To my parents , specially to my father , ENG . Mohammed Riyal .

To my family , my friends ,and all my teachers .

Tamer Riyal

- B-ISDN services are categorized as:
  INTERACTIVE

Abstract

This project is a graduation project "com 400 ", which it is about ISDN which it is a kind of network or communication , and because of the importance of network and communication I interested to write some thing about it , so I hope my project to be useful to all students in computer engineering and any student who is interesting to know a little bit about ISDN .

THANK YOU

INTRODUCTION

The telephone, which was invented more than one hundred years ago, has become a common feature in every home today and indispensable in the society for voice communication. Thereafter, facsimile communication, data communication and image transmission have been developed, however those services are provided through independent networks as shown in Figure 1.

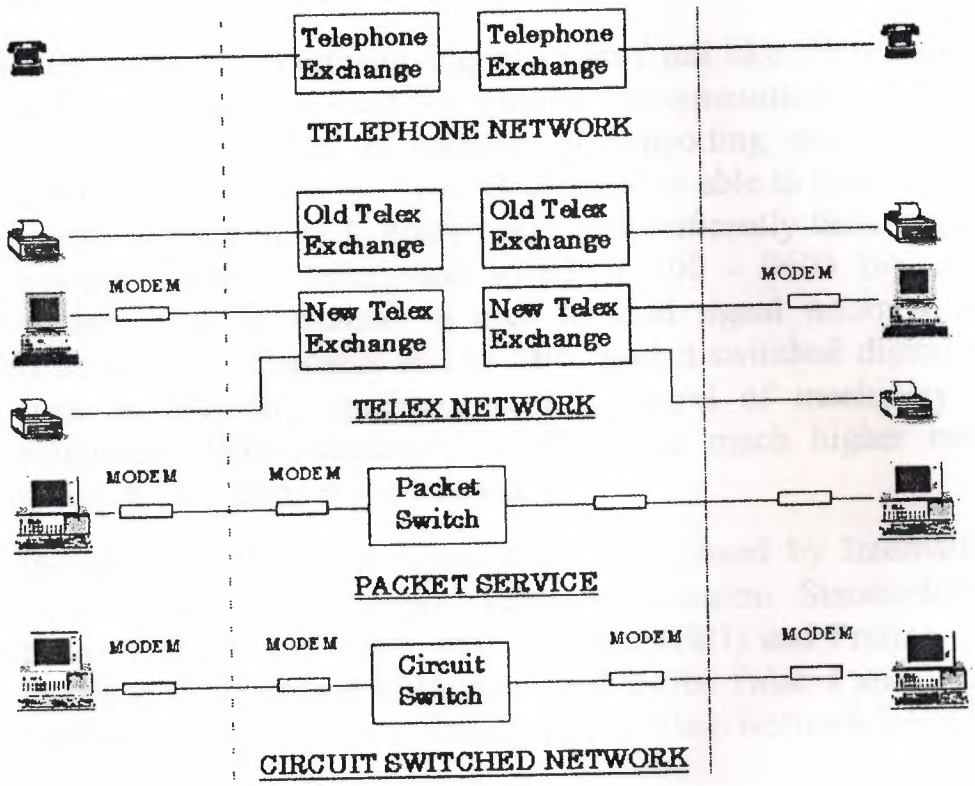


Figure 1
EXISTING STATE OF TELECOMMUNICATION NETWORK

ISDN has been developed to overcome these problems. The abbreviation "ISDN" stands for the internationally adopted term of the "Integrated Services Digital Network" and it integrates the various dedicated networks of today into one common network with standard interface. This is shown in Figure2

To the telecommunications administration/carriers, this means to construct a standardized digital network for total telecommunications services. While to the user, this implies convenient and economical services through simple facilities in accordance with his needs.

ISDN provides a common 'digital sockets' just like electric sockets and water tap to be used for various telecommunication services. Each 'digital socket' is capable of supporting three types of communication channels. The 'B' channel, is able to transmit voice or data at rates of 64 K bits/s which is significantly faster than the existing analog transmission speed of 300 - 9600 bits/s with modem. The 'D' channel is used to send signal information to control the 'B' channels and to carry packet-switched digital data such as telemetry, enabling remote control of machinery and equipment. When transmission of data at much higher rate is required, 'H' channel can be used.

Initially, two ISDN interfaces had been defined by International Telecommunication Union- Telecommunication Standardization Sector (ITU-T) i.e. Basic Rate Interface (BRI) and Primary Rate Interface (PRI) known as Narrow band ISDN. Table 1 and Table 2 explain the Channel Specification and the User-Network Interface.

Table
CHANNEL SPECIFICATION

Name of Channel			Transmission Speed	Usage
B			64 KBPS	• User's communication Channel (multiplexed transmission by combination of 8, 16 ,32 KBPS is possible) • Circuit switch, Packet switch or Dedicated line is applicable
D			16 KBPS	• Signaling channel for B or D channel as a primary use • User's packet information channel as a secondary use
Ho			384 KBPS	• User's communication channel • Circuit switch, Packet switch or Dedicated line is applicable
H	H1	H11	1,536 KBPS	
		H12	1,920 KBPS	
	H2		30 - 44 MBPS	
	H4		90 - 138 MBPS	

Table 2
ISDN USER-NETWORK INTERFACE STRUCTURE

Interface Type	Physical Interface Rate	Interface Structure		Remarks
		Structure Name	Channel Structure	
Basic Interface	192 KBPS	Basic Interface	2B+D	D=16 KBPS
Primary Rate Interface	1544 or 2048 KBPS	B-channel Interface	23B+D (1544 KBPS) 30B+D (2048 KBPS)	D=64 KBPS
		Ho-channel interface	4Ho or 3Ho+D (1544 KBPS) 5Ho+D (2048 KBPS)	D=64 KBPS
		H1-channel interface	H11 (1544 KBPS) H12+D (2048 KBPS)	D=64 KBPS
		B/Ho-channel mixed interface	nB+mHo+D	D=64 KBPS

Meanwhile, the recommendation for the higher bit rate interfaces (e.g. 155.52Mbps) has been also defined by ITU-T for the application of Video signal transmission or high-speed LAN connection, etc.

The services supported by ISDN are divided into two main categories namely: bearer services and Tele services, and supplementary services can be added to these two (2) services to grade them up. The scope of the service categories is illustrated in Figure 3.

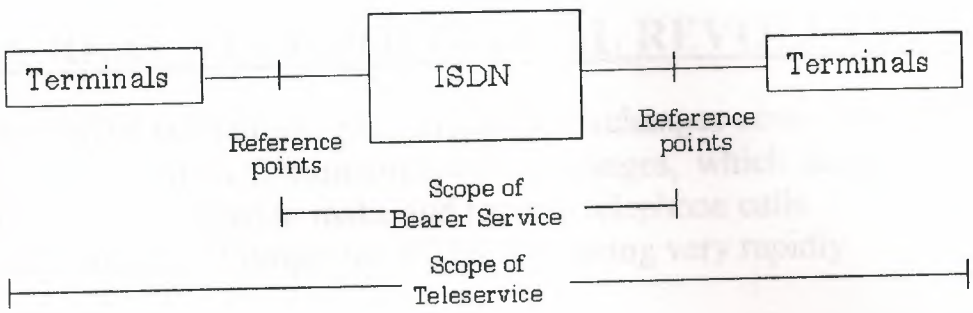


Figure 3
SCOPE OF ISDN SERVICES

Integrated Services Digital Network is a set of digital transmission protocols defined by CCITT (the Consultative Committee for International Telephone and Telegraphy which was renamed the Telecommunications Standards Sector of its parent, the International Telecommunications Union). The protocols are accepted by virtually all the world's communications carriers as standard.

CHAPTER ONE : What is ISDN

1.1 THE BORDER BETWEEN PAST AND FUTURE

Since the invention of the telephone in 1876 by Alexander Bell , the manual, automatic and digital PABX s have only switched a single type of signal, VOICE.
Today the ISDN, which means Integrated Services Digital Network, as its very own name indicates, makes a clean break on traditional communications, introducing a profound change, integrating and transporting on the same wire, all company's vital communications, in other words, VOICE, IMAGE and IDATA simultaneously.

1.2 A REAL TECHNOLOGICAL REVOLUTION

With the ISDN technology, the Telephone Exchanges cover new features and are promoted to Communication Exchanges, which amongst other functions, are also used to make and receive telephone calls..
All over Occidental Europe, the ISDN is growing very rapidly

1.3 WHAT IS ISDN, ANYWAY?

ISDN, or Integrated Services Digital Network, takes advantage of the fact that modern telephone switching systems are already digital; in fact, ATU was one of the first companies to go digital way back in 1986.

When you place a telephone call, the signal travels to the nearest ATU switch in analog form. When it reaches the switch, it goes into a line card which converts the conversation into a 64 KBPS (thousand bits per second) digital stream of ones and zeroes.

The signal remains digital as it is switched and transported to other switches, either local or long distance. It is only converted back to analog for the last leg from the final switch in the chain to the person you're calling.

ISDN simply moves the line card in the switch to a box on your desk, so the conversion from analog to digital happens right away, instead of in the switch. That feature alone would be attractive, but ISDN does much more.

The most important is that you get two 64 KBPS channels over the existing pair of copper wires to your home or business. These are called the "B" channels. You also get a third channel, called the "D" channel, that operates at 16 KBPS; it's normally used for signaling to set up calls, although it can handle other data such as home energy usage and ATM machines.

The "Two B plus D" configuration is called Basic Rate ISDN. ATU offers both a business and a residential version of this service. There's also Primary Rate ISDN, which is made up of 23 B channels and one 64 KBPS D channel.

Primary Rate is of interest to large businesses. Among other things, it allows Caller ID to work to and from extensions from a company switchboard, something which is otherwise not possible.

But the big demand is for Basic Rate ISDN, because it provides so much bandwidth over existing wires at a competitive price. A big reason for the service's popularity is its flexibility: the two B channels can each be used for different purposes, or they can be "bonded" together into one 128 KBPS channel.

Here are four of the most popular uses for ISDN:

- Telecommuting: One channel is used for telephone, and the other is connected to a company's computer network. This allows employees to work at home.
- Videoconferencing: Both channels are bonded together; the resulting 128 KBPS channel is fast enough to generate jerky but recognizable color video in a small window on a computer screen at each end.
- Tele medicine: ISDN allows digitized X-rays and other medical images to be transmitted far faster than the typical modem/phone line arrangement.
- Internet Access: Possible either with one B channel, reserving the other for telephone, or bonded at 128 KBPS. As many Internet users are learning, the faster the access, the better.

So Integrated Services Digital Network (ISDN), while new to many people, has actually been around for quite some time. Engineering

development began over twenty years ago and limited deployments of ISDN have been in place for several years. Recently however, local phone companies have been aggressive in building out their ISDN networks, thus allowing Paradigm Technologies, LLC to offer ISDN connections to the Internet on a more common and much lower cost basis. ISDN service is simple. It uses the same wiring that is in your home or office and can be configured to achieve a variety of communication needs. If you are currently using the old fashioned 28.8K analog dial up method of connecting to the Internet, ISDN offers you a much more powerful, effective and faster method of working on the Internet. ISDN can save you or your company substantial dollars in staff time and phone line cost.

Paradym Technologies, LLC has built a state-of-the-art digital network to carry you to the web using ISDN technology. Our fees vary depending on the amount of time you need access to the web and the speed at which you intend to connect. ISDN offers a connection speed of up to 128K uncompressed and 512K with compression. Paradigm will help you order, configure and install your ISDN circuits. This is especially helpful when you are installing ISDN at the office to be used in conjunction with your internal computer network.

ISDN is a high-speed, fully digital telephone service. Just as compact discs have made recorded music digital, ISDN upgrades today's analog telephone network to a digital system.

ISDN can operate at speeds up to 128 kilobits/second, which is five or more times faster than today's analog modems.
ISDN can dramatically speed up transfer of information over the Internet or over a remote LAN connection, especially rich media like graphics, audio or video or applications that normally run at LAN speeds.

1.4 Integrated Services Digital Network (ISDN)

ISDN stands for Integrated Services Digital Network - the name for digital telephone service that works over existing copper telephone wiring. There are several types of ISDN service, but the most appropriate type for individual computer users, and the type that this site focuses on, is the ISDN Basic Rate Interface (BRI).

Basic Rate ISDN divides the telephone line into 3 digital channels: 2 "B" channels and one "D" channel, each of which can be used simultaneously. The B channels are used to transmit data, at rates of 64k or 56k (depending on your telephone company). The D channel does the administrative work, such as setting up and tearing down the call and communicating with the telephone network. With two B channels, you can make two calls simultaneously.

Most of the world's existing telephone network is already digital. The only part that typically isn't digital is the section that runs from the local exchange to your house or office. ISDN makes that final leg of the network digital.

1.5 Availability

Unlike analog telephone service, ISDN service is not yet available everywhere. Your telephone company must have installed the necessary equipment in the central office that serves you.
Because ISDN is a digital service, it is very sensitive to outside interference. You must be within a given distance of the telephone company equipment that serves you (typically 18,000 feet). Further, there can not be any other anomalies near the wiring that might interfere with the transmission. As a result, even if the equipment is installed at the central office, it is possible you will not be able to get ISDN due to line interference or your distance from the central office. To determine whether your particular wiring will support ISDN, the telephone company will perform what is known as a line qualification.
Some telephone companies offer what is called "ISDN Anywhere", which means if you order ISDN, they will find a way to get it to you. In cases where the telephone company does not have the right equipment in the local central office that serves you, they can use "line extension"

technology to serve you from another exchange. The use of line extension technology may significantly increase the cost of your ISDN service.

Generally, ISDN has better availability in urban and suburban areas, and is harder to get in rural areas.

1.6 Pricing

Assuming you can get ISDN, the next question is probably "What does it cost?" ISDN rates, known as tariffs, vary by phone company. ISDN pricing generally has three components:

- Installation Charge - this is a one time charge to have the ISDN service installed. Part of this charge may be waived if you commit to keep your ISDN line for a period of time.
- Monthly Charge - this is a recurring monthly charge.
- Usage Charges - this is a charge associated with use of the ISDN line. Typically it is not more than a couple of cents per minute. The monthly charge may include a certain number of hours of free usage each month. Some packages have no usage charges at all, or may waive usage charges during evenings and weekends.

1.7 Configuration: Switch Type and SPID s

In addition to the configuration the telephone company must do at their end of your ISDN line, there is also some configuration you must do at your end. You need to know three pieces of information supplied by the telephone company to make your ISDN service work with your Windows-based PC:

- Switch type
- Phone numbers
- SPID(s) - Service Profile Identifier(s)

Most ISDN hardware adapters need to know what type of switch they are connected to. The switch type simply refers to the brand of equipment and software revision level that the telephone company uses to provide you with ISDN service. There are only a few types of switches in the world and usually just one in countries other than the United States.

The second type of information is your phone number or numbers. In some cases, each B channel on an ISDN line has its own number, while in other cases both B channels share a single phone number. Your telephone company will tell you how many numbers your ISDN line will have. Separate numbers may be useful if you plan to take incoming calls on your ISDN line.

The last type of information is the Service Profile Identifier (SPID), which is only used in the United States and Canada. The SPID usually consists of the phone number with some additional digits added to the beginning and end. The SPID helps the switch understand what kind of equipment is attached to the line, and if there are multiple devices attached, helps route calls to the appropriate device on the line.

1.8 Alternatives to ISDN

There really aren't a lot of alternatives today if you want more bandwidth at home or at a small business. There are a variety of faster network choices available to larger organizations, but these solutions tend to be priced beyond the reach of most individuals. For Internet access or remote access to a corporate LAN, ISDN is the only higher speed option available for most people.

If you are looking for a continuous connection, such as connecting a Web server to the Internet, a dedicated frame relay or T-1 line may make more sense. ISDN is a circuit-switched service, which means it is only connected when it is being used. Leaving ISDN connected around the clock can end up being more expensive than a dedicated line or "leased" line, which has a flat monthly price.

Over the next several years, the bandwidth bottleneck residential and small business users face will be alleviated with new technologies such as Asymmetric Digital Subscriber Line (ADSL) which works over regular telephone wires and cable modems which work over coaxial cable television wiring. Both of these services will offer multiple megabits per second, but it will take time to deploy these technologies.

1.9 Internal and External ISDN Adapters

There are two types of ISDN hardware adapters: internal and external. Internal ISDN adapters are cards that you put inside your PC. External adapters connect though a port on the back of your PC.

CHAPTER TWO : ISDN adapters

2.1 ISDN adapters compatible with the Windows operating system

Internal ISDN adapters can take the fullest advantage of your ISDN line. These are cards that go inside your PC. Internal adapters require you to open your PC to install the card. In order to install an internal adapter, you need a slot free in your PC that supports the same type of bus (ISA, EISA, PCI, for example) as the card you want to install. Look for ISDN adapters with the Windows 95® logo, which support Plug and Play, so Windows 95 can automatically detect and configure the adapter for you .

External ISDN adapters are easy to install and do not require any special software, but they do not provide the same level of performance that internal adapters do. External ISDN adapters look just like a modem to the PC (some manufacturers even call them "ISDN modems"). Communication programs control the external ISDN modem just like they control an analog modem (typically with AT commands). An external ISDN adapter plugs into a PC's serial or parallel port.

There are certain limitations imposed by these ports. Most PC serial ports will not transmit information faster than 115 kilobits/second, which is less than ISDN maximum data speed of 128 kilobits/second. These serial ports impose overhead on the transfer of information between the PC and the external adapter, further slowing data speeds. An external ISDN modem can impact performance of your system, because an external adapter places heavy requirements on the CPU. To use an external ISDN adapter, it is recommended you have a 486/33 or faster PC.
There are also potential interoperability issues with external adapters because higher level protocols like PPP or authentication are implemented in the modem itself. These protocols are evolving quickly and can be difficult to update in the modem for new protocols or to fix bugs.

Connecting to the Telephone Network - U and S/T Interfaces. Once you have ISDN service, you need to know which ISDN interface your equipment expects. There are two ISDN interfaces.

The U- Interface carries ISDN signals over a single pair of wires between your location and the central office. This interface is designed to carry ISDN signals over long distances. The Subscriber/Termination (S/T) Interface uses two pairs of wires to deliver the signal from the wall jack to your ISDN adapter or other ISDN equipment.

If your equipment supports the S/T-Interface, you need to get a device known as a Network Termination 1 (NT-1) which converts between the U-Interface and the S/T-Interface. The NT-1 has a jack for the U-Interface from the wall and one or more jacks for the S/T Interface connection to the PC, other ISDN or analog devices, as well as an external power supply.

