International Telecommunication Union

QUESTION 19/1

Implementation of IP telephony in developing countries

ITU-D STUDY GROUP 1 RAPPORTEUR FOR QUESTION 19/1

Report on the implementation of IP telephony in developing countries

International Telecommunication Union

THE STUDY GROUPS OF ITU-D

The ITU-D Study Groups were set up in accordance with Resolutions 2 of the World Telecommunication Development Conference (WTDC) held in Buenos Aires, Argentina, in 1994). For the period 2002-2006, Study Group 1 is entrusted with the study of seven Questions in the field of telecommunication development strategies and policies. Study Group 2 is entrusted with the study of eleven Questions in the field of development and management of telecommunication services and networks. For this period, in order to respond as quickly as possible to the concerns of developing countries, instead of being approved during the WTDC, the output of each Question is published as and when it is ready.

For further information

Please contact:

Ms Fidélia AKPO
Telecommunication Development Bureau (BDT)
ITU
Place des Nations
CH-1211 GENEVA 20
Switzerland
Telephone: +41 22 730 5439
Fax: +41 22 730 5484
E-mail: fidelia.akpo@itu.int

Placing orders for ITU publications

Please note that orders cannot be taken over the telephone. They should be sent by fax or e-mail.

ITU
Sales Service
Place des Nations
CH-1211 GENEVA 20
Switzerland
Fax: +41 22 730 5194
E-mail: sales@itu.int

The Electronic Bookshop of ITU: www.itu.int/publications

International Telecommunication Union

Question 19/1
Report on the implementation of IP telephony in developing countries

ITU-D Study Group 1
3rd Study Period
(2002-2006)

International Telecommunication Union

TABLE OF CONTENTS

Page

LIST OF FIGURES

1 INTRODUCTION

The current implementation and continuous and progressive use of Internet Protocol (IP) networks for communication services, including applications such as telephony and broadband services, has created important issues for the telecommunications industry worldwide. The possibility of transmitting voice over IP-based networks, along with broadband services, with all its challenges and associated opportunities, such as voice and data integration, is a critical component in the convergence of the information, communication and technology sectors.

One challenge is the transition from the current technology based on circuit-switched systems to networks based on packet-switched technology, each of which typically has different policy and regulatory regimes:

– the fairly extensively regulated Public Switched Telephone Network (PSTN);

– the Internet, which has evolved as a data network subject to little, if any, regulation.

In this environment, the alternative of providing voice over IP-based networks has been a difficult issue for ITU Members' administrations, especially for developing countries given the unlimited number of additional challenges they face. Many of these administrations are interested in addressing the important technical, socio-economic and policy issues raised by "IP telephony," including the benefits it may provide to their national interests, their citizens, and their service providers, including new entrants.

"IP telephony" was the theme of the third World Telecommunication Policy Forum in 2001. Some of the research for that forum was presented in a report which described the state of the art of "IP telephony" at that time. In the following year a subsequent report to the World Telecommunication Development Conference (WTDC-02) identified a number of issues for further study that formed the rationale for the establishment of Q.19 in ITU-D Study Group 1 and the preparation of this report on the implementation of "IP telephony" in developing countries.

As an important and recurrent issue, during the WTDC-02 the developing and developed countries, Members of ITU and ITU-D Sector Members examined IP telephony, in view of:

i the important role that national telecom policy can play in stimulating innovation and investment in new technologies;

ii the sovereignty of each country in establishing its national telecom priorities and policies;

iii the potential for a broader range of communications applications that technologies such as IP-based networks offer to Member States and their citizens;

iv the lack of both broadband and basic telephony access within many developing countries; and

v the importance of Information and Communication Technology (ICT) infrastructure to economic development.

Considering that continued discussion of the evolution to IP-based networks, including IP telephony and broadband access, will allow Member States and Sector Members to exchange information, share experiences and discuss issues that emerge as developing countries plan and implement IP-based infrastructure, Members of ITU and ITU-D Sector Members approved a new Question, numbered as Question 19 under ITU-D Study Group 1, in order to study the following issues:

- How can a nation and its citizens, current telephone operators, ISPs (Internet Service Providers) and new entrants benefit from the introduction of IP telephony and broadband access?
- How can national telecom policy increase the benefits of the introduction of IP-based technologies?
- What are the potential challenges that developing countries experience in attempting to evolve to or implement IP-based networks including IP telephony and broadband access capabilities, and what are possible approaches for overcoming these challenges?

By addressing these issues, the Rapporteur's Group was expected to present, as output, Annual progress report(s) indicating status of the study of the issues being addressed and, at completion of study, a detailed final report with issues raised by each question as well as lessons learned, success stories, findings, and conclusions. This document presents the draft summary report on the implementation of IP telephony in developing countries.

2 TERMS AND ACRONYMS

ADSL	Asymmetric DSL
ATM	Asynchronous Transfer Mode
BICC	Bearer Independent Call Control
BSA	Broadband Satellite Access
DDOS	Distributed Denial of Service
DNS	Domain Name System
DSL	Digital Subscriber Line
HDSL	High bit rate DSL
IAB	Internet Architecture Board
ISDN	Integrated Services Digital Network
ISP	Internet Service Providers
ISUP	ISDN User Part
LAN	Local Area Network
NSS	Narrowband Signalling Syntax
PLC	Powerline communication
PSTN	Public Switched Telephone Network
RLAN	Radio LAN
SHDSL	Single-pair high speed DSL
SIP	Session Initiation Protocol
SIP-I	SIP with encapsulated ISUP
SIP-T	Session Initiation Protocol for Telephones
S/MIME	Secure Multipurpose Internet Mail Extensions
SOHO	Small Office Home Office
SSL	Secure Socket Layer
TCP/IP	Transfer Control Protocol / Internet Protocol
TLS	Transport Layer Security
UPT	Universal Personal Telephony
URIs	Uniform Resource Identifiers
VDSL	Very high speed DSL
VPNs	Virtual Private Networks

3 BROADBAND ACCESS NETWORKS

The introduction of broadband technologies, including DSL, fibre, satellite, and fixed and mobile wireless, has enabled users new forms of communication, bringing new services, social and economic development and providing enormous benefits to citizens, including the implementation of real-time connection to the Internet. With this in mind, administrations are analysing the introduction of broadband access networks

but given that the physical infrastructure and geography are vastly different from country to country, technology that works well in one geographic area may not work as well in another. Therefore, administrations need to determine the technologies that best meet their needs.[1]

The real-time connection to the Internet by means of broadband access networks has allowed technology companies to innovate in the development of equipment that makes the introduction and the growth of IP telephony worldwide easier. IP telephony could be the "killer app" that would drive further demand for broadband and bring more competition to the phone business.

Thus, this section presents briefly the broadband access networks being used to provide broadband services and IP telephony: Broadband Satellite Access, Hybrid Fibre Coax / Cable Modem, Digital Subscriber Line, Fibre Optics Access, Powerline Communication, Mobile Networks and Radio Local Area Networks (RLAN).

3.1 Broadband Access Networks – Alternatives

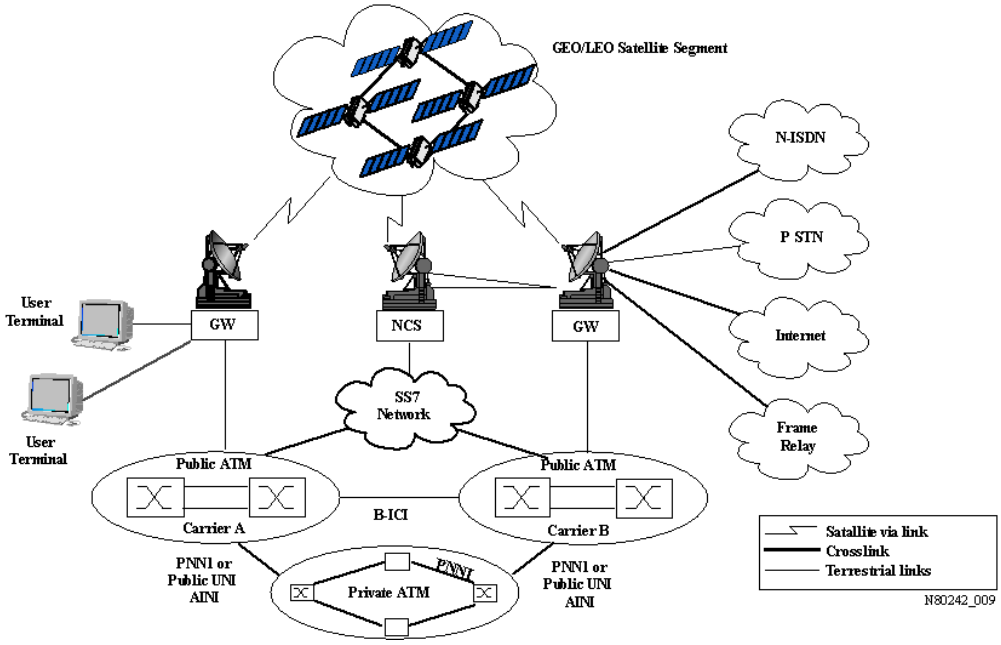
3.1.1 Broadband Satellite Access

Satellite technology is distinguished by several characteristics such as global coverage, bandwidth on demand, flexibility, multicast, and broadband capability. It is an excellent candidate to provide broadband Internet access.

Broadband Satellite Access (BSA) is an access system with a satellite segment representing its access network. In BSA, two-way interactive broadband services are supported to and among network end users whether at home or in the office.

The figure below presents an example of BSA architecture:

Figure 1 – BSA architecture



[1] For further information on the introduction of Broadband Networks, see the report on Question 20/2.

3.1.2 Hybrid Fibre Coax / Cable Modem

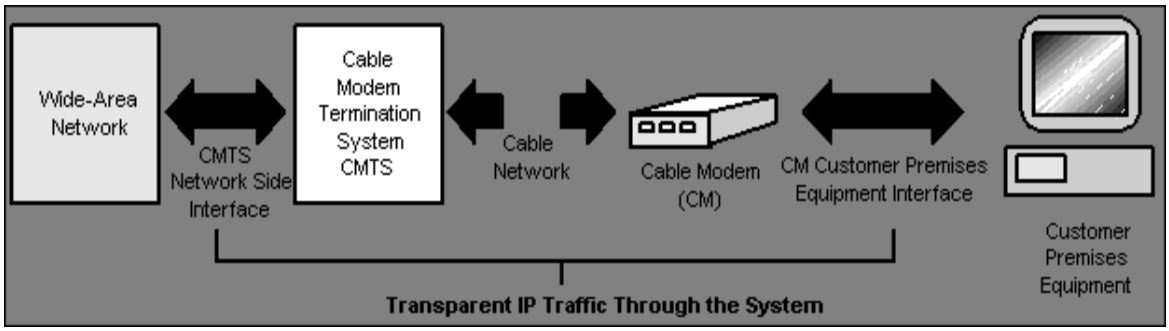
Cable networks were originally designed for one-way video transmission. Cable companies provided video that was sent, or broadcast, over lines to subscribers' homes. However, as the networks have evolved, new equipment has made it possible to send data in both directions on a cable network, (i.e. downloading and uploading from a household), thus making Internet access over cable a viable solution. The physical cable network sends different "channels" on separate blocks of 6 MHz frequencies along the same cable. Originally, these channels each carried different television channels until a method was developed to reserve unused channels and dedicate them to Internet traffic. One channel sends data from the Internet to users (6 MHz of frequency corresponds to roughly 30 Mbit/s) and another channel is used to send data back on the Internet from households.

These reserved channels are "broadcast" around the network to all subscribers in a certain area. Each cable modem can recognize which parts of the broadcast are destined for it and pull them off the network. Cable modems are then able to send information back to the Internet by waiting for their "turn to talk" on the response channel and essentially broadcasting their request in quick bursts back to the central office of the cable company.

All cable subscribers in a small area share the same channels to send and receive data, and the amount of bandwidth users receive is directly tied to how much bandwidth their neighbours are using. If no other users are using a cable node at a given time, cable subscribers may theoretically have disposal of all of the combined bandwidth allotted to their own and their neighbours' homes. Conversely though, during heavy usage, cable modem subscribers can see significant reductions in their bandwidth. Typically, 1.5 Mbit/s download speeds or higher can be expected over cable modems during normal usage times. In order to protect against abuse, many cable companies have restricted the upload bandwidth to 128 kbit/s in order to stop high-bandwidth users who use more than their share from running server or peer-to-peer applications on their home computers. Cable companies have also found another way to increase the bandwidth of users in an area by simply dedicating additional channels to data and dividing the number of users on a particular node[2].

Figure 2: Cable modem connections

How cable technology connects to the Internet



Source: ITU-T Recommendation J.122, ITU-T Study Group 9.

3.1.3 Digital Subscriber Line

Building upon the traditional analogue system that formed the basic telephone network, the integrated services digital network (ISDN) was the digital switched network technology that first enabled improved quality and speed, not only for the transmission of voice, but also of data and images. While ISDN offered a significant upgrade to traditional copper phone lines, digital subscriber lines (DSL) have advanced the

2 For further information: http://www.itu.int/osg/spu/ip/chapter_seven.html

technology and increased the speeds further still. A key advantage of DSL technologies is that they use existing copper twisted pair wiring and do not require new cabling as would, say, fibre optics. DSL utilizes different frequencies to split voice and data services over the same standard phone line. Previously, phone networks only used a small portion of the available bandwidth for voice traffic. However, DSL has taken advantage of the unused space on the copper pair to include data traffic. DSL speeds are influenced by the distance between the subscriber and the local exchange, the gauge of the phone wire, and the type of DSL technology.

DSL technologies includes high bit rate (HDSL), asymmetric (ADSL), very high speed (VDSL) and single-pair high speed (SHDSL), and employ highly sophisticated techniques that limit near end crosstalk and, therefore, greatly expand the bandwidth potential over a single pair of copper wires. The technologies comprising the DSL family achieve broadband speeds that differ, depending on the variety of DSL technology but also on the upstream and downstream, from a range of around 128 kbit/s to 51 Mbit/s.[3]

3.1.4 Fibre Optics Access Networks

Fibre-optic transmission is moving deeper and deeper into networks, and recently has been deployed to the curb, closer to the residences, serving a very small number of residences, and to the home, where each fibre termination serves a single home/office. Fibre optics access networks offers unrivalled bandwidth capacity, being a "future proof" infrastructure, as once laid in the ground it is the boxes, rather than the fibre, which might need upgrading.

3.1.5 Mobile Networks

Mobile communications is one of the fastest growing markets in the world. Concerning Broadband Mobile Networks, IMT-2000, the "International Mobile Telecommunications" system was born at ITU as the third-generation system for mobile communications. IMT-2000 envisages a platform for distributing converged fixed, mobile, voice, data, Internet and multimedia services. IMT-2000 may provide higher "broadband" transmission rates ranging from 144 kbit/s to 3 Mbit/s for fixed, portable and mobile applications. IMT-2000 aims to provide seamless delivery of services, over a number of media (mobile, satellite and fixed) making this platform flexible from both the operator and consumer point of view.

Since 2000, over 25 countries (half of them developing) have launched IMT-2000 technologies[4], many by permitting operators to migrate their existing networks utilizing existing mobile spectrum. A number of countries have also licensed additional spectrum for terrestrial IMT-2000 networks. Consumers are utilizing IMT-2000 as a medium for broadband in fixed, portable and/or mobile environments.[5]

3.1.6 Powerline Communication

Powerline communication (PLC) has for several years been a topic of interest for researchers the world over, as well as for the world's major electricity providers. It consists in using electricity distribution networks to carry digital data. With PLC, plugging a computer into the mains supply will provide it not only with electric power but also with an Internet connection, based on the same principle as that currently used by telephone networks.

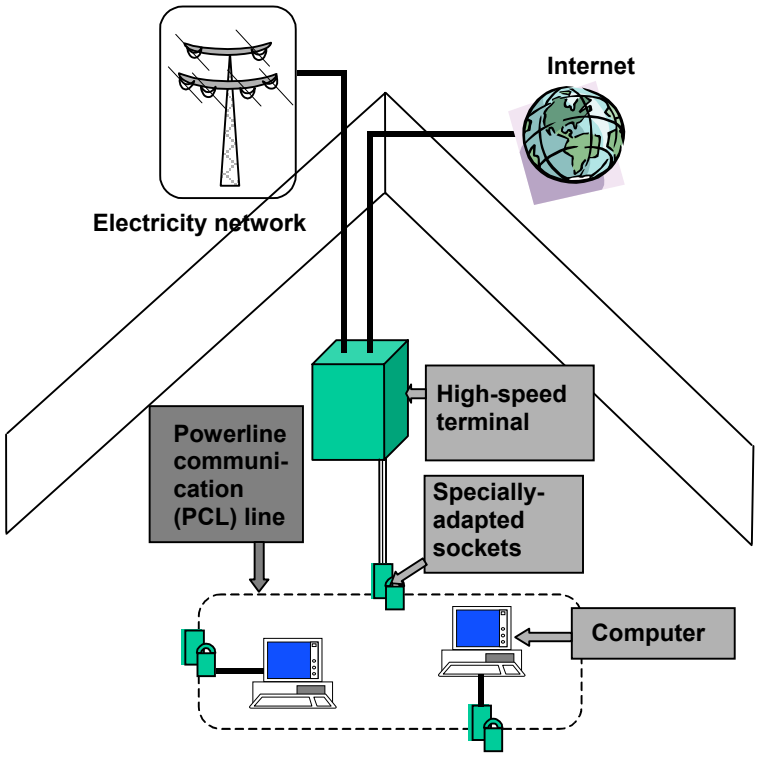
---

3 For further information: http://www.itu.int/osg/spu/ip/chapter_seven.html

4 http://www.3gtoday.com/operators_flash.html

5 For further information: http://www.itu.int/home/imt.html

Figure 3 – PLC principle within the home



The electricity network and the Internet network come together at the high-speed modem terminal, after which the electricity and the digital data are both carried within the domestic electrical circuit. The plug which connects the computer to the electrical circuit re-splits the current and the Internet data just like the high-speed plugs that are used in the telecommunication network (e.g. DSL). PLC can also be used for a more extensive network (village, town, etc.), in which case the terminal at which the signals are brought together is located upstream of the PLC circuit. Repeaters located approximately every 300 metres are used to amplify the signal. The development of high-speed Internet and the deregulation of energy markets favour this technology and its emergence within the context of the globalization of the information society.

PLC/Internet projects are currently under way in both North America and Europe, and are acknowledged as being economically viable.

In France, the Ministry for Research and New Technologies considers PLC, in the same way as wireless Internet (for example, Wi-Fi), to be an excellent means of reducing the digital divide that exists between those regions in which the creation of information transport infrastructure poses no problem and those in which its cost is very high. With this in view, Electricité de France (EDF) has initiated a project in the Paris area, while in both Brittany and the south of France a network combining satellite and PLC is to be developed. It should be noted that EDF has for two years been conducting a full-scale network experiment in the east of France.

In conclusion, it can be said that although the cost of introducing PLC/Internet is currently still higher than for wireless links, it has numerous advantages for geographic areas and buildings that have not yet been cabled, one such example being the connection of schools to the Internet.

3.1.7 Radio Local Area Networks (RLAN)

Emerging broadband RLAN standards are being developed to be compatible with current wired LANs and are intended to function as a wireless extension using TCP/IP and ATM protocols, thus breaking the "bottleneck" experienced with current wireless LANs.

Broadband RLAN systems, which use high data rates of more than 20 Mbit/s, make it possible to move a computer within a certain area such as an office, a factory, a warehouse to maintain contact with lift trucks for example or a SOHO (Small Office Home Office). Broadband RLANs may be either pseudo-fixed as in the case of a desktop computer that may be transported from place to place, or portable, as in the case of a laptop or palmtop devices working on batteries.

One of the most useful RLAN features is the connection of mobile computer users to their own LAN network without wires. In other words, mobile users can be connected to their own LAN subnetwork anywhere within the RLAN service area. Moreover, RLAN terminals can be used without any additional operation at other company offices where they move.

3.2 Benefits from Broadband Networks

Broadband networks, including BSAs, can reduce the disadvantages of low population density and physical remoteness from cities. Moreover, with the advent of broadband technologies, myriad applications become possible or are enhanced beyond their current capabilities with dial-up Internet access. Some of the applications made possible or enhanced with broadband include:

- Telemedicine
- Teleworking
- E-Government
- Agriculture
- Distance Learning
- Public Safety
- Small Business Assistance
- Information Gathering
- Tourism
- E-Commerce
- Entertainment

While this is not an exhaustive list, these applications comprise some of the most important or popular applications for which broadband can be used.

The featured broadband access networks presented above and the service they make available once they have been implemented, make it clear that all broadband technologies can lead to enormous economic and social benefits for peoples of every development level, such as:

– Increased worker productivity;
– Job creation;
– Efficiencies in the distribution of: goods, services and information;
– Can reduce the challenges of low population density and physical remoteness from cities;
– More efficient / increased access to "basic" services like healthcare, education;
– Bundled services (voice, video, data) enable operators to offer more services at lower prices;
– Helps bridge the "Digital Divide"; and
– Helps the introduction of IP telephony!

