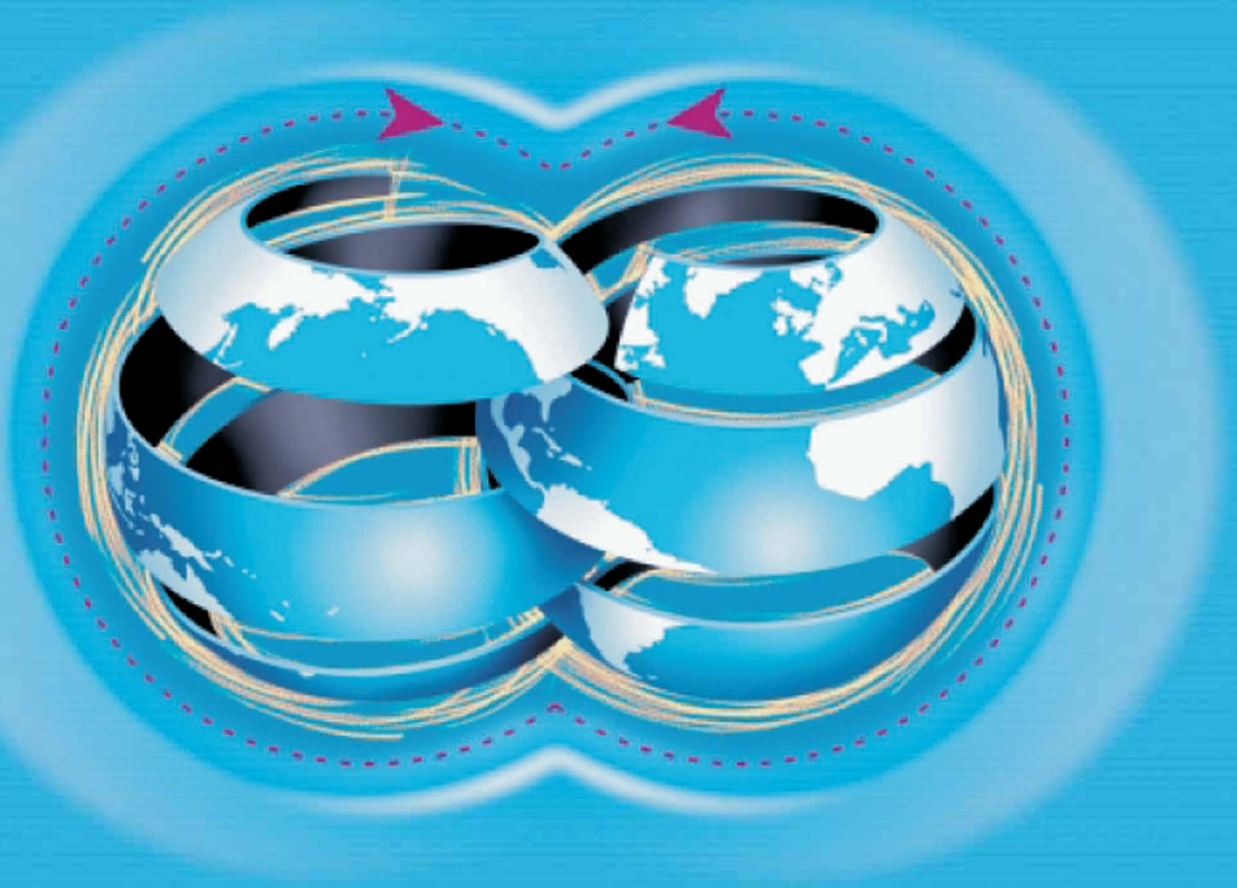
ITU INTERNET REPORTS

IP Telephony



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FOREWORD

This new report in the ITU Internet Reports series looks at the topic of IP Telephony. Internet Protocol (IP) Telephony is rapidly reaching the top of the agenda for the telecommunications industry worldwide. The possibility of transmitting voice over IP-based networks, with all its challenges and associated opportunities, such as voice and data integration, constitutes a milestone in the convergence of the communications sector.

This is the third in the series of ITU Internet Reports (the series previously known as "Challenges to the Network"). The first two in the series looked at "Telecommunications and the Internet" (in 1997) and "Internet for Development" (in 1999). In July 2000, the ITU Council selected IP Telephony as the topic of the third World Telecommunication Policy Forum, to be held in Geneva, 7-9 March 2001. This report presents some of the research carried out within the ITU in preparation for the Forum. It is intended to serve to inform participants at the meeting, and also to provide a reference document for others interested in this emerging topic.

Chapter one of this report, ***Why IP Telephony*****,** looks at how IP Telephony is defined and the different forms that IP Telephony can take. Chapter two, ***Technical Aspects of IP Telephony***, suggests more specific definitions and looks at the interworking of IP-based networks with circuit-switched networks. Chapter three, ***Economic aspects of IP Telephony***, looks at the reasons for the popularity of IP Telephony, which mainly stem from the fact that it offers certain price and cost advantages compared with other more conventional forms of telephony. Chapter three also considers the likely impact on public telecommunication operators. Chapter four, ***Regulatory aspects of IP Telephony***, discusses the different regulatory approaches to IP Telephony, and the methods used to categorize it within those regulatory structures. Chapter five, ***IP Telephony in practice***, summarises the results of a series of country case studies carried out by the ITU in support of this research programme. Finally, Chapter six, ***Conclusions***, bring these different themes together and concludes that the IP Telephony industry is now approaching maturity.

Much of the research for this report, including the case studies, was carried out under the "New Initiatives" programme, launched at the ITU in 1999. A workshop on IP Telephony was held in Geneva on 14-16 June 2000.

The ITU is committed to playing a positive role in the development of the Internet and to extending the benefits of new telecommunications technology, such as the Internet, to all the world's inhabitants. The Minneapolis Plenipotentiary Conference (1998) passed Resolution 101, which calls upon the ITU to "*fully embrace the opportunities for telecommunication development that arise from the growth of IP-based services*." The ITU Internet Reports are hopefully a significant contribution to that commitment.

Acknowledgements
The report has been prepared by a team led by Tim Kelly, which included Craig McTaggart, Ben A. Petrazzini, Robert Shaw and Mark Woodall. The statistical tables have been compiled by Mark Woodall with assistance from, Maria-Concetta Gasbarro, Vanessa Gray, Michael Minges and Shalini Sankaranarayanan. Mark Woodall also oversaw the production of the report and served as editor. The case studies programme was co-ordinated by Ben A. Petrazzini and included contributions from Arturo Briceño, K.K. Gunawardana, Peter Lovelock, Gustavo Peña-Quinones, Somkiat Tangkitvanich and William Withers. The report's cover was designed by Jean-Jacques Mendez.

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The data contained in this report are taken from the ITU's "World Telecommunication Indicators Database", which is managed by a team comprising, Maria-Concetta Gasbarro, Vanessa Gray and Dalia Mendiluce under the supervision of Michael Minges. The Database is available on diskette, or via the Internet as a subscription service. Internet host data is sourced from Network Wizards (<http://www.nw.com>) and, for Europe, from RIPE (<http://www.ripe.net>). All of the ITU's indicator reports and databases are available for purchase, on the Internet, at <http://www.itu.int/indicators>.

The views expressed in this report are those of the authors and do not necessarily reflect the opinions of the ITU or its membership.

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GLOSSARY[1]

Bandwidth The rate, measured usually in bits per second, at which data can be carried through a transmission circuit.

Bandwidth on Demand

Capability of an end-user or network device to access available network capacity at a rate as required by the application being utilised for a specified period.

Best Effort The service model for the standard Internet service. In the face of congestion of a network interface, packets are discarded without regard to user or application until traffic is reduced.

Bit ("Binary Digit")

A bit is the primary unit of electronic, digital data. Written in base-2, binary language as a "1" or a "0".

Byte (1) A set of bits that represent a single character. A byte is composed of 8 bits.

(2) A bit string that is operated upon as a unit and the size of which is independent of redundancy or framing techniques.

Cache A local temporary store of information.

Certificate Authority (CA)

A trusted third-party organisation or company that issues digital certificates used to create digital signatures and public-private key pairs. The role of the CA in this process is to guarantee that the individual granted the unique certificate is, in fact, whom he or she claims to be. CAs are a critical component in data security and electronic commerce because they guarantee the identities of parties exchanging information.

Circuit Switched Connection

A temporary connection that is established on request between two or more stations in order to allow the exclusive use of that connection until it is released.

Connectivity The capability to provide, to end users, connections to the internet or other communications networks.

Domain Name The registered name of an individual or organisation eligible to use the Internet. Domain names have at least two parts and each part is separated by a dot. The name to the left of the dot is unique for each top-level domain name, which is the name that appears to the right of the dot. For instance, the International Telecommunication Union's domain name is itu.int. "Itu" is a unique name within the gTLD "int".

Domain Name System (DNS)

Databases located throughout the internet that contain Internet naming information, including tables that cross reference domain names with their underlying IP numbers. When an end-user enters a domain name, the network converts the domain name of its destination into the corresponding IP number, and the IP number is used for routing purposes.

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[1] The main source of terms listed in this Glossary is the Internet Rapporteur's Group established by ITU-T Study Group 3 (see document COM3-D73). However, other terms have been added to facilitate comprehension of the way in which they are used in the text.

Encryption The translation of data into a secret code. Encryption is the most effective way to achieve data security. To read an encrypted file, one must have access to a secret key or password that enables it to be decrypted.

End user The individual or organisation that originates or is the final recipient of information carried via the Internet (i.e., the consumer).

Exchange point Points within a network at which IP packets are exchanged between ISPs.

Gateway Any mechanism for providing access to another network. This function may or may not include protocol conversion.

Half-circuit A component of an international circuit that originates or terminates between countries and terminates or originates at a theoretical midpoint between countries

Host Any computer that can function as the beginning and end-point of data transfers. Each Internet host has a unique Internet address (IP address) associated with a domain name.

Internet The collection of interconnected networks that use the Internet protocols (IP).

Internet Backbone

The high-speed, high capacity lines or series of connections that form major pathways, and which carry aggregated traffic within the Internet.

Internet Content Provider

A person or organisation, that provides information via the Internet either for a price or free of charge.

Internet Service Provider (ISP)

ISPs provide end users, and other ISPs, access to the Internet. ISPs may also offer their own proprietary content and access to online services such as e-mail.

Internet Telephony

The transmission of voice over the Internet. In this insert the term is used to refer to voice carried primarily over the public Internet, not over private, managed networks (see VoIP).

Intranet An intranet is a network, based on TCP/IP protocols, accessible only by the organisation's employees, or other authorised users. Intranet websites are similar to other websites, but are surrounded by firewalls that prevent unauthorised access.

IP Internet Protocol

IP Telephony A generic term for the transmission of voice over Internet Protocol Networks.

IP numbers An IP number (also referred to as Internet address number) is the addresses of hosts or other intelligent device on the Internet. All servers and users connected to the Internet have an IP number.

Leased line A leased line is the transmission capacity reserved for the exclusive use of a customer. It is also referred to as a dedicated or private line.

Local Area Network (LAN)

A computer network that spans a relatively small area. Most LANs are confined to a single building or group of buildings. However, one LAN can be connected to other

LANs over any distance via telephone lines or radio waves. A system of LANs connected in this way is called a wide-area network (WAN).

Mirror site A host which duplicates the contents of another host in the same or another network.

Network Access Point (NAP)

(1) Point at which the dedicated Internet backbone lines are reached.

(2) A point at which ISPs connect with one another. NAPs serve as data interchange points for backbone service providers. NAPs and Metropolitan Area Exchanges (MAEs) were generally spoken of at the beginning of 1999 as public Internet exchange points (IXPs).

Packet An information block identified by a label at layer 3 of the OSI reference model. (*Source*: CCITT Blue Book Volume 1 Fascicle1.3 Terms and Definitions).

Packet-Switching

The function of handling, routing, supervising and controlling user packet data, as required, by an exchange. (*Source*: CCITT Blue Book Volume 1 Fascicle1.3 Terms and Definitions).

Peering The exchange of routing announcements between two Internet Service Providers for the purpose of ensuring that traffic from the first can reach customers of the second, and *vice-versa*. Peering takes place predominantly at IXPs and usually is offered either without charge or is subject to mutually agreed commercial arrangements.

Point of Presence (PoPs)

A Point of Presence is a node offering users dial-up access to the Internet via a specific telephone number. The greater the number of Points of Presence, the higher the likelihood that the users can connect using a local telephone call.

Portal Although an evolving concept, the term portal commonly refers to the starting point, or a gateway through which users navigate the Web gaining access to a wide range of resources and services, such as e-mail, forums, search engines, and shopping malls.

Protocol A set of formal rules and specifications describing how to transmit data, especially across a network.

Routing Policy An expression of how an ISP will choose to direct traffic on or off network. For example, ISPs may choose to route traffic with preference to certain paths or through other ISPs depending on the commercial relationships between the parties.

Router Specialised computers that take incoming packets and compare their destination addresses to internal routing tables and, depending on routing policy, send the packets out to the appropriate interface. This process may be repeated many times until the packets reach their intended destination.

Server (1) A host computer on a network that sends stored information in response to requests or queries.

(2) The term server is also used to refer to the software that makes the process of serving information possible.

Telecommunications Facility Provider

An entity that supplies underlying transmission capacity for sale or lease and either uses it to provide services or offers it to others to provide services.

Transmission Control Protocol/Internet Protocol (TCP/IP)

The suite of protocols that defines the Internet and enables information to be transmitted from one network to another.

Throughput The effective transmission rate through the network from one end point to another. A measurement of throughput will necessarily be impacted by the slowest link in the path of transmission as well as current traffic volumes on each of these links on the path from start to the end.

Uniform Resource Locator (URL)

The standard way to give the address or domain name of any Internet site that is part of the World Wide Web (WWW). The URL indicates both the application protocol and the internet address e.g., http://www.itu.int.

Voice Over IP (VoIP)

The transmission of voice over circuits employing Internet Protocol. In this report, VoIP is used to denote a type of IP telephone service where transmission is primarily over private, managed networks. Also FoIP: Fax over IP.

Website / page A website (also known as an internet site) generally refers to the entire collection of HTML files that are accessible through a domain name. Within a website, a webpage refers to a single HTML file that, when viewed by a browser on the World Wide Web, could be several screen dimensions long. A "home page" is the webpage located at the root of an organisations URL.

Whole Circuit A circuit that connects points in different countries where a single entity owns the circuit in its entirety or owns, leases or operates two half-circuits in combination.

World Wide Web (WWW)

(1) Technically refers to the hypertext servers (HTTP servers) that are the servers that allow text, graphics, and sound files to be mixed together.
(2) Loosely refers to all types of resources that can be accessed including: HTTP; Gopher; FTP; Telnet; USENET; and WAIS.

LIST OF ABBREVIATIONS AND ACRONYMS

ADSL	Asymmetric Digital Subscriber Line
AOL	America Online
API	Application Programming Interface
ATM	Asynchronous Transfer Mode
CAGR	Compound Annual Growth Rate
CLEC	Competitive Local Exchange Carrier
CERN	European Laboratory for Particle Physics
DARPA	(US) Defense Advanced Research Projects Agency
DNS	Domain Name System
DSL	Digital Subscriber Lines
EDI	Electronic Data Interchange
ETSI	European Telecommunications Standards Institute
EU	European Union
FOIP	Fax Over Internet Protocol
FTP	File Transfer Protocol
GNP	Gross National Product
gTLDs	Generic Top Level Domains
http	Hypertext Transport Protocol
IANA	Internet Assigned Numbers Authority
ICANN	Internet Corporation for Assigned Names and Numbers
IDD	International Direct Dial
IETF	Internet Engineering Task Force
IN	Intelligent Network
IP	Internet Protocol
ISO	International Standardisation Organisation
ISP	Internet Service Provider
ITU	International Telecommunication Union
IXP	Internet Exchange Point
LAN	Local Area Network
MGCP	Media Gateway Controller Protocol
NAP	Network Access Provider
NSF	National Science Foundation
OECD	Organisation for Economic Co-operation and Development
OSI	Open Standards Interconnection
PC	Personal Computer
PoP	Point of Presence
PSTN	Public Switched Telephone Network
PTO	Public Telecommunication Operator
RIPE	Réseaux IP Européens
RSVP	Resource Reservation Setup Protocol
RTP	Real Time Protocol
SIP	Session Initiation Protocol
SLA	Service Level Agreement
SS7	Signalling System 7
TCP/IP	Transmission Control Protocol / Internet Protocol
UDP	User Datagram Protocol
VANS	Value Added Network Services
VODSL	Voice Over Digital Subscriber Line
VoIP	Voice Over Internet Protocol
VPN	Virtual Private Network
WTO	World Trade Organisation
WWW	World Wide Web
XOIP	‘Everything’ Over Internet Protocol

DATA NOTES

Country groupings

A number of economic and regional groupings are used in the report. Economic groupings are based on Gross National Product (GNP) per capita classifications used by The World Bank. Economies are classified according to their 1998 GNP per capita in the following groups:

- *Low income* — Economies with a GNP per capita of US$ 725 or less;
- *Lower-middle income* — Economies with a GNP per capita of more than US$ 726 and less than US$ 2'895;
- *Upper-middle income* — Economies with a GNP per capita of more than US$ 2'896 and less than US$ 8'955;
- *High income* — Economies with a GNP per capita of US$ 8'956 or more.

The classification *Major Economies* is also used in the report, and this classification is further divided into:

- The 15 Member States of the *European Union*;
- The 14 *Other Organisation for Economic Co-operation and Development (OECD) Economies*;
- 16 *Major Non-OECD Economies*, which are Argentina; Brazil; Chile; China; Hongkong SAR; India; Indonesia; Israel; Malaysia; Philippines; Russia; Singapore; South Africa; Taiwan, China; Thailand and Venezuela.

A number of regional groupings are used in the report. The main regional groupings are *Africa, Asia, Americas, Europe* and *Pacific*. The following sub-regional groupings are also used:

- *Arab States*—Arabic-speaking economies;
- *Economies in Transition*—Albania, Bosnia-Hertzegovinia, Bulgaria, Croatia, Czech Republic, Hungary, Poland, Romania, Slovak Republic, Slovenia, The Former Yugoslav Republic of
- Macedonia and Yugoslavia as well as the former Soviet Union;
- *Asia-Pacific*—the combined economies of Asia and the Pacific;
- *Latin America and the Caribbean*—Central (including Mexico) and South America and the Caribbean;
- *Least Developed Countries*—the 48 economies recognised by the United Nations General Assembly as being accorded special priority for the purpose of granting assistance;
- *North America* —Canada and the United States;
- *Sub-Saharan Africa*—the countries of the African continent south of the Sahara desert but excluding South Africa.

Data notes

- Billion is one thousand million.
- Dollars are current United States dollars (US$) unless otherwise noted. National currency values have been converted using average annual exchange rates.
- Growth rates are based on current prices unless otherwise noted.
- Thousands are separated by an apostrophe (e.g., 1'000).
- Totals may not always add up due to rounding.
- Numbers shown in italics are estimates.

Additional definitions are provided in the Technical Notes.

CHAPTER ONE: WHY IP TELEPHONY?

1.1 Why?

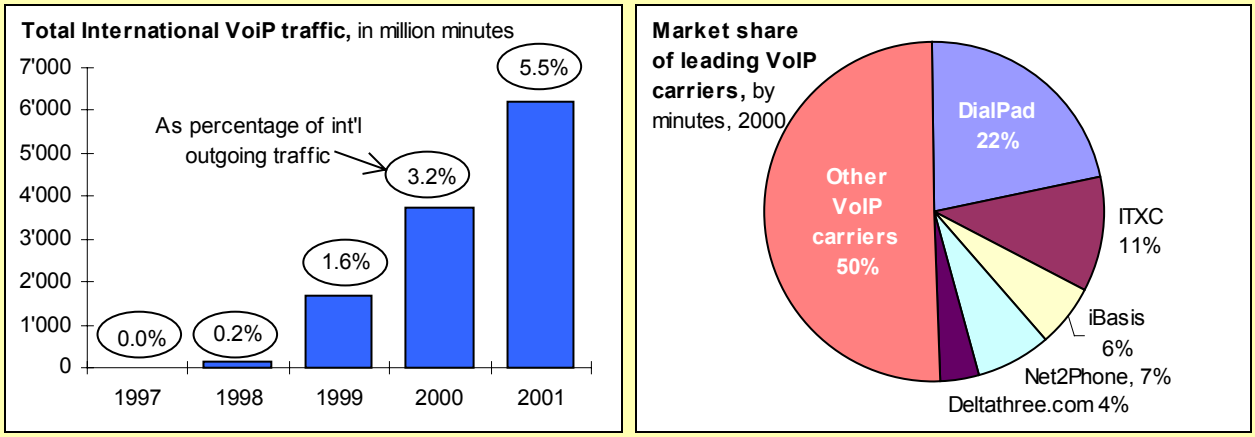
Internet Protocol (IP) Telephony is rapidly reaching the top of the agenda for the telecommunications industry worldwide. The possibility of transmitting voice over IP-based networks, with all its challenges and associated opportunities, such as voice and data integration, constitutes a milestone in the convergence of the communications sector. In July 2000, the ITU Council selected IP Telephony as the topic of the third World Telecommunication Policy Forum, to be held in Geneva, 7-9 March 2001. While the Counsellors were united in recognising the importance of IP Telephony, they did so for very different reasons. Some Counsellors expressed the view that IP Telephony would become a key technology in the coming convergence between circuit-switched and packet-switched networks. Others saw the danger it posed to the revenue stream and monopoly status of their incumbent public telecommunication operator (PTO). One Counsellor, from a developing country, said that, for them, it was a matter of survival; it was time "to put out the fire".[1]

The key issue that has gained the attention of policy-makers, regulators, and industry alike is the fact that the Internet, and other IP-based networks, are increasingly being used as alternatives to the circuit-switched telephone networks. The many different 'flavours'of IP Telephony provide, to varying degrees, alternative means of originating, transmitting, and terminating voice and data transmissions that would otherwise be carried by the public switched telephone network (PSTN). In many countries it is now possible, using a standard telephone, to call almost any other telephone in the world by means of IP Telephony, for some or all of the route travelled by the call. These calls are mainly carried outside of the PSTN, and hence outside the regulatory and financial structures which have grown up around it.

As of late 2000, more than three-quarters of international traffic originated in countries in which the provision of IP Telephony was liberalised. Furthermore, the majority of IP Telephony now travels over managed, private IP networks as opposed to the public Internet. It is estimated that the total volume of Voice over Internet Protocol (VoIP) traffic carried over international networks in 2000 will be around 4 billion minutes, or just over 3 per cent of the global total. What is more significant, however, is not so much the total volume of traffic as the rate of growth, which continues to be exponential at a time when overall international traffic growth appears to be slowing. It is also clear that the market is still far from mature. One sign of this is that, a new entrant, like DialPad.com, can enter the market, as it did in October 1999, and steal a significant chunk of the market. It claims to have carried some one billion calls, both domestic and international, in its first year of operation from its 10 million registered users.

Figure 1.1: Taking off

Voice over IP market growth, 1997-2001 (left), and carrier market shares, 2000 (right)



Source: ITU, adapted from TeleGeography Inc and Company annual reports.

But it is not only start-ups that are generating excitement about IP Telephony. Major international PTOs have announced that they will migrate all their international traffic onto IP platforms. For instance, Cable & Wireless is spending more than US$ 2 billion on a global IP network. It plans to use VoIP to deliver some 900 billion minutes of calls in the year 2006 compared with just 675 million in 1999. It estimates that VoIP technology will allow it to carry calls at a quarter of the cost of doing so over a conventional, circuit-switched network.[2]

1.2 When?

IP Telephony began life as a curiosity among computer hobbyists. Starting in around 1994, it first became possible to send voice messages from one PC user to another, providing they both had multimedia PCs and the same software (Figure 1.2a, diagram 1). Crucially, both users had to be logged on at the same time. For many people, this first incarnation of IP Telephony is still the one that comes to mind when the term is used. But the industry has moved on. Nevertheless, PC-to-PC use is still very popular, and has been given a recent boost by the popularity of instant messaging combined with chat such as the Yahoo Messenger service that offers free calls to anyone in the United States from its popular portal site.

Starting around 1996, it became possible to convert voice messages originating on the public Internet to telephone subscribers on the public switched telephone network (PSTN). This type of usage was dubbed PC-to-Phone (see Figure 1.2a, diagram 2). The significance of this development was three-fold:

1. It enlarged the addressable market from just a few tens of millions of PC users with multimedia PCs and IP Telephony software to the hundreds of millions of telephone and mobilephone users;
2. The problem of having to have both users logged on simultaneously could be overcome by using the ringing mechanism of the telephone to announce that a call is waiting;
3. From a commercial point of view, PC-to-Phone IP Telephony created a number of new market opportunities that did not really exist with PC-to-PC, notably for intermediary service providers and for equipment manufacturers.

For a while, PC-to-Phone became the dominant form of IP Telephony. Early companies into the market were those that already had a profitable business in call-back or other forms of discount international telephony, such as IDT, USA GlobalLink and Net2Phone. IP Telephony streams originating from PCs gave these service providers more volume, which they could put onto their leased lines and other international connections. This market continued to expand and was given a major boost (or, alternatively, a major blow, depending on one's perspective) by the development of "free" Internet Telephony calls, around 1999. This works well mainly in environments where local call charges are not metered and where there is a potentially buoyant demand for advertising, which helps to underwrite the costs of services, which are free of charge to users. One company that is closely associated with this development is Dialpad.com, which is profiled in Box 3.1. DialPad's entry onto the market has made PC-to-Phone an interesting proposition for calls made within countries as well as between countries.

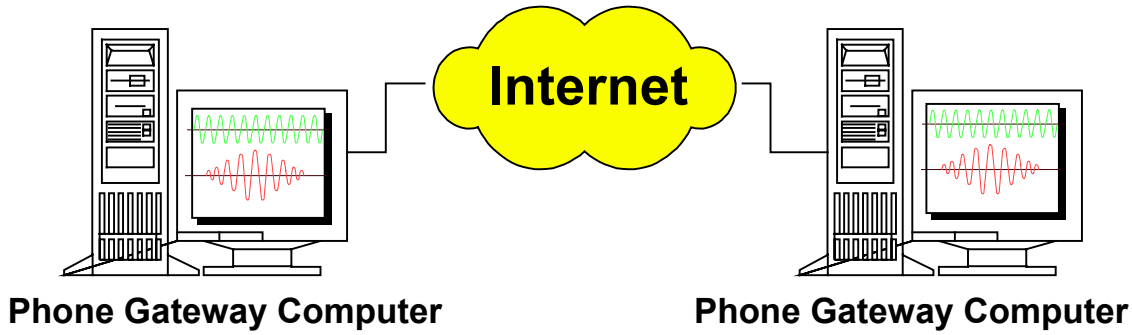
The next logical stage in its market evolution occurred around 1997. By this stage, IP Telephony was becoming, "respectable", and attracting the attention of the large established telecommunication manufacturers and vendors. The first edition of the ITU's "Challenges to the Network" report, issued in September 1997, had a full chapter on Internet Telephony. It noted, for instance, that public telecommunication operators were making preliminary excursions into the market, offering Phone-to-Phone services over IP (see Figure 1.2b, Diagram 3). Relevant examples include:

- Telecom Finland (now Sonera) launched an Internet Telephony project in December 1996, called MediaNet;
- Deutsche Telekom launched its service on 24 July 1997. It also acquired part ownership of VocalTec, an Internet Telephony software company.
- In August 1997, AT&T Jens, AT&T's Japanese subsidiary, launched an IP Telephony service for calls between Tokyo and Osaka and 36 other countries, accessed via a toll-free number.

Figure 1.2a: Examples of different "flavours" of IP Telephony
PC-to-PC and PC-to-Phone, over IP

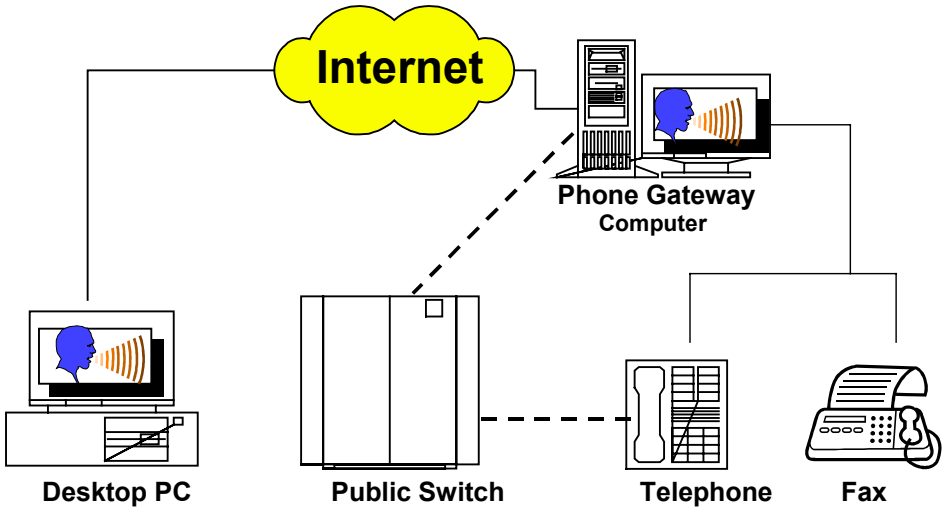
1. PC-to-PC over IP

- Needs similarly-equipped Internet users (e.g., with same IP Telephony software, multimedia PC, etc.), both logged-on simultaneously.
- Main applications: avoidance of usage-based telephone charges; chat-rooms; company LANs, etc.
- Application providers include Firetalk, and Phonefree.
- Potential market - probably less than 100 million users.



2. PC-to-Phone (or fax) over IP

- Internet users with multimedia PC able to call any phone or fax user (not, at present, *vice versa*)
- Main motivation: reduced telephone charges, "free" calls to US, Korea (Rep. of), Hongkong SAR etc.
- Service providers include IDT, Net2Phone, DialPad, etc.
- Market potential-sending >350 million Web users; receiving >1.5 billion telephone/mobile users

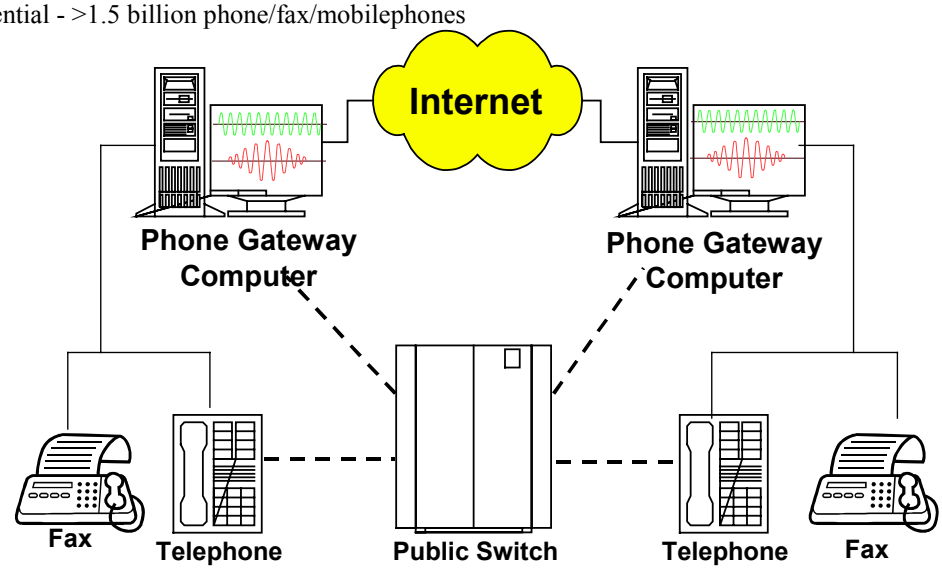


Source: ITU.

Figure 1.2b: More examples of the different "flavours" of IP Telephony
Phone–to-Phone over IP and Phone/Website integration

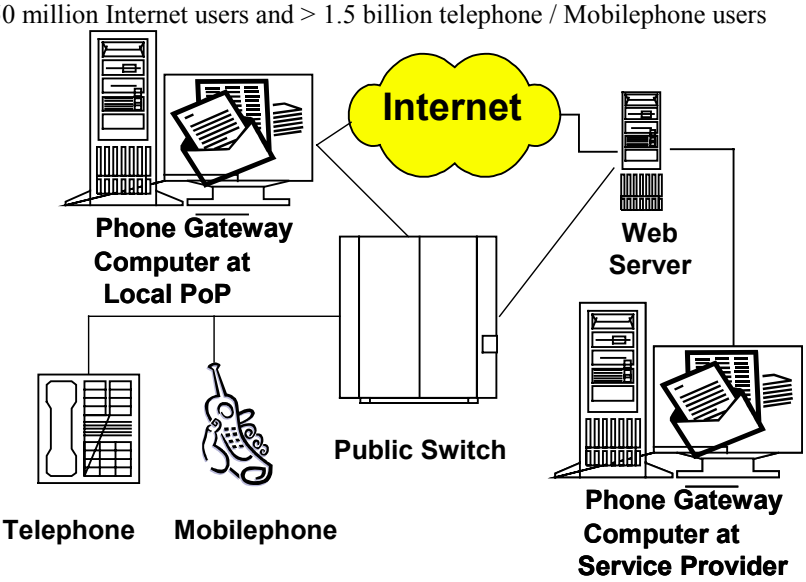
3. Phone-to-Phone, (or fax-to-fax) over IP

- Communication between any phone/fax/mobilephone user and any other
- Main motivation: reduced call charges; accounting rate bypass; market entry for non-facilities-based carriers (e.g., via pre-paid cards)
- Service providers include speak4free, I-link etc
- Market potential - >1.5 billion phone/fax/mobilephones



4. Phone / Web integration, over IP

- Internet users with multimedia PC browse Website and choose voice/video connection option
- Phone users browse voice-activated websites, pick up email.
- Main motivation: service provider can interact directly with potential clients, via voice or video, for instance for telemarketing, freephone access, computer/telephony integration, m-commerce; user can access email from phone.
- Service providers include NetCall, ITXC, Yac.com. T2mail.com etc.
- Market potential - >350 million Internet users and > 1.5 billion telephone / Mobilephone users



Source: ITU.

Box 1.1: Poland – New telecommunication law will permit Internet Telephony

Poland is in the midst of a transition in its IP Telephony policy. IP Telephony was initially banned as a form of illegal competition with the exclusive international licensee, Telekomunikacja Polska S.A. (TPSA). In early 2000, the Telecommunications Ministry informally reversed that position, pending new telecommunications legislation clarifying the situation.

Mirroring other countries, mobile operator PT Centrala (PTC) pioneered the routing of international long distance calls over the Internet. In February 2000, the Ministry granted PTC a temporary permission to use the Internet for price arbitrage on outbound calls until the end of May 2000. New legislation is expected.

Since TPSA's monopoly on international calls is set to last until 2003, this legislation will likely include some grounds on which Internet Telephony can be distinguished from the traditional voice service offered by the incumbent. It is not known whether the PTC routes calls over the public Internet or a private IP Telephony network.

Source: Totaltele.com, <http://www.totaltele.com/secure/view.asp?ArticleID=25860>.

At present, Phone-to-Phone is probably the biggest segment of the IP Telephony market in terms of revenue, and it may also be the largest in terms of minutes of international traffic too. There are multiple operators, many of whom sell services via calling cards. As more and more of the traditional PTOs enter the market, it is becoming harder to distinguish between "pure" IP Telephony traffic and other traffic which perhaps traverses an IP-based network at some stage of its journey but which would otherwise be classified as normal PSTN telephony. However, the initial gloss concerning "free long distance over the Web" has begun to wear off as PTOs have found technical difficulties in providing the equivalent functionality over IP-based networks that customers expect over circuit-switched networks. Also, the motivation for carriers (as wholesalers) to use the IP-based networks, rather than the PSTN, has diminished as accounting rates have come down towards cost and as many new least-cost routes have become available on conventional networks.

The motivation of price arbitrage is still the driving force for Phone-to-Phone IP Telephony. However, the number of markets where price arbitrage is still a viable commercial proposition for low volumed traffic is diminishing as competition spreads through the world (see Figure 1.3). Indeed, many of the country case studies featured in this report are taken from developing country markets, where both wholesale and retail prices for international calls remain high, or from transition economies, where there is a short-term opportunity for price arbitrage ahead of the termination of a period of monopoly control (see Box 1.1 on the case of Poland).

Table 1.1: Retail Phone-to-Phone Voice Services
Selected examples of different marketing approaches

Discount International Services via Access Numbers	Like other alternative or "dial around" long distance and international services, Phone-to-Phone Internet telephony and VoIP services require the user to dial a local access number to get a "second dial tone." After dialling the gateway server of an IPTSP, the user inputs an access code and then the destination phone number. Examples include Czech Telecom's "Xcall" service[3] and CLEAR's "CLEAR 0505" service.[4] Panasonic offers an "Internet phone" with a button by which the user can "select" (speed-dial) an IPTSP instead of his or her regular long distance or international provider.
Pre-selected Long Distance and International - Mobile	The most common implementation of Internet Telephony and VoIP as a pre-selected route for outgoing long distance and international calls is on mobile networks. Indeed, a good deal of pioneering use of IP Telephony technology was done by mobile operators, such as the Czech operator Radiomobil (see Box 3.5), which routes its international calls through a Global One gateway to its partner Deutsche Telekom's global VoIP network (see the ITU-commissioned case study, "Colombia: IP Telephony and the Internet"[5] for a detailed examination of the use of IP Telephony by mobile operators in that country).
Calling Cards	In practice, most retail Phone-to-Phone Internet Telephony and VoIP services are marketed through pre-paid calling cards. Just as in the above scenario, the user dials the local PSTN access number of an IPTSP, is prompted to enter an account code, and then gains a second dial tone to dial the desired telephone number. Services of this type are offered by independent IPTSPs[6] all over the world, often without any indication to the user that the service is provided with Internet Telephony or VoIP.
Freephone Access	Specialized services such as ITXC's "Borderless800"[7] give callers around the world access to toll-free (freephone) numbers in the US, which would otherwise be unavailable to them.

Source*: ITU.*

Box 1.2: IP Telephony heads for the stars

IP Telephony is one of the fruits of the convergence between two-way personal communications media, such as the telephone, and interactive multimedia, such as the Web. As IP Telephony develops, the distinction between what is really "telephony" and what is another type of communication will become blurred.

To take one example: there is a current vogue for "reality TV" shows, like "Big Brother" or "Survivor". The entrepreneurs that develop these services recognise that their website offers the main opportunity for contact with their customers and for commercialising their product. Customers want to be able to interact with the characters in the show as well as with others watching the show. Because most contacts will be based around the website, IP Telephony offers a perfect medium for this to occur, especially if it is combined with video via web cams. The number of participants in the show limits the scope for real-time communication, but there would seem to be a lot of potential demand for non-real-time voice and video messaging. The success of formats such as Big Brother and Survivor has generated proposals for ever more ambitious formats, which involve for instance participants breaking out of jail or even the chance to visit the Mir space station (www.mir.tv). Perhaps this will present the chance for IP Telephony to reach out to new horizons.

In low-price, developed country markets, we are now seeing a fourth stage of IP Telephony evolution that is characterised by convergence. The main driver for IP technology in these markets is the desire of service providers to offer value added services that combine the functionality of the Web with the ease of use and ubiquity of the telephone or mobilephone. Examples of this type of service include unified messaging (e.g., access to voice-mail or fax messages by telephone or mobilephone), number portability, and "click-to-talk" functions on websites. ITXC's "webtalkNOW!" service demonstrates the possibilities for integrating voice into e-commerce Websites.[8]

Phone-to-Phone services most closely approximate the traditional telephone experience and can display very good or very poor quality, depending on the nature of the network or networks over which packets are carried (see Table 1.1). While the Internet can be used as the underlying means of transmission for Phone-to-Phone calls, it is much more likely for these services to rely on closed, managed IP networks and formal billing relationships among gateways and carriers. In that respect, Phone-to-Phone VoIP services actually have very little to do with the Internet, but rather operate nearly in parallel to the global PSTN and its settlement rate system. China Telecom has taken a novel approach to bridging this chasm by negotiating specific accounting rates for terminating IP Telephony traffic.

To the user, the fact that a particular call travels for part of its journey via the Internet or another IP network is irrelevant, as long as the price is low and the quality is acceptable. For IPTSPs, the main motivation is to reduce costs, particularly on the international leg of a call. Fax-to-Fax over IPservices work in substantially the same way as Phone-to-Phone voice over IP.

There is scope for service providers to develop commercial opportunities, but the boundaries that define telephony from other services (such as radio, broadcasting, messaging) are diminishing (see Box 1.2). As so often occurs, the first applications to colonise this new commercial space were in the pornographic and gambling sectors, but the technology is now becoming more mainstream.

Table 1.2: Wholesale Phone-to-Phone Voice Services
Internet Telephony and VoIP services for the PTO and IPTSP

Least-cost-routing	Just as many telecommunication carriers employ IP Telephony in their backbone networks, several operators sell IP capacity (often combined with termination services) as a least-cost routing solution for international calls.[9] Given the increasing prevalence of this type of transmission, many callers are probably already making IP Telephony calls without knowing it. Pulver.com's "Minutes Exchange"[10] acts as a "market maker" between parties originating and terminating IP minutes.
Call Termination	Hundreds of small companies, many related to established ISPs, offer international call termination in almost every country in the world (including many where IP Telephony is prohibited). Some of these firms are full-service clearinghouses and offer billing services as well.[11] The barriers to entry are low and so are the prices. See, for instance, the list of termination rates around the world available on the IPxStream Website,[12] or that of Arbinet-TheXchange, where the prices quoted are often below the settlement rates that would otherwise apply.[13] Just about anywhere the Internet reaches, IP Telephony minutes are being terminated on the PSTN.

Source: ITU.

Table 1.3: Enhanced IP Telephony Applications
Digitisation and packetisation enable endless opportunities for new services

Enterprise internal	The field of computer and telephone integration (CTI) aims to make voice, video, and data merely different applications running over unified IP networks. When combined with a private data network, CTI can provide worldwide voice service for closed user groups. When these networks happen to interconnect with local PSTNs, then they can function as "leaky PBXs," providing yet another way to terminate call minutes around the world.
Integrated voice/data (real-time)	Capitalizing on the ease of integrating digitised audio with other electronic media, new applications such as distant work collaboration allow real-time voice conversations between users looking at the same visual information, such as an architectural plan or a product catalogue. Images, text, and audio can be combined to produce a true multimedia experience, taking Internet chat to a new level of interactivity. In the first instance, the main market for this type of application has been in the field of pornography, where there is already a US$ 2 billion market for telephone sex.
Integrated voice/data (messaging)	Where the exchange of voice signals need not be "live," other opportunities present themselves. Some early commercial applications are electronic greeting cards that can be created and delivered over the Web. In addition to graphics and "canned" music, the greeting can include a short recording of the well-wisher's voice.[14] Similarly, voice messages can be integrated into email messages, business presentations or educational materials. These are not necessarily examples of IP Telephony, but rather of "store-and-forward" computer technologies, which have existed for several years.
Integrated voice/video	If integrating voice and data proves commercially successful, adding video would be the logical next step. IP technology enables very low-cost teleconferencing (albeit presently at low quality) over the Internet, using simple PC cameras. As technology and bandwidth improve, expect text, graphics, audio, video, and Web-style data to be integrated in creative and unpredictable ways.
Telemetry	Moving even further from traditional voice telephony is the emerging field of telemetry – the monitoring and reporting of just about anything, anywhere. Audio-enabled devices can monitor sound levels and transmit images from industrial installations, day care centres or babies' cribs.

Source: ITU.

The flexibility of IP Telephony can be summed up in the term "XoIP," the optimistic industry acronym for "anything over IP." The basic IP Telephony technology can be extended to create limitless possibilities for the transmission of voice alone, or in combination with any other information that can be digitised. Drawing regulatory lines between what is voice, what is telecommunications, what is computing, and what is Internet will only continue to get more difficult. Regulators who try to delimit these boundaries will need to have a clear motivation for doing so.

IP Telephony technology now represents a fully-fledged alternative to traditional circuit-switched telecommunication equipment and services. So-called 'next generation telcos'are building vast global networks, based around IP, on which voice service can be provided alongside data. It is likely that we will see a further stage in the evolution of IP Telephony in which IP–based networks become the default medium for carrying all types of communication. While IP-based networks are optimised for the carriage of data rather than voice, they can nevertheless carry voice very competently and cheaply. Voice currently occupies less than half the bandwidth available on international telecommunication networks, and by the end of the coming decade, that percentage may well be below 1 per cent, by volume. For PTOs, it may well become cheaper just to have a single, IP-based network than to have parallel voice and data networks. At that point, the phrase "IP Telephony" will have become a tautology: most voice will be carried over IP-based networks. It will be "circuit-switched telephony" which will be the exception.

1.3 What?

The distinction between Internet Telephony and VoIP turns on the nature of the principal underlying the means of transmission. The following definitions are offered as a means of interpreting the many different terms that are thrown about in this field:

- **Internet Protocol (IP) Telephony**: The transmission of voice, fax and related services over packet-switched IP-based networks. Internet Telephony and VoIP are specific sub-sets of IP Telephony;
- **Internet Telephony**: IP Telephony in which the principal transmission network is the public Internet. (Internet Telephony is also commonly referred to as "Voice-over-the-Net" (VON), "Internet Phone," and "Net Telephony" – with appropriate modifications to refer to fax as well, such as "Internet Fax");

- **Voice-over-IP (VoIP)**: IP Telephony, in which the principal transmission network or networks are private, managed IP-based networks (of any type). (Depending on the type of network, you can have "Voice-over-frame relay," "Voice-over-cable," and "Voice-over-DSL" or "VoDSL," as examples);
- The **Public Internet** (also referred to as *the* Internet): The global, public, IP-based meta-network created by the interconnection of many public and private IP-based networks.

While the many different retail, wholesale, and internal services which can be provided by combining these three elements in different ways are often generically referred to as "Internet voice" or "VoIP," it is important to identify the precise service being offered in any given case. The labels for these services introduced in this section are also used throughout the analysis presented in this report.

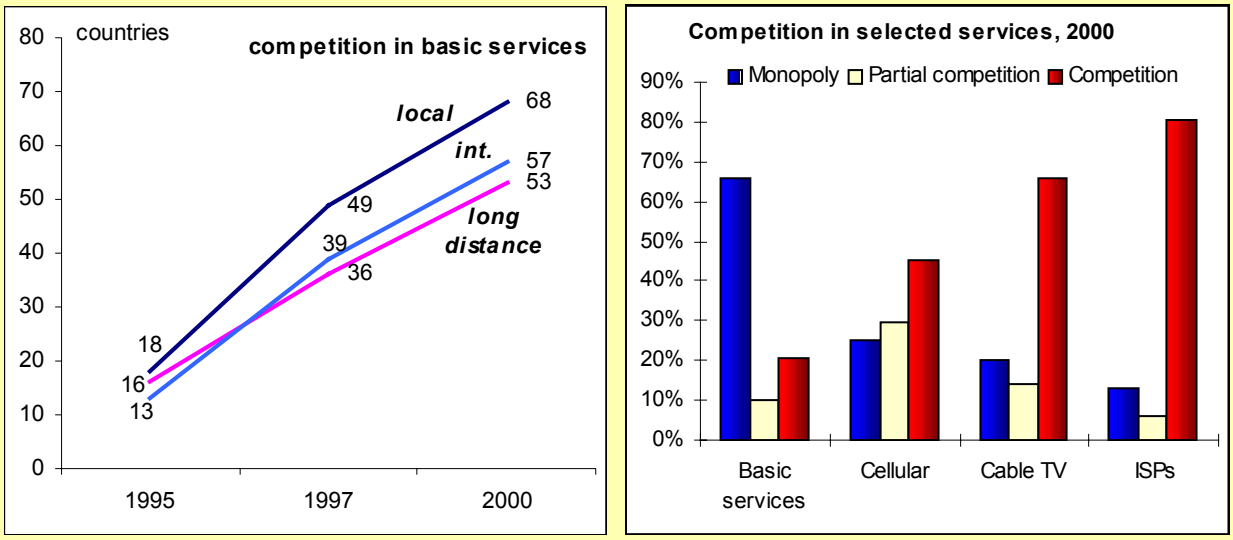
Chapter two, concerning the technology of IP Telephony, suggests more specific definitions and gives a more detailed description of many of these diverse services. While the emergence of IP Telephony is often associated with the rise of the Internet itself, it is important to appreciate that *IP Telephony often does not involve the public Internet at all* – but rather only its underlying technology, the Internet Protocol suite.

The days when IP Telephony could be ignored, and a meaningful distinction between voice and data maintained, are coming to an end. IP Telephony is happening almost everywhere and growing very quickly. ***Chapter three*** describes the economic impact of IP Telephony and, in particular, its impact on PTOs and its relationship to the international accounting rate system. IP Telephony is pushing telecommunication liberalization faster than policy-makers in many countries had planned. As Figure 1.3 shows, the telecommunication markets of ITU Member States have been progressively liberalizing over the past ten years, such that in 2000, more than 80 per cent of international telephone traffic originating in more than 50 countries was open to some degree of competition. While falling prices for international calls are now curtailing some of the attractiveness of IP Telephony, it is important to note that much of its early success can be explained by the lack of competition on a number of international routes, creating significant arbitrage opportunities.

IP Telephony is treated in widely divergent ways within ITU Member States, from being completely prohibited, to being licensed, to merely being another technological platform that can be adopted by operators. ***Chapter four*** discusses the different regulatory approaches to IP Telephony, and the methods used to categorize it within those regulatory structures. The significance of IP Telephony for universal service schemes, convergence policy, and cross-border issues raised by IP Telephony are also considered. The majority of countries have yet to develop formal policies relating to IP Telephony.

Figure 1.3: Competition continues to grow, with Internet services leading the way

Number of countries permitting competition in basic telecommunication services, 1995, 1997 and 2000 (left), and degree of competition in selected services, worldwide, 2000 (right).



Source: ITU World Telecommunications Regulatory Database, "Trends in Telecommunication Reform, 2000".

One of the consequences of the fact that few countries have yet tried to develop a formal policy for IP Telephony is that there are now almost as many different strategies as there are countries. In ***Chapter five***, we review some representative case studies, covering China, Colombia, Peru and Thailand. The research for these case studies was commissioned by the ITU as part of the preparations for a workshop on IP Telephony that was held, 14-16 June in Geneva. More information, including full copies of the studies, is available at: <http://www.itu.int/iptel>. These studies will be extended and updated as part of the background research for the World Telecommunication Policy Forum (see the website at: <http://www.itu.int/wtpf>).

Chapter six attempts to bring together the different technical, economic and regulatory themes developed in the report. It poses the question: *where next for IP Telephony?* Will the Internet indeed become the new public network, and therefore will telephony delivered over IP-based networks become the new public telephone service? Or, will IP Telephony continue to co-exist with PSTN telephony for the foreseeable future? No one can be sure of the answers to these questions, but major corporate decisions, to enter or stay out of particular markets, won't wait for the answer to become clear. Instead, major PTOs, such as AT&T, MCI WorldCom, NTT or Bell Canada seem to have decided that, in a world of rapidly changing technology, size may no longer be an asset. IP Telephony alone could not be said to have caused the break-up of these companies, but it may have speeded up the process

[1] See discussion on the third World Telecommunication Policy Forum, at the ITU's 2000 Council, in the 5th Plenary Meeting on 25 July 2000, summarised in document: <http://www.itu.int/itudocr/gs/council/c00/docs/78.pdf.>

[2] See "Cable & Wireless announces the industry's largest VoIP migration programme", 2 October 2000, at: <http://www.cablewireless.com/news.asp?NewsId=66.>

[3] <http://www.telecom.cz/set.php3>.

[4] <http://www.clear.co.nz/about/media-releases/release.ptml?FROM=index.ptml&ID=11&row_start=6>.

[5] <http://www.itu.int/osg/sec/spu/ni/iptel/countries/colombia/index.html>.

[6] Examples include: DeltaThree.com (based in New York, NY, USA), <http://deltathree.com/unified_signup/signup_calling_cards.asp>; Incomtel (based in Moscow, Russia), <http://www.incomtel.ru/>; and Pan EC Technology Corp. (based in Taipei, Taiwan, China), <http://www.pan-ec.com.tw/>.

[7] <http://www.itxc.com/borderless800.html>.

[8] <http://www.webtalknow.com/>.

[9] Least-cost-routing services offered by discount service providers often use a hybrid mix of different technologies on different routes, according to what is cheapest, where, and when. A press release relating to CLEAR New Zealand's "CLEAR 0505" retail discount calling service describes the method also used by wholesale least-cost-routing operators: "Ordinary voice calls are transmitted via ATM (asynchronous transfer mode) to a switch in Los Angeles, which then directs the call on the cheapest available route to its eventual destination, where it is converted back into an ordinary voice call. The cheapest available route might mean sending the call using voice-over-IP, voice-over-ATM or traditional calls." <http://www.clear.co.nz/about/media-releases/release.ptml?FROM=index.ptml&ID=11&row_start=6>.

[10] <http://www.min-x.com/>.

[11] See, for example, Concert Global Clearinghouse, <http://www.concert.com/clearinghouse/>; Telia Clearinghouse Services, <http://clearinghouse.telia.com/>; NTT Communications Clearinghouse Service, <http://clearinghouse.ntt.com/>; iBasis, Inc., <http://www.ibasis.net>; GRIC Communications, Inc., <http://www.gric.com/>; and ITXC, <http://www.itxc.com>. A complete list of IPTSPs and clearinghouses is hosted by IPxStream at <http://www.iptelephony.org/GIP/providers/index.html#settle>.

[12] <http://www.iptelephony.org/GIP/popshop/tshop/index.html>.

[13] <http://www.arbinet.com/>.

[14] See, for example, Blue Mountain Arts Voice Messaging, <http://www.bluemountain.com/eng/voice/>.

CHAPTER TWO: TECHNICAL ASPECTS OF IP TELEPHONY

2.1 Introduction

A fundamental shift has been occurring in the telecommunications industry, a shift that is arguably as important as that from the telegraph to the telephone or from the mainframe to the personal computer. That change is a shift from traditional PSTN *circuit-switched* voice networks to *packet-switched* data networks, using Internet Protocol (IP) technology. For the most part of the last century, voice traffic was dominant. Today voice represents an ever-diminishing percentage of overall telecommunications traffic when compared to data. One result is that support for IP-related technologies is now a strategic element in the design, development and use of telecommunication networks. It also means that most PTOs are aggressively implementing IP technologies in their networks.

IP technology chops up electronic transmissions into packets of varying number of bytes. Each packet is given a "header" or address label, and sent from one network node "towards" another. The packets are bounced along from one *router* to another, armed at each "hop" with only enough information to get them safely to another router, where the process is repeated. By contrast, on circuit-switched networks using protocols such as Signalling System 7 (SS7) a call is routed through a hierarchy of local, inter-urban and international switches to establish an end-to-end circuit between caller and called party.

The architectural differences between telephone and IP networks are clearly rooted in their origins. Telephone networks have been carefully engineered to provide extremely reliable, high-quality voice transmission, making real-time or *synchronous*, two-way conversations possible between almost any two points on earth. IP networks, on the other hand, were originally designed for two-way, not real-time, that is, *asynchronous* communication. While Internet communications are typically "connectionless" or "stateless" (that is, no unique end-to-end circuit is created and held for the duration of a particular session), current IP Telephony developments seek to imitate the more connection-oriented, PSTN-like circuits, rather than other types of IP communications. In other words, the touted differences between packet-switching and circuit-switching are becoming increasingly blurred (see Figure 2.1). During the last few years, the desire to make these two types of networks interconnect and interoperate, without the user being able to tell the difference, has prompted enormous technical research and development efforts in both the telecommunication and computer industries. In this respect, IP Telephony is the embodiment of convergence and will force both types of networks to mutate and eventually merge.

2.2 IP Telephony standards activities

It should not be surprising that IP Telephony standards development represents, in many ways, attempts to replicate long-established technical practices in the PSTN, such as call set-up and tear-down, Intelligent Network (IN) services and guaranteed quality of service. Although not always well coordinated, a great deal of work on technical standards for IP Telephony is underway in many industry and regional bodies as well as in conventional standardization bodies such as the European Telecommunications Standards Institute (ETSI), the Internet Engineering Task Force (IETF) and the ITU Telecommunication Standardization Sector (ITU-T).

Of course, most telephones are—and for several years to come will continue to be—connected to traditional circuit-switched telephone networks. IP Telephony services must be able therefore to accept calls originating on the PSTN, to terminate calls on the PSTN, and to do it all seamlessly. Today, the most basic IP voice services accomplish this by means of *gateways*, which can convert and forward calls in one direction or another. However, before IP Telephony can be a mass-market alternative to the PSTN, there must be much greater integration between the two. The initial enthusiasm of "free long distance on the Internet" appears to have been dulled by the reality of the immense complexity of achieving transparent interconnection with the PSTN infrastructure.

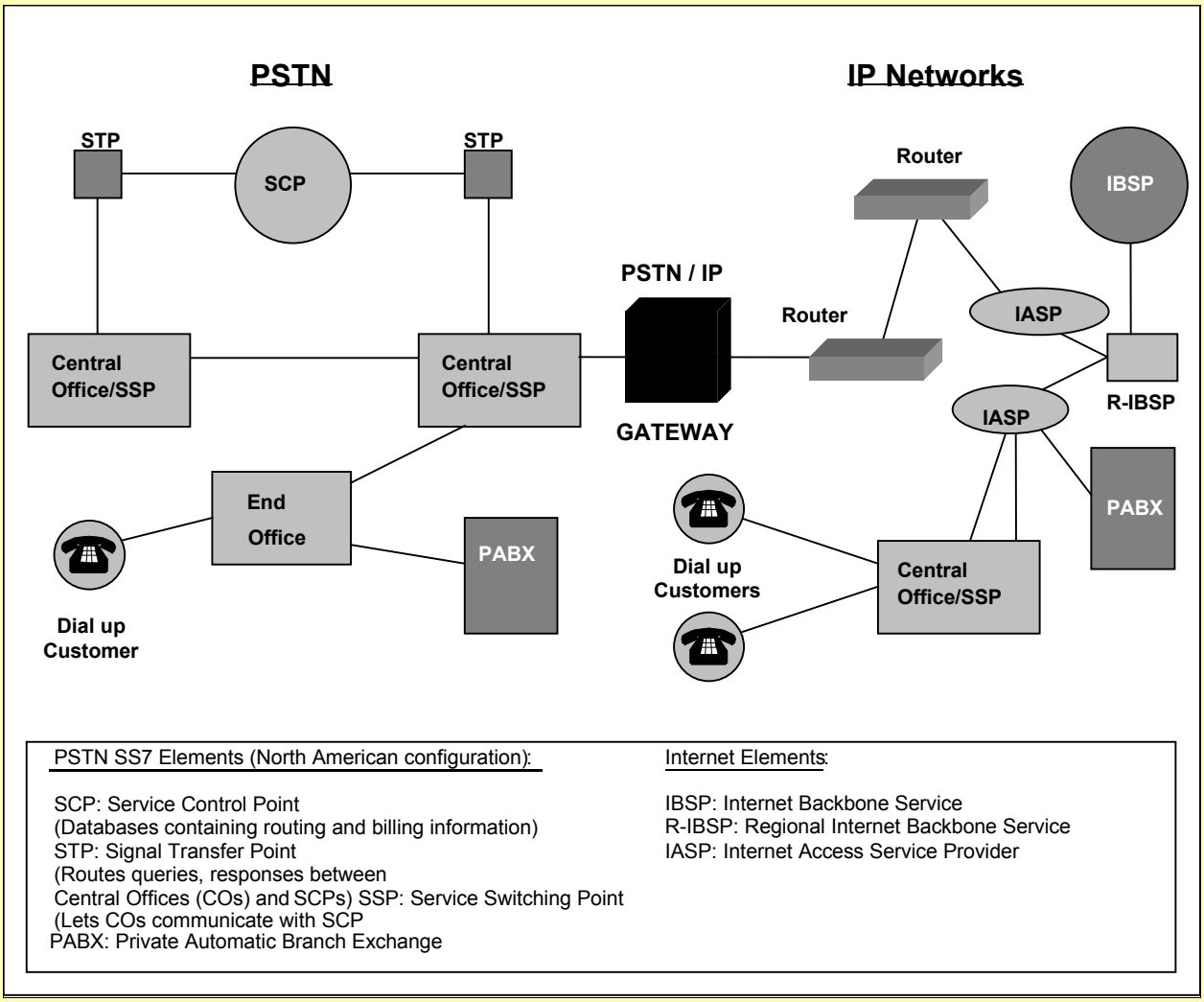
Current research and development work, both into proprietary vendor solutions and open industry standards, seeks to make telephony more *media-neutral*, that is, equally functional and interoperable across many different types of physical networks, equipment, and control software (e.g., switches, routers, signalling systems). The first generation IP Telephony services that linked to the PSTN via gateways were not capable of Intelligent Network (IN) functionality, such as calling party identification (indeed, on the Internet,

guaranteed anonymity is often considered an advantage), nor could they interface seamlessly with PSTN signalling systems such as Signalling System 7 (SS7). These advanced call control functions facilitate the advanced level of functionality to which telephone subscribers have become accustomed, and which form the basis for many premium rate and enhanced services. Recognizing this, the latest generation of IP Telephony standardization activities has focused on the architecture of *gateways* linking PSTN and IP networks. These include two key architectural functions, namely:

- **Media gateways (MG):** This function performs simple encoding and decoding of analogue voice signals, compression, and conversion to/from IP packets; and
- **Media gateway controllers (MGC):** This function contains call control intelligence and analyses how calls are to be handled and performs functions similar to the SS7 network in the PSTN environment. It needs to understand various signalling systems such as SS7 and GSM in order to ensure PSTN interconnectivity.

The two functions above can reside in the same or separate devices. For example, some PSTN/IP gateways combine both the MG and MGC functions in one device.

Figure 2.1: Two different ways of doing the same thing
Gateways bridge PSTN and Internet architectures



Source: Adapted from TeleGeography, Inc., Hubs and Spokes: A TeleGeography Internet Reader (Washington, DC: 2000), p. 50, <http://www.telegeography.com>.

Table 2.1: "Everything-over-IP (XoIP)" Standards, Protocols, and Vendor Fora
Standards for interworking among IP Telephony hardware and software and with the PSTN

Standards Body	URL	Major XoIP Standards/Protocols	Notes
International Telecommunication Union (ITU)	www.itu.int	T.120	Real Time Data Conferencing (Audiographics)
		H.248	Gateway control protocol (same as IETF Megaco)
		H.320	Narrow-band visual telephone systems and terminal equipment
		H.323	Packet-based multimedia communications systems
ETSI/TIPHON	www.etsi.org	OSP	Open Settlements Protocol provides XML-based IP traffic settlements
Internet Engineering Task Force (IETF)	www.ietf.org	SIP	Session Initiation Protocol
		RSVP	Resource Reservation Protocol prioritizes packet traffic by use
		Diffserv	Differentiated Services
		Megaco	Same as ITU-T H.248
		MPLS	Multiprotocol Label Switching
Industry Forum	**URL**	**Membership**	**Notes**
International Multimedia Teleconferencing Consortium (IMTC)	www.imtc.org	Founded 1993, currently 145 members	IMTC covers H.323 (and other ITU standards), iNow, and others
Softswitch Consortium	www.softswitch.org	Founded 1999, 50 members	Focused on SIP/MGCP and other internetworking Technologies
Internet & Telecoms Convergence Consortium	itel.mit.edu	Academic/corporate	Covers technical, economic, and policy issues
Industry Initiative	**URL**	**Founders**	**Notes**
Interoperability Now! (iNow)	www.imtc.org/act_inow.htm	ITXC, Lucent, VocalTec	Standards-based IP Telephony interoperability profile for vendors and service providers based on H.323
IP Call Detail Record Initiative (IPDR)	www.ipdr.org	Jerry Lucas and 19 charter members	Goal is to define call records for IP traffic exchange and billing and submit to standards bodies for discussion
VON Coalition	www.von.org	Jeff Pulver and 22 charter members	Seeks to keep IP services as unregulated as possible and educate consumers and the media about relevant technologies

Source: Adapted from TeleGeography, Inc., Hubs and Spokes: A TeleGeography Internet Reader , p. 54, <http://www.telegeography.com>.

