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# VoIP: Revolution in Telecommunication

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# VoIP: Revolution in Telecommunication

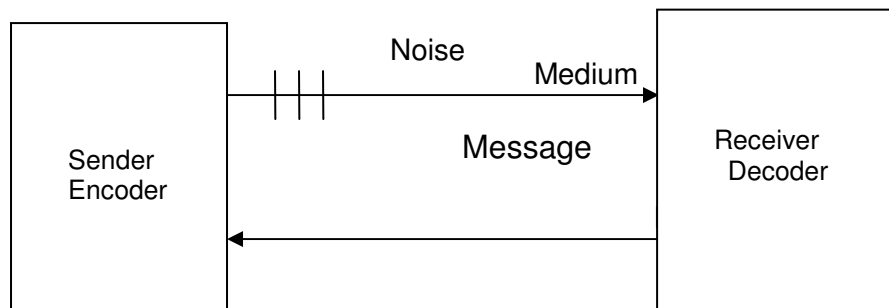
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**Abstract:** This working paper explores the concept of VoIP – what it is, the requirements to use it (hardware & software), features, applications and its scope. This study was done using Internet sources, books and magazine. Non-technical individuals will also be able to understand the concept of VoIP. This paper has been benefited from suggestions given by Dr.Vandita Dar & Prof. K.T. Upadhyaya.

## Introduction

***“Communication is the life blood of an Organisation.”***

Communication has always been one of the basic needs of human beings. They communicate through verbal and non-verbal signals. The process of communication is as shown in the following diagram.



In the above model sender encodes the message and sends it through some medium. Many a times some noise also gets associated with the messages and goes to the receiver. Receiver receives the message, decodes the message, and if possible filters the noise. After interpreting the message receiver sends the feedback to sender.

Factors driving communication.

1. Covering longer distance.
2. Maintaining low cost.
3. Being synchronous.
4. Being secure.
5. Speed of communication
6. Redundancy.

Depending upon above factors human beings have adopted several methods to execute this model in practice.

In early years, when there was no language developed, people used to communicate with actions. After few years' language was developed, then people used to use face to face communication using verbal & non-verbal methods. But here distance was a major obstacle. To communicate over longer distance people played drums and conveyed their messages. As the distance increased again pigeon played a role of post man & carried the letters & hence communication was done. There are other ways of communication like

painting on the walls to tell the stories or messages, conveying message through smoke etc. but then there are chances of wrong interpretations of the message.

Now, people wanted to communicate over longer distances without commuting the distance at the low cost & faster speed. The challenges in communication are increasing as it competes with commuting.

In 1876, Alexander Graham Bell played a major role in voice communication & came out with a revolutionary invention called 'Telephone'. One after another inventions followed like Telegraph, Radio, computers etc.

The architecture of today' s Public Switched Telephone Network (PSTN) is a direct successor of the original manned switchboards of Bell' s days. Voice is transmitted in one way:

Sampled in 8-bit bytes, 8000 times a second, for an aggregate rate of 64 Kbps. The entire telephone network is designed around this rate and for this one type of traffic voice.

PSTN is a circuit-switched architecture: a direct connection is closed between two users. The users have exclusive and full use of the circuit until the connection is released. The connection is bi-directional with very low delay between the two end points.

PSTN was designed for circuit switching of voice calls. This fact makes it very difficult to add new services to the network, or change traffic handling methods. Another major disadvantage of circuit switching is that once a circuit is established, it consumes the full-predefined bandwidth, no matter if the call contains many silent periods. The increasing difficulties in maintaining the existing networks and upgrading them to many new demands together with the inefficient bandwidth usage, has driven the market to seek after a new architecture. The demand was for a technology that will enable easy and rapid growth and updating, together with efficient use of bandwidth that will enable more simultaneous connections with larger volumes on the same bandwidth.

During the early 90' s the Internet was beginning its commercial spread. The Internet Protocol (IP), part of the TCP/IP suite (developed by the U.S. Department of Defence to link dissimilar computers across many kinds of data networks) seemed to have the necessary qualities to become the successor of the PSTN. IP works in a packet-switching method: the data is sliced and bundled into packets (pieces of information). These packets are transmitted from the source end-point to the destination end-point by moving from router to router until they reach their destination. No circuit is closed between the two end points as in the circuit-switched PSTN. IP as a connectionless mode is very efficient because no bandwidth is spent when there is nothing to transmit. When transmission is needed, IP enables using all the free bandwidth. Another big advantage of IP - it enables easy and rapid network growth and updating, because of the IP design. It is possible to add features to a part of the network without changing other parts. The great efficiency in the use of bandwidth causes problems when dealing with voice. Real-time transmission needs constant rates with small (known) delays, otherwise the conversation sounds abnormal. Other problems that might occur in IP: packet loss due to routers overflow, packets arrive out of order due to different routes, causing unacceptable delays. These problems do not appear in PSTN because real-time transmission is inherent in circuit-switched networks.

