP services is changing the telecommunication landscape, bringing new players into competition with incumbents and rewriting the sector's economics. While governments and regulators move to embrace the growing reality of VoIP, operators are adapting to the altered competitive landscape and the emergence of new business models. As this chapter has sought to reveal, regulators are responding in flexible and measured ways to address and resolve these issues, pointing the way toward bringing all of the benefits of IP-based voice services to consumers. The track record bodes well for further integration of networks, services and applications in the era of convergence.

Endnotes

[1] This chapter updates a 2006 survey of the "Status of Voice over Internet Protocol (VoIP) Worldwide, 2006", available at: http://www.itu.int/osg/spu/ni/voice/papers/FoV-VoIP-Biggs-Draft.pdf

[2] Convergence has been defined as the provision of various services (e.g. voice, video and data or information) over infrastructure allowing the use of a range of devices (e.g. mobiles, PCs and TVs). In reality, 'convergence' refers both to a market trend and different converged technologies – "IP over everything" (e.g. Internet access over copper, cable modem or mobile broadband) or "everything over IP" (IPTV or VoIP) (Michael Kende).

[3] For an early account of the disruption caused by VoIP to PSTN-based telephony models, see ITU (2001) "ITU Internet Reports: IP Telephony", which one was one of the inputs to the 2001 ITU World Telecommunication Policy Forum on IP Telephony (see http://www.itu.int/osg/csd/wtpf/wtpf2001/index2001.html).

[4] Technical Developments - Work on Advanced Multimedia System (AMS) – see: http://www.itu.int/ITU-T/studygroups/com16/ams/index.html. WIK Consult paper.

[5] Telegeography (2008).

[6] Maravedis (2009).

[7] Slide 4, "Defining VoIP", presentation by Josua Turaganivalu, Ministry of Commerce, Industry, Investment & Communications of the Government of Fiji, at the workshop held on 12 July 2007, available at: http://www.fiji.gov.fj/uploads/DEFININGVOIP.pdf

[8] "VoIP Deployment and Regulation in Asia" (2006), Konrad L. Trope, Novo Law Group.

[9] See the ITU-T definition of NGN as "a packet-based network able to provide Telecommunication Services to users and able to make use of multiple broadband, QoS-enabled transport technologies and in which service-related functions are independent of the underlying transport-related technologies. It enables unfettered access for users to networks and to competing service providers and services of their choice. It supports generalised mobility which will allow consistent and ubiquitous provision of services to users" (ITU-T Recommendation Y.2001 (12/2004), available at: http://www.itu.int/ITU-T/ngn/definition.html

[10] http://www.metrics2.com/blog/2006/09/25/voip_by_the_numbers_subscribers_revenues_top_servi.html.

[11] Infonetics Research, through VoIP News, 1 march 2008, at: www.voip-news.co.uk/2008/03/01/80-million-worldwide-voip-subscribers-in-2007/

[12] For example, Infonetics Research estimated that there were some 80 million VoIP subscribers worldwide by 2007, far more than earlier predictions forecasting 55 million subscribers by 2009. In 2006, In-Stat predicted that the global market for consumer VoIP services has arrived, with total VoIP subscribers worldwide at 16 million in 2005 projected to grow to over 55 million in 2009 (www.in-stat.com).

[13] Point Topic, 23/10/2008: http://point-topic.com/content/bmm/profiles/BMMIPT081021.htm&comp_id=4685&g=2.

[14] Source: Telegeography Annual Report 2008, chapter on VoIP.

[15] Matthew Rosen, CEO of Fusion Telecom, quoted at: http://www.itp.net/news/523624-living-with-voip

[16] http://www.cisco.com/web/solutions/smb/need_to/ready_to_adopt_voIP.html

[17] Telecom feature, "Nortel's Nadir: How Canada's Top Tech Firm Lost Its Dial Tone - And Why Other Telephony Firms Will Follow It", as reported in *Time Magazine*, 11 May 2009.

[18] ACMA Media Release, 20 December 2007, "VOIP in Australia: awareness and interest high, take-up low" at: http://www.acma.gov.au/WEB/STANDARD/pc=PC_310902. As reported to the OECD, the Australian regulator will regularly monitor the VoIP market and reserves the right to respond to further regulatory issues, as they arise.

[19] Biggs & Kelly (2006), "Broadband Pricing Strategies", Telecom Info, Vol. 8, Issue 6, 2006.

[20] http://www.datadubai.com/United_Arab_Emirates/Dubai/Dubai_Business_and_Economy/Industries/Telecommunications/16017-1505.html

[21] P.6, Rendon, Garcia-Murillo, Villegas & Kuhlmann, "VoIP Regulation in Latin America" (2007). Paper to be presented at the 35th Research Conference on Communication, Information and Internet Policy (TPRC 2007), 28-30 September 2007, Arlington, Virginia, USA, available at: http://www.web.si.umich.edu/tprc/papers/2007/777/VoIP_LatAm_TPRC2007.pdf

[22] http://www.i4donline.net/jan06/safaids.pdf

[23] http://www.bdnews24.com/details.php?id=81347&cid=2

[24] http://voipbangladesh.com/voip-providers/bangladesh-parliament-recomemded-govt-to-open-voip-119.html

[25] "Etisalat Boss Claims Telco is VoIP-Ready", 31 January 2008, available at: http://www.itp.net/news/509859-etisalat-boss-claims-telco-is-voip-ready?ln=en

[26] "Batelco offers cheaper IDD calls through VoIP", October 2008, available at: http://www.gulfbase.com/site/interface/NewsArchiveDetails.aspx?n=74458

[27] http://investor.google.com/fin_data.html

[28] Adapted from http://jubaerarif.blogspot.com/2007/01/pstns-fear-of-losing-revenue-to-voip.html and supplemented with information from: http://www.vonage.com/features.php?feature=411.