An example of this combined gateway architecture is the H.323 series of Recommendations from ITU-T Study Group 16. The H.323 series is a set of multimedia standards originally designed for networks, which do not provide guaranteed Quality of Service (QoS), that include IP-based networks, most LANs, and the public Internet. The scope of the H.323 series is very broad and supports point-to-point and multipoint multimedia conferencing, call control, multimedia and bandwidth management, as well as interfaces between different network architectures. The current ITU-T H.323-related work-plan includes many enhancements including the release of Version 4.0 (planned for approval in November 2000) and a large number of Annexes that include, *inter alia*, support for improved security, new signalling, user and service mobility, and QoS. The H.323 series has proven to be very successful in the IP Telephony Service Provider marketplace with adopters such as China Unicom, iBasis, DialPad, and many others.

Although the H.323 series intended to standardize both the *media gateway* and *media gateway controller* architectural components, an industry initiative called MGCP (Media Gateway Control Protocol) gained some prominence in further "decomposing" media gateway controllers from media gateways.[1] Reacting to divergent industry efforts, the Internet Engineering Task Force (IETF) and ITU-T collaborated closely, and jointly produced a new single protocol called H.248 (ITU-T name)[2] and Megaco (IETF name). The resulting H.248/Megaco defines a master/slave protocol to control media gateways that can pass voice, video,

facsimile and data traffic between PSTN and IP-based networks. H.248/Megaco supports various "packages" that interface with conventional PSTN switches and Intelligent Network (IN) services, with plans to support a range of existing signalling protocols including the ISUP (SS7 Signalling Protocol), GSM and others.

Competing with H.323 is an IETF-developed standard called Session Initiation Protocol (SIP). SIP is a signaling protocol for Internet conferencing, telephony, presence, events notification and instant messaging originally developed within the IETF's Multiparty Multimedia Session Control (MMUSIC) working group.[3]

Box 2.1: Switzerland – It all comes down to a few milliseconds

Internet Telephony and IP Telephony services are currently not subject to detailed regulation in Switzerland. However, as in those countries bound by the European Commission's directives on voice telephony and Internet voice services (which Switzerland is not), that situation could change if the services provided are considered "real time."

The key criterion in determining whether a certain type of IP Telephony constitutes public telephone service under the Swiss policy is whether the service is "transmitted through direct transport and switching of speech in real time." This comes down to a question of milliseconds. The authors of a recent article on the Swiss perspective on IP voice telephony explain the milliseconds issue well:

"So far, IP Telephony over the public Internet only provides usable communication with significantly impaired speech quality and end-to-end delays of over 450 milliseconds (ms) being likely to impact the overall conversational interactivity and causing a perceived deterioration of voice quality which is less than that of a GSM Full Rate Speed Coder (FR). Uncongested IP networks have the potential to provide a user experience similar to common wireless mobile telephony services (GSM FR), delays being up to 450ms. QoS-engineered IP networks might provide a quality similar to the PSTN and GSM Enhanced FR, but with increased delays of up to 250ms. Only QoS-engineered IP networks in Local Area Network (LAN) environments can provide a quality similar to or better than the PSTN, delays being only up to 150ms (see ETSI-TIPHON, TR 101.329 on General aspects of Quality of Service, p. 24)."

For more detail, see <http://www.itu.int/osg/sec/spu/ni/iptel/countries/switzerland/index.html>.

Source: Pierre-Yves Gunter and René Pfromm, "IP Voice Telephony – A Swiss Perspective," *World Telecom Law Report*, Vol. 3, No. 2 (February 2000), pp. 26-29.

Box 2.2: The life (and death?) of an IP Telephony packet

The genius of Transmission Control Protocol (TCP) is that it can automatically adjust the rate at which packets are transmitted to account for network conditions, such that in periods of network congestion, packets are made smaller and not sent out after each other as quickly. In this way, everybody's packets have about the same chance of being successfully routed across the same network. This is a function of the Internet traditionally having only one class of service – known as "best efforts." User Datagram Protocol (UDP) packets are a bit different to TCP packets. They refuse to be held back in favour of other packets, and are always sent out at the same rate.

UDP is used for Internet Telephony packets to minimize delay to some degree – at least to keep them from being slowed due to traffic conditions. UDP is normally used for simple network transactions, like Domain Name System (DNS) lookups and network management functions. For this reason, it would be impractical to reprogram core Internet routers to block UDP packets, if this was desired. However, at an IPTSP or ISP's servers, this may be possible. All real-time voice and video applications running on IP have a "port number" over 1024 (a port is a program on a computer that receives or sends information for the computer – each port has a number in order to identify it). Port numbers from 0-1023 are for use by privileged services which are allocated certain numbers by Internet technical bodies. They are unchangeable by users. However, ports above 1024 can be set by anyone.

ISPs can use this fact as a straightforward way of guarding against IP Telephony traffic clogging up data lines. They can simply "drop" UDP packets with a port number over 1024, or monitor data streams and "shape" their traffic by treating such packets differently. However, once IP Telephony calls have been patched from IP networks onto the PSTN, they are almost impossible to detect. This makes it very difficult for national authorities to prevent IP Telephony calls from being terminated in their territories.

Box 2.3: Changing quality of service expectations?

It is widely believed (and mostly with good reason) that the clarity of sound on an Internet Telephony or VoIP connection is not as good as that of the PSTN. This fact has implicitly supported many permissive IP Telephony policies. The most important factor in sound quality is the degree of delay inherent in the transmission of speech, or whether voices appear to be transmitted instantaneously. While sound quality can be improved on closed IP Telephony systems, only the most well-provisioned and controlled networks can currently offer equivalent clarity of sound to that of an ordinary PSTN connection.

Consumer expectations of sound quality may be falling to the point that the lower quality of sound available on most IP Telephony systems is acceptable in exchange for a lower price. Mobile telephone service tends to suffer poor quality and occasional break-up of service. It is not by chance that the first major application of IP Telephony for preselected long distance and international carriage was in the mobile market, where quality expectations are already slightly lower than on the PSTN. With greater use of voice compression and speakerphones, even standard PSTN quality has deteriorated somewhat in recent years. For this reason, sound quality alone may not be a sensible basis on which to distinguish between unregulated IP Telephony services and regulated voice telephony services.

Under the Hungarian policy (see Box 4.2), service providers must inform their customers of the quality limitations of IP Telephony services but that appears to have had little impact on their popularity particularly among mobile users. While IP networks may never achieve the 99.999% reliability targets aimed at by fixed-line operators in developed markets, it may simply not matter as consumers in many countries, and particularly those in countries which have never had such high-quality service, have shown a preference for lower-cost services, even at the expense of sound quality.

2.3 Quality of service

Quality of service is at the core of voice telephony and, as such, is often the focal point of the IP Telephony debate. There are many aspects to quality, including reliability, throughput and security. However, it is the perceived poor transmission quality of voice delivered over the current public Internet that explains why Internet Telephony is often not considered as carrier-grade service. While it has been technically possible to transmit voice telephone calls over IP-based networks for years, poor sound quality and inconvenience have prevented IP Telephony from threatening traditional voice telephone systems. There are, in general, two ways in which this quality can be improved—implementing quality of service support and increasing available bandwidth. Massive amounts of research time and money are being put into enhanced and prioritized routing or switching research, while billions of dollars are also being spent to increase the bandwidth capacity of global data networks. Each have the potential to make IP Telephony a viable commercial alternative to the PSTN, but are based on very different philosophies.

When IP packets carry bits of an email message, delays of milliseconds or even seconds caused by inherent limitations of the Internet do not make much difference. But when those packets carry pieces of a telephone conversation, these time delays, added to the overhead of packetization and compression of voice signals, can accumulate and make normal conversation unintelligible and impractical. Research has been underway in the Internet industry for several years on ways to prioritise certain packets over others. One recognized solution is that latency-sensitive transmissions, such as voice and video, are given higher priority over asynchronous services such as email and Web browsing.

Therefore, a considerable amount of research has gone into allowing for different classes of service for different kinds of traffic. In an integrated network where different types of traffic compete for resources, priority should generally be assigned to real-time traffic. Class of service differentiation is already a well-known feature of ATM networks, which grew out of broadband ISDN standardization. A lot of comparable work has gone into developing technologies to implement the same features in an IP environment including various IP over ATM architecture schemes, the Integrated Services framework (Intserv), the Resource reSerVation Protocol (RSVP), Differentiated Services (Diffserv), and Multiprotocol Label Switching (MPLS).

2.4 Bandwidth

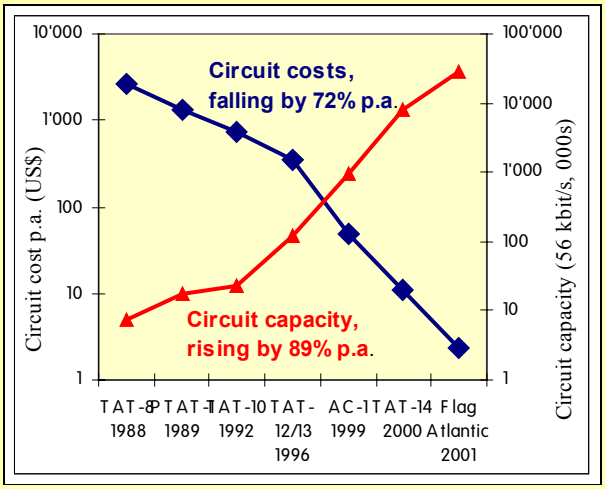
The other basic means of decreasing latency in IP packet transmission is to increase or "over-dimension" the bandwidth of the network or networks employed. More bandwidth means less congestion, which in turn means less delay and more natural voice conversations. Indeed, some observers argue that increasing the available bandwidth is a far more practical means of speeding up the Internet than is enhancing QoS, because

it does not require coordinated action across Internet services providers.[4] In this regard, debates over the principles of Internet peering, transit and interconnect demonstrate that there are still a wide range of views on how bandwidth providers should be appropriately compensated for their contributions to the overall performance and capacity of the Internet.

The situation is much simpler with respect to private managed IP networks. More bandwidth, faster transmission, and better voice quality combine to produce satisfied customers for more of the time. Privately operated bandwidth is therefore typically a key element today in commercially viable IP Telephony, and much more so at present than QoS. The take up of IP Telephony has clearly been faciliated by considerable increases in the availabilty of economical leased circuits and bandwidth, which in turn, has been set in motion by the ever growing requirements of IP-based data traffic. Ironically, IP Telephony (like Web browsing) is not nearly as lucrative a way of using that capacity as traditional voice telephony, particularly given the predilection of Internet users towards 'free' services.

Figure 2.2: The boom in trans-Atlantic capacity

Trends in the availability of circuits on the trans-Atlantic route and on the average cost per voice path, 1988-2001



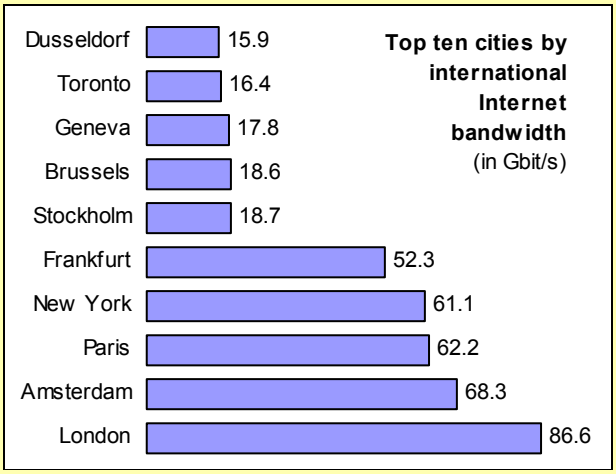
Transatlantic Cable System Total Capacity		Trans-pacific Cable System Total Capacity	
1990	24'570	1990	7'560
1991	24'570	1991	24'570
1992	62'370	1992	39'690
1993	85'050	1993	62'370
1994	160'650	1994	62'370
1995	251'370	1995	69'930
1996	311'850	1996	190'890
1997	372'330	1997	190'890
1998	795'690	1998	311'850
1999 est.	2'005'290	1999 est.	1'279'530
2000 est.	9'746'730	2000 est.	3'819'690
2001 est.	52'687'530	2001 est.	11'561'130

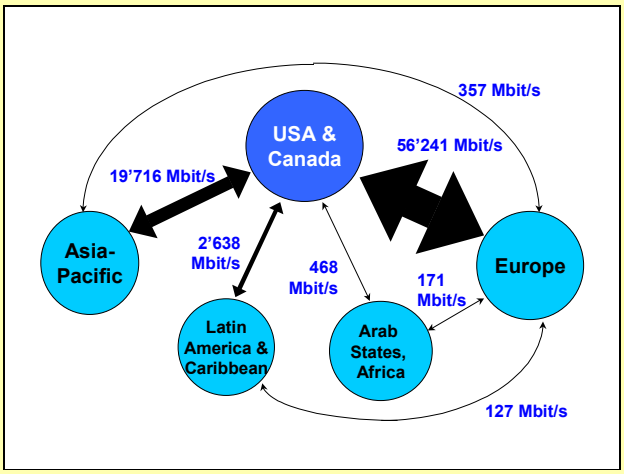
Note: "Circuits" are 56/64 kbit/s international circuit equivalents, as reported to the FCC. The "circuit cost p.a." is calculated by dividing the construction cost of the cable by the available number of circuits on the cable, their anticipated capacity usage (18%) and dividing by an expected working life of 20 years. Estimates are used for 1999, 2000 and 2001 for the right-hand table.

Source: Adapted from data supplied by FCC and TeleGeography Inc.

Figure 2.3: Top ten international Internet hub cities, and inter-regional Internet bandwidth

International bandwidth as of September 2000





Source: TeleGeography Inc.

2.5 Numbering

One of the technical challenges raised by the ever-closer integration between circuit-switched and packet-switched networks concerns how to address calls that pass from one to the other. Generally, it is assumed to be desirable that a single integrated global addressing system (subscriber access plan) exists. For example, the same ITU-T E.164 telephone number would reach a subscriber regardless of whether IP-based or PSTN network technologies are used. Indeed, the concept of being "technology independent" suggests that any global numbering/addressing plan should be abstracted as much as possible from underlying lower layer technologies.

It is now widely possible to originate calls from IP address-based networks to other networks, but it is currently rare to terminate calls from other networks to IP address-based networks. Rather, calls are generally terminated on the PSTN, so the called party can only use a terminal device connected to these networks. In order to access a subscriber on an IP address-based network, some sort of global numbering/addressing scheme across both PSTN and IP address-based networks needs to be developed and implemented.

ITU-T Study Group 2 (SG2) is currently studying a number of possible options whereby users in IP address-based networks can be accessed from/to PSTN users. As one of these options, SG2 has temporarily reserved, for test purposes, a part of the E.164 numbering resource +878 878 for an IP-based implementation of Universal Personal Telecommunication (UPT) services.

Box 2.4: How do I find thee? Let me ENUM the ways

The ENUM protocol offers the possibility of doing a database query where any subscriber's E.164 telephone number is the look-up key to finding other associated services. To do this, ENUM uses a new type of Internet DNS record called Naming Authority Pointer (NAPTR) resource records, as defined in RFC 2915.[5] The ENUM protocol defines and uses a specific type of NAPTR service, with the mnemonic "E2U" (E.164 to URI resolution).

The result of an ENUM query can be one or more URIs with their order of processing and preference indicated though NAPTR record fields. These URIs can be used to reference existing resources or services associated with the E.164 number (e.g., associated fax number, mail address, GPS coordinates, mobile number, phone redirection services, unified messaging services, voice mail, user's public key for asymmetric encryption applications, etc.). Indeed, one of the exciting possibilities of ENUM is the potential for new creative E.164-based lookup services.

The Internet Architecture Board (IAB) has recommended that the top level of the corresponding DNS structure for ENUM be "e164.arpa".[6] The justification given is that .arpa (Address and Routing Parameters Area) is a top level domain intended for Internet infrastructure purposes.

How would an E.164 number be looked up in the DNS? Because DNS hierarchies (right-to-left) are the opposite of telephone number hierarchies (left-to-right), ENUM services are looked up through a one-to-one *reverse* mapping of the digits in a telephone number into separate DNS "zones". The user interface to this reverse mapping and lookup are performed (and hidden from the user) through application software.

As an example, lets construct the related DNS zone to look up NAPTR E2U resource records associated with the E.164 number +33 1 40 20 51 51 — the telephone number of the information desk at the Louvre Museum in Paris, France:

- Write the E.164 number in its full form, including the country code, then remove all non-digit characters with the exception of the leading "+".
- Example: +33140205151
- Remove all characters with the exception of the digits and put dots (".") between each digit.
- Example: 3.3.1.4.0.2.0.5.1.5.1
- Reverse the order of the digits and append the string ".e164.arpa" to the end.
- Example: 1.5.1.5.0.2.0.4.1.3.3.e164.arpa

The client application can now perform the lookup of associated NAPTR E2U records and, as an example, retrieve a corresponding fax number, email address, or voice mail redirection service for +33 1 40 20 51 51.

Another potential approach to the integration of different subscriber access systems in the PSTN and IP address-based networks is the ENUM protocol. The ENUM protocol is the result of work of the IETF's Telephone Numbering Mapping working group[7]. The charter of the ENUM group is to define a Domain Name System (DNS)-based architecture and protocol for mapping an E.164 telephone number[8] to what are known as Uniform Resource Identifiers (URIs)[9]. A relatively stable standard-track version of the ENUM protocol has recently been published as RFC 2916[10]. URIs are strings of characters that identify resources such as documents, images, files, databases, email addresses or other resources or services in a common structured format. The most commonly known types of URI are Uniform Resource Locators (URLs), which are used to locate resources using the World Wide Web. For example <http://www.itu.int/infocom/enum/> is the URL for the ITU web site providing an overview of ENUM activities.

ITU-T Study Group 2 and the Internet Architecture Board (IAB) have been collaborating on how to facilitate deployment of ENUM services. One overriding consideration is that because E.164 numbers typically start with country codes, they have direct implications of sovereignty (geographic country codes) that, in turn, are associated with national Administrations responsible for numbering policies. This, along with the inherent monopoly of DNS zones, suggests that it is appropriate that E.164 country-code numbering authorities (or other governmental authorities), decide how ENUM-related services are to be deployed, synchronized with telephone numbers, and sub-delegated in subordinate DNS zones (especially when routing is involved). The view of ITU-T Study Group 2 is that administrative entities, including DNS administrators, should adhere to the applicable tenets of pertinent ITU Recommendations[11] with regard to the inclusion of E.164 resource information in the DNS.

2.6 Impact of IP Telephony on network architectures

In a remarkably short time, IP has become the platform of choice for new telecommunication networks. Vast global IP networks are now being created to support Internet-style applications accessible from anywhere. As one example, AT&T has prominently announced it will purchase no more circuit-based switches, only IP-based routers and servers.

This is part of a broader trend. Generally, over the last few years, the backbone network architectures of international and regional networks have evolved from territorially constrained (geo-political) services to ones that serve global or regionally wide geographic areas. This change has been gradual and brought on by a combination of deregulation, privatisation and technology advances. This evolution in architecture is already well illustrated in Europe, where incumbent carriers have changed their international networks from ones that connected with half-circuits through the traditional international gateways to totally owned pan-European networks. Each of the major incumbent carriers, as well as the new carriers, now operates separate parallel networks that compete with each other.

Second, the expanding growth of data services, primarily driven by the Internet and other IP-based networks, is a driving force in requiring fundamental changes in network architecture. This impact is most easily demonstrated through the globalisation of carrier offerings. For example, the historical international PSTN gateways are disappearing, as a carrier or an alliance of carriers builds out global networks. The left side of Figure 2.4 shows four country or regional networks using the older conventional architecture where each has its own international gateway interconnecting with the other international gateways using half-circuits. In this scenario, each country or regional carrier is responsible for the half-circuit to the other gateway.

The new architecture is shown in the right side of Figure 2.4 where three of the networks have expanded to become global. In this scheme, each carrier owns or leases full circuits between each of its nodes. One carrier (Net A) has not become global and is dependant on one or more of the global carriers for its international services. The point where Net A connects to the global carrier probably will change from the old international gateway on the left to a new location that could be in another country or region physically closer to the Net A carrier.

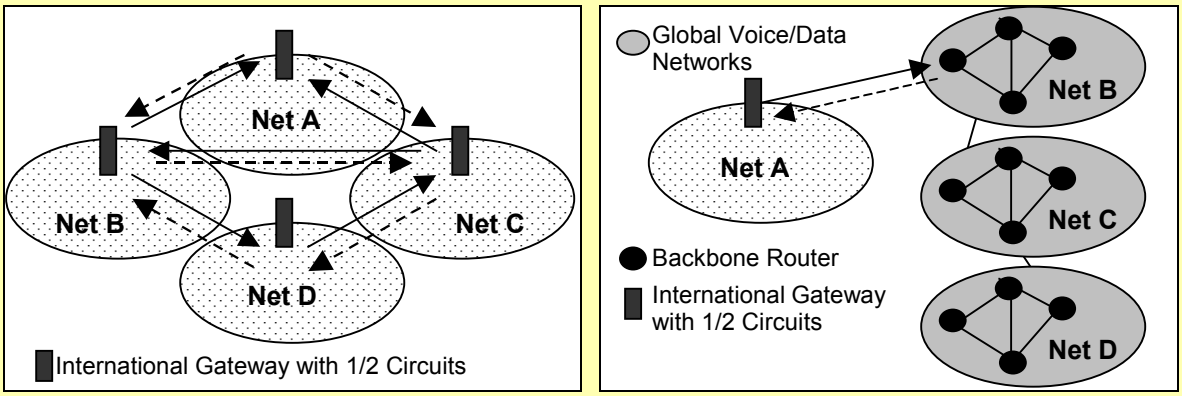
This architectural change directly relates to how new telecommunication services are now being built-out and deployed. Where the PSTN backbone was previously TDM half-circuits connecting gateway switches, the new architecture is rather a high speed optical network platform carrying a number of different services such as switched voice, ATM and IP. This change in architecture, of course, also brings about fundamental changes in the ways carriers look for compensation, namely, a shift from international accounting rates to

private contracts between carriers. New compensation schemes are required, typically resembling more ISP-type interconnection arrangements.

The degree to which these architectural trends are also influenced by the regulatory distinctions maintained in many countries between voice and data is a subject explored in Chapter 4: "Regulatory Aspects of IP Telephony". This issue becomes particularly significant in the case of cross-border and international traffic, where prices have traditionally been the highest—and arbitrage opportunities the greatest. The issue of price arbitrage, one of the primary drivers in the early market development of IP Telephony, is explored further in the next chapter.

Figure 2.4: Evolving Architectures

Conventional international PSTN gateway architecture evolving to global voice/data networks



Source: Adopted from Genuity.

[1] One objective was to define a simpler "IP Phone" specification that would replace H.323 in simple end-points.

[2] Approved in June 2000.

[3]< http://www.cs.columbia.edu/~hgs/sip/>

[4] See Odlyzko, A.M., "The current state and likely evolution of the Internet," presented at IEEE Globecomm '99, <http://www.research.att.com/~amo/doc/globecom99.pdf>; and Huston, G., "Quality of Service: Fact or Fiction?" The Internet Protocol Journal (Cisco) (March 2000), <http://www.cisco.com/warp/public/759/ipj_3-1/ipj_3-1_qos.html>.

[5] <http://www.ietf.org/rfc/rfc2915.txt>

[6] <http://www.iab.org/iab/statement-on-infrastructure-domains.txt>

[7] <http://www.ietf.org/html.charters/enum-charter.html>

[8] <http://www.itu.int/itudoc/itu-t/rec/e/e164.html>

[9] <http://www.ietf.org/rfc/rfc2396.txt>

[10] <http://www.ietf.org/rfc/rfc2916.txt>

[11] For example, ITU-T Recommendations E.164, E.164.1, E.190, and E.195.

CHAPTER THREE: ECONOMIC ASPECTS OF IP TELEPHONY

3.1 Consumers, carriers and countries

The economic advantages of IP Telephony for **consumers** can be described very simply: it is invariably *cheaper* than the traditional alternative, especially for Internet Telephony (carried over the public Internet). If all other factors (e.g., quality, convenience, reliability, etc.) are equal, the choice to use whichever type of IP Telephony is cheapest is an economically rational one (see Box 3.1). For the moment, the other factors are not equal. In Hungary, for instance, IPTSPs would be regarded as breaching the monopoly of the incumbent, Matav, if the average delay of voice transmissions was less than 250 milliseconds or if packet loss was less than 1 per cent. Therefore, consumers must generally make a trade-off between price and quality. In the medium-term, it is likely that VoIP (over managed IP networks) will be equivalent in quality and reliability, and may in some circumstances be more convenient (e.g., for unified messaging), than traditional telephony. Thus price will be the main distinguishing factor.

Box 3.1: "Free" IP Telephony?

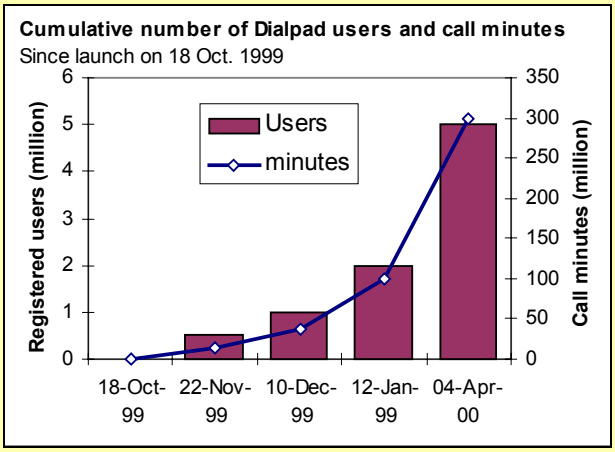
In October 1999, a company called Dialpad.com started advertising "free" PC-to-phone calls from PCs anywhere in the world to telephone subscribers in the United States. Within a few months, the regulatory agency in far-away Nepal had urgently faxed all ISPs in the country asking them to block traffic to Dialpad.com's site. News travels fast on the Internet, and news about "free" services seems to travel even faster. Within a few months of launch, Dialpad.com had more than six million registered users and had carried some 300 million minutes of traffic (see Box Figure 3.1).

Dialpad.com's strategy was not particularly new: Free World Dial-up project, for instance, was offering a "free" Internet Telephony service as long ago as 1995, relying upon volunteers in different countries to patch incoming calls to their local telephone network. But Dialpad.com offers a convenient, H.323-compatible service in which calls within the United States are delivered over a managed fibre-based VoIP network run by Genuity, a subsidiary of GTE, a major US telecommunications company. It is able to offer service for free by offsetting any interconnect charges which might be incurred (typically a few US cents per minute) against advertising revenue, both via audio and on the website. It also gains revenues from offering the application to ISPs to promote under their own brand.

Dialpad.com is not alone in this market. As the table below shows, there are many different companies that offer advertising-funded IP Telephony, with a recent trend towards enhanced services and applications (e.g., Internet call-waiting, integrated messaging etc). As awareness of such services grows, and their geographical coverage spreads (they are particularly popular in countries which have free local calls or very low interconnect charges for terminating calls) it will be hard for services which levy per minute usage charges to compete. The list of Web-based services which began as a priced service and ended up as free of charge is growing (e.g., free browsers, free e-mail, free website hosting).

Box Figure 3.1: IP Telephony wants to be free

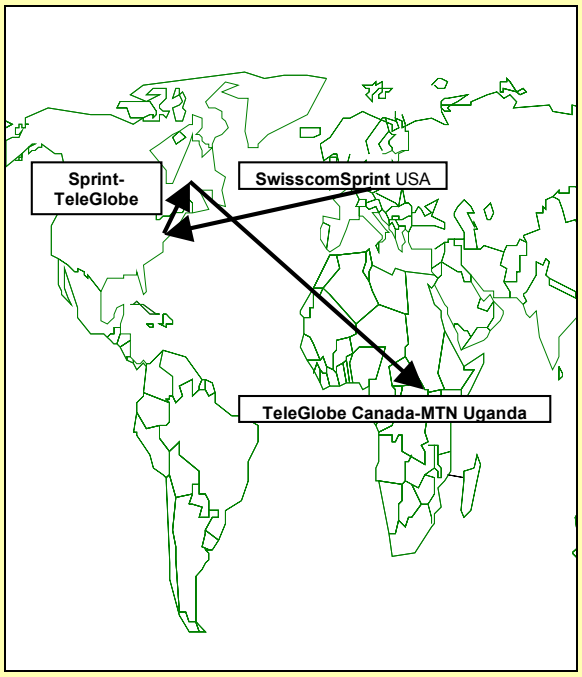
Cumulative growth in Dialpad.com's registered users and call minutes, October 1999-April 2000, and examples of different "free" IP Telephony applications and services



Type of "free" service	*Example providers and coverage*
PC to PC	Firetalk.com (International) Phonefree.com (International)
PC to Phone	Dialpad.com (US & Rep. of Korea) Deltathree.com (free for US & Canada) e001.com (Hongkong SAR & Singapore) hottelephone.com (US + 15 countries)
Phone to Phone	speak4free.com (US) I-link.com (US)
Enhanced services (e.g. voicemail, call w aiting call forw arding)	yac.com (UK and International) buzme.com (US) 2bsure.com (Asia-Pacific)
Fax	efax.com (US, UK)
Email to voice	T2Mail.com (Singapore & HK)

Sources: ITU, adapted from Dialpad.com, Pulver.com and company websites.

Figure 3.1: Map and traceroute showing path of message between Switzerland and Uganda
Between the networks of Switch (www.switch.ch) and Africa Online (www.africaonline.co.ug)



Domain	Time (ms)	Note
swiCS2-F0-0-0 (130.59.10.202)	0.577	SWITCH, Switz.
swiEG1-F5-1-0 (130.59.20.211)	1.217	SWITCH, Switz.
swiNY2-P4-0 (192.65.93.250)	88.199	SWITCH, Switz.
i00nye-005fas-9-1-0.ip-plus.net (164.128.236.69)	88.481	Unisource, Switz.
i00nyh-005-POS4-1-0.ip-plus.net (164.128.236.58)	88.606	Unisource, Switzer.
sl-gw18-nyc-6-0-0.sprintlink.net (144.232.228.149)	89.353	Sprint, NY, USA
sl-gw18-nyc-8-0.sprintlink.net (144.232.13.226)	89.716	Sprint. NY, USA
208.30.204.18 (208.30.204.18)	89.505	Sprint, USA
if-7-0.core1.NewYork.Teleglobe.net (207.45.220.196)	89.988	TeleGlobe, USA
if-7-2.core1.Montreal.Teleglobe.net (64.86.80.25)	97.317	TeleGlobe, Canada
if-7-0.core1.Laurentides.Teleglobe.net (64.86.80.18)	99.307	TeleGlobe, Canada
if-12-0-0.bb3.Laurentides.Teleglobe.net (64.86.80.14)	109.562	TeleGlobe Canada
ix-0-1-2-0.bb3.Laurentides.Teleglobe.net (207.45.194.186)	641.651	TeleGlobe, Canada
212.88.97.49 (212.88.97.49)	642.568	MTN Uganda
212.88.96.22 (212.88.96.22)	1449.166	MTN Uganda
212.88.99.3 (212.88.99.3)	853.447	MTN Uganda

Note: A traceroute results in a list of routers between your site and the entered domain with the first router encountered at the top of the list, and the destination domain machine at the bottom. At each site, both the name and IP number are listed, along with a typical timing value that indicates round-trip packet propagation time.
Source: ITU "Trends in Telecom Reform 2001".

For **carriers** however, the economics are much more complex. That is because incumbent carriers have existing revenue streams that they fear may be cannibalised by a shift to lower-priced IP Telephony. In the case of Hungary quoted above, the initial pressure to offer IP Telephony came from mobile service providers who saw the opportunity to bypass Matav's monopoly on carrying international calls, although Matav itself is now an IP Telephony service provider.

Even if VoIP offers a cheaper alternative to substitute for those existing revenues[1], it may not be economically rational to move immediately towards providing telephony services over an IP platform. The speed of the transition will be dictated by:

- The regulatory environment (see Chapter Four);
- The degree of competition the carrier experiences in its domestic and in foreign markets. The greater the level of competition, the faster the shift will be towards lower cost services;
- Whether a particular carrier is an incumbent or a new market entrant. New market entrants, with no legacy network to defend, are likely to be the first movers towards VoIP;
- The anticipated level of price elasticity in the demand for voice-based services. Where price elasticity is high, then the shift towards VoIP will be quicker.

The opportunities to develop enhanced services that combine voice with data and video services. Where the market is relatively sophisticated (e.g., high penetration of PCs, extensive business use of the Internet) then the shift to VoIP will be quicker.

The precise nature of the cost advantage offered by IP networks is the subject of much debate. It will depend, for instance, on:

- Whether a particular investment in an IP network is as a new build, or as an upgrade or overlay to an existing network. The incentive to choose IP will be greater for new, or substantially new, networks. For instance, in Senegal, where existing networks serve just over 1 per cent of the

population, *Sonatel* plans to migrate it's existing core network to an IP backbone by 2004 and to offer both voice and data services over the same integrated IP network.

- Whether a particular carrier is an incumbent or a new market entrant. New market entrants, with no legacy network to defend, are likely to be the first movers towards VoIP. In China, for instance, *China Netcom*, a new market entrant, which is based around the Ministry of Railway's network, is building a voice over IP network that will cover 15 cities and include some 9'600 kilometres of fibre optic cable by the end of 2000. The use of IP has allowed *Netcom* an earlier entry into the market than might otherwise be the case.
- The extent to which value-added services are being offered. In economies such as Hongkong SAR or Singapore, where local call charges are free (bundled into the access charge), new market entrants are offering value added services which allow, for instance, voice users to retrieve their email (*T2mail.com*) or unified email, voicemail, fax mail communication services (*2Bsure.com*) over an IP platform.

The downside is that the quality of service on an IP network will be more variable and, on average, lower than that achieved in a circuit-switched network. As an illustration of this, consider the case of a message (in this case a web-browsing request) addressed from Switzerland to Uganda. As the traceroute in Figure 3.1 shows, the message undergoes some 16 separate "hops" and has to cross the Atlantic twice before reaching its destination. Even so, the majority of the delays introduced are caused by delays within the network of the same African operator (in this case MTN Uganda) which is using a wireless ISDN system for delivery to the client, Africa Online. While IP Telephony traffic would be afforded a higher priority for transmission of packets than a simple web-browsing request, the implications for the loss of service quality are clear. There needs to be only one short hop in the route which is congested or poorly maintained for the whole message to suffer.

In reviewing these factors, it seems likely that the pressures to shift towards IP Telephony will be different in economies at different states of development and with differing degrees of market competition:

- In developing countries, where **prices for international traffic are high**, the main opportunity for voice over IP will be for price arbitrage of simple voice transmission. In many of these countries, outgoing IP Telephony is banned. Thus, the main form of IP Telephony traffic is for incoming traffic. Even though this may be no more legal than for outgoing traffic, it is harder to detect and block. In Nepal, for instance, incoming PSTN traffic fell from 29 million minutes in 1998 to 22 million in 1999 during a period when outgoing international traffic grew from 20 to 25 million minutes. It is thought that at least part of the decline in recorded incoming traffic is due to the fact that carriers are bringing their traffic into the country as a packetised Internet traffic stream to VSATs (very small aperture terminals) and then breaking out into the PSTN locally (see Box 3.2).
- In countries where **prices for international traffic are falling** — for both retail (consumer) and wholesale (settlement) rates — voice over IP traffic may be already playing a role in promoting price competition (as, for instance, in Hungary or Thailand) or in providing an alternative to the services of the fixed-line incumbent (as, for instance, in Colombia). However, a critical factor is how easy it is for subscribers to use the service. In Peru, for instance, the success of IP Telephony was partly based on a telephone-like device (Aplio) that could use IP networks and/or the PSTN for establishing calls.
- In countries where **prices for international traffic are already low**, due to the effects of competition, IP Telephony is likely to be important for reasons other than price arbitrage. The market opportunity for IP Telephony is likely to lie, on the one hand, in the prospects of value-added functionality for users and, on the other hand, cost reductions for operators. As an example of the former, in the United Kingdom, *yac.com* offers a service for personalised numbers and automated call forwarding via the Internet. As an example of the latter, the BT/AT&T joint venture, *Concert*, is building a new managed IP-based global network to deliver services, such as electronic commerce and global call centres, to link some 90 cities worldwide. Even though the required investment is of the order of US$1 billion per year, an integrated IP network offers the most cost-effective solution for handling multiple traffic streams.

For **policy-makers and regulators**, the question of whether to permit or ban different forms of IP Telephony is a sensitive one. For countries in which the interests of regulators are aligned with those of consumers, it would appear to be Luddite to ban IP Telephony. There may be some scope for consumer protection legislation (for instance, to disallow misleading advertising or to encourage honest statements concerning anticipated level of quality on pre-paid services). But generally a liberal approach offers the best prospects for consumer welfare. A less liberal approach might be expected in countries where the interests of regulators are more closely aligned with those of the incumbent carrier (e.g., where the carrier is state-owned). Some carriers might restrict the offer of IP Telephony to a limited range of licensed carriers, reinforcing existing restrictions on market entry for voice communications. A more nuanced approach might be to permit (or even encourage) use of the Internet to carry outgoing international calls (thereby bypassing the accounting rate system) while insisting that carriers making incoming international calls pay the full inward settlement rate. Asymmetric policies of this nature are being applied in some developing countries with a view to maximising incoming settlement payments (see Table 3.1).

3.2 Size, substitutability and settlements

From an economic viewpoint, the significant questions to ask about IP Telephony are:

(1) how large is the market?

(2) to what extent is IP Telephony generating new traffic or is it substituting for that which already exists?

(3) what impact is it having on the business models of existing carriers?

Looking first at the issue of **size**, market estimates vary widely:

- The market research company, IDC, estimates that the IP Telephony market generated traffic worth 2.7 billion minutes in 1999 and will expand to around 135 billion minutes, with revenues of US$19 billion, by 2004;
- Deltathree.com forecasts that IP Telephony will generate around 16 billion minutes of international traffic in 2000 and will account for some 35 per cent of the total by 2005;
- Tarifica estimates that more than 40 per cent of all international calls will be carried over IP by 2004. Analysys thinks that it will reach 25 per cent by the same date.
- In China alone, the Ministry of Information Industry (MII) has estimated that the IP Telephony business will be worth some US$12 billion by 2004.

Most studies show that the main use of IP Telephony at present is for international traffic rather than for domestic long-distance, mobile or local traffic.

One reason that the market estimates differ so much is because the studies use different definitions. Market forecasts, such as those put out by IDC, are based mainly on traffic reported by IP Telephony service providers (IPTSPs). They do not generally include traffic that is being carried over IP (for at least some of the route) by the major public telecommunication operators. This is particularly difficult to estimate. The Sema Group reports that some 60 per cent of public telecommunication operators believe that IP Telephony is capable of becoming the main means of telecommunication by 2004 and that one quarter of them believe that the majority of their voice traffic will be carried over IP by that date. Already, the number of international circuits which are used for leased lines (primarily for Internet use) outnumber those that are used for the PSTN, especially on the busiest routes, for instance between the United States and Europe (see Figure 3.1). These figures suggest that, within a few years, a significant share of international telephony traffic will be carried over IP for at least part of its route.

The issue of **substitutability** is more complex. Clearly, much of the traffic carried over PC-to-PC Internet Telephony will be "new" traffic that would not otherwise have existed. Much of the discount traffic generated over PC-to-Phone services, especially that which is "free," is also likely to be new traffic. But some of this traffic, and the vast majority of calls carried over Phone-to-Phone services, are likely to be calls that would otherwise have been made over the PSTN, and can therefore be regarded as substitute traffic. The cheaper prices generally available for IP Telephony may spur higher growth rates in traffic, where demand is elastic. But existing carriers will inevitably lose some market share.

Box 3.2: Nepal: Two faces of IP Telephony – origination and termination

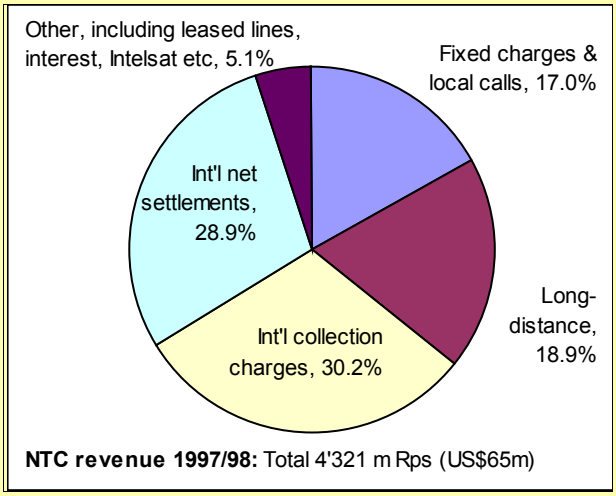
Nepal, a mountainous landlocked country squeezed between India and China, has a situation which is typical of many developing countries in that it is highly dependent on international traffic for network development and to cover the costs of loss-making local networks. Some two-thirds of the total revenue of the incumbent public operator, NTC, come from international traffic with the proportion split approximately equally between collection charges for outgoing calls and settlements for incoming traffic.

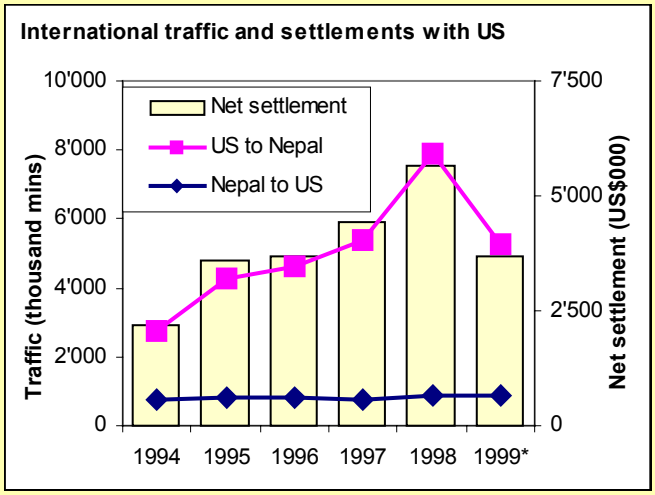
For international traffic passing through the accounting rate system, the major source is the United States with whom Nepal has a ratio of incoming to outgoing traffic of around nine to one. This is mainly due to the fact that the United States is home to the major call-back service providers. The result is that US operators made net settlements (excluding transit payments) of some US$5.7 million in 1998. However, the picture appears to be changing. In the first seven months of 1999, the annualised rate of traffic reported as incoming from the United States (AT&T) was down by just over 30 per cent with a particularly big fall in July, the same month that VSAT data traffic began to be delivered to Nepal. The same pattern is true also for the United Kingdom. While it would be unwise to draw conclusions on the basis of one month's data, the available evidence would seem to point towards an increasing percentage of traffic from AT&T and BT being diverted outside the accounting rate system, possibly via the Internet.

VoIP is illegal in Nepal as it is seen as impinging upon NTC's international voice service monopoly. While the regulator, the Nepal Telecommunications Authority (NTA) takes a neutral view on the matter, arguing that IP Telephony is almost impossible to block, the policy-making body, the Ministry of Information and Communications (MoIC), has obliged the NTA to make clear to domestic ISPs that VoIP is illegal. In January 2000, NTA sent a notice to all ISPs instructing them specifically to block the Dialpad.com P Telephony service, which offers free calls to the United States and other destinations (see Box 3.1). The ISPs duly contacted their user-base to inform them of NTA's notice. However, given that Fax-over-IP ("FoIP") is liberalised (requires a license), and that it is virtually impossible for ISPs to distinguish between incoming voice and fax traffic, it would be surprising if the ISPs were able to comply with this ruling. Indeed, some cybercafés still openly advertise VoIP on their websites.

The main usage of VoIP is almost certainly not for outgoing traffic from Nepal but rather incoming international calls. While it is difficult to obtain concrete evidence, it appears to be the case that a growing proportion of incoming international voice traffic is coming in over IP and then breaking out into the PSTN locally. This service is relatively easy to provide since VSAT data services were liberalised in mid 1999. More than 5 MB of VSAT capacity is available to private ISPs. One person interviewed for an ITU case study described being offered tens of thousands of US dollars to provide a locked room in which a gateway linking incoming international voice over IP calls to the PSTN could be located. This particular offer was refused, but others may not have been so circumspect. The MOIC is blocking outgoing VoIP while being unable to block incoming VoIP. Thus Nepal is suffering twice over: NTC is losing out on valuable incoming net settlements, while Nepalis are losing out on the chance to make low-cost foreign calls.

Box Figure 3.2: Nepal Telecommunications Corporation: vulnerable to IP Telephony?
Sources of revenue, 1997/98 (left) and traffic and settlements with the United States, 1994-July 1999 (right).





Note: In the left chart, data are from NTC's annual report, for Financial Year-ending July 15 1998. In the right chart, the figures for 1999 are estimated based on the first seven months of the year. The data are for calendar years ending 31 December.

Sources: "NTA Bans VoIP," The National NewsMagazine, 28 January - 3 February 2000; ITU Country Case Study of Internet diffusion in Nepal, available at: <http://www.itu.int/ti/casestudies/nepal/nepal.htm>.

Table 3.1: Top ten net settlement surplus countries

As measured by estimated net settlements from the rest of world, in US$ million, 1998

Country	Outgoing traffic 1998, million minutes	Incoming traffic 1998, million minutes	Imbalance (outgoing minus incoming)	Imbalance as % of total traffic	US settlement rate, 1998 (US cents per minute)	Estimated net settlement, 1998 (US$m)
India	436.2	1'498.8	-1'062.6	-54.9%	64.0	*680*
Mexico	1'307.6	3'060.5	-1'752.9	-40.1%	35.0	*620*
Philippines	286.4	681.2	-394.7	-40.8%	36.5	505.
China	1'711.5	2'400.0	-688.5	-16.7%	70.0	*480*
Pakistan	87.5	640.4	-552.9	-76.0%	60.0	*330*
Viet Nam	56.0	334.0	-278.0	-71.3%	55.0	*240*
Lebanon	70.0	300.0	-230.0	-62.2%	85.0	201
Egypt	127.3	475.3	-348.0	-57.8%	87.5	*150*
Poland	602.4	1'144.4	-542.0	-31.0%	65.0	*145*
Dominican Rep.	157.5	730.5	-573.0	-64.5%	10.5	*130*

Notes: Figures shown in italics are estimates. All other figures are as reported by the countries concerned. The methodology used for estimation of net settlement is as follows: Where the country reports this indicator, it is calculated as incoming payments minus outgoing payments; where the country does not report this indicator, it is estimated by multiplying the traffic imbalance fir each country by its settlement rate to the United States during 1998.

Sources ITU/TeleGeography Inc. "Direction of Traffic Database", FCC.

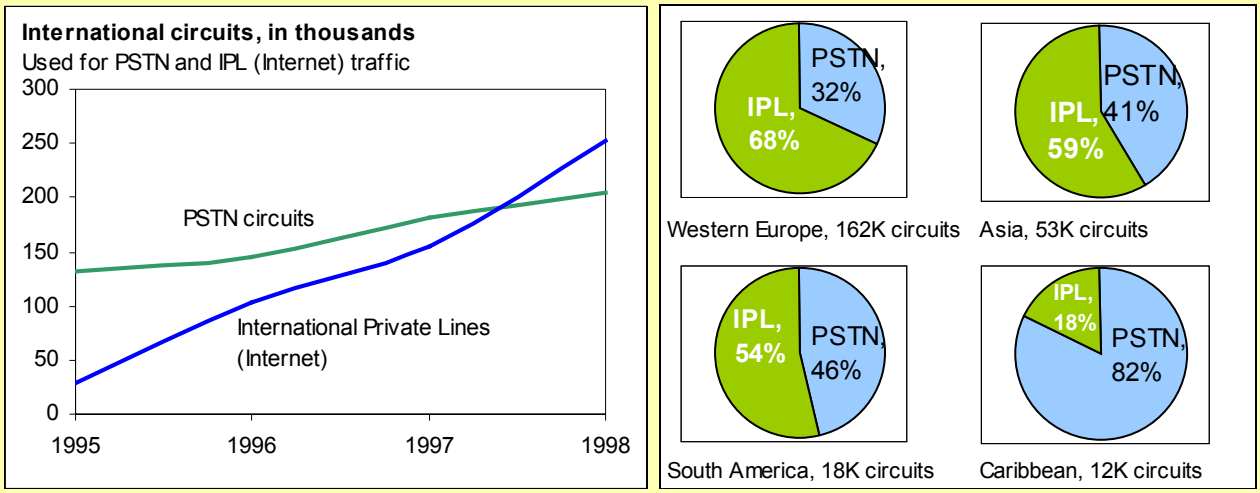
In fact, the traffic statistics show a more complex picture. The growth rate in international traffic has recently slowed, starting in 1998 and continuing in 1999. Traffic originating in the United States had been growing by 20 per cent per year consistently since the mid-1980s then suddenly fell to just 8 per cent in 1998 despite the boom that the US economy was experiencing. It is hard to credit this slowdown in traffic growth. It is likely that the real traffic did in fact continue to grow at a rapid rate, but that it is not being reported by carriers because it is not passing through the accounting rate system. The motivation for sending traffic outside the accounting rate system is to reduce the level of **settlements** that are due to partner countries. Under the international settlements system, the operator(s) in the country that originates a call has traditionally made a compensatory payment to the operator(s) in the country that terminates the call. Payments are made when traffic in one direction is greater than traffic in the return direction. The level of payment is based on bilaterally negotiated "accounting rates". A net settlement payment is usually made on the basis of excess traffic minutes, multiplied by half the accounting rate (the accounting rate share, or settlement rate). Net settlement payments, primarily from developed countries, have grown larger as traffic flows have become less balanced. ITU estimates that, during the 1990s, net flows of settlement payments from developed counties to developing ones amounted to some US$50 billion[2]. The top ten net settlement surplus countries (i.e., that receive more money than they spend) are illustrated in Table 3.1.

Operators that send more traffic than they receive have an incentive to develop alternative routing procedures. They do this to avoid having to make settlements based on above-cost accounting rates and instead pay interconnect fees at local call rates or below. This is one reason for using international IP backbones instead of PSTN circuits to deliver traffic. Analysis of individual country's traffic data appears to confirm that this is happening to an increasing extent.

The settlement rates between the United States and Argentina and Colombia on 1 March 2000 stood at 27 and 32.5 US cents per minute respectively. Increasing volumes of traffic from US carriers have been routed outside the accounting rate mechanism, for instance via the Internet (see Figure 3.2) or via refile through other countries. In the case of Argentina, estimated bypass traffic amounts to almost the same as the total reported volume of traffic on the route to the United States in 1998 (i.e., just over 200 million minutes). In the case of Colombia, where call-turnaround was historically less significant, estimated bypass traffic amounts to around 160 million minutes (see Figure 3.2 for more details[3]). The losses incurred from bypass traffic by Argentina and Colombia were over US$60million for each country, at 1998 settlement rates.

Figure 3.2: IP capacity overtaking voice capacity

Number of international circuits used for private lines (Internet) and PSTN traffic, worldwide, 1995-98, and in selected regions, 1998



Note: Based on international circuits reported to the FCC.
Sources: ITU, adapted from FCC.

3.3 Impact on the Public Telecommunication Operator

The major impact of IP Telephony on Public Telecommunication Operators is likely to be loss of income from international calling, both direct (loss of collection charges) and indirect (loss of settlement payments). In the case of Sri Lanka Telecom, for instance, incoming international traffic streams have fallen from some 16 million minutes to just 9 million minutes per month and the estimated loss to the incumbent operator, Sri Lanka Telecom Ltd., is around US$2 million per month. At least some of this lost traffic is thought to be due to IP Telephony and the Operator has initiated court action against some of its competitors that it believes are using IP Telephony to carry incoming traffic.

But arguably, this would happen even without IP Telephony. Markets for international calls are shrinking in value as, on the one hand, prices fall precipitously, while, on the other hand, traffic is routed on least cost routes and settlement rates are forced closer to costs. Operators in developing countries may be better advised to embrace IP Telephony, and bear the consequences of reduced per-minute revenues from long-distance and international services, than to risk missing the opportunity to develop revenues in future growth areas. There are a growing number of public telecommunication operators that have chosen to offer IP Telephony services, even though this may cannibalise their existing revenue streams. These operators include Telecom Egypt (see Box 3.3), GamTel (Gambia), Matav (Hungary: see Box 3.4), Cesky Telecom (Czech Republic: see Box 3.5) and CAT (Thailand).

In more competitive markets, where prices for international calls have already come closer to costs, the impact of IP Telephony on operators is likely to be less significant. VoIP is just one of many options for discounted calling. Operators will direct traffic over whichever route is cheapest, and customers will choose operators according to their ability to combine low cost calling with value added services.

The public telecommunication operator of the future may "own" the customer, in terms of providing billing and customer care support, and may "own" the local network, in terms of providing origination and termination of calls. However, the operator of the future is unlikely to be able to "own" or control the types of application that the customer chooses. Operators have traditionally used profitable long-distance and international services to cross-subsidise the functions of network access and local calling. In an increasingly competitive market, such hidden cross-subsidies can no longer be sustained.

Box 3.3: Telecom Egypt: If you can't beat them, join them

It is estimated that some 3 million Egyptians live in North America, half a million of them in the academic sector alone. Thus, there is tremendous potential for increased calling between the two destinations. While outgoing traffic from Egypt to the United States has increased modestly since the mid 1990s, incoming traffic to Egypt increased dramatically, at least until 1998, when it stabilised and declined (see the Figure below), a pattern familiar to many developing countries. In 1998, US carriers started routing their traffic via alternative routes, which resulted in lower settlement payments, including refile via third countries, routing via "leaky PBXs" and, increasingly, via the Internet.

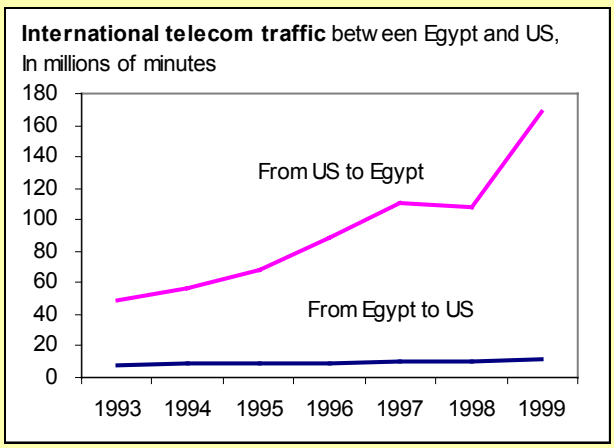
The reason why US carriers have been shifting traffic away from the direct route is due to mounting settlement payments to Egypt, which reached some US$65million in 1997 before falling back to US$58million in 1998. While Egypt has been reducing its settlement rate with the United States by an average of 12 per cent per year, and has made an agreement to come down to US benchmark rates on schedule, this was not enough to placate US carriers, nor to off-set the increasing effects of asymmetry in the traffic balance. It can be estimated that around 30 million minutes of traffic from the United States was diverted in 1998. It is not possible to know what proportion of this went via the Internet, but it is thought to be a considerable amount. Net2phone, a subsidiary of US international carrier, AT&T, is known to have been particularly active in Egypt.

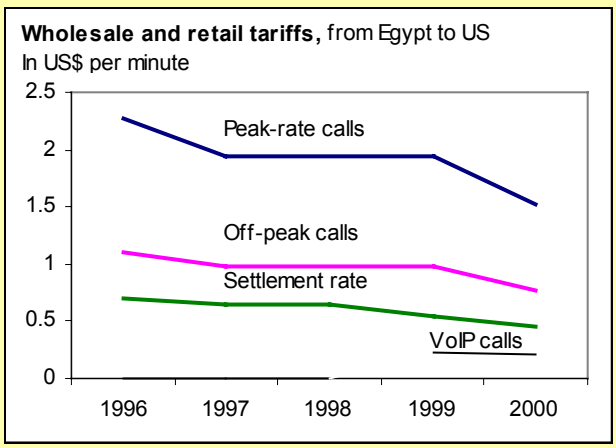
Telecom Egypt tried to block Net2phone's traffic, but with only mixed success. So, in 1998, it tried a new tactic. It started making alliances with US IPTSPs to provide IP Telephony services to and from the United States. In September 1998, it signed a deal with Digitcom for handling IP Telephony traffic. More recently, in March 2000, it signed a deal with eGlobe of the US to market a retail IP Telephony service. Telecom Egypt did not feel the requirement to ask for regulatory permission, either to block Net2phone's service or to offer its own. Indeed, the press release for the agreement with eGlobe shows support from the highest levels, quoting the Eyptian Communications Minister, Dr Ahmed Nazif, as saying "*I am pleased to offer the newest of technologies allowing our people to more efficiently and economically access the global marketplace*".

Telecom Egypt is offering the new IP Telephony service at 80 piastres (21.6 US cents) per minute for calls to the United States compared to the published rate for PSTN calls of LE 3.50 per minute (US$0.95). This represents a considerable saving for customers. In order to promote the service, Telecom Egypt is offering ISPs and other resellers a 10 per cent discount. Even so, Telecom Egypt reports that the majority of traffic is incoming rather than outgoing, suggesting that it is being less successful than it had hoped in marketing the service nationally. One reason may be that the website it established to market the service, <www.commegypt.net>, is always congested and works only sporadically.

Because of its tie-up with eGlobe and Digitcom, Telecom Egypt is effectively offering IP Telephony terminated minutes as a type of discounted settlement rate. That is one reason why the level of incoming traffic from the US grew again in 1999. The rate of 21.6 US cents per minute is considerably below the official settlement rate with the United States, which is currently 45 US cents per minute, or even the unofficial wholesale rate of 25.9 US cents per minute for calls terminating in Cairo offered by Arbinet (<www.arbinet.com>: this quote dated 23 October 2000). It is not known what exactly Telecom Egypt is receiving for incoming calls terminated over its IP Telephony service, but one can assume it is pitched at a level that is competitive with the Arbinet rate. The main point is that, at least Telecom Egypt is gaining some revenue from traffic that would otherwise be lost.

Box Figure 3.3: Traffic and tariff trends between Egypt and the United States
Traffic trends, in millions of minutes, 1993-99, and tariff trends in US$ per minute, 1996-2000





Source: ITU Internet Diffusion case study of Egypt.

Box 3.4: IP Telephony can be mobile, too: the case of Hungary

The main focus of discussions of IP Telephony has been on the savings that can be made on international calls. But a growing proportion of international traffic, probably as high as 15 per cent, is now generated from mobilephones, especially by GSM users roaming outside their home country. If price arbitrage is the main motivation for international telephone users to shift to IP, then the motivation is even higher for mobilephone users who usually pay a premium over standard international call rates, especially in countries that employ calling party pays. Roaming rates are particularly high, and users only realise quite how much they have been paying when they return home to their bill.

Many countries that have introduced competition in mobile service have obliged mobile operators to pass through the incumbent fixed-line operator for origination and termination of international traffic. This is the case, for instance, in Hungary where Matav, the Deutsche Telekom-owned incumbent, has the international service monopoly until 2002, under a concession granted in 1993. There are now three operators of mobile networks in Hungary: Westel 900, is a subsidiary of Matav; Pannon, a consortium with investments from Norwegian, Danish, Dutch and Finnish PTOs; and Vodafone DCS 1800, which entered the market in June 1999.

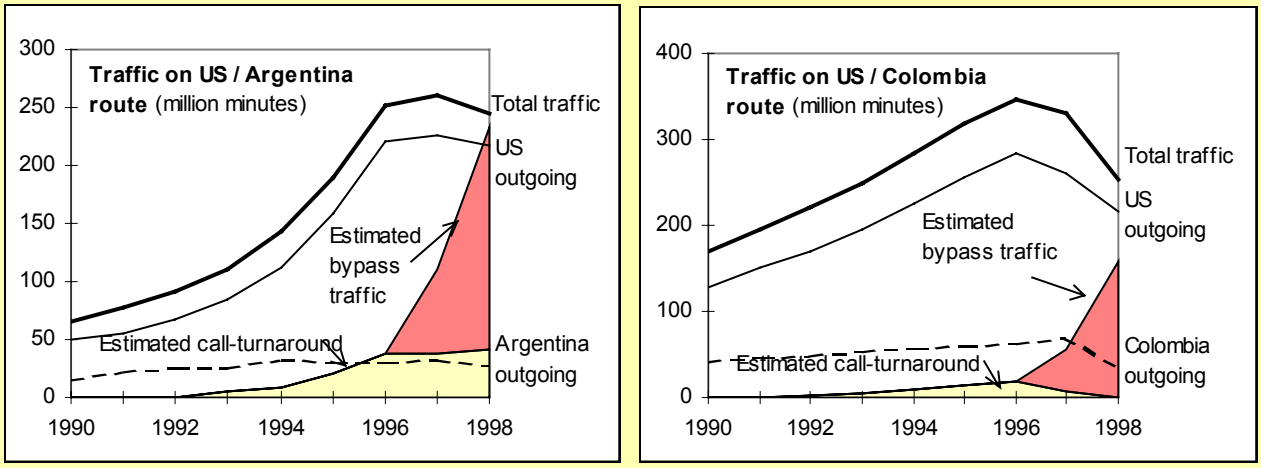
The competitive mobile operators saw the opportunity to bypass Matav's monopoly and secure lower rates for international calls for their customers. They found that the regulatory agency, HIF, was willing also to look for ways of introducing "soft competition" to Matav ahead of full competition in 2002 (see Box 4.2). Accordingly, HIF started licensing IP voice telephony providers and there are currently more than 15 companies licensed to provide the service including the mobile service providers. In practice, however, what has emerged is that there are a smaller number of wholesale IP providers, including Matav and Novacom, and a larger number of retail providers. The potential savings to be made are very attractive and, in some cases, a call made abroad from a mobile in Hungary via IP can be cheaper than the equivalent call made over a fixed-line network.

One of the reasons for the success of IP Telephony in Hungary is that it is relatively simple to make a call, simply by adding an extra zero to the number being called. There is a pre-registration scheme, but at least one of the operators (Westel 900) bypasses this requirement by having an opt-out scheme. Interestingly, the option of sending calls via IP Telephony is also available to foreign users roaming in Hungary, again by adding an extra zero to the number.

It is difficult to build up an accurate picture of the volume of traffic currently being routed via IP Telephony but it is clearly growing and, according to the operators, customers are happy, both with the quality of service and with the reduction in call prices. However, the operators do report some reliability problems with the VoIP equipment. Perhaps the real test will come at the start of 2002 when the mobile operators and other entrants have the opportunity to bypass Matav's international gateway by more conventional means. Will they still choose to use to VoIP?

Figure 3.3: Where did all that traffic disappear?

Traffic balance on routes between US - Argentina and US - Colombia, including estimates of call-turnaround and bypass traffic



Note: "Estimated call-turnaround" traffic is the volume of traffic on a particular route that has been re-routed so that it appears that it is coming from the United States. This includes call-back, calling card and home-country direct traffic. It is estimated by applying the ratio between incoming and outgoing traffic that applied before 1992 to the subsequent traffic balance. "Estimated bypass traffic" is the volume of traffic on a particular route which is estimated to be rerouted via a least cost route (e.g., refile) or outside the accounting rate mechanism (e.g., via the Internet) such that it is not reported in official traffic statistics. It is estimated by comparing the projected growth in the total volume of traffic on the route, based on trends before 1996, with what actually happened after that date.

Source: ITU "Americas Telecommunication Indicators," ITU/TeleGeography Inc. "Direction of Traffic" Database.

