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D.O. No. 5-1/2001-TRAI(CN)

Dated 20th Feb. 2002

Dear Shri Ghosh

Kindly refer to your D.O. letter No. 820-1/98-LR(Vol.IV) dated 4th October, 2001 requesting us to send our recommendations on Internet Telephony. The recommendations of the Authority are enclosed. These recommendations have been formulated after due consultations with all the stakeholders and the general public, in accordance with our established practice of transparent decision making. Details of the consultation process are given in the explanatory memorandum enclosed with the recommendations. A copy of the consultation paper is placed at Annexure C.

2. The recommendations of the Authority on the following specific issues are contained in the report and the rationale behind these recommendations are set out in the explanatory memorandum;

- i) Timing of introduction of Internet Telephony
- ii) Scope and Definition of Internet Telephony Service
- iii) Use of VOIP as a Technology option by existing Facility Based Operator
- iv) Issues relating to Digital Divide
- v) Quality of Service (QOS)
- vi) The Tariff.

3. We hope these recommendations will be accepted by the Government and will result in the induction of the state of art technologies in the country causing reduction in prices and greater availability of value added services to the consumers. The recommendations alongwith the text of this letter have been placed today on the TRAI website (www.traigov.in) for public information.

With
regards

Yours sincerely,
(M.S. Verma)

Shri Shymal Ghosh,
Secretary Department of
Telecom.
New Delhi.

TELECOM REGULATORY AUTHORITY OF INDIA

RECOMMENDATIONS ON OPENING UP OF INTERNET TELEPHONY

A. BACKGROUND

1. In regard to Internet Telephony, the Government had taken the following decision in 1999 and the same was incorporated in the National Telecom Policy document released the same year:

"The Internet Telephony shall not be permitted at this stage. However, the government will continue to monitor the technological innovations and their impact on national development and review this issue at an appropriate time."

2. In accordance with the decision taken in 1999, the Government decided to carry out a review last year and an internal group was set up for the purpose. Subsequent to the Group's recommendation, the Government made a reference to the TRAI vide their letter No.820-1/98-LR(Vol.IV) dated 20.7.2001 (Annexure A). Annexure A also contains the recommendations of the internal group. One of the recommendations of the group was that the opening of the Internet telephony be considered after opening the International voice telephony, and be done after introduction of cost based tariff. In accordance with the established practice the process of decision making followed by the Authority has been transparent and after consultation with all the stakeholders/general public. The Authority would like to recommend as follows:

B. Recommendations of the Authority:

1. Timing of introduction of Internet Telephony:

Internet Telephony may be introduced with effect from 1st April, 2002 i.e. date of opening of the ILD sector for private participation.

2. Scope and Definition of Internet Telephony service:

2.1 The Authority would like to define Internet telephony as an Application Service, which the customers of ISPs can avail from their Personal Computers (PC) capable of processing voice signals. Other IP based Customer Premises Equipment (CPE) such as H.323 terminals/SIP terminals which are directly connected to the ISP node through point to point links (wireless/optical fibre) in the last mile, as per existing stipulation in

the ISP licence, can also be employed to offer Internet Telephony, through the public Internet. Similarly, access to the ISP node through the facilities of authorized Cable Operators shall be permitted subject to applicable Cable Laws. 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) and not E.164 numbering scheme of the ITU.

2.2 The scope of this service will include the following types of connections using the public Internet:

- i) PC to PC (Both within the country as well as abroad)
- ii) PC to Phone (PC in India, Phone abroad)
- iii) IP based H.323/SIP Terminals in India to similar Terminals both in India and abroad, employing IP addressing scheme of 'IANA'.

2.3 The Authority is of considered view that at this stage of telecom development in the country, when the facility based operators such as Basic Service Operators including the incumbent, are obliged to provide telephones in uneconomic areas as well as uneconomic telephones in economic areas, to discharge their Universal Service Obligation (USO), it is important not to disturb significantly their revenue streams to which they are entitled in accordance with the stipulations in the Licences granted to them. It is, therefore, important to differentiate between the real-time telecommunication services offered by facility based operators, under their existing licences, and those offered by ISPs, which are multimedia applications & content services, not subject to strict time constraints of real-time telephony services. To have a clear distinction between Internet Telephony & telephony services offered by facility based operators under their existing licences, the latter may be defined as the provision of real-time voice communication from anywhere to anywhere by means of dialing a Generic Telephone Number (PSTN/ISDN/PLMN) as defined in E.164 recommendation of the ITU. Suitable modification to existing licences of the facility based operators as well as ISPs is recommended, to bring out this difference to avoid any ambiguity. Internet Telephony through PCs or IP based terminals should be made available also through the Public Tele-Info Centre (PTIC) & Internet Kiosks at Sanchar/Cyber dhabas for the benefit of those who do not own the Customer Premises Equipment required for this service. This will make Internet Telephony an integral part of the USO programme on which the Authority has already given its Recommendations, and which includes provision of PTICs as an essential element, to help address the issue of digital divide. Internet Telephony through PTICs is likely to provide a cheaper option to conventional telephony, in rural & remote areas.

3. Use of VOIP as a Technology option by existing Facility Based Operators

3.1 The licences issued in early 90s to BSOs & CMSOs had specified a Switched Circuit Network i.e. PSTN/ISDN for BSOs and GSM technology for CMSOs, mainly because of maturity of these technologies and their proven ability to provide guarantees in respect of Quality of Service (QOS) parameters such as Delay, Grade of Service (GOS), excellent voice quality (MOS better than 4), and a large number of features and

facilities such as calling line Identity Presentation, Detailed Billing, Call Transfer etc, called "custom calling services", and also Intelligent Network Services (Premium Services), which the subscribers routinely expect to get from such a network, at an affordable price. A large number of these features/facilities i.e. teleservices/supplementary/ Intelligent Network Services are not available at present from PC based voice application service from the public Internet, as these are mainly derived from the Access Nodes (ANs) of the ISDN/PSTN/PLMN, as well as Intelligent Network nodes, interconnected, by a powerful signaling system called Common Channel Signalling System-7 (CCS7).