2.2 Wiring and Jacks

ISDN service from the phone company officially ends at what is called the demarcation point ("demarc") usually just inside the building. You are responsible for the "inside wiring" from the demarc to your ISDN equipment including the wall jacks. The telephone company or an electrical contractor will install and maintain the inside wiring for an additional charge.
If you are just connecting your PC to the ISDN line, the wiring requirements may be very simple. Many homes and offices are wired with extra sets of telephone wires and one of those sets can be used for your ISDN line. There are a number of possible wiring pitfalls however:

- your 'extra' wires may already be in use for analog line(s)
- your 'extra' wires are being used to power lighted phone buttons
- your 'extra' wires are not connected directly to the democrat
- the wiring may be 'daisy-chain' rather than 'home-run'

Direct wiring between the ISDN wall jack and the demarc (also known as a 'home run') is recommended. For more information on wiring issues, consult your telephone company or an electrical contractor.
There are two types of jacks associated with ISDN:

- RJ11 - the standard analog phone jack. The RJ11 has 4 wires. The wire from the wall to the NT-1 will usually have RJ11 jacks.

- RJ45 - this jack is slightly wider than the RJ11, and has 8 wires. The wire from the NT-1 to the ISDN adapter will usually use RJ45 jacks.

2.3 Connecting Multiple Devices to an ISDN Line

If you do not plan to connect anything except a single PC ISDN adapter to your ISDN line, you can ignore this section. It is possible to connect up to eight devices to a single ISDN line. These devices can include network routers and bridges, Group 4 ISDN fax machines, ISDN telephones as well as traditional analog telephone devices. ISDN is intelligent enough to arbitrate the use of the two B channels between these devices (up to two devices can be in use simultaneously) and route incoming calls to the appropriate device. Instead of connecting the ISDN line to a single PC, it is possible to connect an ISDN line to a LAN so all the PCs on the LAN can share the ISDN line. This requires an ISDN network bridge or router. It is possible to connect several ISDN devices to a single ISDN line. For example, you might wish to have an ISDN adapter in your PC, an ISDN telephone to make voice calls and a Group 4 ISDN fax machine all connected to the same ISDN line. Incoming data calls would go to the PC, voice calls to the telephone and fax calls to fax machine. To support this configuration, you need an NT-1 that supports multiple S/T Interface connections. Each device would be connected to the NT-1. Each device would also need its own Service Profile Identifier (SPID) to ensure the telephone company can route calls to the appropriate device. In addition to ISDN devices, some NT-1s or ISDN adapters also support analog telephone devices like phones, data modems, Group 3 fax machines and answering machines. The NT-1 or the ISDN adapter converts the analog signal into ISDN and vice versa.

2.4 How it Works

"Always On" uses the packet data capability that is an integral part of the ISDN international standard. Over the "D" (signaling) channel of the ISDN line, the user establishes a packet connection (virtual circuit) to a remote LAN or an ISP. A user creates this bi-directional connection when she/he logs on to his/her work-at-home computer and e-mail package. Once the connection is established, the user is on-line and can exchange information (packets) with a remote network as required - to send and receive e-mail, for example. This packet connection can operate at 9,600 bits per second and when there is more information to transfer than can be handled by the packet connection, a circuit -switched connection

(telephone call) is placed using one or both of the ISDN "B" channels. This connection can be made automatically and without user intervention, and permits data to move at speeds up to 128Kbps (512Kbps with compression). Once the data transfer is complete, the circuit-switched connection is dropped and the user remains on-line via the D-channel.

For example, when a user receives an e-mail message with a large or lengthy file attachment, the initial notification of the e-mail will come via the D-channel. To transfer the large attached file, a B-channel connection is initiated automatically. When the file transfer is complete, the B-channel(s) call(s) end.

CHAPTER THREE :

ESTABLISHMENT OF THE COMMON NETWORK FOR ISDN

Today, Administrations are entering a transition period towards ISDN. The implementation steps towards ISDN in each country will vary depending on various circumstances such as demand variation, existing network quality and situation and financial capabilities, among others. In any case, however, evolution towards ISDN will be grasped by the following three (3) basic stages.

Stage 1: Digitalization of Telephone Networks

In this stage, existing analog telephone networks are digitized up to the line concentrator through the adoption of digital switching and transmission techniques. This will form an Integrated Digital Network (IDN) with 64 KBPS bearer channels is.

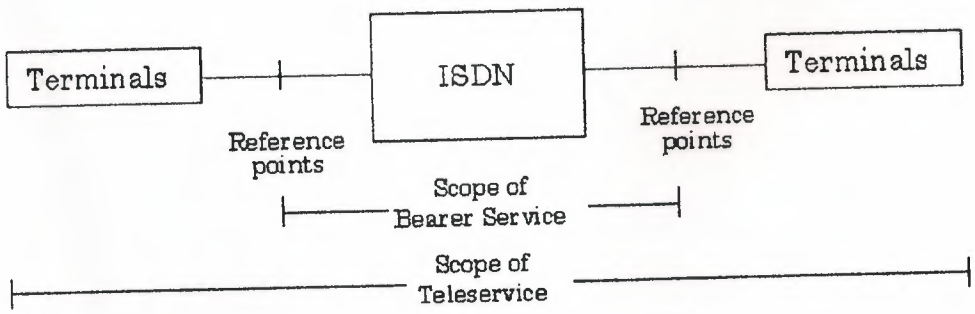


Figure 3
SCOPE OF ISDN SERVICES

Stage 2: Provision of ISDN Interfaces (Narrow band ISDN)

An ISDN interface and the common channel signaling shall be provided to enable the user to access to the service capabilities and/or network facilities of the ISDN.

The subscriber loops shall be digitalized completely to satisfy the "end to end digital connectivity" requirement for ISDN, and the ISDN services by basic and primary rate interfaces will be realized. This stage will take a considerably long time to complete that during the transition period it will be necessary to provide network interfaces between ISDN and other networks such as data networks and the conventional telephone networks.

Stage 3: Integration of Telephone and Data Networks (Establishment of Broadband ISDN)

The ultimate ISDN is achieved in this stage. Different dedicated networks such as telephone networks and data networks are integrated as an ultimate form of an ISDN. This single network will then possess the capabilities for data switching at speeds higher than 144 KBPS and provide video transmission and switching services too.

Figure 4 outlines the ISDN evolution.

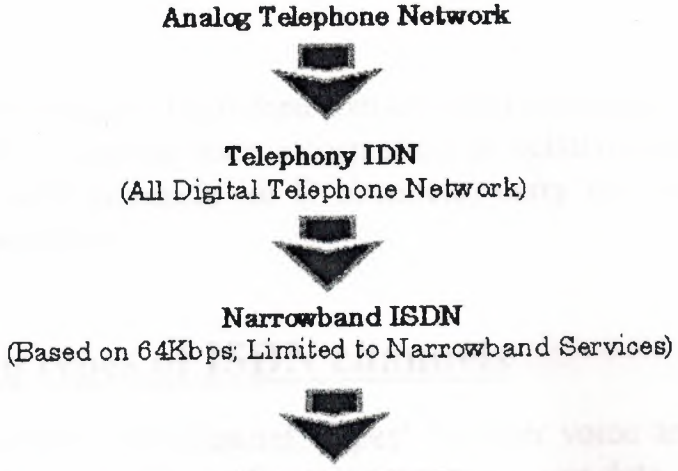


Figure 4
EVOLUTION OF ISDN

CHAPTER FOUR : Characteristics of ISDN

It builds on groups of standard transmission channels. Bearer channels (or B channels) transmit user information at relatively high speeds, while separate Delta channels (or D channels) carry call setup, signaling and other information.

4.1 Two types of ISDN channels

B channels are clear channel "pipes" for user voice and data. D channels are packet-switched links for call set-up and user data.

- It handles all types of information. Unlike some other digital communications technologies, ISDN handles all types of information: voice, data, studio-quality sound, still and moving images. They are all digitized and transmitted at high speeds in the same flow of data.

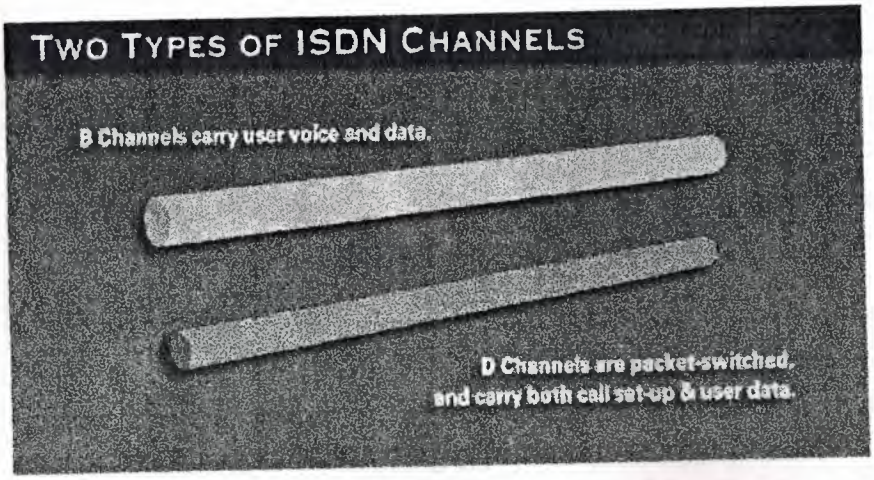
- It handles many devices and many telephone numbers on the same line. Up to eight separate telephones, fax machines or computers can be linked to a single ISDN connection, and have up to 64 "call appearances" of the same or different telephone numbers.

- It supports up to three calls at the same time. Two voices, fax or PC "conversations," and one data "conversation" can take place at the same tie, through the same ISDN connection. "Always On/Dynamic ISDN"

- "ISDN and the Power of Packet Switching" will enable the three channels to work powerfully and efficiently together, providing the best matched channel to the application at hand, improving efficiency and lowering costs.

- It offers variable, responsive transmission speeds. Two or more channels can be combined into a single larger transmission "pipe". Channels can be assembled as needed for a specific application (a large videoconference, for example), and then broken down and reassembled into different groups for other applications (normal

voice or data transmissions). Combining B channels in this manner is called inverse multiplexing, or bonding.



4.2 ISDN system Architecture

It is now time to look at the ISDN architecture in detail , particularly the customer's equipment and the interface between the customer and the telephone company or PTT. The key idea behind ISDN is that of digital bit pipe *, a conceptual pipe between the customer and the carrier through which bits flow whether the bit originated from a digital telephone , a digital terminal ; a digital facsimile machine or some other device is irrelevant. All that matters is that bits can flow through the pipe in both direction .

the digital bit pipe can ,and normally dose , support multiple independent channel by time division multiplexing of the bit stream . the exact format of the bit stream and its multiplexing is a carefully defined part of the interface specification for the digital bit pipe . two principle standards for the bit pipe have been developed , a low bandwidth standard for home use and a higher bandwidth standard for business use that support multiple channels that are identical to the home use channel .furthermore ,business may have multiple bit pipe if they need additional capacity beyond what the standard business pipe can provide .

In fig 1 we see the normal configuration for a home or small business . the carrier places a network terminating device,NT1, on the customer's premises and connects it to the ISDN exchange in the carrier's office , several kilometers away ,using the twisted pair that was previously used to connect to the telephone . the nt1 box has a connector on it into which

a passive bus cable can be inserted .up to eight ISDN telephones, terminals, alarms, and other devices can be connected to a LAN. From the customer's point of view , the network boundary is the connector on NT1.

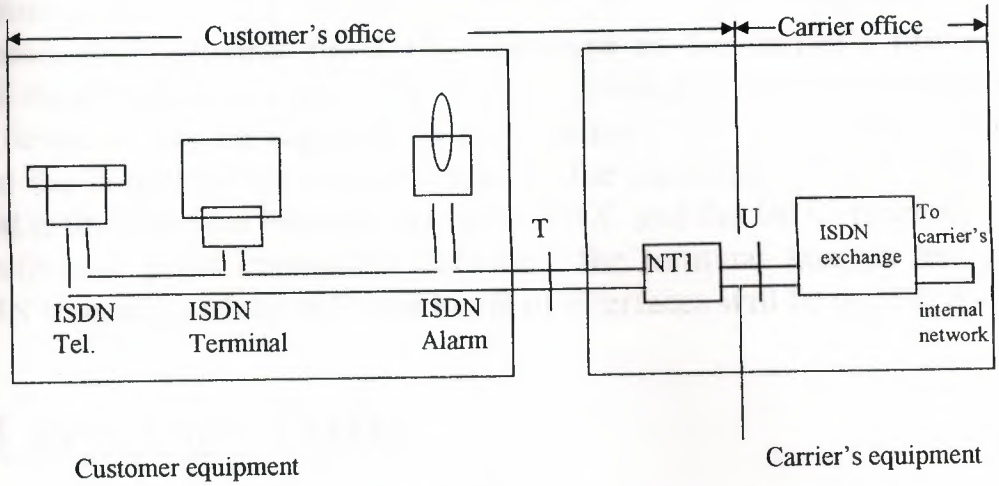


fig (a)

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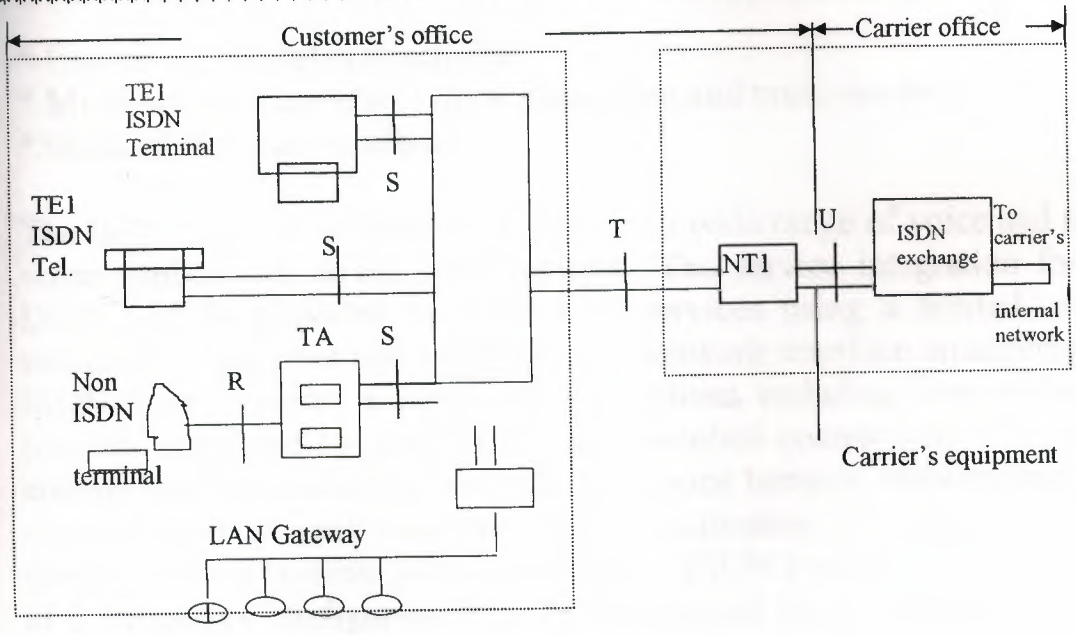


For large business , the model of fig 241 (a) is inadequate because it is common to have more telephone conversation going on simultaneously than the bus can handle . therefor ,the model of fig (b) is used . in this model we find a device ,NT2 ,called a PBX (Privet Branch exchange), connected to NT1 and providing the real interface for telephones,

terminals and other equipment .an ISDN PBX is not very different conceptually from an ISDN switch ,although it is usually smaller and can not handle as many conversation at the same time .

CCITT defined four reference points called R ,S, T ,and U ,between the various devices. These are marked in fig 241 . The U reference point it is connection between the ISDN exchange in the carrier's office and NT1.At present it is a two-wire copper twisted pair, but at some time in the future it may be replaced by fiber optics . The T reference point is what the connector on NT1 provides to the customer . The S reference point is the interface between the ISDN PBX and the ISDN terminal .The R reference point connection between the terminal adapter and non-ISDN terminals. Many different kinds of interfaces will be used at R .

4.3 Principles of ISDN

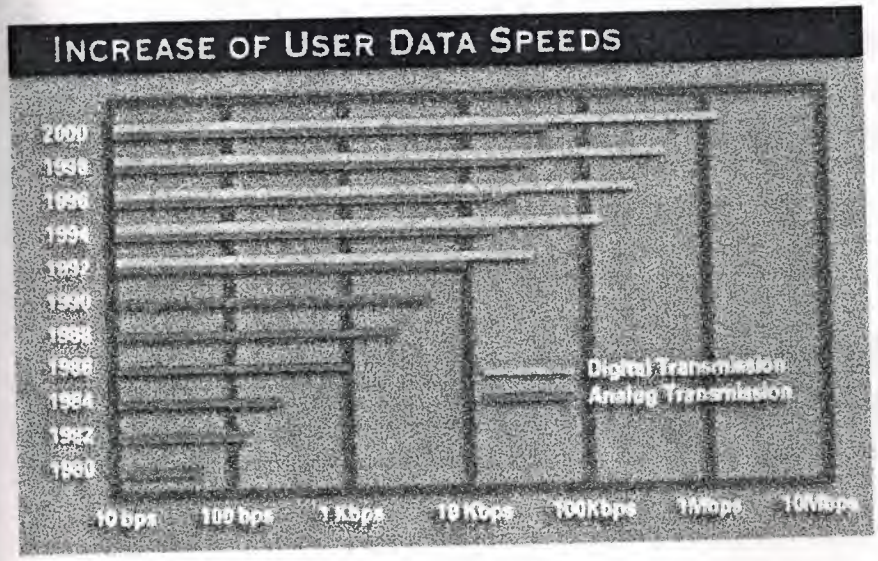
An ISDN can be characterized by its three essential features:

* End-to-end digital connectivity
* Multi-service capability (voice ,data,video,and multi-media)
*Standard terminal interfaces

The ISDN concept includes the support of a wide range of voice and non-voice applications in the same network. The service integration for an ISDN will be provided by a range of services using a limited set of connection types and multi-purpose user network interface arrangements. ISDN s will support a variety of applications including both switched (circuit- or packet-switched) and non- switched connections. They will contain intelligence for the provision of service features, maintenance and network management functions. The specification of access to ISDN should be by a layered protocol structure. ISDN s may be implemented in a variety of configurations to be determined by the national service providers. Hence the details of underlying network will not be important for the users, since they will see common service across ISDN s (save for optional services and features).

4.4 The Unique Value of ISDN

To many users, especially individuals and those in smaller companies, ISDN is by far the most important of these technologies. To literally millions of users, it offers inexpensive dialed service, high-speed data transmission, and the ability to send and receive voice, data, still and moving images through the same fully digital connections. It is also based on communications standards accepted throughout the world, which means that high-speed data connections to most of the major business centers of Europe and the Pacific Rim can now be set up with a simple dialed call.



4.5 Multiple Devices

Previously, it was necessary to have a phone line for each device you wished to use simultaneously. For example, one line each was required for a telephone, fax, computer, bridge/router, and live videoconference system. Transferring a file to someone while talking on the phone or seeing their live picture on a video screen would require several expensive phone lines.

It is possible to combine many different digital data sources and have the information routed to the proper destination. Since the line is digital, it is easier to keep the noise and interference out while combining these signals. ISDN technically refers to a specific set of digital services provided through a single, standard interface. Without ISDN, distinct interfaces are required instead.