Box 3.5: Czech Republic – Licensed providers of all kinds offer Internet Telephony and VoIP

The Czech Republic has been the site of several legal disputes over the regulatory status of IP Telephony. The incumbent operator, Czech Telecom (formerly SPT Telecom), complained to the Czech Telecommunication Office (CTO) in 1998 that mobile operator Radiomobil was offering international long distance service in violation of Czech Telecom's exclusive licence for such services until 1 January 2000. The CTO agreed and suspended the service in November 1998.

Radiomobil had originally announced the service as the first ever commercial mobile IP Telephony service. Once users dialled a special access number, their call was converted to IP packets and routed to GlobalOne's gateway. From there it was carried by Deutsche Telekom (a major Radiomobil shareholder) to another gateway nearer the called party. Until blocked by CTO, the service offered lower-cost (albeit lower quality) international long distance to subscribers to the Radiomobil's Paegas GSM service.

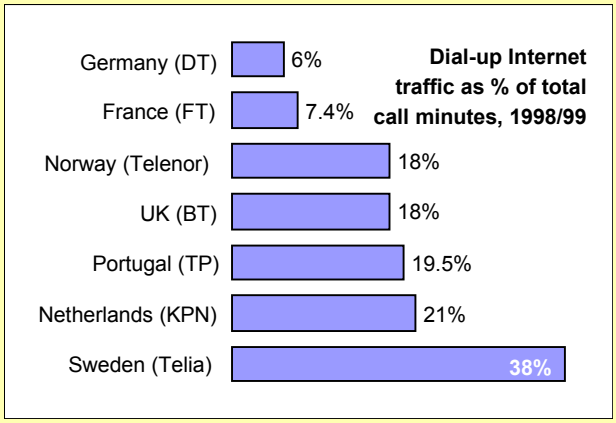
The CTO changed its policy effective 1 August 1999 to allow certain classes of operators to provide most forms of Internet Telephony. ISPs, mobile operators, and Cesky Telecom itself are now offering discount international calls using IP Telephony. Several PC-to-Phone services offer cheap international calling, and mobile operators can route their outbound international calls through either Internet Telephony or VoIP. The incumbent Czech Telecom's "XCall" service enjoys special status, for the time being, as the only licensed Phone-to-Phone IP Telephony service accessible on the fixed line network. Users dial a special access code, the destination country code, and the telephone number. Calls are billed afterwards on the fixed-line telephone bill.

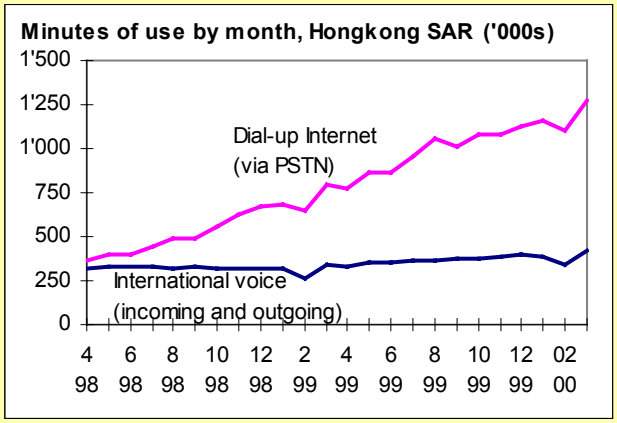
For more detail, see <http://www.itu.int/osg/sec/spu/ni/iptel/countries/czechrep/index.html>.

Sources: InternetNews.com, <http://www.internetnews.com/intl-news/print/0,1089,6_39251,00.html>; US Office of Telecommunications, "IP Telephony Market Information for Czech Republic as of October 1999," <http://infoserv2.ita.doc.gov/ot/VoiceOve.nsf/>.

Figure 3.4: Dial-up Internet traffic contributing to carrier revenue streams

Dial-up Internet traffic as a percentage of total traffic, selected European carriers, 1998/99, and trends in dial-up Internet traffic and international traffic, April 1998 – March 2000, Hongkong SAR





Note: Left chart shows dial-up traffic as a percentage of local traffic for Germany (T-Online only), Sweden and UK (BT only); of national traffic for France and Norway, and of total traffic for Norway, Portugal and UK. The data is valid for 1998 for France, Germany, Netherlands and UK and for 1999 for the other countries.

Source: Carrier annual reports, OFTA (<www.ofta.gov.hk>).

Future operators will need, instead, to ensure that their local access networks are self-financing. This will require substantial and urgent tariff rebalancing to bring the price of local and international calls much closer together. The good news is that, while VoIP may bypass certain parts of a carrier's operations, where the price structure is not cost-oriented, it will not take away the need for local networks. Indeed, insofar as VoIP as a new "killer application" makes access to the Internet even more popular, it will actually increase the volume of local calls and the demand for second lines. Already, in some economies, as much as a third of all local calls are to the Internet and around 15 per cent of all local lines are used primarily for Internet access. Furthermore, dial-up Internet access is on a steeply rising curve while international traffic growth is slowing down (Figure 3.3).

Over time, the price arbitrage opportunity for IP Telephony on international routes may disappear, but other opportunities may emerge. For instance, in many European countries, rates for the termination of calls on mobile networks are widely believed to be out of line with costs[4]. Routing calls to mobiles via IP networks may offer a solution to bypass these high prices. Similarly, countries that maintain many different call zones for domestic traffic, based on distance, may find that these are unsustainable in an IP-based world. Competition will drive prices closer to costs and where IP Telephony offers the lowest cost alternative, it will be the preferred solution.

[1] See for instance Weiss, M. & Hwang, J. (1998) "Internet Telephony of Circuit-Switched Telephony: Which is cheaper?" at: <http://www2.sis.pitt.edu/~mweiss/papers/itel.pdf>. Their analysis suggests an approximate cost of US$1.058 per month per subscriber cost for providing IP Telephony compared with US$1.70 for traditional telephony, a 38 per cent saving.

[2] See, for instance, analysis in ITU/TeleGeography Inc. "Direction of Traffic: Trading Telecom Minutes", ITU, Geneva, October 1999, 347 pp, available at: <http://www.itu.int/ti/publications/DOT99/index.htm>.

[3] See <http://www.itu.int/osg/sec/spu/ni/iptel/countries/colombia/index.html>.

[4] See the discussion of this issue in the ITU Workshop on Fixed-Mobile Interconnection, available on the ITU website at: <http://www.itu.int/interconnect>.

CHAPTER FOUR: REGULATORY ASPECTS OF IP TELEPHONY

4.1 Introduction

There is no single set of telecommunication regulatory issues presented by IP Telephony. The technology is being applied in many different ways in many different markets around the world. Each market is subject to a unique regulatory framework, guided by unique policy goals and subject to unique challenges. IP Telephony may represent an urgent issue in one market, while being considered as a complete "non-issue" in another. The goal of this chapter is to describe some of the issues being faced in many markets around the world, and to analyse the policy approaches to them.

A rough means of categorizing types of markets (not specific countries), based simply on prices for international direct dialed (IDD) telephone calls, can be used here as a method of describing IP Telephony markets because the regulatory aspects of IP Telephony tend to group together into three categories:

- **High-price markets** – where outbound IDD rates and incoming settlement rates tend to be high for a variety of reasons: a lack of competition; implicit or explicit subsidies from long distance to local service; or public policy reasons in favour of high rates. Such markets tend not to be subject to commitments under the WTO Agreement on Basic Telecommunications, and other forms of alternative calling methods, such as call-back, tend to be prohibited as well as IP Telephony, most often due to a general prohibition on competition with an exclusive licensee than on specific technologies.
- **Falling-price markets** - where outbound IDD rates and incoming settlement rates are in the process of falling due to: the introduction of competition and tariff rebalancing; commitments under the WTO Agreement on Basic Telecommunications; and the relaxing of prohibitions on alternative calling methods such as call-back. However, exclusive licences for certain services tend to continue in force until prescribed dates.
- **Low-price markets** - where outbound IDD rates and incoming settlement rates are quite low compared to historical levels, due to vigorous competition in many market segments, tariff rebalancing, extensive commitments under the WTO Agreement on Basic Telecommunications, and the absence of restrictions on alternative calling methods such as call-back and IP Telephony. In such markets, exclusive licences have either expired or have been terminated, and only local access networks remain subject to detailed regulation.

It is important to note that this classification method is used for analytical purposes only. It is not intended to account for every possible market environment, nor to imply the superiority of one type of environment over another. However, since the different markets do tend to vary based on degree of liberalization, the experiences of one type of market may be instructive for other markets moving towards more extensive market liberalization.

This chapter is based on certain assumptions about the goals of modern telecommunication regulatory policy. These goals are:

- telecommunication regulatory policy should encourage, not hinder, technological innovation in the provision of telecommunication services;
- the availability of lower-priced calling alternatives is in the consumer's interest and should be encouraged;
- access to telecommunication services, including both voice telephony and the Internet, should be as wide as possible; and
- local access networks are the first link to telecommunication, multimedia, and e-commerce services and, as such, their sustainability must be assured.

4.2 Changing conceptions of telecommunication networks and services

The issue of the regulatory status of IP Telephony is, to some degree, a matter of a clash of two very different views of the telecommunication industry. That is, whether telecommunications networks should be thought of in terms of traditional service categories, or whether notions of networks and services should be separated conceptually. IP technology enables many different services, of which telephone calls are just one.

Box 4.1: European Union: A common framework for electronic communications networks and services

The European Commission's long-awaited "convergence proposals", released on 12 July 2000, represent the most comprehensive attempt yet to subject all forms of electronic communications (i.e., telecommunication, broadcasting, and information technologies, including the Internet) to one regulatory framework. While the proposals are not expected to become law until 2002 at the earliest, the convergence proposals are designed to adapt a competitive environment to technological changes which are blurring boundaries between previouslydistinct industries.

According to the Commission's press release, the following are the main features of the proposals:

- Liberalise the "last mile" of telecommunications markets by unbundling access to the local loop. This will lead to cheaper and faster Internet access over local copper-wire networks;
- Introduce flexible mechanisms in the legislation to allow it to evolve with future technology and market changes and to roll back regulation when markets become competitive;
- Create a level playing field across EU by facilitating market entry through simplified rules and ensuring harmonised application through strong co-ordination mechanisms at European level;
- Adapt regulation to increasing competition by limiting most of market power based regulation to dominant operators, as defined in EC competition law;
- Maintain the universal service obligations in order to avoid exclusion from Information Society; and
- Ensure the protection of right to privacy on the Internet.

The package comprises six proposed directives (as described by the Commission):

- Directive on a common regulatory framework for electronic communications networks and services - sets out the horizontal provisions of the new electronic communications regulatory framework of the European Union.;
- Directive on the authorisation of electronic communications networks and services – aims at a single European market for electronic communications services by harmonising the rules for authorising provision of such services.;
- Directive on access to, and interconnection of, electronic communications networks and associated facilities – establishes a framework for access and interconnection agreements across the EU.;
- Directive on universal service and users' rights relating to electronic communications networks and services – sets out the rights that users have in respect of electronic communications services, in particular universal service.;
- Directive on the processing of personal data and the protection of privacy in the electronic communications sector – updates the current Directive to ensure it is technologically neutral and can cover new communications services.;
- Regulation on unbundled access to the local loop – introduces a requirement for local loop unbundling, designed to enter into force by 31 December 2000, in advance of the entry into force of the rest of the package.;

Source: European Commission, New regulatory framework for electronic communications infrastructure and associated services, <http://www.ispo.cec.be/infosoc/telecompolicy/review99/Welcome.html>.

These services, or "applications", as the IP industry refers to them, "ride" on top of networks of many types, of which public telephone networks are, again, just one.

In this context, it makes less and less sense to think about networks and services together, since there is now tremendous diversity at both levels in low-price markets, for example, where there used to be unity. Indeed, the convergence proposals of the European Union released in July 2000 recognize this dichotomy. They propose that "electronic communications networks" and "electronic communications services" be subject to separate regulatory provisions (see Box 4.1).

In some ways, this trend mirrors the conceptual step taken in the early days of long distance and international competition in what are now low-price countries. Previously, the same operator provided all local and long distance and international services. In the first stage of liberalization, long distance service was "decoupled" from local networks. As a result, there is now great diversity in long distance and international service offerings, yet they are all reached by essentially the same local access network. This network is subject to very different regulatory treatment.

With the advent of local competition in many low-price markets, a further decoupling is taking place. Now services are being further separated from the networks over which they are delivered. Incumbent local network operators are required to unbundle the various elements of their networks and competing local carriers share databases and trunk lines, instead of all of these parts being operated by one operator.

The "IP revolution" takes the process one step further, by making it possible for some functions to be performed by customer premises equipment instead of telephone company facilities. In this model, customers so equipped can "pick and choose" which services, and even which elements of services, they

require. This has both threatened the traditional business of the PTO and created new opportunities, primarily in the provision of private lines, but increasingly in application hosting and value-added services.

IP Telephony is another example of this trend towards separation of networks and services. It has resulted in added diversity in the number and types of providers of both. Thus, it is important for policy-makers to recognize these trends and find new ways to achieve traditional goals while not holding back the deployment of potentially more efficient and functional technologies.

4.3 Current approaches to the regulatory status of IP Telephony

Current approaches to the regulatory status of IP Telephony ranges from complete prohibition to unconditional permission. Different countries have taken widely differing approaches, influenced mainly by prevailing market conditions and commitment to market liberalization. It is important to note that it is voice telephony *service*, delivered by means of Internet or IP Telephony, which is most frequently the subject of policy, not IP *technology* itself.

Many countries, particularly developing ones, do not specifically prohibit IP Telephony but probably do not allow it because no forms of competition with incumbent carriers are permitted. It is possible, however, as a practical matter, that IP Telephony (or at least PC-to-Phone services) may be permitted in these countries because it is not considered voice telephony at all, and therefore not a competing service. However, reliable, reasonably high-speed access to the Internet is required for tolerable PC-to-Phone service, and this is often not available in developing countries. Termination of international calls is the much more significant aspect of IP Telephony in developing countries (see Section 4.4 below).

Box 4.2: Hungary - Keep the sound (quality) down, okay?

While many jurisdictions have implicitly used the inferior sound quality of Internet and IP Telephony as the basis for a regulatory distinction between voice telephony and Internet data, Hungary has gone one step further and made sound quality the *explicit* distinction. Indeed, Hungary's VoIP policy may be the most direct and detailed in the world. The policy, released on 22 July 1999, applies to all telecommunications service licensees and licence applicants, including previously-licensed Internet Service Providers (ISPs) and would-be Internet Telephony Service Providers (ITSPs).

Since the incumbent MATÁV's exclusive rights (until 31.12.2001) to carry international public long-distance voice telephone traffic can only be by-passed if the established speech connection qualifies as a "non-public-voice-telephony" connection, the Hungarian policy imposes sound quality limits to prevent IP Telephony from serving as a perfect substitute for PSTN voice services.

If voice telephony service is provided by means of transmission of speech signals in a "customary" (circuit-switched) way in any section of the domestic Public Switched Telephone Network (PSTN) or Public Land Mobile Network (PLMN) (except for leased lines), to qualify as a non-public-voice-telephony connection, those speech signals must meet a series of conditions. They must be differentiable from customary voice telephony service in several ways.: The service provider must (in addition to other minor requirements, such as using only type-approved equipment): (1) ensure a minimum 250 millisecond (ms) average delay of speech signal transmission between the terminal devices; (2) not guarantee that the loss of speech packets causing short interruption of speech will be less than 1%; and (3) draw users' attention to the quality parameters that differ from those of public voice telephony when publicizing the service. Services that use a PSTN of PLMN number as an originating gateway to the Internet are also covered by these requirements (e.g., freephone numbers or calling card access numbers). Calls originating on leased lines are not affected.

Hungary has a vibrant IP Telephony services market, with 14 service providers licensed under this policy as of early 2000, including ISPs, incumbent carriers, and mobile operators. IP Telephony licensing has been successfully used as a way of diversifying the Hungarian market for international voice telephony in advance of its full liberalization.Presumably, IP Telephony will be treated as simply another platform for providing public voice telecommunication services once the market is fully liberalised.

Sources: Communication Authority, Hungary, "Information for telecommunications service licence applicants intended for voice telephony usage of Internet" (22 July 1999), <http://www.hif.hu/voipdir3.htm>, and "Regulation of public fixed telephone services and VoIP (Voice over Internet Protocol) in Hungary", <http://www.itu.int/osg/sec/spu/ni/iptel/countries/hungary/index.html>.

Box 4.3: European Union - If it's not real-time, it's not voice telephony

In May 1997, the European Commission released a draft policy statement concerning voice on the Internet under Directive 90/388/EEC on competition in the markets for telecommunications services. Following public consultation, this document evolved into its January 1998 "status notice," formally titled "Status Of Voice Communications On Internet Under Community Law And, In Particular, Under Directive 90/388/EEC."

Under Article 1 of Directive 90/388/EEC, "voice telephony" means: "The commercial provision for the public of the direct transport and switching of speech in real-time between public switched network termination points, enabling any user to use equipment connected to such a network termination point in order to communicate with another termination point."

The subject of the status notice was whether Internet Telephony can be considered as voice telephony, or rather whether it falls into the category of services liberalised under Directive 90/388/EEC. The status notice gives four criteria which an Internet voice service would have to meet to be considered voice telephony: (1) the service is the subject of a commercial offer; (2) is offered for the public; (3) provides service to and from public switched network termination points; and (4) involves direct transport and switching of speech in real time.

The most important of the status notice's four criteria is the issue of whether the service is "real-time." Since Internet Telephony signals generally involve several conversion steps and face unpredictable traffic conditions, and as a result suffer levels of delay not generally experienced with circuit-switched telephony, they are not considered by the European policy to meet this criterion. IP voice services could be subject to relevant regulatory schemes in EU countries once the "real time" threshold is met (and/or when the service provider claims it is met in its advertising).

Much like the April, 1998, FCC "Report to Congress" in the United States, the notice demonstrated an awareness that IP voice technology was improving quickly, and noted that the situation must be kept under review. A consultative communication was issued on 27 June 2000 to review the status notice, and it is discussed in Box 4.11.

For more detail, see <http://www.itu.int/osg/sec/spu/ni/iptel/countries/eu/index.html>.

Source: European Commission, "Status of Voice Communications on the Internet Under Community Law and, in Particular, Under Directive 90/388/EEC," Official Journal, No. C6, 10.1.1998, p.4, <http://europa.eu.int/comm/dg04/lawliber/en/voice.htm>.

Table 4.1: "Are any Internet services prohibited?"

Answers of responding countries to this question in ITU-D 1999 and 2000 Regulatory Survey

"Yes – IP Telephony" (and/or "IP Fax")		"Yes" (with specifics given)	"Yes" – except for existing licensee(s)	No specific prohibition	No response, but call-back is prohibited
Albania	Mauritania	Burundi (Telephony on Internet – VoIP)	Bulgaria (to 31.12.2002)	Antigua & Barbuda	Afghanistan
Argentina	Mauritius	Cyprus (Fax, Voice)	Estonia (to 31.12.2000)	Bhutan	Chad
Azerbaijan	Mongolia	Israel (No basic telephony, fax or wireless services)	Ghana (to 2003)	Congo	Congo (DPR)
Bahrain	Morocco	Kenya (Internet telephony)	Philippines (test period)	Costa Rica	Guinea
Belize	Mozambique	Mexico (IP Telephony and Internet Video-conferencing)	TFYR Macedonia	Dominican Republic	Jamaica
Botswana	Myanmar	Seychelles (Voice and fax over IP are prohibited, however, Internet telephony which is an Internet application rather than a telecommunication service provided by ISP's is authorised)	Uganda	Guatemala	Kuwait
Cambodia	Nepal	South Africa (VoIP)	Colombia	Kyrgyz Republic	Lebanon
Cameroon	Nicaragua	Thailand (voice and fax)	Egypt	Malaysia	Malaysia
Côte d'Ivoire	Nigeria	Turkey (Voice over the Internet)	Gambia	Malta	Syria
Croatia	Pakistan			Moldova	United Arab Emirates
Cuba	Panama			Sri Lanka	Zambia
Cyprus	Philippines			Viet Nam	
Ecuador	Qatar				
Eritrea	Romania				
Estonia	Senegal				
Gabon	Seychelles				
India	Swaziland				
Indonesia	Trinidad &				
Jordan	Tunisia				
Latvia	Turkey				
Lithuania	Venezuela				
Madagascar	Yemen				
	Zimbabwe				

Notes: Countries indicated in italics did not respond to this survey, but fall into the categories indicated.

Source: ITU Regulatory Survey (see <http://www.itu.int/osg/sec/spu/ni/iptel/countries/99survey/index.html>) and OECD 1999 *Regulatory* Overview *of the Telecommunications and Broadcasting Sectors* (see <http://www.oecd.org/dsti/sti/it/cm/act/regulatory.htm>).

Table 4.2: Countriesthat specifically permit IP Telephony

Depending on whether speech transmission is "real-time" or not, normal voice regulation may apply to varying degrees

Permitted unconditionally (exempted from international settlements regime)	Permitted if not real-time (not considered voice telephony)	Permitted. If real-time, subject to light conditions (notification/registration may be required, other basic provisions of voice regulation)	Permitted. If real-time, treated similarly to other voice telecommunications services (licensable, subject to more extensive provisions of voice regulation)
USA	EU Countries Hungary (if delay =/>250ms and packet loss >1%) Iceland Paraguay (Fax only) *Peru*	Czech Republic (except Phone-to-Phone by other than incumbent) Hongkong SAR Japan New Zealand Poland (Phone-to-Phone by mobile operators only, temporarily) Singapore Slovak Republic Switzerland	Australia Canada China Korea (Rep.)

Notes: The 15 countries of the European Union are Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden, and the United Kingdom.

Source: ITU Regulatory Survey (see <http://www.itu.int/osg/sec/spu/ni/iptel/countries/99survey/index.html>) and OECD 1999 Regulatory Overview of the Telecommunications and Broadcasting Sectors (see <http://www.oecd.org/dsti/sti/it/cm/act/regulatory.htm>).

Tables 4.1 and 4.2, based on available data, do not include all countries because a majority of ITU Member States simply *do not have* specific IP Telephony policies. IP Telephony may be either permitted *de facto* or prohibited in these countries.

Under the WTO General Agreement on Trade in Services, signatory governments have generally agreed not to introduce any new categories of reserved services, but may interpret how services fit into existing categories. As these markets are progressively liberalized, IP Telephony services will likely fall more and more into liberalised areas of telecommunication markets over time. In these markets it is often only universal service funding schemes which render regulatory classifications necessary (see Section 4.4 below).

Most national IP Telephony policies specifically refer to Phone-to-Phone services. PC-to-Phone services tend to be prohibited in countries that prohibit IP Telephony generally, while they tend to be permitted without conditions in countries that permit some or all forms of IP Telephony. This is why PC-to-Phone services are not specifically referred to in Tables 4.1 and 4.2. Calling card services are rarely treated separately in policy, but rather rolled in with other forms of Phone-to-Phone service, since the difference has more to do with marketing and billing than technology.

Table 4.3: Some IP Telephony alliances involving PTOs from countries in which competition is restricted

Existing licences for international services interpreted to permit outgoing and/or incoming IP Telephony

Operator	Country	IPTSP Alliance Partner	Description of Relationship
Telecom Egypt	Egypt	eGlobe	Developing VoIP services in Egypt. Covers both incoming outgoing traffic but mainly the former at present. Telecom Egypt markets the service via ISPs which gain some 10 per cent of revenues generated
CAT	Thailand	iBasis	CAT to route outbound international voice and fax calls over the iBasis Network. iBasis partner Hatari Technologies will route customers' calling card voice and fax traffic over the iBasis Network to destinations around the world
Government of Albania	Albania	Crys-Tel Telecommunications.com	Crys-Tel to install VoIP gateways and fax port hubs to handle Internet, voice, data and video communications in the Balkan region

Source: IPxStream (<http://www.iptelephony.org>).

Box 4.4: USA – IP Telephony looks like a telecommunications service, but is not regulated like one

There is currently no explicit regulation of any form of IP Telephony in the United States, at either the state or federal level. The US Federal Communications Commission (FCC) has ruled that Phone-to-Phone IP Telephony (both true Internet Telephony and VoIP) appears to be functionally equivalent to PSTN voice telephony. However, these services are not covered by telecommunications regulation.

In May, 1996, America's Carriers Telecommunication Association (ACTA) filed a petition before the FCC requesting that it classify as telecommunications carriers those companies that offer Internet Telephony-facilitating software. At the time, IP Telephony concerned primarily the PC-to-PC flavour.

Although the FCC did not immediately respond to the petition, the issue of IP Telephony was considered extensively in a review of universal service, called for in unrelated legislation. This process resulted in the Federal-State Joint Board on Universal Service's "Report to Congress," released on 10 April 1998. That process did not result in regulation of Phone-to-Phone services because, the FCC said, it lacked a complete record on particular service offerings. After speculating about future proceedings in which the FCC would have to face these issues head-on, the FCC made these remarks about the international aspects of the issue:

"We recognize that our treatment of phone-to-phone IP Telephony may have implications for the international telephony market. In the international realm, the Commission has stated that IP Telephony serves the public interest by placing significant downward pressure on international settlement rates and consumer prices. In some instances, moreover, IP Telephony providers have introduced an alternative calling option in foreign markets that otherwise would face little or no competition. We continue to believe that alternative calling mechanisms are an important pro-competitive force in the international services market. We need to consider carefully the international regulatory requirements to which phone-to-phone providers would be subject. For example, it may not be appropriate to apply the international accounting rate regime to IP Telephony."

The issue of IP Telephony regulation in the United States returned to the fore in May 2000 with the passage in the House of Representatives of a bill (HR 1291, or the "Upton Bill") intended to pre-empt the FCC from imposing special access charges relating to dial-up Internet sessions. One clause of the bill, which would still have to be passed by the Senate before becoming law, states: "Nothing in this subsection shall preclude the Commission from imposing access charges on the providers of Internet telephone services, irrespective of the type of customer premises equipment used in connection with such services." This appears to have been an afterthought in a bill otherwise focused on keeping Internet access in the US free of per-minute charges. Even through the FCC has not revealed any intention to impose specific charges related to "Internet telephone services," the bill has the US IP Telephony industry lobbying hard against its passage in the Senate.

For more detail, see <http://www.itu.int/osg/sec/spu/ni/iptel/countries/usa/index.html>.
Source: Federal-State Joint Board on Universal Service, "Report to Congress, (10 April 1998) (also known as the "Stevens Report"), <http://www.fcc.gov/Bureaus/Common_Carrier/Reports/fcc98067.html>; ITU.

It should also be noted that, for many countries, information is not available as to whether incumbent operators are employing IP Telephony or not, and if they are, whether by right of their existing licences, or under special authorization. Some PTOs may simply assume that their international franchise allows them to use IP Telephony, should they decide to pursue it as a cost-saving measure, or to offer a discounted service. In this respect, several PTOs from countries which prohibit IP Telephony have announced international IP Telephony alliances with IPTSPs such as DeltaThree.com, ITXC, and Net2Phone (see Table 4.3). Those schemes which have been publicly announced may be only the tip of the iceberg. Many more PTOs in liberalised countries have entered into similar arrangements.

An important issue of competitive equity arises when monopoly operators, which are also ISPs (in competitive markets), offer cheap telephony services which they are in a unique position to offer, compared to other, independent, ISPs. This advantage may prove to be a "killer application" for the affiliated ISP, hence extending monopoly power into new areas.

In some countries, mobile operators are given special rights to use IP Telephony to route international calls, allowing them to bypass the incumbent's international gateway:

- In Uganda, full-service operators UTL and MTN (which are not yet ISPs, but plan to become so) can offer IP Telephony, while mobile operator Celtel, which is also an ISP, is not permitted to provide IP Telephony;
- In the Czech Republic, mobile operators can use "the Internet telecommunications network" to route international calls, despite an early claim by incumbent Czech Telecom that doing so violates its exclusive franchise for international calls;

- Mobile operators in Poland currently enjoy the same privilege, in advance of a new telecommunications law which is expected to liberalize IP Telephony more widely.

4.4 IP Telephony in high-price markets

In markets where outbound IDD rates and incoming settlement rates are high, IP Telephony is experienced primarily as incoming accounting rate bypass traffic. As explained in Chapter 3, high settlement rates for terminating incoming international voice and fax traffic creates powerful incentives for an alternative means of termination in such markets. In fact, the arbitrage opportunity presented by the ability to bypass traditional (and expensive) means of terminating such traffic constitutes the basic business case of most IPTSPs today, just as it has for call-back operators for several years.

While IP Telephony can pose significant regulatory challenges for high-price markets, it is important to note that these are often part of larger, pre-existing issues of industry structure and state of liberalization. Indeed, it is high prices and accounting rates which create the arbitrage opportunity in the first place. Call-back has been seen as a troublesome form of competition to the incumbent which has often been banned in an attempt to protect the sometimes significant revenue streams derived from terminating international traffic. If that is a policy goal in a particular country, then IP Telephony will also present difficult issues. However, accounting rates are falling due to a combination of political pressure and market competition.[1]

The consequences of a ban on IP call origination can be most starkly seen in markets where IP call termination is either liberalized or monopolies not enforced (for various reasons, including technical difficulty). In this scenario, citizens in the high-price market are prevented from taking advantage of the advent of IP Telephony, and thus from making low-cost calls. Rather, foreign consumers and foreign carriers gain the benefits of lower charges and costs, respectively. Thus, consumers and operators in developing countries which prohibit outgoing IP Telephony tend not to gain from the spread of IP Telephony to nearly the same degree as consumers and operators in developed countries, particularly where international IP bandwidth is cheap.

IP Telephony thus presents a dilemma for high-price markets, and for their incumbent PTOs:

- On the one hand, IP Telephony promises to reduce the price of international telephone calls, for instance, enabling residential customers to make calls to relatives living abroad which might otherwise be too expensive, and enabling business customers to participate more effectively in the global marketplace.
- On the other hand, IP Telephony could be viewed as a Trojan Horse that threatens to undermine the pricing structure of the incumbent PTO and undercut its profitable business in originating and terminating international calls. IP Telephony might also threaten the ability of the PTO to invest in extending the domestic network and meeting its universal service obligations (see Section 4.5 below).

Both arguments hold some truth. IP Telephony does indeed present a major challenge to developing country PTOs, but one that they would be better advised to embrace rather than ignore. However, this will normally require liberalizing both the international call origination and termination markets. Only by bringing rates down closer to costs will the incentives to bypass traditional networks be lessened. IP Telephony can thus be viewed as only the latest in a series of alternative calling procedures which makes such a change necessary.

4.5 Sustainability of local access networks

In some countries, the sustainability of the local access network may be at stake. While developing countries have frequently been criticized for maintaining high accounting rates and not using all of the associated revenue to improve the quality and reach of domestic local access networks, reductions in settlement revenue have the potential to dramatically reduce the funds available for such investment. The very reason that IP Telephony is a viable business proposition in these countries is that such charges can be avoided. Whether the relevant accounting rates are unreasonably high or not, it is worth noting that IPTSPs generally make little to no contribution towards the development of local access networks in the countries where they terminate traffic.

Box 4.5: iBasis: The business model of a wholesale IPTSP

US Internet Telephony service provider iBasis, Inc. styles itself as an Internet application host. That is, it provides many different types of "back office" communications services to international carriers and other service providers, which sell packaged services to consumers. In the near term, the most important applications it provides is voice telephony. iBasis is somewhat different to most IPTSPs in that it claims to use the public Internet as its primary means of transmission. This makes it all the more impressive that iBasis is able to offer service level agreements (SLAs) to its customers.

iBasis counts among its customers many of the world's top traditional carriers, including Telstra, Cable & Wireless, WorldCom, KDD, NTT, Teleglobe, Communications Authority of Thailand, and China Unicom. Longer term, iBasis' strategy is to offer its customers new hosted value-added services such as unified messaging, audio conferencing, and device-independent global roaming.

iBasis' corporate profile describes the company this way:

iBasis, founded in 1996 as VIP Calling, is the global leader in Internet-based communications services. iBasis currently provides voice, real-time fax, and IP CallCard™ services for telecommunications carriers and other communications service providers.

The iBasis Network™, a global, scalable Internet communications network sets the industry standard for Quality of Service and is the world's largest Cisco Powered Network for Internet Telephony. The open architecture of the iBasis Network enables customers to realize the benefits of IP communications by rapidly deploying new services and simultaneously reducing costs. The iBasis Network consists of strategically located, high-capacity Internet Central Offices and Internet Branch Offices located throughout Asia, Africa, Europe, the Middle East and the Americas. The iBasis Network is optimised to deliver low latency and packet loss, high voice quality, no echo, and low post-dial delay with one stage dialing. Answer Seizure Ratios (ASR) are equal to or better than the leading PSTN carriers. iBasis is able to provide a superior Quality of Service through its proprietary Assured Quality Routing™ (AQR) software that dynamically reroutes traffic from the Internet to the PSTN as a result of triggers from a set of tools that monitor the performance of the public Internet on a continuous basis. Over 90% of the traffic on the iBasis Network is routed over the public Internet.

Source: iBasis, Inc. Website, <http://www.ibasis.net/>.

This problem is certainly not unique to high-price markets. In markets with very large local access networks historically subsidized by long distance calling, such as the United States and Canada, a change in the character of calls from long distance to local reduces the amount of "contribution" payments flowing into local access subsidies. The fact that these two otherwise similar markets have, to date, taken very different approaches to this problem (with Canada incorporating IP Telephony into its contribution regime but the United States leaving it outside of its access charge regime) demonstrates that there is no single right answer to the problem.

Policy-makers and PTOs in high-price markets need to find ways to maintain and increase levels of investment in local access networks without perpetuating inefficiencies in those networks, or unnecessarily inhibiting the development of alternative means of access. Wireless local loop and "greenfield" IP Telephony networks are potential examples of access-expanding technologies. It must also be recognized that even where they are permitted, alternative local access networks may simply not develop for economic reasons. In these environments, regulation will likely remain necessary to strike the right balance between the sustainability of local access networks and competition in other market segments.

This complex undertaking continues to bedevil regulators in all types of markets. For instance, the Canadian regulator spent a good deal of 2000 considering the reform of the mechanism by which contribution is collected, reform necessitated by the decreasing significance of traditional billing concepts such as minutes and distance.[2] New ways of charging for and subsidizing local network use are necessary but change is likely to be politically difficult anywhere, to the extent that it requires local rate increases.

4.6 IP Telephony development does not equal Internet development

While "free" Internet Telephony services (see Box 3.1) appear to offer consumers in high-price markets the opportunity to call relatives and business contacts around the world for free, two important caveats must be made. First, such calls are rarely actually free, given the need of the calling party to have an Internet connection, which, if local calls are metered, can accumulate much like long distance calling charges, by the minute. Second, the type of consumer in high-price markets who might choose lower-quality, low-cost

Internet Telephony is unlikely to be the same type of consumer who can afford a multimedia PC and an Internet access link in the first place.

It is very important not to confuse development of IP Telephony with development of the Internet. As demonstrated in Chapter 2, the majority of international IP Telephony traffic is *not* true Internet Telephony, but rather VoIP (though iBasis appears to be an exception, see Box 4.5). That is, the lines which carry IP Telephony traffic tend to be dedicated, managed IP bandwidth, not public Internet bandwidth, on which congestion and quality are nearly impossible to control. An increase in the amount of incoming IP Telephony traffic coming into a country does not translate into an increase in the availability of outgoing Internet bandwidth. The circuits are closed to public Internet traffic to maintain their performance characteristics.

Despite claims to the contrary, IPTSPs do not make the Internet more available in the countries in which they terminate traffic. Rather, they simply bypass the incumbent operator(s) by a method very similar to leased line resale, with the only difference being the use of IP instead of circuit-switched telephony technology. In fact, as opposed to extending Internet infrastructure in high-price markets, VoIP may actually contribute to the decline of the very local access networks which are essential for basic Internet access, by avoiding universal service payments.

A preferential policy towards IP Telephony, therefore, does not necessarily constitute promotion of the Internet in a given country. As suggested above, it may actually be counter-productive if not accompanied by a means of assuring viable funding for local access networks. IPTSPs can be expected to continue describing themselves as Internet Telephony providers (even while their services are more accurately described as VoIP) so long as there are regulatory advantages to being an "Internet company," as opposed to a telephone company (see, for instance, the case of ITXC in Box 4.6).

One strategy for a liberalizing country to consider might be to impose specific obligations on new entrant IPTSPs to expand the availability of full-fledged Internet access as a condition of licence. The expansion of such access would make PC-to-PC and PC-to-Phone IP Telephony services more available, further increasing consumer welfare, but also applying further pressure on the tariff structure of the PTO. It is not surprising that for this very reason some countries have implemented technical measures to block "free" IP Telephony services like Dialpad and Aplio from operating in their countries.

Just as IP Telephony bypasses the traditional circuit-switched telephone network, VoIP in effect bypasses the public Internet. Ironically, IPTSPs are finding that the Internet is not enough like the telephone network to serve as a telephone network. Call quality tends to be substandard due to the inability to control congestion on public Internet bandwidth, and structures do not exist (yet) to meter and bill for calls without passing them through some kind of clearinghouse at one end. Despite claims that IP Telephony is fundamentally different to circuit-switched telephony, looking a bit deeper reveals network architectures and financial arrangements which are not dramatically different to those found in the PSTN. Circuits carrying IP Telephony have much more in common with regular leased circuits than the public Internet. Given these similarities, and the functional equivalence of phone-to-phone IP Telephony calls with PSTN calls, the basis for treating them differently as a matter of policy becomes more and more difficult to justify.

Box 4.6: ITXC: It's easy to get started with a SNARC

For a traditional carrier to get into the IP Telephony business, it can be as easy as buying a server and hooking it up. In fact, U.S. IP Telephony service provider ITXC will give you the server if you qualify (by sending a minimum of 400'000 minutes of traffic per month to ITXC). These excerpts from ITXC's promotional materials for its "SNARC" product explain:

A SNARC is ITXC-owned and operated turnkey equipment that allows qualifying carriers to quickly originate or terminate voice and fax calls over ITXC.net™, the world's largest Internet telephony network. ITXC.net utilizes patent-pending Best Value Routing™ voice traffic management technology to provide wholesale call completion at exceptional prices and with consistent quality to any phone or fax in the world. SNARCs are co-located behind a facilities based carrier switch. Originating SNARCs provide carriers with access to an instant, world-wide call termination footprint using high quality, low cost Internet telephony routes. Terminating SNARCs generate additional revenues by completing calls from ITXC.

Source: ITXC, "SNARC": Internet telephony originates and terminates here," <http://www.itxc.com/services/snarc.html>.

Perhaps the most telling sign that the wind of change is blowing in high-price markets is the steadily increasing number of PTOs using IP Telephony to carry their own international calls. As demonstrated in Table 4.3, even PTOs in countries where IP Telephony is nominally banned are getting involved. The reason is simple – lower international termination costs mean higher profits.

IP Telephony is no longer a fringe service lying outside the traditional telecommunication world. Telstra of Australia and Gambia Telecommunications Company (GamTel) both entered into agreements in 2000 with ITXC, an American IPTSP, to exchange international IP Telephony traffic.[3] In May 2000, iBasis, another IPTSP, announced that its network was to be interconnected with that of Concert, owned by British Telecom (BT) and AT&T, allowing the exchange of IP Telephony traffic between customers of the two companies.[4]

This kind of alliance, between PTOs and IPTSPs, and among IPTSPs themselves, is being announced at a startling pace all over the world and it seems likely that many more remain undisclosed. Clearly, both IP Telephony technology and IP Telephony operators are being embraced by the traditional telecommunication industry worldwide. Whether this is by choice or compulsion is another matter. Some of these arrangements fall within the boundaries of existing telecommunications financial and regulatory structures, but many do not. IP Telephony cannot be ignored and it can almost certainly not be eradicated without employing extremely heavy-handed measures.

Competition is here to stay, and IP Telephony is best viewed as part of this larger trend. Reform of the accounting rate system is continuing and prices must be brought closer to costs in competitive environments. When that happens, the issues of IP Telephony in high-price markets will likely come to resemble the issues observed in falling-price markets, and, in turn, those of low-price markets. In this latter group of economies, IP Telephony is being integrated into telecommunication regulatory regimes as a matter of course.

Box 4.7: Level 3: VoIP is functionally equivalent to circuit-switched voice and should be regulated the same way

Level 3 Communications, Inc. is a U.S. based "next-generation carrier" which is building a global IP-based data network. This network will support Internet-type applications on a managed, end-to-end IP network which can offer much higher quality of service than either the public Internet or hybrid circuit-switched/packet-switched networks. In fact, some of those customers can be expected to be the IPTSPs referred to elsewhere in this report.

In the company's submission to the French regulator's public consultation on IP Telephony (see Box 6.2), Level 3 made these comments, indicating its belief that it is time that IP Telephony and PSTN Telephony be treated the same from a regulatory perspective:

As we explained repeatedly, we do not think it is useful to define Internet Telephony in terms of underlying technology, architecture, let alone a coincidental combination of types of terminal equipment. Academic research may have an interest in developing typologies and the like, but from both a policy and strategic point of view, what counts is what counts for the customer, and this,undeniably, refers to quality and functionality, and in this respect there is no single reason to treat VoIP differently from the diverse inhabitants of the circuit switched voice services universe.

Therefore, the one and only approach that makes sense is a definition in relation to the legal, technology-independent definition of voice. In this context, we have, at this stage, no substantial problem with the European Commission's notice on the "Status of voice communications on Internet." Since the publication of this notice, VoIP has evolved so far that it satisfies now all relevant criteria to be considered as public voice in the sense of the Services Directive[…]

The Level 3 submission later concludes as follows:

Rather than dealing with all questions in detail, Level 3 has attempted to substantiate the fundamental axiom that VoIP has reached such degree of maturity that it is to be equated to carrier-grade public voice, both from a customer perception and a regulatory point of view. We are convinced that insertion in the existing regulatory framework is the only sensible approach in this context, if the public policy purposes whichunderlie this framework are to survive the arrival of the next generation network.

It is nowhere implied that the regulatory framework is perfect, far from it. The point Level 3 has been making throughout is that the necessary review of the regulatory framework should focus solely on the nature of the services provided and not on the technology supporting those services. To keep on isolating VoIP from the common regulatory framework for voice services would be tantamount to regulating against the unavoidable evolution of the industry.

Source: Level 3 Communications, "Voice over IP and the Next Generation Network: response to the ART consultation on Internet Telephony," 14 April 1999, <http://www.art-telecom.fr/publications/level3.htm>.

4.7 IP Telephony in falling-price markets

In a second group of markets, outbound IDD rates and incoming settlement rates are in the process of falling, due, for example, to the introduction of competition and tariff rebalancing, commitments under the WTO Agreement on Basic Telecommunications, and the relaxing of prohibitions on alternative calling methods such as call-back. However, exclusive licences for certain services tend to continue in force in these markets, usually until prescribed dates.

It has been this type of market where the most well-publicized battles over the nature and legality of IP Telephony have taken place. As opposed to high-price markets, where alternative calling procedures have generally been banned, and low-price markets, where such procedures have long been permitted, markets in between monopoly and full competition have seen call-back, resale, and most recently IP Telephony, make inroads despite exclusive franchises. In some countries, the introduction of IP Telephones by enterprises outside of the traditional telecommunication industry led to protracted legal battles over what IP Telephony is and whether it infringes on monopolies of incumbents. An illustrative example is that of Colombia (see Chapter 5).

As much as these court battles have been about incumbents trying to extinguish unauthorized competition, the actions of policy-makers and regulators in some of these markets have been about finding a way to permit alternative calling procedures *in spite of* incumbents. In these markets, IP Telephony in particular has ushered in a measure of competition short of full liberalization, but within the strict legal interpretation of existing licences. The Czech Republic and Hungary are examples (see Box 4.2 and Table 4.4).

It is easy to see why fine definitional distinctions have had to be made in some falling-price markets. When fixed-line international voice service, for instance, is the subject of an exclusive licence, but data transmission is liberalized, a legal interpretation that IP Telephony is a form of data, and not voice, can be very significant. The issue is otherwise a nearly meaningless exercise since digital networks carrying voice are technically very similar to data networks (particularly cell-switched ATM networks). Similarly, an interpretation to the effect that the Internet is something other than basic telecommunications (for instance, an "enhanced" service) can render an existing monopoly over voice service inapplicable.

In high-price markets, competition with licensed operators is prohibited. In low-price markets, IP Telephony is recognized as simply another technology which licensed carriers are free to choose if they wish. An example of the exception, however, is the United States, where IP Telephony remains categorized as an "enhanced service" and therefore outside the traditional voice regulatory regime (see Box 4.4). In the US market, this definition has been the subject of intense debate for several years, as incumbent carriers protest the burdens which IPTSPs place on their facilities in the course of offering an unregulated service which is functionally equivalent to their regulated service.

Box 4.8: Voice or data?

The most important regulatory distinction in many countries is whether IP Telephony constitutes voice or data. The voice/data distinction is largely arbitrary, since IP Telephony services can achieve a level of functional equivalence to traditional telephony services. This should make its use of packets instead of electronic pulses irrelevant. In fact, modern digital networks can also be considered a form of data transmission, as voice signals are digitised and often packetized as well, where ATM is used. Still, the voice/data distinction is commonly used as a definitional tool in legislation and rulings to implement policy or frequently the lack of a specific policy.

The Internet has been treated in most countries as something other than traditional telecommunication. The trend has been in favour of little or no regulation of Internet services, even while traditional voice services are subject to extensive (though generally decreasing) regulation. The key is that Internet traffic is considered data traffic, even though in some forms (e.g., dial-up Internet sessions), the bits actually pass over regular public voice circuits. When voice became one of the services that can be provided over the Internet, the argument for treating it differently was that it is simply another form of Internet data. Hence the regulatory advantage of Internet Telephony – being treated as something other than voice, even though voice is the actual service being offered (particularly in the case of Phone-to-Phone service).

As more voice becomes data, it may become necessary to devise a more sophisticated distinction than voice/data to differentiate between those voice services which are regulated in one way and those regulated in another, if at all.

Table 4.4: The fuzzy line between public voice telecommunication and everything else
Typical regulatory distinctions adopted in selected countries

Nature of distinction	Explanation	Countries in which the distinction is relevant
Real-time?	Can the service provide instantaneous, two-way (or "full-duplex") transmission of speech? If not, the service is often not considered voice telephony, but rather a store-and-forward or messaging service. The latter are often considered "value-added" or "enhanced" services are therefore traditionally subject to little or no public regulation. The difference between real-time and store-and-forward may be measured in milliseconds as a technical matter, but is usually undefined in policies (except Hungary – see Box 4.1).	EU (see Status Notice) Hungary Switzerland
Phone-to-Phone?	Can an ordinary telephone be used as the originating terminal device? This feature can make IP Telephony appear to be a substitute for traditional service in the eye of the consumer (whether or not a carrier access code must be dialed).	Canada EU (see Status Notice) Switzerland
Where IP/PSTN conversion takes place (i.e., whether there is a service provider)	In Phone-to-Phone services, the initial conversion of speech from circuit-switched mode to IP mode takes place on the premises of a service provider of some kind, particularly in the case of calling card services. In PC-to-PC and PC-to-Phone services, the initial conversion takes place at the user's PC, such that there is often not a service provider located in the same country as the user, which is usually a precondition for effective regulation.	Canada
PSTN Use?	Does a given IP Telephony call ever "touch" the PSTN? If it does not, but goes from a private data network to an IP gateway and then over international Internet links, then the PSTN has not been "used." Regulation relating to basic telephony often focuses on the local access network. If that network is not used, then the service in question may not be considered a basic telecommunication service.	Canada Hungary Czech Republic EU (see Status Notice)
Stand-alone Commercial Offer To The Public?	Are IP Telephony services offered in the originating country for the use of the public, and provided as a standalone commercial service with the intention of making a profit? These criteria eliminate services for closed user groups (such as enterprise networks) and services to which voice transmission is ancillary, such as video telephony, or other multimedia services, such as networked video games.	EU (see Status Notice)
Priced/Billed?	"Free" services, such as Dialpad.com, aim to make a profit from advertising, and from ISPs that promote the service. Thus, it may not collect any revenue in all the jurisdictions where the service is used. This can make domestic regulation of such a service very difficult. Other services can be either pre-paid (e.g., calling cards) or post-paid (e.g., discount access numbers, such as Czech Telecom's "XCall.")	USA Korea (Rep.) Singapore Hongkong SAR
True Internet Telephony or VoIP?	Only North American policies distinguish between the Internet and other IP networks as the underlying means of transmission for IP Telephony calls. It can make the difference between a service being characterized as an Internet service, or simply another form of resale, provided by means of a different technological platform.	Canada USA
Originating or terminating?	It is somewhat surprising that few IP Telephony policies refer to *terminating* international calls via IP Telephony, yet this is the primary form of the business in developing countries. Since developing countries tend to have higher than average accounting rate levels, there is a greater incentive to use IP Telephony as a form of bypass of the accounting rate systems (see Chapter 3). While there may not appear to be much IP Telephony business activity in a particular country because it is not advertised, international IPTSPs have more than likely already struck deals with local ISPs to terminate calls for them outside of the accounting rate structure maintained by the incumbent PTO(s).	(n.a.)

Box 4.9: Real-time?

Excerpt from ITU-T Recommendation G.114 (2.96 revision) (One-way Transmission Time)

"[T]he ITU-T *recommends* the following limits for one-way transmission time for connections with echo adequately controlled (see Note 1) according to Recommendation G.131 (*Stability and Echo*):

- **0 to 150 ms**: Acceptable for most user applications (see Note 2).
- **150 to 400 ms**: Acceptable provided that Administrations are aware of the transmission time impact on the transmission quality of user applications (see Note 3).
- **above 400 ms**: Unacceptable for general network planning purposes; however, it is recognized that in some exceptional cases (see Note 4) this limit will be exceeded.

NOTES

1 The use of echo control equipment that introduces other impairments, such as speech clipping and noise contrast, may have to be controlled in order to achieve acceptable transmission quality.

2 Some highly interactive voice and data applications may experience degradation for values below 150 ms. Therefore, increases in processing delay on connections with transmission times even well below 150 ms should be discouraged unless there are clear service and application benefits.

3 For example, international connections with satellite hops that have transmission times below 400 ms are considered acceptable.

4 Examples of such exceptions are unavoidable double satellite hops, satellites used to restore terrestrial routes, fixed satellite and digital cellular interconnections, videotelephony over satellite circuits, and very long international connections with two digital cellular systems connected by long terrestrial facilities."

As it stands, the US regime provides an incentive for telephone companies to become Internet companies, and declare their service to be a data service, not a telephone service. In this light, it should not be surprising that in mid-2000, the chief executive of WorldCom, the second-largest US long distance company, remarked that his company might sell off or restructure its residential long-distance telephone business to concentrate on its Internet network and business markets.[5] The two businesses have subsequently been separated, following a similar path as AT&T.

While IP Telephony has predominantly been successful with the price-conscious international-calling residential user (often immigrants to North America), the IP Telephony industry is united in acknowledging that bundled, IP-based services, of which voice will be but one, is the future. The customers for these services will be predominantly business customers, since they already have significant data network needs.Enterprise VoIP can replace a significant portion of such customers' PSTN bill, keeping more calls "on-net" within an enterprise data network. As long as regulatory asymmetries encourage the transformation of voice into data, these kinds of trends can be expected to continue even in falling-price markets.

The need for fine distinctions such as "voice vs data" and "real-time vs non-real-time" qualified the European Union at the time of the 1998 status notice (see Boxes 4.3 and 4.11) in the same category as those cases discussed above. However, since that time, many IPTSPs have forgone whatever advantages "non-real-time" status might have conferred and registered as carriers like any other. The views of global IP carrier Level 3, which holds several licences in Europe, demonstrate that for an IPTSP to become commercially successful outside of the pure price arbitrage segment, it needs to "grow up" and behave like its competitors, the phone companies (see Box 4.7).

4.7.1 Classifying IP Telephony

Nevertheless, in many markets the need to define IP Telephony persists. It is possible to identify a number of distinctions that are commonly used to distinguish IP Telephony from other, usually reserved or licensed, telecommunication services. In making the determination as to whether a particular service constitutes ordinary voice telephony or not (usually the issue at stake), a number of different distinctions are employed, alone and in combination, in many markets around the world. Table 4.4 lists several of these criteria, while Boxes 4.8 and 4.9 focus on two of the more common ones.

4.7.2 IP Telephony and existing liberalization schemes

Falling-price markets are also subject to a particular challenge from IP Telephony. Often such markets have chosen particular regimes for the introduction of competition, such as the proportionate returns system, which require that on international routes, return traffic is divided up between licensed carriers in the same

proportion as outgoing traffic. In these markets, IP Telephony is not banned out of a distaste for competition, but rather precisely to maintain the integrity of a pro-competitive transitional regime. In these markets, IP Telephony poses a unique problem for regulators. This is an example of technological change outpacing regulatory change, and there are no easy answers. However, it can be expected that the long-term effect of such transitions may be that the price arbitrage opportunities to be exploited by means of IP Telephony disappear. Thus the challenges are at least likely to be time-limited.

4.7.3 The regulator can make all the difference

A second challenge encountered in falling-price markets relates to regulators. A phenomenon which has been experienced in many environments where competition is a new concept is the loyalty of the government, which is making the rules, to the incumbent, which stands to lose from competition. In some countries, the line between the operator, the regulator, and the policy-maker is not clear enough to create a transparent regulatory environment.

There is too often a lack of clarity as to which organ of the state has the authority to rule on the legal status of IP Telephony. The case of Colombia again provides a good example (see Chapter 5). Quite apart from the issue of whether IP Telephony infringed on the franchise of the incumbent, a separate issue concerned which government body had the authority to decide if it infringed. This is probably the case in many other markets, particularly where competition either does not exist, or is in its early stages. It is essential that regulatory agencies be independent and authoritative. They should be given the legal tools to guide changing telecommunications markets, or be recognized by the courts as authoritative on such matters. [6]

The authority of regulatory agencies can vary. In Canada, the regulator introduced long distance competition without specific legislative direction, and was deferred to in that decision by the courts. At the other extreme, there are regulatory agencies which are not independent of the ministry and whose members are either sympathetic to the interests of the incumbent, or fear for their jobs if they act against those interests.

4.8 IP Telephony in low-price markets

IP Telephony tends to present very different issues in markets where outbound IDD rates are already quite low, due to vigorous competition, tariff rebalancing, extensive liberalization under the WTO Agreement on Basic Telecommunications, and the absence of restrictions on alternative calling methods such as call-back resale and IP Telephony. In such markets, exclusive licences have generally either expired or been terminated (for instance, through a buy-out, as in Hongkong SAR), and only local access networks remain subject to detailed regulation.

Low-price markets tend to be large, industrialized nations, most often OECD members, where a philosophical commitment to competition in telecommunications was made in the 1980s and early 1990s. Today, the ethos of full competition underlies telecommunications regulation, not monopoly or service exclusivity (such as between cable TV and telephony). Just as the concept of bypass is of little relevance in these markets as compared to high-price markets, there are many other issues that are unique to low-price markets. Price arbitrage opportunities have little role in domestic long distance or international calls between low-price markets. Rather, IP Telephony is currently a cost-saver for carriers, although it is projected to be the future of telephony more generally.

Technology analysts have been suggesting for several years that all forms of electronic communications will eventually merge into one. Recently, IP appears to have emerged as the unifying platform. While this may take many years, this is definitely the direction in which communications appears to be headed in liberalised markets. With telecommunication carriers and broadcasters entering each other's markets in many countries (theoretically doubling the number of local access platforms for telephone service), regulatory structures are facing new issues of interconnection and access.

4.8.1 Convergence is here, and its name is Internet

The Internet is the logical outcome of technological convergence. Devising ways to allow cable companies and phone companies to enter each other's markets was only the beginning. Now, IP is enabling true convergence, with the ubiquitous, interoperable Internet as the underlying platform. Convergence demands the development of coherent, cross-platform communications policy, which is preferably neutral towards technology choices, as the submissions to the French public consultation urged (see Box 6.2).

In a fully-converged environment with IP as the unifying protocol, services are separated from networks, and can therefore be provided by anyone with access to a network, if that network is interconnected with other networks. This is the power of the Internet model, and largely accounts for the tremendous innovation which the Internet is enabling. The openness of the Internet platform has allowed large-scale experimentation at low cost. That experimentation has spawned the Web browser, streaming video, and the application service provider industry, as examples. In this exciting environment, the fact that IP technology is used to facilitate what looks like a telephone call is relatively uninteresting from a technical perspective

4.8.2 Hybrid local telecommunications environments

In low-price markets, IP Telephony technology is primarily used by carriers at the backbone level, and only offered as a retail service to large corporate customers (which might otherwise be VPN customers). Thus, not only is VoIP not a residential product for the most part, but it is not a local access technology either. Just as in almost all other markets, the PSTN remains the first link in most IP Telephony transmissions, in the sense that most either terminate or both originate *and* terminate on the PSTN. This reality means that IP Telephony will be part of a hybrid environment for several years, even in low-price markets.

The reality of this hybrid environment will be that IP Telephony will not bypass the PSTN completely, but rather must integrate with it. In fact, for IPTSPs to offer service which is functionally equivalent to the PSTN, it must integrate far more closely with it than early Internet pioneers might have imagined. To be able to display a calling party's number, or to offer full emergency number functionality, for example, an IP Telephony service must be completely integrated with the PSTN. Thus, IPTSPs which seek to offer the full range of telecommunications services (plus innovative value-added services, of course) must effectively become what are referred to in some liberalized markets as competitive local exchange carriers (CLECs).

The process of introducing competition in the "last (or first) mile" has been far more challenging than the earlier introduction of long distance competition. Alternative long distance provision could be set up by means of relatively simple modifications at the local switch level, or through dialling procedures (such as access codes and dial-around numbers). However, full-scale, facilities-based, local competition requires that the local access infrastructure be changed from a one-provider model to a multiple provider model. Elements of telephone networks which had not been thought of a great deal in many years, because they were under the stable management of incumbent local access providers, had to be redesigned to permit access by multiple competing providers. Databases, numbering plans, and end offices, among many such elements, now must be shared by all those providing telephone service in a given area.

This is the environment into which IP Telephony must integrate if it is to be deployed more widely in carrier networks. However, the current international arbitrage business of the IPTSPs, which the industry readily acknowledges is inherently doomed due to falling IDD rates everywhere, requires relatively little physical and technical integration with the PSTN. IP calls are simply collected from the PSTN by means of special access numbers, transmitted over IP networks, and then terminated by a computer dialing a local phone and initiating what appears to be a local telephone call. The same process is performed for IP faxes.

4.8.3 Numbering challenges

However, a very simple and often overlooked hurdle stands in the way of IP Telephony development: it is currently impossible to call an IP phone. That is, one can have an all-IP telephone that is always connected to an IP network, and make outgoing calls, but not be able to receive incoming calls. The reason is very simple and the problem potentially daunting. There is currently no way of identifying IP phones and addressing packets to them, outside of closed enterprise networks. That is because, as described in Chapter two, the numbering and addressing systems are quite different.

Access to numbering resources may be a somewhat obscure example, but the problem demonstrates the degree to which IP Telephony must integrate with the existing telephone network, not only operationally, but also as a matter of regulation.[7] Numbering resources are overseen by regulators domestically and publicly coordinated through the ITU to ensure that they are efficiently allocated, individually unique, and universally findable. There are several other examples of traditional telecommunications regulation that, far from being irrelevant to IP Telephony, may need to be extended to encompass IP Telephony if it is to succeed as a viable alternative to traditional telephony.

Box 4.10: European Commission recommends unbundled access to the local loop

The European Commission Recommendation on Unbundled Access to the Local Loop of 26 April 2000 recommends that the fifteen EU Member States adopt measures to mandate, by 31 December 2000, fully unbundled access to the copper local loop of "'notified operators' (public fixed network operators designated by national regulatory authorities as having significant market power) under transparent, fair and non-discriminatory conditions. Incumbent fixed-line operators would have to provide anyone, including their competitors, with the same facilities as those which they provide themselves or their affiliated companies, on the same terms and time schedules, priced on a cost-oriented basis. Allowing collocation of equipment and the rental of facilities to connect it are also to be required.

Source: Commission Recommendation C(2000)1059 on Unbundled Access to the Local Loop, 26 April 2000, <http://www.ispo.cec.be/infosoc/telecompolicy/en/Main-en.htm>.

4.8.4 Regulatory issues for IP Telephony in advanced markets

Interconnection

Interconnection is by far the most important concept in competitive telecommunication environments, both in transitional and in fully competitive market phases. While the degree to which interconnection must be supervised (and indeed mandated) by telecommunication regulators varies from market to market, it is generally recognized that access to competitors' networks and shared resources (such as directory listings) is essential for healthy competition. There will likely come a time in the development of IP Telephony when the rights of competitive telecommunication carriers are desired by IPTSPs, which must also accept the associated burdens. Indeed, this is the case with the "next generation" carriers and IPTSPs which have already been licensed as long distance carriers in Europe.

The same can be said of unbundled network elements. Access to unbundled elements of the "local loop" is considered essential for the introduction of alternative means of local access. While full local loop unbundling is currently required in relatively few countries, it is seen as an important step in the evolution of markets from monopoly to competition everywhere (see Box 4.10). Unbundling allows new entrants to access customers and provide services to them before, or instead of, constructing all of the necessary facilities. It allows different networks to interconnect and exchange traffic, and, most importantly, makes it all appear seamless to the end-user. The 'opening up' of local networks has proven to be a very challenging regulatory undertaking, and those challenges await those economies which have not yet proceeded to that stage of liberalisation.

Technical interfaces

Interconnection rights are useless if the facilities of interconnecting operators are technically incompatible. There is an equivalent issue in the computer industry, where application programming interfaces (APIs) are the key links which allow software from different producers to interoperate. The manipulation of APIs was a major allegation made against Microsoft Corporation in the U.S. Department of Justice anti-trust prosecution which ended in 1999 with a finding that Microsoft had abused its monopoly position in the PC operating system market. IPTSPs, like CLECs, may find that they need regulatory help to require (particularly dominant) competitors to make interconnection with their networks possible using standard interfaces. This includes access to signalling system 7 (SS7) facilities.

Law enforcement access

While it necessarily has a low public profile, the obligation of PTOs in many countries to prove a means of access to its networks for law enforcement purposes remains an element of telecommunications regulation even in the most liberalized markets. Should the same obligations apply to IPTSPs? Even the most "hands-off" regulators will probably be reluctant to countenance a situation in which calls placed on one type of network can be made the subject of surveillance while those on another type of network cannot. Nevertheless, this issue presents enormous freedom of expression issues that take many different forms around the world.

Quality of service

Prior to the advent of vigorous competition among telecommunication service providers in low-price markets, regulators required that PTOs meet certain minimum quality of service standards. IP Telephony, on the other hand, has been notorious, whether fairly or unfairly, for its poor sound quality. An important

lesson to be learned, of course, is that consumers are often willing to accept less than perfect sound quality for lower prices. Furthermore, in a competitive market, it is the market itself that will sort out differences in quality among competing carriers. That said, many of the submissions to the French regulator's public consultation on IP Telephony stressed the need for quality of service standards for IP transmission (Box 6.2).

While quality concerns are most likely to be dealt with by the market in highly competitive markets, where IPTSPs seek to make inroads in less competitive markets, they may have to meet existing (or modified) mandated quality standards. It is worth noting that the IPTSP iBasis offers service level agreements (SLAs) which meet or exceed those available from traditional carriers on certain metrics (Box 4.5).

Box 4.11: European Union – 1998 status notice under review, but few changes expected

On 27 June 2000 the European Commission opened a public consultation on the review of its 1998 status notice on voice on the Internet (see Box 4.3). This review was called for in the 1998 status notice that explicitly acknowledged that IP voice technology was developing very quickly and thus the situation would need to be reviewed periodically to determine whether the policy set out in the status notice remained appropriate.

The communication provides a useful summary of the status notice and proposes to maintain its main conclusions. It also elicits important market-related information from EU Member States which will be crucial to the review process. This information may also prove useful to non-EU countries, given the dearth of information on the actual market impact of IP Telephony services.