The concept of VoIP (Voice over Internet Protocol) originated in about 1995 by the company called VocalTec, when hobbyists began to recognize the potential of sending voice data packets over the Internet rather than communicating through standard telephone service. This concept allowed PC users to avoid long distance charges, and it was in 1995 that the first Internet Phone Software appeared. The idea was to compress the voice signal and translate it into IP packets for transmission over the Internet. This "first generation" VoIP application suffered from delays (due to congestion), disconnections, low quality (both due to lost and out of order packets) and incompatibility. VocalTec' s Internet phone was a significant breakthrough, although the application' s many problems prevented it from becoming a popular product.

Since this step IP telephony has developed rapidly. The most significant development is gateways that act as an interface between IP and PSTN networks. Later developments are gatekeepers and Multi-point Control Units that have more advanced tools for VoIP communication.

Now, what is this VoIP exactly? Voice over Internet Protocol (also called VoIP, IP Telephony, Internet telephony, and Digital Phone) is the routing of voice conversations over the Internet or any other IP-based network.

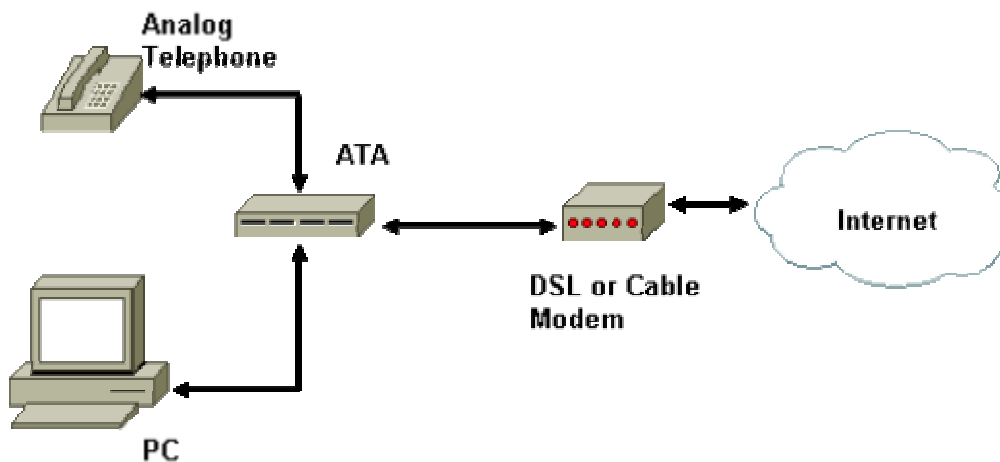
VoIP is a combination of hardware and software that enables people to make telephone calls via the Internet, your phone or computer must be connected to the Internet to make these calls.

### **Basic equipment used for VoIP<sup>1</sup>:**

To make a VoIP call the only additional piece of equipment that a typical setup will need is an Analog Telephone Adaptor (or ATA), which is usually supplied by the VoIP service provider when you sign up for service.

This allows you to make phone calls as normal, using your own standard phone. The ATA does the clever conversion of your analog voice to a digital signal that the Internet can understand. It then sends that signal on to your Broadband Modem, which passes it over the Internet.

A typical residential VoIP solution looks like this:



VoIP (Voice over Internet Protocol) transforms your high speed Internet service into an inexpensive way to send and receive calls. You use your regular phone handset, and the calls sound just as good. The difference is the way the calls travel. VoIP uses an adapter to convert voice signals into data packets for Internet transmission.

Traditional phone service sends calls over the telephone network via copper wire phone lines. VoIP sends calls over the Internet via your broadband connection.

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<sup>1</sup> <http://www.whichvoip.com>

To send voice calls over the Internet, VoIP needs to convert them into data. It does this with an easy to install telephone adapter (provided as part of your neighbourhood Broadband Calling service).