3.2 However, the Authority has taken note of the recent deployment of VOIP backbones by a number of carriers globally to provide NLD & ILD services, in their respective countries, as an alternative transport mechanism. In some countries, such deployment of 'managed VOIP' networks have replicated the carriage services traditionally provided by PSTN backbones and have provided a cheaper option to engineer the backbone networks. This has not necessitated any change in the licensing and regulatory regime, as the Tele & Supplementary services derived from the Access Nodes (ANs) remain the same i.e., as specified in the original licence, thus not disturbing the licensing regime. Such a deployment has the potential of providing integrated carriage services for not only voice but also data in not too distant a future, thus providing economy of scale and scope for the carriers in building their respective networks. It also enables the operating companies to gain experience of this new technology, which has potential of providing a converged service platform for multimedia services. The Authority would therefore recommend that the existing facility based operators such as BSOs, CMSOs and NLDOs be permitted the option to deploy 'managed VOIP' backbones, as a means of providing various types of bearer services to derive the range of Tele and Supplementary services as specified in their respective licences, subject to meeting the quality of service norms specified by the Authority in its QOS Regulations issued from time to time.

4. Issues relating to Digital Divide:

4.1 A concern has been expressed that the digital divide could get wider, in case Internet Telephony is permitted to the ISPs. The apprehension in this regard is that if the ISPs, by providing Internet Telephony cause a serious dent in the revenue stream of the facility based operators, particularly the BSOs, the latter (BSOs) who have to meet the USO, they may not be able to do so, thereby adversely affecting programmes covered under the U.S.O which are required to bridge the digital divide. Because of similar concerns, a large number of developing countries still do not permit Internet Telephony of any type. However, the Authority is of the view that VOIP Technology should be fully exploited to provide cost effective services without disturbing the existing licensing regime. Such a policy has been adopted successfully in number of developing countries including China, where an explosive growth of NLD traffic was witnessed after deployment of VOIP Technology in the national backbone by facility based operators. By permitting 'managed VOIP' backbones as a substitute to the PSTN backbone, the Authority would like to bring in greater technology neutrality in regard to engineering of

networks by operators. Such an approach is likely to give the facility-based operators, a wider choice while deciding upon the most cost effective technology option in their service areas. This would improve teledensity in these areas, and reduce the digital divide, besides exposing the country & its R&D institutions to this new technology. Any cost saving in the backbone should enable the operator to invest more in the access network, i.e. the last mile, thus extending the telecom network to rural & remote areas.

4.2 In the light of what has been stated above, the Authority recommends that the facility based operators i.e. BSOs & NLDOs, CMSOs be permitted to employ 'managed VOIP' backbones in their networks, subject to their meeting the existing norms in respect of voice quality, grade of service etc., so as to provide end to end toll quality service. For achieving toll quality service, a Mean Opinion Score (MOS) of 4 and above (on a scale of 5) should be stipulated. The 'managed VOIP' backbone should be transparent to Fax as well as calls made from voice band modems, as is the case with existing PSTN networks.

4.3 To give greater flexibility to operators and more options to customers, the Authority recommends that the facility based operators be permitted to also offer a 'lower than toll quality' telephony service for customers who are prepared to accept some degradation in the voice quality, by engineering a separate 'managed VOIP' backbone accessible by a different service code. On this backbone, the quality of service offered may be 'lower than toll quality i.e. with MOS less than 4, but greater than 3. The subscriber should, however, be made fully aware of the lower quality of service being offered and the lower tariff applicable for such a service, as well as its distinctive service code.

5. Quality of service (QOS):

The Authority in its recommendations in previous sections has laid special emphasis on customer's right to get a specified Quality of Service (QOS) from a 'Managed VOIP' backbone, deployed by Facility based operators. Issues relating to QOS and standards relating to VOIP network, need to be studied in detail, both in regard to performance parameters and their monitoring in real time as well as specification of Network - Network Interface (NNI) between PSTN & IP Networks. The Authority therefore, recommends setting up of a high level technical committee under the aegis of TRAI with the participation of experts from TEC as well as Telecom/IT industries to carry out an in-depth study and issue detailed guidelines for monitoring of voice quality both by objective (R-Value) as well as subjective (MOS) methods, to ensure that the VOIP networks are engineered to meet the customers' expectations of voice quality on both types of networks i.e. one for the 'toll quality' and the other for 'lower than toll quality'. The Committee would also define technical interfaces for VOIP gateways in conformance with best international practice, so that seamless interoperability between various types of networks in a multi-operator environment is ensured. In this context, the Authority would like to mention that generally the customer's expectation from any new technology is quite high, and therefore the issues relating to network performance, QOS as well as seamless interoperability would need to be addressed urgently.

6. The Tariff

The tariff for the VOIP based toll quality service offered by facility based operators should be same as that for equivalent PSTN based services. For VOIP based lower than toll quality service, the tariff should be lower than that for the toll quality service. It should be provided through a different dialing code. The Authority would initially let the market determine the tariff for lower than toll quality service. The Authority would also forbear with respect to tariff for Internet Telephony offered by ISPs over public Internet, because of sufficient competition in the ISP market, where the entry barrier is practically non-existent, and also because at present, it is not functionally equivalent to the telephony (real-time) services offered by facility based operators.

7. Explanatory Memorandum:

The rationale behind these recommendations is set out in the enclosed Explanatory Memorandum.

Enclosure: Explanatory Memorandum along with Annexures

**EXPLANATORY MEMORANDUM
TO
RECOMMENDATIONS OF THE TRAI
ON
OPENING UP OF INTERNET TELEPHONY**

20th February, 2002

PREAMBLE

1. Terms of Reference

As per NTP-99, the Government was required to monitor the technological innovations relating to Internet Telephony and its impact on national development and review the present policy of not permitting any form of IP Telephony. Accordingly, the Government has referred the issue of opening up of Internet Telephony in India to the TRAI vide their letter No. 820-1/98-LR (Vol.IV) dated 20.7.2001 placed at Annexure-A.