However, the key to success in implementing a broadband technology is a combination of favourable regulatory, economic and development strategies that support broadband deployment.

4 PAST ITU WORK AND REFERENCES TO EXISTING DOCUMENTS

Internet Protocol (IP)-based networks were recognized by the Plenipotentiary Conference of Minneapolis 1998, in its Resolution 101, as an issue of crucial importance to the future, as important engine for growth in the world economy in the twenty-first century, stressing the need to identify the implications of the development of such networks in ITU Member States.

By Decision 498, at the 2000 session of the ITU Council, it was decided to convene the third World Telecommunication Policy Forum (WTPF-01) in order to discuss and exchange views on the theme of Internet Protocol (IP) Telephony. Having in mind the "IP telephony" challenges in developing countries, "Opinion D" was adopted by the Forum. Opinion D was supposed to address many challenges and issues facing developing countries, in particular facing many public (or dominant private) telecommunication operators when "IP telephony" is introduced, such as:

- its impact on their revenue streams, as a result of lower-priced "IP telephony" tariffs compared with their PSTN tariff schemes,
- not to place any additional requirements on PSTN networks when interconnected to IP-based networks,
- how to meet the performance metrics and traffic identifications when IP-based networks interwork with PSTN,
- how to generate the necessary funds to invest in IP-based networks,
- how to deal with numbering and addressing issues.

Then, during the World Telecommunication Development Conference (WTDC-02, Istanbul), the BDT Director presented the Document "Report by the Group of Experts on Internet Protocol (IP) telephony/ITU-D (Conclusions and main issues related to Opinion D Part 3)", which proposed continued discussion of IP telephony, originating Question19/1, which is covered in this report.

In this process, the work of ITU in the past has been important in the global effort towards the promotion of IP-based networks, service and technology convergence, communication technology standardization, frequency harmonization, and telecommunication reform.[6]

5 TRENDS RELATED TO THE IMPLEMENTATION OF IP TELEPHONY

In many cases, data networks are becoming the universal means for transporting any communication service, from voice to video and data. In these cases, the past concept of separated networks, each one carrying its own services, is being replaced by the concept of convergent networks that are able to carry any communication service.

Along with the introduction of the concept of convergent networks, one key issue that has gained the attention of policy-makers, regulators, and industry alike is the fact that the global Internet backbone, and other IP-based networks, are increasingly being used in combination with and as alternatives to circuit-switched telephone networks, lowering the barriers to entry and bringing new competitors to the marketplace. Additionally, several major international Public Telecommunication Operators (PTOs) have announced plans to eventually migrate their international traffic onto IP platforms. One reason for this transition is the apparently lower cost of moving traffic over IP-based networks and its flexibility.

Telecommunication reform across the globe, the liberalization of markets, and the establishment of independent regulators promoting universal service and competition are also contributing to the migration to IP-based networks. Additionally, in some cases, IP telephony has been introduced by means of IP PBXs, mainly for enterprise customers.

---

[6] Further information on the previous ITU efforts on the IP telephony subject can be found at: http://www.itu.int/ITU-D/e-strategy/Internet/

Another trend is that new entrants have been asking the telecommunication regulators to review the interconnection rules since IP-based networks make better use of the existing infrastructure, reducing the cost of interconnection circuits.

In some cases, regulators and policy-makers are considering such issues as whether to create a separate regulatory framework for the implementation of IP telephony and whether to regulate IP telephony as a functional equivalent of PSTN.

The growth of IP-based networks around the globe has profound and broad implications for societies, including consumers, industry, and national administrations. In part, this is because telecommunication infrastructure is increasingly being viewed as a fundamental element of national competitiveness in the age of the Information Society. Improvements to communications networks may serve as a dynamic stimulus to economic growth. In competitive markets, established PTOs are evolving their networks towards IP not necessarily to provide cheaper voice services (competition has already forced down prices of traditional circuit switched services) but to offer a much wider and diverse range of multimedia services and innovative applications and particularly to be able to compete effectively in future e-commerce markets.

IP telephony is an important part of this picture. For consumers, IP telephony has been used to offer cheaper long-distance and international telephone calls compared with the alternative of using a circuit-switched, fixed-line or mobile network. These cost savings may, at least partially, offset any possible loss of quality. IP telephony also offers consumers advanced services, integrating voice and data, such as merged World Wide Web and voice services (e.g., "click-to-talk") or integrated messaging. Adding voice to traffic on IP-based networks further raises issues of substitution for circuit-switched services and strategies for network transition.

6 METHODOLOGY

The methodology adopted consisted of a three-step process: the distribution of a questionnaire from ITU to the administrations, the analysis of the background from the administrations participating in the research in terms of competitiveness, regulatory framework and Internet status terms and a request to administrations to present case studies of the implementation of IP telephony in their market.

6.1. Questionnaire

In order to gather new information for the work on Question 19/1 (Implementation of IP telephony in developing countries), the Rapporteur's Group has considered all past ITU efforts carried out regarding IP telephony, particularly the Report by the Group of Experts on Internet Protocol (IP) telephony/ITU-D (Conclusions and main issues related to Opinion D Part 3). However, as a matter of bringing new information and issues to the debate, the group sent a questionnaire to the administrations and Sector Members (Administrative Circular CA/17 of 7 November 2002 to be answered by 31 January 2003; 46 answers received from all regions) and the conclusions are presented in this report. The table below presents the list of administrations that replied to the questionnaire:

Country	Organization	Website
BAHAMAS	Public Utilities Commission	www.PUCBahamas.gov.bs
BELARUS	Ministry of Posts and Telecommunications	www.mpt.gov.by
BENIN	Office des Postes et des Télécommunications	mcptn@intnet.bj
BHUTAN	Bhutan Telecom Authority	www.bta.gov.bt
BOLIVIA	Viceministerio de Comunicaciones	www.sittel.gov.bo
BOSNIA AND HERZEGOVINA	Telekom Srpske	www.cra.ba
BOTSWANA	Botswana Telecommunication Authority	www.bta.org.bw
BURKINA FASO	Office National des Télécommunications	www.artel.bf
BURUNDI	Agence de Régulation et de Contrôle des Télécommunications	arc@cbinf.com

Country	Organization	Website
CAMBODIA	Ministry of Posts and Telecommunications	www.mptc.gov.kh
CANADA	Industry Canada, Spectrum Engineering Branch	www.ic.gc.ca
COLOMBIA	Ministerio de Comunicaciones	www.mincomunicaciones.gov.co
COMORES	SNPT	www.snpt.km
COSTA RICA	Instituto Costarricense de Electricidad	www.aresep.go.cr
CYPRUS	Ministry of Communications and Works	www.mcw.gov.cy
DENMARK	National IT and Telecom Agency	www.itst.dk
DJIBOUTI	Djibouti Telecom S.A.	Unavailable
ESTONIA	Estonian National Communications Board	www.sa.ee
FINLAND	Finnish Communications Regulatory Authority	www.ficora.fi
HUNGARY	Communications Authority of Hungary	www.hif.hu
INDIA	Telecom Regulatory Authority of India	www.trai.gov.in
JAPAN	Ministry of Public Management, Home Affairs, Posts and Telecommunications	www.soumu.go.jp/english/index.htm
JORDAN	Telecommunications Regulatory Commission	www.trc.gov.jo
KENYA	Communications Commission of Kenya	www.cck.go.ke
KUWAIT	Ministry of Communications	Unavailable
LIECHTENSTEIN	Office for Communications	www.ak.li
LITHUANIA	Communications Regulatory Authority and the Ministry of Transport and Communications	www.rrt.lt and www.transp.lt
MADAGASCAR	Telecom Malagasy	www.omert.mg
MAURITANIA	Autorité de Régulation	www.are.mr
MAURITANIA	Secrétariat d'Etat auprès du Premier Ministre chargé des Technologies Nouvelles	www.are.mr
MYANMAR	Post and Telecommunications Department	DG.PTD@mptmail.net.mm
OMAN	Ministry of Transport & Communications	www.comm.gov.om
PAKISTAN	Pakistan Telecommunication Authority	www.pta.gov.pk
PERU	INICTEL	Not applicable
PERU	Ministerio de Transportes y Comunicaciones	www.mtc.gob.pe
PHILIPPINES	Department of Transportation and Communication	www.ntc.gov.ph
POLAND	Office of Telecommunication and Post Regulation	www.urtip.gov.pl
SENEGAL	Agence de Régulation des Télécommunications	www.art-telecom-senegal.org
SINGAPORE	Infocomm Development Authority	www.ida.gov.sg
SLOVAKIA	Telecommunication Office	www.teleoff.gov.sk
SPAIN	Ministerio de Ciencia y Tecnología	www.setsi.mcyt.es/
SUDAN	National Telecommunication Corporation	itisalat@email.sudanet.net
TANZANIA	Tanzania Communication Commission	www.tcc.go.tz
THAILAND	Post and Telegraph Department	www.ptd.go.th
TURKEY	Telecommunication Authority	www.tk.gov.tr
UGANDA	Uganda Communication Commission	www.ucc.co.ug

Considering the different administrations that responded to the questionnaire and noting their distribution in terms of the developed and developing countries, it is possible to say that the answers to the questionnaire roughly represent the distribution of the countries in terms of developed and developing nations in the world.

6.2 Administrations' Backgrounds

Assuming that the implementation of IP telephony requires a pro-competitive market, a stable regulatory environment and technology/Internet knowledge, and in order to form a deeper understanding of the responses to the questionnaires, the 46 administrations that answered the research were grouped in terms of market competitiveness, regulatory framework and Internet status. All these analyses were made on the basis of ITU-D databanks.

6.2.1 Market Competitiveness

Market competitiveness was the concept created by the Rapporteur's Group in order to assess the level of competition allowed by the administrations listed above in the provision of the following services:

– Local service;
– Domestic long distance;
– International long distance;
– Digital Subscriber Line (DSL);
– Wireless Local Loop (WLL);
– Leased Lines;
– Data;
– Fixed Satellite;
– Cable Television;
– IMT-2000; and
– Internet Service Provision (ISP).

The analyses covered all those services because they are associated with the broadband access networks infrastructure that may be used to provide IP telephony and are services accelerating service and technological convergence, particularly radiocommunication services (either fixed or mobile) convergence.

The graphs[7] in Annex 1 presents those administrations in terms of market competitiveness in the provision of the above-mentioned services. Basically, the conclusion is that telecommunication markets are becoming more competitive in all segments and in this sense, the implementation of IP telephony along with technology/service convergence open up a great number of opportunities to developing countries and their companies to partner with others and search for new markets, while becoming stronger in their local markets.

6.2.2 Regulatory Framework

The regulatory framework concept was created by the Rapporteur's Group in order to assess to what extent administrations have a structure prepared for the development of IP telephony. In this sense, assuming the Regulatory Authority will play a role in the administration's decision on the way forward in the development of IP telephony and broadband networks, which will bring more competition to the national markets, and considering, in addition, that interconnection will also be an important issue for the development of IP telephony, the administrations above were further analysed according to their regulatory environment in the following terms:

– interconnection agreements made public;
– interconnection prices made public; and
– a regulatory authority autonomous in taking its decisions.

---

7 Based on ITU-D databases, for further information: http://www.itu.int/ITU-D/databanks.html

That analysis resulted in the graphs contained in Annex 2. Basically, the result is that the regulatory framework is becoming more stable and market oriented, which allows for more competition and foreign investment. Thus, this trend is positive for the implementation of IP telephony in developing countries by creating a satisfactory environment for innovation, new services and investment.

6.2.3 Internet Status

Considerating the high level of interaction between IP telephony, Internet and Internet users, the Rapporteur's Group created the concept of Internet status, in which administrations were assessed according to the level of information technology infrastructure and knowledge, and number of Internet users and density. In this sense, administrations participating in this task were distributed according to:

– Number of Internet hosts;

– Number of Internet hosts per 10 000 inhabitants;

– Internet users; and

– Internet users per 10 000 inhabitants.

The results are in Annex 3. Basically, the conclusion on this point is that there is much to do in developing countries in order to increase the Internet network and the level of Internet access.

6.3 Case Studies

Finally, in light of the importance of sharing the experiences of developing countries in implementing IP telephony, the Group solicited case studies on the introduction of IP telephony, and two case studies are presented in the applicable section.

7 BENEFITS FROM THE INTRODUCTION OF IP TELEPHONY TECHNOLOGIES

The first issue established in Question 19/1 is how a nation and its citizens, current telephone operators, ISPs and new entrants can benefit from the introduction of IP telephony and broadband access. In addressing this issue, a number of benefits were presented by the administrations contributing to this study.

In general, the following summarizes the results of the questionnaire regarding the benefits of introducing IP telephony technologies:

– foster technical and market innovation and diversity and growth in the economy;

– create new and enhanced communication capabilities that might be essential for the development of other service sectors, and for the production and distribution of goods in the global economy as a whole;

– bring an opportunity for all countries to speed up the convergence of information and communication technologies;

– expand the use of Internet and IP-based networks as a major medium for communications and commerce;

– integrate voice and data networks, allowing opportunities of synergies and cost reductions;

– enable the provision of new and innovative services and applications for the benefit of all citizens, allowing new sources of revenue from these services;

– offer opportunities for the development of new multimedia applications, including voice;

– reduce the barriers to entry, allowing more competition, new services and cheaper prices for voice communications;

– could contribute in reducing poverty using converging technologies;

– could contribute to capacity building through eventual reduction of the costs of telecommunications.

In addition, some of the administrations that answered the question have made specific comments on the benefits a nation and its citizens, current telephone operators, ISPs and new entrants can derive from the implementation of IP telephony, which are presented below:

Administration	Benefits from the introduction of IP telephony
BURKINA FASO	The benefits from IP telephony are a cheaper cost for communication, absence of settlement cost/tariffs, etc.
BHUTAN	Relatively cheap equipment and falling prices, easy and fast to install, low power consumption and rural access technology.
CAMBODIA	IP telephony enables poor people in Cambodia to communicate with relations or business abroad with ample duration and the ISP's subscriptions increase particularly the wireless broadband access.
COLOMBIA	IP telephony, along with other applications based on IP networks, is viewed as an opportunity to reach the services and technological convergence and a way to increase the availability and the use of the network deployed. Such characteristics, if exploited in a liberalized market, would have a great influence on the development of IP telephony since operators could diversify their business into new areas.
ESTONIA	The benefits are mainly economic: lower prices ensure monetary savings for consumers. Also it has widened possibilities and the use of supplementary services.
LITHUANIA	The major benefit of IP telephony introduction is promotion of competition in the market and increased variety of services for the user.
MAURITANIA	Contribute in reducing poverty using converging technologies. Contribute to capacity building through eventual reduction of the costs of the telecommunications. The possibility to address a much larger market in real time (i.e. electronic commerce).
MYANMAR	IP telephony service offers cost-saving opportunities, new services, full support to Internet connection and other utilizations, provide telecommunication and multimedia to households and in conjunction with satellite offer the possibility to reach remote and rural areas.
PERU/INICTEL	The major benefit from the introduction of IP telephony has been the reduction of long-distance calls in both conventional PSTN and IP telephony markets.
PHILIPPINES	For the nation and its citizens, though most operators are still in the planning stage of their implementation of IP telephony, the mere popularity of these schemes shows that some people are looking for a cheaper way to place their long-distance calls. For business, IP telephony can offer new business opportunities, if regulations allow it. For operators, IP telephony offers additional alternative to deliver voice services. For users it has the benefit of supporting converged services on a single network. Also, an integrated infrastructure that supports all forms of communication, allowing more standardization and reducing the total equipment and spares complement.
POLAND	Internet Technology offers significant cost savings for the provision of voice services. In addition, Voice over IP enables innovative features such as videoconferencing. Moreover, companies providing Internet telephony benefit from the cost of investment reduction from the replacement of the separate networks for voice and data services with one convergent system.
SINGAPORE	With the introduction of innovative international telecommunications services, including IP telephony, international rates have dropped by as much as 80% to certain destinations.
THAILAND	IP telephony is seen as a means to benefit from domestic long-distance savings, from the decreased cost of running businesses such as mobile phones and, by being an open-system architecture, it increases the service options offering more value-added service, which will attract more Internet users
UGANDA	To the nation and citizens, the cost of making international call would be greatly reduced, hence it would give an opportunity to even ordinary people to communicate with their acquaintances and associates abroad. This would benefit many areas of life, specifically the commercial sector. To current telephony operators, this would ease costs of providing international call services to their subscribers, since a lot of financial costs are incurred in paying carriers of international traffic. To the ISPs and new entrants, it would be a source of extra revenue besides the usual income from Internet access fees collected from subscribers.

As seen in the responses above, IP telephony brings along compelling advantages and benefits to administrations. In this sense, IP telephony, by promoting integration of data and voice in a single infrastructure, streamlines the linking between computer applications and communications technologies, integrates services and applications, supports flexible working practices and brings opportunities to innovation in many different areas. These benefits have been discussed within ITU-D, and a profound analysis was made in "The Essential Report on IP Telephony"[8]. Therefore, before any final decision on the way forward, administrations have to consider if the above benefits can be achieved in their own market or not, and must take into account the potential challenges derived from the implementation of IP telephony.

8 POTENTIAL CHALLENGES FOR DEVELOPING COUNTRIES

The work in Question 19/1 has demonstrated that ITU Member States take different approaches on the developing IP telephony. As seen, while there are administrations where IP telephony is provided under a fully liberalized market, in others it is provided under a more regulated framework. Also, it was verified that some countries are even prohibiting the introduction of IP telephony.

This may have resulted from the potential challenges faced by developing countries in allowing IP telephony into their markets. Given this, Q.19/1 Rapporteur's Group discussed this issue in the questionnaire, enquiring administrations to present their views on the potential challenges the implementation of IP telephony might present to them. In general the challenges presented by the administrations covered the following:

– examination of the structure of the national telecommunication industry, particularly for telephony, analysing the impact of IP telephony on the current telephony regulatory framework;
– decision on what kind of regulatory framework should be put in place, analysing issues like: licence restrictions, regulatory distinctions from PSTN to IP telephony, IP telephony definition, interconnection charges for both incumbents and new entrants, quality of service, numbering and addressing, etc.;
– assessment of the economic impact of allowing IP telephony, and the likely competition to come along with it, on the revenue streams of national operators;
– evaluation on whether or not IP telephony will have an impact on the current universal services programmes or are able to help those programmes;
– development of human resources in order to cope with the new technologies made available by convergence, including IP telephony, bridging the digital divide;
– need to find alternatives to tariff rebalancing and technology transfer;
– need to find alternatives to stimulate investment and competition;
– enforcement of the local regulations, avoiding, if it was the case, the illegal operation of IP telephony;
– quality of IP telephony service;
– evolution of the current network infrastructure towards a full IP-based network, including the interoperability issue;
– development of market strategies to best benefit from the IP telephony business opportunities; and
– adoption of security measures to protect IP networks from cybercriminality.

8.1 Administrations' Concerns

The following table presents, additionally, specific concerns presented by administrations:

[8] For further information: http://www.itu.int/ITU-D/e-strategy/publications-articles/pdf/IP-tel_report.pdf

Administration	Challenges verified/foreseen
CAMBODIA	The challenge faced is the revision of contracts currently held by different operators.
CANADA	There were some discussions among the service providers, in particularly between the Local Exchange Carriers (LEC) and Inter-exchange carriers (IXC), on the definition of a "switch" in the IP telephony environment. This definition affects the interconnection arrangements and the associated tariffs between the service providers that were established under the legacy telephony regime. This issue is still under discussion in the Network Working Group of the Canadian Radio-Television and Telecommunications Commission (CRTC) Interconnection Steering Committee (CISC)
COLOMBIA	Define and approve an appropriate telecommunication law for the current telecommunication trends, including IP telephony. Also, the exclusivity of current telephony operators imposes an additional challenge since existent operators have paid for such exclusivity, whose resources are paying for universal services in the country.
ESTONIA	The most critical aspect in implementing IP telephony is quality of service. Regulating quality of service in Estonia, including IP networks, is now in progress.
FINLAND	The regulations are updated to cover also IP telephony and no special new regulations for IP technology are planned. However, the definition of IP telephony has been somewhat problematic.
INDIA	There have been reports that some ISPs were blocking websites of their competitors to prevent their customers from using the Internet telephony service of other ISPs.
KENYA	The increased use of Internet telephone services by end users in the country is inevitably hurting Telkom Kenya's revenue from international calls. Telkom Kenya Limited should be preparing and has been encouraged to enter the Internet phone service provision in a bid to maintain their position as the market leader for international telecommunications by focusing its business on becoming a fully integrated telecom service company, which envisions core competence in backbone network, mobile and multimedia communication, on an IP platform. The telecommunication infrastructure in the country over which voice over IP would run still needs to be improved, with the introduction of such technologies as broadband access.
MAURITANIA	The main preoccupation of the Administration is in relation with cost of the IP interconnection between the different operators for the benefit of users.
PERU/INICTEL	The challenges are mainly related to legal and regulatory issues since technologically and commercially the implementation of IP telephony is more easily managed.
PHILIPPINES / PLDT COMPANY	The challenges encountered by operators are the following: excess capacity in circuit-switched network that makes introduction of IP technology for capacity building less compelling and uncertainty over quality of service of IP telephony.
POLAND	Challenges incurring from the Internet telephony include the issues of quality of service. However, analysis, conducted by I-Metria S.A. in September 2002, reveals improving quality of voice service provided over Internet protocol. Moreover, current market players consider the cost of roll-out of such network as the factor which is the most discouraging in terms of the introduction of the voice over IP technology. Other discouraging factors include the threat of possible changes in regulation and technical problems.
SUDAN	There are Internet cafés and individuals passing telephony traffic over IP illegally.