## Why use Broadband Internet Service<sup>2</sup>?

There are many reasons why Broadband internet service is desirable over your dial up modem. One of the main advantages is that broadband internet access is much faster than dial up speeds. For the people who are new to broadband internet service you may be wondering what this 'Broadband' is. Well, the term '**Broadband**' is used to describe any kind of **high speed internet** access service. The main types of Broadband internet access technologies that are introduced below are 'DSL Service' and 'Cable Internet'. These are commonly used technologies by both business and residential customers. The following provides a summary of some of the main reasons why Broadband Internet service is the best choice:

- **Internet Speed:** Broadband internet speed is typically 10 to 30 times **FASTER** than dial-up modem connections. Internet speed is an important factor when using the internet. The faster your internet speed the faster you can view websites on the internet, the faster you can download MP3 music files, the faster you can download photographs emailed from family and friends, and the faster you can download Microsoft updates, to name but a few. With a broadband internet service, these types of applications can take seconds rather than minutes/hours with a dial up connection.
- **Always-on:** Broadband internet service is an 'always on' connection. This means that 24 hours a day and seven days a week you will have instant internet access when your computer is powered on. No more trying to connect with user names and passwords or trying different dial-up numbers to find the best connection or after annoying busy tones.
- **You can use your telephone line:** With broadband internet service you can 'surf' the internet without tying up your phone line. No more missed calls or logging off your dial-up connection to make an important phone call. DSL service technology does not affect your normal phone line usage. You can talk to family and friends while you download your favourite MP3 audio soundtrack from the internet.
- **More than 1 computer:** With broadband internet service you can link several computers together on the same connection. This can be useful if your spouse or kids have a PC separate from yours and want to use the internet at the same time. This can also be useful for small businesses that require more than one PC for the employees/owners.
- **Applications:** High speed internet access opens up a whole new world of applications and use for your computer whether from a residential or business focus. For residential users this can include applications from internet games with other gamers on the other side of the world, or sending large files such as photographs to family and friends via email. These types of applications would be painfully slow or just unusable with dial-up internet speed. For business users this can include applications such as videoconferencing and telecommuting.
- **VoIP (Broadband Phone Service):** Broadband internet service is the only requirement for Voice over Internet Protocol (VoIP), also known as Broadband Phone Service. VoIP can be used to replace your traditional phone line. VoIP broadband phone service uses your high speed internet access to 'carry' your voice call, rather than like your ~~normal~~ telephone service that uses your dedicated phone line.

There are two types of broadband services:

1. **DSL Broadband Services:** DSL stands for Digital Subscriber Line. DSL service is a technology for bringing high-bandwidth broadband internet service to homes and small businesses over ordinary copper telephone lines.

Some advantages of DSL service are as follows:

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<sup>2</sup> <http://www.whichvoip.com>

- DSL service is "always-on" and you can still use the phone line for voice calls.
- Broadband speed is much faster than dial-up service.
- DSL service can use the phone line you already have at your home or business.
- A DSL modem is typically supplied to you by your DSL service internet provider.
- Fixed monthly billing, regardless of usage time.

Some disadvantages of DSL service are as follows:

- DSL service works better the closer you are to the central office that the internet provider uses.
- DSL service is not symmetrical in that the uplink internet speed is slower than the downlink internet speed.
- DSL service is not available everywhere.
- DSL service currently requires a local telephone line connection.

2. **Cable Broadband Services:** Cable internet is a technology for bringing high-bandwidth broadband internet service to homes and small businesses over your cable TV line.

Some advantages of Cable internet service are as follows:

- Cable internet service is "always-on" and you can still watch your TV channels.
- Broadband speed is much faster than dial-up service.
- Cable internet service can use the cable outlet you already have at your home or business.
- A Cable modem is typically supplied to you by your Cable internet provider.
- Fixed monthly billing, regardless of usage time.
- The distance between you and your internet provider will not affect your internet speed.

Some disadvantages of Cable internet service are as follows:

- Cable internet service is shared between you and other people on your network segment.
- Cable internet service is not symmetrical in that the upload (send) internet speed is slower than the download (receive) internet speed.
- Cable internet service is not available everywhere.