4.5 Multiple devices and multiple numbers.

Depending on the capabilities of the central office switch, ISDN can support up to eight devices and as many as 64 separate telephone numbers through a single BRI connection. ISDN telephones can, of course, call to and receive calls from ordinary telephones everywhere, since the digital and analog systems are fully interconnected. Digital ISDN connections also produce voice conversations that are free of noise and crystal clear.

4.7 The increase of users' data speeds

A logarithmic view of how transmission speeds available to individual users has accelerated in the past two decades. Digital speeds should continue to grow, while analog speeds begin to peak.

4.8 The economics of ISDN

A typical analog office or department vs. the same office with ISDN. While only two actual conversations, or PC or fax transmissions, or any combination of these, could take place at the same time, all devices share the same line.

What's more, multiple data devices such as credit card units, PCs, remote sensors or the like could all contend for and use the packet-switched D channel at the same time that two conversations take place on the B channels.

4.9 Two Conversations on the Same Line

As we know, ISDN enables two separate voice conversations to take place, at the same time, through the same single twisted-pair telephone wire that traditionally, in an analog environment, carried only one conversation. What's more, since ISDN delivers two separate channels through the wire, it is also possible to conduct a conversation on one channel, and simultaneously use the other for a data device such as a PC or facsimile machine.

These multiple conversations could also take place while the speaker or someone else used the D channel for a third simultaneous transmission.

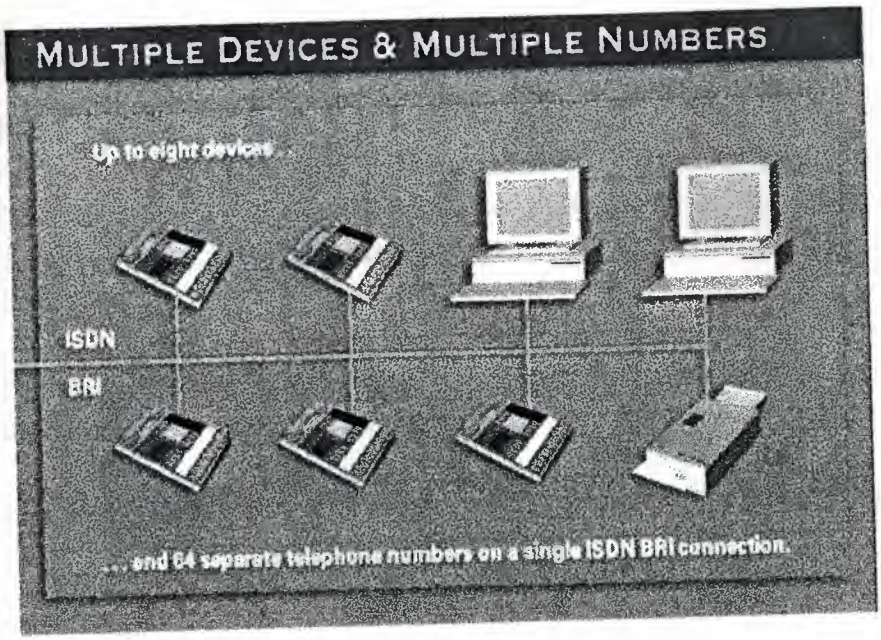
4.10 Evolution of ISDN

ISDN s will be based on the concepts developed for the IDN (Integrated Digital Network) and will progressively incorporate additional functions and features at present provided by separate networks, as will as other new ISDN-specific features and services. During the transition period ,arrangements will be developed for the inter working of services on ISDN s and services on other networks.

4.11 Three conversations at a time

The digital connection of ISDN delivers three separate communications channels, letting users carry on two separate circuit-switched voice or data calls at the same time through a single line, with a third packet-switched data channel available to send or receive data on the D channel.

Furthermore, as many as eight separate devices (telephones, computers, fax machines and more) can be connected to the same ISDN line and each given as many separate telephone numbers as needed. All of which means it is no longer necessary to have multiple telephone lines to handle multiple telephone devices, or multiple telephone numbers, or multiple telephone calls. One ISDN line does it all.



4.12 The Advantages of ISDN Voice

It is also possible to attach up to eight devices -- telephones, computers, faxes and more on every BRI connection -- and to give these devices as many as 64 call appearances of the same telephone number, or virtually any combination of different numbers. This feature alone offers enormous advantages. A few examples will show why:

- In a busy sales location, several representatives who are frequently out of the office might share a series of numbers on a single ISDN line. Each incoming call could be answered correctly ("Jane Green's office" or "Dan Brown's line"), yet theoretically as many as 64 representatives, served by up to eight telephones, faxes or PCs require only one ISDN line, not the many lines currently needed.
- A busy individual might have two or more appearances of a single number on an ISDN telephone, as well as different numbers linked to a PC and/or a fax, so that incoming calls could be answered by the appropriate device. At any time, a voice conversation on one call appearance could be put on hold, and another voice call made or received on another call appearance. These calls could even be conference into a three-way conversation. Yet all of this takes place through a single ISDN line, not the three or four required today.

4.13 Easy-to-use Call Management

ISDN also offers better call management. Not only is the range of features extended, but the telephone's liquid-crystal display (LCD) is linked to the ISDN D channel so that useful telephone functions are no longer buried in a complicated system of double presses and two-second holds.

Rather, they become as quickly available as when pressing a button on an automatically displayed menu.

Normal ISDN BRI links, such as those offered by Pacific Bell, include the most widely used features:

- Hold. For anyone who has inadvertently disconnected a caller rather than put them on hold, the easy use of this capability will make it the important tool it should be.
- Three-way conference. Adding another voice to a conversation is a powerful feature, yet one rarely used. With ISDN, it can be as simple as touching a button and dialing an extension.
- Call transfer. Again, an important feature. Used by receptionists and operators, who use it enough to remember, but rarely by anyone else. ISDN makes it almost automatic.

4.14 ISDN Equipment

In addition to an ISDN line from Pacific Bell individual users will need to purchase or lease specific ISDN components, depending on the applications and uses envisioned. Some of these include:

- ***Network Termination Device and Power Supply***. Called an NT1, this serves as a network interface for each BRI connection and offers two-to-four-wire conversion as well as line-testing capabilities. Current prices are $100-200. Many manufacturers now incorporate this device into other ISDN components. The power supply plugs into a standard wall outlet and brings power to the NT1. Without power, the NT1 will not work and the ISDN line will not be usable. Often the power supply is attached to or integrated into the NT1.

- ***Terminal Adapter***. Sometimes referred to (erroneously) as a "digital modem" or an "ISDN modem". The Terminal Adapter adapts equipment not specifically designed for ISDN for use on the digital network - such as analog telephones or fax machines. Some devices, such as ISDN telephones, have their terminal adapter built-in. TA's can also be cards added to PC's or fully separate ("outboard") units. The position of the TA in a data communications configuration is the one the modem (no longer required because it is no longer necessary to convert the computers digital data stream to analog) used to occupy - between the Data Terminal Equipment (DTE) and the Data Circuit Equipment (DCE) - the NT1. At this writing prices range from approximately $200 and up.

- ***Aggregation Device***. This is a specialized terminal adapter that can aggregate, or combine, the two B channels "on the fly" into a higher-speed connection. Some devices also include an Ethernet bridge. Prices begin at roughly $500.

- ***ISDN Telephones***. Advanced, full-featured telephones incorporating a terminal adapter, and usually equipped with an advanced LCD screen for messaging and feature control. Prices start at about $350.

Also required, of course, is the endpoint equipment: PCs, workstations, or video systems, credit-card readers and the like to be used for specific applications. There is also a wide range of equipment, from ISDN routers, multiplexes, bandwidth-on-demand controllers and other devices, required to implement specific installations and applications.

4.15 Finding and Buying Equipment

It is now possible to buy Basic Rate ISDN equipment at computer stores and other high-technology retail venues. Many companies offering ISDN-enhanced services - such as Internet Service Providers or Online Service Providers will also help make choosing and ordering ISDN equipment easier. The entire ISDN Industry is working together to simplify the process of obtaining and using ISDN satisfactorily for the fast-growing list of applications. You can shop in catalogs or on-line to select ISDN equipment that meets your needs and get documentation, on-screen or live help configuring everything. Some, however, prefer not to have to make these selections. For individual consumers and residential customers, Pacific Bell has created Home back an integrated ISDN solution that includes a Pacific Bell *Fast rake* ISDN line, the 3Com Impact IQ - a Terminal Adapter with built in NT1 - and a Pacific Bell ISDN Internet account. Home Pack includes all the pieces needed to enable speedy access to the Internet at one's home and it can all be ordered together either online at or by calling 1-800-4PB-ISDN.

Also available to our business customers is internet ISDN back a complete telecommuting solution that includes fast rake ISDN, a choice of top manufacturers' ISDN equipment, installation, testing, warranty and maintenance, all available from a single source - Pacific Bell. Contact your account representative for more information on Internet ISDN Pack.

For more complex needs Pacific Bell has developed equipment joint-marketing arrangements with approved manufacturers and distributors. In

this program, Pacific Bell has thoroughly tested each piece of equipment to make sure that it works with the Pacific Bell ISDN services in the applications for which it was submitted. We then offer this equipment to our customers at competitive retail prices. The range of equipment tested and sold by Pacific Bell meets the needs of applications for a broad range of individual terminals including Macintosh and MS-DOS personal computers, Sun and other Unix workstations, telecommuting equipment and PC video systems, LAN-to-LAN and LAN-to-host interface systems, bridges and routers, video-and audio conference systems, remote-to-host and remote-to-LAN links for applications such as telecommuting, image transfer, multimedia, remote health diagnostics, electronic bulletin boards, point-of-sale systems, Group 4 facsimile devices, and backup and overflow equipment for leased lines and networks.

4.16 Wiring Alternatives

While some homes and offices may need to be rewired for ISDN, most will not. The copper twisted pairs that currently serve analog telephones can be successfully used for the digital signals of ISDN. Nonetheless, depending on the usage of the ISDN line, and the number of existing handsets or other devices currently installed, those who plan on ordering ISDN may want to consider the costs and advantages of several wiring alternatives.

4.17 What Does ISDN Give You?

Basic Rate ISDN gives you two 64 Kb "data pipes", which are referred to as "B" channels, and one 9.6 Kb "D" channel, which can be used for packet data. Depending upon your need or application, these three channels can be set up to allow you do transmit and receive:

- One channel voice / One channel data
- One channel voice / One channel alternating to support either voice or data
- Two channels data
- Two channels voice
- Two channels, alternating to support either voice or data
- Packet data only
- Various combinations of voice / data and packet data

4.17 ISDN as a Network Controller

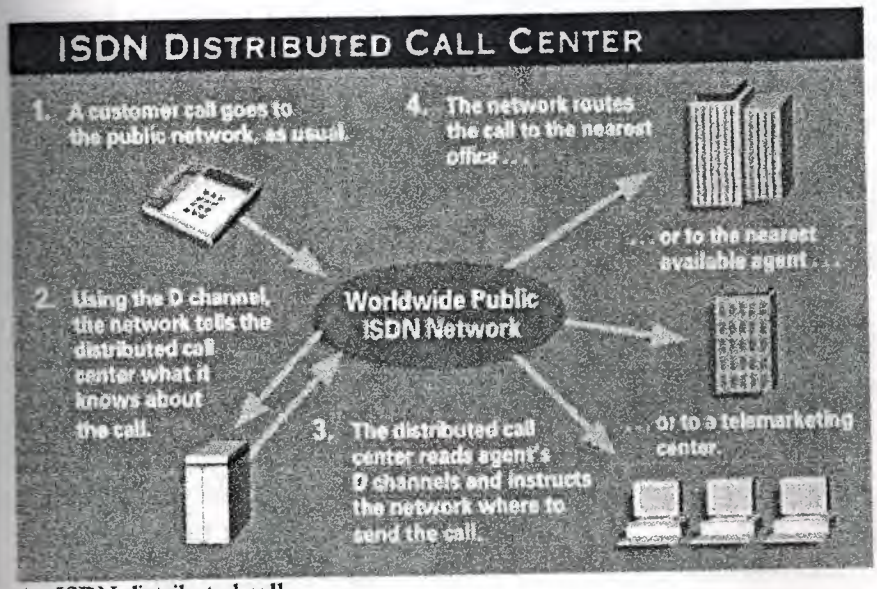
"ISDN offers a command-and-control structure that can actually mold the public phone network to your needs," says Bob Pokress, co-founder and Chairman of Eloquent Communications Corporation of Billerica, MA. In effect, he notes, the D-channel command language can transform the network itself into:

- A virtual PBX that has no boundaries, creating what is truly a virtual office.
- An automatic call distributor, or more accurately a call optimizer, that logically directs incoming calls to agents worldwide.
- A user-controlled link between a computer and voice applications anywhere.

Eloquent is one of several companies today offering computer-based systems which let users communicate with the telephone network in the actual command language used by the network itself. The practical result: companies with many offices statewide or even nationwide can link them all into a single, responsive telephone center. Calls can be routed to the best person, regardless of location. At the same time, calls to a local office where everyone is busy can be seamlessly forwarded to the nearest site with someone available, or even to agents working at home.

According to Pokress, who managed the original ISDN Architecture Group at Bell Labs in the early 1980s, a Distributed Call Center gives users an enormous ability to shape and manage the network itself through the D channel.

A regular customer, for example, can be routed to a specific sales agent, while someone needing specialized assistance, as entered in initial prompts, can be directed to an appropriate specialist. Distributed Call Centers can also balance workloads, centralize after-hours calling, and work around service interruptions at any site. Call redirection can be programmed by a range of customer options.



An ISDN distributed call.
The system exploits the power of ISDN to intelligently route the call, using the same D-channel language as the network itself.

CHAPTER FIVE : What's required for ISDN?

Most of the telephones wiring in place today (the copper twisted pairs that have carried telephone conversations since the days of "Number, please?") can successfully transmit ISDN digital signals. Although some older buildings and homes may need to upgrade wiring, most are "ISDN ready" today.

5.1 What do You Need to use ISDN?

To use ISDN, you need an ISDN line at your location and typically at the far-end location that you will communicate with. ISDN requires special equipment, which is typically referred to as Terminal Adapters. A Terminal Adapter or TA, is a generic term that describes equipment that converts from the ISDN signal, to whatever interface or output that you need. For instance, an ISDN LAN Bridge is considered a TA, as it converts from ISDN to either Ethernet or Token Ring. An ISDN telephone is a TA, as it converts from ISDN to the functionality of a telephone.
There are Hundreds of Terminal Adapters, each supporting some type of application. Below is a list of some of the more common applications of ISDN:

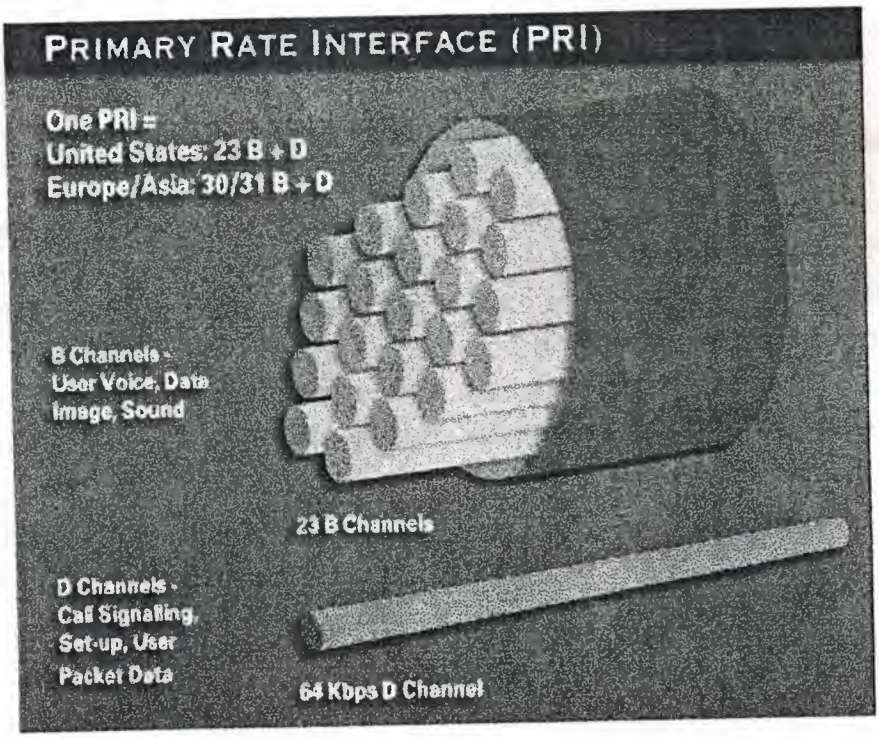
- Desktop video conferencing
- High speed access to the Internet
- LAN interconnection
- Private line back-up
- Work-at-home
- High quality radio/audio broadcast
- Credit card verification (Point of Sale)
- Distance learning
- High-speed file transfer ISDN Availability and Pricing
- ISDN Availability for Ameritech customers to get specific availability information.
- ISDN Rates providing general rate information.

5.2 Combining channels to make larger "pipes"

- It uses switched digital connections. Perhaps the most important single feature of ISDN, however, is that it offers inexpensive dialed digital access to the worldwide telecommunications network. It is no longer necessary to lease costly dedicated lines for high-speed digital transmission, or to limit data speed and accuracy by using modems to convert digital signals to analog pulses.

5.3 Primary Rate Interface (PRI)

A PRI contains 23 B channels, plus one-D channel. In Europe and the Pacific Rim, because transmission standards differ, the Primary Rate Interface is supplied through a standard 2.048Mb/s E-1 channel, and consists of either thirty or thirty-one 64Kb/s B channels, and one 64Kb/s D channel thus 30B+D or 31B+D. Although the specifics of ISDN implementation are still slightly different from nation to nation, interconnections between any two systems in the world are now not only possible, but increasingly practical.



PRI s are dedicated trunks that connect medium and large locations to a telephone company central office. Virtually all modern telephone and computing systems can be connected to ISDN through a PRI including

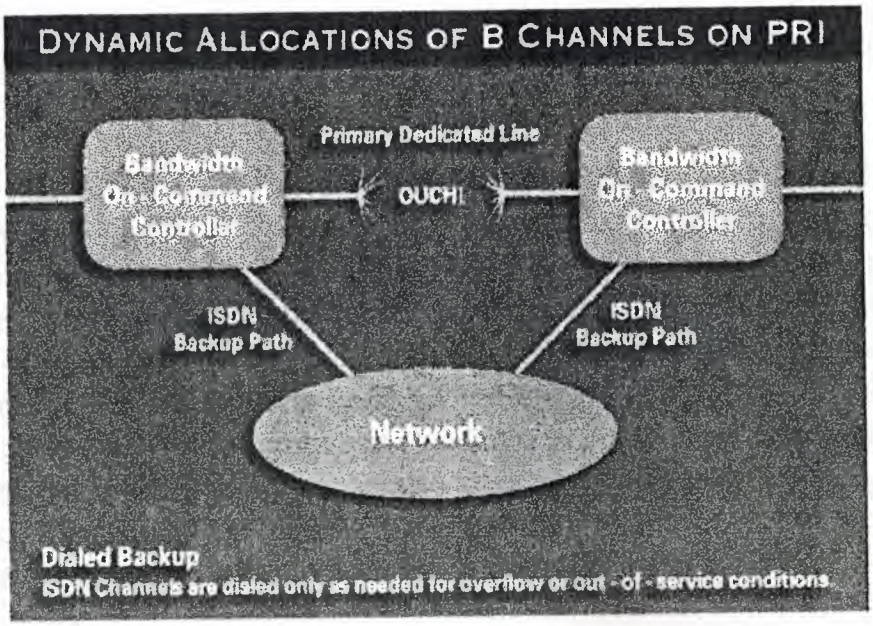
PBXs, mainframe and distributed systems, LANs and WAN s, multiplexes and ISDN controllers, videoconferencing units, and more. PRI s are designed to maximize the use of these systems by allocating dynamically, or call by call, the number and type of channels (e.g.: data, voice in, voice out) required for each application.