Administration	Challenges verified/foreseen
TANZANIA	The serious challenge to deployment of IP telephony is the absence of telecom infrastructure capable of supporting the service and hence limiting the benefits to areas already covered by other telecom services.
UGANDA	The existent law restricts who is licensable to use Voice over IP and there are unauthorized people trying to provide the service.

Considering the general and the specific challenges presented above, the Rapporteur's Group divided the discussion into technical, economic and regulatory challenges, which are presented below. Information on approaches to overcome the challenges are presented in the pertinent section of this report.

8.2 Technical Challenges

8.2.1 Introduction

The use of Internet Protocol networks for voice communication poses a number of technical challenges due to the requirements voice communication presents compared with the requirements for transfer of data, which have predominantly influenced the development of IP networks. In particular, voice telephony requires low and constant delay for the parties to conduct a normal conversation and is not particularly sensitive to information encoding errors whereas data is not sensitive to delay but is error-sensitive. Maintaining voice quality has been one issue that has been raised when discussing the use of IP networks for telephony and the mechanisms for providing different levels of Quality of Service appropriate to specific applications has received much study.

IP networks use different addressing mechanisms from the E.164 numbering scheme used in the global PSTN which presents challenges for the interworking of services between IP networks and the PSTN. In addition, there are issues concerning a number of aspects of Security, such as securing signalling information and providing privacy to the users of telecommunication services.

8.2.2 Access Technologies

As presented in section 3, adequate bandwidth must be available on the subscriber access circuit for provision of "IP telephony" to the end user. Digital Subscriber Line (DSL) technology may be used in densely populated areas in which there is already a copper local access network. Other alternatives are the use of electricity distribution systems for the provision of telecommunication services and wireless technology. Section 11 of this report includes information on a pilot project using wireless technology and "IP telephony" to provide telephony services to remote villages in Bhutan, and a pilot project using a local exchange and connection to Internet to provide voice services to remote villages in Indonesia.

8.2.3 Quality of Service

The use of IP technology presents a number of challenges in terms of providing a similar user perception of the quality of telephony service to that provided by the PSTN. Architectures to achieve end-to-end QoS are being developed in a number of standards organizations and industry forums. These architectures differ in some details but there is broad agreement on the fundamental mechanisms that can be used to provide deterministic quality of service appropriate to a full range of voice, video and data services. These are the Differentiated (Diffserv) and Integrated Services (Intserv) mechanisms defined by the IETF, in addition to fragmenting data on low bandwidth links and overprovisioning of capacity in core networks.

8.2.4 Security

8.2.4.1 Introduction

Security issues related to the convergence of voice and data networks and the use of IP networks for the public telephony service have been widely identified. The security challenges presented by the use of IP networks for telephony services differ from those of the circuit-switched PSTN. For example, network signalling information in the PSTN is separated from user traffic and access to facilities is physically limited. This relative isolation of signalling information has allowed trust relationships to be established between network operators for conveyance of calls internationally and more generally between operator domains. Traffic is often mixed in IP networks and the network infrastructure is more easily accessible resulting in more stringent requirements for the authentication of the senders of signalling information, authorization mechanisms and the encryption of information in transit.

Telecommunication networks are presented with security risks very similar in nature to those of computer systems and these risks can be responded to by using techniques similar to those used to secure computer systems, such as by encrypting data, controlling access to systems by authenticating users and checking that they are authorized to use a service and by blocking certain types of traffic. The risks are those of users masquerading as other users or accessing resources to which they are not entitled in order to gain some financial benefit, such as using a network free of charge, or to cause annoyance or more seriously disrupt services. Users can monitor traffic so as to gain useful information, such as to make fraudulent use of some resources, impersonate other users, modify information in transit, access sensitive information, and spread malicious code that may, for example, be used to initiate Distributed Denial of Service (DDOS) attacks.

And so, in response to these risks:

– information should be encoded so as not to be read by an unintended recipient;

– it should not be possible to modify information in transit;

– it should be possible to check that senders are who they claim to be (authentication);

– that resources can only be accessed by authorized parties; and

– that traffic can be monitored so as detect possible attacks in progress.

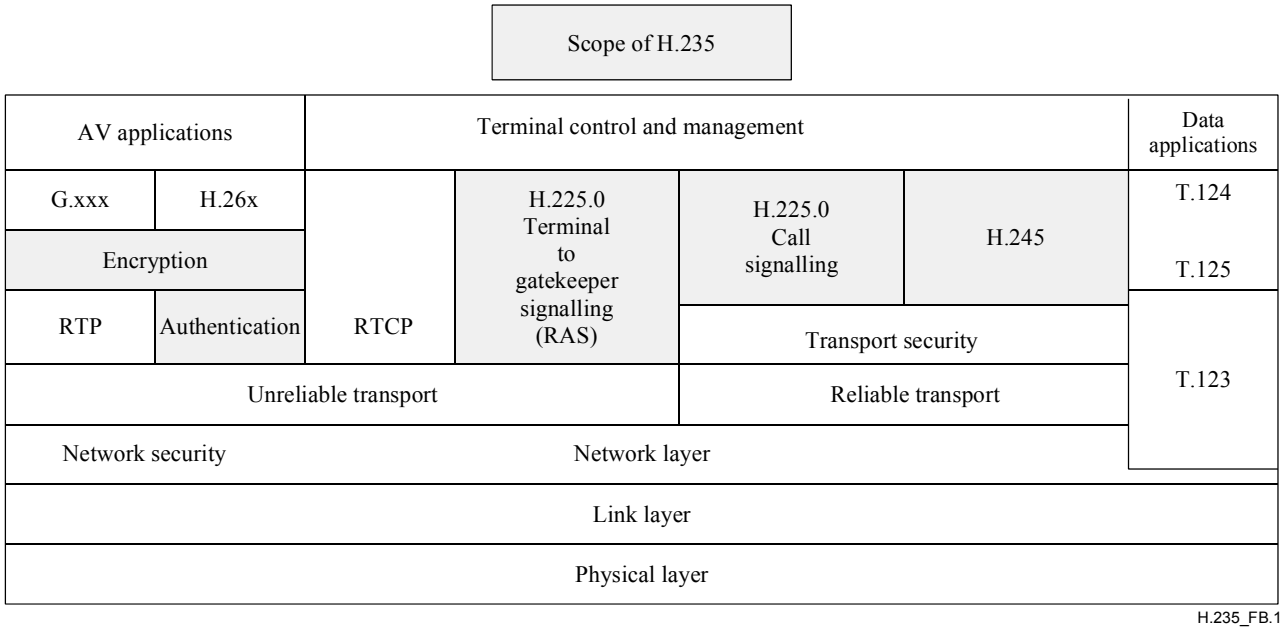
However, these aims can conflict with other requirements. For example, a user's wish for privacy can conflict with company or government wishes to monitor communications and mechanisms to ensure security can conflict with the need to design services that are easy to use and provide broad functionality.

8.2.4.2 ITU-T security specifications

ITU-T Recommendation X.805 describes a framework for providing secure end-to-end communications. This recommendation is intended to be the basis of more detailed specifications of specific aspects of security. Routing protocol and DNS traffic are included in the category of control plane information that needs to be secure in addition to the control signalling protocols such as SIP, SS7, and H.248.

The most widely used protocols for "IP telephony" currently are those that make up the H.323 suite of protocols and Recommendation H.235 specifies mechanisms and protocols for providing authentication and privacy using cryptographic techniques for H.323 systems. The scope of H.235 is shown in the following figure:

Figure 4 – Overview of ITU-T Rec. H.235



Work is progressing in a number of standards organizations on refining the specification of use of optional capabilities in H.235 and specifying transport and network layer security mechanisms. Work with a similar scope is also being undertaken for systems that use the Session Initiation Protocol (SIP).

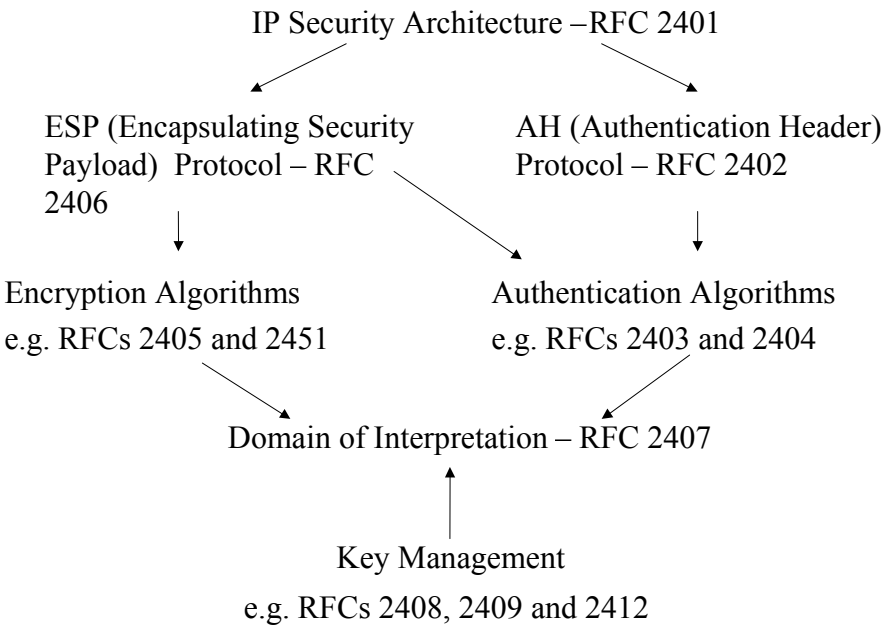
ITU-T has also published a security manual entitled "Security in Telecommunications and Information technology – An overview of issues and the deployment of existing ITU-T Recommendations for secure telecommunications" (http://www.itu.int/ITU-T/edh/files/security-manual.pdf) that includes information on securing "IP telephony" and network management systems.

8.2.4.3 Widely used security mechanisms

IPSec

RFC 2411 describes the relationships between the various RFCs (shown in Figure 5) that define the IPsec protocol that can be used to provide privacy and authentication services at the IP layer.

Figure 5 – IPsec Architecture



S/MIME (Secure Multipurpose Internet Mail Extensions)

S/MIME provides cryptographic security services for applications that use MIME body parts such as electronic mail, http and SIP. The following services are provided:

- authentication;
- message integrity and non-repudiation of origin (using digital signatures); and
- privacy and data security (using encryption).

S/MIME can, for example, be used to secure encapsulated ISUP messages carried by SIP.

SSL (Secure Socket Layer)

SSL is a session-oriented security mechanism used with http, for example, for securing web-based communication such as Internet banking and shopping applications.

TLS (Transport Layer Security)

TLS is a mechanism based on SSL that has been specified by the IETF.

Firewalls

Firewalls are filters that act on the basis of IP packet header information. A firewall can be configured to filter any traffic that can be identified on a per-packet basis. They are typically used between the Internet and private networks. Firewalls have a number of drawbacks such as preventing legitimate applications due to overly large granularity of filtering and a tendency of application designers to use protocols in a creative fashion to get through firewalls. However, firewalls do have a use in limiting denial-of-service attacks and nuisance traffic.

Radius

Radius is based on storing user security information on a Network Access Server through which access to an intranet is controlled.

VPNs (Virtual Private Networks)

A Virtual Private Network is a telecommunication system that emulates a private network within a shared public network infrastructure such that appropriate Quality of Service and security levels can be provided. They can be implemented in a number of ways using and security can be provided by, for example, using IPSec.

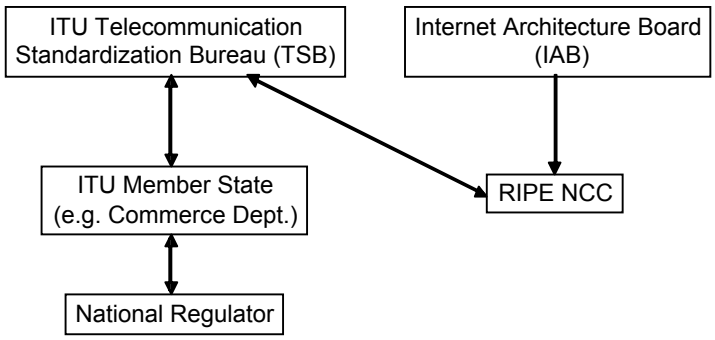
8.2.5 ENUM

8.2.5.1 Introduction

One obvious difficulty associated with interworking between the PSTN and IP networks is that of addressing, in particular for calling an IP telephone from a PSTN telephone. Unless the IP telephone has an E.164 number, associated with an IP PBX that is connected to the PSTN for example, it will be necessary to map an E.164 number, which can be dialled by a PSTN subscriber and used to route a call within the PSTN, to an appropriate address to be used in the IP network. ENUM, specified in RFC 2916 [1] provides a mechanism based on the use of the Domain Name System (DNS) for mapping E.164 numbers to Uniform Resource Identifiers (URIs), such as SIP URIs. ENUM can thus be used in routing a call from the PSTN to an IP telephone and can also be used by an IP telephone user to check if a number they wish to call can be reached directly over the Internet and so avoid PSTN call charges.

There has been a good deal of controversy concerning the choice of root or top level domain for ENUM but for an interim period it has been agreed to use the domain e164.arpa for the storage of E.164 numbers in DNS. The Internet Architecture Board (IAB) has delegated responsibility for the root of the public ENUM system (e164.arpa) to RIPE NCC. The ITU-T Sector cooperates with RIPE NCC by approving requests for delegation of domain names corresponding to E.164 country codes. As of March 2004, ENUM delegations to be performed by RIPE NCC had been approved for 22 countries and a couple of Universal Personal Telephony (UPT) operators. Figure 6 illustrates the delegation scheme. It is then a national matter to designate an organization, known as an ENUM Tier 1 Registry, with the authority to administer ENUM within each country. The administration of an ENUM registry is similar to that required for a Number Portability database.

Figure 6 – Interim ENUM delegation scheme



ENUM is recognized to be instrumental in the convergence of circuit-switched and packet-switched networks and in the transition to the use of "IP telephony". It is also pro-competitive in that it helps open the telecommunication market to competition from IP network operators.

ENUM trials have been conducted in a number of countries including Austria, China, France, Japan, Sweden, and the United Kingdom. The governments of other countries, such as Finland and Italy, have issued reports or consultative documents on ENUM and some countries, such as Denmark, although not conducting ENUM trials, have adopted regulations that give the national regulator authority to manage commercial operation of ENUM.

8.2.5.2 An example ENUM trial – Sweden

The Swedish telecommunications regulatory authority (Post- och Telestyrelsen – PTS) has been tasked by the Swedish government to assess:

- How the technical and administrative responsibility for ENUM should be allocated in the event of commercial use of ENUM;
- The manner in which customer data should be handled;
- The model for financing the operation of ENUM;
- Competition aspects associated with ENUM;
- The need for any statutory regulation associated with use of ENUM; and the
- Need for state involvement in ENUM [2].

An interim report was submitted to the Swedish government in July 2003 and the final report is expected in June 2004. The Swedish trial has not generated a great deal of interest with more interest being shown by companies involved with the Internet than by those organizations most active in the telecommunications sector of the market. This could be a result of the general condition of the telecommunications industry at the moment or also due to a lack of interest on the part of telephony network operators to offer services using ENUM, such as "IP telephony" at present.

PTS functions as the ENUM Tier 1 Manager and the Tier 1 Registry function has been delegated to Network Information Centre Sweden AB (NIC-SE). NIC-SE manages the registration of E.164 numbers and delegation of Tier 2 Registries.

The interim report of this trial [2] concluded that there were a number of interoperating implementations of ENUM and that the technology is mature enough for use in "IP telephony". Tests clearly showed that "IP telephony" solutions using ENUM were easily realized at "very modest cost" for relatively large customers that have their own PBX.

The Swedish regulatory authority also considered there to be a need for state regulation of ENUM and its relationship to the E.164 numbering plan. In addition, privacy risks associated with the use of ENUM and competitive aspects that fall within the scope of state responsibility have been recognized. A number of options have been considered with regard to the method of delegating the ENUM Tier 1 Registry function should ENUM services be introduced for commercial services, including giving the PTS the possibility of appointing a registry as is currently the case with the operation of the Swedish Number Portability Administrative Centre; licensing of the ENUM Registry operator; publicly procuring the service; or by agreement according to civil law. The options of giving the PTS the possibility to appoint a registry and licensing would require modification of Swedish telecommunications law.

8.2.5.3 Privacy concerns related to use of ENUM

The use of ENUM makes it possible to perform reverse directory lookups whereby various items of information associated with the individual user, such as e-mail address, fax number and mobile number, can be found from the E.164 number. This information could be used for spamming or assuming someone else's identity and the ability to perform reverse lookups on telephone directories has been made illegal or subject to special conditions in a number of countries.

It is also possible for users to request that their telephone numbers be withheld from public directories and likewise participation in ENUM should be based on consent being explicitly given by the individual to whom the E.164 number is assigned. Rules should also be established on the legal use of ENUM information [3].

8.2.5.4 Security aspects of using ENUM

It is essential that ENUM is operated securely such that stored information is not tampered with; that clients registering information are authorized and authenticated to do so; and that users of the information are presented with valid information.

8.2.5.5 Conclusions

The ENUM trial results that are now becoming available clearly indicate the feasibility of using ENUM for support of "IP telephony" services but as the Director-General for Telecommunications and Post in the Netherlands has stated "ENUM is one of the new developments in the ICT world which holds great promise for the users of the Internet and mobile telephony. Whether this promise will also be fulfilled depends in practice on many different factors, such as the commercial proposition, ease of use and consumer confidence."[4]

8.2.5.6 References in 8.2.5

[1] RFC 2916 "E.164 number and DNS" (P. Faltstrom, September 2000).

[2] "ENUM – en funktion i innovationsfasen – Förslag till fortsatt svenskt engagemang – Delrapport till regeringen" (PTS, 18 juli 2003).

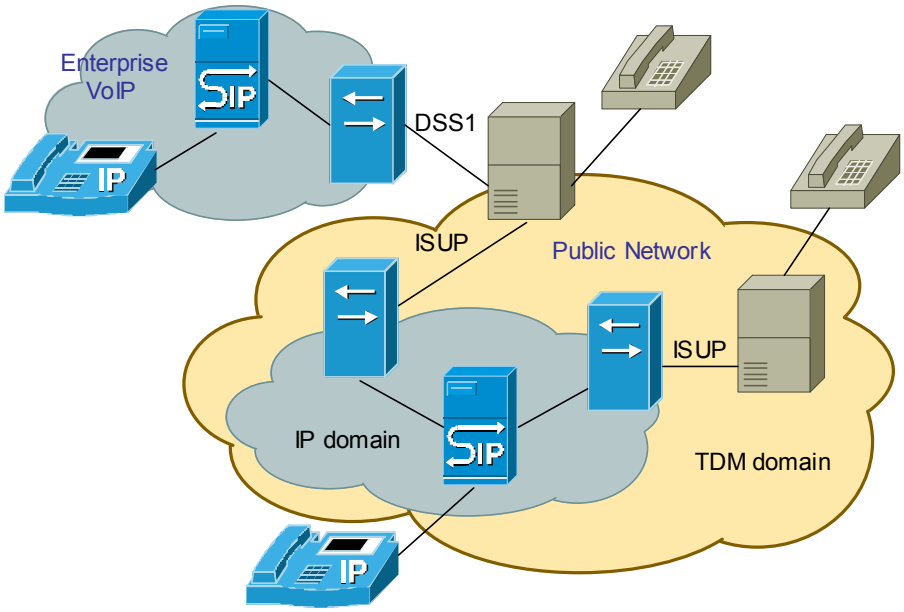
[3] Opinion 5/2000 on The Use of Public Directories for Reverse or Multi-criteria Searching Services (Reverse Directories) European Union ARTICLE 29 – DATA PROTECTION WORKING PARTY

[4] "ENUM in the Netherlands – A report by the Dutch ENUM group (NLEG)", December 2002

8.2.6 Interworking of "IP telephony" with the PSTN

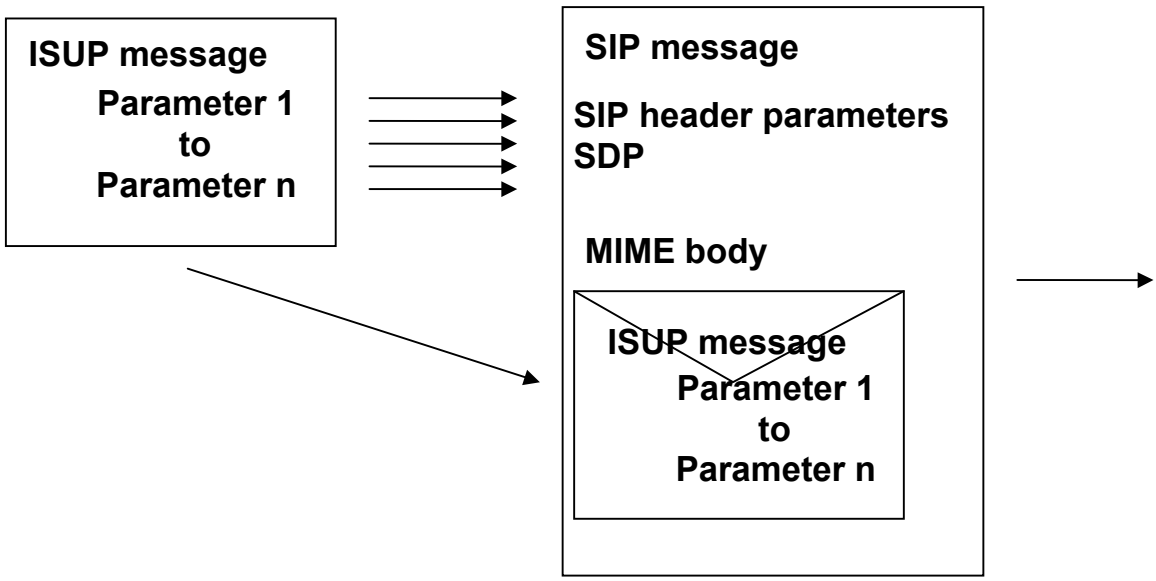
"IP telephony" systems will need to interconnect with the PSTN to allow calls to and from the large worldwide installed base of PSTN subscribers. H.323 or SIP can be used within enterprise networks for controlling multimedia communication, by public network operators to provide services directly to their customers and also by public network operators internally within their networks for controlling sessions over IP domains. These interworking scenarios are illustrated in Figure 7.