This excerpt from the consultative communication indicates the Commission's current thinking on IP Telephony at the beginning of the review process:

On the one hand, the impact of Internet voice has not yet been felt in a major way. Internet telephony can be viewed as a positive and innovative activity, which will indirectly put pressure on existing price structures in the same way as call-back or calling-card services. Until now, though, the categories of Internet voice services, when offered as a discrete stand alone service, have remained a limited activity, because of:

- the difficulty of guaranteeing a quality level as normally expected from voice telephony, due among other factors to the loss of quality resulting from the conversion from data into voice;
- the user inconvenience due to technical complexity and to overhead of evaluating different market offers;
- the erosion of margins subsequent to a decline in retail prices for telephone services over the PSTN, particularly for long distance and international calls.

On the other hand, Internet protocols are being used within the backbone networks of public switched telephone networks and will increasingly be used in private networks to carry voice and data services. The use of IP technology in this way does not affect the regulatory position of the companies concerned, nor does it require any change in the licences or authorisations under which they operate.

For the time being, and without anticipating at this stage possible medium term changes in the regulatory framework following the current review, the Commission envisages that it will confirm that the definition of voice telephony in Directive 990/388/EEC continues to be the adequate basis for assessing the regulatory position of voice communications services on the Internet in the post-liberalisation situation.

Taking into account the current situation and trends mentioned above, it intends to confirm also that Internet telephony still continues to fall outside the definition of voice telephony, in particular since:

- it does, in most cases, not meet the criteria of reliability and sound quality as normally required for voice telephony, and/or
- it is not offered as a single service or as the main element of a range of bundled services marketed as voice telephony, for example because it is technically bundled with data services or is designed to meet demands additional to that for voice telephony.

This means, generally speaking, that Member States should continue to allow Internet access providers to offer voice over Internet Protocol under data transmission general authorisations, and that specific licensing conditions are not justified.

The relevant authorities shall of course remain at any time entitled to request from all market players the necessary information to ascertain whether the conditions set out in the general authorisation scheme are duly complied with. In this framework, national regulatory authorities can thus ensure that the voice telephony regulatory framework is not circumvented by Internet telephony operators.

Source: European Commission, "Consultative communication on a review of the 1998 notice by the Commission on the status of voice on the Internet under Community law, and in particular , under Directive 90/388/EEC," Official Journal of the European Communities, No. C177/4, 27.6.2000.

Directories

Related to the lack of a numbering (or more accurately addressing) scheme for IP Telephony is the lack of comprehensive directories of IP phone users. Not only must such directories be developed, but they must be integrated into the databases of other providers of telephone service, such as cable TV companies, mobile operators and PTOs. One of the requirements of the international telephone service has traditionally been the maintenance of directories. Not only is there no directory available for IP phones, but there does not appear to be enough unity of purpose among the IP Telephony industry to create them. The industry is still struggling to agree on standards for the exchange of billing information and signal encoding. Those challenges are likely to be considered more pressing than numbering resources and directories at this time, but these are issues that will have to be faced.

It is by no means certain that IP Telephony will become a local access technology, nor integrate with the PSTN to the degree suggested above. It has been assumed in this chapter that for IP Telephony to become commercially successful, not only as a voice offering but also as an integrated voice/data offering, it must be able to offer, at a minimum, a level of functionality equivalent to that which consumers have come to expect from the PSTN. Indeed, local competition has so far proven somewhat disappointing in North America, at least, as alternative providers are only serving business markets in the most concentrated metropolitan areas.[8] If IP Telephony does not become an alternative means of local access in low-price markets, but rather remains primarily an alternative backbone platform or international termination alternative, then many of the potential issues discussed above may remain just that.

4.8.5 Technology-neutral regulation

If a country requires a detailed voice regulatory structure, then arguably the goal should be to make it as technology-neutral as possible. On this basis, functionally equivalent services should be subject to similar regulatory requirements, unless overridden by other policy imperatives. The policies of Canada and Malaysia provide detailed examples (see Boxes 4.12 and 4.13, respectively).

Box 4.12: Canada - Voice is voice is voice…

In Canada, the advent of IP Telephony came *after* the liberalization of the long distance telecommunications market, not before, as in many other countries. Instead of trying to ban or restrict IP Telephony, Canada simply incorporated certain types of IP Telephony into its universal service funding regime, beginning in 1997.

Under the current regime (presently under review), providers of interexchange (long distance) services must report their total minutes carried and pay per minute to the local exchange carrier (LEC) which provisions the circuit used to provide the service. As early as May 1997, Canada's telecommunications regulatory authority, the Canadian Radio-television and Telecommunications Commission (CRTC), ruled that providers of Phone-to-Phone voice telephony, where the Internet is the underlying transmission facility, should contribute just like any other form of voice telephony.

In the face of repeated challenges, CRTC confirmed this policy in January 1998, and again in September 1998, when it released a detailed decision setting out a comprehensive IP Telephony regulatory regime (Order CRTC 98-929).

The CRTC ruled that "PC Voice" (referred to in this Paper as PC-to-PC and PC-to-Phone) is not subject to the contribution regime, but "PSTN Voice" (i.e., Phone-to-Phone) is. Contribution must be paid per minute on any Internet access line which allows PSTN Voice calls to be originated or terminated.

This classification method focuses on where the conversion of calls (either originating or terminating) from traditional voice signals to IP format takes place. In general, if that conversion process takes place at the caller's premises, the call is considered PC Voice. If it happens elsewhere, such as the Internet gateway servers of an ISP or IP Telephony calling card service provider, the call is PSTN Voice. Those offering such services must register with the CRTC as resellers and make contribution payments, even though the facilities used are not resold voice circuits, but rather Internet access links.

For more detail, see <http://www.itu.int/osg/sec/spu/ni/iptel/countries/canada/index.html>.

Source: Telecom Order CRTC 98-929, In the matter of Proposed New Contribution Exemption Regime for Internet Service Providers, Telecom Public Notice CRTC 97-37, 3 November 1997 (PN 97-37) (17 September 1998), <http://www.crtc.gc.ca/archive/Orders/1998/O98-929.htm>.

Box 4.13: Malaysia: Licensable "applications services" include PSTN Telephony, IP Telephony

The licensing regulations to Malaysia's pioneering *Communications and Multimedia Act 2000* were released on 1 April 2000 and take a fully "'converged' approach to public voice telephony regulation. An "applications service provider individual licence" (as opposed to a class licence) may be granted to a person providing any or all of: (a) PSTN telephony; (b) public cellular telephony services; (c) IP Telephony; (d) public payphone service; or (e) public switched data service . Thus IP Telephony is treated as just another licensable *application service*, as is PSTN Telephony. The Malaysian government subsequently clarified these rules by stating that they do not apply to true Internet Telephony PC-to-PC calls (made using the public Internet).

Key to the definition of IP Telephony under the Malaysian legislation is an *interface* between circuit-switched and packet-switched systems (otherwise described in this publication as a gateway), suggesting that all-IP systems would not be subject to the same licensing conditions (and would rather, most likely, be exempt from licensing altogether). "IP Telephony" is defined as "a public Internet Protocol telephony which is an applications service involving a multi-stage call set-up that involves a circuit switched to a packet switched interface." The reality, of course, is that most IP Telephony will involve that kind of interface for several years to come, as the hybrid network environment is not expected to be replaced by a pure-IP environment for several years.

The definition of PSTN telephony demonstrates a way of thinking about communications networks which goes beyond merely decoupling services from their networks. The Malaysian approach separates applications services from network services, which are further separated from network facilities. The definition of PSTN telephony is as follows: "*PSTN telephony* means Public Switched Telephone Network which is an applications service involving a public circuit switched voice grade interface for the delivery of voice and data communications."

Source: Communications and Multimedia (Licensing) Regulations 2000, <http://corona.cmc.gov.my/legislation/puA128129/puA128129_102.html>.

With the goal of technological neutrality in mind, Figure 4.1 is a composite "decision tree" based on a number of different IP Telephony policies, where the objective is to identify services which are functionally equivalent to the traditional PSTN voice service. If a particular service reaches the last box on the decision tree, it can be considered functionally equivalent to traditional PSTN voice service. Before this last stage is reached, there are many intermediate stages where there may be near-equivalence to PSTN voice.

After putting a particular service through the decision tree in Figure 4.1, if that service does reach the last box (appears to be functionally equivalent), then a further question may be asked as to whether the principal underlying means of transmission is:

- the public Internet?
- an IP network other than the public Internet?
- the PSTN?

Should it matter? Only the presence of external factors, such as a desire to encourage the development of IP networks, or, conversely, to conserve restricted provision of the PSTN, would suggest that it does matter. Should any services which reach the same point in Figure 4.1 be treated differently? While technology may have provided a bright-line distinction between services in the past, that, of course, is no longer the case.

4.9 Impact of IP Telephony on universal service schemes

One issue that is relevant to all types of markets is that of universal service. IP Telephony can present serious challenges to those telecommunication regulatory regimes that redistribute funds from one segment of the market to another in order to subsidize prices for (usually) local access. In many countries, particularly developing ones, revenues from outgoing international telephone calls charged at above-cost rates and net settlements from incoming calls subsidize domestic network development and the price of basic local access. In both cases, associated revenues may be reduced if calls can be originated and terminated by means other than traditional operators and services.

The asymmetrical regulation of voice and data services creates an incentive for arbitrageurs to develop the capability to handle voice in such a way as to avoid the regulatory obligations associated with voice traffic, in particular, contributions towards implicit cross-subsidies or explicit universal service funds. This can make offering international services more profitable for small carriers, or give larger carriers crucial cost savings in extremely competitive markets.

At its most basic, the question is: Should calls on one technological platform be treated differently from calls on another? This is particularly relevant where there is extensive integration between the two types of networks and calls are passed back and forth. At that point, asymmetry must be justified on grounds other than technological or quality differences. In some countries, the difference is often justified as a means of encouraging the development of IP networks (e.g., China), or as a way of increasing the number of choices for long distance services available to citizens in advance of full liberalization (e.g., Hungary).

Certain universal service funding schemes present the possibility of competitive inequities, where only some providers of functionally equivalent services are "taxed" in respect of those services, while others are not, based solely on the technological platforms which they employ. Worse, it creates incentives for those operators that have traditionally paid into universal service funding schemes to switch to alternative platforms, reducing even more the volume of traffic on which payments are payable.

While a policy of permitting relatively unregulated provision of "Internet Telephony" may be designed to encourage the development of the Internet in a particular country, the focus of such a policy may be suspect if most commercial IP Telephony traffic does indeed travel over private IP networks, and not the public Internet. IP Telephony is being used more and more to offer functionally equivalent services without the regulatory burdens associated with providing traditional voice telephony. While this is good for competition, and therefore good for consumers, it can render universal service schemes increasingly unsustainable, where such policies depend on distinctions between voice and data traffic.

The universal service funding schemes of Uganda and Nepal offer creative solutions to this problem. In both countries, ISPs are required to be licensed and to contribute a small portion (1-2 per cent) of their revenues to universal service funds. These funds are intended to be allocated through competitive tendering. In this way, the possible cost advantage enjoyed by ISPs is somewhat lessened because universal service charges cannot be avoided.

Where universal service schemes are not dependent on different classifications of traffic, nor on the routing of traffic through particular facilities or operators, the main impact of IP Telephony is usually on the revenues of incumbent operators and their tariff structures (see Chapter 3). On the other hand, the projected cost benefits of IP networks suggest that developing nations could use IP to enhance access to basic telecommunications. Particularly under schemes in which subsidies are provided on a competitive tendering basis, such as in Chile, Colombia, Guatemala and Peru, these cost savings (if indeed they are borne out), could provide significant opportunities for extending access. IP Telephony can be combined with wireless technology to serve rural and remote areas in new ways. The ITU-D Study Group 2 Rural Application Focus Group is currently studying the development of wireless IP-based technologies for rural areas.[9]

Increasing access to the Internet may already be a policy goal in some countries, and low-cost long distance and international voice services can be easily added to email and Web services available at community telecentres. Such services would by definition not compete with the incumbent's existing business, and can be used as an interim strategy to provide easy and affordable access to those without a phone in their home.[10]

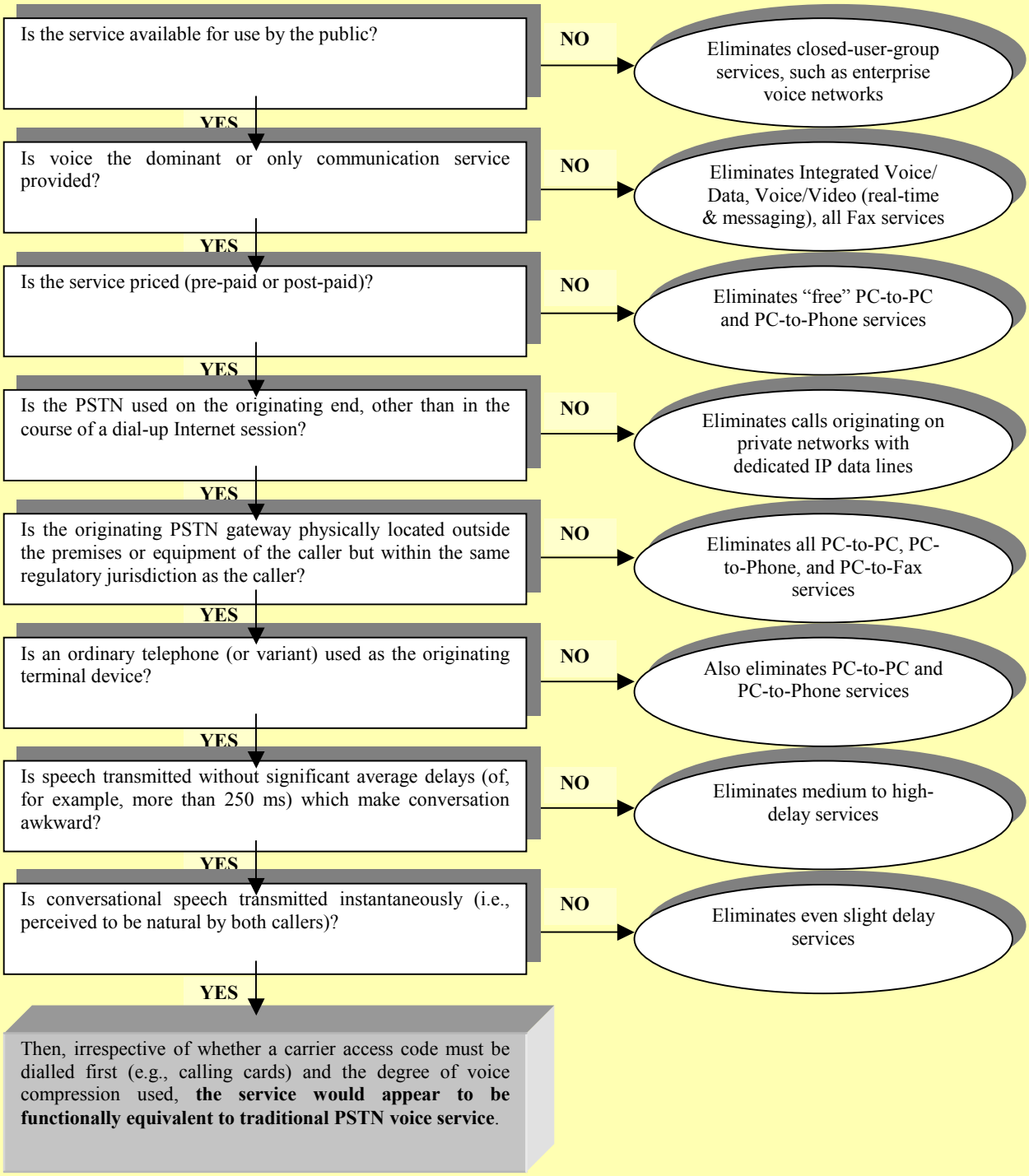
4.10 IP Telephony puts downward pressure on IDD charges

Simply by providing an alternative means of making long distance and international calls, the various forms of IP Telephony constitute another factor pushing down the cost of international direct-dialed (IDD) telephone calls. Indeed, within a particular country, it may serve the ultimate purpose of enhancing consumer welfare whether it is permitted or not (at least in countries where origination is possible).

It is this effect of the emergence of IP Telephony that may be causing many countries to either "turn a blind eye" to it, or refuse to define and regulate it as public voice telephony. It remains to be seen what real impact the various forms of IP Telephony are having on PTO IDD revenues. On many routes, vigorous price competition among PTOs is driving the cost of regular voice services down so low as to make lower-quality or inconvenient services less attractive. Due to this intense competition, the days of IP Telephony as a standalone business proposition may be numbered on all but a few high-priced international routes. Instead, the future of IP Telephony will lie in bringing cost savings for carriers and offering value-added services to consumers.

Figure 4.1: Testing the functional equivalence of IP Telephony and PSTN voice services

How closely do IP Telephony services resemble traditional PSTN voice?



[1] See the Website for accounting rate reform at: <http://www.itu.int/intset/>.
[2] See Telecom Public Notice CRTC 99-6 – Review of Contribution Collection Mechanism and Related Issues, <http://www.crtc.gc.ca/eng/Proc_rep/TELECOM/1999/8695/PN99-06/C12-06.htm>.

[3] See ITXC Corp., news releases, "ITXC and Gambia Telecommunications Company in Pact for Domestic and International Internet Telephony," 24 March 2000, <http://www.itxc.com/PRA119.html>, and "ITXC Corp. and Telstra Interconnected," 10 May 2000, <http://www.itxc.com/PRA127.html>. ITXC markets a standalone piece of equipment called a "SNARC" which allows facilities-based carriers anywhere to interconnect with ITXC and offer VoIP (referred as Internet Telephony) without owning or managing their own gateways. The equipment is colocated at the carrier's switch site but remains the property of ITXC. See <http://www.itxc.com/snarc.html>.

[4] iBasis, Inc., news release, "Concert Global Clearinghouse and iBasis Announce Interconnection of their Internet Telephony Networks: Leaders in VoIP To Exchange International Voice and Fax Traffic, Leverage Combined Footprint to Broaden Global Reach," 15 May 2000, <http://www.ibasis.net/News/pr05152000.htm>.

[5] See P.S. Goodman, "WorldCom May Sell Long-Distance Business," *The Washington Post* (28 July 2000), p. E3, <http://www.washingtonpost.com/wp-dyn/articles/A58990-2000Jul27.html>.

[6] See *Trends in Telecommunication Reform 1999: Convergence and Regulation*, Geneva: ITU, 1999, Chapter 1, "The Institutional Framework."

[7] See *Trends in Telecommunication Reform 1999: Convergence and Regulation*, Geneva: ITU, 1999, Chapter 8, "Numbering in a Digital World."

[8] See A. Zurcher, "Local Phone Choice: Still on Hold," *The Washington Post* (28 July 2000), p. E1, <http://www.washingtonpost.com/wp-dyn/articles/A57657-2000Jul27.html>.

[9] See <http://www7.itu.int/itudfg7/>.

[10] See the information on public Internet access centres in Peru in the ITU-commissioned case study available at <http://www.itu.int/osg/sec/spu/ni/iptel/countries/peru/index.html>.

CHAPTER FIVE: IP TELEPHONY IN PRACTICE

5.1 Introduction

The accumulated experience of IP Telephony development around the world (gathered, for instance, through the case studies included in this report, see Table 5.1 below, and other sources of information) shows that the pace at which the service has been expanding in various markets depends heavily on a number legal, institutional, technical, and economic factors. Depending upon how these different factors have played out in each individual marketplace, IP Telephony deployment has sometimes spread like wildfire (as in the case of China) or has sometimes stalled and contracted (as in the case of Colombia). The experiences gathered through the case studies also show that the rise of IP Telephony has, in turn, had a considerable impact on existing laws and regulations. The entry (legal or illegal) of IP Telephony service providers in domestic markets has, for example, accelerated the pace of market opening and, hence, the introduction of competition in the long distance and international service markets.

5.2 The impact of the regulatory environment on IP Telephony

Today it is almost a premise in the telecommunications industry that new technologies bypass any attempt to regulate them and, for that reason, governments should just give up regulation and let technologies and markets determine the path and evolution of the industry.

Recent experiences with IP Telephony however, seem to defy this premise. The evidence gathered from a number of case studies indicates, instead that pre-existing national legislation and regulation is a strong determinant of the evolution of IP Telephony in each country.

5.2.1 Going by the rules

In some countries, like China, the legislation that was in place at the time that the first IP Telephony services were launched provided a basis for the legal system to argue that the provision of such services was not breaching the law and, therefore, should be allowed to be provided in an unrestricted manner.

More specifically, when the Chen brothers were prosecuted because they were providing IP Telephony services from their computer shop, they argued in court that the only one telecommunication legislation or regulation appeared to be directly relate to their service. That was the 1993 "Provisional Arrangement for the Approval and Regulation of Decentralized Telecommunications Services" which listed the services considered to be telecommunications value-added services, for which a license was required. Computer services, they reasoned, having not been listed, could not therefore be considered a telecommunication service, and as such fell outside the authority of the Ministry. While the Chen brothers lost their original hearing at the court of first instance, the Mawei District People's Court, they won on appeal at the Fuzhou Intermediate People's Court. The judge accepted their argument that the activity was not covered by criminal law, and was at most an administrative matter. Local court officials then agreed with the brothers that offering IP Telephony service was not explicitly prohibited under existing administrative rules and regulations. The decision of the courts unleashed the possibility for IP Telephony services to spread throughout the country, with various government agencies taking the lead in the building of a national IP Telephony marketplace.

In Colombia, by contrast, pre-existing legislation and regulation led to the punishment of those who defied the regulatory framework. The provision of IP Telephony by any company other than those with a license (to provide international services) was not welcome.

The Colombian government is, in general, highly supportive of the development of the Internet in the country and has drafted a "Digital Connectivity Agenda" to wire the country and its institutions to the global Internet. Yet, despite this commitment to the Internet, the government found it very difficult to bypass existing regulatory and legal commitments to allow the provision of IP Telephony in the country.

It is important to recognize that all the services that can be offered over the Internet domestically in Colombia are liberalized. Voice over the Internet is not subject to any regulatory restriction of any kind if it is provided from, or to, a computer.[1] On the other hand, existing provisions establish regulatory barriers which restrict access to international long-distance voice services via the Internet when such service is offered to or from a cellular telephone by operators other than those authorized to provide international

service[2] or when the communication originates and terminates at a telephone.[3] This does not imply that authorized operators have any restriction on using IP technology, or any other technology of their choosing, in their services or networks.

The fact is that this regulatory framework and its premises pre-determined the outcome in the first case in which a cellular company—Comcel—attempted to provide IP Telephony services to its customers. The conflict erupted in December 1998 when Comcel advertised in a local newspaper that it was offering its customers a new service based on IP Telephony. The Ministry of Communications opened a preliminary investigation on 22 December 1998. Its purpose was to determine whether there were grounds for Comcel being considered in breach of the telecommunication rules and regulations, and in particular in breach of the system for licensing the mobile cellular telephone service, by providing IP voice service for international communications. The Superintendencia de Industria y Comercio (Superintendent of Industry and Commerce) opened an investigation as well to determine whether Comcel had engaged in unfair competition or had obtained an illegal competitive advantage.

The arguments presented by the three operators—Comcel, Occel and Rey Moreno —to defend their services were oriented towards demonstrating that the communications in question were neither basic switched international long-distance telephony nor cellular mobile telephony. After nine months of operation, the IP Telephony, service was suspended.

In February 2000, the Ministry of Communications and the Superintendent of Industry and Commerce wound up two of the three investigations. In the first of these cases, the penalty imposed on each of the two cellular operators and the value-added operator was a fine (1'000 times the monthly minimum wage, an amount equivalent to some US$ 140'000). In the second, a fine was imposed while the long-distance operators were given 15 days to present a claim for the damages caused by the conduct of the IP Telephony service provider. The Superintendent of Industry and Commerce imposed a penalty, on Comcel only, in the form of a fine of 2'000 times the monthly minimum wage. Comcel has appealed against this decision.

Table 5.1: Market statistics and regulatory structures
For selected case-study countries, 1999/2000

Country	Teledensity, at 1/1/2000	General market structure	Degree of state involvement in incumbent fixed-line PTO	Price of 3 minute peak-rate call to US, 1999, in US$	Price of settlement rate per minute with US, 1999, in US $
China	8.7	Some degree of competition between different state-owned firms.	100% state owned	$5.44	$0.505
Colombia	16.0	Three companies hold licenses to provide international services.	100% state owned.	$1.65	$0.325
Czech Republic	37.1	Incumbent held international services monopoly until 2000.	Partially privatised.	$1.71	$0.185
Hungary	37.1	Incumbent holds international services monopoly until 2002	Fully privatised.	$1.09	$0.19
Nepal	1.1	Full monopoly by state-owned incumbent. A regulatory body has been established, but policy-making body not yet separated from incumbent.	100% state owned	n.a.	$0.84
Peru	6.7	Partial competition in local services; monopoly in international services.	Partially privatised	$2.35	$0.33
Thailand	8.6	State-owned operators for domestic and international service have legal monopoly but share revenues with franchisees able to provide domestic services.	100% state owned	$3.38	$0.30

Source: ITU World Telecommunication Indicators Database and country case studies.

The experience of Colombia is not unique. A fairly large number of countries around the world either banned explicitly the provision of IP Telephony or had pre-existing legislation that restricts the provision of this type only to those with a licence to provide voice services—which in a large number of countries are only the incumbent carrier or carriers with exclusive license or licenses for such services. On the other hand, the countries that explicitly allow the provision of IP Telephony are relatively few (see Tables 4.1 and 4.2 for a detailed list).

5.2.2 Leveraging definitions and deficiencies

Some countries explicitly ban IP Telephony while others allow it, based on existing legislation. The majority of countries have no particular policy at all. But there are some nations that, in their effort to promote the Internet and to spread its benefits to the population, have used definitional tools or the argument of regulatory deficiency either explicitly to allow the service or to avoid prosecuting those that are providing the service.

In Hungary, for example, the incumbent operator MATÁV has exclusive rights until the end of 2001 to carry international public voice telephone traffic. The government, which is actively promoting the expansion of various Internet services across the country, established a definitional boundary between public voice telephony (which remains closely regulated) and non-public voice telephony (which is open to competition), based on the quality of the service, and, more precisely, on the transmission delay (see Box 4.2).

In China, the Chen brothers' case also posed the question of definitions and legality of the services, based on the market boundaries set by those definitions. To solve the matter the Appeals Court consulted with a number of legal and technical experts on telecommunications and the Internet and based its final decision for the case on the basis that Internet Telephony is technologically different from conventional telephony.

Similarly, Peru faced a similar dilemma at a certain point. The Peruvian legislation on telecommunications does not cover Internet services specifically, but the Ministry of Transport and Communications has regarded them as value-added services—based on the notion that they involves the addition of some feature or facility relative to basic services. The Peruvian legislation explicitly states that all value-added services are covered by a regime of free competition.

A peculiarity of the Peruvian law however is that it excludes real-time voice traffic from being classified as a value-added service. Apparently, at the time when this classification was made, it was already known that value-added companies might be able to carry voice traffic, to do so in real time wouldnecessitate them holding a licence. As a result, discussions on the subject of VoIP have focused on whether or VoIP transmission is performed in real time. Regrettably, the legislation does not give a satisfactory definition of what "real time" means, giving rise to a variety of opinions on the matter. With the opening of the domestic market to competition many of these definitional problems have moved to the background of the telecommunication agenda.[4]

In Nepal, although VoIP is illegal, the national regulatory agency, the Nepal Telecommunications Authority (NTA), has taken a hands off position by arguing that IP Telephony is almost impossible to block.[5] The policy-making body, the Ministry of Information and Communications (MoIC), has in response obliged the NTA to make clear to domestic ISPs that VoIP is illegal.[6]

5.2.3 Definitional boundaries lead to jurisdictional boundaries

Another important factor in the definitional dilemma is that, the way IP Telephony is defined and, therefore, regulatory regime under which it falls, determines also the kind of institutions that will deal with the legal and regulatory challenges posed by the new technology and the actions of those that provide the service. This is an important factor because, according to the particular historical, social and institutional ties, and the "ideology" of the institutions involved (whether they favour progressive and limited or unrestricted liberalisation), one would expect different outcomes from the legal and regulatory conflicts posed by the rise of IP Telephony.

In the case of China, for example, although China Telecom was quite successful in convincing the police that the Chen brothers had broken the law and having them detained, the matter was later submitted to the judicial system of the country (not the telecommunications regulator or the communications ministry or the competition regulator, as has been the case elsewhere). The judge accepted their argument that the activity was not covered by criminal law, and was at most an administrative matter. Local court officials then agreed

with the brothers that offering IP Telephony service was not explicitly prohibited under existing administrative rules and regulations.

In Colombia, by contrast, the challenge posed by the cellular operator Comcel was considered in first instance as a matter to be dealt by government agencies — the problem was tackled by the Telecommunications Regulatory Commission (CRT), Ministry of Communications, and the Superintendent of Industry and Commerce. By early 2000 the Ministry of Communications and the Superintendent of Industry and Commerce wound up their administrative investigations. The Ministry imposed penalties on the three operators Comcel, Occel and Rey Moreno. The decision was appealed by Comcel and confirmed by Resolution 984 of 8 May 2000.

Peru also offers an interesting case related to the role of definitions and jurisdictional boundaries. The Ordinary Collegiate Body (CCO) nominated by the OSIPTEL — the telecommunications regulatory body — and charged with settling the dispute resolved that, if RCP had been supplying long-distance service without a licence, then the competent body to resolve the dispute would be the Ministry of Transport and Communication. However, the key conclusion of the CCO was that use of APLIO, a phone-like IP Telephony device, did not constitute a long-distance public service because no payment had to be made for the communication service.[7] According to the CCO, RCP did not require a licence for marketing the APLIO equipment since its authorization for offering Internet services was sufficient for the functions it was performing.[8]

The three cases offer a wide array of ways of dealing with the legal challenges posed by IP Telephony. In China the matter was resolved by the courts, in Peru it was resolved by an Ordinary Collegiate Body nominated by the telecommunications regulator, while in Colombia it was tackled by the government bodies as an administrative matter. It might be pure coincidence, but it is nevertheless interesting to see that in the case in which the courts were involved, the outcome of the case favoured IP Telephony providers; and in the case in which an Ordinary Collegiate Body was appointed, the jury also granted judgement in favour of the party attempting to provide IP Telephony services—rather than supporting the position of the incumbent.[9] However, in the case in which the Ministry of Communication and other government bodies were involved, the final decision benefited the traditional voice carriers (in which the state still has some ownership interests).

5.2.4 The incentives of asymmetric regulation

There are a number of other elements in the legal and regulatory framework of each country that can work in favour or against IP Telephony services. For IP Telephony service providers, the degree of asymmetry in obligations between traditional voice telephony carriers and value added operators could be an important factor in deciding whether or not to enter a particular telecommunications market.

The fact that regulatory asymmetry can work in favour or against the rise of IP Telephony services is clearly reflected in the Peruvian legislation. While carriers that provide traditional voice telephony over the PSTN are obliged to hold a licence (which generally takes 50 days, with a possible extension to 70 days) with a range of requirements; value-added service operators need only to obtain an authorization (which takes five days) to enter the market, and in most cases have to fulfil only very limited requirements.[10]

Some of these requirements in Peru are:

- Traditional voice carriers are required to present a technical/economic profile; a requirement from which value-added network service providers (VANs) are exempt;
- PSTN voice service operators are obliged to make a one-off payment of 0.25 per cent of forecast initial investment, while VANShave no obligation in this regard;
- Voice PSTN operators are obliged to contribute 1 per cent of gross annual revenue to the Fondo de Inverstiones en Telecomunicaciones (FITEL) a sort of universal service fund, while VANs have no obligation in this area.
- Traditional voice service providers are obliged to have, in two years from the time of licensing, their own infrastructure and at least one switching centre in at least five cities. VANs, by contrast, have no obligation to expand their services or to own the infrastructure the use to provide services.
- Traditional carriers may be subject to tariff regulation; a regulatory intervention from which VANs are exempt.

- Similarly, traditional carriers are obliged to meet quality parameters, which are not applicable to VANs.
- Traditional carriers are obliged to interconnect with other public service providers – interconnection requirements for VANs are at the discretion of the regulator.
- Finally, traditional PSTN voice service providers are obliged to contribute towards the cost of implementing the pre-selection system that is required in liberalized markets, while the no obligation is required of VANs.

One of the few regulatory requirements that is applicable to both PSTN voice service providers and VANs is related to the payment of a regulatory supervision fee: both type of carriers are required to contribute to the costs of inspection with 0.5 per cent of gross annual revenue.

5.3 Impact of public telecommunication operators on the evolution of IP Telephony

Aside from the impact of legal factors, such as the pre-existing regulatory environment in each market, there are a number of more dynamic factors that affect, in rather unpredictable ways, the evolution of IP Telephony in each market.

5.3.1 Policy-makers and regulators

According to the evidence provided in the case studies, high-level government officials and policy-makers have, in general, adopted a positive attitude toward the emergence of the Internet and related services. However, as with privatisation, competition and other telecommunication market reforms, there are divergent positions within each national administration. The pace and direction of the evolution of IP Telephony in each market will depend heavily on the power play between different groups, such as advocates and the detractors of IP Telephony.

China offers a clear illustration of the important role played by the various interest groups that struggle in favour or against the rise of IP related services. In the particular case of IP Telephony, it is widely accepted that senior government officials in Beijing countered any overt pressure from the Ministry of Information Industry (MII) and made the court aware of the administrative battle surrounding the Internet. Premier Zhu Rongji's widely-known antipathy for carriers with market dominance had dovetailed with the government's administrative restructuring program and the leadership's desire to promote economic growth and market competition. Organizations such as the Ministry of Foreign Trade and Economic Cooperation (Moftec), began to argue that, unless the MII allowed Chinese companies to make international calls at the cheapest rate, then domestic companies would be at a competitive disadvantage.

Experience in the Czech Republic was similar. Here the government endorsed the rise of IP Telephony services in the domestic market through a ruling issued in August 1999. The IP Telephony conflicts were triggered in 1998 when the incumbent operator, Cesky Telecom (formerly SPT Telecom), complained to the Czech Telecommunication Office (CTO) that mobile operator Radiomobil was offering international long distance service in violation of the exclusive license Cesky Telecom enjoyed for such services, until 1 January 2000. The CTO agreed and suspended the service in November 1998.[11] But the regulatory agency later changed its policy and from August 1999 onwards, allowed certain classes of operators to provide most forms of IP Telephony.

ISPs, mobile operators, and Cesky Telecom itself are now offering discount international calls using IP Telephony. The incumbent Cesky Telecom's "XCall" service enjoys special status, for the time being, as the only licensed Phone-to-Phone IP Telephony service accessible on the fixed-line network. Users dial a special access code, the destination country code, and the telephone number. Calls are billed afterwards on the fixed-line telephone bill.

5.3.2 The courts and administrative tribunals

The judicial and administrative tribunals of a country can play a crucial role in promoting (China) or undermining (Colombia) the development of IP Telephony services.

Prosecution of presumed illegal IP Telephony service operations can send a chilling message to the market and undermine the growth of the service. In Colombia, new telecommunication legislation, together with the complexities of micro-managing the liberalization of the market, has lead to penalties being imposed, which include imprisonment for failure to abide by telecommunication rules and regulations.[12]

Rapid technological innovation and the convergence of technologies and services have posed significant challenges to the existing regulatory frameworks in most countries. Colombia has been no exception in that regard, and a number of value-added operators in the country became increasingly involved in the transmission of voice over data networks.

Several of these operators have been affected recently by the actions taken by the Fiscalía (Office of the Inspector General, at the end of 1999, which started investigating in at least 20 of them on the basis of accusations made by Telecom that they were transmitting voice over their networks.

Apparently, there was a considerable amount of traffic being routed in the form of data over IP networks, because the three long distance operators—namely Telecom, ETB and Orbitel—saw their traffic increase considerably after Fiscalía started investigating the value-added operators. According to unconfirmed reports, traffic to and from the United States increased by as much as 50 per cent.[13] Several of the CEOs of the value added companies were thrown in jail and, since then, most of the other VANs have become extremely circumspect about moving forward with the provision of IP Telephony services.

5.3.3 The incumbent operator(s)

In general, as would be expected, there is considerable reluctance on the side of incumbents to embrace or support the emergence of IP Telephony for fear that it would undercut their existing services. However, there is a tangible difference in the attitude of incumbents in open and closed markets.

In emerging markets, where competition in basic telephony services is either not allowed or is limited in scope, incumbents have been proactively blocking the rise of IP Telephony services. In Peru, for example, the incumbent, Telefonica del Peru (TdP), has been denounced several times by other carriers for its anti-competitive practices and its strategy to undermine the provision of IP Telephony services.

The Net2Phone service had been very popular in Peru among Internet users. However, in the first half of 1999 there were many complaints that clients using TdP's Internet service were suddenly unable to access Net2Phone services. It was argued that the Net2Phone equipment was at fault, unable to cope with such high levels of demand. However, in a counter claim, Red Cientifica Peruana (RCP), one of the major ISPs in the country, published a complaint claiming that TdP had been blocking access to IP numbers that identified the Net2Phone servers, so that Internet users could not route calls via the Internet and were obliged to use TdP's own services. RCP argued that, according to its tests, access to Net2Phone was possible when the Internet was accessed other than through TdP.[14]

In some other countries, like Thailand and China, the rise of competition from IP Telephony and other least cost routing services has been fought on the same grounds, that is, by the PTO entering that segment of the market and taking the lead in the provision of the service.

In Thailand, the exclusivity of CAT in the international service market has been severely eroded in recent years by competition from international call-back services, and substitution of fax and phone calls by e-mail, instant messaging and other Internet-based services. Another important reason for the declining revenue is the decrease in the international settlement surplus that used to contribute a significant proportion of revenues to CAT's coffers. Due to these changes, CAT's revenue fell to Bt30.3 billion (US$694m) in 1999 from Bt33billion (US$755 m) in 1998. During the same period, its profit also plunged by 39 per cent from Bt7.38 billion (US$ 169m) to Bt4.50 billion (US$103m). It was in this context that the CAT decided to introduce its VoIP services.

In China, once it became clear that, given the courts decision on the Chen brothers' case and the media coverage of it,it would be almost impossible to sustain a ban of IP Telephony services, the Ministry quickly decided to push its national carriers to take the lead in the provision of IP Telephony. Soon after the results of the courts case, the four major national carriers were engaged in an IP Telephony trial promoted by the MII itself.

As the cases of China and Thailand show, public ownership of the incumbent carriers can make it easier for governments to introduce IP Telephony service, if they choose to do so. The initiative is framed as part of a national policy programme and the services can even be provided at a subsidized rate for promotional purposes or for universal service aims. In the case of Thailand, the VoIP service of the Telecom Organization of Thailand (TOT; operating under the name of Y-Tel 1234) is aimed at providing cheap domestic long-

distance call service to distant regions of the country. The service is in line with the government's policy of low-cost services in the provinces.

Yet, on the other hand, public ownership of the incumbent(s) can work as a deterrent to IP Telephony. That is the case of Colombia where pre-existing legislation, a high license fee (US$ 150 million) paid by the three long distance/international carriers, and the interest the state has in some of them led to a negative reaction to the rise of IP Telephony in the country.

5.3.4 New entrants and ISPs

New entrants and ISPs have been quite enthusiastic to engage in the provision of IP Telephony services. In most cases they have both the capability and the technical and financial conditions to implement services. However, regulatory restrictions and/or market structure constrains the ability of these carriers to provide services, even if incumbents have no interest to promote it themselves.

Furthermore, in a large number of developing countries, incumbent carriers control both the main national backbones and the retail ISP market. In Latin America, for example, most incumbent PTOs control between 40 and 95 per cent of the domestic ISP market. In Asia also, incumbent operators influence, through their control of the PSTN, the business development plans of most ISPs in some of the major countries of the region.[15] The concentration in ownership and control of the Internet market is true even in countries where the telecommunication sector has been opened to competition in all segments of the market.[16]

Given the current market structure in the IP services segment of most developing country markets, and the manifest reluctance of PTOs to engage in the provision of IP Telephony services, the short term prospect for this new service is sometimes quite gloomy, in spite of the fact that most government officials support the development of low cost services such as those offered through IP Telephony.

5.4 The impact of IP Telephony on the regulatory environment

The relations between IP Telephony and the legal and institutional environment in each marketplace are, at this stage of the evolution of the technology, rather fluid. The rise of IP Telephony has affected the evolution of the regulatory environment as much as, if not more than, the regulatory environment has affected the evolution of IP Telephony. One of the most tangible effects, in those markets where IP Telephony has started to spread, is the acceleration of market liberalization (either *de facto* or through the reform of existing legislation). The other aspect of IP Telephony that is affecting traditional telecommunication market arrangements is the relatively low prices offered through IP Telephony, which is having the effect of reducing overall market prices.

5.4.1 Increasing competition and market reform

In most cases the rise (legal or otherwise) of IP Telephony, tends to exert considerable market pressure to accelerate the liberalization process. In China, for example, the attempts to block the provision of IP Telephony services failed, and China Telecom realised that its position was untenable; it embarked upon a dramatic turnaround. Government officials at the MII created a new licensing framework for Internet Telephony operators, limited in the first instance to the government-affiliated telecom bodies – China Telecom, China Unicom and Jitong. They also focused the newly licensed carrier, China Netcom, on IP services and they galvanized China Telecom to undertake the largest roll-out of an IP Telephony platform anywhere in the world.

Almost overnight, the government had swung around from blocking IP Telephony (in much the same way that they had banned call-back operators) to rolling it out as a central plank of their emerging telephony, data and Internet agendas. China's IP Telephony market formally opened on April 28, 1999, with the MII issuing licenses to China Telecom, China Unicom, and Jitong to begin six-month periods of operation in a total of 26 cities. The legalization of IP Telephony ended what was effectively a *de facto* long distance and legal international monopoly held by China Telecom.

The acceleration of the liberalization process is also being experienced in Hungary and the Czech Republic where the rise of IP Telephony services offered their governments a tool to accelerate the introduction of competition in a market segment that was under the exclusive domain of the incumbent operators.[17]

5.4.2 Challenging the existing price structure

Data gathered in the case studies indicates that the new pricing scheme offered by emerging IP Telephony services is another important component affecting the current regulatory and pricing regime in most markets. As data from the different countries show, prices for IP Telephony have turned out, in most cases, to be between 30 to 50 per cent lower than for traditional voice telephony. Consequently, they are posing serious challenges to the conventional services of traditional PSTN carriers.

In the case of China, for example, the MII's initial pricing structure for the IP Telephony trial showed the potential consumer appeal of IP Telephony.[18] During this stage, domestic long distance charges were levied at Rmb 0.30 (US$0.04) per minute, while international calls were charged at Rmb4.8 (US$0.58) per minute. In comparison, non-IP long distance telephony tariffs at that time stood at Rmb 0.90 to 1.10 per minute while international calls stood at Rmb 12 to 15 per minute. In December 1999, the Ministry of Information Industry reduced the prices of international telephony services. The price for peak period calls on 16 major routes was cut to RMB 4.8 per minute (the same price as an IP international call), and for off-peak calls the price was cut to Rmb 2.9 per minute (40 per cent cheaper than comparable IP calls.). It is doubtful whether such cuts would have taken place in the absence of competition from IP Telephony.

Similarly, in Peru, a call to the USA placed through an IP Telephony service provider, like Net2Phone, offers significant savings compared with the rates of the incumbent carrier, Telefonica del Peru. For a PC-to-telephone call from Peru to the United States, the tariff per minute is US$ 0.15 via Net2Phone, compared the US$ 0.66 charged by Telefonica del Peru.[19]

In Thailand, IP Telephony rates of PhoneNeduring standard rate calling hoursare between 29 per cent (to South and Central America) to 33 per cent (to Europe and East Asia) cheaper than the rates of traditional PSTN voice telephony offered by the Communications Authority of Thailand (CAT).

In addition to lower rates, the IP service provider claims that there are other benefits to users. Firstly, the service is not charged in blocks or units of time, as in the case of international call, but on the number of actual seconds used. Thus the prices of the service will effectively be lower than in the simple comparison. Secondly, with the calling cards, users can more easily control their expenditures. It is interesting to note that the prices of PhoneNet do not change with the time of the day. Thus it seems that the service will be most attractive for business users who have less flexibility over the time to make when calls are made.

Similarly, the IP Telephony rates for national long distance calls are quite competitive. As of May 2000, during the peak hours (7:00-18:00 on working days) the VoIP service prices ranged from Bt 2 to Bt 8 per minute (4.5 to 18 US cents per minute). This is significantly lower than the current traditional long-distance voice telephony rates of Bt 3-18 (8-41 US cents) per minute, and is competitive with the relatively low prices of mobilephone services.[20]

The attractive prices offered by IP Telephony services have gained wide popularity among telephone users. China offers interesting anecdotal evidence of such positive reactions of the population to the emergence of IP Telephony services.

Jitong, one of the Chinese companies licensed to provide IP Telephony services during the trial period reported that, at its sales offices in Shanghai, more than 2'000 people lined up to buy the IP Telephony cards when they went on sale on May 19 1999 — some of them having lined up at 2:00 a.m. Jitong employed a small army of people in 15 sales agencies to promote their cards and, in their first month of service, was able to sell some 50'000 in just five cities. From June to August 1999, the total revenue from sales of IP phone cards was estimated at US$35 million, with an annual potential of US$150-200 million (assuming that the service is expanded).

Unicom, one of the other carriers licensed to provide IP Telephony services during the trial period, argued that between June and November of 1999, the company had acquired nearly 700'000 customers through its 12-city trial and was already generating "several million minutes" in monthly traffic between China and the United States. Another important outcome of the trial is that Unicom's 12-city trial network reached full capacity in only 80 days instead of the 180 days predicted at the start of the operations.

China Telecom, the incumbent, was reluctant to promote the service and set up only one sales counter at the Beijing Long distance Telephone Exchange Bureau, and issued only a very limited number of IP cards. Even

so, the Beijing Telecom office had over 500 people per day sign up for telephone service during the first two days following the announcement. Previously, the office handled about 20 telephone subscriptions per day.

In sum, evidence from the case studies suggests that, where IP Telephony has been allowed, the competition introduced has contributed to a substantial reduction in the prices for international and long-distance calls, which in turn has brought about considerable consumer benefits. It is likely that the effect of lowering prices has been to stimulate demand, which will partially offset any possible revenue loss. Further research is required in this area to show what happens.

5.5 Conclusion: Who benefits from restrictive policies?

The country case studies (summarised in Annex A) show that the rise of IP Telephony services varies considerably from one market to another. A closer look at the cases shows that the factors affecting the pace of evolution of IP Telephony are varied. There are, however, some commonalties among the cases that provide some basis to draw some preliminary "lessons" related to the interaction and interdependence between the national regulatory environment and the IP Telephony services. Some of these "lessons" can be summarized as follows.

- Defying the almost unchallenged notion that efforts to regulate new technologies and services are useless, the case studies show that pre-existing and newly crafted legal instruments and regulations do have a considerable effect on the pace and direction that new technologies and services such as IP Telephony take in the marketplace.
- The cases also show that the degree of government support for cutting prices, via IP Telephony, is as (if not more) important for the future of the service as the existence of restrictive or permissive legislation.
- Supportive governments can "interpret" restrictive legislation in ways that provide incentives for IP Telephony services to develop, in sheltered market niches. In this context, definitional tools that differentiate between IP Telephony and PSTN Telephony can help.
- On the other hand, the effective prosecution of "illegal" IP Telephony operations sends a chilling message to the market and constrains growth.
- Incumbent operators are invariably less enthusiastic towards IP Telephony than new market entrants or ISPs.
- The approach adopted towards IP Telephony often hinges on the degree of state involvement in the incumbent operator and who takes the decision. Where decisions are taken by the national courts, or by a regulatory agency that is completely independent of the incumbent, the outcome is more likely to be favourable to IP Telephony service providers than if a decision is taken by a policy-making body which retains links with the incumbent operator.
- The rise of IP Telephony services has exerted considerable pressure on current market arrangements and has, in most cases, speeded up the liberalization process underway in most countries of the world.
- Use of IP Telephony can offer considerable price savings for consumers, particularly in market where there is little other competition or where prices for international calls are kept high in order to generate revenues to cross-subsidise local calls and subscription charges.
- In some cases, it is shown that IP Telephony networks can be established relatively quickly, allowing for accelerated market entry.

The case studies and the data gathered elsewhere also indicate that many countries, particularly developing ones, do not specifically prohibit IP Telephony but most likely do not allow it because the incumbent still has (or will have for a period of time) exclusivity over the supply of voice telephony services.

Although it is difficult to obtain concrete evidence, it appears to be the case that a growing proportion of incoming international voice traffic to developing countries markets is coming over IP networks and then breaking out into the PSTN locally. Given that the lines rented by ISPs would normally show large volumes

of traffic being directed to users, it is relatively easy to hide incoming voice traffic, worth around a hundred times more per minute that the IP data and fax traffic with which it is mixed.

In most developing countries, governments choose to block outgoing VoIP traffic while being unable to block incoming VoIP. With a restrictive policy like this, the country suffers on all fronts. On the one side, the incumbent (and most likely the state given that in more than half of the countries of the world the state is either the only owner of the incumbent or still controls majority of shares) is being hurt by the fact that VoIP traffic bypasses the accounting rate system causing a significant decline in incoming net settlements. On the other hand, citizens of the country are also hurt by the high international tariffs levied by the incumbent and by the fact that they cannot benefit from cheaper IP Telephony services.

In view of the evidence presented here, it is appropriate to encourage policy-makers to review their positions vis-à-vis IP Telephony and to establish policies for IP networks in the broader context of national economic development, productivity and competitiveness.

[1] It is worth stressing, however, that the regime governing both basic service and value-added service is one of open competition, and that while basic long-distance telephone service has to meet certain conditions, there is no express limitation on the number of operators that may be authorized to provide it.

[2] See Resolution 70 of January 2000.

[3] CRT opinion, "Concepto sobre criterios diferenciales de los servicios de valor agregado" ["Opinion regarding differential criteria for value-added services"], 19 January 2000.

[4] At the IP Telephony Workshop held by the ITU in Geneva in June 2000, there was broad agreement that "different definitions might be required for different market environments. Rapid technological change means that it may not be advisable to attempt precise definitions."

[5] "NTA Bans VoIP," The National NewsMagazine, 28 January - 3 February 2000 and ITU Country Case Study of Internet diffusion in Nepal, available at: <http://www.itu.int/ti/casestudies/nepal/nepal.htm>

[6] In January 2000, NTA sent a notice to all ISPs instructing them specifically to block the DialPad.com IP Telephony service, which offers free calls to the United States and other destinations. The ISPs duly contacted their user base to inform them of NTA's notice. However, given that Fax-over-IP ("FoIP") is liberalised (requires a license), and that it is virtually impossible for ISPs to distinguish between incoming voice and fax traffic, it would be surprising if the ISPs were able to comply with this ruling. Indeed, some cybercafés still openly advertise VoIP on their websites.

[7] National legislation states that public communication services, unlike private ones, are those that are supplied in exchange for payment ("economic compensation").

[8] For the final first instance ruling and further material, see <http://ekeko.rcp.net.pe/rcp/controversia/EXP-9902/index.shtml>

[9] It would be useful to carry out further research in this matter to see if this is a pure coincidence or if there is a close correlation between the type of institutions charged with settling the disputes and their final decision on the cases.

[10] For more details see the IP Telephony Peru Case Study at <http://www.itu.int/osg/sec/spu/ni/iptel>.

[11] For more detail, see <http://www.itu.int/osg/sec/spu/ni/iptel/countries/czechrep/index.html>.

[12] Law 422 of 1998 states in Article 6: "Anyone who accesses or uses the cellular mobile telephone service or any other telecommunication service by means of the unauthorized copying or reproduction of signals which identify terminal equipment for such services, or taps, or use of unauthorized lines of the local switched basic public telephone service, extended local service, or long-distance service, or who provides or engages in unauthorized telecommunication services or activities for profit shall be subject to imprisonment for a period of from four to 10 years and a fine of from 500 times to 1'000 times the monthly minimum wage established by law."

[13] One problem for the regulatory authorities is the lack of reliable information, particularly in regard to long-distance traffic. Initially Telecom considered this information confidential, and this has made it difficult to obtain historical series that would provide accurate and reliable data, and hence valid studies. Responsibility in this area has subsequently been scattered among a number of bodies, particularly the Ministry of Communications, the CRT and the Office of the Superintendent of Public Utilities. These bodies have had no structure in place to handle or process the data, or produce timely reports. The most recent reforms have brought some institutional clarity to the issue, giving the CRT responsibility for preparing a corpus of data on the sector, with the Ministry of Communications and the SSP as participants in this effort. The CRT is now setting about this important task, which will be of great benefit to the entire sector.

[14] Net2Phone was not the only case where allegations arose of apparent blockages by Telefonica to prevent long-distance communications using IP Telephony. Users of the Internet telephony hardware device, APLIO, experienced a similar situation. For more details see the Peru case study in Annex A.

[15] In China, because China Telecom owns the vast majority of telecommunications infrastructure in China, this in effect means it is the monopoly supplier. All 150 or so of China's ISPs are small and local, and China Telecom has shown little compunction in squeezing as much money from these businesses as possible, with the result that whereas in the Unites States, line rental accounts for only about five per cent of an ISP's costs, in China the average is nearly 80 per cent. Even more restrictive is a China Telecom practice of linking line rental to the amount of revenue per line. Consequently, instead of rental declining with volume, it rises; making an ISP less profitable the more it increases its user base or traffic volume. Given a playing field tilted so steeply against them, most independent ISPs have found it impossible to stay in business without receiving some degree of assistance or lenience from China Telecom. As a result, although China saw a small blossoming of ISPs in 1997 and 1998 (many being small bulletin board service operations which decided to go commercial), many of the companies granted ISP licenses have subsequently stopped offering ISP services, or have been incorporated into the ChinaNet framework.

[16] In Peru, for example, the number of ISPs has been falling since July 1998 owing to a consolidation of the industry in the hands of Telefonica del Peru.

[17] Poland was, during 2000, following a similar path by endorsing the provision of IP Telephony services by a cellular operator.

[18] The price pressure from IP Telephony on traditional phone services had already been made clear when, on February 28, the MII announced major price reductions in existing phone service and installation fees.

[19] It should be emphasized that the settlement rate (which is the equivalent of half the international accounting rate) that TdP has to pay to the United States carriers is currently USD 0.31 per minute. This indicates that the settlement rate that Net2Phone Peru pays to Net2Phone USA must be much less than the rate paid by TdP, probably somewhat less than the peak tariff.

20 In the Asia-Pacific region other companies are providing IP Telephony services at very competitive prices. In Singapore, for example, SingTel's VoIP service provider eVoiz offers calls from Singapore to New York at 5 US cents a minute. See "SingTel offers overseas calls via Internet", Bangkok Post, Business Section, 7 March 2000, page 2.

CHAPTER SIX: CONCLUSIONS

6.1 The perils of cost-oriented pricing

In the closing months of the year 2000, two closely related themes have dominated the headlines in the telecommunications press:

- The precipitous decline in the share prices of leading telecommunication service providers, worldwide. While the collapse in value in telecommunications vendors has not reached the same level as among the dot.coms of the new economy, it is nevertheless more surprising and, in the longer term, more significant;
- The rush among those established public telecommunication operators to split their business into component parts. The purpose of this is to raise shareholder value by separating high-growth parts of the business, such as mobile and broadband, from the slower-growth or declining parts, notably in long-distance and international voice services. Those taking this step include AT&T, Bell Canada, BT, NTT and MCI WorldCom.

Did IP Telephony cause this crisis among public telecommunication operators? No, not on its own. A lot of other things, notably the need to invest in 3G licences and infrastructures, have put the share price of PTOs under strain. However, this has come at the same time that revenue from core businesses has either ceased to grow or is in decline. IP Telephony is only one of a slew of new technologies that has permitted a shift towards least-cost routing of long-distance and international traffic and has facilitated competitive market entry.

Least cost routing is eating into the profit margins of public telecommunication operators. In developed countries with competitive markets, least cost routing is part of an ongoing price war, which is forcing the long-established, incumbent PTOs to cut their cost base in order to compete against new entrants and resellers. But arguably the problem is even greater for incumbent operators in developing countries, which rely on international settlement payments for a significant part of their revenue and profit (see Table 6.1).

The "loss" of settlement revenue to China and India, for instance, was around US$40 million each in 1999 and probably twice this amount in 2000. Even though these countries are taking bold steps to reduce their settlement rates towards cost, nevertheless they are seeing increasing proportions of their incoming traffic diverted onto the Internet, as a way of bypassing the accounting rate system. In the Republic of Korea, for instance, an estimated 9 per cent of international traffic travelled over IP-based networks rather than the PSTN in 1999, and that proportion can only be expected to grow (see Box 6.1).

PTOs are caught in a dilemma. If they don't reduce their prices for international services towards costs, then they will lose market share to IP Telephony service providers. On the other hand, if they do reduce prices towards costs, they may endanger their profitability. Unfortunately for PTOs, evidence seems to suggest that there is insufficient latent demand in the international voice market to cover, through volume growth, what is being lost in profit margin. In the longer term, a move towards cost-based pricing probably means the abandonment of usage-based pricing in favour of a move towards flat rate, or capacity-based pricing. In such a world, voice would become very cheap relative to, say, bandwidth-intensive applications such as file transfer or video-streaming. A pricing structure based on users perceived value of telephone calls (so-called Ramsey pricing), may be a more logical way forward than a narrow reliance upon cost trends..

Table 6.1: The impact of IP Telephony on public telecommunication operators
Selected Asian economies, the correspondent relations with the United States, 1999

Economy	Estimated minutes VoIP traffic (million)	VoIP % of total traffic with US	Settlement rate with US in 1999	"Lost" settlement due to VoIP	As % of total inpayment from US
China	85	5%	51¢	US$43m	19%
Korea (Rep)	12	9%	36¢	US$5m	3%
India	68	4%	54¢	US$37m	8%
Malaysia	17	1%	19¢	US$3m	13%
Philippines	34	2%	29¢	US$10m	5%
Singapore	51	3%	15¢	US$8m	10%

Source: ITU, adapted from TeleGeography Inc., FCC.

Ultimately, it comes down to the question of whether or not consumers are willing to pay a little bit extra for the slightly higher quality and reliability that can currently be delivered over circuit-switched networks compared with the lower-prices available on IP-based networks. Cost-oriented pricing will mean that, over time, the price differential between circuit-switched and packet-switched networks will diminish. But equally, technological progress should ensure that the quality premium that circuit-switched networks currently enjoy is also eroded. Consequently, the choice will get harder not easier.

What will almost certainly tip the balance is that voice is becoming less and less significant as a component of overall traffic. Data is now providing the lion's share of traffic and this will soon be joined by audio and video-streaming. But sources of "content" are much more localised than sources of "chat". The content world is highly US-centric, much more so than the telephony world. IP-based networks are set to continue their expansion while circuit-switched networks will grow only slowly. In the long term, therefore, whatever the merits and cost advantages that circuit-switched networks may currently have over IP-based networks is likely to be lost. The networks of the future will be IP-based.

Box 6.1: "Wait and see" in the Republic of Korea

The Korean government has generally taken a "wait and see" attitude towards IP Telephony. This approach has its roots in the policies regarding alternative calling procedures, such as call-back, in the early 1990s. Initially, the government wanted to ban such practices and tried to estimate the traffic being carried by such non-traditional methods. However, it proved very difficult to detect.

IP Telephony provided an opportunity for foreign service providers to enter the Korean market by way of offering prepaid cards, targeted at small businesses and residential customers. The government did not pay much attention in the beginning due to the low quality and small volume of IP Telephony traffic. But, technological problems associated with IP Telephony have progressively been removed. Quality has improved and the low price has proven attractive to many users. Gradually the traditional international market shrunk, quite significantly, forcing the government to recognize the significance of IP Telephony and the attractiveness of the low prices that came with it.

IP Telephony providers were categorized as special carriers, which did not need licences. Rather, a simple registration procedure was sufficient to enter into the market. Numerous entities registered and some proved commercially successful. Even licensed international carriers started to provide their own Phone-to-Phone IP Telephony services, along with regular PSTN in order to defend their market shares and to survive. Traditional PSTN international revenue was squeezed by both the market penetration of IP Telephony and price competition among licensed carriers.

All three licensed international carriers in Korea now have two separate international access numbers, one for traditional circuit-switched telephony; the other for IP Telephony. The profit margins on traditional services are more generous, and therefore the carriers are not promoting their IP Telephony services aggressively. As they do not necessarily want to expand the IP Telephony market, their strategy is more to take defensive measures to prepare for the new environment.

Korea Telecom started to provide international IP Telephony services by means of a special access number (00727) in April 1998. Like the other carriers, it did not advertise the new services at all. It simply wanted to hold on to those of its customers who were likely to be attracted to the lower-priced IP alternatives. In 1999, international traffic via IP Telephony reached 9 per cent of all international calls, a total of around 80 million minutes. The traffic volume was expected to double and associated revenue to reach about 28 billion Korean Won in 2000 (around US$24 million).

In the realm of IP Telephony, other IT providers actually outperform the three licensed carriers. As of July 2000, some 18 service providers were doing business. Major suppliers include SK Telink, and Samsung SDS. Many of them are affiliated with mobile carriers or large conglomerates that already face considerable demand from their own customers for lower priced voice telecommunication services.

With respect to domestic long distance services in Korea, IP Telephony has yet not proven very successful. Circuit-switched telephone rates are already quite low. In fact, Dialpad.com started to provide free domestic long distance call along with Hanaro (a new local carrier), and even though many people were attracted by their approach, their advertising revenue was not enough to cover the interconnect expenses they had to pay to terminate calls on the PSTN. Despite the field being largely unregulated, effective business models have yet to be found for using IP Telephony for domestic long distance telephony.

Source: "IP Telephony in Korea," Dr. W. Cho, Korea Telecom.

Box 6.2: France - Public consultation emphasizes need for technology-neutral regulation

France is one of the very few countries that have held wide-ranging public consultations on IP Telephony. In September 1999, the Autorité de régulation des télécommunications' (ART) published a news release, which cited seven key opinions that had come out of this public process:

1. The regulatory treatment of IP Telephony should be harmonized as much as possible at the international level, and, in France's case, at least at the European level.

2. It is desirable that regulation be infrastructure and technology-neutral, and therefore that the same rights and duties apply to substitutable services, such as IP Telephony and traditional voice telephony. The rights and obligations of various parties should be, in general, in proportion to their investments.

3. With regard to the appearance of new services like IP Telephony, the major objective of regulation should be to support their sustainable emergence, by avoiding momentary reductions of tariffs unbalancing the market.

4. Certain contributions underlined the advisability of extending the principles of interconnection applicable to voice networks to data networks as well, due to their character of offering services to the public.

5. The attribution of numbering resources, making it possible to identify IP Telephony customers within the national numbering plans, offers an interesting prospect. In this area as well, number portability appear to be an essential asset.

6. The parameters influencing the quality of service of the various networks involved will have to be clearly known, and the end-user will need to know whom the operators of the various interconnected networks are.

7. The absence of directories presents significant difficulties for IP Telephony operators.

Perhaps the principal lesson of the consultation was the necessity of technology-neutral regulation: regulation must relate to services, as they are perceived by the user, not to the technologies or infrastructures that support them. Identical services should be subject to the same regulation.

For more detail, see <http://www.itu.int/osg/sec/spu/ni/iptel/countries/france/index.html>.

Source: Adapted from Autorité de régulation des télécommunications' (ART), "Telephonie Sur Internet: L'Autorité rend publics les résultats de l'appel à commentaires sur la téléphonie sur IP" (27 September 1999), <http://www.art-telecom.fr/communiques/communiques/index-30-99.htm> The summary of responses received is available in English at <http://www.art-telecom.fr/publications/index-somsynip.htm> and the list of key points at <http://www.art-telecom.fr/publications/index-key-ip.htm>.

6.2 Towards technology-neutral regulation

What role should regulators play in the future? Where competition is working effectively, then it should not be so necessary to insist upon cost-oriented pricing. Indeed, in a world in which unit prices are tending towards zero, insistence on cost-based pricing may artificially sustain the current regime based on traffic settlements.