## Protocols used in VoIP:

Although many aspects of IP Telephony remain unstandardised, some standards are now beginning to emerge. It is important when considering an IP Telephony solution that, wherever possible, the emergent standards are supported to facilitate interoperability with other existing products and future releases. There are many protocols in existence but the main ones are considered to be the following:

- H.323 is an ITU (International Telecommunications Union) approved standard which defines how audio /visual conferencing data is transmitted across a network. H.323 relies on the RTP (Real-Time Transport Protocol) and RTCP (Real Time Control Protocol) on top of UDP (User Datagram Protocol) to deliver audio streams across packet based networks.
- G.723.1 defines how an audio signal with a bandwidth of 3.4 KHz should be encoded for transmission at data rates of 5.3Kbps and 6.4Kbps. G.723.1 requires a very low transmission rate and delivers near carrier class quality. This encoding technique has been chosen by the VoIP Forum as the baseline Codec for low bit rate IP Telephony.

- G.711. The ITU standardised PCM (Pulse Code Modulation) as G.711. This allows carrier class quality audio signals to be encoded for transmission at data rates of 56Kbps or 64Kbps. G.711 uses A-Law or Mu-Law for amplitude compression and is the baseline requirement for most ITU multimedia communications standards.
- Real-Time Transport Protocol (RTP) is the standard protocol for streaming applications developed within the IETF (Internet Engineering Task Force).
- Resource Reservation Protocol (RSVP) is the protocol which supports the reservation of resources across an IP network. RSVP can be used to indicate the nature of the packet streams that a node is prepared to receive.

### **Requirement of Hardware for VoIP<sup>3</sup>:**

To set up a little VoIP system the following hardware is needed:

- A PC, 386 or more
- A sound card, full duplex capable
- A network card or connection to internet or other kind of interface to allow communication between 2 PCs

All these have to be present twice to simulate a standard communication. The tools above are the minimal requirement for a VoIP connection.

Real situation

Next we'll see that we should use more hardware to do the same in a real situation. The sound card has to be full duplex unless we couldn't hear anything while speaking! Additional hardware cards can be used to be able to manage data stream in a compressed format.

Hardware accelerating cards

Special cards with hardware accelerating capability can be used. They are:

- Quicknet PhoneJack
- Quicknet LineJack
- VoiceTronix V4PCI
- VoiceTronix VPB4
- VoiceTronix VPB8L

Quicknet PhoneJack is a sound card that can use standard algorithms to compress audio stream like G723.1 (section 4.3) down to 4.1 Kbps rate. It can be connected directly to a phone (POTS port) or a couple mic-speakers. It has an ISA or a PCI connector bus.

Quicknet LineJack works like PhoneJack with some additional features.

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<sup>3</sup> <http://www.voip-voice-over-ip.com/solutions/requirements.htm>

VoiceTronix V4PCI is a PCI card pretty like Quicknet LineJack but with 4 phone ports  
VoiceTronix VPB4 is an ISA card equivalent to V4PCI.  
VoiceTronix VPB8L is a logging card with 8 ports.

#### Hardware gateway cards

Quicknet LineJack and VoiceTronix cards can be connected to a PSTN line allowing VoIP gateway feature. Software will then be needed to manage it.

## Software requirement

We can choose what O.S. to use. The most common are the following:

- Win9x, Win2000, WinXP
- Linux

Under **Windows** we have Microsoft Netmeeting, Internet Phone, DialPad or others or Internet Switchboard for Quicknet cards. Note well, however, that the latest Quicknet cards using Swithboard (older version too) NEED to be connected to Internet to get working for managing Microtelco account (not free of charge), so if you plan to remain isolated from the Internet you need to install OpenH323 software.

Under **Linux** we have the free software GnomeMeeting, a clone of Microsoft Netmeeting, while in console mode we use (also free software) applications from OpenH323 web site: simph323 or ohphone that can also work with Quicknet accelerating hardware. Note that all Openh323 source code has to be compiled in a user directory (if not it is necessary to change some environment variable).

#### Gateway software

To manage gateway feature (join TCP/IP VoIP to PSTN lines) you need some kind of software like this:

Internet SwitchBoard (only when connected to Internet) for Windows systems also acting as an H323 terminal;

PSTN Gw for Linux and Windows systems you download from OpenH323.

#### Gatekeeper software

The following can be chosen as gatekeeper:

Opengatekeeper

Openh323 Gatekeeper (GK)

#### Other software

An example of useful h323 compliant software is Phonepatch, which is able to solve problems behind a NAT firewall. It simply allows users (external or internal) calling from a web page (which is reachable from even external and internal users): when web application understands the remote host is ready, it calls (h323) the source telling it all is ok and communication can be established. Phone patch is proprietary software (with also a demo version for no more than 3 minutes long conversations).