Figure 7 – VoIP – PSTN interworking scenarios



VoIP enterprise networks can connect to public networks using TDM connections and an access protocol such as DSS1 (specified in ITU-T Recommendation Q.931). Network operators will need to support interworking between the ISUP (ISDN User Part) protocol and the VoIP session control protocol. Information needs to be mapped between the VoIP session control protocol and the narrowband signalling protocol. As VoIP protocols do not support all PSTN/ISDN services it is sometimes useful to transfer the original narrowband signalling information, either in the form of complete messages or specific parameters. For example, complete ISUP messages can be encapsulated in SIP using the IETF SIP-T or ITU-T SIP-I mechanisms (see Figure 8) or specific parameters can be encapsulated by using the more flexible NSS (Narrowband Signalling Syntax) mechanism that has been developed by ITU-T SG 11. Annexes M1, M2 and M3 of ITU-T Recommendation H.323 describe the tunnelling of the QSIG, ISUP and DSS1 protocols, respectively, in H.323 systems.

Figure 8 – ISUP to SIP mapping and message encapsulation



The general procedure for interworking ISUP and SIP is as follows:

- Map ISUP parameters to SIP headers and SDP; and
- If no encapsulation of narrowband signalling information:
  - Narrowband services which are not supported in SIP must be terminated at interworking point which may result in deletion of information or clearing of the call – the interworking unit acts as a destination local exchange.
- If encapsulation of narrowband signalling information:
  - Narrowband service information for those services which are not supported in SIP must be transferred through the interworking point – the interworking unit acts as transit exchange and this implies that node receiving this information "understands" ISUP; and
  - Encapsulate ISUP within SIP message (i.e. encode as MIME – Multipart Internet Mail Extensions – body part).

The IETF has produced two RFCs that describe the use of SIP for supporting telephony (BCP 63 RFC 3372 – Session Initiation Protocol for Telephones (SIP-T): Context and Architectures) and the mapping of information between the SIP and ISUP protocols (RFC 3398 – Integrated Services Digital Network (ISDN) User Part (ISUP) to Session Initiation Protocol (SIP) Mapping). ITU-T has produced Recommendation Q.1912.5 which describes the interworking of SIP with the ISUP and BICC (Bearer Independent Call Control) protocols. Both IETF and ITU-T specifications describe the mapping of information between ISUP and SIP, although at different levels of detail, and the encapsulation of ISUP messages. ISUP messages are encapsulated by default according to the IETF SIP-T specification whereas Q.1912.5 specifies three interworking profiles of which only one, referred to as SIP-I (SIP with encapsulated ISUP), supports ISUP encapsulation.

The ITU-T Q.1912.5 specification was developed after the IETF had prepared SIP-T and has taken account of a number of SIP extensions, in particular RFC 3312 *Integration of Resource Management and Session Initiation Protocol (SIP)* and RFC 3325 *Private Extensions to the Session Initiation Protocol (SIP) for Asserted Identity within Trusted Networks*, that have been agreed since the time of writing RFCs 3372 and 3398. This results in the possibility of mapping more information from ISUP parameters into SIP headers. Q.1912.5 also includes a specification of SIP overlap sending procedures, the handling of some ISDN supplementary services, mapping of SDP to ISUP parameters and support of SDP offer-answer.

More flexibility is provided by the NSS (Narrowband Signalling Syntax) mechanism specified in ITU-T Recommendation Q.1980.1 that allows the transfer of a subset of ISUP parameters that are required to support certain applications, within SIP rather than complete ISUP messages.

8.3 Economic Challenges

According to the replies of the administrations that participated in the questionnaire, the economic challenges posed by the implementation of IP telephony are manifold and include:

- assessing the economic impact of allowing IP telephony, and the likely competition to come along with it, on the revenue streams of national operators;
- the need to find alternatives to tariff rebalancing and universal service obligations;
- the need to find alternatives to stimulate investment and competition;
- defining the interconnection costs between incumbents and IP telephony operators; and
- developing market strategies to best benefit from the IP telephony business opportunities.

The economic challenges presented above are derived from an unstoppable process in which the limits between different services and technologies are not as well defined as in the past, and the technology and service convergence empires. Additionally, the above concerns are related to the fact that telecommunication companies in developing countries may not have the abilities to compete in reasonable terms in this new telecommunication world given lack of human resources, scarce financial resources, need to comply with universal service obligations, the existence of a restricted regulatory environment, etc.

Thus, with regard to the assessment of the economic impact of allowing IP telephony, and the likely competition to come along with it on the revenue streams of national operators, the need to find alternatives to tariff rebalancing and universal service, to define interconnection costs, to evaluate whether or not IP telephony will have an impact on current universal service programmes or is able to help those programmes, these issues are not new and were presented by ITU in "The Essential Report on IP telephony"[9].

Considering the issue of the development of market strategies to best benefit from the IP telephony business opportunities and the need to find alternatives to stimulate investment and competition, administrations will have to consider the different business models available to companies in order to make money out the IP telephony business and the best way to regulate the market so that the barriers to entrepreneurs and incumbents are leveraged to the benefit of the entire nation, telecommunication industry and citizens.

Approaches on how to deal with the economic challenges are given in the pertinent section of this document.

---

[9] For further information: http://www.itu.int/ITU-D/e-strategy/publications-articles/pdf/IP-tel_report.pdf

8.4 Regulatory Challenges

In the analysis of the questionnaire, a great number of regulatory challenges were raised by administrations. Similarly to the economic challenges, the main regulatory concerns have resulted from the transition from the period in which the border between different services and technologies were well defined, and the present time in which the world has definitely entered the digital era that brings along the technology and service convergence.

In this sense, when an administration informs the need to examine the structure of the national telecommunication industry, particularly for telephony, analysing the impact of IP telephony in the current telephony regulatory framework, this process should be taken not as a result from the implementation of IP telephony but rather from the convergence era.

Thus, to decide what kind of regulatory framework should be put in place, analysing issues like: licence restrictions, enforcement, define IP telephony, regulatory distinctions from PSTN to IP telephony, IP telephony definition, interconnection charges for both incumbents and new entrants, quality of service, numbering and addressing, etc., administrations should consider the convergence era and not specifically IP telephony.

Additionally, the existing format of Universal Service Obligations may not fit in this new world, resulting in the concern about whether or not IP telephony will have an impact on current universal services programmes or is able to help those programmes.

All these concerns may be a stimulus to administrations to consider a review of the existing laws, regulations and contracts in order to create a regulatory framework capable of increasing the benefits of convergence, broadband and IP telephony to the nation and its citizens, current telephone operators, ISPs and new entrants, promoting an environment for innovation, healthy competition and investment.

Regarding this convergence, there will also be a need to develop human resources in order to cope with the new technologies made available by convergence, including IP telephony, for bridging the digital divide.

Further information on approaches to overcome the regulatory challenges is presented in the applicable section of this report.

9 POLICIES TO BEST BENEFIT FROM IP TELEPHONY TECHNOLOGIES

Based on the questionnaire, administrations have indicated the different policies they follow in implementing IP telephony and broadband technologies. Similarly to what has been observed by previous ITU efforts in the matter, in terms of policies to implement IP telephony, the situation is:

- Some countries are including some or all forms of IP telephony within their regulatory system;
- Some countries are prohibiting the implementation of IP telephony;
- Some countries have decided not to regulate IP telephony; and
- Some countries have not yet formally addressed the issue.

In the discussion on which of the above policies should be followed by a particular administration to best benefit from IP telephony, a number of general points to be taken into account in the policies were presented by the administrations, such as:

– the importance of providing IP telephony under competitive market conditions in which multiple, alternative sources or means are available to address user and industry needs;

– the financial implications of IP telephony for incumbent operators whose revenues may suffer from competition by companies that offer lower-priced IP telephony;

– the definition on whether IP telephony should be regarded as a new technology that is functionally equivalent to legacy PSTN services and should be subject to the same regulations, or whether IP telephony requires a new set of regulations, if any;

– the possibility of IP telephony undermining existing universal service programmes;

– the role of IP telephony as a means to offer and encourage new and cheaper services;

– the need to review interconnection regulations and tariff re-balancing;

– the creation of a level-playing field for competitors and new entrants;

– the rights and obligations of IP telephony providers, if any, compared with those of traditional telephony providers;

– the role of regulation in attracting capital investment so as to fund infrastructure that serves users and society as a whole and ensure universal access and service;

– the promotion of new technologies and services stimulating technology transfer and human resources development; and

– the economic growth as a whole and in particular of the communications sector.

The following table presents specific information received from administrations:

Administration	Policies to better benefit from IP telephony regulation
CAMBODIA	The measures a national telecom policy can take include **allowing IP telephony to be legally served** by Internet cafés as Public Call Offices direct to the public, allowing additionally any licensed international gateway operator to provide Voice over IP. There is a regulation established for the introduction of IP telephony.
CANADA	In Canada regulation remains **technologically neutral** and is derived from the current telephony regulatory framework. To **ensure open and fair competition among service providers**, the service providers, through the Canadian Radio Television and Telecommunication Commission, are working among themselves to **determine the appropriate interconnection arrangements**. There is no national telecommunication policy to accelerate or increase the benefits of IP telephony deployment.
COLOMBIA	The measures an administration can take is to **adapt the current regulation** having the following principles: establishment of a clear and predictable regulation to reach the objectives previously defined; covering the users needs, guaranteeing the convergence under an independent and effective regulatory body. By doing this, in the development of IP telephony, it should be considered additionally: universal service at a reasonable cost; consumer interest; tariff re-balancing; level playing field amongst the IP telephony operators; service quality, diversity and plurality; new services and technologies promotion; investment in new services and networks; incumbent operators impact, especially on their revenues streams; technology transfer; human resources development; and economic growth. There is no national telecommunication policy to accelerate or increase the benefits of IP telephony deployment.
ESTONIA	**No restrictions or limitations for IP telephony** have been established so far. However, quality of service is considered the most critical aspect. In this sense, regulation of quality of telecommunication services, including IP networks, is now in progress. No specific regulation has been established.

Administration	Policies to better benefit from IP telephony regulation
HUNGARY	**VoIP is regulated alternatively to traditional PSTN**. The statement on licensing VoIP respect the exclusive rights of voice telephone service providers and among others issues, it establishes: a) If the Voice over IP service is implemented in any segment of PSTN, the transmitting voice signals parameters shall differ from those, which characterize the traditional voice signals carrying information of public telephony service calls; b) The Voice over IP service provider shall declare in its Code of Practice that the Voice over IP is a special kind of data transmission service and shall indicate the quality parameter thereof meet the following requirements: the Voice over IP service provider shall endure a minimum of 250 msec. average delay of voice transmission between terminals; and its general conditions of contract shall not guarantee a packet loss less than 1%. There is a regulation established for the introduction of IP telephony.
INDIA	In India, the introduction of **IP telephony is regulated** and the "Guidelines for issue of Permission to offer Internet telephony service" cover aspects as: scope and definition of Internet Telephony Service, Quality of Service, Tariff/Fees, Security monitoring, Licence agreement, application form/fee for the Permission, etc. There is a regulation established for the introduction of IP telephony.[10]
KENYA	It is widely viewed that **IP telephony should be allowed and encouraged as a cost-effective means of modern communications**, by the deletion of the restrictive clause in the Internet Service Provider Licence and Internet Backbone facilities and service licence. Additionally, the commission's policy should remain to be technologically neutral and new innovative technologies that enhance value to the end users should be facilitated, in the best way possible. The incumbent operator, ISPs and new entrants, should be encouraged to follow ITU Recommendations to deploy more cost-effective networks such as IP-based networks as opposed to the less efficient circuit switched technologies. The administration currently does not have an IP telephony legal or regulatory framework
KUWAIT	The Ministry of Communications has issued a Decree **prohibiting the use of IP telephony for international calls**. Thus, given that local calls (fixed to fixed and fixed to mobile) are free of charge, IP telephony is not used in the country. The main reason for this action is that the communication revenue is mainly from international calls. Therefore, introducing IP telephony will have a big impact on that source of revenue. IP telephony is prohibited for international calls.
LITHUANIA	Lithuanian Authorities support the technologically neutral approach and consider that the same rules should apply to all the players of the same relevant market despite technologies used. IP telephony services provided and promoted as a substitute for traditional voice services with the quality and reliability of fixed telephony services are regulated as public fixed telephony services (under new general authorization rules (which came into force 17 April 2005)), and are subject for notification at the beginning of electronic communications activity.

[10] For further information, refer to Annex 2.

Administration	Policies to better benefit from IP telephony regulation
PERU	The regulation is technologically neutral and operators have the ability to decide the technology that better suits their services. In the Supreme Decree, it has been established no licence for the ISP. However, the ISP needs to make use of the telecommunication network provided by licensed telecommunication operators. There is a regulation established for the introduction of IP telephony and it is based on functional equivalence.
PERU / INICTEL	It is important to have a clear regulatory framework in which: a clear separation from PSTN and VoIP is established; the parameters and indicators for quality of service applicable for IP telephony should be defined, attaching to it the different tariffs if applicable. No specific regulation has been established.
PHILIPPINES	Competition is indispensable to lower telecommunications rate and to improve services; national telecom may deregulate IP telephony services in order for it to be treated separately from PSTN. However, deregulation can be limited to market entry and not to technical regulations which determines quality of services. No specific regulation has been established.
POLAND	The regulation approach does not include separate regulation of VoIP. No specific regulation has been established.
SINGAPORE	The regulation should be technologically neutral, objective, timely, transparent and non-discriminatory. Furthermore, there should be minimal regulatory burden on new entrants to the market. There is a regulation established for the introduction of IP telephony.
SLOVAKIA	The country approaches IP telephony under a General Authorization scheme. Thus, a licence is demanded only in case of limited resources use. There is a regulation established for the introduction of IP telephony and it is based on functional equivalence.
UGANDA	The Uganda Administration believes that a measure a national telecom policy can take in order to increase the benefits of the introduction of IP-based technologies is to remove restrictions on the use of the technology. There is a regulation established for the introduction of IP telephony.

10 APPROACHES TO OVERCOME THE IP TELEPHONY CHALLENGES

In this section, all the previous answers are considered as background information to the "Approaches to overcome the IP telephony challenges". This is assumed because apparently there is a general agreement on the benefits of implementing IP telephony and the issue seems to be the challenges of rolling out this technology.

In this sense, the table below presents the administrations that replied to the questionnaire regarding the implementation of IP telephony in developing countries and expressed their beliefs as to the best approach for establishing policy to overcome the IP telephony challenges.

The questionnaire invited respondents to agree with one of three options or describe an additional option. The three options were: "regulation should cover all the aspects related to IP telephony", "regulation should be technologically neutral and limited to Licensing, Interconnection and Competition amongst the players", and "regulation should be derived from the current framework since minor changes are needed in it in order to cover the introduction of IP telephony".

Basically, the general proposal is that there is a need to incorporate IP telephony in the regulatory framework by the adoption of a regulation technology neutral, and limited to licensing, interconnection, and competition amongst the players.

Administration	Policies and strategies to implement IP telephony
CYPRUS[11], INDIA, JAPAN, JORDAN, UGANDA[12]	The introduction of IP telephony is already regulated.
DENMARK[13], LITHUANIA[14], SPAIN, SUDAN	The introduction of IP telephony should not be regulated.
BELARUS, BHUTAN, BOTSWANA, COLOMBIA, HUNGARY, KENYA, LIECHTENSTEIN[15], POLAND, SENEGAL, TANZANIA	The introduction of IP telephony should be regulated. The regulation should be technology neutral, and limited to licensing, interconnection, and competition amongst the players.
CANADA[16], MYANMAR	The regulation should be technology neutral and limited to licensing, interconnection, competition among the players. It should be derived from the existent regulatory framework since minor changes are needed in it, in order to cover the introduction of IP telephony.
BOLIVIA, CAMBODIA[17], PERU[18] , PHILIPPINES[19]	The introduction of IP telephony should be regulated. The regulation should be derived from the existent regulatory framework since minor changes are needed in it, in order to cover the introduction of IP telephony.
BOSNIA and HERZEGOVINA, BURUNDI, COMORES[20], DJIBOUTI	The introduction of IP telephony should be regulated. The regulation should cover all aspects related to IP telephony.
ESTONIA	The Administration is making an effort to regulate voice over IP service by regulating quality of service. Regulation, if any, should be established at appropriate extent needed for protecting consumer's interest and guaranteeing telecommunication market functioning.
SINGAPORE	The review of a existent strategy towards IP telephony would include, among others, review of changing technologies, taking into consideration industry feedback, competition issues, technology neutrality and principles of the WTO Telecommunications Reference Paper including: objectiveness, timeliness, transparency and non-discrimination.

11 In Cyprus the introduction of IP telephony is already regulated but there is a need to review it in accordance to the to the new European Union Telecommunication Framework.

12 For Uganda the operators should be given liberty to select appropriate technology to apply based on commercial and technical considerations.

13 In Denmark the regulation is technologically neutral.

14 In Lithuania this is considered from the point of view of the principle of minimum necessary regulation.

15 In Liechtenstein this is considered to be in following appropriate directives from the European Union.

16 In Canada the exact level of regulation is to be determined.

17 In Cambodia the existent contracts are a particular issue on the implementation of IP telephony.

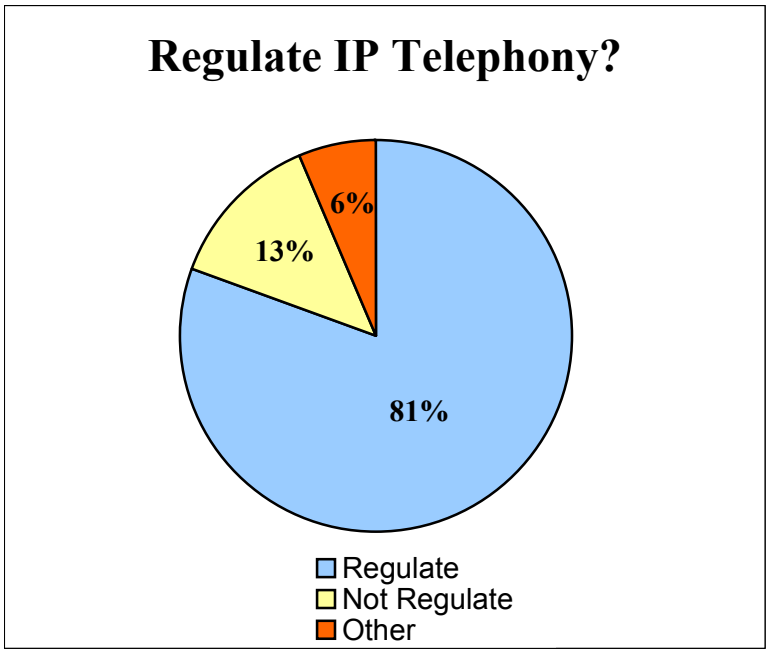
18 In Peru the adaptation in the existent regulatory framework is in place.

19 In Philippines the adaptation is related to revision in the existent telecommunication Law.

20 In Comores there still is no regulation for the implementation of IP telephony.

Considering the responses presented above, it was possible to draft the following graph, which summarizes the use of regulation as an approach to overcome the IP telephony challenges in the terms below:

Figure 9 – Graph on regulating IP telephony



It is interesting to observe that the vast majority of the administrations believe that for the implementation of IP telephony, regulation is needed. However, this conclusion has no meaning if no consideration is given to the kind of regulation administrations are considering in order to implement IP telephony.