As shown in this report, the majority of ITU Member States have yet to develop formal policies relating to IP Telephony. One of the few that has considered it in detail, and which has carried out a formal consultation process, is France, which did so in 1999. The consultation produced a rough consensus on seven principles based around the notion of technology-neutral regulation (see Box 6.2). This implies that regulators should treat all suppliers that are providing essentially the same service, say voice telephony, in the same way, irrespective of the particular technological platform they are using.

This runs counter to the received wisdom that the Internet is somehow new or different. Lobbying groups, such as the Voice over the Net (VON)[1] coalition argue that the Internet should be kept free from all types of government regulation. They are half right and half wrong. They are right to assert that the new, increasingly competitive telecommunications market deserves a much lighter regulatory touch. But they are wrong to assert that IP Telephony Service Providers should be given preferential treatment compared with companies offering the same service over more conventional networks. If a government chooses to place a regulatory obligation, for instance to contribute towards universal service, on players in the telecommunications market, then why should those that use a particular transmission protocol rather than another be excused? Public consultation exercises, such as the one carried out in France, are to be encouraged.

In reality, technology-neutral regulation is a longer-term goal. In the short-term, while telecommunication markets in most ITU Member States still carry the traits of a long history of monopoly-service provision, some degree of asymmetry in regulation is probably inevitable. Sometimes, regulators may make use of definitional tools to exempt IP Telephony from restrictions on competition, as they have done in Hungary. At other times, in more liberalised markets, regulators may wish to use functional equivalence tests, such as those outlined in Figure 4.1, to either include or exclude IP Telephony Service Providers from regulations applied to other players in the market. What is important is to look at the service, not the technology, and to consider broader policy goals, not just representations from particular interest groups.

In the economics literature, there are a number of examples where a lightly regulated sector has grown up alongside a more regulated one to the detriment of the latter. The road haulage sector, for instance, was largely free of the regulation that was imposed on the rail sector. Similarly, in the early days of radio broadcasting, the new industry grew up without the constraints imposed on the telegraph. More recently, mobile communications has grown up alongside fixed-link telecommunications without anywhere near the same weight of regulation. Technological change of this nature poses new challenges to regulators. There is not necessarily a right and a wrong way to approach these different situations, but it is important to be consistent. While there may be arguments for favouring a new industry while it is still in its infancy, those arguments cannot be sustained once it reaches maturity. IP Telephony is now becoming a mature industry. It should be treated accordingly.

[1] <www.von.org>. To quote: “The VON Coalition's mission is twofold: actively advocate the viewpoint that the IP Telephony industry should remain as free of governmental regulations as possible, and to educate consumers and the media on Internet communications technologies”.

IP Telephony
Country Case Studies:

China *

Colombia *

Peru *

Thailand *

The IP Telephony case studies form part of a series of telecommunication case studies produced under the New Initiatives Programme of the Secretary-General of the International Telecommunication Union (ITU). Further detail on the socio-economic profile of the countries and the status of the Internet and of the telecommunications sector can be found in extended versions of the cases—including an additional case study on Hungary—at the ITU website at <http://www.itu.int/iptel/>.

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A1. CHINA

A1.1 Introduction

In the latter part of the 1990s, many small computer and ISP outlets across China used the country's network backbone to provide domestic long distance and international calls to the public, and in some cases at less than half the rate charged by the incumbent, China Telecom. Yet, despite an abundance of network infrastructure, the Ministry of Information Industry (MII), via its leading telecom enterprise, China Telecom, had until 1998, steadfastly resisted the proliferation of IP Telephony services – *implying* that such services were not legal and then clamping down on anyone who tried to provide them.[1]

When, however, the prosecution failed and they realised that their position was untenable, China Telecom rapidly embarked upon a dramatic turnaround. Government officials at the MII created a new licensing framework for Internet telephony operators, limited in the first instance to the government-affiliated telecom bodies – China Telecom, China Unicom and Jitong. They also focused the newly licensed carrier, China Netcom, on IP services and they galvanized China Telecom to undertake the largest roll-out of an IP Telephony platform in the world.

Almost overnight the government had swung around from blocking IP Telephony (in much the same way that they had banned callback operators) to driving it out as a central plank of their emerging telephony, data and Internet agendas.

China's IP Telephony market formally opened on April 28, 1999, with the MII issuing licenses to China Telecom, China Unicom, and Jitong to begin six-month periods of operation in a total of 26 cities. This was later extended into the new year. In so doing, the legalization of IP Telephony ended what was still effectively a *de facto* long distance and legal international monopoly held by China Telecom.

China Telecom was the first of the three carriers to launch services in an initial roll-out comprising 25 cities. The network was rated as one of the fastest IP Telephony roll-outs to date, taking just two months. To build a circuit-switched network of comparable size and capacity would have taken 1.5 years and cost three times the amount. Unicom launched its IP Telephony trial in 12 test cities, acquiring nearly 700'000 customers between June and November 1999. The company plans to have IP Telephony gateways in 250 of China's biggest cities by the end of 2000. Unicom's 12-city trial network reached full capacity in only 80 days instead of the predicted six months.

During the trial, the three companies issued IP Telephony telephone cards. The cards contained a unique account number for use from any phone from within the service areas of the respective companies. At Jitong's sales offices in Shanghai more than 2'000 people lined up—some of them from as early as 2 a.m.—to buy the IP Telephony cards when they went on sale on 19 May 1999. From June to August 1999, the total revenue from sales of IP phone cards was estimated at US$35 million, with an annual potential of US$150-200 million. China Telecom instead set up only one sales counter at the Beijing Long distance Telephone Exchange Bureau, and issued only a very limited number of IP cards. Even with their limited attention to the market, the Beijing Telecom office had over 500 people per day sign up for telephone service during the first two days following the announcement. Previously the office had handled about 20 telephone subscriptions per day.

Since the trial, the IP Telephony market in China has been expanding at a rapid pace. The MII has predicted that the market size of China's IP network will reach US$12 billion by the end of 2000.[2] Ironically, by the start of 2000, with the government ready to open the market to new competing licensees, many inside of the three existing competitors—Unicom, Jitong and Netcom—already questioned the basic business proposition for IP Telephony in the country. A recent China Telecom price revision meant that all three were looking for replacement revenue streams with long-term growth potential. Nobody doubted the importance of IP services, nor that voice traffic in China would increasingly be IP traffic. However, IP Telephony as a stand-alone business proposition has rapidly become questionable.

A1.2 The Internet in China

The first Chinese Internet connection was established by the Chinese Academy of Science (CAS) in 1988, which registered the '.cn' domain name with the Internet Society in 1990.[3] In China, commercialization of the Internet occurred in June 1995.

Many expected that the Chinese government's regulatory restrictions on the Internet were related to a desire to keep the number of Internet users in China to a linear growth path. After all, it was widely accepted that the Chinese government was not keen to promote widespread access to information.[4] However, constrained Internet development was quite obviously *not* the case – as the roll-out of the network, the Government Online program, and the extraordinary growth in subscription levels began to demonstrate. In China, growth, rather than simply control, was the government's primary objective (as had been demonstrated through the early 1990s in basic telecommunications).

Clear evidence of this is, for example, the fact that, in 1999, to expand access to the Internet, Chinese authorities twice cut the fees that ISPs pay to access telecommunications lines. By late-October, the fees for a 2-megabyte domestic connection to an international digital line had been reduced to 220,000 yuan (US$26,579) per month. (Prior to the cut in October the fee was 320,000 renminbi.) The monthly rental fee for the use of switching stations was 280 yuan per month (down from 600 yuan) and the charges for domestic long distance digital lines had fallen to 80,000 yuan (down from 431,000 yuan) per month. (Digital data line fees were also reduced by 45 per cent in October 1999.) With this and a number of other promotional measures the stage has been set for an explosion in Internet subscription and usage.

By July 1997, there were some 25,594 Internet hosts using the .cn national top-level-domain (TLD), according to China's domain name registrar, China National Network Information Center (CNNIC).[5] By December 1999, this had grown to 3.5 million. The number of Internet subscribers was growing even more dramatically. From about 80,000 subscribers in 1996, the market had grown to 2.1 million by the end of 1998 and 8.9 million by the end of 1999. The government predicted that there would be at least 20 million Chinese on the Internet in China by the end of 2000 and more than 80 million by 2003. There is good reason to think, however, that these numbers – impressive as they are – are still conservative. Many observers would agree that the real number of Internet *users* in China is significantly higher than the official figures.[6]

The main providers of Internet access to the public are:

- China Public Computer Network (ChinaNet). ChinaNet, run by the operator of China's national public telephone network (China Telecom), is the dominant Internet access provider. Often referred to as the 163 network after the number users dial to gain access to it (see "Going on-line in Beijing"), ChinaNet is also the effective international gatekeeper by virtue of the fact that all networks must go 'through' China Telecom's international telecommunications access.
- China Public Multimedia Network (169 Network). The Multimedia Network, more often known by its dial-up access number, 169, is an attempt by the government to build a China-specific content platform for domestic users. Effectively, an America Online style platform, it does not provide direct access to the Internet, but rather creates a Chinese intranet, allowing the government to provide cheaper access and Chinese-language content.
- Golden Bridge Network (GBNet). GBNet provides the commercial alternative to ChinaNet. Run by Jitong, a state-owned company formerly linked with the now abolished Ministry of Electronics Industry, GBNet has focused primarily on the corporate market.
- China's Education and Research Network (CERNET). CERNET is the principal academic network. It is centred upon Beijing's prestigious Qinghua University and links together the universities, schools and education and research institutes. It is still technically distinct from the main public network such that Web sites which are blocked by the government on ChinaNet (see below) will often be accessible from CERNET.
- China Science and Technology Network (CSTNet). CSTNet is similar to CERNET, but significantly smaller in scale: it connects subsidiaries of the Chinese Academy of Sciences (CAS).

Table A1: Bandwidth: Limited but growing
Total bandwidth, million bits per second

	Jan. 1999	July 1999	Jan. 2000
ChinaNet	123	195	291
GBNet	8	18	22
CERNET	8	8	8
CSTNET	4	8	10
UNINET[7]	--	12	20
TOTAL	143	241	351

Source: CNNIC

ChinaNet is by far the most important of the four Interconnecting Networks; it is by far the dominant provider and, through China Telecom (and thence the MII) is the only point of public international interconnection. This means it can – ostensibly – control who can set up web sites and which web sites can be blocked. Although technical means do and will always exist for users with the know-how to find their way to blocked sites, formally this means that China Telecom remains in charge overall of who accesses what on the Internet via the public telephone system.

Of the four Interconnecting Networks (INs), only ChinaNet and GBNet can sell Internet access [on commercial terms] to other Internet service providers (ISPs). CERNET and CSTNet are limited to only providing access to educational and research institutions. Because China Telecom owns the vast majority of telecommunications infrastructure in China, this in effect means it is the monopoly supplier. As a consequence, the majority of subscribers, whether companies, organizations or individuals, are connected with ChinaNet, either directly or indirectly.

One recent alternative to ChinaNet's 163 network has been China Telecom's 169 network – again named after its dial-up access number. The 169 network, also known as the China Public Multimedia Network, is an attempt to build a China-only Internet. Started in 1998, it is run by China Telecom's Data Communications Bureau. Despite its title, it uses the same telecom backbone as 163, the public network. Its main distinguishing feature to date is that all its content is in Chinese.

It is also difficult to access the network from outside, making it far more secure than the Internet proper, while at the same time allowing users controlled access to the "real" Internet. The network is being pushed by the telecommunications authorities as the best home for the country's On-line Government project, a scheme aimed at getting ministries and other state organizations to have an on-line presence. This project has gained widespread acceptance amongst the senior Chinese leadership and government departments which are not yet connected to the 163 network are being encouraged by the State Council to go on-line via the 169 network.

The government has recognized the importance of data transmission. As a result, the government's goal of installing fibre optic telecommunications lines to major buildings in urban areas and to large villages in rural areas by the end of 2000 meant significant near-term investments. MII authorities expected China to invest US$2.5 billion to develop its broadband infrastructure in 2000 alone, with investment expected to reach US$24 billion by 2005, of which transmission systems would account for US$15 billion, access networks US$6 billion, and data communications hardware US$3 billion.

A1.3 IP Telephony: The government initiative

China's IP Telephony market formally opened on April 28, 1999, with the MII issuing licenses to China Telecom, China Unicom, and Jitong to begin six-month periods of operation in a total of 26 cities. This was later extended into the new year.[8] In so doing, the legalization of IP Telephony ended what was still effectively a *de facto* long distance and legal international monopoly held by China Telecom. The opening of the IP Telephony market had been preceded by a substantial amount of 'grey market' activity by ISPs, computer shops, and local CATV networks. What galvanized the market was a lawsuit brought against the MII by two brothers in the southern Chinese province of Fujian.

A1.3.1 The brothers Chen

In 1998, the Chen brothers had begun offering IP phone service through their computer store in Fuzhou city. China Telecom insisted that the brothers had broken the law, and filed a judicial demand to get them arrested. After the police detained the brothers and seized their equipment, the Chens filed suit against China Telecom for the illegal capture of their computer equipment.

The Internet phone service offered by the Chens from their store allowed customers to make international calls at half the rate charged by China Telecom. The brothers pointed out that the only *telecommunication* regulations which appeared to directly relate to their service were the 1993 "Provisional Arrangement for the Approval and Regulation of Decentralized Telecommunications Services" which had listed the services considered to be telecommunications value-added services, for which a license was required. Computer services, they reasoned, having not been listed, could not therefore be considered a telecommunication service, and as such fell outside the authority of the MII. While the Chens lost their original hearing at the court of first instance, the Mawei District People's Court, they won on appeal at the Fuzhou Intermediate People's Court. The judge accepted their argument that the activity was not covered by criminal law, and was at most an administrative matter. Local court officials then agreed with the brothers that offering IP Telephony service was not explicitly prohibited under existing administrative rules and regulations.

Reports from the case in the Chinese media said that the appellate court had consulted with Internet 'experts' and made its decision on the basis that Internet telephony is technologically different from conventional telephony. While the judge's position was said to be sympathetic because he himself was a *wangchong* (an Internet worm), it is widely accepted that senior government officials in Beijing countered any overt pressure from the MII and made the court aware of the administrative battle surrounding the Internet. Premier Zhu Rongji's widely-known antipathy for the MII's market dominance had dovetailed with the government's administrative restructuring program and the leadership's desire to promote economic growth and market competition.

The MII's response was two-fold. First it issued a notice of its intent to clarify any regulatory ambiguity regarding IP Telephony (while simultaneously stating that the ministry still had responsibility for all matters to do with telecommunications in China and that IP Telephony was a telecom activity – in short, an assertion that the Fuzhou court was wrong). However, with the gate now opened there was widespread recognition, even within the ministry, that a ban on IP Telephony would be a difficult position to maintain.

Chinese newspaper editorials began to point out that overseas users would be able to adopt Internet phone technology to make calls *to* China, while organizations such as foreign companies in China would be able to use Internet telephony over their networks for outbound calls, using private lines leased from China Telecom. Policing of such set-ups would be virtually impossible. As had been the case prior to the 1993 bout of regulatory liberalization and the eventual introduction of (limited) domestic competition, arguments in favour of cheaper costs and alternative operators for Internet access began to emerge from major users. Organizations such as the Ministry of Foreign Trade and Economic Cooperation (Moftec), began to argue that unless the MII allowed Chinese companies to make international calls at the cheapest rate, then domestic companies would be at a competitive disadvantage. Minister Wu Jichuan and his colleagues found themselves under siege. It began to look as though the gray market activity was to be legitimized and that the IP Telephony market would rapidly become competitive, just as, for example, the paging sector had experienced in the mid-1990s.

The MII's second response therefore turned out to be perfectly in character. In April 1999, they licensed three carriers – all now under the umbrella administrative control of the MII – to conduct a six-month trial of IP Telephony services. They also announced that China Telecom would begin one of the world's fastest large-scale IP Telephony roll-out programs.

A1.3.2 The IP phone trial

Using VocalTec equipment (both hardware and software), China Telecom was the first of the three carriers to launch services on April 28, 1999 in an initial roll-out comprising 25 cities (Table 3). The roll-out was fairly small in financial terms, with the US$2million project utilizing 100 E1 connections.[9] However, the network was rated as one of the fastest IP Telephony roll-outs to date, taking just two months. To build a

circuit-switched network of comparable size and capacity would have taken 1.5 years and cost three times the amount.[10]

Yang Xianzu, China Unicom's Chairman and President (until early-1999 Yang an MII Vice Minister) stated that, in 1999, Unicom would, by contrast, invest Rmb2 billion (US$241 million) to complete its IP Telephony trial in 12 test cities and build up a data and computer network covering as many as 90 additional cities. Unicom's 12-city trial network reached full capacity in only 80 days instead of the predicted six months.

During the trial, the three companies issued IP Telephony 'phone cards with face values of Rmb50, Rmb100, Rmb200, Rmb300, and Rmb500. The cards contained a unique account number for use from any phone from within the service areas of the respective companies. (The cards were not interchangeable.) To access the service, a user entered the local access number (a POP) of the vendor, account number, area code, and phone number. The phone charges were then deducted from the account.

The MII's initial pricing structure for the trial showed the potential consumer appeal of IP Telephony (see Table A2).[11] During the initial trial stage, domestic long distance charges were levied at Rmb0.30 (US$0.04) per minute, while international long distance calls were charged at Rmb4.8 (US$0.58) per minute. Long distance calls to Hong Kong SAR, Macau SAR and Taiwan, China were charged in two ways. When calling from mainland China (except Shenzhen) to Hong Kong SAR, from mainland China (except Zhongshan and Zhuhai) to Macau SAR, or from mainland China to Taiwan, China, the charge was Rmb2.5 (US$0.30) per minute. When calling from Shenzhen to Hong Kong SAR, or from Zhongshan or Zhuhai to Macau SAR, the charges were Rmb1.5 (US$0.18) per minute. In November 1999, China Telecom expanded the number of countries to which its IP telephone cards provide service from 16 to 50.[12]

Several technical issues appeared early in the trial, but were effectively solved. First, there was limited access capability (in cities where the service was available), so that certain customers had to dial local long distance for access, thereby incurring higher charges. This problem was dealt with by the provision of national access numbers. Second, all three networks experienced serious traffic congestion and dropped calls as they failed to cope with the levels of traffic – particularly during peak periods. As a result of the traffic load and slow response time, a high per centage of calls were not picked up on the first attempt. The gateway for Beijing Telecom, for example, had to go through a capacity upgrade only weeks after the service was introduced. Finally, voice quality was poor because of deep compression, traffic load, and possibly lost packets. These problems were alleviated after network expansion and new management tools were implemented by all three service providers. Assessing trial results The MII announced at the outset of the trial that how and who they would subsequently license to provide IP Telephony services would depend on the results of the trial. The results of the trial, however, seemed to depend on who was asked.

Table A2: Falling prices

MII's IP Telephony prices compared vs. non-IP prices.

Services	Telephony (non-IP) tariffs	IP Telephony tariffs
Domestic long distance	0.9-1.1 Rmb/min	0.3 Rmb/min (US$.04)
HK SAR, Macau SAR, Taiwan, China[13]	5 Rmb/min	2.55 Rmb/min
International	12-15 Rmb/min	4.8 Rmb/min (US$.58)

Source: Ministry of Information Industry, China

A1.3.3 Assessing Trial results: China Telecom, Unicom and Jitong

China Telecom went out of its way to play down both the impact of the trial upon the market and the demand for such services. Two months into the trial, company spokesmen announced that Internet Protocol telephony services had been a disappointment in China: "Long distance and international IP phone trials have failed to attract the anticipated response on the local market."[14] According to a report from the Beijing Telecom Administration, the total business volume of international phone services had decreased 5.67 per cent in the first half of the year, while the total business volume of domestic long distance calls had increased "only" 25.6 per cent. The report showed that customers preferred to use IP phone cards for domestic long distance

calls, with the number of domestic long distance calls made via the Internet 3.17 times greater than that of international calls. The "unsuccessful trial" was attributed to limited market demand for international phone calls and the relatively small area where the trial was held.

However, this data was contradicted by both the evidence and the tone from the other IP Telephony operators. While international calls accounted for less than 50 per cent of Unicom's IP business, by November 1999 the carrier – which had not previously been licensed to carry international voice traffic – was already generating "several million minutes" in monthly traffic between China and the US. Between June and November, Unicom had acquired nearly 700,000 customers through its 12-city trial. Another important outcome of the trial is that Unicom's 12-city trial network reached full capacity in only 80 days instead of the 180 days predicted at the start of the operations. Company representatives interviewed were predicting that 10 per cent of international phone calls from China would be carried over the Internet by 2000 and 35 per cent by 2003.[15]

Indeed, using IP Telephony as a lever to liberalize the international services market in China has prompted aggressive roll-out plans. Unicom, for example, planned to have IP Telephony gateways in 250 of China's biggest cities by the end of 2000.16 It publicly aspires to a 50 per cent share of China's IDD traffic by 2003. In the past, Unicom has more often than not failed to achieve its own ambitious sales targets. With a customer base in excess of two million cellular phone subscribers, Unicom did, however, stand to benefit enormously given that it had previously collected no revenue for outgoing international calls. Initially though, Unicom was required to carry IP Telephony traffic over China Telecom's digital data network until its own US$200 million IP backbone (built in association with strategic supplier Cisco) was completed. While Unicom had the additional option of using the MoR's fibre backbone, this had proved a contentious issue over the previous five years, due to disputes over revenue-sharing arrangements and control of the network.

Similarly, Jitong portrayed the trial as an unmitigated success. At Jitong's sales offices in Shanghai more than 2,000 people lined up to buy the IP Telephony cards when they went on sale on May 19 – some of them having lined up at 2:00 a.m. Jitong employed a small army of people through 15 sales agencies to push their cards and in their first month of service was able to sell some 50,000 in just five cities. From June to August, 1999, the total revenue from sales of IP phone cards was estimated at US$35 million, with an annual potential of US$150-200 million (assuming the service is expanded). And yet, compared with Jitong's strong IP sales force, China Telecom's IP cards sales were like "the shy blossom of roses," according to one newspaper editorial. China Telecom set up only one sales counter at the Beijing Long distance Telephone Exchange Bureau, and issued only a very limited number of IP cards. While the cards sold out quickly, the difference in emphasis and effect was telling.[17]

A1.3.4 China Netcom

The fourth carrier to be licensed by the government to trial IP Telephony services was a new [state] company, China International Network Telecommunications Co. Ltd. (China Netcom). Netcom, in and of itself, provides an interesting study of where the IP Telephony market may be heading in China and what the government's designs may be.

In 1998, a number of Chinese economists in the State Development & Planning Commission (SDPC) began calling for the establishment of a new telecommunication firm incorporating the existing network and equipment of the railway industry. Plans for the MoR's network had been considered by both senior Chinese leaders and the leaders of the ministry for several years. With some 35,000 kilometres of fibre already laid, the MoR had the largest high-speed network outside of the MII.[18] (It was the MoR's spare network capacity which was the initial *conceptual* basis for domestic competitor Unicom back in 1993. However, the MPT managed to thwart Unicom's fixed-line ambitions and Unicom became effectively a 'cellco'.)

One part of the motivation for the plan for Netcom was to foster competition in the domestic telecommunications market, as earlier reforms and the existing structure had not created an "effective competition mechanism". Another part was the emergence of the Internet and the market for broadband communications.

Box A1: Future Transportation with the Ministry of Railways

The Ministry of Railways' (MoR) telecommunications network, by far the largest and most advanced of the 'private' telecom systems in China, is formidable. This is because the MoR has long occupied a central strategic position in the nation's infrastructure development plan. In 1985, the MOR received the first of a series of World Bank loans dedicated to building a reliable internal ('private') communications network. (This was a US$259 million loan for route electrification along the Chongqing-Guiyang line.) By 1986, the system accounted for 5-12 per cent of the total estimated active local circuits installed in China, with 250,000 line subscribers nationwide. By the end of 1993, the MoR was estimated to be in control of some 80,000 exchange lines and 500,000 mainlines.

By 1998, the Ministry was actively exploring the creation of multi-lateral Internet peering sites in China to improve network efficiency and the co-location of Web servers, and the building of an international exchange so as to enable pan-Asian traffic exchange and reduce dependence on costly international connectivity. As it did so, the MoR (in a bid to supplement its revenues by moving into the lucrative telecommunications sector) was eyeing the growing enterprise market – estimated to encompass 5-10 per cent of China's population. Highlighting the less-than-comprehensive reach of China's telecommunications administration, the MoR had also begun talking with several of the more geographically remote and economically disadvantaged PTAs to build independent IP networks and e-commerce services.

In addition then to the resources that it had provided separately to Netcom and Unicom, the MoR also commissioned Hong Kong systems integrator Computer and Technologies Holdings to build a US$3 million voice over IP network for the ministry itself. According to the company, the MoR plans to offer the service to 36 cities throughout China once it is licensed. The internal VoIP network will provide dial-up links between phones, faxes and PCs. The network's E1 network backbone will span 29 nodes with Cisco 7500 routers installed at the ministry's support center in Beijing, as well as in Shanghai, Guangzhou, Lanzhou, Chengdu, Zhengzhou, and Shenyang. The network will be capable of supporting up to one million customers initially.

Source: Computer & Technologies Holdings

As a result, a high-speed Internet project, known formally as the Broadband Internet Protocol Network Model Project, was ratified by the SDPC under the State Council. This was to be a broadband, high-speed network designed and built for Internet Protocol (IP) services. In the first instance, the project involved the Chinese Academy of Sciences (CAS), the Ministry of Railways (MoR), the State Administration of Radio, Film, and Television (SARFT) and the Shanghai Municipal People's Government.[19] Each of the four participants had an equal stake in the company, capitalized at US$50 million.[20] The initial plan was to build a backbone network linking 15 major cities on the eastern seaboard of China, including Beijing, Shanghai, and Guangzhou.[21] The company designated to run the project was Netcom.

Netcom's 20Gbit/s IP/DWDM (dense wavelength division multiplexing) fibre-optic network backbone will cover 6'000 miles and 15 Chinese cities and be ready for operation by late-2000. With one of the highest-speed backbones in the world, Netcom aims to link corporate and government buildings in major cities directly to the IP backbone, providing 2-10 Mbit/s to the desktop – enough to download video in real time. In addition to focusing on the corporate market, Netcom is pursuing the opportunity to create a niche as a wholesaler of broadband network capacity. Netcom began trials of IP Telephony services across its 15 cities in October 1999.[22]

On 30 March 2000, China's Ministry of Information Industry (MII) granted licenses to China Telecom, China Unicom, Jitong Communications and China Netcom to perform commercial operations of IP Telephony services. Officials from the Telecommunications Administration Bureau of MII informed that another license is reserved for China Mobile, which will provide IP phone service by using the wireless application protocol (WAP). China Mobile will obtain its operating license once it completes the application process, which may take another month.

A1.4 Going forward

A1.4.1 The growth of the China IP market

The MII is expected to extend IP phone services across the country and to grant licenses to a number of other groups such as the Ministry of Railways, Shenzhen China Motion Company, a number of the PTAs (either under their own domains or, more likely, under a sub-domain of China Telecom) and perhaps the State

Administration of Radio Film and TV. Government estimates already suggest that the IP Telephony market will amount to some Rmb100 billion (US$12.2 billion) by the year 2002.

With the national teledensity still only 11.2 per cent (as of March 1999) and more than 50 per cent of villages still without basic communications access, one suggestion for the government's rather dramatic push is that IP Telephony may be the low-cost solution to vastly increasing universal access. Another suggestion is that, as part of its 'buy local' push, the government believes that it cannot afford to fall behind in the adoption of new technologies.

Indeed, there is a general consensus in the Chinese telecommunications administration that IP Telephony based on packet-switching technology will eventually replace the traditional telephone technology. To this end, the government has established an IP Telephony standards group, consisting of 27 domestic telecommunications research institutes and equipment manufacturers to:

- Establish a set of technology standards for IP Telephony in China;
- Support and facilitate interconnection among Chinese IP gateways;
- Evaluate the four existing test networks (China Telecom, China Unicom, Jitong and Netcom);
- Support deployment of domestic IP products; and
- Work on laws and regulations relating to IP Telephony.

Localization has already become an issue in China's IP Telephony program, following complaints from vendors that they have been shut out from the market during the trial period. Following patterns established with a previous generation of basic telecom equipment such as switches, the Chinese are now being offered discounts of up to 60 per cent by foreign vendors, keen to get in at the ground level of what is obviously going to be an extensive roll-out. VocalTec, for example, offered a basic platform (not including billing) covering about 20 million subscribers to China Mobile (the newly separated arm of China Telecom) for US$500,000. CMC responded that this was "too expensive"!

Unicom and Jitong have both planned to roll out post-trial networks of some 300 E1 lines. China Telecom, on the other hand, is looking to build a network in the next phase which encompasses 1000 E1 lines – perhaps the largest roll-out in the world. And yet, as of Friday December 17, 1999, the Ministry of Information Industry had once again mandated lower international call tariffs: dropping the per minute price for calls on its 16 major routes to Rmb 4.8/minute – or the same price as IP phone tariffs; and for off-peak times, tariffs were dropped to Rmb 2.9/minute – 40 per cent cheaper than comparable IP calls. Clearly, China Telecom is not yet ready to promote IP Telephony, but nor is it ready to give away the market, by ignoring it.

Box A2: Equipment production and national champions

If Chinese telecommunications equipment vendors (such as Huawei and Zhongxing) were to develop the necessary production lines to become national champions, let alone world class vendors, then China Telecom could not simply shut down the market. However, nor could China's protected telecommunications services and Internet market simply be opened to international competition – particularly if the domestic vendors were to be given the chance to catch the leading foreign equipment manufacturers in R&D. Thus, the government offered a limited number of licenses to leading domestic telecoms concerns, and at the same time, encouraged China Telecom to undertake a dramatic build-out program, so as to maintain its dominant position.

From the viewpoint of the state in China, the challenge continued to be to steer regulatory reforms in the direction of industrial and technological modernization without weakening China's bargaining position with the world's leading multinational IT companies. At root, that bargaining position is to demand a commitment to technology transfer into China. The multinationals will be hoping for a growing convergence of interests between themselves and Chinese enterprise partners, especially where research and development, intellectual property rights, licensing and franchising issues are involved. Nevertheless, IP Telephony has offered a valuable window of opportunity in China's lucrative long distance services market.

A1.4.2 Conclusion

China's official licensing and commencement of IP Telephony was expected to begin sometime early in 2000. However, for all intents and purposes, the IP Telephony business had already been launched quite

successfully in China by the end of 1999, with the four trial licensees having committed resources, developed networks, and begun to market their services – with varying degrees of aggressiveness.

In quite a dramatic reversal of attitude, the government had gone from trying to marginalize IP services and alternative network solutions, to actively licensing and promoting such options, and then to sponsoring the incumbent telecom operator, China Telecom, to build the largest such network in the world. In the space of less than a year, IP Telephony had moved from *de facto* illegal status in China, to being at the centre of telecommunications development, and prospectively one of the world's largest markets.

The government's turnaround has not, however, simply reflected a wholehearted intent to respond to and drive nascent market demand. Rather, it can be seen, on the one hand, to reflect the MII's concern over lost revenues and China Telecom's desire to dominate all major telecommunication sectors, and on the other, to reflect the government's desire to promote sustained economic development and technological growth. Through focusing on the emergence of this new market sector, China Telecom has also begun to refocus the roll-out of its networks on an advanced 'next-generation' data communications platform.

To comprehend the government's push for an IP Telephony network alternative the various contending forces of Internet development in China need to be put into context. By 1995, China already had an Internet 'grey market'. The imminent arrival of commercial Internet access, its convergence with existing data traffic, its perceived importance to sustained economic development, along with the types of content that were being transmitted, motivated the government to commercialize access to the Internet. It also motivated the Ministry of Posts and Telecommunications to refocus its attention on the Internet, having underestimated its early significance. Within two years the MPT had very successfully achieved its goal of market dominance. But its implementation of a centralized network administration meant that by 1998 there was once again a 'grey market' in the provision of various Net-based services – certain networks were successfully bypassing China Telecom's ATM network – and if left unanswered, these services would eventually challenge China Telecom's dominant market position.

Perhaps not surprisingly then, the outside observer can perceive several contending objectives within the government's IP Telephony initiative. The first is the contradiction between the MII's concerns over lost revenues and China Telecom's ambition to dominate the market. To grab market share with a new service offering in a competitive field, China Telecom has had to price and market its service competitively, hence prices have been driven down – at precisely the time the government is looking for the necessary investment to roll out a new infrastructure platform. Given that telecommunications in China was, by 1999, the second largest contributor to state coffers (after the tobacco industry), many in the government were loathe to cannibalize this revenue stream, by opening to the doors to such competitive offerings as IP Telephony.

The second, and related, challenge was the trade-off between control and market growth. Uptake of the new IP Telephony service required a wide roll-out and convenient access. But, following on the heels of concerns related to the Internet and to information access, there were again voices in the government arguing for a slower, more orderly development of the market, rather than a chaotic, market-driven approach. Equally, however, with a teledensity of only 11.2 per cent, IP Telephony was seen by certain sections within the government as a possible low-price means to rapidly increase China's universal access to basic communications.

Third, China's highly centralized ATM network infrastructure was already stressed, and it was increasingly recognized that the squeeze on cheap access and high-speed connectivity would result in China being poorly positioned to participate in international e-commerce. China's single network structure limited availability and escalated the prices for bandwidth – marketed both as leased data circuits to ISPs and as plain old telephone service to enterprises and consumers – as well as for Internet access.

Finally, there was the issue of domestic market development in the face of increased international competition. Government estimates in mid-1999 suggested that the IP Telephony market could amount to Rmb100 billion (US$12.5 billion) by the year 2002 – for both equipment and services. But while China was producing much of its own basic telecommunications equipment by 1999, the equipment required for broadband and IP-based infrastructure was new and comprised leading edge technology. Telecommunication officials in China were therefore quite concerned that they would once again be forced to rely on foreign vendors. Therefore, in a bid to drive down the prices charged by foreign vendors and to stimulate domestic production, the government's strategy was to initiate *and* centralize domestic demand. This coordinated approach suggested countering China Telecom's built-in dominance of the market by opening it to some

degree of "controlled" competition. The government's solution was to mimic its earlier success in market 'liberalization' by introducing a limited competitor as a pace-setting 'hare' for China Telecom to chase – the aim being to promote domestic development while simultaneously maintaining overall market control.

Ironically, by the start of 2000, with the government ready to open the market to new licensees, many inside of the three existing competitors – Unicom, Jitong and Netcom – already suspected that the basic business proposition for IP Telephony was finished. China Telecom's price revisions meant that all three were looking for replacement revenue streams with long-term growth potential. Nobody doubted the importance of IP services, nor that voice traffic in China would increasingly be IP traffic. However, IP Telephony as a stand-alone business proposition had rapidly become questionable.

[1] In late-1998 the proprietors of a small computer shop in the southern Chinese province of Fujian were arrested and hustled off to jail for selling Internet Protocol (IP) telephony services to the public. The prosecution failed, for more information see the original case study <http://www.itu.int/osg/sec/spu/ni/iptel/index.html>.

[2] *Communications World*, 18th edition, March 2000.

[3] Tan Zixiang. 'China's Information Superhighway: What is it and who controls it?' Telecommunications Policy, 19(8): 721- 31.

[4] This is not to say that the issue of content control is trivial in China – it is in fact very important – but controlling it is does not have the priority among government agencies that many [outside or Western] observers stress.

[5] CNNIC Newsletter, No.1, November 1997. See <www.cnnic.net.cn>

[6] This is because there are usually more than one individual to each official account in China, i.e., multiple users. CNNIC realizes this and assigns multipliers to different categories – 1.85 users per dial-up account, 3.96 users per leased line. But the government agency goes no further than this; making no distinction between the different kinds of users – whether they are in business, government or education. Surveys of different work places, however, have consistently found more people logging on from each account, especially for dial-up and leased lines in businesses and for leased lines used in government offices.

[7] Uninet is a commercial IN under the Shanghai municipal government. Information can be found at: <www.uninet.com.cn>.

[8] At the end of 1999, the MII announced that, with new Internet regulations in the process of being drafted and placed before the State Council, the existing IP telephony licenses would be extended. Once the new Internet regulations were published, the existing licenses were expected to be extended and new licenses awarded.

[9] E1 refers to European (digital signal level) 1 and has a capacity of 2.048 Mbit/s; while a T1 carries 1.544 Mbit/s

[10] See the Yankee Group report: "Internet Telephony in the Asia-Pacific Region," Asia-Pacific Communications, Vol.7, No.12, August 1999.

[11] The price pressure from IP telephony on traditional phone services had already been made clear when, on February 28 the MII announced major price reductions in existing phone service and installation fees.

[12] See Tongxin Chanye Bao (Communications Weekly), November 17. The 34 added countries were: Albania, Algeria, Argentina, Australia, Austria, Belgium, Brazil, Colombia, Denmark, Egypt, Finland, Greece, Hungary, Iceland, India, Indonesia, Korea, Malaysia, Mexico, New Zealand, Norway, the Philippines, Poland, Portugal, Romania, Singapore, Slovakia, Sweden, South Africa, Spain, Thailand, Turkey, the Ukraine and the United Kingdom.

[13] Except HK SAR-Shenzhen & Macau SAR-Zhuhai, Macau SAR-Zhongshan (see text).

[14] Quoted in ChinaByte (www.chinabyte.com), August 11.

[15] The Yankee Group has predicted that upwards of one-third of all China's international traffic minutes could be carried over IP telephony services by 2002. See the Yankee Group report: "Internet Telephony in the Asia-Pacific Region," Asia-Pacific Communications, Vol.7, No.12, August 1999.

[16] In late-1998, China gave state-owned Unicom, its second-largest telecommunications carrier, permission to become the country's fifth Internet service provider.

[17] Even with limited attention to the market, the Beijing Telecom office had over 500 people a day sign up for telephone service during the first two days following the announcement. Previously, the office handled about 20 telephone subscriptions a day.

[18] China Telecom's fiber optic network runs to approximately 200,000km.

[19] As one commentator put it, "CAS provides the 'brains', MoR the trunk lines, SARFT the access lines, and the Shanghai city government its internet gateway called Shanghai Infoport."

[20] In addition to the original investment, the Ministry of Finance issued Rmb200 million in 10-year bonds on behalf of the company.

[21] The eldest son of Chinese President, Jiang Zemin, is linked to the project unofficially through his role as IT supervisor to the Shanghai city's government. China Netcom's CEO is Edward Tian, a 37 year old national who was educated in the US at Texas Tech University.

[22] One of the first commercial offerings from Netcom, in late-1999, was pre-paid VoIP telephony services to the Chinese ex-pat community, estimated at some 50 million people, in the US and Japan. The service is to be made available via local resellers. On-demand content services will also be offered.

A2. COLOMBIA

A2.1 Introduction

In Colombia, the entire telecommunication sector operates in a competitive environment. There are more than 50 operators providing basic local telephone service, four cellular telephone operators, and over 100 value-added operators. Although the first liberalization provisions were put in place in the early 1990s, it took more than seven years to open up long-distance service to competition, and during that time the process was subject to various pressures from the main players involved.

In December 1998, Colombia became the first country in Latin America[1] to offer long-distance service from mobile telephones using Internet technology. The key factors in the emergence of this service were the steep advances in IP technology, the bold commercial moves on the part of one cellular company and an apparent lack of clear regulations governing cellular and Internet telephony. The process gave rise to three investigations by telecommunication regulatory and oversight bodies and a great upheaval in the sector.

Three operators participated in providing this service, two from their cellular networks and one value-added operator that completed the link. After nearly nine months of operation, the service was suspended at the initiative of the value-added operator.

The authorities have just wound up two of the three investigations. In the first of these cases, the penalty imposed on each of the two cellular operators and the value-added operator was a fine (1'000 times the monthly minimum wage, an amount equivalent to approximately US$ 140'000), and in the second, a fine was imposed while the long distance operators were given 15 days to present a claim for the damages generated by the conduct of the IP Telephony service provider.

The prosecution of the cellular and value added companies for providing IP Telephony services over their networks is one of a number of actions brought by the national administration to deter the diffusion of illegal or unauthorised IP Telephony services in the country.

In the second half of 1999, in response to complaints by long-distance operators, and on the basis of allegations to the effect that unauthorized international voice transmission services were being provided by some operators, the judicial authorities conducted inspections of the head offices of more than 20 operators legally established to provide value-added services. Some of the operators were closed down and charges were laid; these cases have not yet been resolved.

In these circumstances, the agencies responsible for regulating telecommunications in Colombia are facing the challenges posed by globalisation and convergence, as well as facing the task of promoting the development of the Internet as laid down in the National Development Plan.[2] These agencies are being called upon to resolve the delicate conflicts that have arisen as a result of operators with value-added licences offering IP Telephony services.

A2.2 The Internet in Colombia

Telecom[3] established its first Internet connection in March 1994. The precursor to that connection, however, dates back to 1986, when a group of Colombian institutions joined together in an effort to establish computer services for the country's higher education system. This was the first step in providing access to a global data network through connection to Bitnet.[4]

The number of Internet servers in Colombia has grown exponentially, rising from 63 in 1994 to 47'155 in July 1999. As of early 2000, there were some 162'000 Internet accounts, including some 18'000 business accounts. Taking into consideration those users who access the Internet from cafes, or from universities, and those who have access through local networks in companies and organizations, it is estimated that there are some 500'000 regular Internet users in Colombia.[5]

However, many users still have limited access to PCs and modems and are, at present, unable to acquire their own due to the low level of the average income and the high cost of such equipment. The monthly income per capita in 1996 was US$ 182 and the cost of purchasing a computer and a modem was approximately US$ 1'300, so purchasing the necessary equipment to access the Internet would require more than seven times the average monthly income. In comparison, the cost of a television set is approximately US$ 150,

which means that buying a television requires less than the average monthly income.[6] Consequently, it will be some years before Internet access is extended to the majority of Colombians, unless a clear national strategy is developed and successfully implemented.

There is a considerable number of ISPs operating in the Colombian market. Of the 134 firms that hold a value-added licence issued by the Ministry of Communications, only the larger players like Telecom, Latinonet, Impsat, Cablenet, EPM, Telesat, Colomsat, Global One, Rey Moreno, and 54 others of various sizes, offer Internet connections. However, the bulk of market share in Colombia is divided between only a few of these ISPs.

As of early 2000, a wide variety of rate plans were to be found, starting at as little as three dollars for four hours a month. The rate for unlimited Internet access ranged between US$ 15 and US$ 40 per month, at speeds of 30 to 56.6 kbit/s. Cable television operators in Bogotá offered home Internet access in addition to the regular television service for US$ 340, plus US$ 60 per month for 300 MB. Although this price included a modem, installation and a network card, clearly, these are not competitive prices for residential service.

The wide variety of existing ISPs have brought a great deal of competition and, consequently, a broad array of services, prices and promotions are being offered. Since January 2000, for example, one company has been offering Internet access free of charge, a development that will surely lead to significant changes in the pricing scheme currently in force in the market. Another company has been offering a computer with an Internet connection for US$ 50 per month under a locked-in three-year contract, and many firms are offering special rates for students.

Most ISPs are connected to basic local networks by means of switched lines or access connections, or by means of E1 lines leased under individual contracts which are usually the same sort of as those for end users. Thus, approximately 50 E1 lines account for the total transmission capacity of all Colombian ISPs having servers in the United States. Some ISPs, however, have the potential to expand that capacity immediately, among them Telecom and Global One. In 1999, IP connections grew by 250 per cent (20 per cent of the capacity is by fibre optics and 80 per cent by satellite).[7]

Recent months have seen a spurt in the volume of Internet traffic originated by the ISPs linked to the NAP. This is evidence of the clear growth trend for all service providers. Most of the rapidly growing traffic is linked to the various services offered by companies in the market, such as e-mail, VPN, application hosting, content services, Web browsing, distance learning and network management. At the end of 1999, the sites most often visited included banks, radio news programmes, a newspaper, the Ministry of Health, the Chamber of Commerce, a university and an airline.[8]

A2.3 IP Telephony in Colombia

In the various sectors of the economy, the Internet is seen as something that is necessary for the development of modern society and very important for economic development. However, most telecommunication operators in Colombia have not been thinking seriously until recently of using Internet technology to offer their services.

The first and only case until early 2000 has a cellular phone company-Comcel-which apparently was not able to offer the service according to existing laws and regulations.

In local telephony, which is completely open and where there are no regulatory restrictions, there is no evidence at all of any initiative on the part of these operators.[9] The largest cable television service provider in Bogotá-Tvcable-with more than 200'000 subscribers and a cable network installed in good part of the city, is awaiting numbering assignment by the CRT to start providing local telephony. Their forthcoming service packages will include television service, Internet service, and basic telephone service. Another company that could easily get into the local IP market is the recently AT&T acquired Firstcom, a former subsidiary of Telecom as Teleductos. The company has a good infrastructure in Bogotá and other cities throughout the country.

In long-distance, Orbitel recently began testing a voice communication service that provides a connection to the operator from a computer, using Ericsson software. ETB hopes to be able to offer long distance IP service this year, but has no plans for local service. Telecom appears to be planning to offer IP voice services this year at lower cost.

Table A3: Defining Telecommunication Services
Decree Law 1'900 of 1990

Services		Definition	Criteria for the granting of telecommunication service concessions
Basic	Carrier services	Those services which supply the necessary capacity for the transmission of signals between two or more specified points in the telecommunication network. They include those services that are provided over circuit-switching or packet switching networks and those that are provided over non-switched networks. Examples of such services are those for the leasing of insulated pairs and of dedicated circuits.	May be granted to duly constituted specialized companies. Holders of concessions for basic services may not provide telematic or value-added services unless they hold the corresponding licence. Concession contracts for telecommunication services covering the operation and exploitation of the different types of basic service and of indirect broadcasting services are administrative contracts governed by the provisions of Decree Law 222 of 1983, or by any provisions that replace, modify or amplify it, or by the present Decree.
	Teleservices	Those services which in themselves provide the full capacity for communication between users, including terminal equipment functions. Such services include telephony (fixed, mobile and cellular mobile), telegraphy and telex.	
Broadcasting services		Those services in which communication is effected simultaneously and in one direction to various points of reception. Such services include sound and television broadcasting.	Through direct contracting, with the proviso indicated in the following article.
Telematic services		Those services which, using basic services as their support, provide for the exchange of information between terminals with established protocols for open interconnection systems. Such services include telefax, publifax, teletext, videotex and datafax.	Granted by means of a licence, within a framework of free competition, for both the national and international services.
Value-added services		Those services which, using basic, telematic or broadcasting services, or any combination thereof, provide full capacity for the transmission or exchange of information and which add additional facilities to the support service or satisfy specific new telecommunication requirements. Such services include the accessing, transmission, processing, delivery and recovery of stored information, electronic fund transfer, videotext, teletext and e-mail. Only those services that can be differentiated from basic services may be considered value-added services.	
Auxiliary assistance services		Telecommunication services that are linked to other public services for the purpose of ensuring the safety of human life, State security or for humanitarian purposes. Such services include radio services for distress and the safety of human life, and to assist in meteorological provision and aeronautical or maritime navigation.	Granted by means of a licence.
Special services		Those services intended to satisfy, without any kind of profit or business motive, needs of a cultural or scientific nature. Such services include the amateur service, experimental services and services relating to industrial, scientific and technical research.	

Source: Decree 1'900 of 1990.

Value-added companies have very good prospects of getting into the local IP Telephony business, since they know the business, they have the equipment, and have operating structure in place. There is, however, strong constraints imposed by the cost of long-distance service licences (US$ 150 million) and pressures of companies that have already paid for such a licence to keep the market closed to new entrants. Hence, it will be difficult to open up the long-distance market entirely unless some significant regulatory reforms are carried forward.

A2.3.1 Legal aspects of Internet voice service

It has been recognized since the advent of Internet access in 1994 that value-added service operators are legally authorized to permit access to the network and that such operators may connect to local networks by means of switched access or any other interconnection provided that it is acceptable to the interconnecting operators. Value-added operators may also build and operate their own bearer or transport networks, if they have the proper licence. These general principles were set forth at the beginning of the 1990s by Decree-Law No. 1'900 that was later amended by Regulatory Decree 1'794 of 1991. [10]

Colombia's new Constitution[11], which came into force in 1991, established that, while public services are inherent to the social aims of the State, private providers may still supply these services. This had not been explicitly stated before. Pursuant to the Constitution, Law 142, better known as the Law on Public Utilities was enacted in 1994. In addition to creating the CRT with a view to promoting competition in basic local telephone services, this law required the long-distance service be opened to competition, established that companies could freely enter the market for local telephone services, and set out the principles governing such services. This Law also created the Superintendencia de Servicios Públicos Domiciliarios [Office of the Superintendent of Public Utilities] and established it as the agency responsible for monitoring and overseeing telecommunication, water, electricity, sewerage and gas services. The enacting of this law, in 1994, coincided with the arrival of the Internet in Colombia.

It was not until 1997 that the CRT, after a lengthy reform process, managed to open the market by issuing Resolutions 86 and 87 of 1997. Although those Resolutions did not contain any specific provisions with respect to the Internet, they did set a price of US$ 150 million for licences for new long-distance operators. Taken together, this fact and the existing provisions have caused problems in the overall regulatory structure, particularly in regard to the desired atmosphere of liberalization for promoting the use of the Internet and its applications.

A2.3.2 Long-distance operators and value-added operators

Without a doubt, value-added operators can offer more services nowadays through the Internet than those referred to (in a non-exclusive listing) in Decree-Law 1 900 of 1990.[12] In the early licences, there is tacit acceptance of value-added operators being able to handle voice traffic, if they do so under special conditions. The CRT and the Ministry of Communications have just made their official decision public in this matter, by means of an opinion (see Box 3) and Resolution 70/00, whereby the Comcel case was resolved.

Rapid technological innovations and the convergence of technologies and services have posed significant challenges to the existing regulatory frameworks in most countries. Colombia has been no exception in that regard, and a number of value added operators in the country became increasingly involved in the transmission of voice over data networks.

Several of these operators have been affected recently by the actions taken by the Fiscalía [Office of the Inspector General], at the end of 1999, which started investigating at least 20 of them on the basis of accusations made by Telecom that they were transmitting voice over their networks.

Apparently, there was a considerable amount of traffic being routed in the form of data over IP networks, because the three long distance operators-namely Telecom, ETB and Orbitel-saw their traffic increase considerably after Fiscalía started investigating the value-added operators-according to unconfirmed reports, traffic to and from the United States increased as much as 50 percent.[13]

Countries, such as Argentina and Colombia (whose settlement rates with the United States on 1 March 2000 stood at 27 and 32.5 US cents per minute respectively), have been 'punished' by US carriers that have routed increasing volumes of traffic to those countries via refile or routes which bypass the accounting rate mechanism, such as the Internet. In the case of Argentina, estimated bypass traffic amounts to almost the same as the total reported volume of traffic on the route to the United States in 1998 (i.e., just over 200 million minutes). In the case of Colombia, where call-turnaround was historically less significant, estimated bypass traffic amounts to around 160 million minutes. At the level of settlement rates that prevailed in 1998, the losses incurred by Argentina and Colombia from bypass traffic were over US$ 60 million for each country.

In the process of opening the Colombian market to competition, telecommunication legislation has become very complex. In the course of this process, penalties including imprisonment can be imposed[14] for failure to abide by telecommunication rules and regulations. As new services emerge the legislation often has to be amended or supplemented with opinions. These usually arouse controversy and debate amongst those concerned, namely the value-added operators, long-distance operators, and cellular operators.

These difficulties can be compound by technological issues. To take the case quoted above, when an operator is in a position in which it is practically impossible to control or stop the service. How can an operator tell the difference between Internet traffic originating by means of web-to-phone software and traffic originating at a telephone on the basic switched network? The question then arises as to whether hardware or software is available that the operator can use to filter communications transmitted on its network in order to ensure that it is not providing the unauthorized service and, if such hardware or software does exist, whether it is logical to force the operator to buy it or to force the user to deprive himself of the service. Whether regulation focuses on how the Internet is used or on the user's experience, the outcome is the same.

It is important to recognize that all the voice services that can be offered over the Internet are liberalized. Voice over the Internet is not subject to any regulatory restriction of any kind if it is provided from or to a computer.[15] On the other hand, existing provisions establish regulatory barriers which restrict access to international long-distance voice services via the Internet when such service is offered to or from a cellular telephone by operators other than those authorized to provide international long-distance service[16] or when the communication originates and terminates at a telephone.[17] This does not imply that authorized operators have any restriction on using IP technology or any other technology of their choosing in their services or networks. It is the government's policy to promote the Internet, as set forth in the development plan, and clear activities in support of this are envisaged, such as considering Internet access to form part of the universal service.

As Internet coverage and access are broadened, there are ever more opportunities to use the Internet to offer voice services. The fact that all Colombian ISPs can be accessed from the United States means that the free calling offered via the Internet in the United States, or via toll-free "1 800" numbers, can also be offered from Colombia.[18]

It is very difficult, if not impossible, to maintain the regulatory structure that has existed in the past without taking into account the rapid technological change that the industry is experiencing. To what extent can services which are perceived by the user to be the same be defined in the rules and regulations as being different.

A2.4 The case of Comcel

In late 1998, Comunicación Celular S.A. (Comcel), one of the operators holding a cellular mobile telephone service licence, concluded a contract with another value-added operator to offer a voice service via the Internet, which in the view of many in the telecommunication sector was illegal.[19] The companies that had just received licences to provide long-distance services for which they had paid US$ 150 million each, immediately raised formal complaints on the legality of the service offered by Comcel. The national administration subsequently launched three investigations, of which two were completed by the beginning of 2000.

The conflict erupted at the end of 1998 when Comcel (of which Bell Canada International was the majority shareholder) published on 20 December 1998 in *El Tiempo,* one of the country's leading newspapers, an advertisement announcing that it was offering its more than 500'000 users a new service based on IP Telephony. The advertisement stated:

> *"Exclusively for Comcel users. Now it costs less to phone anywhere in the world with your Comcel cellphone than from a regular telephone. Using your Comcel cellphone you can call anywhere in the world and talk for just 770 pesos a minute (plus VAT) all inclusive, any time, any day. Just dial #124 + country code + area code + telephone number + Send."* [20]

Orbitel, one of the new long-distance operators, immediately accused Comcel of operating in breach of telecommunication rules and regulations.

The next day, the CRT issued two resolutions:

- The first established that all companies other than basic service providers that provided telephony services or were preparing to provide telephony services, regardless of the technology used, were brought under the regulatory function of the CRT and the oversight of the Office of the Superintendent of Public Utilities (SSP).
- The second ordered that an administrative investigation be started against Comcel S.A. to determine whether the service being offered by that firm could constitute unfair competition or lead to a reduction of competition between public telecommunication service companies.[21]

The Ministry of Communications also opened a preliminary investigation on 22 December 1998. Its purpose was to determine whether there were grounds for Comcel being considered in breach of the telecommunication rules and regulations, and in particular in breach of the system for licensing the mobile cellular telephone service, by providing IP voice service for long-distance communications.

Finally, the Superintendencia de Industria y Comercio opened an investigation as well to determine whether Comcel had engaged in unfair competition or had obtained an illegal competitive advantage.

While from the standpoint of the relevant regulations and authorities, Comcel may have been in breach of rules governing the provision of services in the telecommunication sector, from the standpoint of the user, Comcel offered inexpensive international calls to any other telephone located anywhere in the world. Furthermore, the quality of the service, which often undermines IP Telephony services to the public, seemed to be quite reasonable.[22]

The arguments presented by Comcel, Occel and Rey Moreno to defend their service were oriented towards demonstrating that Rey Moreno was providing its service to a specific group of users of the basic Comcel and Occel support service, and that Rey Moreno was adding value. The communications in question were neither basic switched international long-distance telephony nor cellular mobile telephony. Accordingly, the provisions requiring long-distance communications to be handled through licensed operators did not apply.

The curious point about Comcel's activities is that it is a major, well organized cellular provider. With over 26 per cent of the country's cellular-telephone market, it is ranked among the top companies in the country, and it is in a good position to compete and expand its presence in the market.[23] Why then would such a company decide to offer a service that would cause it such great problems?

The most reasonable explanations revolve around the notions that Comcel managers:

- were sure that they could provide IP Telephony services and were empowered to do so under the existing rules and regulations;
- were not satisfied with the original conditions of their licence, and believed that the lack of regulatory clarity gave them good reason to take risks and press for regulatory change; [24]
- believed that offering IP Telephony service through their network was an effective way to compete and to open new horizons in the market, while the legal risk of doing it was very low and could justified the decision to offer the service.

Indeed, the regulations in place include three important distorting factors, and taken together they make for a competitive environment which has certain deficiencies. For example:

- Cellular service operators are required to use legally established operators and do not receive any compensation for initiating or completing an international long-distance call through the companies that hold long-distance licences;
- Billing is based on the "calling party pays" principle.

For these reasons, the cellular companies had in various ways restricted long-distance service from cellular telephones. Not all users can access domestic or international long-distance service. In the case of Comcel, only 3 to 5 per cent[25] of its subscribers have the service because subscribers must make a separate application for it, must demonstrate their ability to pay and must complete other procedures that makes it cumbersome and difficult to obtain the service.

When Comcel started offering its new service in December 1998, this coincided with the start of operations of the new companies that had obtained their long-distance licences a year earlier. Both the new long-distance operators and the established provider did a great deal of advertising suggesting that international long-distance charges were falling, and this caused an increase in the amount of traffic on cellular networks connecting to long-distance services. This brought about an increase in the amount of long-distance traffic being carried on cellular services, yet without the cellular services receiving any compensation for it. This distortion altered the structure of the cellular companies' revenues and expenses.

If one analyses the telecommunication services price structure, the prices offered by the #124 service would not make the cellular user a clear winner, since most of the traffic is to the United States, and the promotional rates to that country offered by the new long-distance operators were lower and with a much higher level of quality than those offered by Comcel's IP Telephony service. Generally speaking, the new service seemed to be aimed at broadening the alternatives available to cellular users and serving a market artificially closed by the same operator. This is borne out by the traffic volumes that the #124 service attracted in December 1998[26], when calling demand was high because of the holidays. Perhaps the appeal to a cellular user is being able to access the long-distance service from his automobile or when he is on the move.

Comcel's IP Telephony service was offered for more than nine months, until the value-added company decided to suspend it. The company was taken over by Spain's Telefónica group in the first half of 1999, and this was a determining factor in the decision to suspend the service, alongside the pressure of the government investigations.

The most important issue related to the introduction of this new service is that it gave a clear signal of the change in the structure of telecommunication services that was forthcoming thanks to the advent of the Internet, and particularly the need for the regulatory structure to evolve, accepting this new world and keeping pace with its development.

Box A3: Enforcing the law

The Ministry of Communications issued Resolution 70 on 2 February 2000, by which it ended an administrative investigation concerning the three companies involved in the IP Telephony case and imposed penalties on them. The main body of the document, accounting for 14 pages out of the total 30-page length of the resolution, describes the service and analyses it against the criteria for defining a value-added service. It then discusses the four elements that distinguish the nature of a value-added service: that it must be a support service; that it must add features to the support service; that it must have distinguishing characteristics; and that it must satisfy specific new telecommunication needs. It then goes on to say, "It is not sufficient, then, under Colombian law, for it to possess the distinguishing characteristics referred to in Decree 1'794 of 1991, inasmuch as the conditions established in Decree-Law 1'900 of 1990 must be met in their entirety, and it cannot be considered a value-added service if any one of those conditions is not met." Its final conclusions with respect to the #124 service were as follows:

The providers of the service were Comcel and Occel, the cellular providers, and not Rey Moreno, the operator of the value-added service.

The communications used Internet Protocol technology but did not access the public Internet.

"Colombian law classifies telecommunication services on the basis of a methodology and criteria focusing on an analysis of functionality, and not on the basis of purely technical criteria."

That the #124 service constitutes a teleservice[27] in which a connection is made between the TMC networks and the value-added networks of the operators involved, and one that the operators are not authorized to provide.

That the definition of teleservices is not exclusive, and permits the provision of services not expressly described in the rules and regulations, provided that such services conform to the applicable terms and conditions and classification criteria.

The penalty imposed on each operator was a fine of 1'000 times the monthly minimum wage, an amount equivalent to approximately US$ 140'000. In the case of the Resolution by the Superintendencia de Industria y Comercio, the penalty was a fine—imposed only on Comcel—of 2'000 times the monthly minimum wage.

Source: Adapted from Resolution 70 of February 2000.

This situation led to great concern on the part of the CRT, and consideration is being given to courses of action which would lead to removing regulatory barriers without creating alarm amongst operators and other players. What is clear from the government's standpoint is that it believes in the importance of promoting the development and implementation of new uses of the Internet as they arise.

During preparation of the present report, the Ministry of Communications and the Superintendencia de Industria y Comercio wound up their administrative investigations. The Ministry imposed penalties on the three operators Comcel, Occel and Rey Moreno. The decision was appealed by Comcel and confirmed by Resolution 984 of 8 May 2000. The Superintendencia's decision to fine Comcel and allow damage claims by the long distance operators has been appealed and a final decision is expected by mid June 2000. It is expected also that CRT will probably conclude its investigation soon. Most likely the regulatory agency will close the case without a specific pronunciation because it has become evident through the other two resolutions that the services were illegal, and, in such cases CRT would have not jurisdiction.

A2.5 Conclusion

IP Telephony in Colombia, as elsewhere in the world, has been emerging in an environment which is open to competition but in which operators are subject to regulatory restrictions in the form of many permits, too many regulatory bodies, costly licences, and the prospect of imprisonment for anyone in breach of the telecommunication rules and regulations.

Regulatory restrictions, like artificial barriers, do not just foster the emergence of services outside the strict scope of application of the rules, as in the case of voice service offered by a cellular company, such situations also sew confusion and regulatory uncertainty.

In conclusion, the limitations imposed by the traditional regulation of communication services, coupled with a lengthy process of liberalization, has helped to produce levels of confusion that may be exploited by companies that are aggressive in their approach to the market and their application of new technology.

In the case of Comcel, the outcome of the investigations was one that maintained the market structure in the sector. However, the pressure of technological advances will make it impossible for the small apparent limitations that exist in the regulation of telecommunications in Colombia to be maintained for much longer.

This is borne out by the fact that exclusivity in cellular service has already ended, and that no exclusivity or special rights have been given to the operators that have obtained long-distance licences. As new applications involving the Internet emerge day by day, this will broaden the spectrum of voice communications and cut the price at which this service is offered to the barest minimum, leading users to press for a complete opening of the market. Thus, today's regulatory restrictions will be resolved either by the regulatory agency opening the market altogether, or by these technologies being implemented in ways that bypass regulatory restrictions and are difficult to police.

One lesson to be taken from this situation is that regulatory functions must keep pace with the technology. Rules and regulations have to be devised in such a way as to accommodate change and innovation, they must be clear and simple to avoid confusion, and they must pave the way for economic development without limiting users' access to the most convenient technologies and services available. In the case of Colombia, recent developments in the area of IP Telephony will certainly have negative consequence in the recently launched "Connectivity Agenda"—unless regulatory and policy bodies find positive ways of solving conflicts of the nature of those presented in this case.

[1] According to the operator's advertising when it began offering the service.

[2] On February 2000 the President of the country issue a document entitled "The Connectivity Agenda: The Internet Jump", that presents a number of strategies and actions calling the country to embrace the information technologies with the aim of constructing the information society as national goal.

[3] Telecom is a corporation established in 1947, which held a monopoly on long-distance service until 1997.

[4] In the late 1980s, Telecom built the X.25 data network which it believed would be the underpinning standard for this service. This was critical in connecting the Colombian universities to Bitnet.

[5] CRT, "Propuestas al Esquema Tarifario de Acceso a Internet, Enero 24 de 2000" ["Internet access rate proposals, 24 January 2000"]. This provided for 380'000 dedicated and university users, 110'000 dial up users and 4'000 users connected by cable modem.