2. Consultation Process

A Consultation Paper on various techno-economic / regulatory issues relating to Internet Telephony Service was brought out by the TRAI. It was released on 23rd November, 2001. Open House discussions were held by the Authority at the four metro cities, i.e. Mumbai, Chennai, Kolkata and Delhi during Decmeber, 2001 and January, 2002 on the issues brought out in the Consultation Paper. All the stakeholders such as Service Providers Associations (ISPAI, ABTO, COAI), Consumer Organisations as well as reputed Telecommunication and IT professionals participated in these consultations and gave their valuable inputs. A copy of the Consultation Paper is placed at Annexure 'C'. Comments received in response to the Consultation Paper are available at Annexure 'D'. These inputs/ comments have been duly taken into consideration by the Authority while arriving at its Recommendations.

3. Structure of the Memorandum

The explanatory memorandum gives the rationale behind the Authority's Recommendations and is organized in following two sections.

SECTION -I gives the background related to the opening up of the Internet Telephony Service with reference to the policy objectives of NTP-99 & the present status of

Internet Telephony /VOIP in other countries.

SECTION-II gives the rationale related to following aspects of introduction of Internet Telephony:-

- A. Timing of introduction of Internet Telephony.
- B. Scope & Definition of Internet Telephony service.
- C. Use of VOIP as a technology option by existing Facility Based Operators.
- D. Issues relating to Digital Divide.
- E. Quality of service (QOS)
- F. Tariff

Section I

1. Background

1.1 Based on a reference (Annexure A) from the Department of Telecom, relating to the Opening up of Internet Telephony in the country, the Authority has examined the various issues comprehensively through detailed consultations with all the stakeholders, Consumer Organisations & telecom/IT professionals. Open House discussions were held at Mumbai, Chennai, Kolkata & Delhi based on a Consultation Paper (Annexure C). The paper was put on TRAI website and comments were invited from all the stakeholders as well as general public, on the specific issues brought out in the consultation paper.

1.2 In the Open House discussions, there was a broad consensus among participants that Internet Telephony & VOIP technology should be permitted. It was argued that the benefits of technology (VOIP) should not be denied to the customers. It was also felt that VOIP technology could provide a cheaper option to engineer a telecom network and will thus help the industry in meeting one of the most important objectives of NTP 99, i.e. of providing affordable telecommunication services to the customer. A contrary view was that its introduction at this point of time, would adversely impact the revenue streams of Access Providers (CMSOs/BSOs), NLDOs/ILDOs through the bypass of their traffic. It would particularly affect the ILDOs, as a significant proportion of their incoming international calls will be routed through the public Internet, thus bypassing the PSTN/ISDN based settlement system. Such an adverse impact on their revenue streams, will affect their ability to rollout facility based networks which in turn would adversely affect the achievement of teledensity targets set out in NTP 99, as well as infrastructure building, which is one of the goals of country's economic policy. According to this view, Internet Telephony should be introduced, only after tariff rebalancing is completed, i.e., only when no tariff arbitrage is available to the providers of Internet Telephony. Majority of the participants in the public consultations were against creation of another licensing category called Internet Telephone Service Providers (ITSPs), who could be licensed to provide Internet Telephony. It was felt that this new service should be provided under the existing licensing framework, so as to cause least disturbance to the existing regulatory & policy framework. It was evident from the deliberations and

inputs provided by experts that a full featured end-to-end public Internet Telephony system comparable to PSTN/ISDN/IN was not yet available, and the Quality of Service (QOS) parameters cannot be specified and ensured on the public Internet.

1.3 While examining the question of Internet Telephony, according to ITU, most of the developing countries have taken the following factors into consideration:

- <> Universal Service/Universal Access
- <> Affordable telecommunication services
- <> Tariff re-balancing
- <> Ensuring a level-playing field for incumbents and new entrants
- <> Promotion of new technologies and services
- <> Stimulating investment in network build-out and new services
- <> Impact on revenue streams of incumbent operators
- <> Technology transfer
- <> Human resource development
- <> Economic growth as a whole and in particular in the Communications sector.

1.4 Taking account of the above factors, as well as the inputs received during its public consultations, the Authority is of the view that Internet Telephony should be permitted in India, but with the least disturbance to the existing licensing regime/level playing field. In this context, the Authority is of the view that there is a need to clearly differentiate between PSTN based real-time telephony, and Internet Telephony offered on the public Internet, which is a voice application, based on client server architecture of Internet, and is non real-time and thus at present cannot be compared to the conventional telephony service derived from PSTN / ISDN / PLMN etc. Another distinction between the two types of service is the fact that for conventional telephony service, the subscriber dials a generic telephone numbers, whereas for PC-to-PC Internet Telephony an Internet address needs to be keyed.

1.5 The Authority has received a lot of inputs from 3rd World Telecom Policy Forum organised by the ITU last year on IP Telephony, in which more than 100 countries participated. ITU has also brought out a report on IP Telephony last year. As per this report, IP Telephony traffic as a percentage of total international traffic has been increasing steadily from 0.2% in 1998 to 5.5% in 2001. However, application of VOIP/IP Telephony in the national networks (NLDO/BSO) was less than 1% in North America and Europe till end of 2000. This figure has not increased significantly during 2001. It would, therefore, seem that the key factor for deployment of IP Telephony in the ILD market in developed countries, is the opportunity it gives to their ILD operators to bypass the Settlement system of the developing countries. The latter received about 7 billion dollars in settlement from developed countries, particularly USA.