Thus, analysing further the responses of those administrations that suggested the need for regulation, it was possible to draft a new graph related to the kind of regulation, in terms of:

– **General Terms Regulation**, i.e., the IP telephony regulation should be technology neutral, and limited to licensing, interconnection, and competition amongst the players;

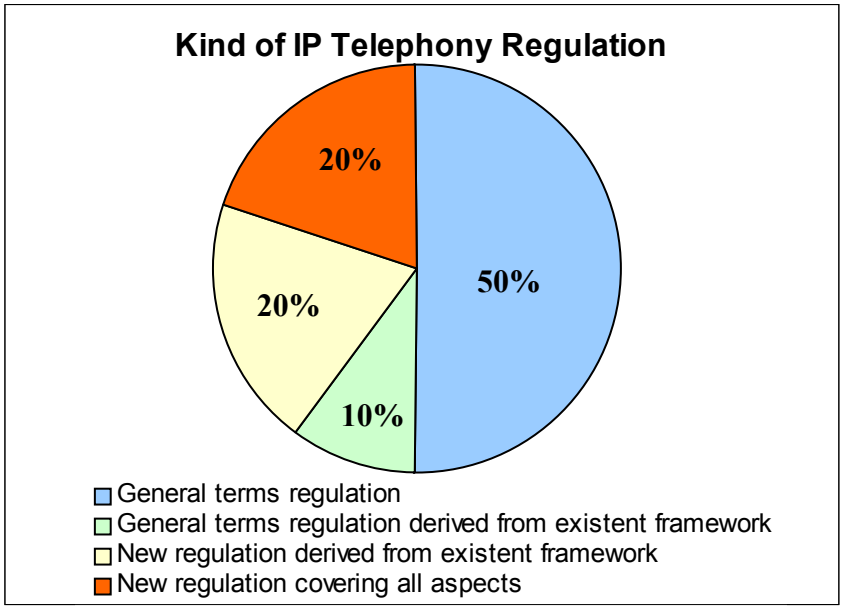
– **General Terms Regulation derived from the existent framework**, i.e, the IP telephony regulation should be technology neutral, and limited to licensing, interconnection, and competition amongst the players, and resulted from a adaptation in the existent framework;

– **New regulation derived from the existent framework**, i.e, the IP telephony regulation should be entirely new but derived from the existent framework and the details are not defined; and

New regulation covering all aspects, i.e, the IP telephony regulation should be entirely new and covering any details of IP telephony.

The graph below presents the summary:

Figure 10 – Graph on kind of IP telephony regulation



The majority of the administrations (60%, which includes the administrations advocating General Terms Regulation and those suggesting General Terms Regulation derived from existent framework) participating in the questionnaire suggested that IP telephony regulation should be established having focus on technology neutrality and limited to licensing, interconnection, and competition amongst the players.

Thus, in the next sections are discussed further the way to overcome the technical, economic and regulatory challenges of IP telephony, considering that a regulation was appointed by the administration as the way to overcome IP telephony challenges, particularly the technologically neutral regulation limited to licensing, interconnection and competition amongst players.

The Rapporteur's Group, however, advises administrations to not take this as a general rule since any decision on the way to implement IP telephony should be taken considering their particular national needs. Additionally, the Rapporteur's Group notes that in some administrations with a more dynamic market, IP telephony implementation free from any regulation burden may result in the promotion of innovation, competition and new services to the market.

10.1 Approaches to overcome the technical IP telephony challenges

As of the result of the questionnaire submitted to the administration, the following technical IP telephony challenges were identified:

– Access technologies

– Quality of Service

– Security and legal intercept

– ENUM and numbering

– Interworking of "IP telephony" with the PSTN

Concerning the development of Access Technologies, administrations will have to decide on what kind of broadband access technologies they require for their particular needs. In this sense the findings from Question 20/2 might be of interest.[21]

Concerning the remaining technical IP telephony challenges, there were few contributions for these points. In this sense, the Rapporteur's Group could not go into detail about those. However, as a matter of information distribution, a recent report prepared by Analysis on Internet Protocol (IP) voice associated convergent services for the DG Infosoc, European Commission (EC), covered those technical IP telephony challenges and might be of interest to administrations.[22]

Finally, as discussed in the report, IP telephony offers a vast range of opportunities from new services to potential economic benefits. However, for all this to happen, human resources development will play a major role in the process. Therefore, in order to overcome the technical IP telephony challenges, the first skill needed will be technology knowledge. This may result in initial costs for the administration; however, in the long term it is the only way to have a consistent policy for any technical IP telephony challenge. ITU is helping in this and many activities have been conducted in this regard (for further details, please refer to the following website: http://www.itu.int/ITU-D/e-strategy/publications-articles/pdf/IP-tel_report.pdf

10.2 Approaches to overcome the IP telephony economic challenges

In order to deal with the economic impact, administrations may start the analyses in terms of an assessment on whether or not the so-called savings opportunities derived from the IP telephony implementation are real or merely a result of avoidance of telephony access charges and settlement costs.

In this consideration, a comparison on the cost structure between circuit-switched network and IP telephony network would help to address additionally the potential cost savings an incumbent or a new entrant may gain by implementing IP telephony.

Then, administrations may consider that for new entrants the main economic problem could be the lack of investment capital and a clear regulatory framework, while for the incumbent operator the obstacle would be the capital invested in the legacy networks in the past few years and the possible decrease in revenues resulting from a loss of market share to competitors.

Also, the implementation of IP telephony brings impacts in terms of costing and pricing, traffic rebalancing, billing, international settlement rates and interconnection; these issues were analysed by ITU in "The Essential Report on IP telephony"[23] and there was no evidence in this work to modify that analysis.

Also, administrations need to consider that IP telephony implementation along with broadband networks allow companies to establish several business plans with different services/value-added services and reach different markets segments, which may allow them to profit from establishing broadband networks and IP telephony even in regions where in the past the service was not profitable, becoming more attractive to users and differentiated from competitors and, perhaps, more attractive to potential investors.

Related to business plans a recent report presented for the European Commission[24] brings light to the discussion by categorising IP telephony business plans in:

– self-provided consumer;
– independent of Internet access;
– provided by broadband access service provider;
– corporate internal use on business LAN/WAN; and
– carrier internal use.

---

21 For further information: http://www.itu.int/ITU-D/study_groups/SGP_2002-2006/SG2/index.html

22 For further information: http://www.analysys.com/pdfs/EC_VoIP_Report.pdf

23 For further information: http://www.itu.int/ITU-D/e-strategy/publications-articles/pdf/IP-tel_report.pdf

24 For further information: http://www.analysys.com/pdfs/EC_VoIP_Report.pdf

The self-provided consumer is the model in which there is no service provider. The user, by making use of an IP connection and a VoIP enabled device, can connect to other users with similar equipment, over the public Internet, and for free. This is the case of skype.

Independent of Internet access is the model in which the users are subscribers to an IP telephony company, independent of an ISP, which uses a gateway to connect to the PSTN. This may be the case of new entrants.

The IP telephony model "provided by broadband access service provider" is the case in which the user subscribes to an IP telephony company, also the ISP, which uses a gateway to connect to the PSTN and has broadband access networks. This may be the case of cable network companies.

Moving to the "corporate internal use on business LAN/WAN", this is the case of connecting larger companies' offices, in which the business uses their IP-enabled private branch exchanges (PBXs) to provide in-house telephony on their LAN and WAN.

Finally, the "carrier internal use" model refers to the ability of international fixed operators to use IP for their traffic in order to benefit from the less restricted environment of IP telephony.

Thus, in order to assess the economic impact on their markets, administrations need to consider which is the business plan best placed for their market and even internationally.

10.3 Approaches to overcome the IP telephony regulatory challenges

In the analysis of the questionnaire, a great number of regulatory challenges were raised by administrations. The main concerns are:

– examining the structure of the national telecommunication industry, particularly for telephony, while analysing the impact of IP telephony in the current telephony regulatory framework;

– deciding on what kind of regulatory framework should be put in place, while analysing issues like: licence restrictions, regulatory distinctions from PSTN to IP telephony, IP telephony definition, interconnection charges for both incumbents and new entrants, quality of service, numbering and addressing, review the existing law and contracts, etc.;

– evaluating on whether or not IP telephony will have an impact in the current universal services programmes or are able to help those programmes;

– enforcing the local regulations, avoiding, if it was the case, the illegal operation of IP telephony;

Concerning the examination of the structure of the national telecommunication industry and the impact of IP telephony in the current telephony regulatory framework (including USO), the decision on what kind of regulatory framework should be put in place, these issues were discussed by ITU in "The Essential Report on IP Telephony"[25].

Regarding the regulatory regime for IP telephony, the vast majority of the administrations consulted presented their view that IP telephony should be regulated. However, the kind of regulation chosen, for the vast majority of administrations, was the technologically neutral kind and limited to licensing, interconnection and competition amongst players.

Thus, it is up to each administration to deal with "definition, interconnection charges for both incumbents and new entrants, quality of service, numbering and addressing, licence restrictions, etc." within the regulatory framework to address not only the implementation of IP telephony but also the entire convergence phenomenon.

Looking at the need to find the best way to enforce the local regulations, this point was discussed in Question 18/1 and further information can be found in the pertinent report[26].

---

25 For further information: http://www.itu.int/ITU-D/e-strategy/publications-articles/pdf/IP-tel_report.pdf

26 For further information: http://www.itu.int/ITU-D/study_groups/SGP_2002-2006/SG1/index.html

11 CASE STUDIES

Additionally to what has been presented above and considering the need of sharing the experiences of developing countries in implementing IP telephony amongst the Members of ITU, administrations have been asked to present their case studies on the introduction of IP telephony.

11.1 Bhutan

This section is based on information given by Bhutan Administration concerning rural communications [1].

11.1.1 Background

Bhutan is a land-locked country of about 38 500 square kilometers bordered by Tibet and India in the heart of the Himalayan range. The rural population comprises 79% of the total population of about 650 000. The national teledensity is low at about 3.38 per 100 inhabitants and is even lower in the rural areas at about 0.01% [2].

Bhutan Telecom is a public state-owned corporation with 600 employees and is the sole provider of telecommunications services in the country. It offers domestic and international telephony, Internet, fax, pay phone, telex, leased line services and HF communications in rural areas. The network is totally digital with a satellite earth station for international calls and VSAT network for back-up. The backbone of the network is provided by 34 Mbits/s digital microwave radio links.

There are no regulations in Bhutan on the use of either the 2.4 GHz band or of IP telephony and Bhutan Telecom has no exclusive monopoly rights to operate its Internet service, Druknet. The telecommunications sector is regulated by the Bhutan Telecommunications Authority and the Division of Information Technology has been established to promote the development of IT in Bhutan.

11.1.2 Rural communication challenges

Bhutan Telecom has a universal service obligation and needs a cost-effective solution for providing rural telecommunication services. Challenges are presented by the mountainous terrain. There is often no line of sight over long distances and villages are often hidden in valleys. In addition there is a lack of infrastructure including unreliable or complete lack of electricity supply.

Wireless was a preferred technology for the pilot project due to the difficult terrain. The solution also needed to be inexpensive; consume as little power as possible; be simple, small, modular and scalable; and have a long life cycle. It was also important that the equipment could be managed remotely and that it could interoperate with the PSTN and other suppliers' equipment.

The solution chosen was based on IP technology, as this allows for the provision of voice and data services over one network, and IEEE 802.11b as it meets many of the requirements mentioned above.

There were concerns about using a non-proven solution and also a number of questions regarding the choice of technology, such as whether SIP or H.323 should be used for call control. It was recognized that the pace of technological change could quickly make equipment obsolete and that the "off-the-shelf" equipment selected might not be sufficiently rugged for the challenging environmental conditions. It was also questioned whether voice quality might be overly degraded. Future bandwidth constriction, telephone numbering and billing were other concerns raised.

11.1.3 The pilot project

The pilot project consisted of the implementation of two networks in different areas of the country (Limukha and Gelephu) covering 84 households in 14 villages. Preference was given to basic health units, schools and municipal offices. The project aimed to establish whether a wireless IP network is appropriate for the last mile delivery of universal service by assessing the technical and operational merits of such a solution. The reliability of available equipment, ease of installation and testing, degree of system flexibility and capacity, performance (e.g. in terms of delay), battery backup power system reliability and efficiency were all to be assessed. In addition, the pilot project aimed to determine whether the bandwidth that could be provided would be adequate for rural calling patterns with the final objective of determining if customers would receive a good quality service.

The total investment for the entire pilot project was USD 300 000. This included an entire packet billing system, a network management system, radio and core equipment, power supply (solar panels, batteries and chargers), transport and freight, civil structures, installation and installation materials. The Limukha network provided services to 44 households in 6 villages and the Gelephu network covered 40 households in 8 villages. The cost per line, based on these 84 customers was USD 3570. This metric, though useful, is sometimes misinterpreted. For instance, if the 4-port gateways were replaced by 8-port gateways, increasing the number of customers to 120 instead of 84, at an additional cost of USD 3600, the cost be line drops by 30% to USD 2530. In addition, the core equipment, which accounts for more than two thirds of the costs, is capable of handling many more customers. In particular:

- The gatekeeper used can process 52 call attempts per second, which under standard calculations equates to 5000 ports.
- The billing server can process 500 000 minutes per month and is currently processing about 40 000 minutes per month.
- Similarly, the E1 gateway, once fully equipped can handle 4 E1s, whereas currently half an E1 is occupied.

Hence, incremental cost per line to at least 1000 customers will be much lower.

11.1.4 Comments

This pilot project indicated the viability of using wireless and IP technology to provide telecommunications services to rural populations under difficult environmental conditions.

Voice quality was judged to be similar to that of mobile phone calls. The 2 Mbit/s provided amble bandwidth for the number of calls that were processed and dimensioning was straightforward since there was no Internet usage. The round-trip time was surprisingly low even for 3 hops one-way. Quality would drop in bad weather but to not to an unacceptable level.

Currently, the revenue generated from the two networks is approximately USD 2000 per month (compared to USD 1000 per month that was initially generated) including revenue from prepaid "scratch" calling card business introduced in November 2002. It is interesting to note that the monthly spending of a "rural customer" is as much as that of an "urban customer". This is also due to the fact that the phones were provided to relatively wealthy farmers but at least it shows that reliable potential customers do exist in rural areas. The payback period for the current total investment is approximately 12 years (it was initially projected to 20 years) and will keep on improving as the additional cost per line is substantially lower than the initial investment.

A number of issues were identified. For example, CPE power consumption was too great and should be reduced in the future. It was also noted that a stable and regularized power supply is needed; that it is essential to ground equipment; and that core equipment should be redundant. Other issues identified were those of possible spectrum interference and the importance of staff training.

Concerns were also expressed about the excessive number of licence fees associated with the deployment of such a system, for example related to call processing, network management and billing minutes.

The project manager concluded that "the cost effectiveness, reasonable quality, fast and easy installation, extreme flexibility and scalability make [such a solution] a likely candidate for rural communications."

11.1.5 References to 11.1

[1] Bhutan – A case study on the use of Wi-Fi and VoIP for rural communications,
Tensin C. Tobgyl, http://www.itu.int/ITU-D/pdf/B406011-1_093A1-en.pdf
Document RGQ19/1/010 from Mr Kezang Kezang:
http://www.itu.int/ITU-D/webdocuments/list_new.asp?question=Q19/1&lang=en&period=2002

[2] Information and Communications Technology (ICT) for Bhutan White Paper "An inclusive information and communications for all Bhutanese, Dzongkhags and Geogs by 2007"
15 August 2003 http://www.bta.gov.bt/bta/BhutanICT_WhitePaper2003-07.htm

11.2 Indonesia

11.2.1 Overview of the project's targets and objectives

The Internet is becoming an increasingly vital tool in Indonesian information society. More and more Indonesians are going to conduct such day-to-day activities as education, business transactions, personal correspondence, research and information gathering and job searches. Each year, being digitally connected becomes ever more critical to economic and educational advancement and community participation. Now that a "piece" number of Indonesians regularly use the Internet to conduct daily activities, people who lack access tools are at a growing disadvantage.

Unfortunately, Indonesia – as other developing countries with a majority population living in rural areas – has been facing problems to explore the technology. The problems are: information technology infrastructure availability in rural areas is still limited, community knowledge relatively low and community economics also very low. It means that developing countries should find a solution to apply the technology in the rural areas so that rural communities can explore the technology optimally.

Given such conditions, DivRisTI (R&D Division TELKOM), as information technology researcher in Indonesia, is trying to set up a concept based on field trial of the information technology implementation for the rural community of Indonesia in Tarakan (Kalimantan). We call this product VOICE INTERNET. Voice Internet promises to bring the information age to the often impoverished and scattered rural population of all the developing countries. This product combines existing technologies to create an interactive device that offers Internet features – e-mail retrieval based on voice – through what is essentially a network and a voice processing server. The Voice Internet system interfaces with the Internet through a software application specifically developed to transform text into digital speech. It converts text from the Internet into digitized speech, which will then be transmitted to users through a terminal similar to a regular payphone.

The name of Tarakan comes from the Tidung language formed by two words: Ngakan means "eat" and Tarak means "meet". It tries to tell us that long ago Tarakan island was used as a meeting place by the Tidung ethnic group who live as fishermen. Tarakan City, which was known as the city of oil in the past, has only one subdistrict, Tarakan.

Based on government regulation No. 47 1981, the status of the Tarakan subdistrict was developed as an administrative city, authenticated by the Minister of Home Affairs on March 23rd 1982, which became the date of the birthday of the Administrative City of Tarakan. This City has a motto called "Mantap", abbreviation of: Nyaman (Comfort), Tertib (Order), Aman (Secure), Permai (Beautiful). The administrative city of Tarakan has now split into two subdistricts: they are West Tarakan Subdistrict and East Tarakan Subdistrict.

11.2.2 Geography

Size of Tarakan Island: 241.5 km² with about 100 000 people. Tarakan Island is located to the north side of Samarinda, on the east coastal area of Bulungan Regency, between 3° 19′ and 3° 20′ North Latitude and 117° 34′ and 117° 38′ East Longitude.

North: Bordering with the coastal area of Sembakung Subdistrict and Bunyu Subdistrict.

South: Bordering with the coastal area of Tanjung Palas Subdistrict;

West: Bordering with the coastal area of Bunyu Island;

East: Bordering with the Sulawesi Sea.

The objectives of the project are summarized below:

a) Provide education for rural people to access Internet by voice

b) Provide simplicity in order to obtain such information based on voice in retrieval mode and/or interactive mode; hence the rural community can be stimulated to be more advanced.

c) Provide information for rural areas.

11.2.3 Infrastructure and regulatory environment

This project requires the infrastructure of local exchange and connection to Internet. This matter is required for the connection to peripheral voice Internet.

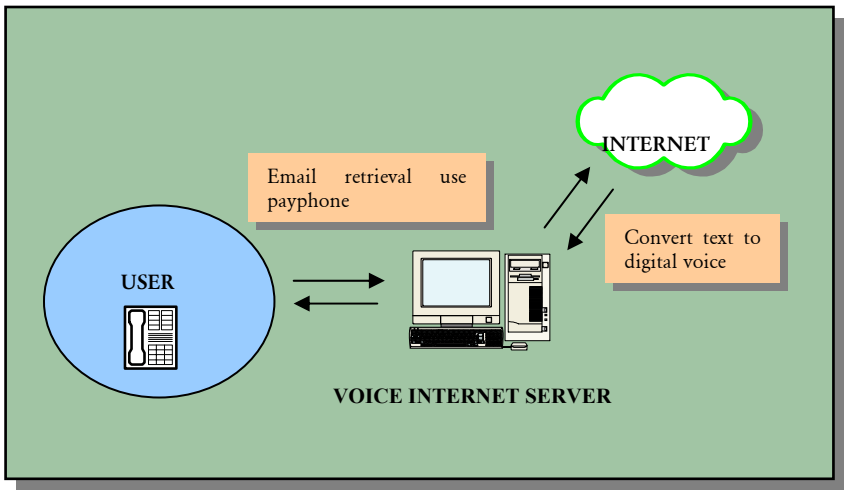
11.2.4 Technical description of the project

Voice Internet is developed from Desa Maju services and it is integrated between Internet and PSTN (Public Switch Telephone Network), that's used to provide Internet service applications such as speech browser, speech mail, and hyperlink Desa Maju server to others based on voice. This technology can be a substitute for Internet services for rural areas because rural areas have low economic levels and little knowledge of browsing Internet.

11.2.4.1 Network Aspect

The Voice Internet configuration has two components i.e. Voice Internet server and Search Engine, with each server connected one to another using PSTN (circuit switch base) or IP Network (packet switch base). Function of Voice Internet server is to download any information from Internet sites and convert to digital voice using Indonesian text-to-speech software. So the user can retrieve information from the Voice Internet server by payphone based on voice.

Figure 11 – Configuration of Voice Internet



11.2.4.2 Technical description of the services provided

Service Application Aspect

Service applications from Voice Internet system are speech browser and speech mail.