5.4 Basic Rate Interface (BRI)

The Basic Rate Interface, or BRI, is defined as two 64Kb/s Bearer (B) channels, and one 16Kb/s Data (D) channel that carries both call setup and user packet data across the network. The BRI interface is also referred to as a 2B+D connection. As noted earlier, BRI s can carry a wide and flexible range of communications. A single BRI, for example, can carry two simultaneous voice or data conversations (to the same or different locations). In either example, the D channel can also be used for packet communications to a third location, also simultaneously. The two B channels can also be combined for transmitting data at uncompressed speeds of up to 128Kb/s.

5.5 Dynamic Allocation of B Channels in a PRI

For practical purposes, combining multiple channels in a PRI for large videoconferences, data transfers and the like is most often programmed into the digital switch serving the location. However, new bandwidth-on-demand controllers have begun to enable a network manager to combine larger bandwidths in real time to meet specific needs. They can also monitor quality and traffic on both corporate leased-line and ISDN networks, and perform dynamic allocation of B channels to relieve bottlenecks, or back-up error-prone or damaged lines.



5.6 What does an ISDN network connection look like?

A Basic Rate Interface (BRI) is two 64K bearer ("B") channels and a single delta ("D") channel. The B channels are used for voice or data, and the D channel is used for signaling and/or X.25 packet networking. This is the variety most likely to be found in residential service.

Equipment known as a Terminal Adapter (TA) can be used to adapt these channels to existing terminal equipment standards such as RS-232 and V.35. This equipment is typically packaged in a similar fashion to modems, either as standalone units or as interface cards that plug into a computer or various kinds of communications equipment (such as routers or PBXs). TA s do not inter operate with the modem; they replace the modem.

There may be cases where there is no need to interface to existing terminal equipment or to emulate existing terminal equipment, or there may equipment with synchronous interfaces present. In these cases, standalone units or computer interfaces can provide high speed synchronous connections to the B channels without converting to an asynchronous standard.

Another common type of equipment can be used to implement a bridge between local area networks using the ISDN channel to transport the data. These devices typically provide features such as demand dialing and/or data compression.

Of course, more traditional devices such as telephones and fax machines can be attached to the BRI, assuming they have the proper interface hardware and software.

Another flavor of ISDN is Primary Rate Interface (PRI). Inside North America and Japan, this consists of 24 channels, usually divided into 23 B channels and 1 D channel, and runs over the same physical interface as T1. Outside of these areas the PRI has 31 user channels, usually divided into 30 B channels and 1 D channel and is based on the E1 interface. It is typically used for connections such as one between a PBX (private branch exchange, a telephone exchange operated by the customer of a telephone company) and a CO (central office, of the telephone company) or IXC (inter exchange carrier, a long distance telephone company).

5.7 What's an NT1, why do I need one, and where do I get one?

An NT1 (network terminator 1) is a device which provides an interface between the two-wire twisted pairs used by telephone companies in their ISDN Basic Rate (BRI) network and an end-user's four-wire terminal equipment. The NT1 also provides power for the terminal equipment if necessary (most ISDN phones need power from the NT1, but most data terminal adapters--TA s--don't). Most ISDN central office equipment (including AT& T 5ESS and Northern Telecom DMS-100 switches) sends data to your home or office via what's known in ITU-T lingo as a U interface on a single twisted pair. The NT1 hooks up to this twisted pair, and converts the signals from the U interface to the four-wire S/T interface. Most terminal equipment (for example, the IBM Wave Runner add-in-card TA and most telephones) offers the S/T interface. In North America, you have to buy and maintain your own NT1 device. The telephone company offers end-users a U interface. In Europe and Japan, the telephone company provides the NT1, owns it, and offers end-users a S/T interface directly. In North America, some ISDN equipment vendors offer devices which connect directly to the U interface (for example, the Combine CB160). If you have one of these devices, you don't need to buy a separate NT1. The U interface can't be built in to the device when it's offered for sale in Europe or Japan.

(This is unfortunate for vendors, who must build and test separate products for the relatively small North American market if they want to offer the convenience of a U-interface.)

Many types of NT1s require an external power supply, although some include a built-in supply. There are typically two classes of external power supplies. One class provides ten to twelve watts--enough power for both the NT1 and for the terminal equipment. The other class provides about two watts--enough power for the NT1 alone. Many good power supplies offer at least a few seconds of battery backup, to cover for glitches in line power.

Physically, the NT1 is a little plastic box with LED s on it which can be screwed to a wall. The external power supply (if one is included) is a typical plug-wart. If you're using a lot of BRI lines, you can buy a rack holding a dozen or so NT1s with a built in power supply.

It's a good idea to install your NT1 in a permanent fashion. If you unplug the ISDN line (the U interface twisted pair) from the NT1, it shows up as a sign of line trouble in the central office. Some telephone companies respond to this so-called "trouble" by disabling your ISDN line at the central office, and require you to place a service call on your analog telephone to get your ISDN service restored.

All the vendors shown here accept credit card orders and ship promptly. All the vendors have well-organized telesales operations with friendly and reasonably knowledgeable sales people.

5.8 What will Basic Rate (2B+D) ISDN look like in my house/office?

An ISDN BRI U-Loop is 2 conductors from the CO (telephone company central office) to the customer premises. Its maximum length may be 5.5 km (18000 ft). The equipment on both sides of the U loop has to be carefully designed to deal with the long length of the U loop and the noisy environment it operates in.

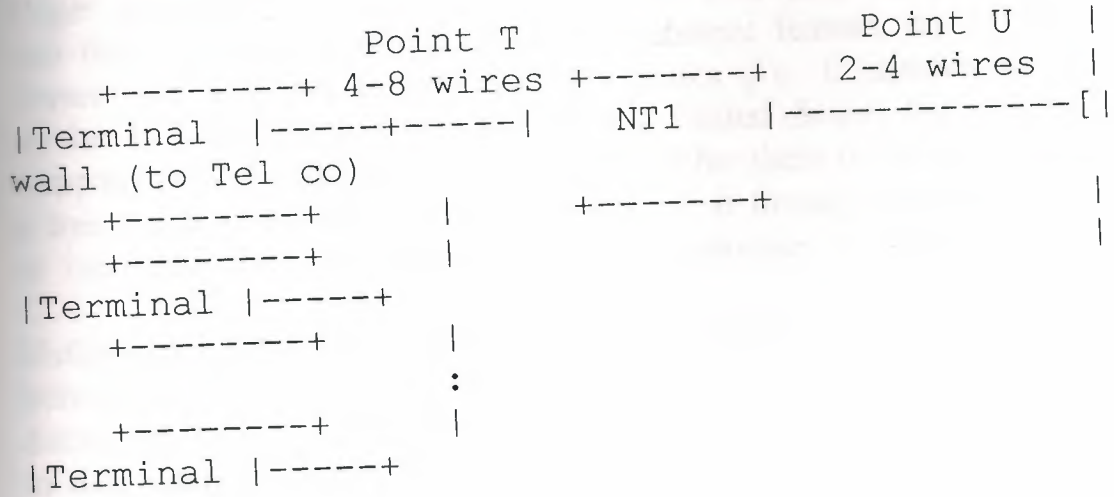
At the customer premises the U-loop is terminated by an NT1 (network termination 1) device. The NT1 drives an S/T-bus which is usually 4 wires, but in some cases it may be 6 or 8 wires. In these optional cases, the extra wires are used provide power to operate telephones when normal power fails. Alternately, 'phantom' power may be derived from the standard four wires.

Outside of North America emergency mode operation provides power for basic voice service only in the case of loss of local power.
In emergency mode operation the NT1 receives up to 1.2W from the central office. In North America there is no provision for emergency mode operation.

The name of the S/T bus comes from the letters used in the ISDN specifications used to refer to two reference points, S and T. Point T refers to the connection between the NT1 device and customer supplied equipment. Terminals can connect directly to NT1 at point T, or there may be a PBX (private branch exchange, i.e. a customer-owned telephone exchange).

When a PBX is present, point S refers to the connection between the PBX and the terminal. Note that in ISDN terminology, "terminal" can mean any sort of end-user ISDN device, such as data terminals, telephones, FAX machines, etc.

This picture shows what a residential ISDN connection looks like.



The T bus is a multi point bus in this configuration. It is sometimes called the passive bus because there are no repeaters on the line between the NT1 and the devices. It can be implemented using the same cable and connectors as is 10 base T Ethernet. There may be up to 8 devices on the S/T bus. The bus may be formed with splitters and T connectors - it is a bus, not a star. The D channel is used to control the attachment of the one to eight devices to the two B channels. No two devices attach to the same B channel at the same time.

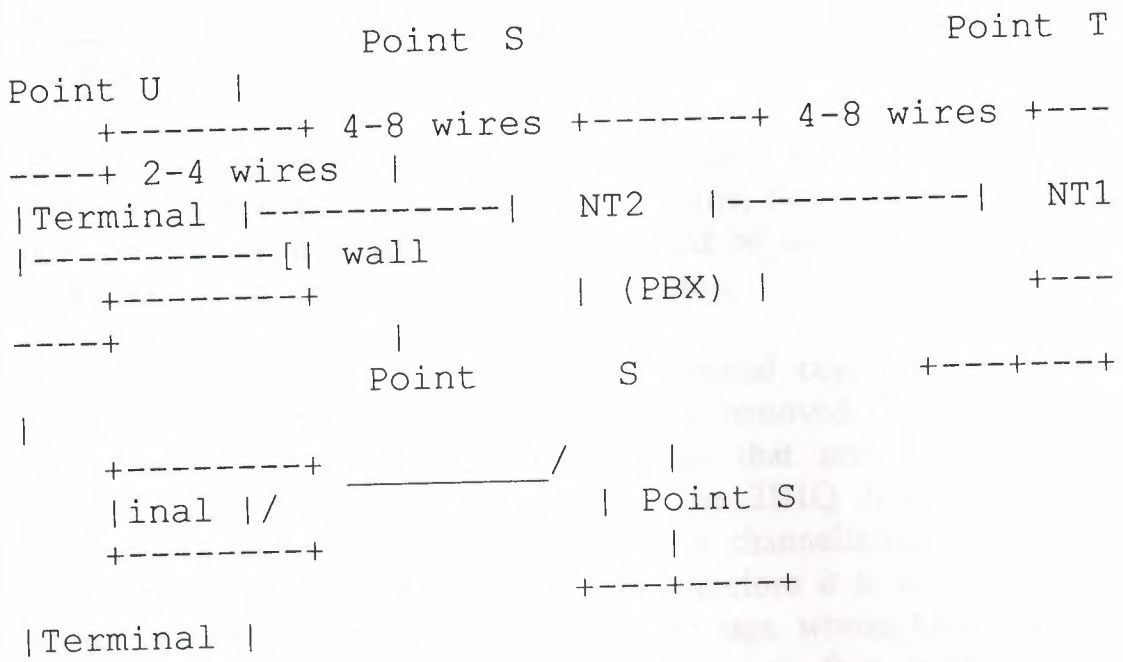
In this configuration, the major function of the NT is to allow more than one device to have access to the 2 B channels provided by the ISDN BRI. For instance, you may have an ISDN telephone, an ISDN fax and an ISDN computer interface attached to the BRI. Each device can listen for calls and only connect to a B channel when it identifies a message requesting a service it can provide.

The NT1 only implements part of the channel sharing scheme; the other devices participate as well, and the communication protocol used by the NT1 and the other devices is an integral part of the scheme. The NT1 also performs other functions; it translates the bit encoding scheme used on the lines between it and the telephone company (the U loop) to the encoding used between it and the devices. These schemes are different because the device to NT encoding was designed to enable channel sharing whereas the NT to Tel co encoding was designed to allow transmission across long distances.

In the United States, the customer pays for the NT device, so don't forget to include the cost of this unit in your cost estimates, or if you don't need the multiple device attachment feature, try to find a device that does not require the NT device (i.e. it attaches directly to the U loop). If you are not in the United States the telephone company provides the NT device, but remember there is no such thing as a free lunch - you are probably paying for it through increased rates, or increased taxes, etc. (flames to SCI. economics or alt.talk.politics).

Unfortunately, the NT1 is not an inexpensive device. It has to convert between the signaling used on the U loop (which is operates over long distances (5.5 km, 18000 ft) in a noisy environment and does not have to deal with contention between devices) and the signaling of the S/T bus (which operates over shorter distances in a quieter environment but it does have to deal with contention between devices and other protocol functions).

It also provides diagnostic functions such as loop back mode, and it may have to provide power, as described above. This picture shows what an ISDN connection looks like when a PBX is present.



In this configuration, the wires at points S and T are point-to-point links. Electrically, the S and T points are the same, which is why the name S/T bus is almost always used. This makes sense; the terminal should see the same physical interface whether it is hooked up with or without a PBX. But, logically they are different. The telephone company needs to know that there is a PBX between itself and the user so that it can coordinate its efforts with the PBX. So, in cases where the difference is important, the specifications use the S and T terminology.

When there is no PBX in the configuration, the NT1 device is usually a standalone device that is packaged a lot like a modem: in a small box when there are only a few, and in a rack mount when you need a lot of them. In the United States, the customer buys the NT1 but in most of the rest of the world the telephone company provides the NT1. When there is a PBX the rack mounted NT1s are quite common. Also, when there is a PBX the use of PRI lines instead of BRI lines is common.

CHAPTER SIX : Important questions about ISDN

6.1 Can the existing local loop lines be reused for ISDN?

The ISDN pairs are the same wires as used for regular telephone service. If you became an ISDN user at home, the same wire pair that now provides your telephone service would be used to provide ISDN (assuming you no longer have the regular line).

Most of the lines do not require any special conditioning. Yes, if a line has load coils on it they must be removed, BUT load coils are usually only found on existing lines that are 15,000 feet or longer. As to lines with bridge taps, the 2B1Q line transmission scheme (not to be confused with 2B + D channelization) is tolerant of a certain amount of bridge taps and, therefore it is only a minimal subset of existing lines (lines with bridge taps whose total length is greater than 3000 feet for the bridge taps) that would require special "de-conditioning."

With those things as the criteria, (in North America) we find than generally around 90% or so of existing telephone lines need no "de-conditioning" in order to be used for ISDN BRI service.

6.2 How does this compare to regular phone lines?

The ISDN line may act like two independent phone lines with two numbers. Depending on the CO equipment, conferencing features etc. may be available (conferencing in the telephone switch). BRI ISDN phones can support key-set features such as you would expect to get on an office PBX like:

- multiple directory numbers per line.
- multiple lines per directory number.
- conferencing features.
- forwarding features.
- voice mail features.
- speed call.
- call park.

- call pickup.
- ring again.
- textual status displays.

6.3 Is caller ID available on ISDN?

Caller ID (name or number display) may be supported (depending on the COM setup). The availability of caller ID for residential phones would depend on the capabilities of the local phone network and legislation allowing or disallowing caller ID. The availability of Caller ID relies on the underlying switching protocol used by the switches that make up the telephone system (e.g. SS7).

6.4 What do I get above and beyond plain old telephone servise ?

Plain old telephone service is transmitted between the central office to your home or office telephone set (or modem, or fax) in analog form. At the central office, the analog signal is converted to a series of digital samples at a rate of 8000 samples per second. Each sample is seven or eight bits in length. As the signals for a telephone call move around the central office, or between central offices, they are transmitted in digital form. Thus, a telephone call consumes a transmission bandwidth of either 56 or 64 kilobits per second. The theoretical (NY quest) limit for the frequency response of a signal sampled 8000 times per second is 4kHz. However, due to various losses in the telephone system, the frequency response of an ordinary telephone call is usually quoted as 3.1kHz. Ordinary modem-based data transmission uses schemes for encoding data in an analog signal so it fits in this 3.1kHz bandwidth. 14.4kbps is a commonly available transmission rate at the high end of the scale. With this transmission rate, over three-quarters of the bit rate handled by the central office is wasted.

Notice that in telephony, 64kpbs means 64000 bits per second, whereas in computer engineering 64k bytes typically means 65536 bytes.

ISDN brings the digital signal all the way to your home or desktop. With ISDN, you can place a data call which uses all 56kbps or 64kbps, because there is no need to convert the signal to analog in your modem and back to digital at the central office. The availability of the full bandwidth presents some interesting technological opportunities:

- transmission of high-fidelity compressed audio
- transmission of encrypted audio
- transmission of lots of data
- transmission of other compressed signals, such as video

Basic-rate ISDN (BRI) offers two channels of this service. In BRI, the connection between your site and the central office offers 64kbps bidirectionally on each channel. Each of these channels may be used for a voice call, for circuit-switched data, or for X.25 packet switched data. Thus, the existing POTS circuit [POTS: Plain Old Telephone Service, i.e. traditional analog telephony] can be conditioned to carry two calls at the same time. (Your mileage may vary; you have to specifically order and pay for the various services from your telephone company, just as you have to order and pay for Call Waiting for an ordinary phone line. Also, not all services are available everywhere; X.25 connectivity between COs is a notable problem in the Greater Boston area as of 9/93, for example.)

Incidentally, ISDN brings another interesting service to your home or desktop: a highly reliable 8000Hz clock signal. In most cases, the central office switches, long-distance carriers, and ISDN terminal equipment all operate with exactly the same clock frequency. In a real-time communications environment (like a voice phone call) this means that there's no need to compensate for differences between the sampling rates at each end of the call.

One of the other features is that instead of the CO sending an AC ring signal to activate your bell, it sends a digital packet that tells WHO is calling (if available), WHAT TYPE of call (speech, data communication?), the NUMBER DIALED (maybe one of your aliases) and some other stuff. Your equipment can then analyze this stuff and make an "intelligent" decision what to do with it. For example, a phone (with speech-only capacity) would completely ignore a data Comm call

while a Terminal Adapter (ISDN "modem") or a phone with built-in data com functions would respond to it.

If you have several "aliases" tied to your line, you can program certain phones to answer calls for certain numbers only. Data comm calls contain baud rate and protocol information within the setup signal so that the connection is virtually instantaneous (no messing around with trying different carriers until both ends match).

CHAPTER SEVEN : Advantages of ISDN

7.1 Speed

The modem was a big breakthrough in computer communications. It allowed computers to communicate by converting their digital information into an analog signal to travel through the public phone network. There is an upper limit to the amount of information that an analog telephone line can hold. Currently, it is about 56-kbps. Commonly available modems have a maximum speed of 56-kbps but are limited by the quality of the analog connection and routinely go no faster than 45-kbps. Some phone lines do not support 56K connections at all, and there are currently 2 competing, incompatible 56K standards (X2 from U S Robotics (recently bought by 3Com), and K56flex from Rockwell/Lucent). This standards problem should be resolved in the next few months when the ITU releases a standard.