1.6 In European countries, like Spain, Belgium, Germany, England and other countries of European Union, the Internet based telephony does not qualify as equivalent to voice telephony because of serious quality issues involving such performance parameters as end-to-end delay, jitter & packet loss. In these countries, most of the carriers make use

of VOIP technology only for the purpose of efficient transmission of data & voice traffic on their backbone. In China also, the national domestic carriers only, are permitted to use VOIP as a technology option for transmission of voice traffic. In Malaysia, the IP based Phone to Phone telephony is treated same as public telephony and PC to PC voice service over Internet is treated as enhanced Value Added Service which is lightly regulated. Similar policy has been adopted in Canada, where Phone-to-Phone Telephony is permitted on the 'managed IP backbone' as well as on public Internet, but subject to regulation & obligations at par with PSTN, such as USO contribution, whereas PC-to-PC voice over Internet called 'PC voice' is not regulated as a telephony service, but as computer application service. 1.7 The status of Internet Telephony in a few selected countries about which information could be collected from ITU publication or directly, are given below:

1.7.1 Malaysia:

1.7.1.1 Till last year, 29 licences were issued to provide IP Telephony service in Malaysia. PC-to-PC voice over public Internet is not treated as telephony and is exempted from normal licensing. Phone-to-Phone telephony over Internet or by way of VOIP as a technology option is treated as functionally equivalent to PSTN Telephony, as it involves a compulsory interface, i.e., gateway between the circuit switched network and the IP based network. Whereas PC-to-PC Internet Telephony is exempt from normal licensing, with no USO obligation, Phone-to-Phone telephony based on VOIP is licensed with license fee and USO obligation.

1.7.2 China:

1.7.2.1 Ministry of Information Industry (MII), until 1999 resisted the proliferation of IP Telephony services by declaring it illegal and hence IP Telephony only existed as grey market activities through ISPs, computer shops and local CATV networks. A lawsuit filed against the MII by a computer company, changed the scenario in this respect wherein 'Computer Service' was ruled not to be covered by relevant legislation.

1.7.2.2 In 1999, there was a major change when MII created licensing framework for Internet Telephony and issued licenses to their facility based operators (Government owned) such as China Telecom, China Unicom and Jitong to begin 6-month trial in 26 cities (later extended to one year), thus ending the long distance and international monopoly of China Telecom. During the trial phase there were several problems such as traffic congestion, dropped calls and the voice quality was poor due to speech compression. These problems were sorted out after network expansion and new management tools were implemented by all the service providers.

1.7.2.3 On 30th March 2000, China's MII granted license to China Telecom, China Unicom, Jitong and China Netcom for commercial operation of IP Telephony services. The new entrants i.e., China Unicom & Jitong have engineered their NLD networks based on VOIP backbones & offer long distance service through the use of cash cards by their customers.

1.7.2.4 With more than 50 percent of the villages still without basic telecommunications access, the Chinese Government is looking to IP Telephony as a low cost universal access solution. To ensure seamless operation of IP Telephony across the country, the Government has set up an IP Telephony standards group, consisting of 27 domestic telecommunication research institutes, and equipment manufacturers to establish a set of technology standards for IP Telephony in China.

1.7.2.5 At present, there are six managed VOIP operators who can be called facility based national carriers. The VOIP based long distance traffic in China has shown a growth rate of about 20% in 2001. Despite the impressive growth registered last year, voice traffic over IP is still quite small, compared to the total long distance traffic carried on the PSTN/ ISDN.

1.7.3 South Korea:

1.7.3.1 In South Korea, PC to Phone service over Internet was introduced by 'Dialpad' as a free service but could not sustain and the 'Dialpad' has since become bankrupt. The liberalization of IP Telephony & its bundling with broadband access has accelerated the deployment of broadband in South Korea. As the tariff for international calls has been rebalanced, arbitrage opportunities have disappeared and Internet Telephony operators are mainly concentrating in offering value added services on the IP platform.

1.7.4 Singapore:

1.7.4.1 In the city state of Singapore, there are 30 to 40 ISPs providing Internet Telephony. Main motivation for so many IP Telephony providers is the price arbitrage as PC-to-Phone based international calls result in 80% price saving, due to unbalanced tariff. The incumbent (Singtel) is offering three types of services i.e. pure PSTN, with VOIP backbone, Hybrid i.e. combining the Internet backbone with PSTN access network and Full IP i.e. PC to PC on the Internet. The QOS is specified for all three types of services, which are well differentiated. QOS is lower in case of Hybrid, and full Internet based voice service, in comparison to the so called 'pure PSTN' telephony.

1.7.5 Canada:

1.7.5.1 Canada is a highly competitive telecommunication market with a proactive regulator who is charged with the responsibility of ensuring a level playing field and also discharge of Universal Service Obligation. In this regard, there is some similarity between India & Canada.

1.7.5.2 In Canada, the advent of IP Telephony came after the liberalization of the long distance market. Instead of restricting IP Telephony, Canada incorporated certain types of IP Telephony in its universal service funding regime. As per decision of the Canadian Regulatory i.e. CRTC, phone-to-phone voice telephony service providers who use Internet or VOIP as a transmission media, should contribute to USO just like any other

telephony operator. However, 'pure Internet' Telephony service providers who provide PC voice service i.e., PC-to-PC and PC-to-Phone are exempt from USO contribution.

1.7.5.3 In order to decide the eligibility for USO contribution, CRTC tries to identify the point where the gateway function is located i.e. where the conversion from TDM to IP format takes place. If the conversion or gateway function is performed in the CPE, the call is considered PC voice. If it takes place in the Internet gateway /server of an ISP or IP Telephony calling card Service Provider, the call is treated as PSTN voice. Those offering such services must register with CRTC as resellers and make USO contribution. The contribution is not applicable when the call starts in a packet switched network and it is not converted to circuit switched network at all i.e., if it's a 'pure IP' call.

1.7.6. Hungary:

1.7.6.1 In Hungary, the incumbent MATAV's exclusive rights (until December 2001) to carry international public long distance voice telephony traffic can only be by-passed if the established speech connection qualifies as a "non-public-voice-telephony" connection and therefore the Hungarian regulator imposes quality degradation limits to prevent IP Telephony from becoming substitute for PSTN voice service.