Speech Browser

The speech browser is a service to allow the user to access Internet sites without a personal computer.

The speech browser works as follows: Voice Internet server downloads any information from Internet sites and converts to digital voice using Indonesian text-to-speech software. So the user can retrieve those Internet sites from the Voice Internet server by payphone without a personal computer based on voice.

Speech Mail

Similar to the speech browser, speech mail is a service to allow the user to access his/her e-mail account without a personal computer. If there are some e-mails, the server will give notification to the user.

Speech mail works as follows: the Voice Internet server converts e-mail to digital voice using Indonesian text-to-speech software. So the user can retrieve e-mail from the Voice Internet server by payphone without a personal computer based on voice. Each user has an e-mail inbox on the Voice Internet server to store his/her e-mail.

This service consists of three software components i.e.:

1) Retrieve e-mail software → the function of this software is to retrieve the e-mail of each user from Internet or intranet.

2) Indonesian text-to-speech software → that converts text to digital voice.

3) VPS script to handle connection between the user and Voice Internet server.

11.2.4.3 Effectiveness and sustainability of the project

This service gives the possibility to the user to consult the e-mail and certain Internet websites accessible by using voice Internet. This service represents a complement to accessing the Internet in addition to accessing conventional Internet (using a PC).

11.2.4.4 Social and human development impacts

Because this service represents a complement to accessing Internet in addition to accessing to Internet through a PC, this service gives the user the facility to access e-mail and the Internet through payphone.

11.2.4.5 Other observations

The results of the project will benefit various people in rural areas. Some people think that to access Internet in Indonesia is expensive, especially in rural areas. With this project, they do not need to buy a personal computer, but simply call the Voice Internet server by phone, because the text on the Internet can be converted to voice, and the information gap between urban areas and rural areas can be bridged.

12 CONCLUSIONS

Given what has been presented above, it is again clear that the administration members of ITU are taking different approaches in implementing IP telephony. This might suggest that there is no magical clue on the way to implement IP telephony, and the administrations need to carefully address the issue and the national context in order to make a better policy and strategic decision.

However, it also appeared that most of the administrations are implementing, or wish to, IP telephony in a regulated environment characterized by a technologically neutral regulation, limited to licensing, interconnection and competition amongst players.

It was also possible to observe that most of the previous issues related to the implementation of IP telephony (such as: numbering, licensing, service definition, tariff rebalancing, competition, universal service obligations, etc.) are still concerns to developing countries.

Considering the previous issues, the analysis presented in the past by the Group of Experts in the "Report by the Group of Experts on Internet Protocol (IP) telephony/ITU-D" seems to be still accurate since there was no new information available on the previous analysis. In this sense, that report should be kept for reference to developing countries implementing IP telephony.

Additionally to that, it seems that most of the concerns related to the implementation of IP telephony are also related to the phenomenon of the technological/service convergence. This is because service/technology convergence has made the frontiers between telecommunication services smaller and made it easier for operators to deploy new services (such as IP telephony) on the same network.

Given this, the major issue for developing countries is to adapt their regulatory framework to the current telecommunication environment, characterized by the service/technology convergence. This may be even more difficult for some developing countries that have just carried out regulatory reform and who again need to adapt their legislation, regulation and contracts.

However, once the changes are adequately made in the administrations, a world of opportunities opens up to developing countries. The opportunities can be seen from two different perspectives: internal and external.

From the internal perspective, developing countries can use the implementation of IP telephony as an alternative to delivering telecommunication services in areas of low population density targeted by Universal Service Obligations (USO), such as the projects carried out in Bhutan and Indonesia. As seen in those projects, the population involved received access to new and innovative services which served to reduce the telecommunication/digital divide.

A great conclusion of this question is that the combination of new technologies with IP telephony allows services to be delivered to the population. In this consideration, the Bhutan project, which combines IP telephony and RLAN systems, was revealing. Additionally, this is increasingly important since it is in line with the project "The Wireless Internet Opportunity for Developing Countries" from the United Nations ICT Task Force.[27]

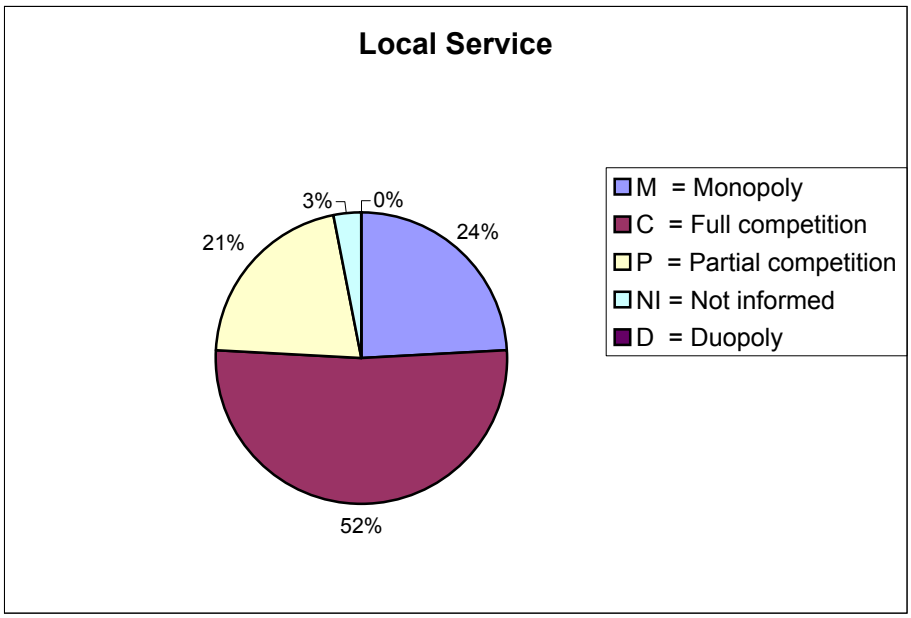
In relation to the external perspective, considering the fact that convergence and IP telephony lower the barrier to market entry and the need of developing countries to attract investment capital, the report presented the analysis of administrations participating in the survey in terms of market competitiveness and regulatory framework. Considering this analysis, the external perspective derived from the implementation of IP telephony is that of opportunities for telecommunication companies in developing countries to partner with foreign companies to deliver services in external markets since there are many markets in which local, regional and international telephony services are provided in a competitive environment. This could certainly make the local company stronger internally and able to face the external competition.

Finally, the implementation of IP telephony may bring a lot of challenges for developing countries but it also brings a lot of opportunities. Certainly, the decision on its implementation is not an easy task, particularly for developing countries that may lack financial resources. However, in the context of technology/service convergence, in which IP telephony was born, the speed of change is high and the sooner an administration starts to get involved in this new telecommunication world, the sooner it will be ready for it!

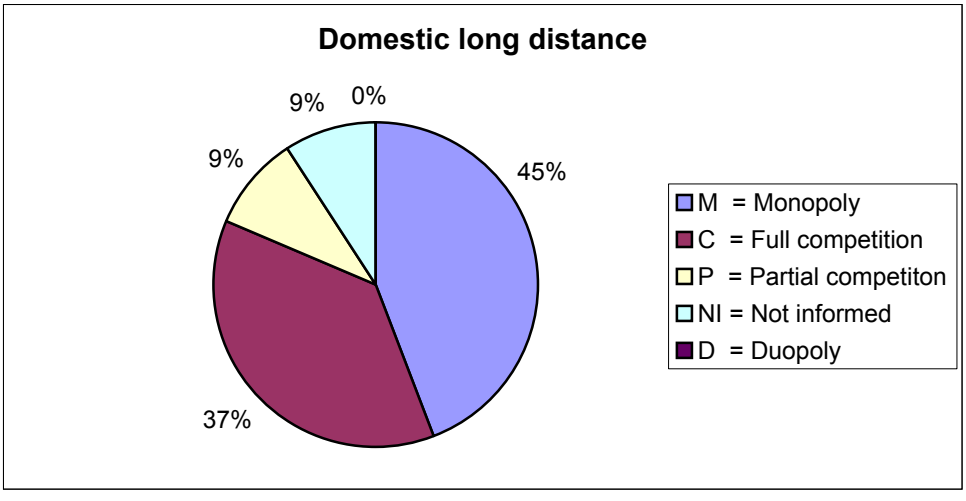
[27] For more information: www.w2i.org/

ANNEX 1

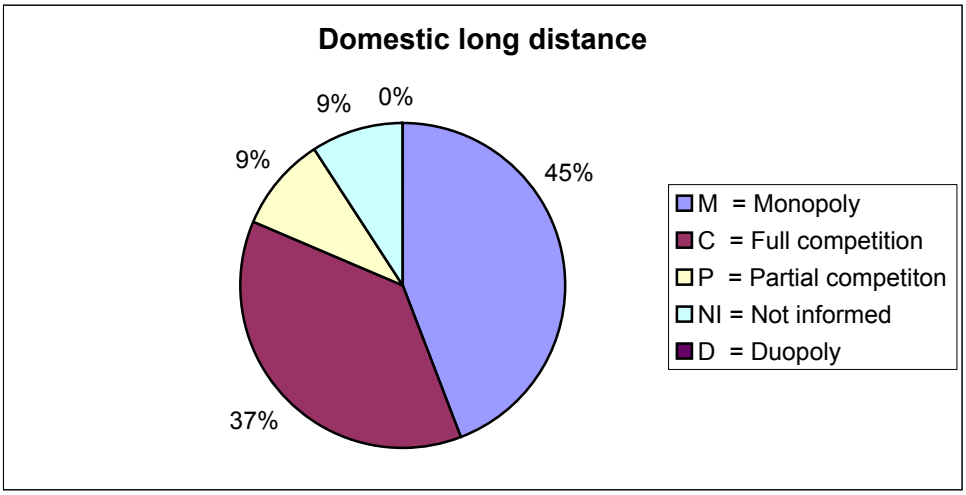
Market Competitiveness



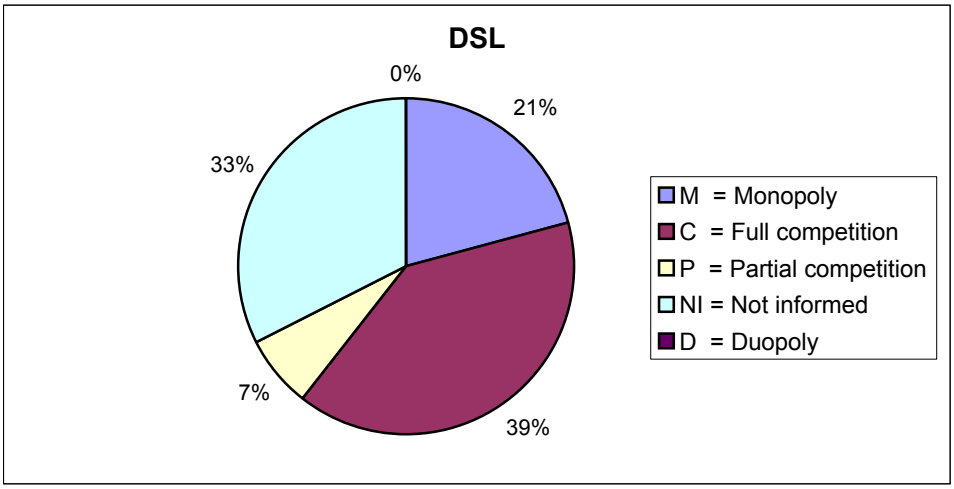
The majority of the administrations participating in the present analysis have the local service either in full competition (52%) or in partial competition (21%) and only a part (24%) has the market still on a monopoly basis. Considering this distribution, IP telephony has a great market in which it can be used to deliver local telephony in the full competition environments. Administrations, regulatory agencies and telecommunication operators worldwide may consider this fact in the future investments/developments on IP telephony since this technology offers lower barriers to market entry and allows easy access to new markets. Additionally, manufacturers could direct products to this area as well.



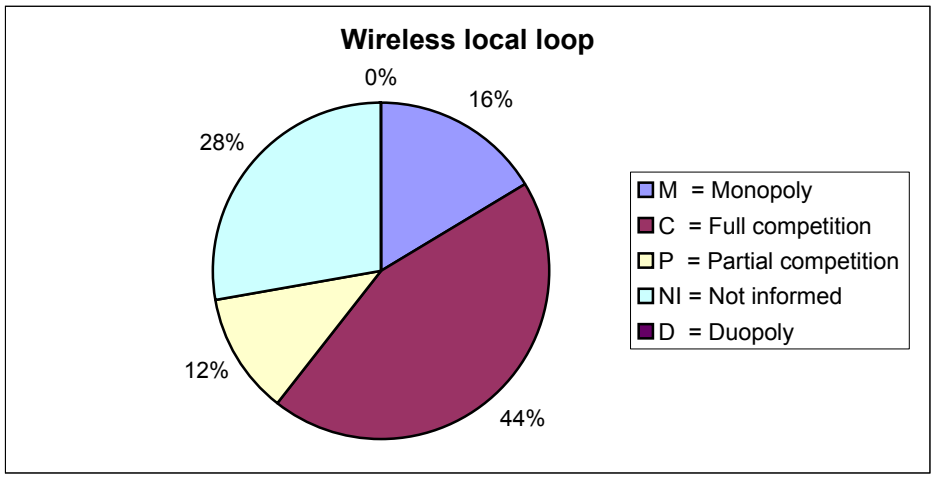
Concerning domestic long distance service, the situation is substantially different and more than half of the administrations still have that service either under a monopoly (45%) or in partial competition (9%). However, that service is provided on a competitive basis in a substantial number of administrations. Considering this distribution, IP telephony has a great market in which it can be used to deliver domestic long distance telephony in the full competition/partial competition environment. Administrations, their regulatory agencies and telecommunication operators worldwide may consider this fact in future investments/developments on IP telephony since this technology offers lower barriers to market entry and allows an easy access to new markets. Additionally, manufacturers could direct products to this area as well.



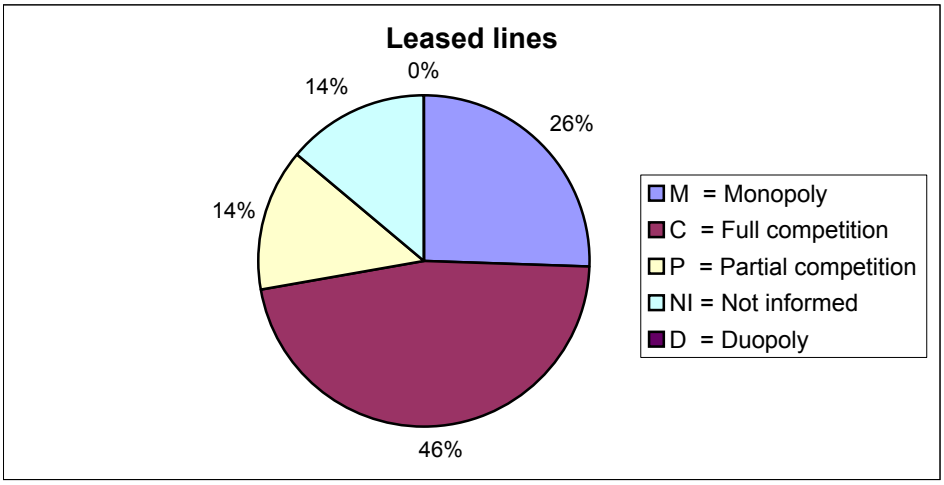
The situation in International Long Distance is similar to that observed in the domestic long distance service. Substantially more than half of the administrations have that service under a monopoly (51%) and in partial competition (7%). However, a substantial number of administrations provide this service on a competitive basis (42%). Considering this distribution, IP telephony has a great market in which it can be used to deliver international long distance telephony in the full competition/partial competition environments. Administrations, regulatory agencies and telecommunication operators worldwide may consider this fact in future investments/developments on IP telephony since this technology offers lower barriers to market entry and allows easy access to new markets. Additionally, manufacturers could direct their products to this environment as well.



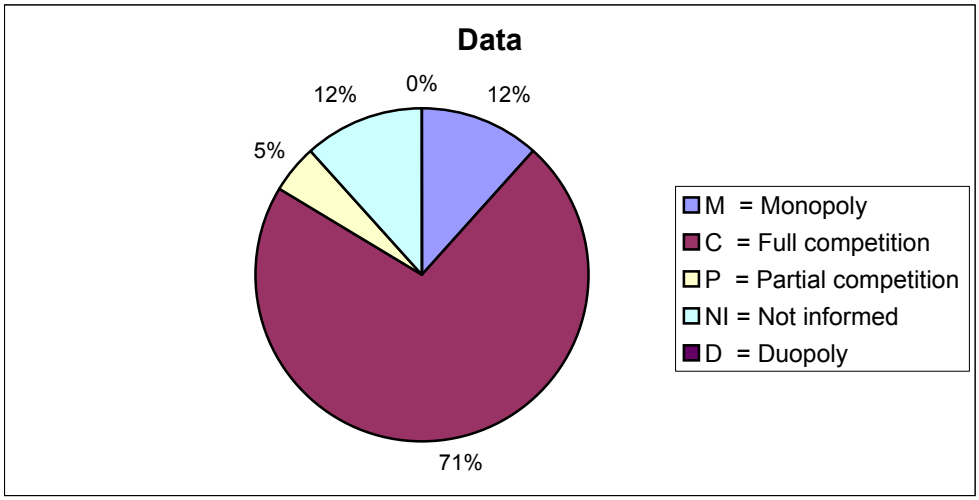
Looking at the DSL provision in the participating administrations, 39% of the administrations have the DSL service provided under competitive conditions, while 7% is under partial competition and 21% in monopoly. It should be noted that 33% of the administrations have not given information on how the DSL is provided in their respective markets. Considering this distribution, IP telephony has a great market in which it could work in conjunction with DSL to stimulate convergence and bring new services in the full competition/partial competition environments. Administrations, their regulatory agencies and telecommunication operators worldwide may consider this fact in future investments/developments on IP telephony and DSL technologies. Additionally, manufacturers, considering that twisted pair networks used by DSL are the main access networks in developing countries, could direct products to this environment as well.



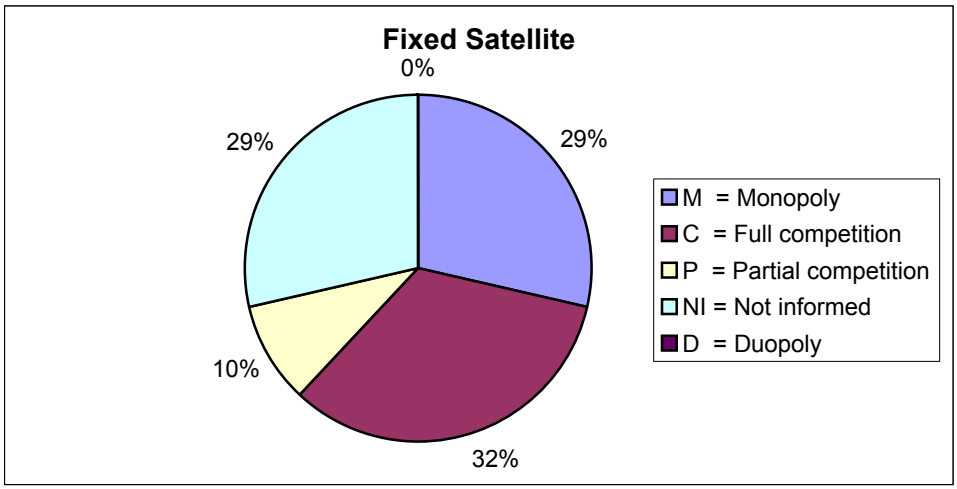
Regarding the Wireless Local Loop (WLL), the situation is similar to that observed in the local service. WLL is mostly offered in full competition (44%) or in partial competition (12%) and only a 16% of administrations have the market still on a monopoly basis. However, there is a considerable number of administrations that have not given information on how the WLL is provided in their market. Given this distribution, IP telephony has a great market in which it could work in conjunction with WLL to stimulate convergence and bring new services in the full competition/partial competition environments; their regulatory agencies and telecommunication operators worldwide may consider this fact in future investments/developments on IP telephony and WLL technologies. Additionally, manufacturers, considering that WLL and IP telephony may be an interesting solution for access networks in developing countries, could direct products to this environment as well.