ISDN allows multiple digital channels to be operated simultaneously through the same regular phone wiring. The change comes about when the telephone company's switches can support digital connections. Therefore, the same physical wiring can be used, but a digital signal, instead of an analog signal, is transmitted across the line. This scheme permits a much higher data transfer rate than analog lines. BRI ISDN, using a channel aggregation protocol such as BONDING or Multi link-PPP, supports an uncompressed data transfer speed of 128-kbps. In addition, the latency, or the amount of time it takes for a communication to begin, on an ISDN line is typically about half that of an analog line.

7.2 Signaling

Instead of the phone company sending a ring voltage signal to ring the bell in your phone ("In-Band signal"), it sends a digital packet on a separate channel ("Out-of-Band signal"). The Out-of-Band signal does not disturb established connections, and call setup time is very fast. For example, a V.34 modem typically takes 30-60 seconds to establish a connection; an ISDN call usually takes less than 2 seconds.

The signaling also indicates who are calling, what type of call it is (data/voice), and what number was dialed. Available ISDN phone equipment is then capable of making intelligent decisions on how to direct the call.

CHAPTER EIGHT : ISDN Basics

ISDN is delivered from a digital switch through two types of user interfaces: the Basic Rate Interface (BRI) and the Primary Rate Interface (PRI). Each consists of a number of 64Kb/s bearer, or B channels, coupled to one data, or D channel. As defined, B channels are 64Kb/s clear-channel connections, and can be used for dial-up voice and data connections. The D channel is defined as a packet-switched call setup and signaling connection shared by all users of ISDN.

D-channel call setup and signaling information is designed to be transmitted through Signaling System 7 (SS7), a separate telephone network intended specifically for statewide and worldwide call-signaling. Call set-up data is carried out-of-band rather than in-band.

Important note: *In the United States, the Federal Communications Commission (FCC) chose to implement ISDN in a way that requires the user to supply at their site a Network terminating device (NT1) to which the line is connected and which must be powered at the customer site. This means that if the NT1 loses power, the ISDN line will not be usable. Traditional analog telephone service does not require any terminating equipment other than the phone, which usually does not require commercial power and therefore functions even when commercial power is absent. For this reason it is strongly recommended that ISDN be installed as a separate line unless a customer agrees to be responsible for providing their own Power Supply in the event of a prolonged outage.*

8.1 Transmission Speeds

Transmission speeds are most often measured in bits per second (b/s or BPS). Commonly used abbreviations are:

- Kb/s or KBPS(Kilobits per second): Thousand bits per second
- Mb/s or MBPS (Megabits per second): Million bits per second
- GB/s or GPS (Gigabits per second): Billion bits per second

The term "bit" is a contraction of binary digit, the smallest unit of digital information -- either an on or off signal. The major computer codes use either seven (ASCII) or eight (EBCDIC) bits to represent one letter, number or symbol.

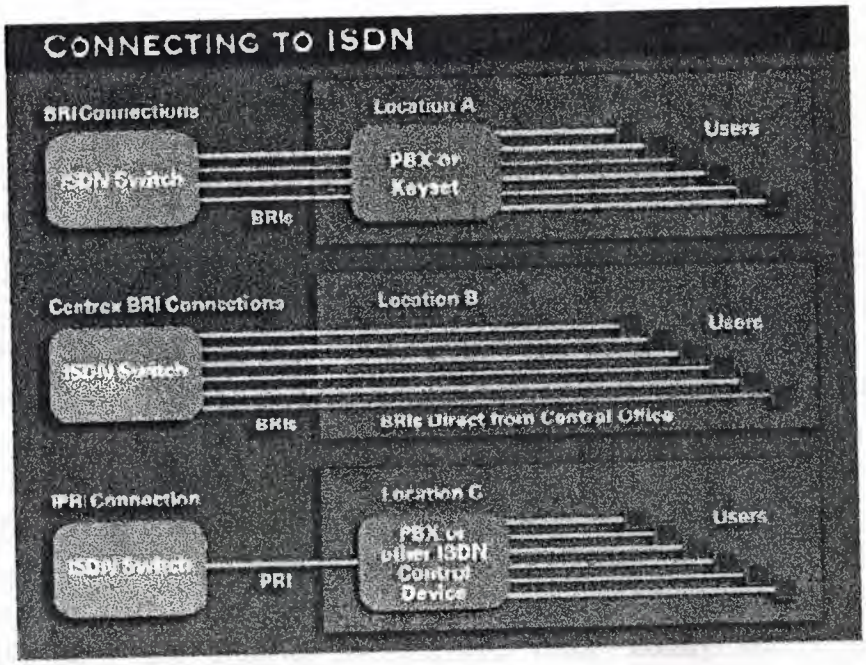
8.2 Connecting to ISDN

There are three ways ISDN can be "delivered" from an ISDN-ready digital switch:

- ***Through a direct BRI connection from an ISDN switch***. One or more standard BRI (2B+D) connections can be used to link a company directly to an ISDN-ready switch .These lines can connect directly to ISDN equipment in a small office or residence, or can be connected through a PBX or key system so that devices can communicate with one another without having to call through an outside connection (Location A in the following chart).

- ***Through ISDN Centrex service***. One or more BRI s can also be linked to ISDN Centrex service (Location B in the chart). This arrangement offers several advantages for an individual or company. Since the ISDN switch functions as the switching system, the company does not have to own or maintain a PBX or key system. It also offers a low-cost, virtually unlimited growth path.

- ***Through a PRI connection***. A PRI delivers 23 B channels plus one D channel from the telephone company to a PBX or other control device, which then distributes the B channels as needed throughout an organization (Location C). How this configuration is set up can vary greatly. Users with heavy data traffic, for example, might configure the connection through an ISDN router, multiplexed or controller rather than a PBX, reducing the chance of congestion through the switch.



8.3 ISDN as the Only Line, or as a Second Line

While ISDN is specifically designed to deliver digital connections through existing copper twisted-pair lines, many smaller locations (and many larger ones as well) will have to decide whether or not to use ISDN as the only telephone connection, or to install it as a separate, second line.

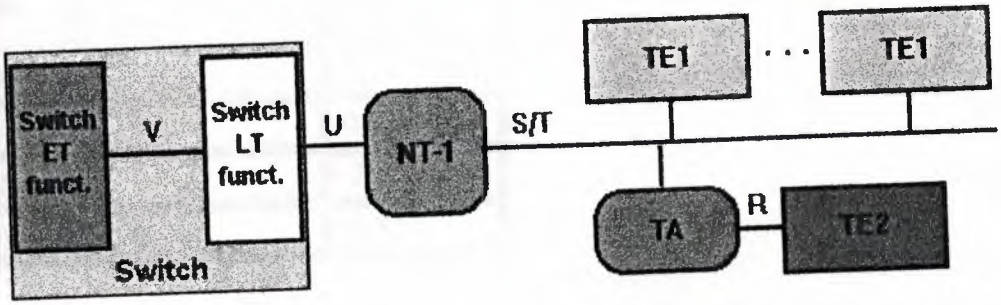
CHAPTER NINE : ISDN Interface

The U interface is a two-wire (single pair) interface from the phone switch. It supports full-duplex data transfer over a single pair of wires, therefore only a single device can be connected to a U interface. This device is called an Network Termination 1 (NT-1) . The situation is different elsewhere in the world, where the Phone Company is allowed to supply the NT-1, and thereby the customer is given an S/T interface.

The NT-1 is a relatively simple device that converts the 2-wire U interface into the 4-wire S/T interface. The S/T interface supports multiple devices (up to 7 devices can be placed on the S/T bus) because, while it is still a full-duplex interface, there is now a pair of wires for receive data, and another for transmit data. Today, many devices have NT-1s built into their design. This has the advantage of making the devices less expensive and easier to install, but often reduces flexibility by preventing additional devices from being connected.
Technically, ISDN devices must go through an Network Termination 2 (NT-2) device , which converts the T interface into the S interface (Note: the S and T interfaces are electrically equivalent). Virtually all ISDN devices include an NT-2 in their design. The NT-2 communicates with terminal equipment, and handles the Layer 2 and 3 ISDN protocols. Devices most commonly expect either a U interface connection (these have a built-in NT-1), or an S/T interface connection.
Devices that connect to the S/T (or S) interface include ISDN capable telephones and FAX machines, video teleconferencing equipment, bridge/routers, and terminal adapters. All devices that are designed for ISDN are designated Terminal Equipment 1 (TE1). All other communication devices that are not ISDN capable, but have a POTS telephone interface (also called the R interface), including ordinary analog telephones, FAX machines, and modems, are designated Terminal Equipment 2 (TE2). A Terminal Adapters (TA) connects a TE2 to an ISDN S/T bus.
Going one step in the opposite direction takes us inside the telephone switch. Remember that the U interface connects the switch to the customer premises equipment. This local loop connection is called Line Termination (LT function).

The connection to other switches within the phone network is called Exchange Termination (ET function). The LT function and the ET function communicate via the V interface.

This can get rather confusing. This diagram should be helpful:



9.1 Layer 1 - Physical Layer

The ISDN Physical Layer is specified by the ITU I-series and G-series documents.
The U interface provided by the Tel co for BRI is a 2-wire, 160 KBPS digital connection. Echo cancellation is used to reduce noise, and data encoding schemes (2B1Q in North America, 4B3T in Europe) permit this relatively high data rate over ordinary single-pair local loops.

9.2 2B1Q

2B1Q (2 Binary 1 Quaternary) is the most common signaling method on U interfaces. This protocol is defined in detail in 1988 ANSI spec T1.601.
In summary, 2B1Q provides:

- two bits per baud
- 80 k baud per second
- transfer rate of 160 KBPS

Bits	Quaternary Symbol	Voltage Level
00	-3	-2.5
01	-1	-0.833
10	+3	+2.5
11	+1	+0.833

This means that the input voltage level can be one of 4 distinct levels (note: 0 Volts is not a valid voltage under this scheme). These levels are called Quaternaries. Each quaternary represents 2 data bits, since there are 4 possible ways to represent 2 bits, as in the table above.

9.3 Frame Format

Each U interface frame is 240 bits long. At the prescribed data rate of 160 KBPS, each frame is therefore 1.5 m sec long. Each frame consists of:

- Frame overhead - 16 KBPS
- D channel - 16 KBPS
- 2 B channels at 64 KBPS - 128 KBPS

Sync 18 bits	12 * (B_1 + B_2 + D) 216 bits	Maintenance 6 bits

- The Sync field consists of 9 Quaternaries (2 bits each) in the pattern +3 +3 -3 -3 -3 +3 -3 +3 -3.
- (B_1 + B_2 + D) is 18 bits of data consisting of 8 bits from the first B channel, 8 bits from the second B channel, and 2 bits of D channel data.
- The Maintenance field contains CRC information, block error detection flags, and "embedded operator commands" used for loop back testing without disrupting user data.

Data is transmitted in a super frame consisting of 8 240-bit frames for a total of 1920 bits (240 octets). The sync field of the first frame in the super frame is inverted (i.e. -3 -3 +3 +3 +3 -3 +3 -3 +3).

9.4 Layer 2 - Data Link Layer

The ISDN Data Link Layer is specified by the ITU Q-series documents Q.920 through Q.923. All of the signaling on the D channel is defined in the Q.921 spec.

9.5 LAP-D

Link Access Protocol - D channel (LAP-D) is the Layer 2 protocol used. This is almost identical to the X.25 LAP-B protocol.
Here is the structure of a LAP-D frame:

Flag	Address	Control	Information	CRC	Flag

Flag (1 octet) - This is always $7E_{16}$ ($0111\ 1110_2$)

Address (2 octets)							
1	2	3	4	5	6	7	8
SAPI (6 bits)						C/R	EA0
TEI (7 bits)							EA1

SAPI (Service access point identifier), 6-bits (see below) C/R (Command/Response) bit indicates if the frame is a command or a response EA0 (Address Extension) bit indicates whether this is the final octet of the address or not TEI (Terminal Endpoint Identifier) 7-bit device identifier (see below) EA1 (Address Extension) bit, same as EA0 Control (2 octets) - The frame level control field indicates the frame type (Information, Supervisory, or Unnumbered) and sequence numbers (N(r) and N(s)) as required. Information – Layer 3 protocol information and User data CRC (2 octets) - Cyclic Redundancy Check is a low-level test for bit errors on the user data.

Flag (1 octet) - This is always $7E_{16}$ ($0111\ 1110_2$)

9.6 SAPI s

The Service Access Point Identifier (SAPI) is a 6-bit field that identifies the point where Layer 2 provides a service to Layer 3. See the following table:

SAPI	Description
0	Call control procedures
1	Packet Mode using Q.931 call procedures
16	Packet Mode communications procedures
32-47	Reserved for national use
63	Management Procedures
Others	Reserved for Future Use

9.7 TEI s

Terminal Endpoint Identifiers (TEI s) are unique IDs given to each device (TE) on an ISDN S/T bus. This identifier can be dynamic; the value may be assigned statically when the TE is installed, or dynamically when activated.

TEI	Description
0-63	Fixed TEI assignments
64-126	Dynamic TEI assignment (assigned by the switch)
127	Broadcast to all devices

9.8 Establishing the Link Layer

The Layer 2 establishment process is very similar to the X.25 LAP-B setup, if you are familiar with it.

1. The TE (Terminal Endpoint) and the Network initially exchange Receive Ready (RR) frames, listening for someone to initiate a connection
2. The TE sends an Unnumbered Information (UI) frame with a SAPI of 63 (management procedure, query network) and TEI of 127 (broadcast)
3. The Network assigns an available TEI (in the range 64-126)

4. The TE sends a Set Asynchronous Balanced Mode (SABME) frame with a SAPI of 0 (call control, used to initiate a SETUP) and a TEI of the value assigned by the network
5. The network responds with an Unnumbered Acknowledgement (UA), SAPI=0, TEI= assigned.

At this point, the connection is ready for a Layer 3 setup.

9.10 Layer 3 - Network Layer

The ISDN Network Layer is also specified by the ITU Q-series documents Q.930 through Q.939. Layer 3 is used for the establishment, maintenance, and termination of logical network connections between two devices.

9.11 SPID s

Service Profile IDs (SPID s) are used to identify what services and features the Tel co switch provides to the attached ISDN device. SPID s are optional; when they are used, they are only accessed at call setup time. The format of the SPID is usually the 10-digit phone number of the ISDN line, plus a prefix and a suffix that are sometimes used to identify features on the line. If an ISDN line requires a SPID, but it is not correctly supplied, then Layer 2 initialization will take place, but Layer 3 will not, and the device will not be able to place or accept calls. See ITU spec Q.932 for details.

9.12 Information Field Structure

The Information Field is a variable length field that contains the Q.931 protocol data.

Information Field							
1	2	3	4	5	6	7	8
Protocol Discriminator							
0	0	0	0	Length of CRV			
Call Reference Value (1 or 2 octets)							
0	Message Type						
Mandatory & Optional Information Elements (variable)							

These are the fields in a Q.931 header:
Protocol Discriminator (1 octet) - identifies the Layer 3 protocol. If this is a Q.931 header, this value is always 08_{16}. Length (1 octet) - indicates the length of the next field, the CRV.
Call Reference Value (CRV) (1 or 2 octets) - used to uniquely identify each call on the user-network interface. This value is assigned at the beginning of a call, and this value becomes available for another call when the call is cleared. Message Type (1 octet) - identifies the message type (i.e., SETUP, CONNECT, etc.). This determines what additional information is required and allowed. Mandatory and Optional Information Elements (variable length) - are options that are set depending on the Message Type.

9.13 Layer 3 Call Setup

These are the steps that occur when an ISDN call is established. In the following example, there are three points where messages are sent and received; 1) the Caller, 2) the ISDN Switch, and 3) the Receiver.

1. Caller sends a SETUP to the Switch.
2. If the SETUP is OK, the switch sends a CALL Proceeding to the Caller, and then a SETUP to the Receiver.
3. The Receiver gets the SETUP. If it is OK, then it rings the phone and sends an ALERTING message to the Switch.
4. The Switch forwards the ALERTING message to the Caller.
5. When the receiver answers the call, is sends a CONNECT message to the Switch
6. The Switch forwards the CONNECT message to the Caller.
7. The Caller sends a CONNECT Acknowledge message to the Switch
8. The Switch forwards the CONNECT ACK message to the Receiver.
9. Done. The connection is now up.

CHAPTER TEN : Applications of ISDN

The real promise of ISDN, is in replacing the dialed analog connections of the past with the dialed digital connections of the future. The ramifications for those who use computers are many.
Digital-to-analog conversions will go away. Modems to convert the digital signals of PCs, computers, LANs, and other devices to the analog signals needed for an analog network will be replaced. Instead, high-speed pulses will flow directly from one digital device to another through a totally digital network.
Many digital connections will become dialed, not dedicated. It will no longer be necessary to lease expensive dedicated digital lines simply to link a high-speed data device to the network. The deciding factor will be the economics of how fast the line must be and how frequently it is used.
Endless connectivity possibilities will open. It will become possible to link individuals, networks and systems that are neither economical nor practical to link today.

Some obvious examples of these new applications are telecommuting, LAN-to-LAN or LAN-to-host interconnection, high speed (greater than 28.8-Kbps modems) Internet access, remote image sharing and retrieval, inexpensive teleconferencing, combined voice and document or image collaborations, high-speed access to remote files or databases, accelerated links to remote libraries and research systems, and literally hundreds of other applications.

While most of these applications are technically possible today without ISDN, very few are practical either because costs are too high or transmission speeds too slowly. The purpose of this ISDN guide, in fact, is to look at these innovative uses. Many are important breakthroughs; others merely helpful conveniences. But all in concert show beyond a doubt that an important new technology has begun to take its place on the stage of telecommunications throughout the world.

10.1 Workgroup Connectivity

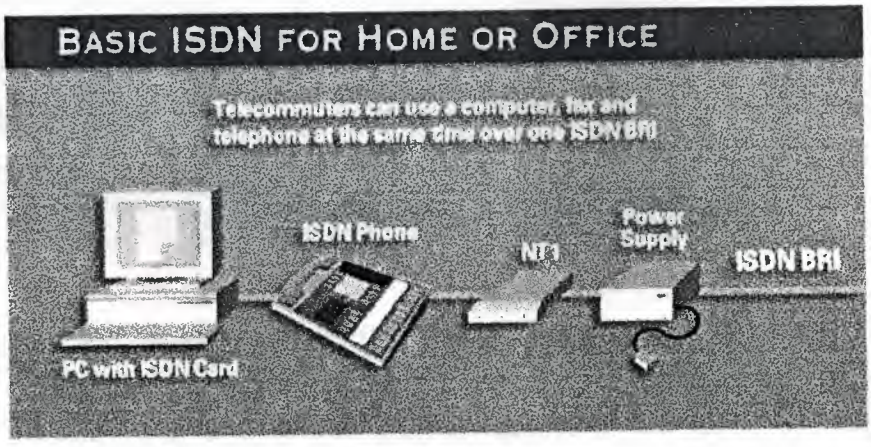
Today, both large and small organizations are choosing ISDN to bring people, offices and locations together in effective, easy-to-use, communications systems. ISDN, with its end-to-end digital connections, offers giant steps forward in speeds up to 128Kb/s today with the quantum leaps of digital data compression still to come. But that, in fact, is just the beginning. As more and more ultra-high-speed channels begin to bind the Pacific Bell network together, and the broadband cables that will carry high-definition television begin to reach into more and more areas, the growth of dialed digital transmission speeds available to ISDN users should continue unchecked well into the future.