1.7.6.2 To qualify as "non-public-voice-telephony", certain conditions are required to be met i.e minimum delay of 250 milliseconds, packet-loss more than 1% and drawing users attention to the quality parameters that differ from those of public voice telephony while publicising the service.

1.7.7. United States:

1.7.7.1 In early 1980s, the FCC exempted Enhanced Service Providers (ESPs) from paying access charges to local telecommunication carriers. This decision stimulated Internet expansion and as ISPs were categorized as Enhanced Service Providers (ESPs). In 1996, the US Congress passed the Telecommunications Act, which has classified Internet services as information services.

1.7.7.2 Recently, FCC reviewed its policy on Internet, and in particular IP Telephony in a Report known as Steven's Report in which the FCC preserved the unregulated status of IP Telephony. The Commission decided to determine on a case-by-case basis, whether certain Phone-to-Phone IP Telephony service, as opposed to PC-to-PC telephony, may be classified as telecommunication service. According to FCC, though phone-to-phone IP Telephony service appears to be functionally equivalent to PSTN voice telephony, these services are not covered by the telecommunication regulations.

1.7.7.3 Thus there is no explicit regulation on any type of Internet or IP Telephony service either at State or Federal Level. FCC adopts a "hands -off" policy in this regard. It uses Internet and IP Telephony as a tool to bring pressure on International settlement rate and consumer prices. The FCC Policy has raised many issues relating to level playing field. The Telecom Carriers Association have already taken this issue with the

Commission.

1.7.8 European Union:

1.7.8.1 Members of the European Union are mandated to maintain strict technological neutrality in regard to Internet Telephony. To be treated as functionally substitutable with PSTN voice, Internet Telephony is required to meet the reliability and quality of the PSTN speech and also to be provided from a circuit switched terminal (Phone to Phone), in addition to be offered as a main commercial public service. Presently, Internet based telephony is treated as an enhanced service application of Internet and not regulated due to its not meeting the above criterion, and also to avoid "Unpredictable Congestion Risk". There is a provision for a review of the present regulation, at a later date as and when the Quality of Service of Internet Telephony becomes substitutable with PSTN.

1.8 SUMMARY & CONCLUSIONS:

1.8.1 Based on the survey of the selected countries in pre-paras as well as inputs received from ITU, It would appear that the policies relating to Internet Telephony in developed & developing countries are not the same, the guiding factor being the state of development of the country concerned, degree of telecom liberalization, and prevailing regulatory/ market conditions etc..

1.8.2 In the Indian context, in order to address the level playing field issue of existing facility based operators as well as to allow the benefits of technology to the end users, the Authority would recommend that the facility based operators be permitted to deploy VOIP in their network as a technology option. This will provide the operators flexibility in terms of technology employed. At the same time, to promote the growth and foster open competition to allow the benefits of cheaper telephony to the customers, ISPs may be permitted to offer PC-to-PC, PC -to- Phone (abroad) services including use of SIP/ H.323 terminal to similar terminal in India or abroad.

1.8.3 The rationale behind recommendations on opening up of Internet Telephony is given in Section-II.

Section II

1. TIMING OF INTRODUCTION OF INTERNET TELEPHONY:

1.1 Based on the Authority's recommendations, the Govt. has decided to open the International Long Distance service market for open competition w.e.f 1.4.2001. In accordance with the recommendations, the ILD operators can deploy VOIP technology in their backbone networks, as an alternative to PSTN & offer two levels of service i.e., one toll quality and the other lower than toll quality. With Internet Telephony, i.e. from PC-to-PC and PC-to-Phone (abroad) service, the customer will get yet another choice to make international calls at an affordable rate. This will indirectly put pressure on ILD

operators to lower prices and to improve their service quality. Since the ILD sector will have open competition w.e.f. 1.4.2002, competition from Internet Telephony, would complement the basic thrust of the ILD policy, i.e. increased competition & provision of cheaper option of making long distance calls.

1.2 In the light of what has been stated above, the Authority is of the opinion that the opening of Internet Telephony market should be synchronised with the opening of the ILD service market, i.e., both should be opened w.e.f. 1st April, 2002. Accordingly, the Authority recommends as following:

Internet Telephony may be introduced with effect from 1st April, 2002 i.e. date of opening of the ILD sector for private participation.

2. SCOPE & DEFINITION OF INTERNET TELEPHONY SERVICE:

2.1 As a follow up to the World Telecom Policy Forum meeting held in Geneva last year, the ITU has set up a number of study groups to define 'IP Telephony'. Study Group 2 of ITU-T has defined IP Telephony as follows:

"IP Telephony is the exchange of information primarily in the form of speech that utilises a mechanism known as Internet Protocol". In accordance with this definition, 'Internet Telephony' derived from public Internet also called 'pure' Internet Telephony service and the one offered by facility based operators from their 'managed VOIP' networks is covered by the term 'IP Telephony'.

2.2 However, the Authority in its consultation paper has defined Internet Telephony as end-to-end telephony service utilising the resources of the public Internet, whereas 'VOIP' or IP Telephony has been categorised as a technology option, which any facility based operators can employ to engineer his network. A clear distinction between the two is important as 'managed VOIP networks' are capable of providing QOS, which can be specified and monitored and is capable of providing satisfactory service to the customers. Whereas, Internet telephony which is derived from the best effort public Internet is not capable of offering a specified level of QOS to the customers at present.

2.3 As indicated in Section-I of this memorandum, most countries treat PC-to-PC voice service, wholly derived from the Internet i.e., with no gateway between Internet & PSTN/ISDN as a voice application i.e., a value added service of the Internet and not a substitute of conventional telephony service.