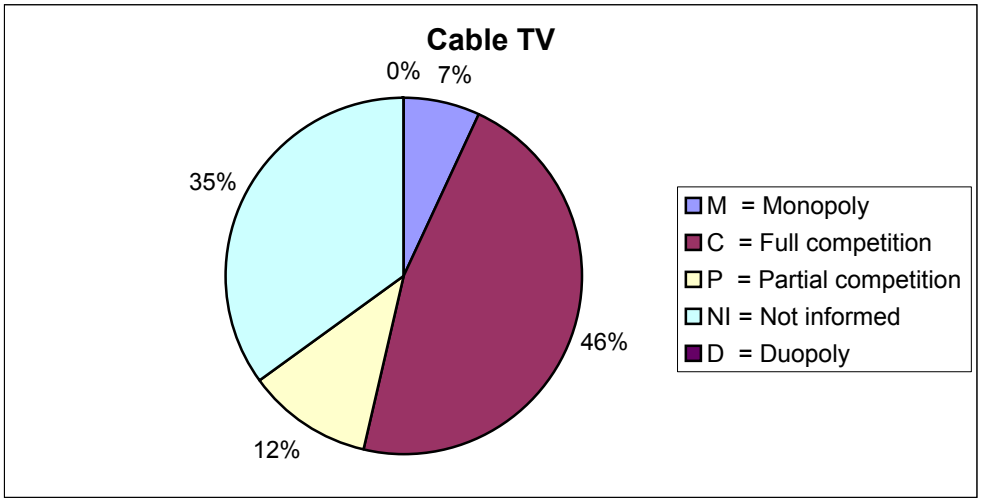
More than half of the participating administrations provide leased lines, either in a fully competitive market (46%) or under partial competition (14%). For more than a quarter of those administrations the service is provided under monopoly. However, there is a considerable number of administrations that have not given information on how the leased lines are provided in their respective markets. Considering this distribution and that leased lines are mainly used by corporate customers, IP telephony has a great market in which leased lines could work in conjunction with it to provide solutions to corporate customers in the full competition/partial competition environments. Telecommunication operators worldwide may consider this fact in redrafting their business plans in consideration of the implementation of IP telephony and to the competition to come in reaching the most interesting customers.



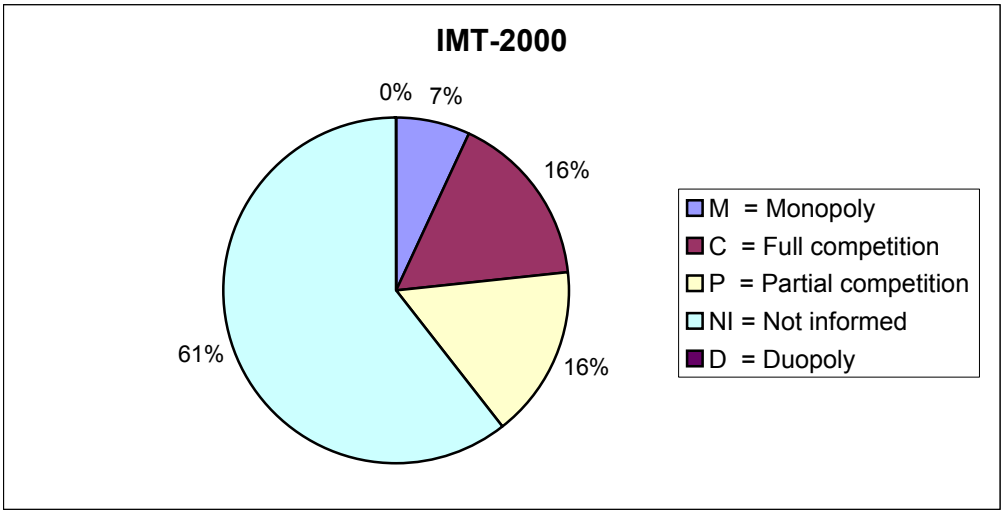
Data services are those mostly served on a competitive basis, having a larger part in full competition (71%) and a smaller part in partial competition (5%). A small number of administrations (12%) have monopoly and others have not provided information (12%). Considering this distribution and that IP telephony makes use of data networks, there is an opportunity to IP telephony grow in the full competition/partial competition data environments, stimulating convergence and bringing new services. Administrations and their regulatory authorities, along with the local telecommunication operators, may consider this fact in their future analysis on IP telephony since this technology allows them to benefit from lower barriers to market entry and easy access to new markets, and stimulates competition and new services to users.



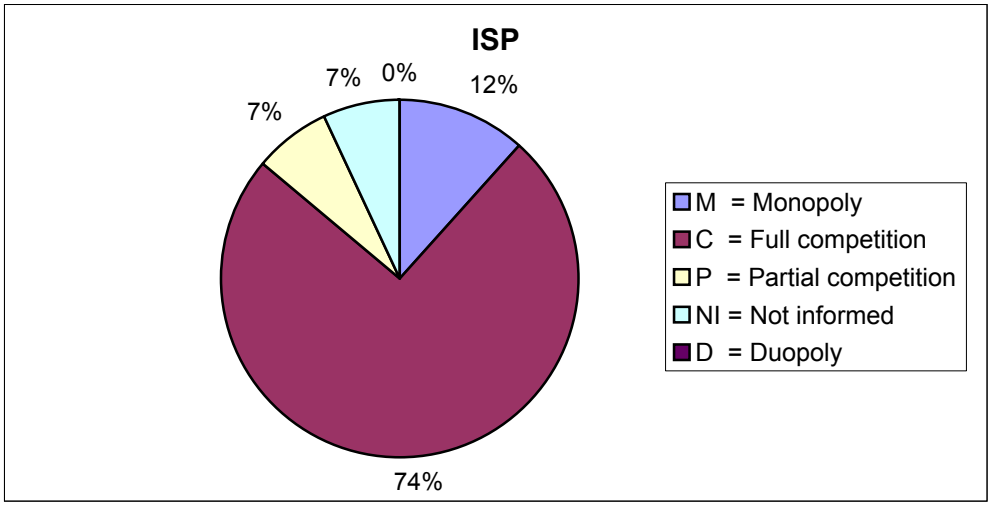
Concerning Fixed Satellite Service, a large share of the participating administrations offer the service in a competitive market, either full (32%) or partial competition (10%). However, a considerable number of administrations report a monopoly (29%) and have not given information on which basis the service is provided (29%). IP telephony has a great market in which it could work in conjunction with fixed satellite to stimulate convergence and bring new services in the full competition/partial competition environments. Administrations, their regulatory agencies and telecommunication operators worldwide may consider this fact in future investments/developments on IP telephony and fixed satellite technologies, especially given developing countries' lack of infrastructure, which may be provided by fixed satellite. Additionally, manufacturers and developers, considering that fixed satellite and IP telephony may be an interesting solution for the future broadband access networks in developing countries, could direct products to this environment as well.



Cable TV is largely served on a competitive basis, either full (46%) or partial competition (12%). Monopoly in this service segment represents a small portion (7%). It should be noted, however, that a large number of administrations have not informed ITU how cable TV is provided in their respective markets (35%). IP telephony has a great market in which it could work in conjunction with cable TV to stimulate voice/data/video convergence and bring new services in the full competition/partial competition environments. Administrations, their regulatory agencies and telecommunication operators worldwide may consider this fact in the future investments/developments for the IP telephony and cable TV technologies. Additionally, manufacturers and developers, considering that cable TV and IP telephony may be an interesting solution for the future access networks in developing countries, could direct products to this environment as well.



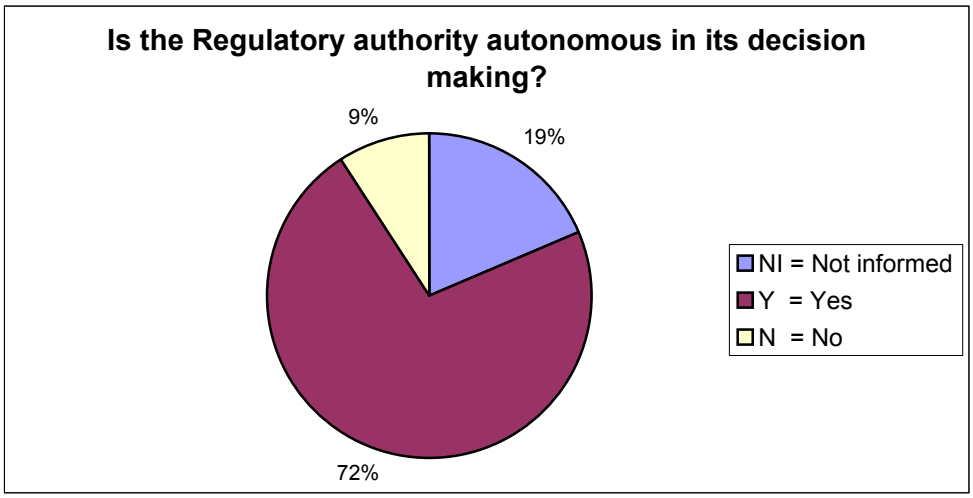
Less information was provided by administrations (61%) on IMT-2000. This may be due to the relative newness of IMT-2000. It is interesting to observe that, in the cases of the administrations that provided information, the service is mostly through competition, either full (16%) or partial (16%), while monopoly represents a small part (6%). IP telephony has a great market in which it could work in conjunction with IMT-2000 to stimulate mobile/fixed convergence and bring new services in the full competition/partial competition environments. In this sense, administrations, their regulatory agencies and telecommunication operators worldwide may consider this fact in their future investments/developments for the IP telephony and IMT-2000 technologies.



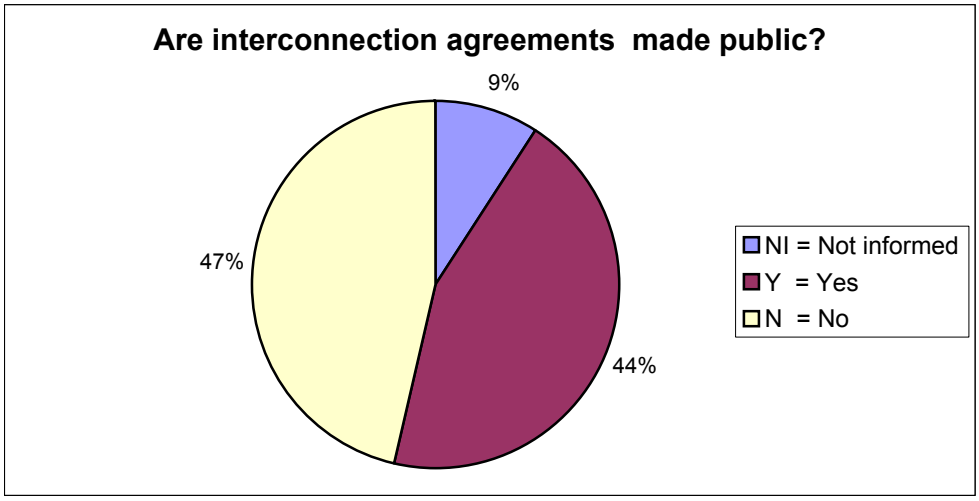
Internet Service Provision, along with Data Services, are those services mostly served on a competitive basis, having a larger share under full competition (74%) and a smaller share under partial competition (7%). A small number of administrations (12%) have monopoly and others have not provided information (7%). Given this distribution, IP telephony has a great market in which it could work in conjunction with the ISP to stimulate Internet access and bring new services in the full competition/partial competition environments. Administrations, their regulatory agencies and telecommunication operators worldwide may consider this fact in their future investments/developments for IP telephony and ISPs.

ANNEX 2

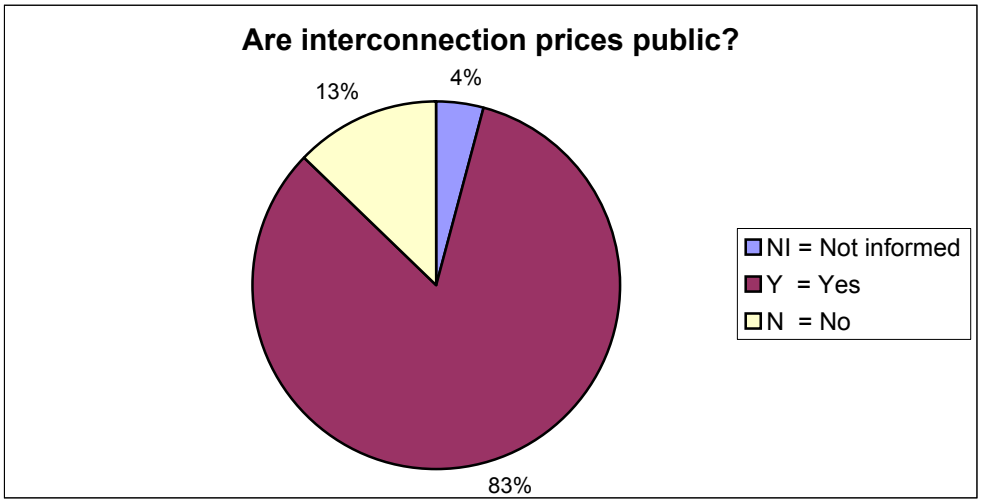
Regulatory Framework



In relation to the autonomy of the regulatory authority, in most of the administrations consulted in this work, the telecommunication regulatory authority has autonomy in its decisions (72%). However, a considerable number of the administrations have not provided this information for the ITU-D databanks. This means that national regulatory authorities are equipped to take the decision on the development of IP telephony autonomously, free from pressures from the different parties. In this sense, it is up to the regulators to decide the way forward for IP telephony in consideration of the national needs, local characteristics, need for further competition, new services, etc.



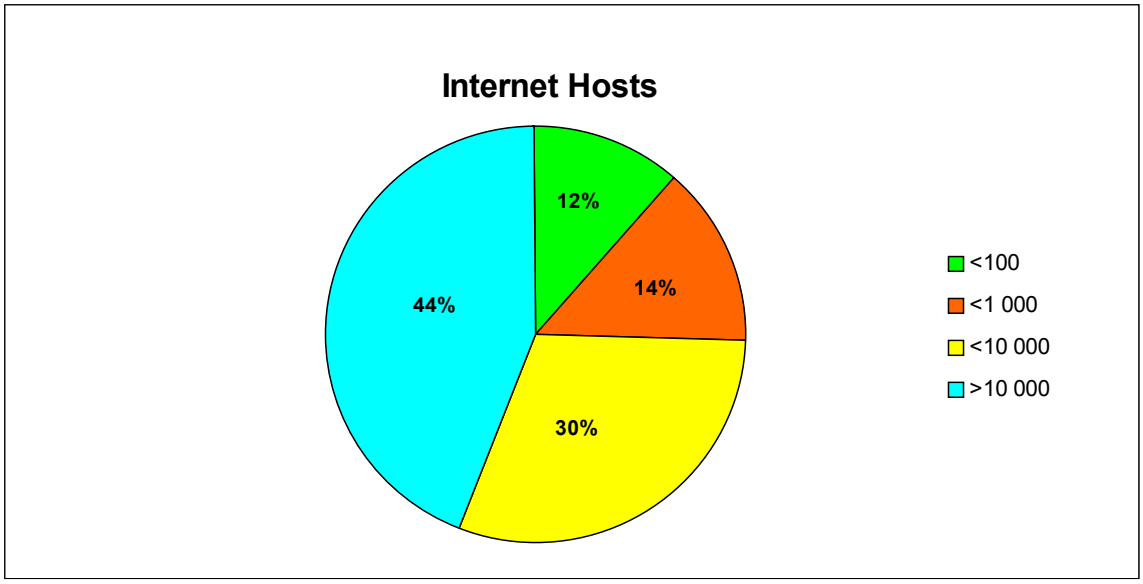
Considering the participating administrations' replies, a large number of them do not make interconnection agreements public (47%). However, a significant proportion of them do make interconnection agreements public (44%). A small number of the administrations have not provided this information to ITU. This means that for a large share of the administrations, IP telephony operators will have the chance to know the basis of existent interconnection agreements, demanding equal basis, modification, etc., if need be.



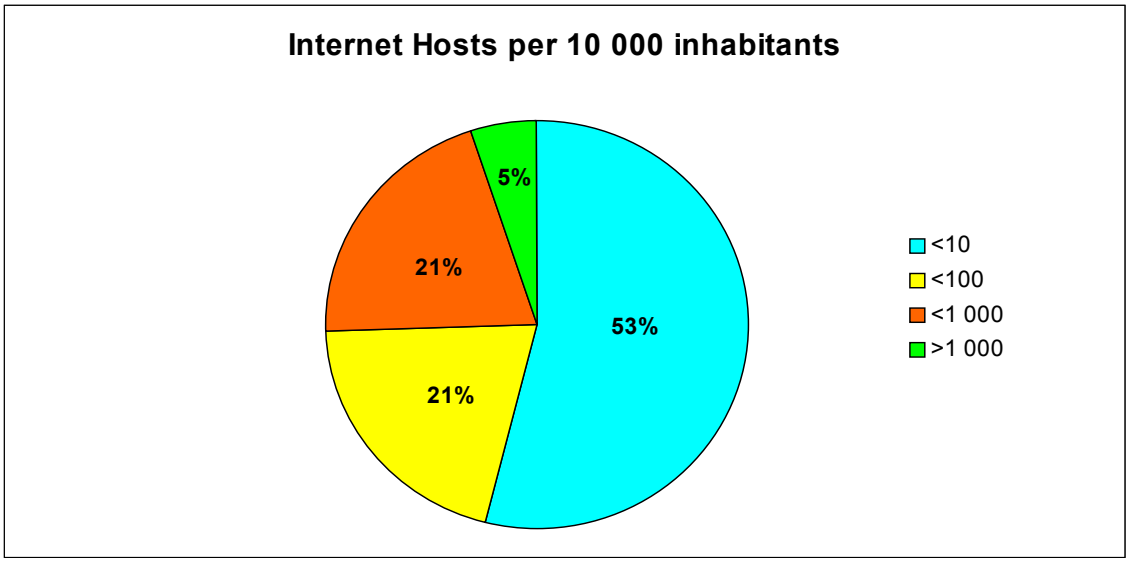
The majority of the administrations participating in this study make interconnection prices public (83%). Therefore, in most administrations, IP telephony operators will have the chance to know the prices for interconnection, demanding equal basis, modification, etc., if need be.

ANNEX 3

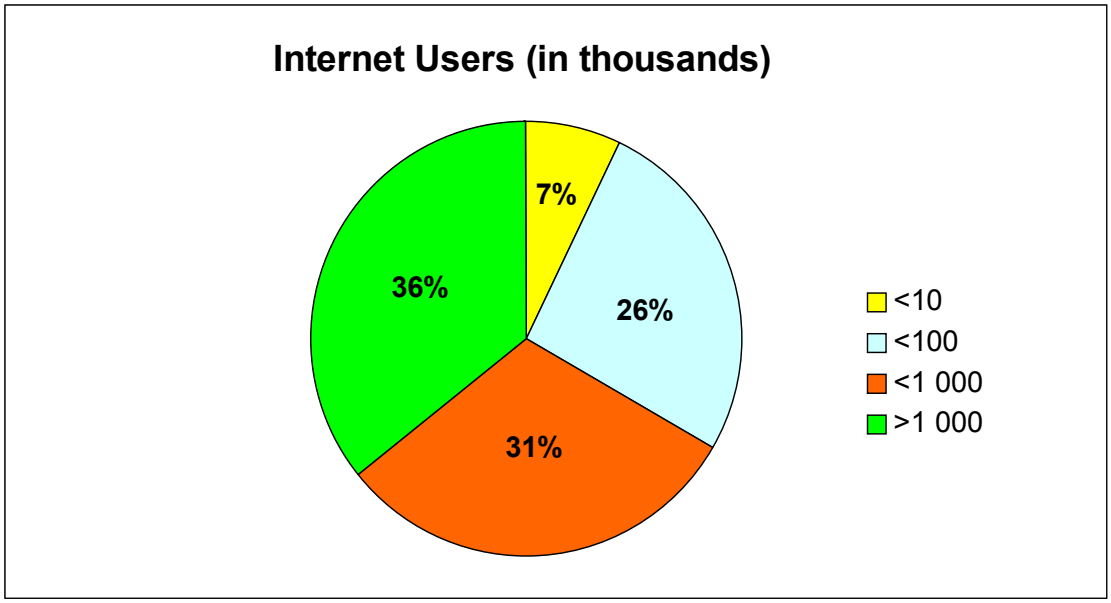
Internet Status



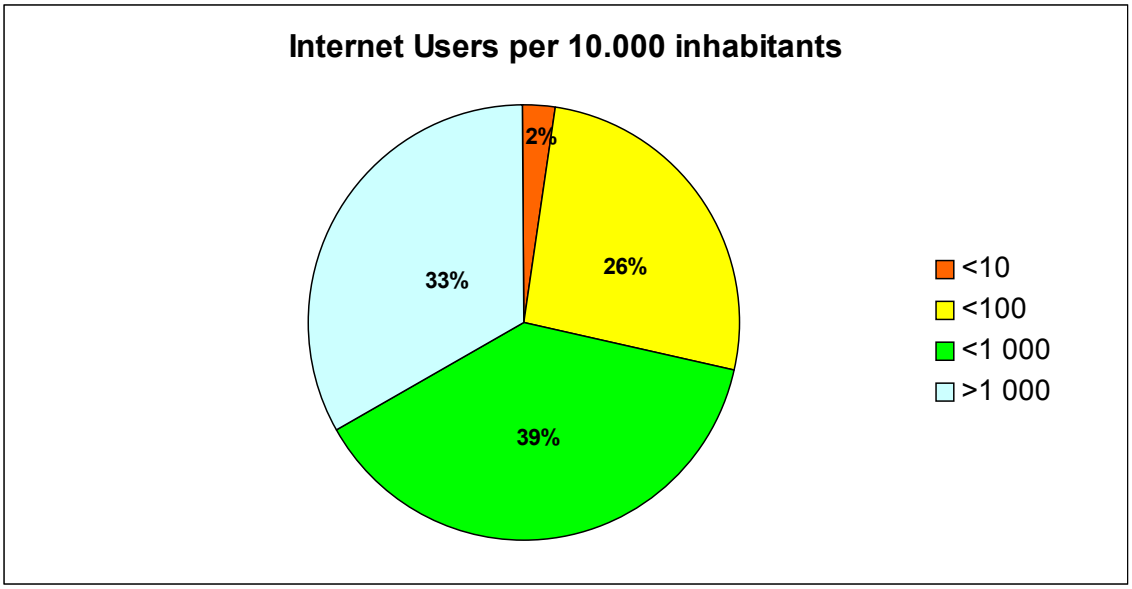
In relation to the number of Internet hosts in the administrations consulted, a large proportion of them have more than 10 000 Internet hosts (44%) and a significant proportion have between 1 000 and 10 000 Internet hosts (30%). However, a considerable number of the administrations have a lower number of Internet hosts (26%). Therefore, in developing countries there is an opportunity/need to develop the Internet infrastructure, which may be solved by integrating the development of telephony service and Internet infrastructure by stimulating the use of IP telephony, which will bring in addition the benefits of a convergent network.