10.2 Basic ISDN setup for home or office

The ISDN line does not provide its own power. Thus, an independent power supply is always required.

The idea of ISDN telecommuting is simple: to "transport" as much of the functionality of the office as possible to a remote site through a single ISDN BRI connection. This functionality includes:
Acceptably high-speed access to the user's LAN and file servers.

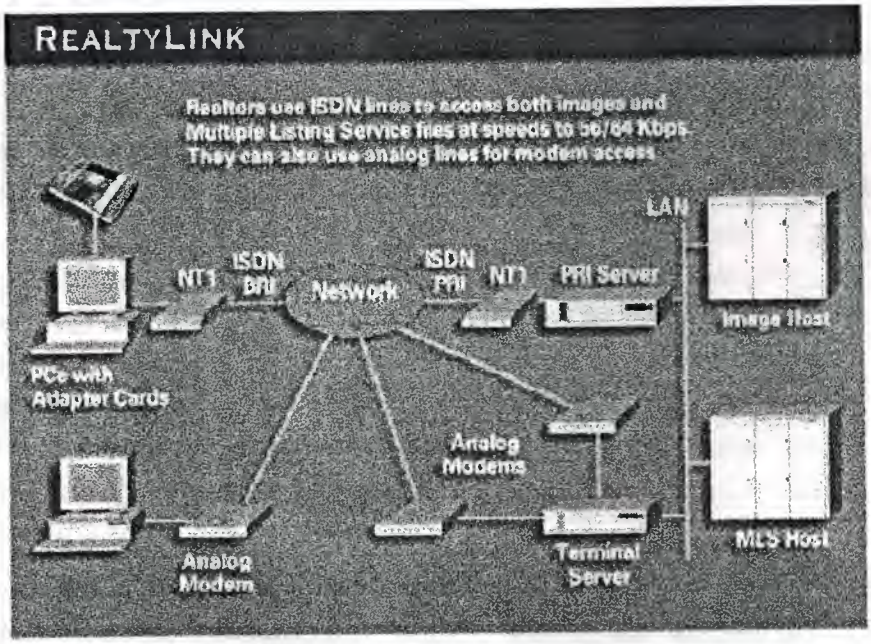
Full access to mailboxes, and the ability to send, receive, forward and annotate both voice and written messages.



Reasonably fast interconnections to other company LANs or hosts, remote systems, and other networks such as the Internet.
Teleconferenced meetings, or the full-color images of co-workers through a range of rapidly emerging PC video technologies.
Note that often these dialed connections can be quite brief, which means that many at-home workers can share the same ISDN channels installed at a network or host, keeping up-front costs reasonable.
Efficient LAN or host access can also be important to someone who is traveling, or home ill, or spending the day at another location. With ISDN, they have not only better telephone contact with co-workers and messaging systems, but efficient laptop access to their LAN or file server.

10.3 Realty Link

The system offers not just MLS information, but photos, drawings, plans and other graphics, as well as electronically stored title, screw and other documents.



Also in development is an ISDN-based system to capture and make available the documents needed to complete a real estate transaction: escrow forms, title and lender guarantees and the like. By scanning these at their point of origin, and making them available to brokers statewide as needed, the real estate industry is rapidly approaching its goal of eliminating the transfer of paper within five years.

10.4 Video conferencing

The use of traditional, full-motion, full-color videoconferences is virtually exploding as equipment costs come down, and the availability of inexpensive dialed ISDN lines goes up.

10.4.1 ISDN Videoconferencing and Large group Systems

offers a range of equipment sizes and costs. High-end applications can combine, or bond, multiple ISDN channels for maximum video quality. In these meetings, individuals or groups at two or more locations use specially designed equipment - turnkey videoconferencing systems that include pan-tilt-zoom cameras, document cameras and other input devices, as well as large TV-like monitors to display in comfortable, easy to see formats the images received from Three sites. The systems also include full audio systems (microphones, speakers, and echo-cancellation), and user interfaces that permit one to dial and setup the videoconference calls easily, and adjust and change settings and combinations of inputs and outputs during the conference. The heart of such systems is the code c (from Code and Decode) a device which takes the moving visual images presented by the camera and encodes these images, which are analog, into digital format, and then compresses them so that they can be sent over the digital circuit-switched connection that ISDN provides. While transmitting a full two-way (remember all videoconferencing is full duplex or bi-directional) analog video signal between two distant points not unfeasible, the cost is usually exorbitant. Compressed digital videoconferencing images can be transmitted satisfactorily using as few as two 64Kb/s channels - perfect for Basic Rate ISDN. With greater bandwidth, a less compressed video stream is sent and motion quality improves accordingly. Many systems run on a single BRI.

Others use special equipment connected to the videoconferencing units called inverse multiplexes which aggregate individual BRI 's for higher data rates to obtain speeds like 384Kb/s or 768Kb/s. For medium and large sites, the videoconferencing equipment may be served by Primary Rate ISDN. A future capability called Multi Rate ISDN will permit PRI users to make calls at these same data rates but without requiring the additional multiplexing equipment to be on the users' premises.

In years past, the only types of digital connections available were private lines. Private lines connect only fixed points on a network (that

In years past, the only types of digital connections available were private lines. Private lines connect only fixed points on a network (that is- connections cannot be dialed ad-hoc to any other point) and they charge users flat, high monthly costs. Since ISDN is a dialed service, it only charges the video conferences for the time actually used to hold their conference - a much more flexible use of the facility. As videoconferencing evolves to become as common as telephone conversations, ISDN will be the connectivity option best suited to allow anyone to video call anyone else.

0.4.2 Desktop Video Systems

Users can see and talk to each other and work together on documents or files.
Videoconferencing systems are also available as PC or Macintosh additions, where the videoconference becomes an application windowed in the PC screen. A growing number of manufacturers are now producing kits that can be installed into the computers consisting of small cameras, microphones, speakers or headsets, software and cards (to perform the code work). Desktop videoconferencing systems also incorporate ways to share information (documents, files, even whole applications) in such ways that permit new kinds of collaborative work. People can see and hear each other, as with large and medium systems; but they can also work together to create documents, spread sheets or other products in real time- that is without having to wait for a new transmission or fax each time one party makes a suggestion or change, all parties can make their changes directly into the application as the others watch. Desktop systems most often run on a single BRI, with some advanced models able to use three.

Data sharing document sharing and application sharing are so valuable, in fact , that the makers of videoconferencing systems have added these capabilities to their medium and large systems as well.

10.4.3 The Importance of Standards

As you may have noticed the presence of standards is extremely important for many of these innovative applications to take root. Videoconferencing has progressed to the point where most manufacturers' equipment now conforms to one or more of the established standards. One such set of protocols the ITU (the same global body that defined ISDN standards) has formalized is the H.320 series.

These are standards for the transmission of compressed digital videoconferencing at speeds varying from 56/64Kb/s to 2Mb/s. The end result is that, just as with fax machines and regular voice telephony, users will eventually not need to be concerned with whether or not the equipment they are communicating with at the distant site is of the same type as they are using.

The combination of the two global standards - ISDN and H.320 videoconferencing are the foundation for a truly open, "anyone-to-anyone" environment - as easy to use and benefit from as the telephone is today.

10.4.4 Network Congestion

When a user dials in to the Internet or an Intranet via an analog modem, a set of telephone network resources are reserved for that user's exclusive use for the duration of the call, whether or not any data is being transmitted. Those facilities include "talk paths" within the telephone switches at the originating and terminating ends of the call, "trunks" which interconnect the telephone switches, a "port" at the ISP or corporate location that the user has called, and of course the user's own phone line.

With ISDN and "Always On," the packet network maintains a set of pointers directing the flow of packet to and from the user. However, no other network resources are used except when data is actually being transmitted; thus, the network can easily support many simultaneous users with the same facilities. The user can actually use two B-channels for other telephone calls while the Internet or Intranet connection is maintained over the D-channel. Many "Always On" users can be simultaneously funneled into the same port at the ISP or corporate location.

10.5 Standards

The "D" channel packet capability is defined in the International standards governing ISDN. Packets are formatted according to X.25, another international standard. The Point-to-Point protocol (PPP) and the Multi link Point-to-Point (ML-PPP), which are in widespread use today for Internet access and remote dial-up, are also used with "Always On". And the newer Bandwidth Allocation Control Protocol (BACP) will also work with "Always On". In addition, Internet Protocol (IP), IPX and

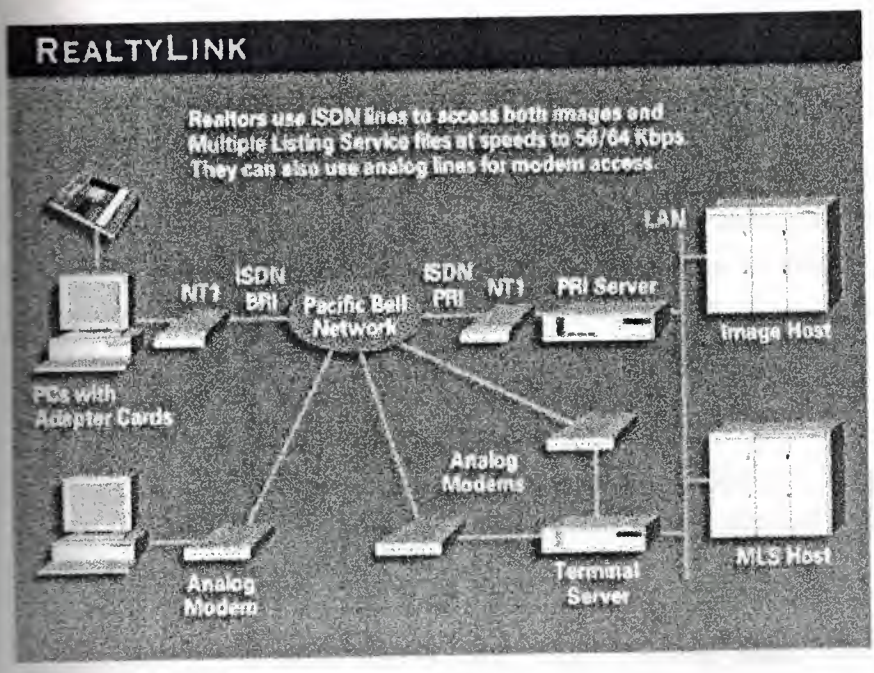
NetBEUI can also operate with "Always On." The users ISDN "terminal adapter" must have an X.25 packet capability and the Internet/Intranet location into which the user is dialing must have a network connection to the packet network in order for the user to establish the "Always On" link.

10.5 Image Archives: A New Kind of System

In many instances where CD-ROM laser disks are being used today, ISDN-based archive systems have begun to offer faster, more convenient access, more up-to-date information and significantly lower overall costs. Some of the digitally stored information ISDN can make available includes X-rays, CAT-scans and other medical images, full-color photographs and illustrations, general and specialized encyclopedias, technical and other professional reference works, repair and service manuals and parts catalogs, film and television images, music and sound libraries, and even virtual reality simulations, games and other visually intensive files. Especially when information is updated revised or added regularly, the currency of its speed and access makes ISDN particularly valuable.

Realty Link is the first multiple-listing service built specifically on the speed of ISDN. Developed by the San Fernando Valley Board of Realtors and Pacific Bell, it stores and makes available photos, renderings, floor plans and other images, as well as title and assessor's documents scanned into the system.

While many computerized MLS systems exist, ISDN-based Realty Link is the first to make the transmission of high-quality images practical. Full-screen color photographs, for example, are drawn on a broker's screen in five to eight seconds. Systems use the IBM Wave Runner card, which also lets brokers access standard analog faxes and modems. Future plans include fully narrated, full-color video tours of a property or area to be called up at a broker's command.



Also in development is an ISDN-based system to capture and make available the documents needed to complete a real estate transaction: escrow forms, title and lender guarantees and the like. By scanning these at their point of origin, and making them available to brokers statewide as needed, the real estate industry is rapidly approaching its goal of eliminating the transfer of paper within five years.

10.6 Photo Retrieval Systems

Today, in France, most larger photo agencies such as Gamma, Sigma, Magnum and Kipa now let their customers, including newspapers, magazines and television stations, use ISDN connections to electronically select photographs. Using standard PCs or workstations, editors view a selection of current or file photographs, and call up full-screen images of individual items.

They can also request thematic searches, try out image zooms and crops, and place orders for photos they choose. High-resolution digital copies of the images can be downloaded, or traditional photographic materials sent by messenger.

The same type of system has now appeared in California. Allsport, a sports photo agency in Santa Monica, currently lets editors, agencies and others view screen images for some 10,000 of its full catalog of six million photos.

Viewers select images online, and download high-resolution files. According to All sport's Steve Power, the agency is scanning about 300 images a day for use in this new service.

Many who work in large organizations spend much of their working day in meetings. Meetings are, in fact, one of the primary ways companies plan, set schedules, solve problems and make decisions. They are often pivotal events where the future of a product or even a company can be shaped.

Yet, as almost anyone in business knows, effective, timely meetings are quite difficult to plan and schedule, and out-of-town meetings, in addition, are usually expensive.

Increasingly, organizations are discovering that carefully structured electronic meetings not only save money, but are much easier to arrange, with key people less likely to cancel. They have also found that these meetings are frequently much more productive:

- Each participant can be better prepared to make or endorse decisions, commit to deadlines and allocate resources, because each has access to the information, advisors, schedules, documents and data they use every day.
- Electronic meetings also seem to promote a more systematic agenda, lessen the tendency to stray from a subject, and dramatically reduce outside and after-hours distractions. It has been said that today it takes less time and effort to hold a meeting than to schedule one.

10.7 A Wealth of Applications

The succeeding chapters focus on some of the many uses of ISDN and how it offers improved productivity, lower costs and more efficient use of valuable human and equipment resources. Some of the applications include:

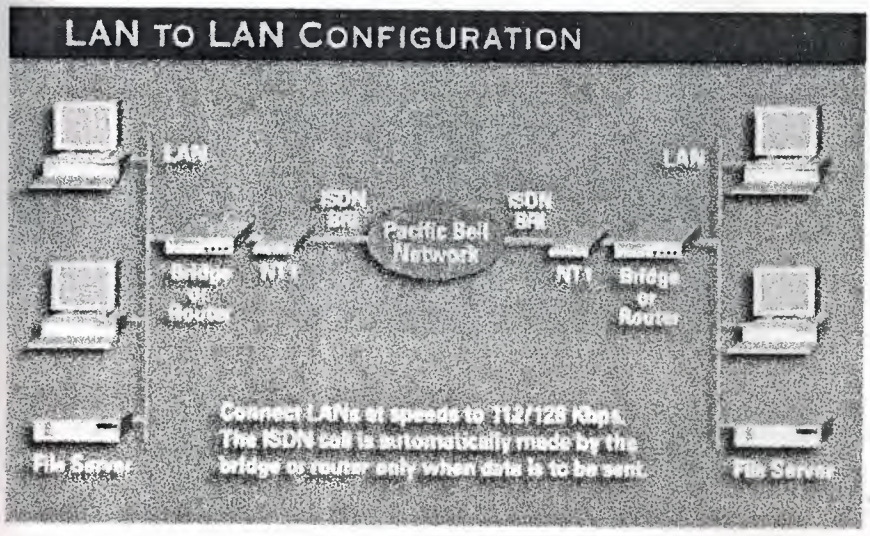
- "ISDN Closes the Digital Loop:" explores the world of shared data, images, ideas and information, from telecommuting and worldwide workgroups, to linking remote LANs across a corporate campus.

- "ISDN Helps Database Systems Come of Age:" shows how ISDN makes finding information easier, from letting high-end research systems offer more useful images and menus, to bringing photographs, catalogs and other visual data on-line.

- "ISDN Produces Better, Less Costly Meetings:" is an overview of how ISDN brings people together, from students in a class whose is teacher 3,000 miles away, to executives attending a meeting without ever leaving their offices.

"The Voice of Tomorrow:" looks at how ISDN brings better, less expensive voice telephone service to virtually any installation.

10.9 LAN-to-LAN Links



A typical LAN-to-LAN configuration
'the connection is used, and changes incurred, only when data is sent. '

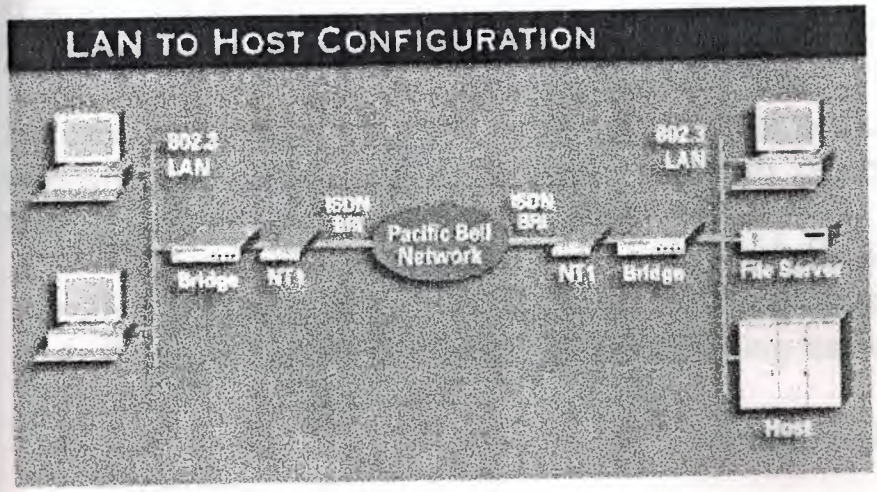
One of the most immediately accepted and widely used applications of ISDN is in linking LANs to each other and the outside world.

Information in most local area networks travels through dedicated fiber optic or coaxial cables at speeds of from 10 to 30Mb/s. Which means that, contrary to a common misconception, ISDN was not designed to replace these LANs, or bridge them into larger local or wide area networks.

Rather, it is ideal for the cost-effective, temporary linking of LANs to each other, to reemit hosts, or to individual non-LAN users or locations for the timely transfer of specific information or files. In fact, the growing popularity of these applications has spurred manufacturers to offer comprehensive lines of ISDN LAN-bridging and file-transfer equipment.

10.10 Are data rates fast enough?

The answer today is a solid yes. Users as acceptable typically characterize current data transfer rates, a rating that should improve quickly as B-channel speeds increase in the near future. Higher LAN-to-LAN speeds are also possible now by inverse multiplexing multiple B channels into larger bandwidth connections .