## Flavours of VoIP<sup>4</sup>:

The interesting thing about VoIP is that there is not just one way to place a call. There are three different "flavours" of VoIP service in common use today:

- **ATA** - The simplest and most common way is through the use of a device called an ATA (analog telephone adaptor). The ATA allows you to connect a standard phone to your computer or your Internet connection for use with VoIP. The ATA is an analog-to-digital converter. It takes the analog signal from your traditional phone and converts it into digital data for transmission over the Internet. Providers like Vonage and AT&T CallVantage are bundling ATAs free with their service. You simply crack the ATA out of the box, plug the cable from your phone that would normally go in the wall socket into the ATA, and you're ready to make VoIP calls. Some ATAs may ship with additional software that is loaded onto the host computer to configure it; but in any case, it is a very straightforward setup.
- **IP Phones** - These specialized phones look just like normal phones with a handset, cradle and buttons. But instead of having the standard RJ-11 phone connectors, IP phones have an RJ-45 Ethernet connector. IP phones connect directly to your router and have all the hardware and software necessary right onboard to handle the IP call. Soon, Wi-Fi IP phones will be available, allowing subscribing callers to make VoIP calls from any Wi-Fi hot spot.
- **Computer-to-computer** - This is certainly the easiest way to use VoIP. You don't even have to pay for long-distance calls. There are several companies offering free or very low-cost software that you can use for this type of VoIP. All you need is the software, a microphone, speakers, a sound card and an Internet connection; preferably a fast one like you would get through a cable or DSL modem. Except for your normal monthly ISP fee, there is usually no charge for computer-to-computer calls, no matter the distance.

## Features of VoIP<sup>5</sup>:

At a very high level of companies that require distance collaboration, healthcare, education, BPO, hotel industry VoIP can be bundled with videoconferencing.

VoIP gives the following features.

### Flexibility

With VoIP, you can make a call from anywhere you have broadband connectivity. Since the IP phones or ATAs broadcast their info over the Internet, they can be administered by the provider anywhere there is a connection. So business travellers can take their phones or ATAs with them on trips and always have access to their home phone. Another alternative is the softphone. A softphone is client software that loads the VoIP service onto your desktop or laptop. The Vonage softphone has an interface on your screen that looks like a traditional telephone. As long as you have a headset/microphone, you can place calls from your laptop anywhere in the broadband-connected world.

### Price

Most VoIP companies are offering minute-rate plans structured like cell phone bills for as little as \$30 per month. On the higher end, some offer unlimited plans for \$79. With the elimination of unregulated charges and the suite of free features that are included with these plans, it can be quite a savings.

Most VoIP companies provide the features that normal phone companies charge extra for when they are added to your service plan. VoIP includes:

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<sup>4</sup> <http://computer.howstuffworks.com>

<sup>5</sup> <http://computer.howstuffworks.com>

- Caller ID
- Call waiting
- Call transfer
- Repeat dial
- Return call
- Three-way calling

There are also advanced call-filtering options available from some carriers. These features use caller ID information to allow you make a choice about how calls from a particular number are handled. You can:

- Forward the call to a particular number
- Send the call directly to voicemail
- Give the caller a busy signal
- Play a "not-in-service" message
- Send the caller to a funny rejection hotline
- Customized ringing tones
- One-touch soft keys to turn features on and off - no need to remember \* or # feature codes
- Line indicators on multi-line sets show when a line is being used and which line has a voice mail message

With many VoIP services, you can also check voicemail via the Web or attach messages to an e-mail that is sent to your computer or handheld. Not all VoIP services offer all of the features above. Prices and services vary so if you' re interested, it' s best to do a little shopping.

### **Advantages of VoIP<sup>6</sup>:**

You get to make free long distance calls, and you get all the free features such as caller id, call waiting, three-way calling, voice mail and more.

VOIP cost about half the cost of traditional phone services and it seems that the taxes and surcharges are much lower. Also your bill is easier to understand and it can be viewed via the Internet. You can track all of your incoming and outgoing calls and the minutes that you are using with real time reporting.

Great instant online and phone customer support that is far better than the service that you receive through the big companies. There are no holding problems, delays, or automated calls.

### **Disadvantages of VOIP services**

Sometimes you hear an echo sound through your phone; it sounds like you are repeating yourself. Also if your cable or DSL goes out, so does your phone line.

There is no emergency reliability. Maybe you will never need it, but if you have to use 911, you have to give exact address and name. They have a hard time tracking where you are and this could cost you valuable seconds.