2.4 The different types of voice services through public Internet are PC-to-PC, PC-to-Phone and Phone-to-Phone. For PC voice service on the public Internet, both PCs should be loaded with the same IP Telephony software & the two users should be logged on simultaneously. Although, Phone-to-Phone service through public Internet is possible by involving the local loop & access nodes (local exchange) of the BSOs, it can be treated as substitutable telephony service, and can seriously disturb the level playing

field and make a dent in the revenue streams of the existing BSOs, CMSOs, NLDOs, ILDOs, etc.

2.5 As per the deliberations during Open House discussions, majority view was that provision of PC to PC, PC to Phone voice services over public Internet are not substitutable service to conventional telephony, as the latter is entirely a different product. ISPAI also represented that PC to PC and PC to Phone Internet telephony should be treated as Application/ Content based service. On the other hand, Phone to Phone telephony over public Internet, though lacking in the quality, may be treated as a functionally equivalent service, and hence infringe upon the rights & obligations of the facility based operators. Also the provision of Phone to Phone telephony over Internet as well as Phone (abroad) to PC (India) will mean termination of incoming international calls without payment of any settlement rate, and hence will adversely affect the revenues of facility based operators, particularly ILDOs. The country may lose foreign exchange as well, as the settlements are received in foreign currency, mostly from USA.

2.6 In the light of what has been stated above and taking into consideration the urgent need of not disturbing the level playing field and the existing licensing regime, the Authority is of the view that the Internet Service Providers be permitted to offer 'PC voice' service over the public Internet, i.e. from PC-to-PC and PC-to-Phone (abroad) only, & not Phone-to-Phone. Since it is only a voice application service, there is no need to specify any QOS. Also the term PC in this context should encompass any Internet access device or terminal, capable of initiating a session with any other device or terminal, by IP addressing. In the interest of end-to-end seamless interoperability, the Authority would recommend use of H.323/SIP based terminals, for offering these services. As the quality of this service is not capable of being specified and the actual usage of this service is rather cumbersome, the subscribers need to be informed the modality of its use/& other details. In the light of what has been stated, the Authority would like to recommend as follows:

2.7 The Authority would like to define Internet telephony as an Application Service, which the customers of ISPs can avail from their Personal Computers (PC) capable of processing voice signals. Other IP based Customer Premises Equipment (CPE) such as H.323 terminals/SIP terminals which are directly connected to the ISP node through point to point links (wireless/optical fibre) in the last mile, as per existing stipulation in the ISP licence, can also be employed to offer Internet Telephony, through the public Internet. Similarly, access to the ISP node through the facilities of authorized Cable Operators shall be permitted subject to applicable Cable Laws. 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) and not E.164 numbering scheme of the ITU.

2.8 The scope of this service will include the following types of connections using the public Internet:

- i) PC to PC (Both within the country as well as abroad)**
- ii) PC to Phone (PC in India, Phone abroad)**
- iii) IP based H.323/SIP Terminals in India to similar Terminals both in India and abroad, employing IP addressing scheme of 'IANA'.**

2.9 The Authority is of considered view that at this stage of telecom development in the country, when the facility based operators such as Basic Service Operators including the incumbent, are obliged to provide telephones in uneconomic areas as well as uneconomic telephones in economic areas, to discharge their Universal Service Obligation (USO), it is important not to disturb significantly their revenue streams to which they are entitled in accordance with the stipulations in the Licences granted to them. It is, therefore, important to differentiate between the real-time telecommunication services offered by facility based operators, under their existing licences, and those offered by ISPs, which are multimedia applications & content services, not subject to strict time constraints of real-time telephony services. To have a clear distinction between Internet Telephony & telephony services offered by facility based operators under their existing licences, the latter may be defined as the provision of real-time voice communication from anywhere to anywhere by means of dialing a Generic Telephone Number (PSTN/ISDN/PLMN) as defined in E.164 recommendation of the ITU. Suitable modification to existing licences of the facility based operators as well as ISPs is recommended, to bring out this difference to avoid any ambiguity. Internet Telephony through PCs or IP based terminals should be made available also through the Public Tele-Info Centre (PTIC) & Internet Kiosks at Sanchar/Cyber Dhabas for the benefit of those who do not own the Customer Premises Equipment required for this service. This will make Internet Telephony an integral part of the USO programme on which the Authority has already given its Recommendations, and which includes provision of PTICs as an essential element, to help address the issue of digital divide. Internet Telephony through PTICs is likely to provide a cheaper option to conventional telephony, in rural & remote areas.

3. USE OF VOIP AS A TECHNOLOGY OPTION BY EXISTING FACILITY BASED OPERATORS.

3.1 In the licenses issued to BSOs/CMSOs in mid 1990s, circuit switching was presumably specified because of its proven ability to guarantee QOS to the customers as well their capability to offer a host of Tele & Supplementary services. These facility based operators have made significant investments in rolling-out their networks, and in paying entry and licence fees as well as performance guarantees in respect of rollout obligations set out in their licences. Comparable obligations are not inbuilt in the licences granted to ISPs, who are value added service providers with practically no licence fee / roll out obligations. The majority of the stakeholders, in the Open House discussions conducted by TRAI were of the view that facility based service providers should be permitted to deploy VOIP technology in their network by suitably amending their respective licences. This will enable them to engineer their network at a lower cost

and thus result in optimal utilization of their capital..

3.2 Taking a technology neutral approach, the Authority is of the view that the facility based operators be permitted to deploy VOIP to engineer their network equivalent to PSTN network, in respect of Quality of Service as well as capable of offering some tele/supplementary services as at present. For achieving a PSTN equivalent (toll) quality, a Mean Opinion Score (MOS) of four, which is rated as 'Very Good' and above (on a scale of 1 to 5, 5 being 'Excellent') is desirable. The VOIP network should also be transparent to the Fax and calls made from voice band Modems as is the case with PSTN based network.