A typical LAN-to-host arrangement.
'Dialed connections offer enormous savings compared to dedicated links.'

Most transfers of large files today take place through dedicated broadband digital connections, or on magnetic media physically transported by messengers and overnight couriers.

The flexibility of ISDN PRI connections, in contrast, expands a system manager's options. It enables the same dialed B channels used for individual connections during the day to be combined into higher-speed links for after-hours file transfers to and from multiple points.

Similarly, many remote sites that currently have only analog access now content themselves with weekly revisions of pricing and inventory updates, manufacturing schedules and the like. The time required to transfer these files from a central system to multiple satellite locations

through analog connections simply takes too long to make more frequent transmissions practical.

Similar limitations exist in many industries. Equity pricing services, for example, often use disks and tapes, messengers and overnight couriers for weekly price updates to the thousands of trust departments, pension funds and other money managers they serve.

The speed and flexibility of ISDN has already begun to solve these problems with a combination of programmed dialing, flexible channel sizes and high-speed downloads.

10.11 Getting Started Now

If you're ready to go now, without any more advice, you can order ISDN 24 hours a day using our simple on line order form.

For anyone interested in ISDN, or trying to gather more information on capabilities and applications, it makes sense to contact Pacific Bell directly for help on a range of issues, including:

- The feasibility and rough cost of the intended mix of applications.
- Recommendations on ways to enhance efficiency or cut costs.
- Possible equipment configurations, including expansion paths and costs.
- The availability of applications software and programming expertise.
- References to other users with similar applications whose experience may be useful, or guidance to specialized equipment and system integrators who can help plan and/or install a comprehensive applications response.

For business, your Pacific Bell account team is fully trained in understanding and helping you reach your objectives and then matching the correct *Fast rake* data transport service to your applications. Whether it's a question of using ISDN BRI or PRI, Frame Relay, Hi-Capacity Digital Service (T-1), Advanced Digital Network, SMDS, ATM-Cell Relay Service or any other, you can obtain invaluable networking consulting expertise at no charge from our Specialists.

10.12 The ISDN Service Center

Another step Pacific Bell has taken to make the initial contact as productive and informative as possible is the establishment of an ISDN Service Center. Opened in 1994, this facility is staffed by knowledgeable communications consultants who can answer questions, offer advice, arrange for follow-up meetings or conferences as needed, and in general help customers get started with ISDN. Help, support and information is available for any Pacific Bell customer, from small business owners looking for simple single-line BRI connections, to corporate MIS executives considering complex, multi location systems. Pacific Bell representatives can also take orders for specific service and equipment installations on the spot, or identify and allocate specialized teams of sales and installation representatives. These ISDN experts are also knowledgeable in the full range of other Pacific Bell *Fast rake* data services.

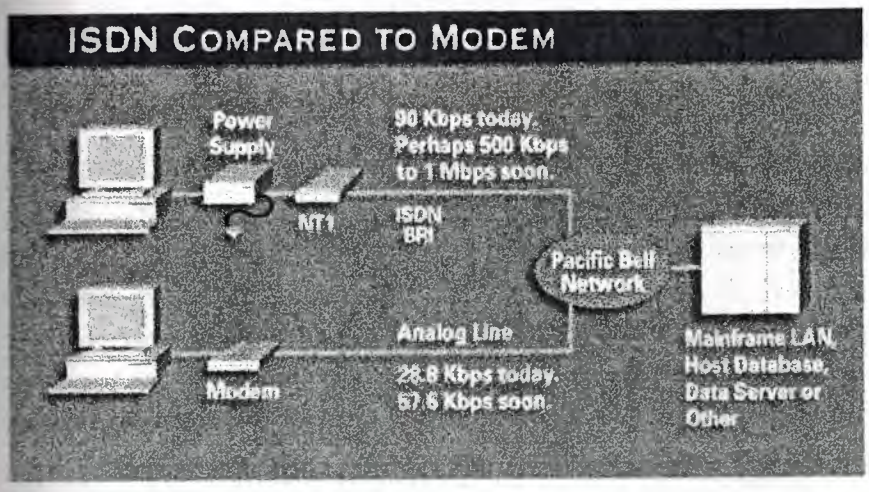
The toll-free number of Pacific Bell's ISDN Service Center is 800-4PB-ISDN (800-472-4736). Assistance is also available through the Pacific Bell Telemarketing Center, 800-622-0735, or Pacific Bell's Public Packet Switching Network Center, 800-287-0353. ISDN lines, equipment and applications expertise are also available from a range of other sources throughout California, including authorized value-added resellers (VAR s) and authorized Pacific Bell sales agents.

10.13 Digital Access to the Facts You Need

ISDN will significantly change the visual presentation of many existing information systems such as Internet Service Providers and Online Service Providers, including professional and amateur bulletin boards.

10.14 Access to Online Information

Greatly increased speeds will let these services begin to incorporate a wide range of graphics photos, drawings, illustrations, charts and diagrams, few of which are practical to transmit at present via traditional modem links. Even leading-edge systems, such as Lexis, ABS Dialog, and a broad range of business, chemical, engineering, cartographic, demographic and similar data sources are beginning to offer more complex graphics and user-friendly graphical interfaces.



10.15 ISDN telephones

Soft keys offer quick, effortless access to features and functions. The "inspect" button displays additional features.

Sometimes called a "virtual key system", Centrex ISDN features make a formidable competitor to premises-based PBX or key systems. The Pacific Bell switch becomes, in effect, the PBX serving a location. It offers extended functionality and the potential for unlimited growth and enhancement, with much reduced capital investment and little risk of obsolescence.

When Centrex locations are scattered, yet still served by the same Pacific Bell Central Office (a requirement on all Centrex systems) the unifying features of the Centrex combine with the ISDN capabilities to create a powerful and versatile system. In this case all calls between Centrex stations, voice or data, even if they are located at different addresses are free, being "in system" or intercom calls. For telecommuters located near their offices, or businesses with multiple locations served by the same telephone company central office, this capability that extends virtually all an enterprises big system features to the remote user is unmatched.

10.16 Hi-fi on the Digital Highway

Throughout California and the world radio stations now use ISDN for clear, quiet sound transmissions from baseball, basketball and other games, concerts, news conferences, political conventions and similar events. At most locations, temporary ISDN lines are installed, although at

more and more venues, permanent ISDN lines have been put in place by both broadcasters and entrepreneurs who lease them to others for major functions.

Modern sound studios are also using ISDN for remote recording of announcer's voices, live music or other components of a film, video, advertising or audio-visual presentations. The latest digitizing equipment can compress the highest quality audio signals (CD quality stereo) which would ordinarily require 1,411,200 bits per second to transmit into bit streams of 56, 64, & 128Kb/s. Many studios also download stereo tracks recorded elsewhere for mixing and enhancement on their more sophisticated equipment, or for incorporation into a film or television presentation. Many voice-over and Automatic Dialog Replacement (ADR) sessions, are now done with the talent and the mixers and directors all in different locations. Today, many voice samplings for dubbing into foreign language films are recorded and then transmitted over ISDN.

Hollywood's Byron Wagner, of Genius, Inc., is convinced that ISDN transmission of CD-quality sound is in its infancy. Wagner is not only an equipment innovator and technology consultant to the entertainment industry, but has been the recording engineer of choice for some of the world's leading popular and country performers.

Wagner used ISDN lines and state-of-the-art compression equipment to link singers in San Francisco, Hollywood and Hawaii into a single real-time concert. He believes the technology opens many possibilities, from remote concerts, talent auditions and collaborative jam sessions, to Tele-jukeboxes in which customers link their stereo systems to a compact disk library to hear and perhaps even buy new releases or hard-to-find classics.

10.17 Corporate Training

Similar educational needs exist in the corporate world, where expert trainers must either travel to the trainees, or the trainees must travel to the experts. In either case, expenses mount rapidly and key people are taken away from their primary jobs for extended periods. Time, energy, and productivity are sacrificed.

Distance learning, combining videoconferencing with graphics, documents, files, or applications allows employees to continually upgrade

their skills, while minimizing time lost off the job or traveling to classes.

10.18 Charles Schwab

One major user of the network-control power of ISDN is Charles Schwab & Co., which is now using an ISDN system with about 10 percent of its brokerage offices nationwide. These are supplemented by four large phone centers in Arizona, Colorado, Florida and Indiana. The Schwab objective is to never miss an incoming call, while minimizing the costs of forwarding them through its network of offices. When agents in a pilot-system office are ready to receive calls, they log in with a D-channel message to Schwa 's computer-based phone server. They then begin receiving calls, with messages on their phone screens telling them whether the call was to their office or is being forwarded. The Schwa system functions as a responsive automatic call distributor, allocating calls to the most appropriate agent, regardless of geography. It can also route calls to agents in nearby offices, or if all agents in all local offices are busy with customers, forward the calls to the nearest Schwa phone center.

Costs are minimized, since calls are forwarded locally when possible, yet service levels are maintained at virtually 100 percent.

The results are total responsiveness to every customer, sensible staffing levels at each branch office, and minimum costs for a truly nationwide telephone system.

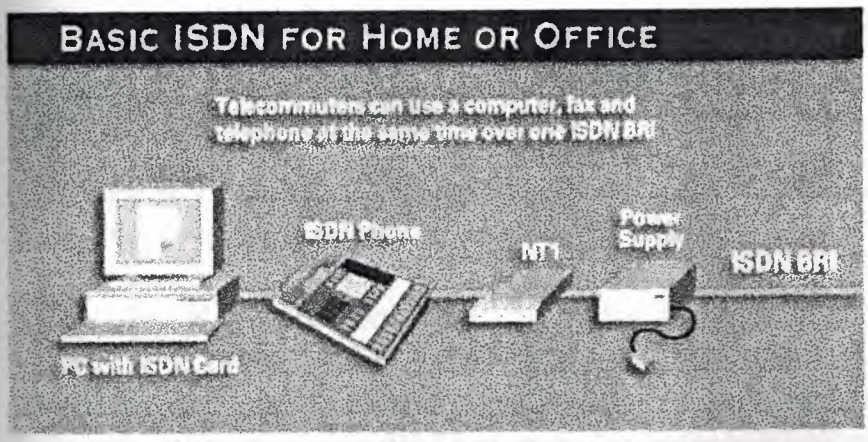
Many users need to be "continuously connected" when they are working from home. They require notification of e-mail so they can quickly respond. They need regular updates of changing information such as stock quotes or news headlines. Or, they want to be available for an on-line conference that might be initiated by co-workers at another location. "Always On/Dynamic ISDN" (AO/DI) satisfies these requirements by providing a continuous connection to the corporate network (Intranet) or Internet for telecommuters, remote workers and independent professionals who require "Always On" connectivity for e-mail and data, such as stock quotes.

Building upon the feature rich ISDN platform, which permits simultaneous voice, data, video and e-mail on a single ISDN connection, D-Channel "Always On" offers a cost- effective way of maintaining a real-time link without having a "dial-up" connection to the corporate

network or Internet Service Provider (ISP). "Always On/Dynamic ISDN" offers the best of all worlds -- An "Always On" digital platform with scalable connections that you pay for only as you use.

CHAPTER ELEVEN : Telecommuting

Across the nation, legislative mandates are being put in place to reduce the number of cars commuting to and from an office each day. For example, the California Clean Air Act, effective in 1994, affects all large and mid-size companies, and allows only 74 cars in a company parking lot for every 100 employees. One immediate answer to this problem is telecommuting.



11.1 Bob Metcalf Telecommutes

One enthusiastic user of ISDN in California is Bob Metcalf, the inventor of Ethernet, and now Publisher/CEO of the news weekly InfoWorld. He uses an ISDN BRI to link an Apple PowerBook Duo in his home to the company's headquarters in San Mateo. "My NetWare servers, Laser Writers, electronic mail, Lotus Notes, and Internet services are all right there," he notes, through a 2B+D connection. "ISDN is fast enough to extend LANs remotely so you can use them for telecommuting. For example, I'm not using Remote cc: Mail from home, but cc: Mail itself." For file transfers, his effective speeds through AppleTalk are about 90Kb/s, which he calls "brisk for most of what I do."

In the near future, he expects speeds of up to 500Kb/s through the same connection, because of evolving digital data compression techniques. "But even the 90Kb/s I get now," he adds, "is an almost five-fold improvement over the analog modem connections which were bogging me down."

11.2 A Concise History of Packet Switching

Defined in the early 1970s, X.25 packet-switching protocols are accepted as a worldwide communications standard. Information is divided into small packets, each of which contains a complete address as well as codes to put it in proper sequence with the other packets being sent. A PAD (Packet Assembler/Dissembler) at the sending end accomplishes this packetizing. At the receiving end, another PAD accepts the transmission, puts it in correct order (packets can travel many routes through the network and may not arrive in the order they were sent), and forwards it intact, in proper sequence, to its destination.

11.3 X.25 Packet Switching

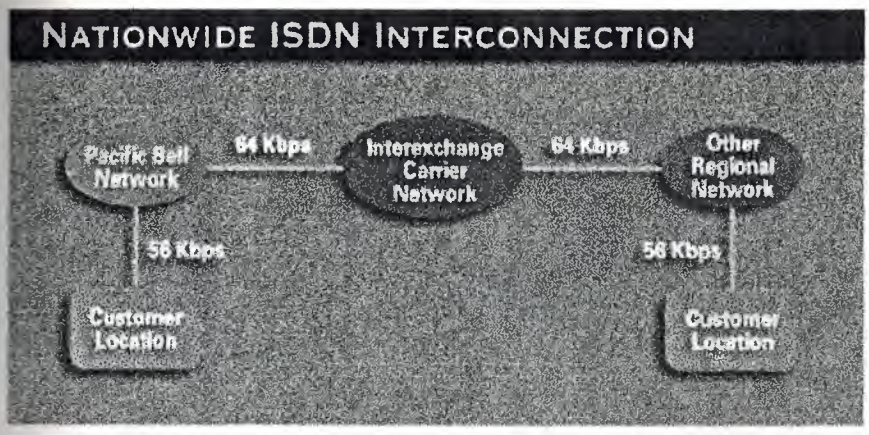
Through X.75 interconnections, it's possible to link directly to services or locations on packet networks around the world.

Since the X.25 protocol was originally designed for often noisy and interference-prone analog lines, Pads also perform a broad range of error-checking and error-correction functions. If any packet is not received correctly, the receiving PAD signals for retransmission until the packet comes through correctly.
The result is exceptional accuracy through lines that were, and in many areas of the world still are, less than perfect for data transmission.

11.4 Extending ISDN with Switched 56 Services

It is also possible today to establish ISDN-compatible data links to out-of-state locations not served by ISDN, by using Switched 56 services.

The major interchange carriers, all regional operating companies, and many specialized international carriers offer Switched 56 services. These are single-channel, dialed, data-only connections, capable of speeds up to 56Kb/s. Virtually all are connected to the interchange carriers' nationwide digital networks, and thus to each other.



Today, in 1997, most Pacific Bell central office switches have been upgraded to either AT&T 5ESS or Nortek DMS-100 systems, both designed specifically for a full range of digital services such as ISDN. In the few areas where a digital switch hasn't been installed yet, ISDN can still be made available through a special remote arrangement. The end result is that 97% of Pacific Bell customers can now get Basic Rate ISDN. Pacific Bell also gives seamless connections to the long-distance ISDN services of the major interchange carriers (Ices) such as AT&T, MCI or Sprint, just as it does for all types of voice (and many data) services. Many of these Ice's offer direct access to their own ISDN PRI services as well.

For international applications, many European and Pacific Rim countries offer ISDN connections to overseas commercial centers, and several of these systems are actively used by customers as hubs for overseas networks. Worldwide ISDN interconnection is available through major interchange carriers, with local connections provided by Pacific Bell and other regional telephone companies.

While some limitations do still remain in the nationwide availability and transportability of ISDN, enormous progress has been made. One problem that is quickly being solved is that for the present, equipment that works on one particular carrier's ISDN service may not function properly on ISDN from another source. The reasons for this problem, and the evolving solution, are discussed in the following section. The solution has to do with, you guessed it, standards.

11.5 Nationwide ISDN interconnection

Calls to areas where ISDN is not available can complete. Examples of ISDN applications which can be effectively extended through Switched 56 services are those that:

- Do not depend on voice transmission,
- Do not use several channels simultaneously for multimedia transmission,
- Do not need data speeds greater than 56Kb/s,
- Do not depend on the call-by-call intermixing of circuit-switched and packet-switched data, and
- Do not depend on out-of-band D-channel signaling.

11.6 ISDN Services from Pacific Bell

Pacific Bell today offers ISDN connections in virtually all of its territory. As described below, many of these switches can provide all three Basic Rate ISDN Products and Primary Rate ISDN.

11.7 Fast rake Business ISDN

fast rake Business ISDN is Pacific Bell's implementation of the standard ISDN BRI for business customers. It offers the standard BRI 2B+D interface, integrated voice and data transmission over a single phone line, with the quality and increased data speeds of digital transmission. For voice calls, *fast rake Business ISDN* offers exceptional flexibility - enabling up to three simultaneous "conversations" through a single twisted-pair phone line. It accommodates multiple devices on a single line, as well as multiple phone numbers, each ringing a separate phone, or multiple numbers on multiple phones. Responses to individual people's incoming calls can be personalized differently based on the number or business dialed. Incoming Calling Number Identification service is included in the basic monthly service charge as well as easy-to-use call-management features, such as hold, three-way conference calls, and call transfer.

ISDN installations can, of course, dial to and receive calls from ordinary voice telephones everywhere, since the digital and analog systems are interconnected. For data, *fast rake Business ISDN offers* two 64Kb/s digital B channels for voice or circuit-switched data with total available speed of up to 128Kb/s without data compression, as well as one 16Kbps

D channel for packet switched data and call signaling only. It is compatible with other Pacific Bell digital services, and offers dialed, fully digital data connections. Pacific Bell works with the major interchange carriers such as AT&T, MCI and Sprint to establish the long-distance ISDN channels needed for worldwide voice and data interconnection. Fast rake Business ISDN is provided through a standard measured service business line ("1MB"), and is available to virtually all Pacific Bell customers either through a digital switch in their area's central office, or through the Alternate Serving Arrangement (ASA), which links them to ISDN in a neighboring Pacific Bell location.

Important note: Asao's require a telephone number different from those in the local exchange. This could affect toll charges. Also, as local switches upgrade to provide their own ISDN service, a line that was provided through an ASA originally, may be "re-homed" at any time, and though this should make no difference in the nature of service provided, the telephone number(s) assigned to the ISDN line will change.

11.8 Fast rake Centrex ISDN

fast rake Centrex ISDN is Pacific Bell's implementation of the standard ISDN BRI for Centrex customers. It offers the standard BRI 2B+D interface, integrated voice and data transmission over a single phone line, with the quality and increased data speeds of digital transmission. With fast rake Centrex ISDN, Pacific Bell in effect allocates a segment of its central office switch to act as a dedicated PBX for the customer's ISDN system. The benefits are significant:

- First, these switches are state-of-the-art digital systems, staffed around the clock by highly trained engineers and technicians. They are also fully disaster-prepared and supplied with power backup in case of an emergency. Centrex services have traditionally offered superior performance, especially during earthquakes and power outages.