You must have a DSL router or a second computer set up to run a second phone line. With traditional phone services, a phone jack is in almost every room.

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<sup>6</sup> <http://www.why-switch-to-voip.com>

## **Issues involved in VoIP<sup>7</sup>:**

As with any new technology, VoIP has several issues that effect its adoption and deployment. VoIP does not offer the same quality of service as direct telephony connections do. There are problems with reliability and sound quality, due to limitations in Internet bandwidth and current compression technology. In addition, there are problems with connectivity, security, disability access, and emergency access. While VoIP is viewed as a cheaper and more efficient alternative to traditional telephone use, there are concerns about the long term cost of the software, hardware and infrastructure used in the technology.

There is no separate power supply for Internet service, including IP Telephony or VoIP. If the power goes out so does VoIP if the service provider does not offer backup power. This can be a major issue for those who need to use their telephone after the power goes out to contact their electrical company to report a power outage or to call an ambulance in the case of an emergency.

Most VoIP systems cannot properly handle outgoing calls from fax machines, TiVO boxes, satellite television receivers, alarm systems, conventional modems or fax modems, and other devices that depend on access to a voice-grade telephone line for some or all of their functionality. H.323 does address and remedy some of these concerns since it does include voice, data, and video transfer. However, not all VoIP service providers use H.323 protocol. The technical aspects of accounting, billing, and charging are still problem areas for VoIP service providers. The inability to quickly and easily calculate and bill VoIP users is preventing the broad commercial deployment of VoIP to individuals. As Congress debates whether Internet Services should be subject to taxation, their decision may affect costs of VoIP. Currently no taxes are paid for VoIP computer calls.

In India, VoIP is still not allowed on the public domain Internet. Despite the inherent advantages the VoIP offers, there are bottlenecks that impede the technology's growth in India. Currently in India, companies are not allowed to use the exchange (Private exchanges in offices) for connecting both the local telephone & data networks. Nevertheless, the same is allowed in closed user groups (CUGs)<sup>8</sup>.

## **Applications of VoIP<sup>9</sup>:**

### **VoIP in Home**

A number of companies offer VoIP calling services that can be used in the home, more or less replacing conventional PSTN service. They deliver telephone calling capabilities using a broadband Internet connection. Not all of them permit placing calls to or receiving calls from PSTN, but almost all allow you to call other users of the same service using Internet instead of the PSTN.

### **VoIP in Business**

Many vendors are producing cost-effective VoIP server devices for small Ethernet-LANs. These devices connect together endpoints in a small office like a PBX, either through the use of conventional analog & digital phones or new generation IP phones. Using VoIP in small business environment is easier when there's some network savvy around the office.

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<sup>7</sup> <http://www.unc.edu>

<sup>8</sup> The new ring on the Internet, Indian Management, Feb 2006

<sup>9</sup> Switching to VoIP- Ten Wallingford

## **VoIP in educational institutions**

In educational and management institutes alike, VoIP is used in almost all major activities like admissions, exams & placements.

In admission process, after CET, generally institutes conduct their own Group Discussion/Personal Interview. If the institute is having the service like VoIP, students don't need to come all the way from different places for Group Discussion or Personal Interview, they can give their GD/PI from their workplace or probably from home.

For delivery of lectures or for distance education, VoIP will be of great utility. For example, if students are spread over various locations for their summer placements or executive placements, VoIP can be effectively used in engaging sessions with resource persons located elsewhere. Similarly vivas and interactions or question-answer sessions with faculty can be conveniently arranged through VoIP. VoIP would also facilitate tie-ups and exchange programmes between universities and institutes across various cities and countries. In case of placement activities too interviews can be arranged for students on-campus especially in the case of corporate situated elsewhere. Further, for research work which is emerging as the core area form many academic institutes; VoIP can be of immense help in getting access to voluminous data world-wide as well as tapping on the expertise of resource persons on a global scale.

## **Future of VoIP<sup>10</sup>**

It is clear that VoIP in general has a great future. Worldwide there is connectivity. If you look as it in terms of deployment from the carrier side and operational side, there is a huge advantage over there

Large & small enterprises will benefit from VoIP in the long-term if they fully utilise their data network for voice calls as well. It is marvellous to see the network do wonders even during disasters like Katrina when all telecom switches crashed in America.

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<sup>10</sup> The new ring on the Internet, Indian Management, Feb 2006