3.3 To give greater flexibility to operators and more options to customers, the Authority is of the view that the facility based operators (CMSOs, BSOs, NLDOs) be permitted to offer a lower than toll quality voice service for customers who can accept some degradation in the voice quality at a lower price. For this category of VOIP based network, whose quality of service will be lower than the toll quality, the MOS should not be less than 3 (which is rated as 'Good'). In this case the subscriber should be made fully aware of the lower quality of service being offered and the lower tariff to enable him to make an informed choice.

3.4 This alternative will permit the usage of new technology with an objective of passing the benefit of technological development to customers. For the purpose of distinguishing and providing a choice to customers both these types of voice services will have to be offered by using different access codes.

3.5 The Authority is of the view that all other terms and conditions of the existing licence of the above service providers should remain unchanged, so as not to disturb the existing licensing regime, as the telecom service industry is in a nascent stage of development and needs a stable regulatory environment for some time.

3.6 In view of the above, the Authority would like to recommend as follows:

The Authority has taken note of the recent deployment of VOIP backbones by a number of carriers globally to provide NLD & ILD services, in their respective countries, as an alternative transport mechanism. In some countries, such deployment of 'managed VOIP' networks have replicated the carriage services traditionally provided by PSTN backbones and have provided a cheaper option to engineer the backbone networks. This has not necessitated any change in the licensing and regulatory regime, as the Tele & Supplementary services derived from the Access Nodes (ANs) remain the same i.e., as specified in the original licence, thus not disturbing the licensing regime. Such a deployment has the potential of providing integrated carriage services for not only voice but also data in not too distant a future, thus providing economy of scale and scope for the carriers in building their respective networks. It also enables the operating companies to gain experience of this new technology, which has potential of providing a converged service platform for multimedia services. The Authority

would therefore recommend that the existing facility based operators such as BSOs, CMSOs and NLDOs be permitted the option to deploy 'managed VOIP' backbones, as a means of providing various types of bearer services to derive the range of Tele and Supplementary services as specified in their respective licences, subject to meeting the quality of service norms specified by the Authority in its QOS Regulations issued from time to time.

4. Issues relating to Digital Divide:

4.1 A concern has been expressed that the digital divide could get wider, in case Internet Telephony is permitted to the ISPs. The apprehension in this regard is that if the ISPs, by providing Internet Telephony cause a serious dent in the revenue stream of the facility based operators, particularly the BSOs, the latter (BSOs) who have to meet the USO, they may not be able to do so, thereby adversely affecting programmes such as installation of PTICs in rural areas, recommended by the Authority to bridge the digital divide. The apprehension is that such a move may in fact widen the digital divide. Because of similar concerns, a large number of developing countries still do not permit Internet Telephony of any type. However, the Authority is of the view that VOIP Technology should be fully exploited to provide cost effective services without disturbing the existing licensing regime. Such a policy has successfully been adopted in China, where an explosive growth of NLD traffic was witnessed after deployment of VOIP Technology in the national backbone by facility based operators. By permitting Managed VOIP backbones as a substitute to the PSTN backbone, the Authority would like to bring in greater technology neutrality in regard to engineering of networks by operators. Such an approach is likely to give the facility based operators, the ability to deploy the most cost effective technology option in their service areas, thus improving the teledensity in these areas, and reducing the digital divide, besides exposing the country & its R&D institutions to this new technology. Any cost saving in the backbone should enable the operator to invest more in the access network, i.e. the last mile, thus extending the telecom network to rural & remote areas.

4.2 In the light of what has been stated above, the Authority recommends that the facility based operators i.e. BSOs & NLDOs, CMSOs be permitted to employ 'managed VOIP' backbones in their networks, subject to their meeting the existing norms in respect of voice quality, grade of service etc., so as to provide end to end toll quality service. For achieving toll quality service, a Mean Opinion Score (MOS) of 4 and above (on a scale of 5) should be stipulated. The 'managed VOIP' backbone should be transparent to Fax as well as calls made from voice band modems, as is the case with existing PSTN networks.

4.3 To give greater flexibility to operators and more options to customers, the Authority recommends that the facility based operators be permitted to also offer a 'lower than toll quality' telephony service for customers who are prepared to accept some degradation in the voice quality, by engineering a separate 'managed VOIP' backbone accessible by a different service code. On this backbone, the quality of service offered may be 'lower than toll quality i.e. with

MOS less than 4, but greater than 3. The subscriber should, however, be made fully aware of the lower quality of service being offered and the lower tariff applicable for such a service, as well as its distinctive service code.

5. Quality of Service (QOS):

5.1 The Quality of Service (QOS) of real time voice services derived from VOIP networks, in case codecs other than G.711 are used in the VOIP gateways, are still not comparable to that of PSTN/ISDN. Apart from the degradation caused by compression & silence suppression by codecs (vocoders), use of Public Internet as a transmission media involving connectionless hops of tens of routers, can cause end-to-end delays in excess of 400 ms causing serious degradation in voice quality. This is mainly due to the fact that the Public Internet was originally designed to carry only delay insensitive data traffic, and its network elements were not QOS enabled. The real problem with the present day Internet is that it cannot be optimally dimensioned for specified Grade Of Service (loss/ delay) on the lines of PSTN. It has to be noted in this context that data traffic is essentially bursty for which dimensioning rules such as Erlang's formula are not available. The real-time voice traffic for most of the applications is very sensitive to total end-to-end delay which should normally not exceed a maximum limit of 150 ms one way. It is also quite sensitive to the variability of delay (called 'jitter') and packet loss, which are inherent characteristics of any IP based network.

5.2 These deficiencies are being addressed by a Special Working Group of the Internet Engineering Task Force (IETF) and ITU. Although, a host of protocols such as RSVP (Resource Reservation Protocol), DIFFSERV (Differentiated Service) and MPLS (Multi Label Protocol Switching) have been drafted to provide QOS on a managed IP Network, network elements based on these protocols are yet to be deployed on the public Internet.