[29] www.canto.co.cu/news_center/voice-of-the-secretary-general/2007/voip-challenges-for-caribbean-operators

[30] VoIP involves the transmission of voice communications over Internet Protocol that is already in use for data transmissions over the Internet. Internet telephony software is also available that enables consumers to use the public Internet as a transmission medium for telephone calls to anywhere in the world.

Wik Consult (2008) offers the following definitions and distinctions between VoB and VoI: Voice over Broadband (VoB) combines the offering of a broadband access line (e.g. via DSL technology or cable modem) with the provision of voice services by a single company.

Voice over Internet (VoI), however, physically requires that the end user has broadband access. From an institutional perspective, the provider of the access line and the provider of the VoI voice services are not necessarily the same. The provider of VoI voice services offers its services "on top" of the infrastructure of some other network operator. Wik Consult (2008) also note a different characterization of VoB and VoI is the following: VoB comprises non-nomadic services (sold as bundles with high speed Internet connectivity), while VoI can support nomadic use.

[31] "Statement on the Implementation of Voice Communication Services Delivered Using The Internet Protocol" , Jordanian Telecommunications Regulatory Commission, 23 August 2007, available at: http://www.trc.gov.jo/images/stories/pdf/TRC%20Statement%20-final-30-8-07.pdf?lang=english

[32] See ITU (2000) "Internet in a transition economy: Hungary case study", available online at: http://www.itu.int/ITU-D/ict/cs/hungary/hungary.html.

[33] "Internet users 'could suffer brownouts due to YouTube and iPlayer'", Daily Telegraph, 27 April 2009, available at: http://www.telegraph.co.uk/scienceandtechnology/technology/technologynews/5224306/Internet-users-could-suffer-brownouts-due-to-YouTube-and-iPlayer.html

[34] Nemertes Research, quoted in The Economist, "Surviving the Exaflood", 6 December 2008.

[35] Nemertes Senior Analyst Mike Jude, based on estimates from the study, "Internet Interrupted: Why Architectural Limitations will Fracture the Net", by Nemertes Research, quoted at: www.telecomweb.com/tnd/262004.html.

[36] "The US broadband battle", BBC News, 27 May 2009, at: http://news.bbc.co.uk/2/hi/technology/8069874.stm

[37] Rob Middlehurst, director of market and competition at Bahrain's TRA, quoted at: "Living With VoIP", available at: http://www.itp.net/news/523624-living-with-voip?start=1.

[38] Page 14, « STATEMENT ON THE IMPLEMENTATION OF VOICE COMMUNICATION SERVICES DELIVERED USING THE INTERNET PROTOCOL« , 23 August 2007, available at : http://www.trc.gov.jo/images/stories/pdf/TRC%20Statement%20-final-30-8-07.pdf?lang=english

[39] Blocking specific types of traffic over an IP network is usually done by blocking "ports" - equivalent to boarding up doors (if you imagine a network as a house with 65,536 doors) or denying access to specific IP addresses (equivalent to turning away particular people) – see http://www.guardian.co.uk/technology/2006/apr/06/voip.telephony

[40] http://www.ofta.gov.hk/en/tips/servicetype/local/voip.html

[41] "Can Your VoIP System Handle 911?", available at: http://www.voip-news.com/feature/voip-911-022107/

[42] Wik Consult (2008)

[43] Maravedis report, "VoIP over 4G: Opportunities, Challenges and Deployment Trends", 2009.

[44] See the regional case study, "The Future of Voice in Africa" by Russell Southwood for the Future of Voice workshop, available at: http://www.itu.int/osg/spu/ni/voice/papers/FoV-Africa-Southwood-draft.pdf

[45] http://www.budde.com.au/Research/Africa-VoIP-Telephony.html

[46] http://www.budde.com.au/Research/Africa-VoIP-Telephony.html

[47] http://www.capacitymedia.com/images/library/files/Middle_East_09_Mohammed_Ali_Bouhelal.pdf

[48] African VoIP markets, Balancing Act Africa, quoted at: http://globaltechforum.eiu.com/index.asp?layout=rich_story&doc_id=10265&title=Africa%3A+Tariffs+tumble%2C+VoIP+rises&categoryid=31&channelid=4

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[62] www.itu.int/ituweblogs/treg/default,date,2007-01-09.aspx

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68 For example, in 2006, Stern (2006) noted that "nine years after the conclusion of the WTO's negotiations on basic telecommunications in February 1997, the process of sector reform has advanced in the whole region. Nearly all countries have put new legal and regulatory structures into place and have established independent regulators. Some have yet to complete the process. Yet, in spite of this the benefits of reform still elude most Caribbeans who continue to pay high prices… a barrier to the development and growth of the ICT sector". See: http://idbdocs.iadb.org/wsdocs/getdocument.aspx?docnum=917357

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