[6] The density of television sets per 100 inhabitants is a better indicator, which suggests that a Web-TV system could gain acceptance in Colombia. Even though, with nearly 22 television sets for every 100 inhabitants, Colombia ranks 98th among countries worldwide, it ranks close to its Latin American neighbours. On the other hand, it does indeed fall behind in comparison with the most developed countries, which in every case have more than 45 television sets per 100 inhabitants.

[7] "Los servicios de Internet en Colombia" ["Internet services in Colombia"], R. Lievano, Adviser to the General Coordinator of CRT. Paper given in La Jolla, California, on 9 November 1999.

[8] See <http://www.nap.com.co>.

[9] Even in Compartel I, the programme recently launched by the Fondo Nacional de Comunicaciones [National Communications Fund] with the aim of providing low cost communication services IP services have not been considered at all. In Compartel II, a move towards the Internet services is expected.

[10] Decree 1 900 of 1990, which has the validity of a law as it was issued pursuant to the special powers given by the Congress to the President.

[11] This did not amend Decree 1 900 of 1990.

[12] According to Article 31 of the Decree-Law, "These services consist, inter alia, of the accessing, sending, handling, storage and retrieval of information, electronic fund transfer, videotext, teletext and electronic mail."

[13] One problem for the regulatory authorities is the lack of reliable information, particularly in regard to long-distance traffic. Initially Telecom considered this information confidential, and this has made it difficult to obtain historical series that would provide accurate and reliable data, and hence valid studies. Responsibility in this area has subsequently been scattered among a number of bodies, particularly the Ministry of Communications, the CRT and the Office of the Superintendent of Public Utilities, and of course these bodies have had no structure in place to handle or process the data, or produce timely reports. The most recent reforms have brought institutional clarity to the issue, giving the CRT responsibility for preparing a corpus of data on the sector, with the Ministry of Communications and the SSP as participants in this effort. The CRT is now setting about this important task, which will be of great benefit to the entire sector.

[14] Law 422 of 1998 states in Article 6: "Anyone who accesses or uses the cellular mobile telephone service or any other telecommunication service by means of the unauthorized copying or reproduction of signals which identify terminal equipment for such services, or taps, or use of unauthorized lines of the local switched basic public telephone service, extended local service, or long-distance service, or who provides or engages in unauthorized telecommunication services or activities for profit shall be subject to imprisonment for a period of from four to 10 years and a fine of from 500 times to 1000 times the monthly minimum wage established by law."

[15] It is worth stressing, however, that the regime governing both basic service and value-added service is one of open competition, and that while basic long-distance telephone service has to meet certain conditions, there is no express limitation on the number of operators that may be authorized to provide it.

[16] See Resolution 70 of January 2000.

[17] CRT opinion, "Concepto sobre criterios diferenciales de los servicios de valor agregado" ["Opinion regarding differential criteria for value-added services"], 19 January 2000.

[18] Dialpad offers free calling throughout the United States; Net2phone offers free calling from Colombia through a toll-free number.

[19] Although this paper refers to the case of Comcel, it in fact covers both Comcel and Occel as Comcel has purchased Occel and both are administered by a single president. The two continue to exist as separate entities because they cover different geographic areas of the country.

[20] The advertisement made clear reference to the fact that the new service would be based on IP technology, saying, "Thanks to Internet Protocol technology, talk to […]. The new service […] is based on the latest IP technology, […] Comcel is the first operator in Latin America to offer this IP service […]" and so on.

[21] The CRT investigation, owing to meticulous respect for due process and the right of defence, took more than a year and produced a dossier of more than 1'500 pages. The last action taken as part of the investigation was the issuance of Resolution 176 of December 1999, which left the CRT's decision in abeyance pending a decision by the Ministry.

[22] Indeed, in the investigation carried out by the Comisión de Regulación de Telecomunicaciones [Telecommunication Regulatory Commission] (CRT) on the provision of IP voice service, the following exchange took place, as transcribed in the background information included in the dossier: "Question: 'We're doing that test I told you about. Would you please tell me what time it is now in your location and how good the connection seems? How well can you hear me?' Reply: 'I can hear you very clearly.' Question: 'Do you sense any difference between this service and the service that you usually use for your international calls?' Reply: 'No, no difference. Sometimes there's an echo on regular calls to Colombia, but there's no echo on this line, I can hear you just fine.' "

[23] Although there are nominally six companies in Colombia's cellular-telephone market (two in each geographic region), effectively they have become consolidated into four service providers as two of them have been taken over by companies operating in the central region. In the central and coastal regions, operators have split the market fairly evenly, with each having won about 50 per cent of the subscriber base, while in the western region one of the operators has taken a lead, having won 56 per cent of the subscriber base compared to the other's 44 per cent.

[24] This latter approach is in part reflected by the "laws" that the president of Comcel seemed to go by. In his office's reception area they hand out a brochure that begins with the sentence "Laws should be broken if the circumstances require and you are willing to face the consequences, especially if they are obsolete and stand in the way of success. Three of what have come to be known as Peter's Laws are: "9. If you can't win, change the rules! 10. If you can't change the rules, ignore them! 15. Bureaucracy, like any other challenge, can be beaten by an unflinching approach, a tolerance for stupidity and, if necessary, a bulldozer."

[25] Statement by the president of Comcel in the CRT investigation dossier, Resolution 132, Comcel.

[26] According to the CRT dossier, traffic volume was between 6 000 and 20 000 minutes per day in December 1998.

[27] Teleservices are telephony, telegraphy, telex services, etc.

A3. PERU

A3.1 Introduction

An advertisement appearing in *Caretas* magazine and offering reduced tariffs for long-distance national and international calls using "APLIO" equipment resulted in the entity responsible, the Red Científica Peruana (RCP) (Peruvian scientific network), receiving a notification from OSIPTEL, the Peruvian regulatory body. It had been officially reported to OSIPTEL for offering long-distance national and international telephone service without having the necessary authorization. The complaint was made by the principal telecommunication operator Telefónica del Perú (TdP), which hitherto had been the sole operator for local and long-distance fixed telephony. TdP argued that RCP's provision of such services without having a long-distance licence from the Ministry of Transport and Communications constituted unfair competition to TdP's detriment.

"APLIO" is an apparatus that facilitates the transmission of telephone calls via the Internet, using the Internet Protocol (IP) suite.[1] While both the calling and called parties must have a telephone line and active Internet connection, a computer is not necessary. Rather, APLIO allows the caller to use an ordinary telephone. The telephone is plugged into the APLIO device, which itself is plugged into a standard telephone jack. Thus, any telephone subscriber who also has Internet access can make long distance and international calls via IP Telephony. At the time of the complaint, however, RCP was only authorized to provide value-added services, Internet access being one of them. It had no legal authorization to offer long-distance or international telephone service.

Several months after the complaint was made, OSIPTEL issued a ruling stating that no licence was required for marketing the APLIO device, and that RCP, like other bodies marketing the same equipment, was not contravening any regulations or the terms of any existing licences by doing so. In addition, marketing the equipment could not be deemed to be equivalent to providing the long-distance telephone service.

At this time, the subject of IP Telephony was the focus of heated discussions in various forms outside telecommunication circles. A pronouncement from a state body, in this case OSIPTEL, was necessary since even limited awareness of this new service was giving rise to all sorts of comments. Some opinions emphasized the tariff advantages for the user, who would now have a much cheaper alternative to traditional long-distance telephony. Others discussed the subject of quality in voice transmission and the possibility of putting switched telephony in its place, while others ventured to discuss the legality or otherwise of offering such a service in Peru.

Even though the ruling issued by OSIPTEL in the APLIO case gave an early hint of the direction which state policy might follow on the matter of IP Telephony in the future, TdP successfully pursued a legal strategy to nullify its effect. This prevented the establishment of a legal precedent on the matter. Regrettably, therefore, the various opinions about IP Telephony are still circulating a year later, and there is no expectation of an explicit, formal pronouncement from any telecommunication authority in the near future.

In spite of this, the situation has changed somewhat since the time the complaint was made, in that there are now numerous other companies offering voice over IP (VoIP) services, or planning to do so soon.[2] A large group of those firms are new licence holders for long-distance or local telephony. Thus, although the subject has not been defined in legal terms, the companies have opted to play it safe by obtaining licences to provide the service. The emergence of many new licensees, especially for long-distance telephony, has been made possible by the Ministry of Transport and Communications' sensible policy of granting licences since the full liberalization started in August 1998. Under the new license policy adopted since then, practically any applicant can obtain a long-distance licence without incurring substantial monetary or transaction costs.

TdP's monopoly in local and long distance telephony ended officially in August 1998. However a set of TdP's dilatory practices have effectively delayed the beginning of the operation of new local and long-distance carriers. For instance, the first new long distance carrier began operation more than a year after liberalisation of the market. Local exchange carriers are still delaying their network deployment until the interconnection charge for local termination/operation is lowered from its current rate of 2.9 US cents a minute. As of May 2000, OSIPTEL, which has stated that it will issue an interconnection mandate, will set the new rate for local interconnection.

The subject of IP Telephony relates closely to other aspects of the Peruvian telecommunication market. For this reason, a more detailed analysis of IP Telephony in Peru is required, including the accelerated development of telecommunications in recent years, the appearance of new players in the market – Internet service providers (ISPs), new long-distance competitors, etc. – legal aspects, and the regulatory framework.

A3.2 The Internet in Peru

As in other countries, the Internet started off in Peru as a network linking the country's scientific community (universities, research centres and non-profit organizations). The Red Científica Peruana (RCP), a non-profit organization, coordinated efforts within the academic and scientific communities, and first enabled academic Internet access services in December 1991. As early as 1994, RCP started selling commercial Internet services. By 1996, both IBM and TdP also begun to offer services.

The estimated number of internet users in mid-1996, (dial-up and dedicated) has been put at around 30'000, while by the end of 1999, this figure was around 500'000 – close to a 15 fold increase in less than three-and-a-half years. Internet user penetration grew from 0.1 per cent to 1.9 per cent during the same period.[3]

As regards the number of companies in the Internet market, it is interesting to observe that owing to favourable market conditions, the situation has changed from a duopoly, existing until July 1996, to as many as 54 ISPs two years later. The services provided by these ISPs have generated a rapid expansion in Internet traffic, which grew by nearly 80 per cent during 1998/99. This meant that the share of Internet traffic in all local switched traffic rose from 5 per cent in 1998 to 9 per cent in 1999.

Since July 1998, the number of ISPs has been falling owing to a consolidation of the industry in the hands of TdP via the bigger CPIs affiliated to it. Nevertheless, in the last quarter of the year growth has been apparent in the number of companies authorized to provide this service.

Table A4: A market showing constant growth
Indicators for Peruvian market in telephone access to the Internet, December 1999

		InfoVía traffic ('000 minutes)	Variation	Dial-up users	Dedicated users	Total	Variation	Number of ISPs
1998	I	68528	n.a.	48200	160000	208200	n.a.	54
	II	91280	33%	66500	180000	246500	18%	54
1999	III	120288	32%	83400	201700	285100	16%	42
	IV	139804	16%	83600	218000	301600	6%	37
	I	144998	4%	92000	255200	347200	15%	42
	II	175850	21%	99000	287000	386000	11%	42
	III	203469	16%	108000	317000	425000	10%	46
	IV	225463	11%	120000	380000	500000	18%	56

Source: OSIPTEL

A3.3 IP Telephony in Peru

The development of private VoIP networks in Peru has basically been spearheaded by large private companies, such as banking institutions, industries or firms involved in natural resource extraction with multiple points of presence in the country, such as mining and oil companies, etc. The construction of private communication networks took place chiefly to reduce costs, the only other alternative being to use public networks, which were still under a monopoly until 1998, as is the case with local fixed telephony.

Currently many companies such as Banco Continental, Banco Latino and Banco Interbank use voice over frame relay internally to supply voice and data services between their regional offices. The migration to an IP platform is said to be recent, largely because, at the time voice over frame relay was chosen, IP technology had not yet gained the full confidence of these companies.[4]

There are basically three means of providing the VoIP service: between two computers, between a computer and a telephone, and between two telephones. The simplest case is communication between two users who, using a computer and an Internet connection, use software which enables them to transmit voice across the

public Internet. The most widespread example is the NetMeeting software, which is supplied free of charge by Microsoft, bundled with its Windows operating system. Callers are not usually charged for using the service, as it is simply an application facilitated by the Internet. Users incur costs for the use of the telephone line (to connect with their ISPs) and for ISP charges, but they do not pay separate charges for the transmission of their voices over the Internet. Thus two users in different parts of the world can enjoy long-distance communication at minimal cost.

Internet telephony and VoIP services are being offered by some of the country's leading telecommunication operators, ISPs and new commercial entities. A brief description of the main players is given below.

***Telefónica del Perú*:** This is the dominant telecommunication company and the top company in terms of revenue in the country. It has total vertical integration of its operations. Since 1996/97, it has been implementing an IP network in Peru, in the same way as the other subsidiaries of Telefónica de España have been doing elsewhere. Various sources say that TdP is already using an IP network for routing part of its long-distance and international traffic to other countries in the region.[5]

***FirstCom*:** This is a company with North American and Latin American (mainly Chilean) capital which began commercial operations in Peru in 1999. It also has operations in other Latin American countries (Chile, Brazil, Colombia). It constitutes what is known in other countries as a competitive provider of basic telecommunication services and its target clientele is business users. In early 2000, it concluded a strategic merger with AT&T, creating the company AT&T Latin America. The new company plans to compete in the Peruvian telecommunication market for long-distance (national and international) services, fixed telephony, wireless services and Internet access.

Investments proposed by FirstCom in Peru total US$200 million, and to date US$70 million has been invested in the fibre optic network and in network support equipment. In June 1999, its infrastructure consisted of a 760 km fibre optic ring in Lima and Callao, 25'131 km of fibre installed, 22 ATM nodes, 140 buildings wired, one long-distance exchange and one teleport.[6] Its basic transmission platform is ATM with IP overlaid. The company offers integrated services for the high-speed transmission of voice, data and video (including LAN interconnection, frame relay, access to remote terminals and dedicated Internet channels). It commenced long-distance operations in November 1999 and also supplies dedicated Internet access. In June 1999, it had 147 clients with dedicated Internet access. This year it plans to enter the local service segment, for which it already holds a licence.

***BellSouth Perú, S.A.*:** This is the second mobile service operator in the country after TdP. In 1999, it also obtained licences for long-distance and local services. In the short term, it is understood to have plans to provide Internet access via dedicated lines and eventually via cable TV.

Currently, it offers dedicated services, the public telephone service and cellular telephony. BellSouth acquired most of the shares of the cable company Tele2000, but it withdrew from the cable TV service offered by the latter, a service marketed as TeleCable. At present TeleCable is still operating but BellSouth states that it has only withdrawn from the cable TV service provision, not from the coaxial cable network covering the whole of Lima. Through this extended network, it should be able to provide Internet access, telephony, data transmission and other services. This would explain the obtaining of licences for long-distance and local services in 1999 and, it is already offering a long-distance international service to its mobile phone customers. In the short term, it is said to be planning to provide Internet access via dedicated services and eventually via the cable TV network. Although its plans for using IP (apart from the Internet) are not yet known, it is possible that this will be used for voice transmission when it enters the local telephony market.

***Red Científica Peruana*:** As stated above, RCP started to provide Internet access services from the beginning of the last decade. In 1999, total revenue was believed to have exceeded US$ 6 million, which constituted an increase of around 40 per cent over the previous year. During the same year, RCP acquired licences for the provision of long-distance and local services. At the end of the same year, RCP formed a partnership with a United States investment fund, Westphere, in order to develop its investments as a telecommunication operator. It announced an investment plan of between US$ 50 million and 60 million in the next two years, with RCP providing 52 per cent of the funding. The aim of the new company, called Red Uno Corporation, is to provide not only Internet services but also to bring together others such as long-distance telephony and television.[7]

Initially, it will provide long-distance national and international IP Telephony through prepaid cards. The commercial name of this service will be "Tarjeta Rojo y Blanco" (red and white card) and tariffs will be 40 to 50 per cent less than those of TdP for long-distance international calls. It is hoped that the product will be launched on the market during March 2000.

RCP plans to continue with the development of public Internet centres by installing an additional 400 public centres in the country. Likewise, it will start a new project for the implementation of a network of several "mono-centres" for access to integrated Internet and VoIP services. A "mono-centre" is a multimedia centre open to drop-in users giving access to the full range of media: TV, radio, Internet and telephony. The project also envisages the development of a major information network supporting urban management in commercial circles, sharing and backing up State administrative management. Covering the 23 departments of the country, the project will be implemented in the next three years, it will have its own satellite network and will require investment of US$ 12 million.[8]

***Net2Phone*:** This is one of the world leaders in Internet telephony, its market being retail end users. Net2Phone Perú has been operating in the country since September 1999. Gateways have been installed in Peru for connections with the public telephone network, and this will make it possible to originate and terminate telephone calls via the Internet.

Table A5 below shows tariffs for long-distance international calls between Peru and the United States via two methods: from PC-to-telephone and from phone-to-phone. In the first case, the tariff per minute for a call from Peru to the United States is US$0.15 via Net2Phone, which is quite attractive compared with the TdP tariff of US$0.66. It should be emphasized that the settlement rate (which is the equivalent of half the international accounting rate) that TdP has to pay to the United States carriers is currently US$0.31 per minute. This indicates that the settlement rate that Net2Phone Perú pays to Net2Phone USA must be much less than the rate paid by TdP, probably somewhat less than the peak tariff. A call from the United States to Lima has a tariff of US$0.21 per minute, while if the call is to a city outside the department of Lima, it has a significantly higher tariff.

An interesting aspect to note is that with the Net2Phone tariffs, it is cheaper to call the US from Peru than *vice versa*, unlike with traditional international telephony tariffs. For example, it was mentioned that currently the TdP tariff for a call to the US is US$0.66 per minute, which has fallen considerably from much higher levels owing to the rebalancing programme and ultimately to liberalization of the sector. Traditionally tariffs from the US to Peru have always been lower than from Peru to the US.

Net2Phone's phone-to-phone method is only available for calls from the US to Peru and tariffs are between 50 and 60 per cent greater than those for the computer-to-phone method.

Net2Phone announced publicly that it does not have a licence or a value-added authorization to provide this service, since, in its view, the Telecommunication Act allows this service to be offered without any kind of authorization or licence. The company also claims to have received communications stating that, to offer the long-distance service, it would require a licence. It has announced publicly its willingness to take legal action against any legal or natural person, whether in the public or private sector, who imposes any kind of limitation on the service which it is offering, and has also mentioned the possibility of taking the matter to the international courts.

When considering the question of demand, it should be emphasized that the Net2Phone service has been one of the most widespread among Internet users. In the first half of 1999, there were many complaints, some of which were aired in the press, that clients using TdP's Internet service were unable to count on access to Net2Phone's services from one day to the next.

It was argued that the Net2Phone equipment was at fault, unable to cope with such high levels of demand. However, in a counter claim, RCP published a complaint claiming that TdP had been blocking access to IP numbers identifying the Net2Phone servers, so that Internet users could not route calls via the Internet and were obliged to use TdP's services.

RCP argued that, according to its tests, access to Net2Phone was possible when the Internet was accessed other than through TdP. But it should be borne in mind that TdP (via Unired) is the dominant Internet service operator, providing even RCP with access. This was the reason why RCP lodged an official complaint against this situation, since many of its users were unable to make use of Net2Phone when the route to the Internet was via Unired.

Nevertheless, Net2Phone was not the only case where allegations arose of apparent blockages by TdP to prevent long-distance communications using this method. In addition, some users who had acquired APLIO appliances also began to have problems with using them. Some CPIs (Internet providers which use only TdP services: Unired and InfoVía) had begun to sell APLIO equipment, just like RCP and other firms. Nevertheless, none of these CPIs was denounced by TdP for offering long-distance services as had been the case with RCP. After a time, the CPIs that had marketed APLIO equipment stopped promoting them and subsequently stopped selling them.

Some users complained publicly that they had acquired this equipment from a CPI but that it had stopped working after a time. These users mentioned that when they complained to the CPI where they acquired the APLIO equipment, they were informed that the equipment only worked if an Internet service other than the Unired service was used.

Despite these complaints, the existence of blockages in access to the services of Net2Phone or of APLIO could not be proven. Such blockages began gradually to disappear without any pattern being found, nor was it possible to prove that they were caused by anyone in particular. At present, no further complaints have come to light regarding the alleged blockages in the use of Net2Phone. Even so, it resulted in RCP promoting its Internet service as being free of blockages and offering the unlimited possibility of using Net2Phone or similar services.

***Cosapidata*:** This is the TdP CPI with the largest number of clients, but it is also engaged in offering integrated telecommunication solutions to major corporations. These solutions include implementation of internal company networks for voice and data transmission, using frame relay technology in some cases and IP in others. The companies using these internal networks for voice and data transmission include AFP Horizonte, AFP Profuturo, Cía de Petróleos Shell, Grupo Daewoo and AFP Integra.

Table A5: Other voice routes

Net2Phone tariffs for calls between Peru and the United States of America, February 2000, in US$ cents per minute.

Origin of call	Destination of call	Net2Phone tariff	Time of day
a. PC-to-phone			
Peru	USA	15 (*)	Peak (7am-7pm)
		10 (*)	Off-peak (7pm-7am)
USA	Peru (Lima)	21 (**)	Any time
	Peru (outside Lima)	30 (**)	Any time
b. Phone-to-phone			
USA	Peru (Lima)	31 (**)	Any time
	Peru (outside Lima)	49 (**)	Any time

(*) Minimum prepayment of US$ 25. (**) Minimum purchase US$ 5.95
Source: Net2Phone Perú S.A.

***IBM*:** Like Cosapidata, IBM not only acts as an ISP but also creates internal networks to interconnect various subsidiaries of companies, whether at the national or international level. The networks created allow the transmission of voice and data, mainly using IP.

***Other companies*:** In this group of providers, there is huge variety in the size of the companies. Many have obtained long-distance carrier licences and their main business revolves around the possibilities of making profits from the international accounting rate system, which is still being used. Since the opening up of telecommunications in Peru to competition in August 1998, the Ministry of Transport and Communications has granted 30 new long-distance licences and applications from 10 to 15 more firms are in the pipeline. The objective of many of the new licence-holders is to make profits in the still lucrative business of international long-distance calls. The main business will be to obtain revenue from call termination in Peru, the traffic for which greatly exceeds outgoing international traffic by a ratio of three-to-one, i.e. three incoming minutes for each outgoing minute.

The current settlement rate (equivalent to half the accounting rate) that TdP pays or receives from generating or receiving international traffic with the United States is US$ 0.31 per minute. Many new entrant long-

distance companies have commercial agreements for the termination or origination of international traffic at significantly lower rates than those of TdP.

For example, it is known that commercial agreements exist whereby every international minute terminated in Peru receives a minimum payment of US$0.06. The new long-distance licence-holders negotiate such termination agreements with external resellers. A little under two thirds of these companies are understood to charge between US$0.06 and 0.15 per minute for the termination of traffic in the country, while 40 per cent of companies receive a rate of less than US$0.10.

The termination rate is related to the costs involved in "bringing down" the international signal and terminating it in TdP's local fixed network. In other words, a low rate, for example, would probably imply that the licensee incurs a low cost, as might be involved in terminating calls routed via the Internet. This might suggest that at least 40 per cent of companies which receive a payment of less than US$0.10 per minute make use of IP Telephony. These are the rates mainly quoted in the United States spot markets for IP Telephony traffic to Peru, in which various international traffic resellers reach commercial agreements with the new entrant companies in Peru.[9] In addition to the cost represented by payment of the termination rate, a company established in Peru must add a margin to cover its other operating costs and its profit margin.[10]

A3.4 Legal aspects of the VoIP service

Peruvian legislation on telecommunications does not cover the Internet service specifically. To date, the Ministry of Transport and Communications has regarded it as a value-added service. This involves the addition of some feature or facility to the basic service (carrier or final services). The apparent justification for classifying the Internet under this heading is that it uses carrier and final services (telephone lines and circuits) adding an additional feature (IP connectivity).

As explicitly stated in the Telecommunication Act, all value-added services are covered by a regime of free competition, which means that OSIPTEL cannot, in principle, regulate tariffs for such services.

The specific name used by many of the Internet service providers is "packet-switched data service". A peculiarity of the legislation is that it excludes real-time voice traffic from being classified as a value-added service. Apparently, at the time when this classification was carried out, it was already known that value-added companies might be able to carry voice traffic, but to do so in real time it would be necessary to hold a licence. As a result, discussions on the subject of VoIP have focused on whether VoIP transmission is performed in real time or not. Regrettably, the legislation does not give a satisfactory definition of what "real time" means, giving rise to a variety of opinions on the matter.

Table A6: Diversification in termination charges

Rate variations for traffic termination in Peru (US$ cents per minute)	Proportion of new long-distance companies
Less than 10	40%
Between 10 and 20	20%
More than 20	40%

Sources: New long-distance licence-holders and OSIPTEL

A3.4.1 The controversial APLIO equipment

The first dispute over the provision of VoIP services in Peru arose in 1999 from legal action brought by TdP against RCP. In March 1999, TdP started proceedings against RCP for alleged "acts of unfair competition". According to TdP, RCP was supplying a long-distance national and international service, for which it did not hold a licence, using so-called APLIO equipment (Box A4.1). The APLIO equipment is a small computer designed specifically for voice transmissions via the Internet. Accordingly, it removes the need for a PC to perform voice transmissions via the Internet.[11]

TdP argued that offering the national and international long-distance service through the APLIO equipment without having a licence allowed RCP to obtain an illegal competitive edge over the companies which were legally authorized to provide that service.

Two things were certain: first, a licence was required to offer the long-distance service; and second, at the time of taking the legal action, RCP only had a licence to supply value-added services, including the Internet service.

The CCO ("ordinary collegiate body") charged with settling the dispute resolved that if RCP had been supplying the long-distance service without a licence, then the competent body to resolve the dispute would be the Ministry of Transport and Communication. However, the key conclusion of the CCO was that use of APLIO did not constitute a long-distance public service because no payment had to be made for the communication service.[12] According to the CCO, RCP did not require a licence for marketing the APLIO equipment since its authorization for offering Internet services was sufficient for the functions it was performing.[13]

TdP appealed against the CCO first instance ruling. According to OSIPTEL provisions regarding disputes between operators, a company has the right to appeal against the first instance ruling issued by a CCO nominated by OSIPTEL. The second administrative instance is the chairperson of OSIPTEL. However, at around the same time as the appeal, RCP received its licence for supplying long-distance services. Before the second instance issued its ruling (upholding the first instance ruling or accepting TdP's accusation), TdP dropped the proceedings and thus, in line with the administrative framework for disputes, no precedent or ruling that the first instance had issued previously was recorded. In other words, TdP avoided a virtually certain ruling against it on the subject of Internet telephony being established as a legal precedent, thereby preventing unlicensed companies from using that ruling to provide VoIP services.[14]

Box A4: APLIO – An innovation in equipment

APLIO is a new type of equipment with software and a modem for voice communication via the Internet. It contains a DSP (digital signal processor) which performs the following functions: (i) voice compression and decompression (according to ITU standard G.723.1 for 5.3 and 6.3 Kbps); (ii) coding and decoding into/from TCP/IP packets; and (iii) the process of Internet connection via an Internet access provider, having a modem chip for this purpose.

APLIO began to be sold in Peru for US$ 295 each, with discounts available for bulk purchases. As in the case of voice communication using a PC, the user must have a telephone line and an Internet access account, which can be supplied by any ISP. APLIO makes the connection, makes the call to the ISP and sends the IP addresses of the parts which will be communicated to the so-called "global management centre" to establish the Internet link. APLIO was bought in mid-2000 by Net2Phone, which is controlled by AT&T.

A3.4.2 Debating the legality of IP Telephony

The ruling on the APLIO dispute was the first and so far the only formal pronouncement from a Peruvian State body on the subject of voice over the Internet. Even though it was limited purely to resolving whether the marketing of APLIO constituted offering long-distance services, it clarified certain doubts on that subject.

The fact that it could not be known *a priori* which would be the competent body to resolve the dispute (the Ministry or OSIPTEL) compounded the lack of clarity on the matter. Here, there were three different positions. The first held that the fact that Peruvian legislation made no mention of the subject of VoIP implied that there was no regulation on it and, therefore, these services could be offered freely. A second position argued that the VoIP service only implied the transmission of data, not voice, therefore, it could not be considered to be telephony and so to offer that service it was only necessary to have an authorization for providing value-added services. According to the third viewpoint, the VoIP service was regarded as the equivalent of telephony and therefore regulations covering the field already existed. In this last case, it would be necessary to have a State licence to offer this service.

These three possible scenarios for the provision of VoIP – free access without regulation, value-added service or licensed service – hold various implications regarding the obligations faced by a company offering that service.

The global trend is to regulate services consistently irrespective of the technology used to provide them. If this is applied to the case of Peru, it would be necessary to determine whether the VoIP service constitutes a telephone service, a value-added service or another, different service, in order to determine the appropriate extent of regulation.

A3.5 Conclusion

IP Telephony in Peru is in its infancy. Major providers exist with capacity to supply the service, such as TdP (the old encumbent), FirstCom and RCP. With the last two of these, the platforms for the transmission of their services consist of integrated frame relay and IP networks, respectively.

In Peru, an important feature of the development of telecommunications since 1994, and which undoubtedly must affect the development of voice over IP, is the promotion of vertically integrated companies, as in the case of TdP, which enjoyed temporary monopoly conditions until 1998, or the case of FirstCom. This has often given rise to anti-competitive practices to the detriment of other more specialized, non-vertically-integrated competitors, such as RCP. Clear examples of this can be seen from the events that took place after 1996, when TdP decided to enter the Internet access business; or in the alleged blocking by TdP of the use of software (e.g. Net2Phone) or hardware (e.g. APLIO) enabling the use of IP Telephony in Peru.

Consequently, it is highly likely that the development of IP Telephony in Peru will continue to be closely tied to the market power of the leading telecommunication operator in the country, TdP. Hence, it is the regulatory aspects, in particular anti-trust aspects – more than technological or market aspects – that will continue to dictate the terms of the agenda for the development of IP Telephony in the country.

It is also to be hoped that the possible use of IP technology by firms entering the long-distance telephony market might result in a reduction in tariffs paid by users. In the face of this competitive threat, the leading operator may speed up its migration towards this new platform.

Other localized and perhaps more appropriate work in the form of specific projects, such as the FITEL projects to install public Internet access centres in rural areas, or further development of existing public centres, will doubtless help to increase the long term prospects of both the Internet and of IP Telephony penetration in Peru.

The commercial activities of the operators in the market and the one-off projects to promote the Internet and its associated technologies would, however, be given a real boost if the competent national authorities issued a clear pronouncement on the national policy to be adopted with regard to this new challenge of the communication era. The situation in Peru is not unique: the majority of countries all over the globe are moving forward slowly and cautiously, trying to avoid any major mistakes in the handling of a technology which raises high hopes but also presents great challenges.

[1] See <http://www.aplio.com/>

[2] It is important, here, to differentiate between the VoIP service and voice by Internet. The first term is general and refers to voice transmission using the IP protocol and the second term refers to voice transmission using the IP protocol but via the Internet. The main difference is that in the first case, transmission can be performed in a private network (to provide public or private services), where it is possible to ensure the quality of transmission, while when the Internet is used, it is not generally possible to guarantee transmission because there may be congestion generated outside the sphere of operation of interlinked companies

[3] The figures for dial-up users correspond to information supplied by the leading firms involved in the business. In the case of dedicated users, the number of users corresponds to estimates supplied by the same firms. It should be emphasized that it is very difficult to estimate the number of users who have access to public Internet centres since there is no need to be registered to use the latter. No official estimates of Internet market share are available. However, RCP is still considered to be a major presence with almost half the market. In October 1999, the general manager of RCP told a leading American business magazine that "RCP controls 56% of the market. The rest is shared between TdP and IBM" (in Business Week, 25 October 1999).

[4] For example, the Banco Latino decided to integrate its voice and data networks into a single platform at the end of 1997. The platform used was frame relay because the IP platforms had still not been fully tested for this company. See the report of Pyramid Research, "Voice-over-packet services and technology in Latin America", Database Qualitative Review, 1st Quarter, 1999.

[5] No official data are available to confirm this. However, at least the following aspects suggest that some level of international traffic is being transmitted over IP to reduce costs. First, Globus, in Chile, a subsidiary of CTC, launched voice and fax services over IP to certain countries in April 1999. The experiment appears to have had mixed results, but the feasibility was proven of offering such services through IP networks. Second, TdP is said to have contracted with Lucent for the implementation of its IP network. Third, a number of publications specializing in telecommunication subjects mention that 4 per cent of international traffic carried by conventional telephony operators is carried over the Internet as a way of cutting costs in comparison with traditional switched telephony. (See "To VoIP or not to VoIP" in Latincom, 22 April 1999).

[6] FirstCom Corporation, Quarterly Report. See <http://biz.yahoo.com/e/990816/fclx.html.>

[7] The Westphere fund plans to invest USD 400 million in two years in various Latin American countries, including Peru, with the aim of developing public centres.

[8] Plans are also said to have been made to supply broadband Internet access (up to 45 Mb) using the satellite link.

[9] Resales of IP telephony international traffic are growing. More and more companies are selling batches of international traffic in an increasingly spot-oriented market. For example, there are "middlemen" currently engaged in mediating between supply and demand for such traffic, such as Pulver, Arbinet, etc. See for example <http://www.pulver.com> and <http://www.arbinet.com>.

[10] For example, if the company is interconnected with TdP, it has to pay the latter an interconnection charge equivalent to USD 0.029 per minute.

[11] The functioning of APLIO requires that both users have access to the Internet through an ISP. Thus, the APLIO can be conveyed from one place to another and be used whenever the user has Internet access, irrespective of which ISP is involved.

[12] National legislation states that public communication services, unlike private ones, are those that are supplied in exchange for payment ("economic compensation").

[13] For the final first instance ruling and further material, see <http://ekeko.rcp.net.pe/rcp/controversia/EXP-9902/index.shtml.>

[14] In legal terms, the dropping of the proceedings by TdP implies that the first instance ruling on the APLIO dispute has no validity, and so, strictly speaking, no formal pronouncement has yet been made by any authority on the subject of VoIP.

A4. THAILAND

A4.1 Introduction

The purpose of this paper is to examine the emergence of new voice services, generally referred to as IP Telephony, in a developing economy, Thailand. The study is set against the background of broader technological developments, national policy, regulatory and market structure realities.

The introduction of Internet Protocol (IP) in many national and international networks over the past three years reflects a number of broad trends in the overall evolution of both global and national information infrastructures. One of these trends is the emergence of a much more vibrant market for long-distance and international calls. There is even a hint of the excitement and chaos of a real marketplace with new sellers and buyers rapidly entering and new products and prices being offered monthly, if not daily.

IP Telephony has been an 'emerging' product since at least 1994[1] and some of the early issues and incentives for the introduction of such a service are noted in the following observations:

'Companies offering Internet telephony have been attracted by the lack of regulatory hurdles and the ability to undercut long-distance operators' tariffs by avoiding international settlement fees, although quality of service remains a problem.
... Although traditional telecom carriers such as Telecom Finland, Sprint and France Telecom are studying the technology, the first widespread commercial offerings are coming from callback operators.'[2]

While new entrants to the long-distance and international markets aggressively employed the early applications of IP for voice services, they also opened up opportunities for traditional carriers as well. By early 1997, a number of major carriers were preparing to offer a variety of IP Telephony products.

The markets for long-distance and international were soon to become much more active both in terms of new products and new price levels. To give some sense of this emerging 'outdoor' or 'open-air' market for international calling, consider the following recently announced prices (US cents) per minute:

1. Singapore to New York - 5 cents (SingTel – eVoiz –Internet-based service)[3];
2. Bangkok to New York - 50 cents (CAT, Thailand – phoneNet – Voice Over Internet Protocol-based service – VOIP);[4] and
3. New York to Bangkok – 39 cents (World Quest Networks – a phone card-based service)[5].

The emerging market for domestic long-distance and international services is being driven more by technology and economics, than by national policy and licensing, as barriers to entry dissipate, not by regulatory initiative, but by the rapid adoption of new technologies by both new entrants and traditional suppliers.

Whether all the traditional operators will be able to find a place in this new, 'open-air' market, remains to be seen. However, the 'early and rapid adapters' stand the best chance of sustaining themselves in this new environment while the 'wait and see' group may gradually witness their customer-base and their traditional markets eroding.

Thailand, as a developing economy, provides an example of how traditional monopoly markets for long-distance and international calls are becoming contestable due to technological developments such as cellular mobile and more recently Internet telephony. The two major state-owned carriers, The Communications Authority of Thailand (CAT) and the Telephone Organization of Thailand (TOT) have both announced their intention to introduce IP-based voice services. In fact, CAT's new service, 'phoneNet', is competing with TOT's traditional international long distance service. In turn, the TOT domestic VoIP service will compete with the domestic long-distance and international service offered by the two major cellular mobile operators. Consequently, *de facto* rivalry has emerged in these two market segments in advance of them being formally liberalised.

Prior to the recent rise in technology-driven market liberalisation, as opposed to policy-driven market entry, the process of telecom market liberalisation in developing economies generally followed a different path then that followed in developed economies. During the formative years of telecommunications liberalisation

in most developed economies, from the 1970s to 1990s, the process of opening markets was one of control and evolution. Entry was permitted to increasingly larger telecommunication market segments on a somewhat sequential basis, for example, first customer equipment, subsequently private line and later domestic trunk and international long distance markets. The pressure to open these traditional markets came largely from potential new entrants and larger business customers.

In developing economies, the liberalisation of telecommunication market segments was primarily focused on new market segments such as cellular mobile as opposed to the traditional segments for example, the domestic and international long distance segments. One result of the difference between the trend and speed of liberalisation in developed versus developing markets is that significant pricing reform in the long distance/trunk markets, both domestic and international, has not occurred in many developing economy markets at the same rate as that in developed economies.

Consequently, and somewhat ironically, some of the more enthusiastic buyers of low-priced IP Telephony are in those markets that, to-date, are the least liberalised. The consequences for demand to shift in these markets, due to the magnitude of price declines envisaged from Internet telephony, are substantial. All things being equal, informed consumers will rapidly shift their demand for national and international calling-minutes from traditional network services to internet protocol based-services whether they be offered by ISPs, new entrants employing VoIP technology or traditional operators employing VoIP.

In turn, such a shift in the structure of the traditional long-distance and international market segment has national information policy implications as well as financial implications for traditional operators. One of the implications related to both national policy as well as the financial sustainability of incumbent operators is with respect to the achievement of universal service and/or universal access. In many developing economies the current telephony penetration rate – telephones per hundred population – is in the order of less than 10. Penetration rates in the main urban centres of developing economies tend to be substantially higher due to higher concentrations of both fixed, cellular mobile and wireless local loop access. However, in rural, remote and smaller urban centres network access, and consequently access to the Internet, remains limited.

While IP Telephony presents an opportunity to bring lower prices for distance calling to those consumers already connected to the information infrastructure, it offers little to the unconnected. However, the technology has immense potential to provide access at an investment cost some 5 to 8 fold less than that of a PSTN line. Therefore, national policy makers in developing economies must also consider the implications of IP Telephony in the context of their plans and objectives for bringing universal access to those parts of their nations which remain either not served or under-served by their information infrastructure. A market deprived of the participation of more than 50 per cent of the potential consumers (households) is neither dynamic nor developed.

The following elements[6] of a policy strategy for developing countries should be considered in the context of addressing both the introduction of IP Telephony, as it is currently offered, as well as the full liberalisation of the international long distance market:

1. Ensure accounting, settlement and collection rates are either closely representative of costs or that international operators have a defined plan for reaching cost-oriented price-levels for international services within the next two to three year period;
2. Ensure that international operators are either employing or planning to employ the most efficient technology available for international voice services within the next three year period;
3. Require all international operators to ensure that settlement rates are essentially uniform from one route to another in order to limit the opportunities for arbitrage;
4. Ensure any ‘sender-keeps-all’ arrangements are discontinued or re-negotiated to prevent the ‘dumping’ of incoming traffic from such destinations;
5. Negotiate with foreign operators to share the cost of international leased lines employed for Internet traffic; and
6. Ensure the policy for the international information infrastructure is comprehensive in that it addresses not only traditional IDD service but also IP Telephony, call-back, country-direct, calling-cards, and simple resale as well as the general liberalisation of the market segment;

Notwithstanding the above-mentioned policy and operator initiatives with respect to settlement and collection rates, national regulators and policy-makers also need to recognise certain underlying trends in the 'flow' of national and international minutes and revenues:

- The first of these is the migration of minutes from the switched-PSTN to the public Internet network (PIN);
- A second and related trend is the decline in net international settlements in both developed and developing economies due to lower prices and reductions in settlement rates as well as the fallout from the above-mentioned trend of minutes migrating from the PSTN to the PIN.

However, the impact of the decline in net international revenues will be particularly acute in the smaller developing economies where net international revenues tend to represent a much more significant proportion of total revenues than they do in developed economies.

Consequently, national policymakers, regulators and operators in smaller developing economies need to examine universal service and access objectives and plans in the light of these trends in international revenue and traffic. Such an examination needs to reconcile their universal service and access objectives with these underlying trends to ensure those currently served continue to have access at affordable prices and those unserved have a reasonable opportunity to gain access to both national and international information infrastructures at affordable prices.

Developing the economic and intellectual potential of those at the lower end of the income spectrum in both developed and developing economies is both a noble objective and a feasible task with the effective development and deployment of a nation's information infrastructure.

A4.2 Internet Development and the Voice Telephony Market in Thailand

According to the Telegraph and Telephone Act of 1934, the government has a statutory monopoly in the ownership and operation of public telecommunications network. Thus, the two state-owned enterprises namely, the Telephone Authority of Thailand (TOT) and the Communication Authority of Thailand (CAT), are monopolies in the local and international call services respectively. Private firms are prohibited from owning or operating a public telecommunications network. During the rapid expansion of the Thai economy in the early nineties, it became evident that the TOT and CAT alone could not expand their services to meet the surge in demand. To circumvent legal restrictions, a number of Built-Transfer-Operate (BTO) concessions were granted to private companies. These concessions allow the state agencies (as concession providers) and the private companies (as investors of network construction and service providers) to share monopoly benefits by revenue or profit sharing schemes. These concessions have led to a limited competition in the telecommunications market[7].

The state monopoly, together with the BTO scheme, thus constitutes a unique feature of the Thai telecommunication market. It is in this context that the VoIP technologies offer a new dimension of competition.

A4.2.1 Long-Distance and International Markets in Thailand

In developed countries where fixed-line penetration level is high, a mobile phone service serves as a complement to the fixed-line service. In developing countries where the penetration level is low, however, mobile acts as a substitute for the fixed-line service. In the case of Thailand, the situation is more complicated. While mobile phones complement fixed-line services in the local call market, the two compete directly in the distance call market.

Due to their lower per minute rates, the mobile services are successful in attracting a large share of domestic long-distance call traffic. For example, while the TOT and their fixed-line concessionaires charge a maximum rate of Baht (Bt) 18 per minute, the rate applicable to mobile services is only Bt 12 per minute, or 50 per cent lower[8]. The cellular operators also offer promotional packages with various pricing schemes to suit the needs of different customer groups. These include, for example, deep discounts for new subscribers or off-peak calls. Table A7 shows recent pricing strategies of the two largest mobile phone operators.

Table A7: Pricing Strategies of Major Mobile Phone Operators

Total Access Communication Plc (TAC)	
Package 1	A monthly fee of Bt 500. Bt1 per minute for local calls and a maximum of Bt12 for a long distance call for the first three years.
Package 2	A monthly fee of Bt 800. Free 400 minutes of local calls per month plus 40 minutes of free long-distance calls for the first two years.
Package 3	A monthly fee of Bt 500. Fifty per cent discount from the normal rates for both local and long-distance calls.
Advance Info Service (AIS)	
Package 1	A monthly fee of Bt 500. Free 400 minutes of local calls per month. Additional calls at normal rates.
Package 2	A monthly fee of Bt 990 for 200 minutes of local calls during peak times and 100 minutes at off-peak times. Additional calls at normal rates.
Package 3	A monthly fee of Bt 1,290 for 200 minutes of nationwide at peak times plus 100 minutes at off-peak times. Additional calls at normal rates.

Source: Compiled from (The Nation, March 13, 2000)

Responding to competition, the TOT recently started to offer cheaper and more flexible pricing schemes. Table A8 shows the new rates. The first package maintains the status quo rate and is designed to attract users who seldom make long-distance calls. The second is aimed at businesses and other users who frequently make long-distance as well as local calls. The last package is designed for users who spend more time making long-distance calls than local ones. In addition to lowering the rates, the state agency also adjusted its pricing criteria for part-minute calls. According to the new pricing scheme, there would be no charge for a call of less than 30 seconds, while those exceeding 30 seconds would be charged as one minute.[9]

Although the new pricing scheme makes the TOT long distance services more attractive to users, the maximum rates charged are still not below those offered by mobile phone service operators. Only the new VoIP service, due to be launched later this year will, offer truly competitive rates and prepare the state agency for competition in a more liberalized market. See section A4.4.2 below for details of the TOT proposal.

The international market is different from the domestic one in that it is completely monopolized by the CAT with no competition from BTO operators. Being a monopoly, however, does not fully protect the state agency from other forms of competition. In recent years, the CAT has seen its revenue eroded by competition from international call back services, substitution of fax and phone call by e-mail, ICQ, and other Internet-based services.

Another important reason for the declining revenue is the decrease in international settlement surplus that used to contribute a significant proportion of revenues to the state agency's coffer. Due to these changes, the CAT's revenue fell to Bt30.3 billion in 1999 from Bt33 billion in 1998. During the same period, its profit also plunged by 39 per cent from Bt7.369 billion to Bt4.497 billion (The Nation, November 24, 1999).

It is in this context that the CAT decided to introduce its VoIP service.

Table A8: Rates of Domestic Long-Distance Telephone Call

Package	Monthly Fee		Local Call Rates		Maximum Long Distance Call Rates	
	Baht	US$	Baht	US Cents	Baht	US cents
1	100	2.63	3 per call	7.9 per call	18	47 per min.
2	120	3.16	3 per call	7.9 per call	12	32 per min.
3	90	2.37	1 per min.	2.6 per min.	12	32 per min.

Source: The TOT (Approximate conversion – 1US$ = 38 Bt)

A4.3 Internet Market in Thailand

The Internet market is classified as an international telecommunications service, and thus falls within the monopolistic domain of the CAT. Since 1995, however, the state agency has granted concessions to

18 Internet service providers (ISPs). These concessions are different from most other BTO concessions in that they are based on a profit-sharing scheme, rather than a revenue-sharing scheme. Moreover, the CAT demands a 32 per cent equity share for free and 3 additional per cent for its employees at par value[10]. Its representative will also assume the position of chairman in the company.

Previous research indicates that the CAT's intervention in the Internet market has posed a major obstacle to the growth of the market. For example, the 32 per cent equity handout is estimated to increases the cost of services at the retail level by 20 per cent, assuming that the ISPs' required rate of return of 30 per cent (TDRI, 1997). The mandatory equity handout and the monopoly in the international leased line services have made Internet services in Thailand much more expensive than those in other Asian countries.

Moreover, the CAT also imposes many operational restrictions on the ISPs. Among these, the CAT representatives can veto the ISPs' business decisions it finds inappropriate. Voice services are also banned. Violators are threatened to have their concessions withdrawn. The threat seemed credible as Loxley Information Services (LoxInfo), a major ISP, which attempted to provide the PC-to-Phone telephony service, was given due warning by the CAT in 1998.

Table A9: Comparison of Internet Pricing in Asian Countries
(Unit: US$ – approximate conversion 1US$ = 38 Baht)

	Dial-up service (20 hours)		Corporate leased-line service (64 Kbps)	
Country	**Start-up fee**	**Monthly fee**	**Start-up fee**	**Monthly fee**
Thailand	-	12.63	1,621.05	1,533.34
Hongkong SAR	6.37	17.55	N.A.	303.53
Taiwan, China	6.42	12.84	N.A.	N.A.
Singapore	23.44	3.50	311.03	909.61
South Korea	-	17.29	129.58	736.95
Malaysia	-	10.82	-	519.37
Indonesia	6.16	14.34	N.A.	N.A.
Japan	N.A.	31.87	N.A.	351.47

Source: TDRI, 2000

A4.4 IP Telephony in Thailand

A4.4.1 The CAT Proposal

As mentioned in Section 2, although being designated as having a monopoly in the provision of international telecommunication services, the CAT has not been fully protected from competition. In recent years, CAT has seen its revenue eroded by competition from international call back and substitution of fax and voice calls by e-mail, ICQ, and other Internet-based services. To regain its falling revenue, the CAT has launched its VoIP services called phoneNet as a low priced alternative to its basic international telephone service. The state agency has subcontracted Hatari Technology Co. Ltd. to market the service. In return, Hatari will earn 10 per cent on sales of the service up to Bt 40 million and 15 per cent on sales of Bt 100 million for five years (The Nation, November 24, 1999).

The service now covers about 75 countries. To access the phone-to-phone service, users must first buy a calling card that will give them a 12-digit access code. There are two types of calling cards: Silver and Gold Cards. The cards cost Bt 5,000 and Bt 10,000, respectively. With the cards, users can make an international call from any phone, including mobile and public telephones.

Table 4 shows the price of phoneNet compared to CAT's existing prices. As can be seen from the Table, the prices of phoneNet are 21-40 per cent lower than the normal prices and 0-17 per cent lower than the nighttime discount prices. In addition to lower rates, Hatari Technology claims that there are other benefits to

the users. Firstly, the service is not charged in blocks or units of time as in the case of international call, but in the number of actual seconds used. Thus the prices of the service will be effectively lower than the simple comparison. Secondly, with the calling cards, users can more easily control the expenditures. It is interesting to note that the prices of phoneNet do not change with the time of the day. Thus it seems that the service will be most attractive for users that cannot change the time to make telephone calls, e.g., business users.

Table A10: Comparison of Phone Net and International Telephone Rates For Major Destinations profit.
With the VoIP service, the CAT expects to increase its revenue to Bt 31.1 billion next year, with Bt 4 billion

Destinations	Standard Rate (1)*	Economy Rate (2)**	Reduced Rate (3)***	Phone Net Rate	% Discount from (1)	% Discount from (2)	% Discount from (3)
East Asia (Japan; South Korea; Taiwan, China)	36	29	25	24	33.3	17.2	4.0
Hongkong SAR	30	24	24	20	33.3	16.7	16.7
ASEAN (Philippines, Indonesia, Brunei)	34	27	27	27	20.6	0.0	0.0
Singapore	28	22	22	22	21.4	0.0	0.0
Middle East	46	37	32	32	30.4	13.5	0.0
Europe (excluding UK)	42	34	30	28	33.3	17.6	6.7
Australia/New Zealand	24	20	20	24	0.0	-20.0	-20.0
North America/Canada	24	20	20	20	16.7	0.0	0.0
South/Central America	55	44	39	39	29.1	11.4	0.0

Notes: * Between 07.00 a.m. to 09.00 p.m.
** Between 09.00 p.m. to 12.00 p.m. and 05.00 a.m. to 07.00 a.m.
*** Between 12.00 p.m. to 05.00 a.m.
Unit: Bt – approximate conversion – 1US$ = 38 Bt
Source: The CAT and Hatari Technology

A4.4.2 The TOT Proposal

The TOT plans to launch its VoIP service under the name Y-Tel 1234 to provide a cheap domestic long-distance call service in the first half of 2000. The service is part of the state agency's efforts to compete with mobile-phone services and is also in line with the Government's policy of low-cost services in the provinces[11].

To use the service, users do not need cards or a subscription. All they have to do is to dial extra digits '1234' before dialing the destination number. The service is available to any telephone including public telephones. Currently, however, only the TOT subscribers will be able to use the service. The TOT's BTO concessionaires, i.e., TelecomAsia Corporation Plc (TA) and Thai Telephone and Telecommunication Plc (TT&T) have yet to develop similar services.

Table A11 summarizes the prices for the service. From the summary, it can be seen that maximum rates (07:00 - 18:00 of working days) for the VoIP service ranges from Bt 2-8 per minute. This is significantly lower than the current long-distance rates of Bt 3-18 per minute and is competitive with the rates of mobile phone services. (See rates of mobile phone services in Section 2.)

Technically, the IP traffic will be passed to the public fixed-line network, unlike most VoIP services which use private networks. It appears that the TOT is attempting to fully utilize its public line capacity. Concerning the quality of voice, the TOT claims that the delay experienced by the users of Y-Tel 1234 is no more than 100 ms, a significant improvement over 250 ms delay of the satellite-based telephone service.

Voice quality will be also on par with that of mobile phones with a comparable compression rate (TOT Y-Tel 1234 Public Relation Document).

The state agency hopes that the new service will be a quick success and improve its declining revenues. TOT projects that the service will soon capture 5 per cent of total long-distance call demand (The Nation, December 20, 1999).

Table A11: Rates of Y-Tel Service
(Unit: Baht – approximate conversion – 1US$ = 38 Baht)

Day	Time	0-50 Km	51-100 Km	101-200 Km	More than 200 Km
Working Days	07:00-18:00	2	4	6	8
	18:00-22:00	1	2	3	4
	22:00-07:00	0.75	1.5	2.25	3
Holidays	07:00-18:00	1.5	3	4.5	6
	18:00-22:00	0.75	1.5	2.25	3
	22:00-07:00	0.5	1	1.5	2

Source: The TOT

A4.5 Conclusion and Future Prospects

While VoIP services are usually offered as lower priced calling packages by new entrants in a liberalized market, in Thailand the services are provided by incumbent state agencies to protect their falling revenues. The services are currently monopolized by the agencies, but the situation is about to change. In fact, the year 2000 is a year of change for the Thai telecommunication market.

Firstly, the law to establish the National Telecommunications Committee (NTC), an independent regulatory body, has become effective in March. Once established, the NTC will replace the state agencies as the regulator. Secondly, the Telecommunication Act, which will determine the market structures and the rules for competition, was approved by the Cabinet and is in the process of parliamentary reading. Thirdly, the CAT and the TOT are due to be corporatized and later privatized. Finally, thirty-three concessions between the state agencies and their concessionaires are in the process of being converted, rendering more freedom to conduct businesses for the private sector participants. In the long term, the whole process will result in a much more liberalized market.

At this stage, however, it is too early to assess the degree of liberalization and the impact of the regulatory changes on the provision of VoIP and other long-distance and international services. The draft Telecommunication Act approved by the Cabinet provided few details concerning the future market structure except that the CAT and the TOT will be able to continue to provide their existing services. The pace of liberalization, the licensing conditions, and the numbers of licenses to be issued are all subject to regulation by the NTC. How much and how soon the Thai people will fully benefit from fully liberalised markets and further technological innovations, such as VoIP services, remains to be seen.

[1] 'Challenges to the Network – Internet for Development', International Telecommunication Union, Geneva, Switzerland, February 1999, Figure 6.4, page 113.

[2] 'EC to close IP telephony loop-holes' by Kenneth Cukier, CommunicationsWeek International, 19 May 1997, page 3.

[3] 'SingTel offers overseas calls via Internet', Bangkok Post, Business Section, 7 March 2000, page 2.

[4] See Table 2, page 27. (CAT's phoneNet Service)

[5] Bangkok Post Website (<www.bangkokpost.net>) (advertisement by World Quest Networks-week of 20 March 2000)

[6] For a more comprehensive discussion on policy and operator strategy options see - 'Challenges to the Network – Internet for Development', International Telecommunication Union, Geneva, Switzerland, February 1999, Chapter Six.

[7] Currently, concessions have been granted to 2 fixed-line telephone operators, 5 mobile phone operators, 18 Internet service providers, and more than 25 pager, VSAT, and other value-added service providers. See (TDRI, 1999) for more information.

[8] However, the cost of a fixed-line handset, at approximately Bt 6,000, is lower than that of a mobile phone at Bt 9,000-30,000.

[9] The Nation, March 3, 2000.

[10] There are few exceptions, however. For example, the CAT's paid for its one-third, equity share in Internet Thailand, a pioneer ISP. This is because other state agencies -- i.e., the TOT and the National Science and Technology Development Agency (NSTDA), paid for their shares. There is thus no rationale for CAT to be the only agency to obtain the shares for free.

[11] For other examples of TOT offers of lower priced distance services, see Section 2.