5.3 A number of international telephony carriers/operators such as British Telecom, Belgacom in Belgium and Telefonica in Spain have deployed managed VOIP networks, which provide quality of service equivalent to PSTN. Some of these networks such as that in Spain do not permit any compression on the VOIP backbone so that there is no deterioration in the quality of speech.

5.4 Another engineering issue relating to VOIP networks is the lack of a common standard for Media Gateway, Gateway Controller & Gate Keeper which are the subsystems used in a VOIP based network. Also presently the various sub-systems of VOIP based network are not capable of providing various tele & bearer services which PSTN based system can provide through IN platform. The Media Gateways & Media Gateway controllers are also not capable of delivering Class 5 functionality, which is required for interfacing with the local loop and POTS. These are two competing standards for the above sub-systems, one called H.323 finalised by ITU in 1990s is more mature & deployed in VOIP backbones in North America /Europe, the other one being drafted by IETF called 'SIP' is still immature and very few products are available in the market. However, it has the potential of gaining wider acceptance in the long run,

because of its capability to provide a large number of value added services such as unified messaging. The multiplicity of these standards and their different versions is likely to create interoperability problems between carriers, for quite sometime. It is important in this context that our country plays its important role in these standardization activities, which are so vital for seamless working of VOIP networks.

5.5 Emphasising a technology neutral approach, the Authority would like to stress that in the interest of consumers, the operators like BSO, CMSO & NLDO should be permitted to engineer their managed VOIP networks to guarantee a minimum specified quality of service as an alternative to Circuit Switched technology (PSTN).

5.6 To clearly distinguish between the various services, it will be appropriate to have different QOS specified for different categories of voice services, i.e. one for 'toll quality' and another for 'lower than toll quality'

5.7 For "toll quality" VOIP network, the voice quality should be comparable to the PSTN quality in respect of both subjective and objective measurement criteria.

5.8 PSQM (Perceptual Speech Quality Measure) defined by ITU-T Recommendation P.861 is one of the techniques for objectively measuring voice quality. For subjective measurement of MOS (Mean Opinion Score), ITU-T Recommendation P-800 is applicable, wherein the Mean Opinion Score derived from evaluation of pre-selected voice samples is rated on a scale of 1 to 5 with 1 being worst and 5 being excellent. For "Toll quality", the minimum MOS should be 4 (rated as 'Very Good').

5.9 Another, emerging QOS standard determined by ITU has resulted in creation of an 'E-Model' for estimating the voice quality of IP Telephony. The output of the 'E-Model' is a scalar "transmission rating factor" called the "R-Value", which is repeatable and can be calculated in real-time from measurable channel and equipment characteristics. 'R-Value' can also be co-related to MOS with a great degree of accuracy. This provides the service providers a mechanism for measuring the quality of their service and relating it accurately to perceptions of their users. The highest score for 'R-Value' is taken as 100, and the quality degradation score for equipment and channel characteristics is subtracted from 100 to yield an overall 'R'. The 'E-Model' generates a maximum attainable 'R' of 94 corresponding to an MOS of 4.5. An 'R' value of 80 correspond to an MOS of 4.0 which is the speech quality most users perceive as satisfactory. Recent technology developments have made it possible to develop measurement tools based on 'E-Model' as an integrated part of the service providers network management system enabling the measurements to be performed by non-intrusive method in real-time.

5.10 In the light of what has been stated above, there is an urgent need to study all aspects of QOS relating to VOIP networks as well as issues relating to seamless interworking of various VOIP networks based on open standards.

5.11 The Authority would therefore like to recommend as follows:

The Authority in its recommendations in previous sections has laid special emphasis on customer's right to get a specified Quality of Service (QOS) from a 'Managed VOIP' backbone, deployed by Facility based operators. Issues relating to QOS and standards relating to VOIP network, need to be studied in detail, both in regard to performance parameters and their monitoring in real time as well as specification of Network - Network Interface (NNI) between PSTN & IP Networks. The Authority therefore, recommends setting up of a high level technical committee under the aegis of TRAI with the participation of experts from TEC as well as Telecom/IT industries to carry out an in-depth study and issue detailed guidelines for monitoring of voice quality both by objective (R-Value) as well as subjective (MOS) methods, to ensure that the VOIP networks are engineered to meet the customers' expectations of voice quality on both types of networks i.e. one for the 'toll quality' and the other for 'lower than toll quality'. The Committee would also define technical interfaces for VOIP gateways in conformance with best international practice, so that seamless interoperability between various types of networks in a multi-operator environment is ensured. In this context, the Authority would like to mention that generally the customer's expectation from any new technology is quite high, and therefore the issues relating to network performance, QOS as well as seamless interoperability would need to be addressed urgently.

6. TARIFF:

6.1 The tariff for the VOIP based "toll quality" service should be same as PSTN, being a fully substitutable service, while that for VOIP based 'lower than toll quality service should be lower than that for the 'toll quality' service, being of lower quality than PSTN.

6.2 The determination of tariff for VOIP based service, specially with lower than 'toll quality' needs lot of details regarding network element costs and operational cost which are not available for the present in respect of our country. Therefore, to start with it will be appropriate to forebear this allowing market forces to determine this. At a later stage, when cost related data for VOIP network in respect of country becomes available, it should be possible to specify the tariff for this category.

6.3 Tariff for the 'best effort' Internet Telephony service should also be left unregulated to be decided by the market forces, on the same line as the Data Services based on Internet, this being another value added application based service.

6.4 In view of the above, the Authority recommends the following:

The tariff for the VOIP based 'toll quality' service offered by facility based operators should be same as that for equivalent PSTN based services. For VOIP based 'lower than toll quality' service, the tariff should be lower than that for the 'toll quality' service. It should be provided through a different dialing code. The Authority would initially let the market determine the tariff for 'lower than toll quality' service. The Authority would also forbear with respect to tariff for Internet Telephony offered by ISPs over public Internet, because of sufficient competition

in the ISP market, where the entry barrier is practically non existent, and also because at present, it is not functionally equivalent to the telephony (real-time) services offered by facility based operator