With regard to the density of Internet hosts, the results are that most of the administrations (53%) have a low Internet host density per 10 000 inhabitants. Therefore, in developing countries there is an opportunity and need to develop the Internet infrastructure, which may be solved by integrating the development of telephony service and Internet infrastructure by stimulating the use of IP telephony, which will bring in addition the benefits of a convergent network.



In 67% of the administrations considered, there are over 100 000 users, while the remaining (33%) have less than that. This means that in developing countries there is an opportunity/need to develop Internet access, which may be solved by integrating the development of telephony service and Internet access by stimulating the use of IP telephony, which will bring in addition the benefits of a convergent network.



Regarding Internet User density in the participating administrations, the majority of the administrations (67%) have a very low Internet user density (below 10%). This means that in developing countries there is an opportunity/need to develop Internet access, which may be solved by integrating the development of telephony service and Internet access by stimulating the use of IP telephony, which will bring in addition the benefits of a convergent network.

ANNEX 4

A Review of the Mechanisms of Ensuring Quality of Service in IP Networks

Introduction

Packet header information is used in packet-switching to determine the handling of a packet in terms of the selection of the output port (routing) and the application of any special action on the packet such as policing or assigning priority in an output queue. Packet handling procedures may be based solely on addressing information (as is always the case with ATM using Virtual Path and Virtual Circuit Identifiers) in which case provisioning or signalling procedures are used to associate a flow between a specific source and destination with use of certain resources and a particular packet handling procedure; or additional information in the header can be used to determine the procedures to be applied to a specific packet.

Packets may be dropped in accordance with various algorithms to control congestion conditions or if service level agreement conditions are violated such as exceeding an agreed service rate. In addition, resources can be reserved for specific flows and the resource reservation mechanism can be linked to call or session control procedures so that connection establishment attempts can be denied if resources are not available, in an analogous manner to that applied in TDM and ATM networks.

Commercial routers have traditionally provided one class or quality of service – "best effort" – although a mechanism was provided (the Type of Service field) in the Internet Protocol specified in 1981 that allowed some differentiation of service quality. Recently, suppliers have begun to implement different scheduling algorithms for different traffic flows identified by a variety of fields in the IP header such as source and destination IP addresses, Type of Service indication, and protocol ID; and also source and destination port numbers. Two approaches have been progressed: one based on the original ToS indication that retains the stateless nature of IP packet forwarding (Differentiated Services) and another (Integrated Services) in which resources are reserved using signalling procedures (the Resource Reservation Protocol) that requires routers to be aware of the state of the "connections" so established. Both approaches are asymmetric in that they are established for unidirectional flows.

In addition, a technique called MultiProtocol Label Switching (MPLS) has been developed. This is a method for forwarding on the basis of a label derived from the IP packet header at the ingress to an MPLS domain which is then used to determine routing and forwarding behaviour at MPLS routers without recourse to the IP packet header. Resources within Label Switching Routers can be reserved by use of RSVP or by a particular usage of the Label Distribution Protocol in which QoS requirements are associated with a Label Switched Path.

The Session Initiation Protocol (SIP) in conjunction with the Session Description Protocol (SDP) can be used to establish multimedia sessions. An indication can be given that specified QoS requirements have to be met for a call establishment attempt to be completed so that, for example RSVP is used to reserve resources for a call before that call is offered to the called party.

Differentiated Services

The idea of differentiated services is that traffic is classified at the input to a differentiated services domain and a marker (DS codepoint) added that each node uses to determine the per-hop forwarding behaviour such that packets can be assigned different queue and drop priorities. Classification is made on the basis of information in the packet header, such as the source and destination addresses and port numbers, protocol ID and DS codepoint, and also possibly on the interface on which the packet is received. Traffic is also policed and shaped at the input to the differentiated services domain. In this way different classes of service are provided to aggregate traffic flows within the Differentiated Services domain. The Differentiated Services approach is intended to give both qualitative (i.e. relative priority) and quantitative (i.e. specified bandwidth) service differentiation. Two types of per-hop behaviour are currently defined: Expedited Forwarding (EF) and Assured Forwarding (AF).

The Expedited Forwarding behaviour is intended to provide a service equivalent to a leased line with assured bandwidth and low delay, jitter and loss. The specific bounds on these parameters are implementation and configuration specific. The Assured Forwarding group of forwarding behaviours consists of four classes of service, each with 3 categories of drop probability (low, medium and high). The specific per-hop behaviour associated with each AF class is network specific.

Routers must be provisioned to support Differentiated Services and a device-level SMIv2 MIB and a domain-level policy configuration MIB for use with SNMP have been developed in addition to a PIB for use with COPS-PR (Common Open Policy Service protocol usage for policy provisioning – RFC 3084).

Integrated Services – the Resource Reservation Protocol

The Type of Service and Differentiated Services approach to providing different qualities of service does not affect the fundamental principle of IP being a state-less protocol. However, in addition to this approach, a Resource Reservation Protocol (RSVP) has also been specified for reservation of resources in IP routers. RSVP is a control signalling protocol that requires the introduction of states for specific information flows, although reservation states are "soft" in that they are regularly renewed by messages sent from the initiator of the reservation request. Resources are reserved for forwarding packets meeting specified criteria (protocol id and port number) from a specific destination address to the initiator of the reservation. Receivers initiate requests for resource reservations along the path that the packets will follow. For a reservation to be successfully applied the resources need to be available and access policy conditions have to be meet. The integrity and authentication of RSVP messages can be ensured using the RSVP Integrity object as described in RFC 2747 (RSVP cryptographic authentication).

A reservation request is made for a particular flow which is described by a "Flow Spec" defining the quality of service, which consists of a specification of the resources to be reserved (Rspec) and a description of the traffic (Tspec), and a "Filter Spec" which specifies which packets (based on protocol header fields) to receive the reserved quality of service. Packets not matching a Filter Spec receive "best effort" service.

Two categories of service are currently defined: a Guaranteed Quality of Service, in which in bandwidth and maximum delay, but not cell delay variation, guarantees are given, and Controlled Load service in which the service is intended to be of the same quality as that of "best effort" service in situations without congestion even when congestion is encountered. These Quality of Service categories are specified in terms of network element behaviour independently of the mechanism used to implement them.

In addition, a Policy Data object, identifying a user or an account for example, can be included to control reservation access and usage policy [RFC 2750]. RFCs 2752 and 2872 further define how users and applications can be identified and authorized to make resource reservations. A Policy Decision Point (PDP) may be remote from a Policy Enforcement Point (PEP) with the Common Open Policy Service (COPS) protocol being used to communicate between these entities [RFC 2749 – COPS usage for RSVP].

Reservations can be aggregated over a single RSVP reservation which dynamically adapts to the characteristics of the reservations being aggregated [RFC 3175 – Aggregation of RSVP for IPv4 and IPv6 reservations]. Aggregation can reduce the load of processing many independent reservations on the routers on the aggregation path as long as the aggregate reservation is not adapted to every individual reservation but modified less frequently. Algorithms and policies for predictive reservations are described in RFC 3175. Differentiated Services techniques for packet classification and forwarding behaviour are used such that a number of aggregated reservations may be established between a pair of routers, each corresponding to a certain class of traffic and identified by a Differentiated Services codepoint. A number of possible traffic classifications are possible ranging from mapping all individual RSVP reservations to one DS codepoint and per-hop forwarding behaviour, through mapping all Guaranteed Service reservations to one DS codepoint and all Controlled Load reservations to another, to in addition using policy information to classify traffic.

Packet Fragmentation

Differentiated Services approach of prioritizing traffic may not be adequate to limit delay sufficiently due to the blocking delay of data packets. A 1500 octet packet, for example, takes 8 ms to transmit at 1.5 Mbit/s. At low link rates it is therefore required to fragment long packets using a technique such as Multilink PPP [RFC 1990] so as to minimize output port blocking delays.

Multi-Protocol Label Switching (MPLS)

MPLS (Multi-Protocol Label Switching) can be used to separate IP packet flows by classifying packets and transmitting different flows over different label-switched paths. The quality of service associated with a specific label switched path is obtained by using an underlying forwarding layer with inherent quality of service assurance mechanisms such as ATM, using one of the IP QoS mechanisms discussed earlier or using the Label Distribution Protocol to establish a Constraint-based Routed Label Switched Path (CR-LSP).

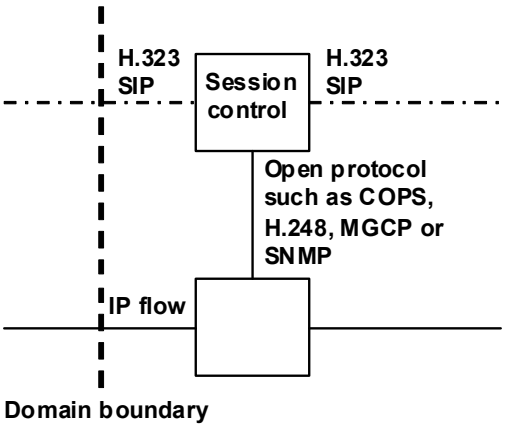
An MPLS router (or Label Switching Router – LSR) forwards packets based on analysis of a label rather than the full packet header. The packet header, and possibly also port identifier, is used at the ingress to an MPLS domain to determine the Forwarding Equivalence Class (FEC) and thereby the label associated with this FEC to be used for forwarding, in much the same way as packets are classified at the edge of a Differentiated Services domain. The label determines the route to be taken by the packet and may also indicate the forwarding behaviour to be applied to the packet, such as scheduling priority.

A Label Distribution Protocol (LDP) is used to configure Label Switched Paths (LSPs). The ability to distribute labels has been added to a number of existing protocols such as BGP [RFC 3107] and RSVP and a new Label Distribution Protocol has been developed for this purpose [RFC 3036].

MPLS can be used for Traffic Engineering and the extensions to RSVP and to LDP [Constraint-based LSP setup using LDP] have been designed with this application in mind. The extensions to RSVP support the establishment of explicitly routed LSPs (as opposed to hop-by-hop routing) both with and without resource reservations, smooth re-routing of LSPs, pre-emption and loop detection.

Session Border Control

Most current QoS architectures also include a mechanism for controlling interfaces between different IP network domains. These control mechanisms are typically referred to as “gate” or “session border” control. The following figure illustrates the border control functional model and lists the potential functions at the session control and forwarding path levels:

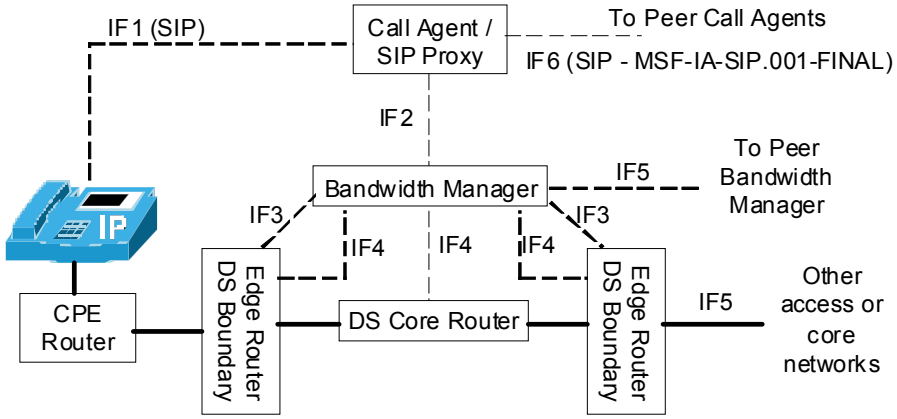


Session Control Functions:
Protocol interworking
Call admission control
Address translation
Routing
Billing
Lawful interception

Forwarding Path Functions:
Firewall
NAT
NAPT
QoS
QoS monitoring
Transcoding
Encryption / decryption
Mid-call codec change
Media transformation
Lawful interception
Usage metering

An example end-to-end QoS architecture is that specified by the Multiservice Switching Forum (MSF) shown in the following figure:

MSF QoS Architecture MSF-TR-QoS-001-FINAL



Key to interfaces:

IF2 Candidate protocols are SIP, COPS and H.248. It is recognized that this need not be an open interface.

IF3 Gate Control – COPS or H.248.

IF4 Protocol for further study. It is noted that this interface may not be required depending upon the network technology used, e.g. if MPLS is used it is sufficient to only control the edge routers.

IF5 Inter-bandwidth manager interface – requirements and choice of protocol under study.

ITU-T SG 13 is currently studying an architecture similar to that shown in the above figure for providing end-to-end QoS guarantees suitable for "IP telephony", and SG 11 is working on corresponding protocol mechanisms.

ANNEX 5

India Regulation on IP Telephony

The New Telecom Policy'99 envisaged the opening up of Internet Telephony whereupon the Government has decided to permit the Internet Service Providers (ISPs) to process and carry voice signals with effect from 1st April, 2002, subject to the following broad guidelines:

Only ISP licencees are permitted, within their service area, to offer such service.

Scope and Definition of Internet Telephony Services

2.1 Internet Telephony means an Application Service, which the customers of ISPs can avail from their Personal Computers (PC) capable of processing voice signals or other IP based Customer Premises Equipment (CPE) as mentioned below:

a) PC to PC (Both within as well as outside India).

b) PC to Telephone (PC in India to Telephone outside India)

c) IP based H.323/SIP Terminals in India to similar Terminals both in India and abroad, employing IP addressing scheme of 'IANA'

2.2 Access to the ISP node through the authorized facilities of authorized Cable Operators shall be permitted subject to the provisions of Cable Television Networks (Regulation) Act, 1995 as modified amended or replaced from time to time.

2.3 The addressing scheme for such a communication involving transmission of voice in packetized data format through the public Internet, will conform to IP Addressing scheme of Internet Assigned Numbers Authority (IANA) alone and not the National Numbering Scheme/plan applicable to subscribers of Basic/Cellular Telephone Service, as defined by Department of Telecom.

2.4 Internet Telephony Service offered by ISPs is different in nature, scope and kind from the real-time voice, offered as telecommunication service by operators such as BSO, CMSO, NLDO, PMRTS, etc, under their existing licence.

3 The following are outside and do not fall under Internet Telephony service:

- Voice communication from anywhere to anywhere by means of dialing a telephone number (PSTN/ISDN/PLMN) as defined in the National Numbering Plan;
- Originating the voice communication service from a Telephone in India;
- Terminating the voice communication to Telephone within India;
- Establishing connection to any Public Switched Network in India;
- Dial up lines with outward dialing facility from nodes;
- Interconnectivity between ISPs who are permitted to offer Internet Telephony Services and the ISPs who are not permitted to offer Internet Telephony Services.

Quality of Service

4 Quality of Service (QoS) shall be as prescribed from time to time by TRAI/Licensor; however, at present QoS is not prescribed.

Tariff/Fees

5 The TRAI has forborne and not levied tariff for Internet Telephony offered by ISPs over public Internet; however, TRAI may review and fix a tariff at any time during the validity of ISP licence which shall be binding on the licencee.

6 If found necessary at any time during the validity of the ISP licence, the licensor reserves the right to impose licence fee including Universal Service Obligation (USO) levy.

Security Monitoring

7 Suitable additional monitoring system is to be set up by ISPs carrying Internet telephony traffic through their Internet gateways, at their own cost, as per the requirement of the security agencies, and the cost of maintenance of the monitoring equipment and infrastructure at the monitoring centre located at the premises of the licencee shall be borne by the ISP.

Licence Agreement

8 ISPs desirous of offering Internet Telephony Services shall be required to sign a Amendment to the ISP licence agreement to such effect. Draft agreement will be put on the DOT website dotindia.com

9 The Amendment to the ISP licence agreement shall be issued and governed by the provisions of Indian Telegraph Act 1885, Indian Wireless Telegraphy Act, 1933 and TRAI Act, 1997.

Application Form/Fee

10 Application in the attached prescribed proforma along with the processing fee can be submitted at the office of ADG(LR), 10th Floor, Sanchar Bhavan, New Delhi – 110 001, between 1500 hrs –1700 hrs on any working day.

11 A non-refundable processing fee of Rs. 10,000/– (Rupees Ten thousand only) in the form of Demand Draft payable to Pay & Accounts Officer (Hqrs.), DOT, New Delhi, should be submitted with an application and any application without the processing fee will not be processed.

GOVERNMENT OF INDIA

MINISTRY OF COMMUNICATIONS & INFORMATION TECHNOLOGY

DEPARTMENT OF TELECOMMUNICATIONS

Application for permission to offer Internet Telephony Services

(**Note**: Please read the Guidelines carefully before filling up this form. The Application form should contain complete information on each and every point. Additional sheets may be added, if required. Incomplete application or application with conditional compliance shall be summarily rejected. Application, alongwith documents if any, may be submitted to ADG(LR), 10th Floor, Sanchar Bhavan, New Delhi – 110 001.)

1 Name of the Company

2 ISP licence No: Service Area
Date of issue of licence

3 Whether started providing service YES/NO
If yes, list of cities where service has been started.

4 Details of connectivity of the nodes to Internet
(give complete network diagram)

5 Details of Interconnectivity with other ISPs
(details should include location, name of ISP, type of connection, etc.)

6 Are you operating/intending to operate own International Gateway for Internet?

If Yes, give full details of Gateway under operation or if applied for, the details of the same (details should include location, medium, up and down bandwidth, etc.)

7 Complete Postal Address with Telephone /fax nos./e-mail address:

Corporate Office ……

Registered Office ……

8 Address for correspondence, with

Telephone/fax nos./e-mail address

9 Name of authorized contact person
Designation and telephone/fax nos. e-mail address

10 Resolution of Board of Directors / other proof that the person signing the application is authorized Signatory (Enclose copy of resolution)

11 List of Telecom Service Licence(s) granted to the applicant company or any promoters/partners thereof or associate/sister concern and their present status (attach separate sheet, if required).

i) ----------

ii) ----------

iii) ----------

iv) ----------

12 Promoters/Partners in the Company:
(details of equity holding)

S. No.	Name of Promoter/Partner	Indian/Foreign	Equity percentage
------	----------	--------	------
------	----------	--------	------

(Total foreign equity participation(s), if any, up to the extent of 74%, including NRI equity, both repatriable and non-repatriable FII is allowed for ISPs owning International Gateways for Internet. Complete break-up of 100% of equity must be given.)

13 Processing fee:

A non-refundable processing fee of Rs. 10,000/– in the form of Demand Draft payable to Pay & Accounts Officer (Hqrs.), DOT, New Delhi, to be submitted with the application.

Details of the processing fee:

Demand draft No. ……..

Date ……

Bank drawn ……

Amount ……

Certificates / Undertaking

(i) We hereby certify and undertake that, having carefully read the guidelines for issue of permission to offer Internet Telephony Services, to fully comply and abide by the terms and conditions therein.

(ii) We also undertake to sign any Agreement with Government of India in this connection.

(iii) We understand that all matters relating to the application or permission/licence if granted to us will be subject to jurisdiction of Civil Courts in Delhi only.

(iv) We understand that our application for offering Internet Telephony Services in India is subject to security clearance by Government of India.

(v) We will provide all technical details of and access to various equipment, including hardware, software and communications equipment, to monitoring agencies as stipulated from time to time.

(vi) We understand that if at any time any information furnished by us for obtaining the permission/licence is found incorrect, our application shall be liable to be rejected, processing fee forfeited and permission granted on the basis of this application shall be withdrawn.

(vii) We understand that the permission to offer Internet Telephony Service is subject to other clearances/permissions that are required as per the laws of the land and it will be responsibility of the licencee/company to obtain these clearances/permissions.

(viii) We understand that the Central Government (Licensor) reserves the right to make changes in the conditions under which this permission/licence is granted.

(ix) We hereby certify that we have cleared dues in respect of all payments arising out of any licence granted under Section 4 of Indian Telegraph Act, 1885 (including Indian Wireless Telegraphy Act, 1933), to the applicant company or any promoters/partners thereof or associate/sister concern.

Date: Signature and name of the

Place: Authorized Signatory

_____