LIST OF TABLES

1. Basic indicators

Economy	Population		GDP		Main telephone lines	
	Total (M) 1999	Density (per km) 1999	Total (B US$) 1998	per capita (US$) 1998	Total (k) 1999	per 100 inhabitants 1999
Afghanistan	21.92	34	...	...	29.0	0.13
Angola	12.48	10	*18.1*	*1'684*	96.3	0.77
Armenia	3.53	118	1.9	537	547.3	15.53
Azerbaijan	7.70	89	4.1	537	730.0	9.48
Bangladesh	126.95	882	33	265	433.0	0.34
Benin	5.94	53	2.5	425	*38.4*	*0.66*
Bhutan	0.66	14	0.4	624	11.8	1.80
Burkina Faso	11.62	42	2.6	228	47.3	0.41
Burundi	6.57	236	1.1	175	19.0	0.29
Cambodia	10.95	60	*2.9*	*286*	27.7	0.25
Cameroon	14.69	31	9.5	664	*93.9*	*0.66*
Central African Rep.	3.55	6	1.1	302	9.9	0.28
Chad	7.46	6	1.7	232	9.7	0.13
China	1'266.84	132	964.5	768	108'715.8	8.58
Comoros	0.68	363	*0.2*	382	*6.2*	0.95
Congo	2.86	8	2.1	757	*22.0*	*0.79*
Côte d'Ivoire	14.53	45	11.7	818	219.3	1.51
D.P.R. Korea	23.70	194	...	...	1'100.0	4.64
D.R. Congo	50.34	21	...	...	*20.0*	*0.04*
Eritrea	3.72	40	*0.6*	*161*	27.4	0.74
Ethiopia	61.09	50	6.3	106	194.5	0.32
Gambia	1.27	119	0.3	284	29.2	2.3
Ghana	19.68	83	*6.9*	*372*	158.6	0.81
Guinea	7.80	32	*5.1*	*677*	46.2	0.59
Guinea-Bissau	1.19	33	*0.3*	*238*	*8.1*	*0.7*
Haiti	8.09	291	3.5	452	70.0	0.87
Honduras	6.32	56	5.2	839	279.2	4.42
India	998.06	315	427.2	435	26'511.3	2.66
Indonesia	209.25	109	124.8	605	6'080.2	2.91
Kenya	29.55	51	11.5	395	304.6	1.03
Kyrgyzstan	4.67	24	1.6	350	355.8	7.62
Lao P.D.R.	5.30	22	1.3	250	34.5	0.65
Lesotho	2.11	69	0.9	432	*20.1*	*0.97*
Liberia	2.93	26	...	...	*6.5*	*0.24*
Madagascar	15.50	26	3.7	243	50.2	0.32
Malawi	10.64	113	1.8	168	41.4	0.39
Mali	10.96	9	2.6	246	*26.8*	*0.25*
Mauritania	2.60	3	1	389	17.3	0.67
Moldova	4.38	130	*1.9*	*430*	555.3	12.68
Mongolia	2.62	2	1	416	103.4	3.95
Mozambique	19.29	25	*1.5*	*86*	78.1	0.40
Myanmar	45.06	66	253.8	5'703	249.1	0.55
Nepal	23.39	165	4.6	200	247.2	1.06
Nicaragua	4.94	41	2.1	453	150.3	3.04
Niger	10.40	9	1.7	167	*18.1*	*0.18*
Nigeria	108.95	118	56.2	551	*407.0*	*0.38*
Pakistan	134.51	167	60.9	466	2'986.1	2.22
Rwanda	7.23	275	2	306	*10.8*	0.16
S. Tomé & Principe	0.14	149	-	358	3.8	2.67
Senegal	9.24	47	4.7	520	165.9	1.80
Sierra Leone	4.72	65	0.7	145	*17.4*	0.38
Solomon Islands	0.43	14	*0.4*	*901*	*7.9*	1.89
Somalia	9.67	15	...	...	*15.0*	0.15
Sudan	28.88	12	*10.2*	*364*	251.4	0.87
Tajikistan	6.10	43	*2.5*	*421*	212.5	3.48
Tanzania	32.79	35	*7.7*	*244*	149.6	0.46
Togo	4.51	79	1.4	322	38.2	0.85
Turkmenistan	4.38	9	*3.8*	*832*	358.9	8.19
Uganda	21.14	89	*6.3*	*317*	57.1	0.27
Viet Nam	78.71	239	*23.4*	*312*	2'105.9	2.68
Yemen	17.49	92	5.9	348	291.4	1.67
Zambia	8.98	12	*3.9*	*463*	83.1	0.93
Zimbabwe	11.53	30	5.9	520	239.0	2.07
Low income	**3'592.11**	**85**	**2'147.7**	**620**	**155'248.4**	**4.33**

Economy	Population		GDP		Main telephone lines	
	Total (M) 1999	Density (per km) 1999	Total (B US$) 1998	per capita (US$) 1998	Total (k) 1999	per 100 inhabitants 1999
Albania	3.85	134	2.8	742	140.4	3.65
Algeria	30.77	13	47.4	1'574	1'600.0	5.20
Belarus	10.27	49	3.1	299	2'638.5	25.68
Belize	0.24	10	0.6	2'736	36.6	15.57
Bolivia	8.14	7	8.5	1'072	502.5	6.17
Bosnia	3.84	75	*3.4*	*898*	367.9	9.58
Bulgaria	8.28	75	12.3	1'470	2'933.4	35.43
Cape Verde	0.42	104	0.3	876	46.9	11.21
Colombia	41.56	36	99.1	2'510	6'665.4	16.04
Costa Rica	3.93	77	4.9	1'273	802.6	20.41
Cuba	11.16	97	14.8	1'329	433.8	3.89
Djibouti	0.63	29	*0.5*	*846*	*7.9*	*1.27*
Dominican Rep.	8.36	173	15.8	1'925	*763.9*	*9.28*
Ecuador	12.41	27	19.7	1'620	1'129.5	9.10
Egypt	67.23	67	82.7	1'254	4'686.4	6.97
El Salvador	6.15	288	12	1'984	468.1	7.61
Equatorial Guinea	0.44	16	*0.5*	*1'290*	*5.6*	*1.29*
Fiji	0.81	44	1.6	2'002	*76.9*	*9.76*
Georgia	5.46	78	4.9	899	671.5	12.31
Guatemala	11.09	102	18.9	1'754	610.7	5.51
Guyana	0.86	4	*0.7*	*881*	64.0	7.49
Iran (I.R.)	66.80	41	187.4	2'850	8'371.2	12.53
Iraq	22.45	51	...	...	675.0	3.01
Jamaica	2.56	224	6.9	2'707	509.6	19.91
Jordan	6.48	68	7.3	1'191	*510.9*	*8.34*
Kazakhstan	16.27	6	21.1	1'289	1'759.8	10.82
Kiribati	0.08	120	-	545	2.8	3.44
Latvia	2.44	38	6.1	2'475	731.5	29.99
Lithuania	3.70	57	10.7	2'902	1'161.0	31.37
Maldives	0.28	934	*0.2*	*680*	22.2	7.97
Marshall Islands	0.06	34	*0.1*	*1'577*	*3.7*	*6.24*
Micronesia	0.12	84	*0.2*	*1'950*	*9.1*	*7.99*
Morocco	27.87	42	35.7	1'288	1'466.6	5.26
Namibia	1.69	2	*3.3*	2'034	108.2	6.38
Panama	2.81	36	9.1	3'305	462.5	16.45
Papua New Guinea	4.70	10	3.5	768	*47.0*	*1.14*
Paraguay	5.36	13	8.6	1'646	297.0	5.54
Peru	25.23	20	62.7	2'530	1'688.6	6.69
Philippines	74.45	248	65.5	898	2'940.0	3.95
Romania	22.40	94	41.5	1'846	3'740.0	16.70
Russia	147.20	9	276.6	1'878	30'388.1	20.64
Samoa	0.18	62	0.2	1'255	*8.5*	*4.87*
Sri Lanka	18.64	284	15.8	854	679.2	3.64
St. Vincent	0.11	291	0.3	2'395	23.6	20.88
Suriname	0.42	3	0.8	1'976	70.8	17.05
Swaziland	0.98	56	*1.3*	*1'388*	30.6	3.12
Syria	15.72	85	69.1	4'505	1'600.0	10.17
TFYR Macedonia	2.01	78	3.5	1'750	471.0	23.40
Thailand	60.86	118	112.1	1'859	5'215.6	8.57
Tonga	0.10	141	0.2	1'589	*7.8*	*7.90*
Tunisia	9.46	58	19.9	2'135	850.4	8.99
Ukraine	50.66	84	*49.7*	*974*	10'074.0	19.89
Uzbekistan	23.94	54	12.5	527	1'599.4	6.68
Vanuatu	0.19	13	0.2	1'273	*5.2*	*2.84*
West Bank and Gaza	3.10	8'145	...	...	*167.3*	*5.78*
Yugoslavia	10.64	104	*11.5*	*1'087*	2'280.7	21.44
Lower Middle Income	**865.85**	**24**	**1'398.4**	**1'685**	**102'704.9**	**11.86**

1. Basic indicators

Economy	Population		GDP		Main telephone lines	
	Total (M) 1999	Density (per km) 1999	Total (B US$) 1998	per capita (US$) 1998	Total (k) 1999	per 100 inhabitants 1999
Antigua & Barbuda	0.07	169	0.6	8'566	36.5	48.86
Argentina	36.58	13	298.3	8'257	7'356.8	20.11
Bahrain	0.67	1'006	6.1	9'529	165.4	24.87
Barbados	0.27	626	2.3	8'731	*113.0*	*42.18*
Botswana	1.60	3	4.8	3'069	120.0	7.51
Brazil	167.99	20	775.4	4'675	24'985.0	14.87
Chile	15.02	20	72.8	4'912	3'108.8	20.70
Croatia	4.48	79	*18.1*	*3'973*	1'633.6	36.49
Czech Republic	10.26	130	55.7	5'418	3'806.1	37.09
Dominica	0.08	102	0.3	3'391	21.3	27.88
Estonia	1.45	32	5.2	3'588	515.5	35.66
Gabon	1.20	4	4.7	3'999	38.0	3.17
Grenada	0.09	271	0.3	3'635	29.4	31.51
Guadeloupe	0.45	264	3.5	8'509	201.0	44.69
Hungary	10.04	108	47.4	4'651	3'725.8	37.09
Korea (Rep.)	46.48	472	317.1	6'829	20'518.1	44.14
Lebanon	3.24	311	*13.2*	*4'292*	*620.0*	*19.43*
Libya	5.47	3	*34.8*	*6'271*	*500.0*	*9.07*
Malaysia	21.83	66	72.5	3'333	4'430.8	20.30
Mauritius	1.15	616	4.1	3'557	257.1	22.36
Mayotte	0.13	353	...	...	9.7	7.27
Mexico	97.36	49	415.0	4'330	10'927.4	11.22
Oman	2.46	9	14.3	6'016	220.4	8.96
Poland	38.74	124	159.3	4'114	10'175.2	26.27
Puerto Rico	3.89	434	34.8	9'020	1'295.0	33.29
Saudi Arabia	20.90	9	128.2	6'353	*2'878.1*	*14.26*
Seychelles	0.08	190	0.6	7'770	*19.0*	*24.79*
Slovak Republic	5.38	110	20.4	3'787	1'655.4	30.76
South Africa	39.90	34	*129.1*	*3'107*	5'492.8	13.77
St. Kitts and Nevis	0.04	148	*0.3*	*6'840*	20.1	51.76
St. Lucia	0.15	247	*0.6*	*3'815*	*40.4*	*26.57*
Trinidad & Tobago	1.29	252	6.1	4'726	278.9	21.58
Turkey	68.20	87	197.9	2'966	18'054.0	26.47
Uruguay	3.31	18	22.5	6'836	896.8	27.07
Venezuela	23.71	26	95.0	4'088	2'585.9	10.91
Upper Middle Income	**634.32**	**27**	**2961.2**	**4'713**	**126'731.4**	**20.00**

Economy	Population		GDP		Main telephone lines	
	Total (M) 1999	Density (per km) 1999	Total (B US$) 1998	per capita (US$) 1998	Total (k) 1999	per 100 inhabitants 1999
Andorra	0.08	162	*1.2*	*16'990*	*33.1*	*44.12*
Aruba	0.10	509	*1.5*	*17'109*	36.6	37.20
Australia	18.91	2	355.5	18'979	9'856.9	52.12
Austria	8.18	98	210.9	25'912	3'939.0	48.17
Bahamas	0.30	22	*3.1*	*11'001*	111.2	36.90
Belgium	10.15	332	250.4	24'688	5'100.0	50.24
Bermuda	0.06	1'187	*2.1*	*33'469*	54.9	85.73
Brunei Darussalam	0.32	56	*5.0*	*17'556*	*77.7*	*24.68*
Canada	30.49	3	603.8	19'962	19'956.6	65.45
Cyprus	0.78	84	9.0	12'057	424.1	54.47
Denmark	5.31	123	173.7	32'775	3'638.1	68.47
Faroe Islands	0.04	32	...	...	24.9	55.72
Finland	5.17	14	128.5	24'904	2'850.3	55.18
France	58.89	108	1'451.7	24'324	34'100.0	57.91
French Guyana	0.17	2	...	...	49.2	28.26
French Polynesia	0.23	59	3.8	16'601	52.3	22.62
Germany	82.16	230	2'150.5	26'214	48'300.0	58.79
Greece	10.63	81	121.5	11'463	5'610.9	52.81
Greenland	0.06	-	...	...	25.6	45.69
Guam	0.16	365	*3.0*	*19'598*	*75.1*	*46.62*
Guernsey	0.06	962	...	...	50.7	81.18
Hongkong Sar	6.72	6'328	163.6	24'612	3'868.8	57.57
Iceland	0.28	3	8.3	30'037	188.8	67.74
Ireland	3.71	54	89.1	24'209	1'770.0	47.77
Israel	6.10	294	99.0	16'540	2'800.0	45.89
Italy	57.34	190	*1'145.4*	*19'966*	26'502.0	46.22
Japan	126.51	335	3'808.0	30'105	62'490.0	49.40
Jersey	0.09	804	...	...	*68.7*	*75.15*
Kuwait	1.90	78	25.3	13'984	455.6	24.02
Luxembourg	0.43	166	18.3	43'286	310.9	72.44
Macau SAR	0.44	27'341	6.5	15'108	178.4	40.79
Malta	0.39	1'222	3.5	9'133	197.8	51.23
Martinique	0.39	356	4.1	10'747	171.9	43.82
Neth. Antilles	0.21	268	...	...	*78.0*	*36.65*
Netherlands	15.85	385	*360.5*	*23'046*	9'610.0	60.64
New Caledonia	0.21	11	...	...	50.7	24.09
New Zealand	3.83	14	53.0	13'905	1'877.0	49.03
Northern Marianas	0.05	109	...	...	*20.6*	*40.44*
Norway	4.45	14	145.9	32'814	3'165.0	71.20
Portugal	9.98	109	106.9	10'732	4'229.8	42.39
Qatar	0.59	52	*9.2*	*16'157*	154.9	26.29
Réunion	0.69	275	5.9	9'270	268.5	38.86
Singapore	3.89	6'321	82.8	21'413	1'876.6	48.20
Slovenia	1.99	98	19.5	9'796	*757.0*	*37.98*
Spain	39.42	78	586.0	14'884	16'480.4	41.81
Sweden	8.86	20	237.8	26'853	5'889.0	66.46
Switzerland	7.14	173	262.1	36'795	4'992.0	69.87
Taiwan, China	22.09	614	271.6	12'387	12'043.8	54.52
United Arab Emirates	2.40	32	46.5	19'750	975.2	40.67
United Kingdom	58.74	240	*1'287.8*	*21'878*	33'750.0	57.45
United States	276.22	30	8'759.9	32'198	188'331.0	68.18
Virgin Islands (US)	0.12	347	...	...	*64.9*	*54.82*
High income	**893.34**	**26**	**23'084.0**	**26'009**	**525'952.2**	**58.88**
WORLD	**5'986.20**	**44**	**29'565.4**	**5'128**	**902'587.7**	**15.10**
Africa	**766.91**	**25**	**569.4**	**836**	**18'556.4**	**2.44**
Americas	**818.11**	**20**	**11'396.6**	**14'178**	**275'838.2**	**33.72**
Asia	**3'572.10**	**116**	**7'504.9**	**2'144**	**297'148.9**	**8.32**
Europe	**798.38**	**31**	**9'695.6**	**12'156**	**306'969.8**	**38.45**
Oceania	**30.11**	**4**	**424.9**	**14'376**	**12'123.5**	**40.28**

Note : For data comparability, see the technical notes.

Source : ITU.

2. Internet host computers

Economy	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*	*July 2000*	*CAGR 1993 - 99*	*Change Jan - July 2000*
Afghanistan	0	0	0	1	1	2	4	n.a.	n.a.
Angola	0	0	2	4	4	11	16	n.a.	132,8%
Armenia	0	173	177	443	951	2'947	3'325	n.a.	27,2%
Azerbaijan	9	16	30	348	435	701	834	n.a.	41,6%
Bangladesh	0	0	0	0	0	2	2	n.a.	n.a.
Benin	0	0	9	13	12	143	49	n.a.	-88,3%
Bhutan	0	0	0	2	36	967	1'392	n.a.	107,2%
Burkina Faso	0	0	1	45	176	376	392	n.a.	8,5%
Burundi	0	0	1	0	0	2	0	n.a.	n.a.
Cambodia	0	0	0	48	60	277	388	n.a.	97,3%
Cameroon	0	0	0	2	3	237	275	n.a.	34,5%
Central African Rep.	0	0	6	6	0	12	11	n.a.	-24,0%
Chad	0	0	0	0	0	9	11	n.a.	49,0%
China	3'138	10'588	38'725	73'359	105'805	128'042	159'575	201,5%	55,3%
Comoros	0	0	0	0	9	59	73	n.a.	52,0%
Congo	0	0	1	0	1	5	5	n.a.	n.a.
Côte d'Ivoire	0	3	202	254	237	769	898	n.a.	36,3%
D.P.R. Korea	0	0	0	0	0	0	0	n.a.	n.a.
D.P. Congo	0	0	1	4	11	14	27	n.a.	263,8%
Eritrea	0	0	0	0	0	9	11	n.a.	46,0%
Ethiopia	0	1	1	78	78	145	152	n.a.	11,3%
Gambia	0	0	0	0	0	21	27	n.a.	61,7%
Ghana	0	6	203	253	192	439	401	n.a.	-16,7%
Guinea	2	2	2	0	0	228	192	n.a.	-29,1%
Guinea-Bissau	0	0	0	11	15	32	31	n.a.	-7,2%
Haiti	0	0	10	0	0	2	2	n.a.	3,5%
Honduras	0	0	408	74	99	212	223	n.a.	10,6%
India	2'128	6'602	16'213	46'454	74'233	41'828	59'877	143,2%	104,9%
Indonesia	879	4'658	14'780	25'192	39'649	37'559	43'820	205,8%	36,1%
Kenya	0	17	274	459	686	3'837	5'556	n.a.	109,7%
Kyrgyzstan	0	0	0	147	1'527	5'418	5'205	n.a.	-7,7%
Lao P.D.R.	0	0	0	0	0	0	2	n.a.	n.a.
Lesotho	1	3	6	12	20	89	154	n.a.	199,1%
Liberia	0	0	0	1	1	0	2	n.a.	n.a.
Madagascar	0	0	27	17	61	601	1'016	n.a.	185,8%
Malawi	0	0	0	0	1	2	2	n.a.	n.a.
Mali	0	0	15	0	1	233	308	n.a.	75,2%
Mauritania	0	0	0	0	15	105	96	n.a.	-16,5%
Moldova	0	5	6	246	613	2'260	3'109	n.a.	89,2%
Mongolia	0	0	10	13	20	89	305	n.a.	1'068,3%
Mozambique	0	0	31	69	141	289	325	n.a.	26,3%
Myanmar	0	0	0	0	1	7	11	n.a.	132,8%
Nepal	0	19	60	139	153	517	1'508	n.a.	749,8%
Nicaragua	49	141	532	507	715	1'834	1'995	n.a.	18,3%
Niger	0	0	5	2	18	57	238	n.a.	1'634,3%
Nigeria	0	0	4	49	410	657	147	n.a.	-95,0%
Pakistan	0	18	513	1'295	3'096	8'448	9'959	n.a.	39,0%
Rwanda	0	0	1	0	0	462	652	n.a.	98,8%
S. Tomé & Principe	0	0	0	12	115	797	1'209	n.a.	129,7%
Senegal	0	14	69	117	194	1'184	1'843	n.a.	142,4%
Sierra Leone	0	0	0	0	13	136	269	n.a.	292,4%
Solomon Islands	0	10	155	19	20	375	592	n.a.	149,4%
Somalia	0	0	0	0	0	4	4	n.a.	n.a.
Sudan	0	0	0	0	0	0	0	n.a.	n.a.
Tajikistan	0	0	0	11	74	684	827	n.a.	46,2%
Tanzania	0	0	3	25	129	389	973	n.a.	525,6%
Togo	0	0	5	37	110	214	287	n.a.	79,4%
Turkmenistan	0	0	0	3	263	792	1'193	n.a.	126,7%
Uganda	0	58	17	30	113	289	856	n.a.	776,5%
Viet Nam	0	0	5	0	34	225	102	n.a.	-79,6%
Yemen	0	0	2	10	20	52	192	n.a.	1'271,2%
Zambia	69	69	173	182	303	958	1'574	n.a.	169,8%
Zimbabwe	19	93	177	601	1'031	3'698	5'739	n.a.	140,8%
Low income	**6'296**	**22'499**	**72'862**	**150'596**	**231'905**	**249'753**	**318'258**	**108,8%**	**62,4%**

Number of internet hosts

Economy	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*	*July 2000*	*CAGR 1993-99*	*Change Jan-Jul 2000*
Albania	0	35	79	117	142	148	454	n.a.	840,3%
Algeria	10	16	28	49	88	220	307	n.a.	94,1%
Belarus	1	18	257	710	1'052	1'589	3'186	n.a.	301,8%
Belize	0	1	12	258	252	492	528	n.a.	15,0%
Bolivia	0	66	431	552	626	1'691	2'610	n.a.	138,1%
Bosnia	0	0	36	374	705	1'049	3'986	n.a.	1343,8%
Bulgaria	138	1'060	3'327	6'851	10'251	26'127	30'922	239,9%	40,1%
Cape Verde	0	0	0	0	1	18	23	n.a.	61,9%
Colombia	1'442	3'296	11'379	17'157	27'043	72'371	77'910	223,7%	15,9%
Costa Rica	1'001	2'161	4'988	7'463	10'244	13'329	16'120	93,3%	46,3%
Cuba	0	1	24	51	80	302	681	n.a.	409,5%
Djibouti	0	0	4	0	0	70	73	n.a.	8,9%
Dominican Rep.	96	453	3'008	6'976	4'825	12'050	14'231	192,8%	39,5%
Ecuador	423	827	1'315	3'215	4'931	3'429	3'822	65,4%	24,3%
Egypt	206	735	2'367	2'978	4'242	5'993	6'605	157,5%	21,4%
El Salvador	0	23	132	196	815	1'739	1'848	n.a.	12,8%
Equatorial Guinea	0	0	0	0	0	5	0	n.a.	n.a.
Fiji	5	52	75	92	214	640	713	124,4%	24,0%
Georgia	0	57	213	414	738	1'632	2'242	n.a.	88,8%
Guatemala	48	186	630	1'736	2'576	1'938	5'252	142,0%	634,2%
Guyana	0	0	52	67	69	29	93	n.a.	951,5%
Iran (I.R.)	18	271	285	204	244	1'609	1'678	n.a.	8,7%
Iraq	0	0	0	0	0	4	9	n.a.	n.a.
Jamaica	76	164	249	267	322	655	1'074	n.a.	169,3%
Jordan	117	405	1'008	2'856	4'418	1'458	1'287	99,0%	-22,1%
Kazakhstan	7	188	809	1'213	1'480	8'655	9'837	n.a.	29,2%
Kiribati	0	0	0	0	0	75	76	n.a.	3,5%
Latvia	526	1'326	5'789	7'110	14'333	29'715	32'578	181,3%	20,2%
Lithuania	127	458	1'730	4'045	9'802	24'152	27'915	n.a.	33,6%
Maldives	0	0	33	52	109	407	481	n.a.	39,8%
Marshall Islands	0	0	0	2	2	4	4	n.a.	3,5%
Micronesia	0	1	40	64	170	526	750	n.a.	102,8%
Morocco	0	229	469	1'407	2'045	2'788	2'443	n.a.	-23,2%
Namibia	0	12	263	643	2'654	3'645	6'242	n.a.	193,2%
Panama	224	828	2'279	5'610	7'869	2'203	5'291	94,0%	476,5%
Papua New Guinea	0	0	1	54	118	601	612	n.a.	3,5%
Paraguay	1	3	191	309	1'147	2'962	2'650	n.a.	-19,9%
Peru	172	816	5'198	3'428	4'795	16'467	18'089	449,3%	20,7%
Philippines	706	2'994	6'377	12'573	22'027	22'112	30'299	158,3%	87,8%
Romania	575	1'855	8'011	14'040	23'529	55'652	60'472	192,9%	18,1%
Russia	6'779	22'737	59'883	158'001	191'036	276'934	517'391	139,2%	249,0%
Samoa	0	0	0	0	1	12	951	n.a.	>5000%
Sri Lanka	0	6	349	680	539	2'157	3'183	n.a.	117,8%
St. Vincent	0	0	0	0	0	0	4	n.a.	n.a.
Suriname	0	1	1	2	2	0	0	n.a.	n.a.
Swaziland	0	1	226	330	278	1'179	1'341	n.a.	29,4%
Syria	0	0	1	2	1	2	7	n.a.	n.a.
TFYR Macedonia	5	101	211	543	1'132	2'608	3'836	230,6%	116,3%
Thailand	2'408	6'289	14'270	29'473	43'962	71'677	97'431	136,3%	84,8%
Tonga	0	1	7	726	1'871	7'122	8'263	n.a.	34,6%
Tunisia	59	90	59	94	17	108	102	95,4%	-10,8%
Ukraine	529	2'409	6'577	13'996	19'775	49'918	59'441	154,7%	41,8%
Uzbekistan	0	35	122	98	236	357	427	n.a.	42,9%
Vanuatu	0	0	7	46	78	268	307	n.a.	31,4%
West Bank and Gaza	0	0	0	0	0	0	0	n.a.	n.a.
Yugoslavia	2	4	2'542	4'914	7'713	18'371	25'834	n.a.	97,8%
Lower middle income	**15'705**	**50'177**	**145'266**	**311'922**	**430'458**	**749'118**	**1'091'454**	**152,0%**	**112,3%**

2. Internet host computers

Economy	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*	*July 2000*	*CAGR 1993-99*	*Change Jan-July 2000*
Antigua & Barbuda	0	160	169	184	175	401	461	n.a.	31,9%
Argentina	2'021	7'805	18'295	36'828	92'607	254'179	318'164	243,5%	56,7%
Bahrain	0	142	841	339	577	2'371	2'442	n.a.	6,1%
Barbados	0	2	21	23	44	121	143	n.a.	39,7%
Botswana	0	24	24	550	658	3'971	4'252	n.a.	14,7%
Brazil	7'919	26'762	92'101	162'122	284'827	796'494	1'203'140	141,4%	128,2%
Chile	3'160	9'376	16'669	20'177	33'761	71'702	93'251	92,9%	69,1%
Croatia	1'047	2'467	4'644	8'263	9'508	25'627	29'839	105,6%	35,6%
Czech Republic	10'511	22'232	41'692	59'411	90'429	210'657	256'215	89,9%	47,9%
Dominica	0	0	55	76	148	323	327	n.a.	2,3%
Estonia	1'158	3'586	7'993	15'862	24'159	53'376	62'433	122,6%	36,8%
Gabon	0	0	0	0	0	24	47	n.a.	300,9%
Grenada	0	0	0	1	3	5	5	n.a.	n.a.
Guadeloupe	0	0	7	57	159	979	1'025	n.a.	9,6%
Hungary	6'972	16'273	30'922	71'137	100'977	208'789	224'704	101,9%	15,8%
Korea (Rep.)	20'710	38'053	85'933	181'027	278'159	505'715	863'609	93,9%	191,6%
Lebanon	80	350	1'190	2'903	5'105	7'597	7'298	179,5%	-7,7%
Libya	0	0	0	1	4	5	15	n.a.	n.a.
Malaysia	2'117	5'873	28'975	43'611	65'461	105'282	116'303	141,0%	22,0%
Mauritius	0	0	122	202	575	1'468	5'964	n.a.	1'549,8%
Mayotte	0	0	0	0	0	0	0	n.a.	n.a.
Mexico	7'243	15'717	34'180	54'696	132'860	722'328	899'750	141,0%	55,2%
Oman	0	1	1	672	664	1'210	1'305	n.a.	16,4%
Poland	10'875	23'441	53'655	90'866	134'298	314'749	440'202	100,2%	95,6%
Puerto Rico	82	82	82	260	1'571	2'337	2'205	n.a.	-11,0%
Saudi Arabia	304	1'021	2'510	6'751	10'743	6'377	6'839	117,4%	15,0%
Seychelles	0	0	1	1	1	4	7	n.a.	n.a.
Slovak Republic	1'442	3'078	8'133	15'107	22'975	48'496	54'961	126,8%	28,4%
South Africa	27'664	50'329	103'899	135'891	165'972	299'075	334'941	73,2%	25,4%
St. Kitts and Nevis	0	0	2	5	5	14	9	n.a.	n.a.
St. Lucia	0	0	21	14	23	23	33	n.a.	98,4%
Trinidad & Tobago	71	288	665	2'493	4'387	8'656	9'888	191,3%	30,5%
Turkey	3'169	9'776	27'014	63'587	93'213	150'174	173'194	140,3%	33,0%
Uruguay	172	626	1'823	10'327	15'395	45'289	64'969	n.a.	105,8%
Venezuela	1'061	2'913	6'347	15'677	26'244	25'479	28'418	93,6%	24,4%
Upper middle income	**107'780**	**240'377**	**567'988**	**999'121**	**1'595'686**	**3'873'299**	**5'206'359**	**109,9%**	**80,7%**

Number of internet hosts

Economy	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*	*July 2000*	*CAGR 1993-99*	*Change Jan-Jul 2000*
Andorra	0	10	171	491	517	1'256	1'857	n.a.	118,6%
Aruba	0	0	98	87	88	630	495	n.a.	-38,1%
Australia	164'373	320'101	538'460	736'604	902'890	1'945'487	2'380'275	66,8%	49,7%
Austria	28'445	57'094	97'245	133'811	172'569	477'607	688'813	77,3%	108,0%
Bahamas	346	1'412	2'749	7'888	12'394	n.a	n.a.	n.a.	n.a.
Belgium	18'808	35'172	75'299	137'557	256'402	590'923	597'367	107,7%	2,2%
Bermuda	549	855	1'829	3'657	4'037	5'040	5'748	163,6%	30,1%
Brunei Darussalam	0	156	206	340	1'196	2'494	2'559	n.a.	5,3%
Canada	229'307	512'847	918'068	1'784'698	2'587'146	2'978'822	3'293'212	77,6%	22,2%
Cyprus	1	392	1'460	3'023	5'500	11'160	13'191	n.a.	39,7%
Denmark	21'178	59'666	127'218	230'912	393'822	602'419	606'827	101,8%	1,5%
Faroe Islands	0	52	96	285	622	1'504	2'099	n.a.	94,8%
Finland	69'055	218'309	319'999	486'811	459'568	956'712	1'034'911	75,1%	17,0%
France	91'636	178'372	298'040	538'788	796'475	1'844'562	2'143'322	79,4%	35,0%
French Guiana	0	0	27	120	113	223	234	n.a.	10,2%
French Polynesia	0	0	25	190	282	1'547	2'133	n.a.	90,1%
Germany	211'241	515'094	783'435	1'407'274	1'877'007	2'969'961	3'383'798	72,2%	29,8%
Greece	3'737	8'469	18'375	35'764	57'537	136'211	173'878	106,1%	63,0%
Greenland	3	88	215	294	1'742	4'159	4'249	n.a.	4,3%
Guam	0	55	122	77	108	214	232	n.a.	17,7%
Guernsey	0	0	5	22	19	1'268	1'252	n.a.	-2,5%
Hongkong SAR	16'763	31'912	81'138	162'681	231'912	204'959	225'684	77,4%	21,2%
Iceland	4'548	8'379	11'697	18'986	25'517	53'079	65'084	76,3%	50,3%
Ireland	6'056	15'310	31'111	52'529	75'521	110'708	180'315	89,0%	165,3%
Israel	13'456	30'308	55'298	104'966	142'848	259'220	263'790	85,1%	3,6%
Italy	33'154	91'099	183'231	360'520	551'544	817'697	1'744'015	90,2%	354,9%
Japan	101'452	285'167	770'028	1'275'971	1'853'675	4'703'813	6'194'890	118,1%	73,4%
Jersey	0	0	6	3	39	1'340	1'349	n.a.	1,3%
Kuwait	221	1'236	2'925	4'070	6'244	7'259	8'338	93,4%	31,9%
Luxembourg	639	2'317	4'501	7'695	12'320	17'196	21'278	94,2%	53,1%
Macau SAR	12	65	179	151	142	289	323	n.a.	24,9%
Malta	0	87	494	824	1'838	6'951	7'605	n.a.	19,7%
Martinique	0	0	0	12	38	587	628	n.a.	14,5%
Neth. Antilles	83	273	660	1'846	2'873	173	183	47,8%	12,2%
Netherlands	90'987	188'344	307'794	503'235	799'659	1'602'773	2'155'635	81,6%	80,9%
New Caledonia	0	1	23	82	113	280	476	n.a.	188,2%
New Zealand	31'582	54'815	87'241	177'403	149'883	483'492	561'761	108,7%	35,0%
Northern Marianas	0	0	0	6	15	12	25	n.a.	314,0%
Norway	49'345	87'519	157'383	314'172	352'823	754'076	861'664	70,3%	30,6%
Portugal	5'341	12'719	25'602	48'817	65'635	148'922	176'330	86,1%	40,2%
Qatar	0	0	21	190	190	n.a.	n.a.	n.a.	n.a.
Réunion	0	0	0	1	1	2	2	n.a.	3,5%
Singapore	6'144	25'699	35'482	77'403	97'796	264'489	281'288	111,5%	13,1%
Slovenia	1'691	5'826	14'281	20'920	25'144	39'700	40'477	99,8%	4,0%
Spain	32'815	68'666	151'930	312'675	487'070	795'485	826'760	93,4%	8,0%
Sweden	80'053	164'528	282'099	481'596	585'917	989'126	1'114'550	69,2%	27,0%
Switzerland	53'177	91'169	157'741	263'728	361'153	509'799	590'408	57,8%	34,1%
Taiwan, China	14'618	25'723	34'650	177'382	309'222	1'065'163	1'640'451	126,1%	137,2%
United Arab Emirate	1	366	1'804	1'946	17'910	39'313	50'278	n.a.	63,6%
United Kingdom	242'281	492'992	839'028	1'347'322	2'007'576	3'230'260	3'373'777	74,6%	9,1%
United States	2'980'275	5'552'363	8'986'122	17'247'802	25'451'418	38'311'428	49'478'846	72,2%	66,8%
Virgin Islands (US)	331	726	1'242	3'252	4'982	467	1'103	23,4%	457,6%
High income	**4'624'414**	**9'183'718**	**15'492'295**	**28'657'082**	**41'427'195**	**66'950'258**	**84'203'768**	**75,7%**	**58,2%**
WORLD	**4'732'424**	**9'455'927**	**16'186'705**	**29'922'973**	**43'382'822**	**71'822'428**	**90'819'840**	**77,2%**	**59,9%**
Africa	**27'973**	**51'615**	**108'641**	**144'344**	**180'621**	**335'089**	**386'183**	**76,5%**	**32,8%**
Americas	**3'236'157**	**6'141'222**	**10'112'072**	**19'400'173**	**28'522'639**	**43'357'415**	**55'554'695**	**73,8%**	**64,2%**
Asia	**185'290**	**478'392**	**1'195'129**	**2'235'381**	**3'321'669**	**7'234'000**	**10'103'038**	**112,0%**	**95,1%**
Europe	**1'088'049**	**2'412'534**	**4'150'958**	**7'243'235**	**10'570'691**	**18'171'086**	**21'817'237**	**78,7%**	**44,2%**
Pacific	**195'960**	**375'036**	**626'157**	**915'366**	**1'055'767**	**2'440'657**	**2'957'169**	**71,4%**	**46,8%**

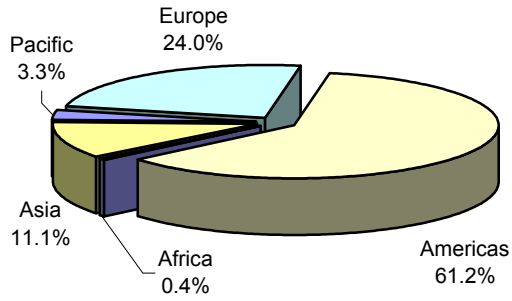
Note : Generic Top Level Domain (gTLD) registrations are distributed between countries according to distribution of country-code TLDs. For additional information, see the technical notes.

Source : ITU, partially based on data from the Internet Software Consortium (www.isc.org) and RIPE (www.ripe.net).

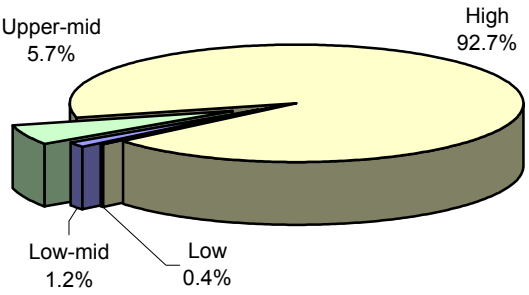
2. Internet host computers

Internet host computers, 1993 - July 2000

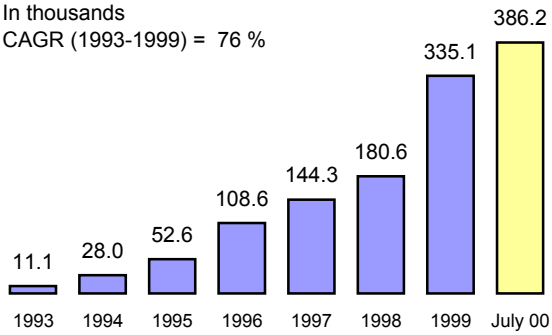
Internet host distribution by region, July 2000



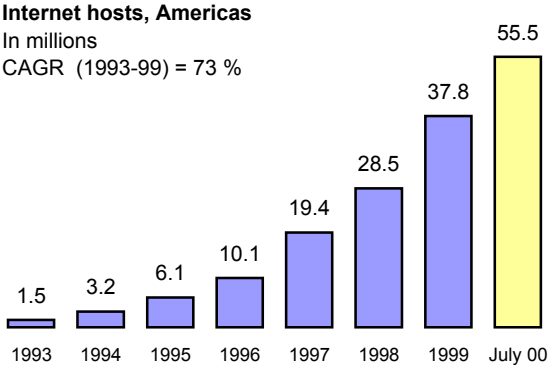
Internet host distribution by income, July 2000



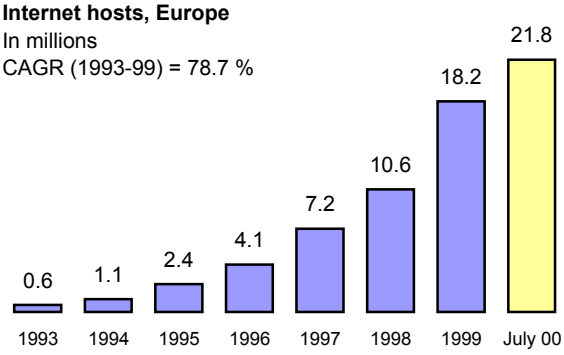
Internet hosts, Africa
In thousands
CAGR (1993-1999) = 76 %



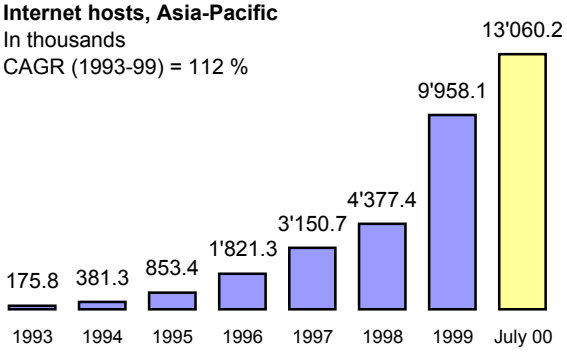
Internet hosts, Americas
In millions
CAGR (1993-99) = 73 %

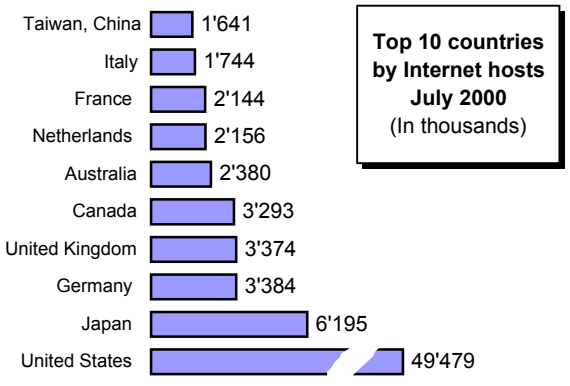


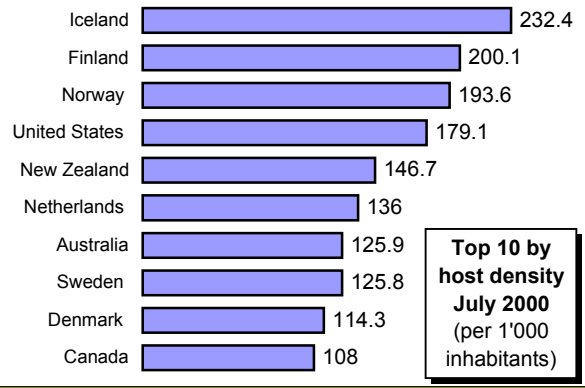
Internet hosts, Europe
In millions
CAGR (1993-99) = 78.7 %



Internet hosts, Asia-Pacific
In thousands
CAGR (1993-99) = 112 %







Source: ITU, partially based on data from the Internet Software Consortium (www.isc.org) and RIPE (www.ripe.net).

Internet host density per 10'000 inhabitants

Economy	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*	*July 2000*	*CAGR 1993 - 99*	*Change Jan-Jul 2000*
Afghanistan	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n.a.	n.a.
Angola	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	n.a.	53%
Armenia	0.00	0.00	0.46	0.47	1.17	2.69	8.35	9.42	n.a.	13%
Azerbaijan	0.00	0.01	0.02	0.04	0.46	0.57	0.91	1.08	n.a.	19%
Bangladesh	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n.a.	n.a.
Benin	0.00	0.00	0.00	0.02	0.02	0.02	0.24	0.08	n.a.	-66%
Bhutan	0.00	0.00	0.00	0.00	0.03	0.56	14.65	21.09	n.a.	44%
Burkina Faso	0.00	0.00	0.00	0.00	0.04	0.16	0.32	0.34	n.a.	4%
Burundi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n.a.	n.a.
Cambodia	0.00	0.00	0.00	0.00	0.05	0.06	0.25	0.35	n.a.	40%
Cameroon	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.19	n.a.	16%
Central African Rep.	0.00	0.00	0.00	0.02	0.02	0.00	0.04	0.03	n.a.	-13%
Chad	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	n.a.	22%
China	0.00	0.03	0.09	0.31	0.59	0.84	1.01	1.26	148%	25%
Comoros	0.00	0.00	0.00	0.00	0.00	0.14	0.87	1.07	n.a.	23%
Congo	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	n.a.	2%
Côte d'Ivoire	0.00	0.00	0.00	0.15	0.18	0.17	0.53	0.62	n.a.	17%
D.P.R. Korea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n.a.	n.a.	n.a.
D.R. Congo	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	n.a.	91%
Eritrea	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.03	n.a.	21%
Ethiopia	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.02	n.a.	5%
Gambia	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.21	n.a.	27%
Ghana	0.00	0.00	0.00	0.11	0.14	0.10	0.22	0.20	n.a.	-9%
Guinea	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.25	n.a.	-16%
Guinea-Bissau	0.00	0.00	0.00	0.00	0.10	0.13	0.27	0.26	n.a.	-4%
Haiti	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	n.a.	2%
Honduras	0.00	0.00	0.00	0.66	0.12	0.15	0.34	0.35	n.a.	5%
India	0.01	0.02	0.07	0.17	0.49	0.76	0.42	0.60	106%	43%
Indonesia	0.01	0.05	0.24	0.75	1.25	1.92	1.79	2.09	149%	17%
Kenya	0.00	0.00	0.01	0.09	0.16	0.24	1.30	1.88	n.a.	45%
Kyrgyzstan	0.00	0.00	0.00	0.00	0.32	3.29	11.60	11.14	n.a.	-4%
Lao P.D.R.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n.a.	n.a.
Lesotho	0.00	0.01	0.02	0.03	0.06	0.09	0.42	0.73	n.a.	73%
Liberia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	n.a.	n.a.
Madagascar	0.00	0.00	0.00	0.02	0.01	0.04	0.39	0.66	n.a.	69%
Malawi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n.a.	n.a.
Mali	0.00	0.00	0.00	0.01	0.00	0.00	0.21	0.28	n.a.	32%
Mauritania	0.00	0.00	0.00	0.00	0.00	0.06	0.40	0.37	n.a.	-9%
Moldova	0.00	0.00	0.01	0.01	0.56	1.40	5.16	7.10	n.a.	38%
Mongolia	0.00	0.00	0.00	0.04	0.05	0.08	0.34	1.16	n.a.	242%
Mozambique	0.00	0.00	0.00	0.02	0.04	0.07	0.15	0.17	n.a.	12%
Myanmar	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n.a.	n.a.
Nepal	0.00	0.00	0.01	0.03	0.06	0.07	0.22	0.64	n.a.	192%
Nicaragua	0.00	0.12	0.32	1.25	1.16	1.60	3.71	4.04	n.a.	9%
Niger	0.00	0.00	0.00	0.01	0.00	0.02	0.05	0.23	n.a.	316%
Nigeria	0.00	0.00	0.00	0.00	0.00	0.04	0.06	0.01	n.a.	-78%
Pakistan	0.00	0.00	0.00	0.04	0.09	0.22	0.63	0.74	n.a.	18%
Rwanda	0.00	0.00	0.00	0.00	0.00	0.00	0.64	0.90	n.a.	41%
S. Tomé & Principe	0.00	0.00	0.00	0.00	0.87	8.16	56.96	86.34	n.a.	52%
Senegal	0.00	0.00	0.02	0.08	0.13	0.22	1.28	1.99	n.a.	56%
Sierra Leone	0.00	0.00	0.00	0.00	0.00	0.03	0.29	0.57	n.a.	98%
Solomon Islands	0.00	0.01	0.25	3.96	0.47	0.48	8.71	13.76	n.a.	58%
Somalia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n.a.	n.a.
Sudan	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n.a.	n.a.
Tajikistan	0.00	0.00	0.00	0.00	0.02	0.12	1.12	1.36	n.a.	21%
Tanzania	0.00	0.00	0.00	0.00	0.01	0.04	0.12	0.30	n.a.	150%
Togo	0.00	0.00	0.00	0.01	0.09	0.25	0.47	0.64	n.a.	34%
Turkmenistan	0.00	0.00	0.00	0.00	0.01	0.61	1.81	2.72	n.a.	51%
Uganda	0.00	0.00	0.03	0.01	0.01	0.05	0.14	0.40	n.a.	196%
Viet Nam	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.01	n.a.	-55%
Yemen	0.00	0.00	0.00	0.00	0.01	0.01	0.03	0.11	n.a.	270%
Zambia	0.00	0.09	0.09	0.21	0.21	0.35	1.07	1.75	n.a.	64%
Zimbabwe	0.00	0.02	0.08	0.15	0.49	0.81	3.21	4.98	n.a.	55%
Low income	**0.00**	**0.01**	**0.04**	**0.10**	**0.26**	**0.42**	**0.70**	**0.89**	**153%**	**27%**

3. Internet host density

Internet host density per 10'000 inhabitants

Economy	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*	*July 2000*	*CAGR 1993 - 99*	*Change Jan-Jul 2000*
Albania	0.00	0.00	0.10	0.22	0.31	0.46	0.38	1.18	n.a.	207%
Algeria	0.00	0.00	0.01	0.01	0.02	0.03	0.07	0.10	n.a.	39%
Belarus	0.00	0.00	0.02	0.25	0.70	1.02	1.55	3.10	n.a.	100%
Belize	0.00	0.00	0.06	0.56	11.51	10.96	20.52	22.01	n.a.	7%
Bolivia	0.00	0.00	0.09	0.57	0.71	0.79	2.08	3.21	n.a.	54%
Bosnia	0.00	0.00	0.00	0.09	0.99	1.92	2.73	10.38	n.a.	280%
Bulgaria	0.02	0.16	1.26	3.98	8.24	12.30	31.55	37.35	241%	18%
Cape Verde	0.00	0.00	0.00	0.00	0.00	0.02	0.42	0.54	n.a.	27%
Colombia	0.02	0.42	0.94	3.19	4.74	7.37	17.41	18.75	213%	8%
Costa Rica	0.82	3.06	6.49	14.68	20.62	26.67	33.92	41.02	86%	21%
Cuba	0.00	0.00	0.00	0.02	0.05	0.07	0.27	0.61	n.a.	126%
Djibouti	0.00	0.00	0.00	0.06	0.00	0.00	1.12	1.17	n.a.	n.a.
Dominican Rep.	0.03	0.12	0.57	3.74	8.62	5.86	14.41	17.02	188%	18%
Ecuador	0.15	0.38	0.72	1.12	2.69	4.05	2.76	3.08	62%	11%
Egypt	0.00	0.04	0.13	0.39	0.47	0.64	0.89	0.98	150%	10%
El Salvador	0.00	0.00	0.04	0.23	0.33	1.35	2.83	3.00	n.a.	6%
Equatorial Guinea	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.00	n.a.	n.a.
Fiji	0.07	0.07	0.68	0.97	1.18	2.69	7.91	8.81	122%	11%
Georgia	0.00	0.00	0.11	0.39	0.76	1.36	2.99	4.11	n.a.	37%
Guatemala	0.01	0.05	0.19	0.62	1.65	2.38	1.75	4.74	136%	171%
Guyana	0.00	0.00	0.00	0.62	0.80	0.81	0.33	1.08	n.a.	224%
Iran (I.R.)	0.00	0.00	0.04	0.05	0.03	0.04	0.24	0.25	n.a.	4%
Iraq	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n.a.	n.a.
Jamaica	0.00	0.31	0.66	0.99	1.05	1.27	2.56	4.20	n.a.	64%
Jordan	0.05	0.23	0.74	1.81	4.95	7.40	2.25	1.99	90%	-12%
Kazakhstan	0.00	0.00	0.11	0.49	0.72	0.86	5.32	6.05	n.a.	14%
Kiribati	0.00	0.00	0.00	0.00	0.00	0.00	9.37	9.53	n.a.	n.a.
Latvia	0.23	2.05	5.24	23.14	28.67	58.30	121.78	133.52	184%	10%
Lithuania	0.00	0.34	1.23	4.67	10.92	26.46	65.27	75.44	n.a.	16%
Maldives	0.00	0.00	0.00	1.25	1.90	3.85	14.53	17.18	n.a.	18%
Marshall Islands	0.00	0.00	0.01	0.01	0.37	0.33	0.59	0.60	n.a.	2%
Micronesia	0.02	0.05	0.10	3.65	5.79	14.93	43.86	62.46	265%	42%
Morocco	0.00	0.00	0.09	0.17	0.51	0.73	1.00	0.88	n.a.	-12%
Namibia	0.00	0.00	0.08	1.67	3.99	15.99	21.57	36.93	n.a.	71%
Panama	0.16	0.87	3.15	8.52	20.61	28.44	7.84	18.83	91%	140%
Papua New Guinea	0.00	0.00	0.00	0.00	0.13	0.28	1.28	1.30	n.a.	2%
Paraguay	0.00	0.00	0.01	0.39	0.61	2.20	5.53	4.94	n.a.	-11%
Peru	0.00	0.07	0.35	2.17	1.41	1.93	6.53	7.17	n.a.	10%
Philippines	0.01	0.11	0.44	0.91	1.74	3.02	2.97	4.07	153%	37%
Romania	0.04	0.25	0.82	3.54	6.22	10.47	24.84	27.00	194%	9%
Russia	0.10	0.46	1.54	4.06	10.74	12.94	18.81	35.15	139%	87%
Samoa	0.00	0.00	0.00	0.00	0.00	0.06	0.69	52.83	n.a.	7515%
Sri Lanka	0.00	0.00	0.00	0.19	0.37	0.29	1.16	1.71	n.a.	48%
St. Vincent	0.00	0.00	0.00	0.00	0.90	0.00	0.00	0.15	n.a.	n.a.
Suriname	0.00	0.00	0.03	0.03	0.05	0.00	0.00	0.00	n.a.	n.a.
Swaziland	0.00	0.00	0.01	2.41	3.49	2.92	12.03	13.69	n.a.	14%
Syria	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n.a.	n.a.
TFYR Macedonia	0.01	0.03	0.51	1.07	2.65	5.66	12.98	19.08	229%	47%
Thailand	0.07	0.41	1.06	2.38	4.90	7.29	11.78	16.01	134%	36%
Tonga	0.00	0.00	0.11	0.72	73.40	188.99	712.21	826.34	n.a.	16%
Tunisia	0.00	0.07	0.10	0.06	0.10	0.02	0.11	0.11	n.a.	-6%
Ukraine	0.04	0.10	0.47	1.29	2.75	3.89	9.85	11.73	156%	19%
Uzbekistan	0.00	0.00	0.02	0.05	0.04	0.10	0.15	0.18	n.a.	20%
Vanuatu	0.00	0.00	0.00	0.40	2.58	4.29	14.08	16.14	n.a.	15%
West Bank and Gaza	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n.a.	n.a.
Yugoslavia	0.00	0.00	0.00	2.40	4.64	7.25	17.27	24.28	n.a.	41%
Lower middle income	**0.02**	**0.09**	**0.29**	**0.87**	**1.78**	**2.47**	**8.69**	**12.66**	**185%**	**252%**

Internet host density per 10'000 inhabitants

Economy	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*	*July 2000*	*CAGR 1993 - 99*	*Change Jan-Jul 2000*
Antigua & Barbuda	0.00	0.01	24.02	24.67	25.99	24.09	57.35	65.86	n.a.	14.8%
Argentina	0.05	0.59	2.24	5.19	10.32	25.64	69.49	86.98	239%	25.2%
Bahrain	0.00	0.00	2.45	14.06	5.47	8.99	35.39	36.45	n.a.	3.0%
Barbados	0.00	0.00	0.08	0.79	0.86	1.64	4.49	5.31	n.a.	18.2%
Botswana	0.00	0.00	0.16	0.16	3.62	4.19	24.82	26.58	n.a.	7.1%
Brazil	0.27	0.52	1.72	5.83	10.14	17.17	47.41	71.62	137%	51.1%
Chile	1.01	2.26	6.57	11.56	13.80	22.77	47.74	62.08	90%	30.1%
Croatia	0.73	2.27	5.42	10.33	18.41	21.22	57.20	66.60	107%	16.4%
Czech Republic	4.35	10.17	21.51	40.42	57.68	87.95	205.32	249.72	90%	21.6%
Dominica	0.00	0.00	0.01	7.42	10.16	19.54	40.36	40.84	n.a.	1.2%
Estonia	2.89	7.72	24.16	54.40	108.80	166.18	368.11	430.57	124%	17.0%
Gabon	0.00	0.00	0.00	0.00	0.04	0.00	0.20	0.39	n.a.	100 .2%
Grenada	0.00	0.00	0.00	0.00	0.10	0.29	0.59	0.60	n.a.	1.7%
Guadeloupe	0.00	0.00	0.00	0.16	1.31	3.59	21.77	22.79	n.a.	4.7%
Hungary	2.99	6.78	15.88	30.28	69.92	99.07	200.76	216.06	102%	7.6%
Korea (Rep.)	2.13	4.62	8.44	18.87	39.36	59.91	44.92	48.34	66%	7.6%
Lebanon	0.06	0.27	1.16	3.86	9.23	16.00	23.45	22.53	173%	-3.9%
Libya	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.03	n.a.	171.3%
Malaysia	0.28	1.08	2.92	13.69	20.13	29.51	48.23	23.92	136%	-50.4%
Mauritius	0.00	0.00	0.00	1.08	1.77	5.01	12.77	51.86	n.a.	306.2%
Mayotte	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n.a.	n.a.
Mexico	0.40	0.78	1.68	3.59	5.73	13.86	74.19	92.41	138%	24.6%
Oman	0.00	0.00	0.00	0.00	2.87	2.79	13.81	14.09	n.a.	2.0%
Poland	1.27	2.82	6.07	13.89	23.51	34.69	81.25	113.63	100%	39.9%
Puerto Rico	0.00	0.22	0.22	0.22	0.69	4.12	6.01	5.67	n.a.	-5.6%
Saudi Arabia	0.03	0.17	0.56	1.33	3.46	5.32	3.05	3.27	111%	7.2%
Seychelles	0.00	0.00	0.00	0.13	0.13	0.90	0.45	0.91	n.a.	103.5%
Slovak Republic	0.67	2.69	5.73	15.12	28.10	42.73	90.14	102.16	126%	13.3%
South Africa	2.79	6.84	12.20	24.51	31.36	37.46	74.96	83.95	73%	12.0%
St. Kitts and Nevis	0.00	0.00	0.00	0.49	1.22	1.22	1.57	2.27	n.a.	44.7%
St. Lucia	0.00	0.00	0.00	1.43	0.94	1.56	0.68	2.18	n.a.	220.5%
Trinidad & Tobago	0.12	0.58	2.31	5.26	19.57	34.20	67.10	76.65	188%	14.2%
Turkey	0.13	0.52	1.56	4.23	10.11	13.97	22.02	25.40	135%	15.3%
Uruguay	0.00	0.54	1.96	5.69	31.81	46.81	136.82	196.28	n.a.	43.5%
Venezuela	0.23	0.50	1.35	2.79	6.82	11.29	10.75	11.99	90%	11.5%
Upper middle income	**0.65**	**1.57**	**3.58**	**8.40**	**14.04**	**22.07**	**56.42**	**71.03**	**110%**	**26%**

3. Internet host density

Internet host density per 10'000 inhabitants

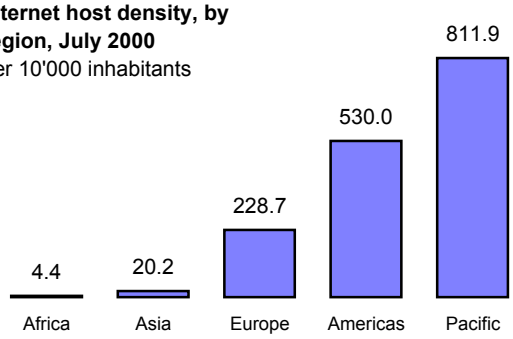
Economy	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*	*Jul-00*	*CAGR 1993 - 99*	*Change Jan-Jul 2000*
Andorra	0.01	0.03	1.53	24.03	66.17	68.94	157.00	232.15	391.6%	47.9%
Aruba	0.00	0.00	0.01	11.42	9.64	9.39	62.98	49.55	n.a.	-21.3%
Australia	51.13	92.06	177.13	294.06	397.48	482.60	1'028.81	1'258.74	64.9%	22.3%
Austria	19.22	35.42	70.95	120.67	165.79	212.00	583.87	842.07	76.6%	44.2%
Bahamas	2.58	12.71	50.60	96.81	272.95	418.70	n.a.	n.a.	n.a.	n.a.
Belgium	7.29	18.64	34.69	74.12	135.02	252.84	582.19	588.54	107.5%	1.1%
Bermuda	2.42	87.85	135.67	285.76	589.82	630.75	840.01	957.98	165.1%	14.0%
Brunei Darussalam	0.00	0.00	5.50	6.77	11.08	37.97	77.94	79.97	496.9%	2.6%
Canada	32.76	78.97	174.71	309.41	594.82	853.83	976.98	1'080.10	76.1%	10.6%
Cyprus	0.01	0.02	6.08	22.11	44.73	79.52	143.08	169.12	425.4%	18.2%
Denmark	17.20	40.74	114.40	242.27	437.74	743.16	1'134.50	1'142.80	101.0%	0.7%
Faroe Islands	0.01	0.02	11.81	22.21	65.06	140.73	375.93	524.63	492.3%	39.6%
Finland	65.47	135.43	421.69	623.50	945.82	891.67	1'850.51	2'001.76	74.5%	8.2%
France	9.61	15.83	30.68	51.06	91.28	133.45	313.22	363.95	78.7%	16.2%
French Guiana	0.00	0.00	0.01	1.77	7.52	6.79	13.12	13.77	n.a.	5.0%
French Polynesia	0.00	0.00	0.01	1.13	8.35	12.19	67.25	92.72	n.a.	37.9%
Germany	14.03	25.91	62.96	95.53	171.50	228.80	361.48	411.85	71.9%	13.9%
Greece	1.71	3.58	8.10	17.54	33.99	54.28	128.14	163.57	105.3%	27.7%
Greenland	0.01	0.56	15.79	38.48	52.41	310.06	693.24	708.15	574.7%	2.2%
Guam	0.00	0.00	3.67	8.00	4.92	6.72	13.38	14.52	n.a.	8.5%
Guernsey	0.00	0.00	0.00	0.82	3.56	3.08	211.37	208.74	n.a.	-1.2%
Hongkong SAR	11.16	27.78	51.84	128.57	250.20	346.80	305.00	335.84	73.6%	10.1%
Iceland	66.63	170.47	312.87	433.66	695.80	924.52	1'895.69	2'324.44	74.7%	22.6%
Ireland	6.82	16.89	42.46	85.80	144.05	205.16	298.40	486.02	87.7%	62.9%
Israel	11.97	24.09	53.94	96.01	177.75	238.72	424.95	432.44	81.3%	1.8%
Italy	3.02	5.79	15.89	31.93	62.68	95.65	142.60	304.15	90.1%	113.3%
Japan	3.50	8.10	22.71	61.18	101.13	146.79	371.81	489.68	117.6%	31.7%
Jersey	0.00	0.00	0.00	0.68	0.34	4.27	148.93	149.91	n.a.	0.7%
Kuwait	0.95	1.37	7.31	16.72	22.86	34.48	38.21	43.88	85.1%	14.9%
Luxembourg	8.05	15.83	56.75	109.03	183.96	290.77	399.91	494.84	91.7%	23.7%
Macau SAR	0.00	0.30	1.59	4.31	3.62	3.35	6.57	7.34	n.a.	11.8%
Malta	0.00	0.01	2.33	13.21	21.73	47.87	178.22	195.00	n.a.	9.4%
Martinique	0.00	0.00	0.00	0.00	0.31	0.98	15.05	16.10	n.a.	7.0%
Neth. Antilles	0.85	4.21	13.16	31.05	84.74	128.67	8.24	8.73	46.0%	5.9%
Netherlands	29.30	59.12	121.51	197.30	321.72	507.97	1'011.21	1'360.02	80.4%	34.5%
New Caledonia	0.00	0.00	0.06	1.22	4.18	5.50	13.34	22.64	n.a.	69.8%
New Zealand	16.55	88.20	150.97	236.97	468.24	384.41	1'262.38	1'466.74	105.9%	16.2%
Northern Marianas	0.00	0.00	0.00	0.00	1.20	2.94	2.50	5.08	389.8%	103.5%
Norway	71.59	113.79	200.77	359.19	713.36	793.57	1'694.55	1'936.32	69.4%	14.3%
Portugal	3.63	5.39	12.82	25.77	49.09	65.92	149.22	176.68	85.8%	18.4%
Qatar	0.00	0.00	0.00	0.38	3.33	0.23	n.a.	n.a.	n.a.	n.a.
Réunion	0.00	0.00	0.00	0.00	0.01	0.01	0.03	0.03	n.a.	1.7%
Singapore	10.27	20.97	86.05	116.55	249.40	309.14	679.92	723.11	101.1%	6.4%
Slovenia	3.14	8.50	29.31	71.90	105.40	126.16	199.50	203.40	99.8%	2.0%
Spain	3.89	8.38	17.51	38.69	79.51	123.71	201.80	209.73	93.1%	3.9%
Sweden	48.35	91.64	186.35	319.03	544.32	661.73	1'116.40	1'257.96	68.7%	12.7%
Switzerland	45.60	72.14	129.09	222.76	371.63	507.84	714.00	826.90	58.2%	15.8%
Taiwan, China	3.81	6.92	12.07	16.10	81.58	141.01	482.19	742.62	124.1%	54.0%
United Arab Emirates	0.00	0.00	1.59	7.98	8.18	76.12	163.80	209.49	n.a.	27.9%
United Kingdom	19.61	41.49	84.22	142.74	228.89	340.58	549.93	574.36	74.3%	4.4%
United States	56.90	114.36	211.09	338.52	643.81	941.35	1'386.99	1'791.28	70.3%	29.1%
Virgin Islands (US)	12.77	31.74	69.14	117.21	303.89	461.34	38.94	91.96	20.4%	136.1%
High income	**25.20**	**50.80**	**100.31**	**168.21**	**309.15**	**444.28**	**749.50**	**942.64**	**76.0%**	**25.8%**
WORLD	**4.20**	**8.44**	**16.61**	**28.06**	**51.25**	**73.23**	**119.52**	**151.73**	**74.7%**	**26.9%**
Africa	**0.16**	**0.40**	**0.72**	**1.46**	**1.89**	**2.38**	**4.37**	**5.04**	**72.9%**	**15.2%**
Americas	**20.96**	**42.69**	**79.98**	**129.95**	**246.27**	**359.07**	**529.98**	**679.07**	**71.3%**	**28.1%**
Asia	**0.24**	**0.55**	**1.41**	**3.47**	**6.40**	**9.39**	**20.23**	**26.33**	**109.1%**	**30.2%**
Europe	**7.09**	**13.77**	**30.45**	**52.31**	**91.06**	**126.95**	**228.73**	**274.63**	**78.4%**	**20.1%**
Pacific	**36.45**	**73.39**	**138.49**	**228.43**	**329.65**	**375.03**	**811.93**	**983.76**	**67.7%**	**21.2%**

Note: Generic Top Level Domain (gTLD) registrations are distributed between countries according to distribution of country-code TLDs. For additional information, see the technical notes.

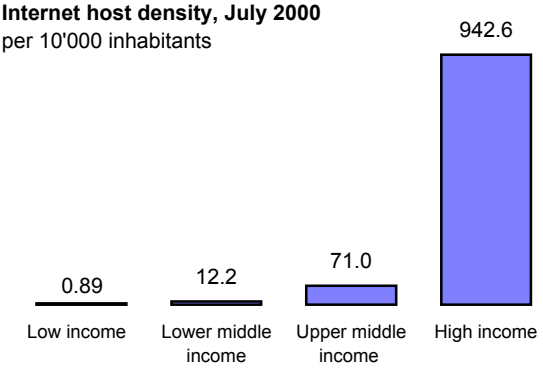
Source: ITU, partially based on data from the Internet Software Consortium (www.isc.org) and RIPE (www.ripe.net).

Internet host density, 1993 - July 2000

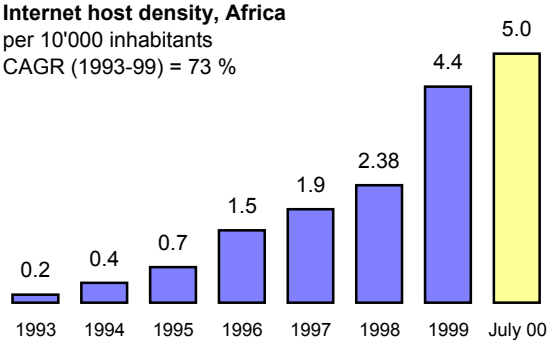
Internet host density, by region, July 2000
per 10'000 inhabitants



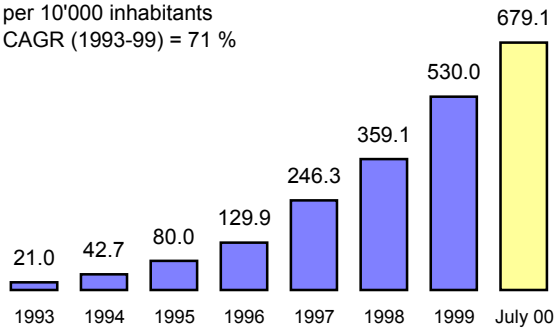
Internet host density, July 2000
per 10'000 inhabitants



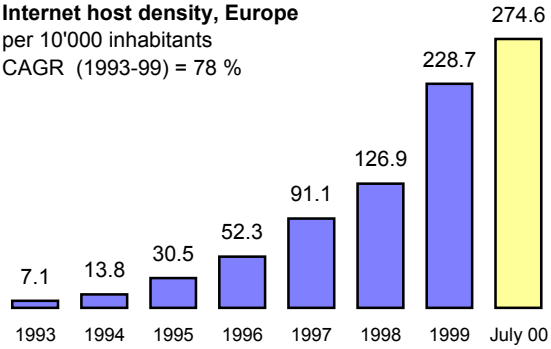
Internet host density, Africa
per 10'000 inhabitants
CAGR (1993-99) = 73 %



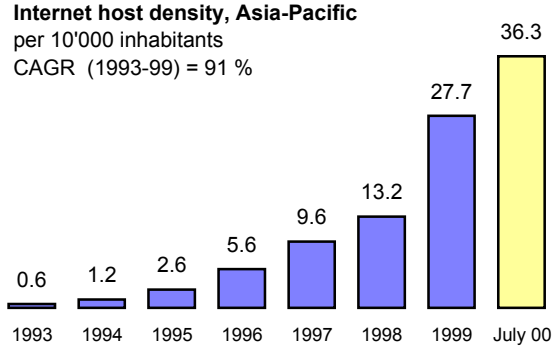
Internet host density, Americas
per 10'000 inhabitants
CAGR (1993-99) = 71 %



Internet host density, Europe
per 10'000 inhabitants
CAGR (1993-99) = 78 %



Internet host density, Asia-Pacific
per 10'000 inhabitants
CAGR (1993-99) = 91 %



Source: ITU, partially based on data from the Internet Software Consortium (www.isc.org) and RIPE (www.ripe.net).

4. Internet hosts, Internet Service Providers and estimated users, major economies

Economy	*Hosts July 2000*	*Estimated ISPs 1999*	*Estimated Internet Users*			
			Estimated total users, 1998	*Estimated total users, 1999*	*Per 100 inhabitants*	*Change 98-99*
Austria	688'813	130	1'230'000	1'840'000	22.5	50%
Belgium	597'367	60	800'000	1'400'000	13.8	75%
Denmark	606'827	29	1'000'000	1'500'000	28.2	50%
Finland	1'034'911	50	1'311'000	2'143'000	41.5	63%
France	2'143'322	230	3'500'000	5'660'000	9.6	62%
Germany	3'383'798	900	10'500'000	14'400'000	17.5	37%
Greece	173'878	140	350'000	750'000	7.1	114%
Ireland	180'315	30	300'000	444'000	12.0	48%
Italy	1'744'015	60	3'000'000	7'000'000	12.2	133%
Luxembourg	21'278	na	50'000	75'000	17.5	50%
Netherlands	2'155'635	130	1'600'000	3'000'000	18.9	88%
Portugal	176'330	30	520'000	800'000	8.0	54%
Spain	826'760	400	1'733'000	2'830'000	7.2	63%
Sweden	1'114'550	100	2'961'000	3'666'000	41.4	24%
United Kingdom	3'373'777	910	8'000'000	12'500'000	21.3	56%
EU	**18'221'578**	**3'199**	**36'855'000**	**58'008'000**	**15.5**	**57%**
Australia	2'380'275	760	4'200'000	5'600'000	29.6	33%
Canada	3'293'212	800	7'500'000	11'000'000	36.1	47%
Iceland	65'084	n.a.	100'000	150'000	53.8	50%
Japan	6'194'890	4'011	16'940'000	27'060'000	21.4	60%
New Zealand	561'761	40	600'000	700'000	18.3	17%
Norway	861'664	40	1'618'000	2'000'000	45.0	24%
Switzerland	590'408	160	1'200'000	1'427'000	20.0	19%
United States	49'478'846	5'775	60'000'000	74'100'000	26.8	24%
Other developed	**63'426'141**	**11'586**	**92'158'000**	**122'037'000**	**26.1**	**32%**
Argentina	318'164	170	300'000	900'000	2.5	200%
Brazil	1'203'140	280	2'500'000	3'500'000	2.1	40%
Chile	93'251	26	250'000	625'000	4.2	150%
China	175'846	5	2'100'000	8'900'000	0.7	324%
Czech Republic	256'215	350	400'000	700'000	6.8	75%
Hongkong SAR	225'684	159	947'000	2'430'000	36.2	157%
Hungary	224'704	155	400'000	600'000	6.0	50%
India	59'877	138	1'400'000	2'800'000	0.3	100%
Indonesia	48'288	35	500'000	900'000	0.4	80%
Israel	263'790	30	450'000	1'000'000	16.4	122%
Korea (Rep.)	863'609	31	3'103'000	10'860'000	23.4	250%
Malaysia	52'222	7	800'000	1'500'000	6.9	88%
Mexico	899'750	8	1'307'000	2'452'000	2.5	88%
Philippines	30'299	160	350'000	500'000	0.7	43%
Poland	440'202	250	1'581'000	2'100'000	5.4	33%
Russia	517'391	16	1'000'000	2'700'000	1.8	170%
Singapore	281'288	3	750'000	950'000	24.4	27%
South Africa	334'941	112	1'266'000	1'820'000	4.6	44%
Taiwan, China	1'640'451	98	3'011'000	4'540'000	20.6	51%
Thailand	97'431	14	550'000	800'000	1.3	45%
Turkey	173'194	76	450'000	1'500'000	2.2	233%
Venezuela	28'418	32	350'000	400'000	1.7	14%
Developing	**8'228'154**	**2'155**	**23'765'000**	**52'477'000**	**2.8**	**121%**
Major economies	**89'875'873**	**16'940**	**152'778'000**	**232'522'000**	**8.6**	**52%**

Note : Generic Top Level Domain (gTLD) registrations are distributed between countries according to country-code TLDs. For additional information, see the technical notes. Figures in italics refer to data from years other than specified.

Source : ITU, partially based on data from the Internet Software Consortium (www.isc.org) and RIPE (www.ripe.net). *Estimated Users* is based on reported estimates, derivations based on reported Internet Access Provider subscriber counts, or calculated by multiplying the number of hosts by an estimated multiplier.

5. Telephone main lines and teledensity

	Main telephone lines (thousands)			*Main telephone lines per 100 inhabitants*		
Economy	***1995***	***1999***	***CAGR 1995 - 99***	***1995***	***1999***	***CAGR 1995 - 99***
Afghanistan	29,0	29,0	-	0,2	0,1	-2,7%
Angola	52,7	96,3	16,3%	0,5	0,8	12,1%
Armenia	582,8	547,3	-1,6%	15,5	15,5	0,1%
Azerbaijan	639,5	730,0	3,4%	8,5	9,5	2,8%
Bangladesh	286,6	433,0	10,9%	0,2	0,3	8,9%
Benin	28,2	*38,4*	10,8%	0,5	*0,7*	8,7%
Bhutan	5,2	11,8	22,5%	0,9	1,8	18,8%
Burkina Faso	30,0	47,3	12,0%	0,3	0,4	9,0%
Burundi	17,3	19,0	2,4%	0,3	0,3	0,1%
Cambodia	8,5	27,7	34,3%	0,1	0,3	32,1%
Cameroon	65,6	*93,9*	12,7%	0,5	*0,7*	10,1%
Central African Rep.	8,4	9,9	4,1%	0,3	0,3	2,4%
Chad	5,3	9,7	16,1%	0,1	0,1	11,5%
China	40'705,7	108'715,8	27,8%	3,3	8,6	27,0%
Comoros	4,4	*6,2*	12,5%	0,7	*1,0*	9,7%
Congo	21,4	*22,0*	0,9%	0,8	*0,8*	-0,7%
Côte d'Ivoire	115,8	219,3	17,3%	0,9	1,5	15,2%
D.P.R. Korea	1'100,0	1'100,0	-	5,0	4,6	-1,7%
D.R. Congo	36,0	*20,0*	-17,8%	0,1	*0,0*	-20,0%
Eritrea	17,5	27,4	11,8%	0,5	0,7	10,7%
Ethiopia	142,5	194,5	8,1%	0,3	0,3	6,3%
Gambia	19,2	29,2	11,1%	1,8	2,3	7,1%
Ghana	63,1	158,6	25,9%	0,4	0,8	21,5%
Guinea	10,9	46,2	43,7%	0,2	0,6	41,5%
Guinea-Bissau	7,4	*8,1*	3,1%	0,7	*0,7*	0,7%
Haiti	60,0	70,0	3,9%	0,8	0,9	0,9%
Honduras	160,8	279,2	14,8%	2,7	4,4	13,1%
India	11'978,0	26'511,3	22,0%	1,3	2,7	19,8%
Indonesia	3'290,9	6'080,2	16,6%	1,7	2,9	14,5%
Kenya	256,4	304,6	4,4%	0,8	1,0	5,2%
Kyrgyzstan	357,0	355,8	-0,1%	7,9	7,6	-0,9%
Lao P.D.R.	16,6	34,5	20,1%	0,4	0,7	16,0%
Lesotho	17,8	*20,1*	4,1%	0,9	*1,0*	3,6%
Liberia	4,5	*6,5*	13,0%	0,2	*0,2*	14,4%
Madagascar	37,1	50,2	7,9%	0,3	0,3	6,8%
Malawi	34,3	41,4	4,8%	0,4	0,4	2,6%
Mali	17,2	*26,8*	16,0%	0,2	*0,3*	15,3%
Mauritania	9,2	17,3	17,0%	0,4	0,7	13,2%
Moldova	566,5	555,3	-0,5%	13,0	12,7	-0,7%
Mongolia	77,7	103,4	7,4%	3,4	4,0	4,1%
Mozambique	61,2	78,1	6,3%	0,4	0,4	3,6%
Myanmar	157,8	249,1	12,1%	0,4	0,6	11,5%
Nepal	83,7	247,2	31,1%	0,4	1,1	28,3%
Nicaragua	96,6	150,3	11,7%	2,2	3,0	8,2%
Niger	13,7	*18,1*	9,6%	0,2	*0,2*	5,7%
Nigeria	405,1	*407,0*	0,2%	0,4	*0,4*	-0,9%
Pakistan	2'127,3	2'986,1	8,8%	1,7	2,2	7,4%
Rwanda	6,9	10,8	16,2%	0,1	0,2	7,2%
S. Tomé & Principe	2,5	3,8	11,3%	2,0	2,7	7,9%
Senegal	82,0	165,9	19,3%	1,0	1,8	16,3%
Sierra Leone	16,6	*17,4*	1,5%	0,4	*0,4*	1,1%
Solomon Islands	6,5	*7,9*	6,6%	1,7	*1,9*	3,0%
Somalia	15,0	*15,0*	-	0,2	*0,2*	-2,3%
Sudan	75,0	251,4	35,3%	0,3	0,9	32,3%
Tajikistan	262,7	212,5	-5,2%	4,5	3,5	-6,2%
Tanzania	90,3	149,6	13,5%	0,3	0,5	10,6%
Togo	21,7	38,2	15,1%	0,5	0,9	12,7%
Turkmenistan	320,3	358,9	2,9%	7,1	8,2	3,5%
Uganda	39,0	57,1	10,0%	0,2	0,3	7,6%
Viet Nam	775,0	2'105,9	28,4%	1,1	2,7	26,3%
Yemen	186,7	291,4	11,8%	1,2	1,7	8,2%
Zambia	76,8	83,1	2,0%	1,0	0,9	-0,6%
Zimbabwe	152,5	239,0	11,9%	1,4	2,1	10,3%
Low income	**65'962,0**	**155'240,8**	**23,9%**	**1,9**	**4,3**	**22,2%**

5. Telephone main lines and teledensity

	Main telephone lines (thousands)			*Main telephone lines per 100 inhabitants*		
Economy	*1995*	*1999*	*CAGR 1995 - 99*	*1995*	*1999*	*CAGR 1995 - 99*
Albania	42,1	140,4	35,1%	1,2	3,7	32,9%
Algeria	1'176,3	1'600,0	8,0%	4,1	5,2	6,0%
Belarus	1'968,4	2'638,5	7,6%	19,2	25,7	7,6%
Belize	28,9	36,6	6,1%	13,4	15,6	3,8%
Bolivia	246,9	502,5	19,4%	3,3	6,2	16,7%
Bosnia	237,8	367,9	11,5%	6,0	9,6	12,5%
Bulgaria	2'562,9	2'933,4	3,4%	30,5	35,4	3,8%
Cape Verde	21,5	46,9	21,5%	5,5	11,2	19,6%
Colombia	3'872,8	6'665,4	14,5%	11,0	16,0	9,8%
Costa Rica	478,9	802,6	13,8%	14,4	20,4	9,1%
Cuba	353,2	433,8	5,3%	3,2	3,9	4,9%
Djibouti	7,6	*7,9*	1,6%	1,3	*1,3*	-0,8%
Dominican Rep.	582,6	*763,9*	9,5%	7,4	*9,3*	8,0%
Ecuador	697,9	1'129,5	12,8%	6,1	9,1	10,6%
Egypt	2'716,2	4'686,4	14,6%	4,6	7,0	10,8%
El Salvador	284,8	468,1	13,2%	5,0	7,6	10,9%
Equatorial Guinea	2,5	*5,6*	30,4%	0,6	*1,3*	27,3%
Fiji	64,8	*76,9*	5,9%	8,4	*9,8*	5,0%
Georgia	554,3	671,5	4,9%	10,2	12,3	4,7%
Guatemala	286,4	610,7	20,8%	2,9	5,5	17,7%
Guyana	44,6	64,0	9,5%	5,4	7,5	8,7%
Iran (I.R.)	5'090,4	8'371,2	13,2%	8,3	12,5	10,8%
Iraq	675,0	675,0	-	3,4	3,0	-2,7%
Jamaica	291,8	509,6	15,0%	11,7	19,9	14,3%
Jordan	317,4	*510,9*	17,2%	5,8	*8,3*	12,6%
Kazakhstan	1'962,9	1'759,8	-2,7%	11,9	10,8	-2,3%
Kiribati	2,0	*2,8*	11,4%	2,6	*3,4*	10,2%
Latvia	704,5	731,5	0,9%	27,9	30,0	1,9%
Lithuania	941,0	1'161,0	5,4%	25,4	31,4	5,5%
Maldives	13,9	22,2	12,5%	5,7	8,0	8,9%
Marshall Islands	3,2	*3,7*	5,5%	5,7	*6,2*	2,9%
Micronesia	7,9	*9,1*	4,9%	7,4	*8,0*	2,7%
Morocco	1'158,0	1'466,6	6,1%	4,4	5,3	4,9%
Namibia	78,5	108,2	8,4%	5,1	6,4	6,0%
Panama	303,9	462,5	11,1%	11,6	16,5	9,2%
Papua New Guinea	43,6	*47,0*	7,7%	1,1	*1,1*	5,9%
Paraguay	166,9	297,0	15,5%	3,5	5,5	12,5%
Peru	1'109,2	1'688,6	11,1%	4,7	6,7	9,2%
Philippines	1'409,6	2'940,0	20,2%	2,1	4,0	17,7%
Romania	2'968,0	3'740,0	6,0%	13,1	16,7	6,3%
Russia	25'018,9	30'388,1	5,0%	16,9	20,6	5,1%
Samoa	7,8	*8,5*	2,8%	4,7	*4,9*	1,0%
Sri Lanka	206,0	679,2	34,8%	1,1	3,6	33,8%
St. Vincent	18,2	23,6	6,7%	16,5	20,9	6,1%
Suriname	54,1	70,8	6,9%	13,2	17,1	6,6%
Swaziland	21,1	30,6	9,7%	2,3	3,1	7,7%
Syria	958,5	1'600,0	13,7%	6,8	10,2	10,8%
TFYR Macedonia	351,0	471,0	7,6%	17,9	23,4	7,0%
Thailand	3'482,0	5'215,6	10,6%	5,9	8,6	10,0%
Tonga	6,6	*7,8*	17,7%	6,7	*7,9*	17,2%
Tunisia	521,7	850,4	13,0%	5,8	9,0	11,5%
Ukraine	8'311,0	10'074,0	4,9%	16,1	19,9	5,4%
Uzbekistan	1'544,2	1'599,4	0,9%	6,8	6,7	-0,5%
Vanuatu	4,2	*5,2*	7,0%	2,5	*2,8*	4,5%
West Bank and Gaza	80,0	*167,3*	27,9%	3,5	*5,8*	18,7%
Yugoslavia	2'017,1	2'280,7	3,1%	19,2	21,4	2,9%
Lower middle income	**76'081,9**	**102'631,4**	**7,8%**	**9,27**	**11,9**	**6,4%**

5. Telephone main lines and teledensity

	Main telephone lines (thousands)			*Main telephone lines per 100 inhabitants*		
Economy	***1995***	***1999***	***CAGR 1995- 99***	***1995***	***1999***	***CAGR 1995 - 99***
Antigua & Barbuda	25,9	36,5	9,0%	38,84	48,86	5,9%
Argentina	5'531,7	7'356,8	7,4%	15,91	20,11	6,0%
Bahrain	140,8	165,4	4,1%	24,23	24,87	0,6%
Barbados	90,1	*113,0*	7,8%	34,53	*42,18*	6,9%
Botswana	59,7	120,0	19,1%	4,09	7,51	16,4%
Brazil	13'263,0	24'985,0	17,2%	8,51	14,87	15,0%
Chile	1'818,0	3'108,8	14,4%	12,74	20,70	12,9%
Croatia	1'287,1	1'633,6	6,1%	28,28	36,49	6,6%
Czech Republic	2'444,2	3'806,1	11,7%	23,65	37,09	11,9%
Dominica	17,8	21,3	4,6%	24,13	27,88	3,7%
Estonia	411,7	515,5	5,8%	27,74	35,66	6,5%
Gabon	32,0	38,0	4,4%	2,98	3,17	1,6%
Grenada	23,2	29,4	6,1%	26,02	31,51	4,9%
Guadeloupe	165,3	201,0	5,0%	38,98	44,69	3,5%
Hungary	2'157,2	3'725,8	14,6%	21,05	37,09	15,2%
Korea (Rep.)	18'600,2	20'518,1	2,5%	41,24	44,14	1,7%
Lebanon	330,0	*620,0*	23,4%	10,96	*19,43*	21,0%
Libya	318,0	*500,0*	16,3%	5,88	*9,07*	15,6%
Malaysia	3'332,4	4'430,8	7,4%	16,57	20,30	5,2%
Mauritius	148,2	257,1	14,8%	13,21	22,36	14,1%
Mayotte	5,3	9,7	16,4%	4,66	7,27	11,7%
Mexico	8'801,0	10'927,4	5,6%	9,39	11,22	4,6%
Oman	169,9	220,4	6,7%	7,87	8,96	3,3%
Poland	5'728,5	10'175,2	15,4%	14,84	26,27	15,3%
Puerto Rico	1'195,9	1'295,0	2,0%	32,05	33,29	1,0%
Saudi Arabia	1'719,4	*2'878,1*	18,7%	9,42	*14,26*	14,8%
Seychelles	13,5	*19,0*	11,9%	17,96	*24,79*	11,3%
Slovak Republic	1'118,5	1'655,4	10,3%	20,84	30,76	10,2%
South Africa	4'002,2	5'492,8	8,2%	9,70	13,77	9,1%
St. Kitts and Nevis	14,4	20,1	8,6%	36,32	51,76	9,3%
St. Lucia	30,6	*40,4*	9,7%	21,02	*26,57*	8,1%
Trinidad & Tobago	209,3	278,9	7,4%	16,78	21,58	6,5%
Turkey	13'215,7	18'054,0	8,1%	21,14	26,47	5,8%
Uruguay	622,0	896,8	9,6%	19,50	27,07	8,5%
Venezuela	2'463,2	2'585,9	1,2%	11,38	10,91	-1,1%
Upper middle income	**89'505,9**	**126'731,1**	**9,1%**	**14,86**	**20,01**	**7,7%**

5. Telephone main lines and teledensity

	Main telephone lines (thousands)			*Main telephone lines per 100 inhabitants*		
			CAGR			*CAGR*
Economy	***1995***	***1999***	***1995 - 99***	***1995***	***1999***	***1995 - 99***
Andorra	29,8	*33,1*	3,6%	43,8	*44,1*	0,2%
Aruba	27,3	36,6	7,6%	33,5	37,2	2,7%
Australia	8'900,0	9'856,9	2,6%	49,3	52,1	1,4%
Austria	3'796,9	3'939,0	0,9%	47,2	48,2	0,5%
Bahamas	83,7	111,2	7,4%	30,0	36,9	5,3%
Belgium	4'682,1	5'100,0	2,2%	46,2	50,2	2,1%
Bermuda	46,4	54,9	4,3%	73,7	85,7	3,9%
Brunei Darussalam	68,1	*77,7*	4,5%	24,0	*24,7*	1,0%
Canada	17'763,0	19'956,6	3,0%	60,5	65,5	2,0%
Cyprus	347,3	424,1	5,1%	53,8	54,5	0,3%
Denmark	3'193,4	3'638,1	3,3%	61,2	68,5	2,8%
Faroe Islands	22,2	24,9	2,8%	50,5	55,7	2,5%
Finland	2'799,4	2'850,3	0,5%	54,1	55,2	0,5%
France	32'400,0	34'100,0	1,3%	55,7	57,9	1,0%
French Guyana	41,7	49,2	4,2%	27,9	28,3	0,3%
French Polynesia	48,7	52,3	1,8%	22,1	22,6	0,6%
Germany	42'000,0	48'300,0	3,6%	51,3	58,8	3,4%
Greece	5'162,8	5'610,9	2,1%	49,4	52,8	1,7%
Greenland	19,6	25,6	6,9%	35,1	45,7	6,8%
Guam	69,2	*75,1*	2,7%	46,1	*46,6*	0,3%
Guernsey	42,0	50,7	4,8%	68,9	81,2	4,2%
Hongkong Sar	3'277,9	3'868,8	4,2%	53,3	57,6	2,0%
Iceland	148,7	188,8	6,2%	55,5	67,7	5,1%
Ireland	1'310,0	1'770,0	7,8%	36,3	47,8	7,1%
Israel	2'342,6	2'800,0	4,6%	41,7	45,9	2,4%
Italy	24'845,0	26'502,0	1,6%	43,3	46,2	1,6%
Japan	61'105,8	62'490,0	0,6%	48,7	49,4	0,4%
Jersey	59,3	*68,7*	5,0%	68,9	*75,2*	2,9%
Kuwait	382,3	455,6	4,5%	22,6	24,0	1,5%
Luxembourg	233,9	310,9	7,4%	57,3	72,4	6,0%
Macau SAR	153,3	178,4	3,9%	37,5	40,8	2,2%
Malta	170,7	197,8	3,7%	45,9	51,2	2,8%
Martinique	160,9	171,9	1,7%	41,7	43,8	1,3%
Neth. Antilles	75,9	*78,0*	0,9%	36,6	*36,7*	-
Netherlands	8'124,0	9'610,0	4,3%	52,4	60,6	3,7%
New Caledonia	43,7	50,7	3,7%	23,6	24,1	0,5%
New Zealand	1'719,0	1'877,0	2,2%	47,3	49,0	0,9%
Northern Marianas	15,5	*20,6*	10,1%	32,2	*40,4*	7,9%
Norway	2'476,5	3'165,0	6,3%	56,8	71,2	5,8%
Portugal	3'642,9	4'229,8	3,8%	36,7	42,4	3,7%
Qatar	122,7	154,9	6,0%	22,3	26,3	4,2%
Réunion	218,7	268,5	5,3%	33,1	38,9	4,1%
Singapore	1'428,6	1'876,6	7,1%	41,2	48,2	4,0%
Slovenia	614,8	*757,0*	7,2%	30,9	*38,0*	7,1%
Spain	15'095,4	16'480,4	2,2%	38,5	41,8	2,1%
Sweden Switzerland	6'013,0	5'889,0	-0,5%	68,1	66,5	-0,6%
Taiwan, China	4'480,0	4'992,0	2,7%	63,4	69,9	2,4%
United Arab Emirate	9'174,8	12'043,8	7,0%	43,1	54,5	6,1%
United Kingdom	672,3	975,2	9,7%	29,1	40,7	8,7%
	29'411,4	33'750,0	3,5%	50,3	57,5	3,4%
United States	159'735,2	188'331,0	4,2%	60,7	68,2	2,9%
Virgin Islands (US)	58,3	*64,9*	3,6%	51,2	*54,8*	2,3%
High income	**458'856,7**	**517'984,4**	**3,1%**	**52,7**	**58,0**	**2,4%**
WORLD	**690'350,3**	**910'636,8**	**7,2%**	**12,1**	**15,2**	**5,8%**
Africa	**12'581,4**	**1'856,4**	**10,2%**	**1,8**	**2,4**	**8,3%**
Americas	**221'327,8**	**275'838,2**	**5,6%**	**28,8**	**33,7**	**4,0%**
Asia	**182'318,0**	**297'148,9**	**13,0%**	**5,4**	**8,3**	**11,5%**
Europe	**263'195,8**	**306'969,8**	**3,9%**	**33,2**	**38,5**	**3,7%**
Pacific	**10'927,2**	**12'123,5**	**2,6%**	**38,8**	**40,3**	**0,9%**

Note : Figures in italics refer to year-end 1998 or earlier data. For data comparability and coverage, see the technical notes.

Source : ITU.

6. Personal computers and Internet hosts 1999, major economies

Economy	*PCs (k)*	*PCs per 100 inhabitants*	*Internet hosts (k)*	*Host density per 100 inhabitants*	*Internet hosts per 100 PCs*
Austria	2'100	25.68%	477.6	5.80	22.74
Belgium	3'200	31.52%	591.0	5.80	18.47
Denmark	2'200	41.40%	602.4	11.30	27.38
Finland	1'860	36.01%	956.7	18.50	51.44
France	13'000	22.08%	1'844.5	3.10	14.19
Germany	24'400	29.70%	2'969.9	3.60	12.17
Greece	640	6.02%	136.2	1.20	21.28
Ireland	1'200	32.39%	110.7	3.00	9.23
Italy	11'000	19.18%	817.6	1.40	7.43
Luxembourg	170	39.61%	17.2	4.00	n.a.
Netherlands	5'700	35.97%	1'602.7	10.10	28.12
Portugal	930	9.32%	148.9	1.50	16.01
Spain	4'800	12.18%	795.4	2.00	16.57
Sweden	4'000	45.14%	989.1	11.10	24.73
United Kingdom	18'000	30.64%	3'230.3	5.50	17.95
EU	**93'200**	**24.87%**	**15'290.2**	**4.08**	**16.41**
Australia	8'900	47.06%	1'946	10.30	21.86
Canada	11'000	36.08%	2'978.8	9.80	27.08
Czech Republic	1'100	10.72%	210.6	2.00	19.15
Hungary	750	7.47%	208.7	2.00	27.83
Iceland	100	35.88%	53.1	19.00	53.10
Japan	36'300	28.69%	4'703.8	3.70	12.96
Korea (Rep. of)	8'500	18.29%	222.2	2.00	2.61
Mexico	4'300	4.42%	722.3	0.70	16.80
New Zealand	1'250	32.65%	561.8	12.60	44.94
Norway	2'000	44.99%	861.7	17.00	43.09
Poland	2'400	6.20%	3.4	0.80	0.14
Switzerland	3'300	46.19%	590.4	7.10	17.89
Turkey	2'200	3.23%	150.2	0.20	6.83
United States	141'000	51.05%	38'311.0	9.40	27.17
Other OECD	**223'100**	**30.19%**	**51'523.5**	**6.97**	**23.09**
OECD	**316'300**	**28.40%**	**66'813.7**	**6.05**	**21.12**
Argentina	1'800	4.92%	254.2	0.700	14.12
Brazil	6'100	3.63%	796.5	0.474	13.06
Chile	1'000	6.66%	71.7	0.477	7.17
China	15'500	1.22%	175.8	0.010	1.13
Hongkong, SAR	2'000	29.76%	204.9	3.050	10.25
India	3'300	0.33%	41.8	0.042	1.27
Indonesia	1'900	0.91%	37.5	0.018	1.97
Israel	1'500	24.59%	259.2	4.250	17.28
Malaysia	1'500	6.87%	105.3	0.482	7.02
Philippines	1'260	1.69%	22.1	0.030	1.75
Russia	5'500	3.74%	276.9	0.158	5.03
Singapore	1'700	43.66%	264.5	6.799	15.56
South Africa	2'400	6.01%	299.1	0.750	12.46
Taiwan, China	4'353	19.70%	1'065.1	4.822	24.47
Thailand	1'382	2.27%	71.6	0.118	5.18
Venezuela	1'000	4.22%	25.4	0.107	2.54
Non-OECD	**52'195**	**1.68%**	**3'971.6**	**5.49**	**7.61**
Major economies	**368'495**	**8.74%**	**70'785.3**	**1.68**	**19.21**
WORLD	**388'080**	**6.80%**	**71'542.2**	**119.52**	**18.43**

Note : Generic Top Level Domain (gTLD) registrations are distributed between countries according to distribution of country code TLDs. For additional information, see the technical notes.

Source : ITU World Telecommunication Indicators Database, partially based on data from the Internet Software Consortium (www.isc.org) and RIPE (www.ripe.net).

7. Intelligent Network indicators, 1999, major economies

Economy	*ISDN subscribers (k)*	*B-channel equivalents (k)*	*Leased circuits (k)*	*% digitisation 1999*
Austria	252.60	662.00	92.00	100.0
Belgium	*184.70*	*507.47*	*108.75*	*77.9*
Denmark	247.00	662.00	*169.60*	100.0
Finland	156.90	467.35	*112.80*	100.0
France	*1'540.01*	3'601.00	*425*	98.0
Germany	5'636.95	13'746.30	*816.53*	100.0
Greece	29.02	99.42	*4.40*	90.6
Ireland	*9.77*	*214.62*	*12.41*	100.0
Italy	*516.34*	3'049.00	297.00	99.0
Luxembourg	27.54	78.36	9.86	100.0
Netherlands	862.36	2'300.00	*171.00*	*89.0*
Portugal	139.66	470.64	56.98	100.0
Spain	364.42	978.83	104.20	86.5
Sweden	*122.62*	631.00	*515.00*	100.0
United Kingdom	655.00	2'596.00	401.00	100.0
EU	**10'744.80**	**30'063.90**	**3'296.53**	**96.1**
Australia	*114.40*	*488.40*	*735.58*	100.0
Canada	109.01	804.04	*0.70*	*99.5*
Czech Republic	11.39	58.04	23.43	74.4
Hungary	8.42	62.64	*1.98*	77.6
Iceland	12.69	39.44	n.a.	100.0
Japan	6'738.08	15'214.50	*1'075.00*	100.0
Korea (Rep. of)	204.49	*79.30*	508.94	72.2
Mexico	n.a.	n.a.	*8.79*	99.6
New Zealand	n.a.	*43.50*	*97.52*	*99.9*
Norway	532.08	1'262.34	*81.83*	100.0
Poland	24.71	24.71	*14.17*	*60.4*
Switzerland	543.87	1'420.10	*130.91*	100.0
Turkey	2.42	3.94	*6.73*	84.0
United States	2'016.93	11'421.77	*13'500.00*	*89.3*
Other OECD	**10'318.40**	**30'922.70**	**16'185.59**	**89.8**
OECD	**21'063.20**	**60'986.60**	**19'482.12**	**92.9**
Argentina	n.a.	n.a.	n.a.	100.0
Brazil	n.a.	n.a.	*9.07*	84.6
Chile	n.a.	n.a.	*1.37*	100.0
China	168.00	*260.00*	n.a.	99.9
Hongkong SAR	11.48	89.29	*51.68*	100.0
India	14.26	28.52	57.57	99.8
Indonesia	5.71	n.a.	*2.43*	100.0
Israel	37.00	n.a.	*12.48*	100.0
Malaysia	18.09	*0.65*	*61.28*	100.0
Philippines	n.a.	n.a.	*0.187*	*92.0*
Russia	37.20	n.a.	n.a.	31.8
Singapore	23.16	46.32	*75.02*	100.0
South Africa	*3.45*	*78.00*	*150.45*	*82.0*
Taiwan, China	28.37	159.55	*55.04*	100.0
Thailand	2.11	6.04	113.96	100.0
Venezuela	-	n.a.	*18.97*	68.5
Non-OECD	**348.83**	**687.37**	**609.50**	**91.2**
Major economies	**21'412.20**	**61'673.97**	**20'091.62**	**89.0**

Source: ITU.

Overall Rank	Economy	Telephone main line density per 100 inhabitants 1999	Rank	TV sets density per 100 inhabitants 1999	Rank	Internet host density per 10'000 inhabitants 1999	Rank	Cellular mobile subscriber density per 100 inhabitants 1999	Rank
1	Norway	71.2	5	58.50	16	1'694.55	3	61.75	4
2	Finland	55.2	18	64.30	10	1'850.51	2	65.12	1
3	Denmark	68.5	7	62.10	12	1'134.50	6	49.47	10
4	Iceland	67.7	9	52.00	25	1'895.69	1	61.93	3
4	United States	68.2	8	84.90	2	1'386.99	4	31.15	25
6	Sweden	66.5	10	53.10	23	1'116.40	7	58.29	5
7	Bermuda	85.7	1	109.40	1	840.01	11	19.64	42
8	Netherlands	60.6	12	55.30	18	1'011.21	9	43.54	17
9	United Kingdom	57.5	16	64.50	9	549.93	18	46.28	13
10	Australia	52.1	23	70.50	7	1'028.81	8	34.28	22
11	Canada	65.5	11	71.50	5	976.98	10	22.65	35
12	Switzerland	69.9	6	51.80	26	714.00	12	41.08	19
13	Japan	49.4	27	71.20	6	371.81	24	44.94	16
14	France	57.9	14	60.30	13	313.22	27	36.40	20
15	Austria	48.2	31	51.60	27	583.87	16	51.44	8
16	Hongkong SAR	57.6	15	43.40	38	305.00	28	63.61	2
17	Germany	58.8	13	58.00	17	361.48	26	28.57	28
18	Luxembourg	72.4	4	38.90	50	399.91	22	48.70	11
19	Taiwan, China	54.5	20	41.60	41	482.19	19	52.24	7
20	Belgium	50.2	26	52.30	24	582.19	17	31.45	23
21	New Zealand	49.0	28	51.20	28	1'262.38	5	23.01	34
22	Italy	46.2	34	48.80	30	142.60	41	52.83	6
23	Portugal	42.4	41	54.20	21	149.22	38	46.81	12
24	Faroe Islands	55.7	17	38.50	51	375.93	23	24.13	32
25	Ireland	47.8	32	40.70	48	298.40	29	45.67	15
26	Greece	52.8	22	47.20	34	128.14	43	31.06	26
27	Estonia	35.7	55	55.30	18	368.11	25	26.77	29
28	Spain	41.8	43	50.80	29	201.80	32	31.20	24
29	Greenland	45.7	36	41.00	46	693.24	14	24.11	33
30	Israel	45.9	35	32.80	60	424.95	21	45.89	14
31	Virgin Islands (US)	*54.8*	19	59.20	14	38.94	64	21.13	36
32	Singapore	48.2	30	29.00	70	679.92	15	41.88	18
32	Malta	51.2	25	54.90	20	178.22	35	9.72	66
34	Czech Republic	37.1	50	46.70	35	205.32	31	18.95	46
35	Slovenia	*38.0*	48	35.60	55	199.50	34	30.86	27
36	Korea (Rep.)	44.1	38	34.60	57	44.92	61	50.03	9
37	Brunei Darussalam	*24.7*	72	63.50	11	77.94	47	20.52	38
38	Hungary	37.1	50	44.20	36	200.76	33	16.21	49
38	United Arab Emirates	40.7	45	30.60	67	163.80	36	34.71	21
40	Latvia	30.0	61	74.10	4	121.78	44	11.25	62
41	Andorra	*44.1*	39	40.00	49	157.00	37	18.82	47
42	Antigua & Barbuda	48.9	29	44.00	37	57.35	55	11.38	61
43	Guam	*46.6*	33	67.10	8	13.38	85	12.16	57
44	Slovak Republic	30.8	60	41.30	42	90.14	45	17.06	48
45	Uruguay	27.1	64	53.20	22	136.82	42	9.54	67
46	Qatar	26.3	67	84.60	3	18.53	93	14.32	53
47	Bahrain	24.9	70	41.30	42	35.39	66	20.48	39
48	Cyprus	54.5	21	15.80	113	143.08	40	19.04	45
49	Kuwait	24.0	74	48.00	31	38.21	65	15.82	50
50	Lithuania	31.4	59	42.00	40	65.27	53	8.97	69
51	Poland	26.3	68	41.30	42	81.25	46	10.21	65
52	Guadeloupe	44.7	37	27.10	78	21.77	73	19.59	43
53	Bahamas	36.9	52	24.30	85	0.24	20	5.28	85
54	New Caledonia	24.1	73	48.00	31	13.34	86	12.11	59
55	Aruba	37.2	49	22.30	95	62.98	54	12.21	56
56	Macau SAR	40.8	44	28.70	71	6.57	102	20.24	40
57	Lebanon	*19.4*	88	35.10	56	23.45	71	19.38	44
58	Puerto Rico	33.3	57	32.40	61	6.01	104	20.92	37
59	Bulgaria	35.4	56	40.80	47	31.55	68	4.23	90
60	Argentina	20.1	85	29.30	69	69.49	50	12.12	58

8. Multimedia access

Overall Rank	Economy	Telephone main line density per 100 inhabitants 1999	Rank	TV sets density per 100 inhabitants 1999	Rank	Internet host density per 10'000 inhabitants 1999	Rank	Cellular mobile subscriber density per 100 inhabitants 1999	Rank
61	Guernsey	81.2	2	n.a.	199	211.37	30	24.51	31
62	Turkey	26.5	66	31.50	65	22.02	72	11.91	60
63	Croatia	36.5	54	27.90	75	57.20	56	6.59	79
64	Martinique	43.8	40	15.40	115	15.05	79	26.00	30
65	Chile	20.7	81	23.60	91	47.74	59	15.05	51
66	Jersey	*75.2*	3	0.00	199	148.93	39	19.96	41
67	Barbados	*42.2*	42	28.70	71	4.49	108	11.14	63
68	Brazil	14.9	95	32.40	61	47.41	60	8.95	70
69	Neth. Antilles	*36.7*	53	32.90	59	8.24	99	7.52	76
70	Trinidad & Tobago	21.6	78	33.50	58	67.10	52	2.99	100
71	Costa Rica	20.4	83	37.40	52	33.92	67	3.53	96
72	Oman	9.0	113	58.80	15	13.81	84	4.92	89
73	French Polynesia	22.6	76	18.30	108	67.25	51	9.49	68
74	Mexico	11.2	101	26.10	80	74.19	49	7.94	74
75	Romania	16.7	90	31.20	66	24.84	69	6.05	81
76	Malaysia	20.3	84	17.00	111	48.23	58	13.70	54
77	French Guyana	28.3	62	22.20	96	13.12	87	10.34	64
78	Yugoslavia	21.4	79	27.30	77	17.27	77	5.69	82
79	South Africa	13.8	97	13.40	120	74.96	48	13.21	55
80	Russia	20.6	82	42.10	39	15.78	78	0.92	126
81	Mauritius	22.4	77	22.70	93	12.77	89	8.88	71
82	St. Kitts and Nevis	51.8	24	25.70	81	1.57	124	1.81	109
83	Colombia	16.0	92	20.30	100	17.41	76	7.54	75
84	TFYR Macedonia	23.4	75	25.00	84	12.98	88	2.37	103
85	Dominica	27.9	63	21.10	98	40.36	63	0.86	128
86	Georgia	12.3	100	47.40	33	2.99	112	1.88	107
87	Venezuela	10.9	103	18.50	107	10.75	94	14.34	52
88	Grenada	31.5	58	36.80	53	0.59	142	2.15	105
89	Ukraine	19.9	87	41.30	42	9.85	95	0.43	136
90	Panama	16.5	91	19.20	102	7.84	101	8.61	72
91	Belize	15.6	93	18.30	108	20.52	75	2.63	102
92	St. Lucia	26.6	65	36.20	54	0.68	139	1.25	120
93	Saudi Arabia	*14.3*	96	26.30	79	3.05	111	4.00	93
94	Thailand	8.6	115	24.00	86	11.78	91	3.84	94
95	Jamaica	19.9	86	18.90	106	2.56	117	5.64	83
96	Seychelles	*24.8*	71	21.50	97	0.45	146	4.98	88
97	Belarus	25.7	69	32.20	63	1.55	182	0.22	154
98	Réunion	38.9	47	19.10	103	0.03	125	7.38	78
99	Dominican Rep.	*9.3*	109	9.60	133	14.41	82	5.02	87
100	Moldova	12.7	98	29.70	68	5.16	107	0.39	139
101	China	8.6	114	28.70	71	1.01	133	3.42	97
102	El Salvador	7.6	122	19.10	103	2.83	114	6.22	80
103	Ecuador	9.1	110	20.50	99	2.76	115	3.09	98
104	Azerbaijan	9.5	108	25.40	82	0.91	135	2.34	104
105	Armenia	15.5	94	23.80	88	8.35	98	0.23	153
106	Fiji	*9.8*	106	11.00	128	7.91	100	2.90	101
107	Botswana	7.5	123	2.00	166	24.82	70	7.51	77
108	Tonga	*7.9*	120	6.10	146	712.21	13	0.20	157
109	Peru	6.7	127	14.50	116	6.53	103	4.02	92
110	Paraguay	5.5	133	10.10	131	5.53	105	8.13	73
111	Kazakhstan	10.8	104	23.80	88	5.32	106	0.30	146
112	Northern Marianas	*40.4*	46	0.00	199	2.50	118	5.59	84
113	Bolivia	6.2	131	11.70	122	2.08	120	5.16	86
114	Bosnia	9.6	107	11.20	127	2.73	116	1.37	116
115	Namibia	6.4	129	3.80	156	21.57	74	1.77	110
116	Suriname	17.1	89	23.70	90	0.00	199	4.21	91
117	Philippines	4.0	140	11.00	128	2.97	113	3.66	95
118	Swaziland	3.1	148	11.30	125	12.03	90	1.43	115
119	Jordan	*8.3*	116	8.50	138	2.25	119	1.83	108
120	Maldives	8.0	119	3.80	156	14.53	81	1.05	124

Overall Rank	Economy	Telephone main line density per 100 inhabitants 1999	Rank	TV sets density per 100 inhabitants 1999	Rank	Internet host density per 10'000 inhabitants 1999	Rank	Cellular mobile subscriber density per 100 inhabitants 1999	Rank
121	St. Vincent	20.9	92	22.80	92	0.00	199	1.25	119
122	Zimbabwe	2.1	110	18.00	110	3.21	109	1.51	113
123	S. Tomé & Princip	2.7	93	22.70	93	56.96	56	0.00	192
124	Morocco	5.3	112	16.30	112	1.00	133	1.34	117
125	Guatemala	5.5	146	6.10	146	1.75	122	3.05	99
126	Iran (I.R.)	12.5	114	15.70	114	0.24	162	0.73	131
127	Turkmenistan	8.2	101	20.10	101	1.81	120	0.09	170
128	Indonesia	2.9	118	13.60	118	1.79	121	1.06	123
129	Egypt	7.0	121	12.00	121	0.89	135	0.72	132
130	Tunisia	9.0	105	19.00	105	0.11	174	0.58	133
131	Nicaragua	3.0	141	7.00	141	3.71	108	0.90	127
132	Sri Lanka	3.6	132	9.80	132	1.16	128	1.22	122
133	Gabon	3.2	83	25.10	83	0.20	167	0.74	130
134	Tajikistan	3.5	64	31.60	64	1.12	129	0.01	191
135	Samoa	*4.9*	150	5.20	150	0.69	137	1.69	112
136	Uzbekistan	6.7	76	27.80	76	0.15	171	0.17	161
137	Micronesia	*8.0*	166	2.00	166	43.86	61	0.00	192
138	Kyrgyzstan	7.6	151	4.70	151	11.60	92	0.06	175
139	Cape Verde	11.2	188	0.50	188	0.42	146	1.93	106
140	Honduras	4.4	135	9.40	135	0.34	153	1.24	121
141	Kiribati	*3.4*	162	2.20	162	9.37	95	0.24	151
142	Mongolia	4.0	146	6.10	146	0.34	152	1.32	118
143	Libya	*9.1*	118	13.60	118	0.01	187	0.36	141
144	Côte d'Ivoire	1.5	141	7.00	141	0.53	143	1.77	111
144	Zambia	0.9	116	14.50	116	1.07	131	0.31	144
146	Cuba	3.9	87	23.90	87	0.27	158	0.05	177
147	Albania	3.7	125	11.30	125	0.38	151	0.29	147
147	Guyana	7.5	145	6.50	145	0.33	154	0.33	143
149	Senegal	1.8	155	4.10	155	1.28	126	0.95	125
150	Vanuatu	*2.8*	179	1.20	179	14.08	83	0.16	162
151	Solomon Islands	*1.9*	173	1.40	173	8.71	96	0.25	150
152	Yemen	1.7	74	28.40	74	0.03	180	0.15	164
153	Pakistan	2.2	133	9.60	133	0.63	140	0.21	156
154	Algeria	5.2	130	10.60	130	0.07	176	0.23	152
155	Bhutan	1.8	166	2.00	166	14.65	80	0.00	192
156	India	2.7	140	7.50	140	0.42	148	0.19	159
156	Marshall Islands	*6.2*	199	0.00	199	0.59	141	0.58	134
158	Ghana	0.8	124	11.50	124	0.22	164	0.36	142
159	Lesotho	*1.0*	171	1.50	171	0.42	147	0.48	135
160	Viet Nam	2.7	153	4.60	153	0.03	181	0.42	138
161	Kenya	1.0	162	2.20	162	1.30	125	0.08	172
162	Togo	0.9	169	1.80	169	0.47	144	0.38	140
163	Djibouti	*1.3*	151	4.70	151	1.12	130	0.04	182
164	Syria	10.2	143	6.90	143	0.00	196	0.03	184
165	Equatorial Guinea	*1.3*	123	11.60	123	0.11	175	0.07	173
165	Guinea	0.6	154	4.40	154	0.29	156	0.28	148
167	West Bank and Ga	*5.8*	199	0.00	199	0.00	199	1.45	114
167	Papua New Guinea	*1.1*	192	0.40	192	1.28	127	0.15	166
169	Gambia	2.3	195	0.30	195	0.17	168	0.42	137
170	Mauritania	0.7	136	9.10	136	0.40	149	0.00	192
171	Cambodia	0.3	184	0.90	184	0.25	160	0.81	129
171	Iraq	3.0	139	8.30	139	0.00	193	0.00	192
173	Madagascar	0.3	162	2.20	162	0.39	150	0.08	171
174	Uganda	0.3	159	2.80	159	0.14	172	0.27	149
175	D.P.R. Korea	4.6	149	5.60	149	0.00	199	0.00	192
176	Sudan	0.9	137	8.70	137	0.00	199	0.05	178
177	Tanzania	0.5	165	2.10	165	0.12	173	0.16	163
178	Comoros	*1.0*	192	0.40	192	0.87	136	0.00	192
179	Cameroon	*0.7*	158	3.40	158	0.16	169	0.03	183
180	Benin	*0.7*	181	1.10	181	0.24	161	0.11	169

8. Multimedia access

Overall Rank	*Economy*	*Telephone main line density per 100 inhabitants* 1999	Rank	*TV sets density per 100 inhabitants* 1999	Rank	*Internet host density per 10'000 inhabitants* 1999	Rank	*Cellular mobile subscriber density per 100 inhabitants* 1999	Rank
181	Angola	0.8	177	1.40	173	0.01	188	0.19	158
182	Haiti	0.9	172	0.50	188	0.00	192	0.31	145
183	Nigeria	*0.4*	190	6.80	144	0.06	177	0.02	187
184	Burkina Faso	0.4	187	1.10	181	0.32	155	0.04	179
185	Congo	0.8	176	1.30	177	0.02	185	0.12	167
186	Nepal	1.1	167	0.40	192	0.22	165	0.04	181
187	Rwanda	*0.2*	202	0.00	199	0.64	139	0.15	165
188	Mayotte	7.3	125	0.00	199	0.00	199	0.00	192
189	Sierra Leone	*0.4*	190	1.30	177	0.29	157	0.00	192
190	Mozambique	0.4	188	0.50	188	0.15	170	0.06	174
191	Mali	0.3	198	1.20	179	0.21	166	0.04	180
192	Eritrea	0.7	178	1.60	170	0.02	184	0.00	192
193	Lao P.D.R.	0.7	183	1.00	183	0.00	199	0.17	160
194	Niger	0.2	201	2.70	161	0.05	178	0.01	188
195	Guinea-Bissau	*0.7*	179	0.00	199	0.27	159	0.00	192
195	Malawi	0.4	189	0.20	196	0.00	194	0.21	155
197	Central African Rep.	0.3	196	0.50	188	0.04	179	0.05	176
197	Bangladesh	0.3	192	0.70	185	0.00	198	0.12	168
199	Burundi	0.3	195	1.50	171	0.00	191	0.01	189
199	Liberia	*0.2*	200	2.80	159	0.00	199	0.00	192
201	Myanmar	0.6	185	0.70	185	0.00	195	0.03	185
202	Ethiopia	0.3	193	0.60	187	0.02	183	0.01	190
203	Somalia	*0.2*	203	1.40	173	0.00	189	0.00	192
204	Afghanistan	0.1	204	1.40	173	0.00	197	0.00	192
205	D.R. Congo	0.0	206	0.20	196	0.00	190	0.02	186
206	Chad	*0.1*	204	0.10	198	0.01	186	0.00	192
	Top 60 average	**50.24**		**51.36**		**432.47**		**30.85**	
	60-120 average	**17.07**		**23.16**		**14.45**		**5.03**	
	120-180 average	**3.35**		**5.68**		**0.58**		**0.37**	
	180-206 average	**0.34**		**0.39**		**0.01**		**0.01**	

Note: Figures in italics refer to year-end 1998 or earlier data.

Source: ITU World Telecommunication Indicators Database. Partially based on data from the Internet Software Consortium (www.isc.org), and RIPE (www.ripe.net).

9. Internet monthly access prices (US$ 20 hours of off-peak use), selected economies, 2000

Country	*Internet Service Provider (ISP)*	*ISP Charge US$* [1]	[2]	[3]	*Call Charge US$* [4]	*Total US$* [5]	*Rank*	*Total with Line Rental US$* [6]	*Rank*
Argentina	SatLink	27.90	*	*	6.00	33.90	*41*	47.12	*41*
Australia	Telstra Big Pond	17.25			1.85	19.10	*25*	27.65	*16*
Austria	IBM Global Network	0.00			15.36	15.36	*18*	32.43	*28*
Belgium	Belgacom Skynet	0.00			21.84	21.84	*27*	27.72	*18*
Brazil	IBM Global Network	27.78	*		6.00	33.78	*40*	44.76	*40*
Canada	Simpatico	12.63			0.00	12.63	*11*	29.74	*23*
Chile	CTC Internet	0.00	*		3.45	3.45	*3*	8.90	*2*
China	China Telecom	4.82		*	26.02	30.84	*38*	31.76	*25*
Czech Republic	IBM Global Network	4.77			13.60	18.37	*24*	23.19	*12*
Denmark	TeleDanmark	5.46			16.10	21.56	*26*	37.37	*35*
Finland	iNet PRO Fun	8.07			6.42	14.49	*14*	27.71	*17*
France	FT Wanadoo	23.72			0.00	23.72	*32*	35.36	*32*
Germany	T-Online	5.46			18.02	23.48	*31*	35.90	*33*
Greece	IBM Global Network	17.28			8.30	25.58	*33*	33.53	*30*
Hongkong SAR	Netvigator	17.44	*		0.00	17.44	*23*	28.97	*20*
Hungary	Matav	12.57			9.72	22.29	*29*	32.07	*27*
Iceland	Nett	12.32			14.99	27.31	*35*	34.61	*31*
India	VSNL	12.57		*	30.16	42.73	*44*	48.53	*43*
Indonesia	Indosatnet	3.18	*	*	2.85	6.03	*4*	8.95	*3*
Ireland	Telecom Internet	0.00			10.23	10.23	*7*	25.63	*15*
Israel	NetVison	6.10			4.39	10.49	*8*	21.19	*11*
Italy	IBM Global Network	0.00			7.55	7.55	*5*	19.98	*8*
Japan	NTT OCN	19.87			22.71	42.58	*43*	61.03	*44*
Korea	Chollian	3.77			10.47	14.24	*13*	16.66	*5*
Luxembourg	IBM Global Network	26.57			0.00	26.57	*34*	39.96	*37*
Malaysia	TMnet	6.32	*	*	9.47	15.79	*19*	21.05	*10*
Mexico	Telmex	8.88			2.60	11.48	*9*	28.49	*19*
Netherlands	IBM Global Network	0.00			14.21	14.21	*12*	31.80	*26*
New Zealand	XTRA	12.20			0.00	12.20	*10*	29.93	*24*
Norway	Telenor Internett	11.82			16.65	28.47	*36*	47.64	*42*
Philippines	Infocom	16.88			0.00	16.88	*20*	24.92	*14*
Poland	NASK	0.00			31.77	31.77	*39*	37.65	*36*
Portugal	PT NETLine	18.93			10.49	29.42	*37*	42.21	*38*
Russia	Cityline	1.71	*		0.00	1.71	*1*	5.13	*1*
Singapore	SingNet	17.94			4.94	22.88	*30*	32.49	*29*
South Africa	Icon	12.95	*		1.97	14.92	*16*	24.30	*13*
Spain	IBM Global Network	0.00			9.43	9.43	*6*	20.98	*9*
Sweden	IBM Global Network	2.76			14.41	17.17	*22*	29.24	*21*
Switzerland	Blue Window	0.00			21.90	21.90	*28*	37.26	*34*
Taiwan, China	IBM Global Network	15.59	*	*	1.30	16.89	*21*	18.35	*7*
Thailand	Internet Thailand	8.99		*	31.75	40.74	*42*	43.39	*39*
Turkey	IBM Global Network	12.28			3.07	15.35	*17*	17.46	*6*
UK	BT Internet	14.60			0.00	14.60	*15*	29.36	*22*
USA	BellSouth.net	0.00			2.33	2.33	*2*	16.62	*4*
Venezuela	CANTV Internet	29.72	*		37.05	66.76	*45*	75.07	*45*
Average		**10.25**			**10.43**	**20.68**		**30.98**	

Note: Internet monthly dial-up access charges for 20 hours of use. ISP and local telephone call charges are included. VAT included. ISP connection charge not included. Monthly line rental included in penultimate column. US$ values computed by using end-1999 exchange rates (Exchange rates from IMF or CNNfn).

1 For 20 hours of usage.

2 * Indicates unlimited access for that price.

3 * Indicates ISP connection charge exists.

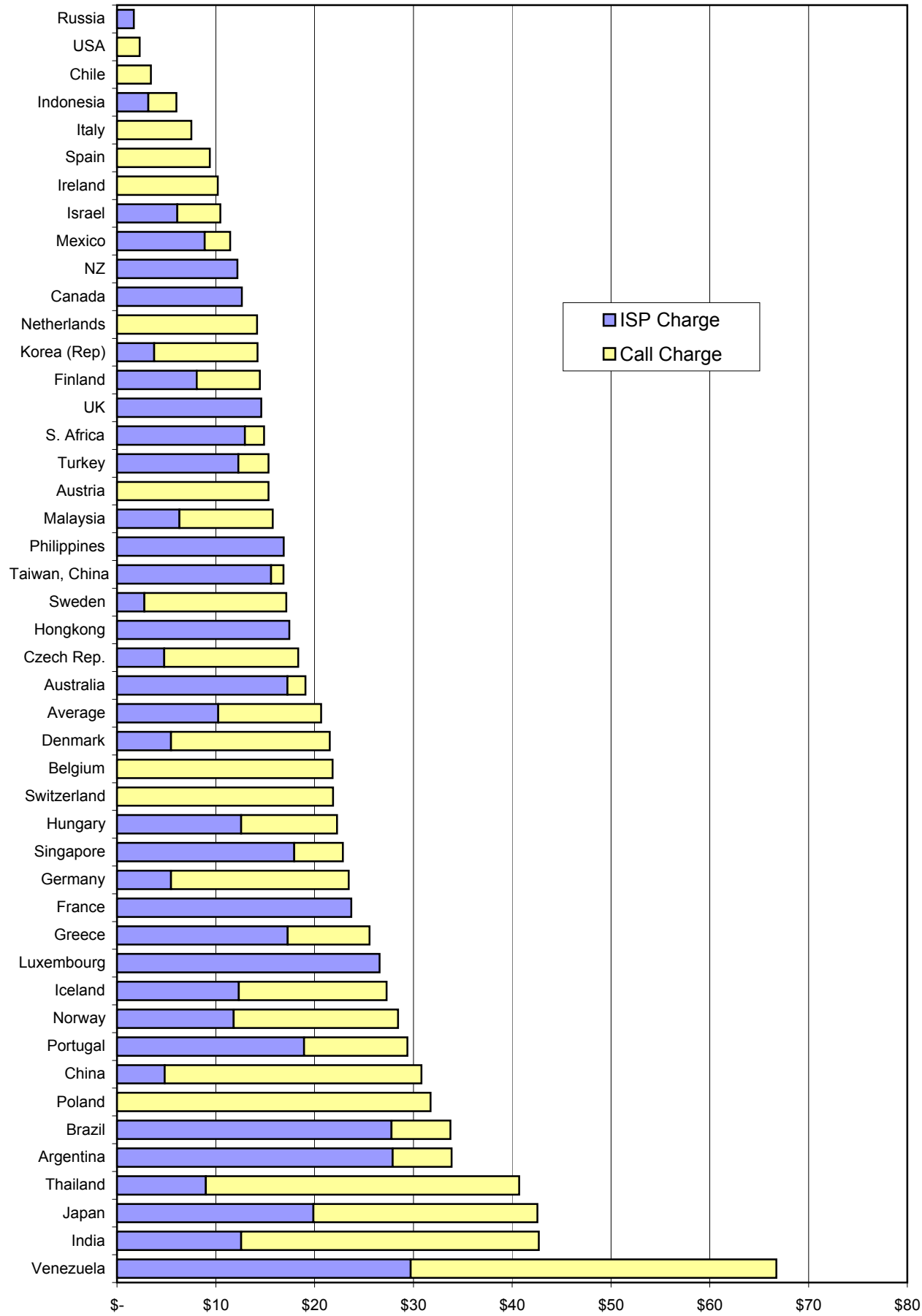
4 Off-peak telephone call charge for 20 hours of Internet access. If a special Internet tariff exists, it is used instead. Note that some countries offer "free" local calls included in the line rental charge.

5 Monthly ISP charge +20 hours telephone call charge (if applicable) + line rental.

6 Monthly ISP charge + 20 hours telephone call charge (if applicable) plus monthly line rental. See technical notes for details.

Source: ITU (some telephone call charge data provided by Teligen).

9. Internet monthly access prices (US$ 20 hours of off-peak use), selected economies, 2000



Note Excludes line rental.
Source: ITU (some telephone charge data provided by Teligen).

TECHNICAL NOTES

The following signs and symbols are used in the tables:

italic	Year other than that specified, or estimate.
k	Thousands (i.e., 1'000).
M	Millions (i.e., 1'000'000).
US$	United States dollars.
%	Per cent.
... / n.a.	Data not available or not applicable.
CAGR	Compound Annual Growth Rate.

The absence of any sign or symbol indicates that data are in units.

General methodology

The compound annual growth rate (CAGR) is computed by the formula:

$$[(P_v / P_0)^{(1/n)}] - 1$$

where P_v = Present value
P_0 = Beginning value
n = Number of periods

The result is multiplied by 100 to obtain a percentage.

Regional and sub-regional figures are either totals or weighted averages depending on the indicator. For example, for Table 5, *main telephone lines* is a total, while *main lines per 100 inhabitants* is a weighted average for each region. Regional figures are shown in bold in the tables. Regional totals are calculated with available data and could therefore be misleading in case of significant missing data. Regional growth rates generally refer to countries for which data is available for start and end years.

1. Basic indicators

The data for Population are mid-year estimates from the United Nations (UN). National statistics have been used for some countries. Population Density is based on land area data from the UN; the land area does not include any overseas dependencies but does include inland waters. The data for Gross Domestic Product (GDP) are generally from the IMF, the Organization for Economic Co-operation and Development (OECD) or the World Bank. They are current price data in national currency converted to United States dollars by applying the average annual exchange rate (from the International Monetary Fund, IMF) to the figure reported in national currency. For countries where the IMF rate is unavailable or where the exchange rate typically applied to foreign exchange transactions differs markedly from the official IMF rate, a World Bank conversion rate is used. For the few countries where neither the IMF nor World Bank rates are available, a United Nations end-of-period rate was used.

Readers are advised to consult the publications of the international organisations for precise definitions of the demographic and macro-economic data. *Main telephone lines* refer to fixed telephone lines connecting a customer's equipment (e.g., telephone set, facsimile machine) to the Public Switched Telephone Network (PSTN) and which have a dedicated port on a telephone exchange. Note that for most countries, main lines also include public payphones. *Main telephone lines per 100 inhabitants* (or "teledensity") is calculated by dividing the number of main lines by the population and multiplying by 100.

2. Internet host computers

Internet hosts refer to the number of computers in an economy that are directly linked to the worldwide Internet network. Note that Internet host computers are identified by either a two digit country code (.za, .uk, etc.) or a three digit generic Top Level Domain (gTLD) code (.com, .edu, etc.) generally reflecting the nature of the organisation registering the domain name. The two digit code does not necessarily indicate that the host is physically located in the country. Hosts for which there is no country code identification (e.g., .com, .edu, .net) are assigned to countries according to a new methodology (see Box 1). The original Internet host computer data (adjusted in this report) come from the semi-annual Internet Software Consortium (ISC, formerly Network Wizards) <www.isc.org> survey and the monthly RIPE survey <www.ripe.net>. RIPE data is used for all countries RIPE covers—mainly European and some African countries. Data from ISC is used for the remaining countries.

The number of Internet hosts shown for each country can only be considered an approximation, as it is not possible to determine the exact number of Internet host computers, nor their location. ISC

emphasises that the numbers they present are fairly good estimates of the *minimum* size of the Internet, but they cannot guarantee that there are no hosts they could not locate.

ISC used a new methodology in its January 1998 survey, in order to better account for all the hosts in the domain system. Due to the new methodology used, the data from old and new surveys are not necessarily comparable in all cases. In this publication we did not attempt to adjust the data from earlier surveys.

Box 1: New methodology for allocating gTLDs

A new methodology has been used in this publication to account for the fact that an increasing share of generic Top Level Domains (gTLDs)—e.g., .com, .net—are located outside of the United States. The use of three-letter-domains .com, .net and .org is open to organisations outside the United States, and an increasing proportion of organisations are choosing a gTLD, in preference to a two-letter country code. In order to reflect this fact, the methodology has been changed, which may mean that they underestimate the real installed base before 1997. Registrations in .com, .int, .org and .net have been allocated to economies according to each economy's share of country code Top Level Domains (ccTLDs)

3. Internet host density

Internet host density is derived by dividing the number of Internet host computers in a country or a region by the population, and multiplying the result by 10'000.

4. Internet hosts and users

See above for discussion on Internet host computers.

Estimated *Internet users* is based on reported estimates, derivations based on reported Internet Access Provider subscriber counts, or calculated by multiplying the number of hosts by an estimated multiplier. Note that the date and methodology used for individual subscriber counts may vary significantly.

5. Telephone main lines and teledensity

Main telephone lines and teledensity, are listed for the years 1995 and 1999. For explanation, see above under Basic indicators.

Teledensity refers to the entire country and is obtained by dividing the number of main lines in the country by the population of the country and multiplying the result by 100.

6. Personal computers and Internet hosts

PCs shows the estimated number of Personal Computers (PCs), both in absolute numbers and in terms of PC ownership per 100 inhabitants. These numbers are derived from the annual ITU questionnaire supplemented by other sources. *Internet hosts per 100 PCs* shows the result of dividing the total number of Internet host computers in a country or region by the estimated number of PCs, multiplied by 100.

7. Intelligent network indicators

ISDN subscribers refers to the number of subscribers to the Integrated Services Digital Network. It includes both basic rate and primary rate interface subscribers. *B-channel equivalents* converts the number of ISDN subscriber lines into their equivalent voice channels. The number of basic rate subscribers is multiplied by two and the number of primary rate subscribers is multiplied by 23 or 30, depending on the standard implemented.

Leased circuits refer to two-way links for the exclusive use of a subscriber regardless of the type of use (e.g., switched or non-switched, voice or data). The leased circuits, also referred to as private lines, can be either international or national.

The *% digitisation* is calculated by dividing the number of main telephone lines connected to digital exchanges by the total number of main telephone lines.

8. Multimedia access

In this table economies are ranked based on the cumulative score in telephone main line density, TV density, Internet host density and cellular mobile subscriber density using data from year-end 1999, where available.

Telephone main line density, or *teledensity*, refers to the number of main telephone lines per 100 inhabitants.

TV density refers to the number of television sets in a country per 100 inhabitants.

Internet host density refers to the number of Internet host computers in a country per 10'000 inhabitants.

Cellular mobile subscriber density refers to the number of subscribers per 100 inhabitants.

Multimedia access ranking is derived by ranking countries separately in all the four categories. The economy with a highest teledensity gets a rank

number one and the country with the lowest teledensity gets a rank of 206. Similarly, economies are ranked in terms of TV density, Internet host density and cellular subscriber density. The rankings for the four different indicators are then added together for each economy. The economy with the lowest sum of the four rankings gets the top ranking, while the economy with the highest sum of the rankings gets the lowest rank.

9. Tariffs

This Table, and the Chart which follows, represent an attempt to compare the average costs incurred by a PSTN dial-up Internet user in selected major economies, based on a basket of charges.

It is assumed that the user pays a monthly subscription to a major ISP in the country (connection charges are not included in the comparisons). It is further assumed that the user makes use of the Internet for a total of 20 hours during the month, using it in half-hour sessions during off-peak hours where a special Internet tariff is available. The monthly call charges plus the subscription charge are summed to provide a total monthly charge shown in the Table and in the Chart. An alternative total is provided by adding also the monthly line rental charge.

The tariff basket provides an indication of relative costs but should not be interpreted as definitive for a number of reasons:

- The treatment of tax is variable,
- Users will adapt their usage pattern to the prevailing tariff in each country. The comparisons do not take into account the time of day or week when the off-peak tariff applies,
- The ISP chosen may not be the cheapest or best one available,
- Some charges, e.g. line rental, may be shared with other services, such as voice.

Despite these shortcomings, the tariff basket approach provides a valid general indication of price variations between major economies.