- Second, for smaller to mid-size businesses, *fast rake Centrex ISDN* offers the power and call-management features of a large modern switching system at virtually the cost of the BRI connections themselves. There is no richer system in terms of features and capabilities content than a *Fast rake Centrex ISDN* voice application.

11.9 Fast Trace Personal ISDN

Fast rake Personal ISDN is Pacific Bell's implementation of the standard ISDN BRI for residential customers. It offers the standard BRI 2B+D interface, integrated voice and data transmission over a single phone line, with the quality and increased data speeds of digital transmission.

Key applications include:

- Access to the World Wide Web or online service providers
- Advanced voice features
- Remote LAN access
- Compact or desktop videoconferencing

For data, *Fast rake Personal ISDN* offers two 64Kb/s digital B channels for voice or circuit-switched data with total available speed of up to 128Kb/s without data compression, as well as one 16Kbps D channel for packet switched data and call signaling only. It is compatible with other Pacific Bell digital services, and offers dialed, fully digital data connections. Pacific Bell works with the major interchange carriers such as AT&T, MCI and Sprint to establish the long-distance ISDN channels needed for worldwide voice and data interconnection. For voice calls, Fast rake Personal ISDN offers exceptional flexibility. It accommodates multiple devices on a single line, as well as multiple phone numbers, each ringing a separate phone, or different numbers on the same phone. This helps respond to incoming calls differently based on the number dialed. Personal ISDN also offers easy-to-use call-management features such as hold, three-way conference calls, and call transfer.

Incoming Calling Number Identification is included in the services basic monthly charge.

Personal ISDN charges regular measured local (zones 1 & 2) usage rates from 8 am-5 PM, Monday through Friday. All other hours, local usage is free up to 200 hours per month per line (both B channels). Fast rake Personal ISDN is provided through a standard measured residence line (1MR) and is available to virtually all Pacific Bell customers, either through a digital switch in their area's central office, or through the Alternate Serving Arrangement (ASA), which links them to ISDN in a neighboring Pacific Bell location.

11.10 Fast rake Primary Rate Interface Service

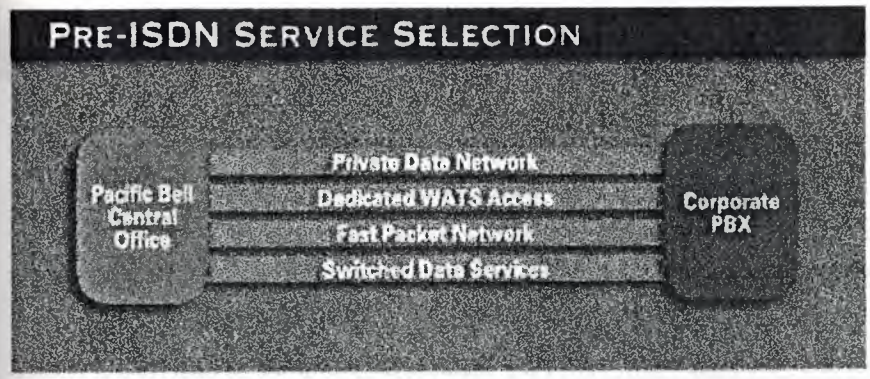
Pacific Bell's ISDN Primary Rate Interface (PRI) Service is provided through standard T-1 (1.544Mb/s) point-to-point, private-line facilities. The service enhances the capabilities of the basic T-1 digital trunk by dividing it into 24, digital, 64Kb/s channels (in effect, DS-0 trunks), and giving the user control of these individual channels.

Pacific Bell is using out-of-band Signaling System 7 (SS7) in California so each channel offers a full 64Kb/s of usable bandwidth for transmissions both within and beyond the central office providing the PRI.

Each B channel may be used for virtually any combination of data, voice, video or packet switching, and Pacific Bell's central office switch can dynamically change the configuration of channels in response to traffic needs, offering a range of advantages and cost efficiencies. Fast rake Primary Rate ISDN gives PBX customers improved trouncing capabilities by consolidating several services into a single, dynamic facility. Instead of having, for example, one group of connections for normal voice access, one for incoming 800-number lines, one for outgoing or special services, and others dedicated to various data needs, it is now possible to allocate any channel to any function, wherever and whenever it's needed.

Groups of B channels (that is, 64Kb/s DS-0 trunks) might be allocated during the day to exchange services, video conferences, and other voice or data needs. Later, after business hours, the same trunks can be combined for broadband data transmissions to and from remote computers. The result: more traffic through fewer facilities, with much more productive use of each trunk.

PBX customers can also consolidate their traffic to one or more interchange carriers through a PRI connection to the central office, eliminating separate connections to each IEC. This also lets users take greater advantage of discount plans for IEC services, and offers an alternative for customers who might otherwise have to maintain dedicated facilities to several of these carriers.



Pre-ISDN service selection

11.11 Distance Learning

A broad range of educational institutions are beginning to use ISDN as the backbone for integrated voice, data and video transmissions that bring expert teachers face-to-face with students in remote classrooms.

In a more elaborate set up, classroom TV screens show the teacher and any visuals being used, while a camera in the class lets the teacher see and interact directly with students. A simpler set up might include a desktop videoconference between a teacher and several students, a screen-sharing link for visuals and interchanged materials, and perhaps a remotely controlled computer screen showing documents, images, data or almost anything else.

ISDN connections, in fact, can effectively handle almost any combination of voice, visual and data interchange.

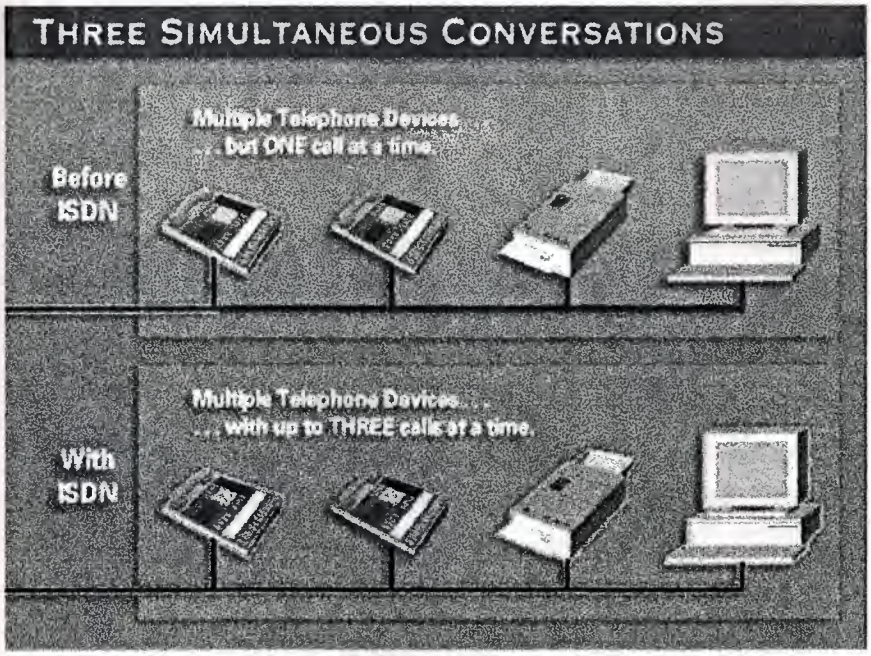
CHAPTER TEWELVE : ISDN BENIFITS

- You can use the same line to transmit and receive voice, data, images and video simultaneously. With a traditional analog line, you'd have to connect to each of those services individually.
- ISDN transmits information digitally, so it's far faster than analog telephone service - and more accurate as well.
- You save money by not paying for leased lines that you may seldom use to capacity. It's also easy and economical to reconfigure backup and emergency networks.
- Your company can improve its communications capabilities while reducing the number of lines it needs, because with ISDN you can use the same lines for different types of calls, either permanently or as the need arises.

12.1 Why Is ISDN So Important?

More than just a means for fast, accurate, data transmission, ISDN truly represents the next generation of the world's telephone service for all forms of telecommunications, including voice. ISDN brings the digital network to the individual user.

Thus, the same Twisted-pair copper telephone line that could traditionally carry only one Voice.



CHAPTER THIRTEEN :

EXTRAINFORMATIONS ABOUT ISDN

13.1 A Technology of Today

ISDN has been called a "technology of the future". But it is also a vital thrust of today, answering today's needs, and amazing even its most avid supporters with the speed and enthusiasm of its acceptance, installation and use. As the world's telecommunications network becomes increasingly digital, ISDN is the final link extending this digital system to the desktops of individual users.

13.2 The Spectrum of Digital Technologies

ISDN is, in fact, one of a number of emerging technologies designed to exploit the power of the worldwide digital communications network. These technologies include Asynchronous Transfer Mode (ATM), Switched Multi meg bit Data Service (SMDS), and Frame Relay (all designed for high-speed network access through dedicated, leased lines) as well as ISDN and Switched 56 services (which offer both dedicated and dialed access).

13.3 Remote Telemetry and Security

ISDN connections can also let machines talk to each other. At a leading California biotechnology company, an ISDN system initially installed for LAN-to-LAN connectivity, telecommuting and other uses now links computers to a growing number of monitoring devices for room and liquid temperature control, fluid disbursement, animal feeding, and the like. For each, the system helps maintain virtually flawless control.

Several other companies are also using ISDN for physical security in warehouses, receiving docks and other similarly vulnerable sites. Both B and D channels can be used as inexpensive conduits for remote TV cameras, and to monitor locks, alarms, and strategically placed sound, movement, heat and other sensors.

13.4 Group 4 Facsimile

Group 4 facsimile offers increased speed, reliability and quality for point-to-point image transmission. B-channel digital connections transmit even the most complex drawings, documents or images anywhere in the world in less than eight seconds with laser-print quality identical to the original. Problems of transmitting over long distances through analog connections are eliminated.

13.5 The San Francisco Examiner

The San Francisco Examiner Magazine takes this processes one more step. Using ISDN, the weekly publication incorporates DPI into what Director of Development Chris Gulker calls a "distributed work model."

The entire publication, in fact, works as a virtual newsroom that includes a small inside staff, writers in other parts of the daily newspaper, a nationwide corps of freelancers that includes a Washington corespondent, a cross-word puzzle expert in Florida, a "people and styles" columnist in Colorado, and more. All are linked to the magazine in a variety of ways, from ISDN and the Internet to America on-line.

13.5 Access to the Internet

One of the major uses of ISDN is high-speed access to the Internet, the information highway nurtured by the federal government, that incorporates and interconnects the nation's most sophisticated research systems and data repositories; and in particular, its subset, the World Wide Web. The Internet offers many things to many people from worldwide electronic messaging to a seemingly limitless wealth of accurate, up-to-date information stored in private and public systems across the nation and around the world.

Content on the Web has evolved at an astounding pace to now include an ever richer palate of Graphical User Interfaces, Plug-in and helper

Applications, Applets, Audio, and Video. All of which tax the networks and patience of the user community as download times begin to increase.

The four to eight fold increase in effective throughput that one achieves with ISDN can seem an exhilarating leap in time saved and productivity gained. Today's Internet browsers demand higher speed connections for satisfactory results.

Today, many corporate and academic organizations have Internet servers linked to the network by high-speed leased lines. At the same time, public Internet servers are beginning to offer full network access to smaller firms and individuals through dialed ISDN connections. Two more recent trends are ***Intranets*** and ***EXTRA nets.***

Intranets are networks that exist totally within an enterprise, protected by a security application known as a "Firewall", which bars access to unauthorized users. Employees typically navigate through their company's Intranet in a very similar if not identical fashion as they would the Internet at large (meaning with a browser with a GUI and IP routing). In fact Intranets usually have Gateways to the Internet so that users can search back and forth, in either network and often sense no difference. Extra nets are combinations of different enterprises' Intranets, or specific partitioned entities of them that would allow access between companies whose partnership requires the sharing of data that would not be appropriate for the Internet. Such arrangements are complex but provide many benefits and the often-sporadic nature of the interconnection traffic can make the dialed-up rate structure of ISDN very practical.

As Robert Berger, President of Internet Information Services in Menlo Park, said, "Using two B channels, ISDN offers 10 times the speed of an analog modem. And prices are now at levels that make the Internet very attractive."

13.7 Credit Card Authorization

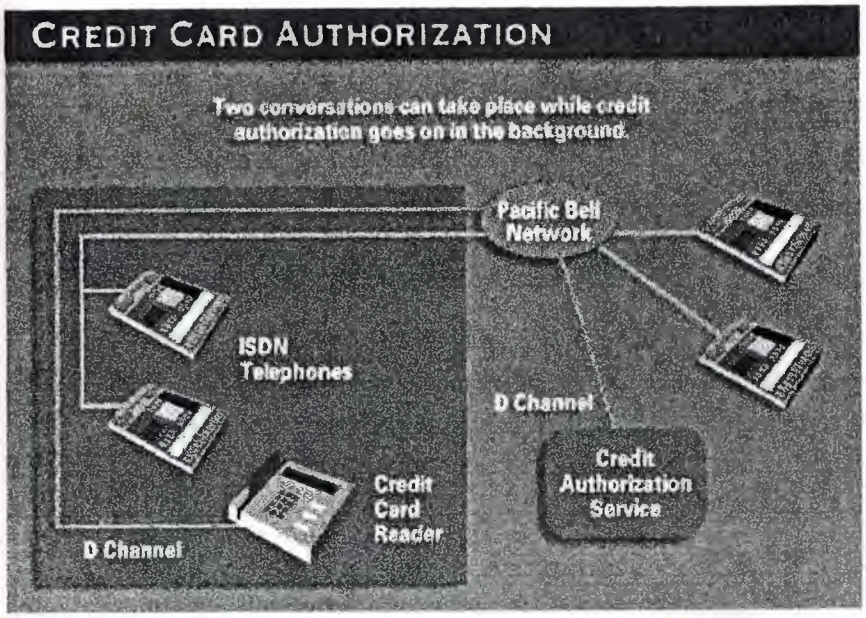
The need for rapid access to data is not limited to databases or research services. The credit-card authorization process consumes significant amounts of a merchant's time. Retailers must dial a computer, wait for a connection, scan a card through a reader, wait for approval, and then hang up. Through all this is the striking irony that the actual amount of data that needs to be sent and received is often quite low - merely a few short

strings of numbers and or characters. Quite often this type of payload ("short and burst") fits beautifully into the 128-256 Kilobyte capacity of a typical X.25 packet. The data transfer rate of 9.6 KBPS, seemingly low by comparison to the B channel speed, actually moves these packets in the blink of an eye. Several times more time is consumed by the analog modem with its call setup, screeching, negotiating, etc. for what is only a few microseconds of usable content travel time. Very inefficient - and the business can not use the line for any other purpose while the transaction takes place.

ISDN connections can shorten and improve the process considerably. Tests in progress at several major card issuers employ D-channel links for high-speed access to credit card data. In all of these tests, response times have been cut from the 12 to 40 seconds required for ordinary connections to 4 to 7 seconds with ISDN. Similar tests are under way for food stamps, and medical benefit authorizations. Expect hundreds of applications whose data flow is "short and busty" to migrate to the more dynamic efficiencies of D channel packet switching such as: Automatic Teller Machine transactions, travel reservations, electronic and on-line ordering, information querying, electronic mail, gaming, stock quotes, trading instructions.... The list is endless.

An added plus in all of these applications: two circuit switched voice or data conversations can go on simultaneously with the transactions. The most versatile ISDN environment will enable users, often with no intervention required, make the best use of the three channels available by continually monitoring activities and receiving X.25 packets from hosts or databases with which they will maintain a constantly logged in status.

"Always On/Dynamic ISDN" (see ISDN and the power of packet switching) represents this paradigm - wherein intelligent hardware and software use packets when sufficient and bring up circuit switched connections when helpful. This will also have an economic benefit to the user and to the carriers. AO/DI will bring together all the richness of ISDN 's multiple channels and flexibility, facilitating inward and outward calls, voice, data, fax, video, all over a simple twisted pair of wires that exists practically everywhere today.



13.8 Electronic Manuals

Many operator, maintenance and repair manuals for computers, airplanes, automobiles, electronic and medical equipment, and other items are being published using ISDN. According to an industry newsletter, ISDN News, a range of corporations in Europe, where nationwide ISDN networks have existed for a number of years, successfully use such systems. At any time engineers, technicians, repair facilities and others can refer to and download the most current documentation. Manufacturers eliminate the costs of printing, storing and distributing massive documents. Users do away with the drudgery of maintaining and updating them.

13.9 Extended Call Management

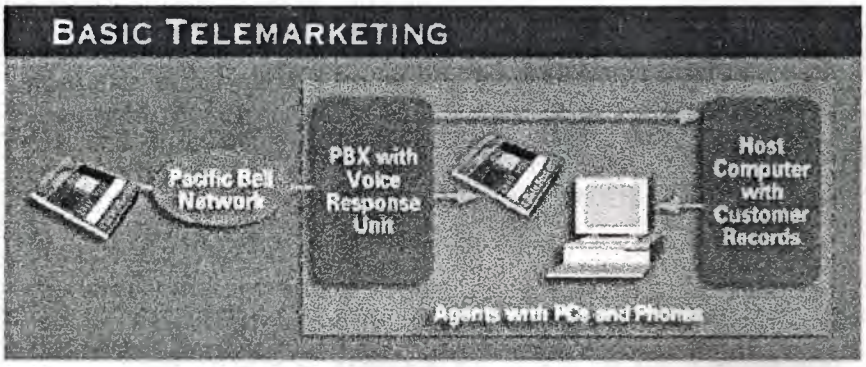
For those who take advantage of Pacific Bell's ISDN Centrex service, or those in a larger organization or campus served by their own comparably equipped digital switch, the range of call management features can be greatly extended. Some of these include:

- Call Forwarding. Forwards calls to a reselected number when the called number is busy, after a preset number of rings, or permanently.

- Call Pickup. Lets an incoming call be picked up at another station where the line does not appear.
- Directed Call Pickup. Lets calls to a specific line only be answered by a different line.
- Message-waiting Indicator. Shows with a light or lamp on the set that a voice message has been received.
- Direct Inward Dial to Direct Outward Dial (DID/DOD) transfer. Allows a call answered at the Centrex location to be transferred to any other dilatable number with the caller staying connected as though they were only being transferred across an office.

13.10 ISDN in Marketing and Service

Telemarketing call centers and telephone service centers are voice installations that also give representatives access to data stored in a computer.



13.11 Basic Telemarketing

The PBX prompts for an account number and delivers both call and customer record to the next available agent.

Using a range of computers, from small PCs to mainframes, these systems automatically answer each call, prompt the caller for an account number (or in other states, read the incoming Caller-ID number when available), and simultaneously deliver both the call and the caller's computerized record to the next available agent.

ISDN adds a new dimension to these facilities, because through a single telephone connection, ISDN offers not only a voice connection to the caller, but a simultaneous high-speed data connection to a computer.

13.12 A Virtual Transaction Network

In effect, ISDN with X.25 D-channel packet switching offers the benefits of a private virtual network, yet uses standard telephone lines and the public telephone network., these advantages are being put to use in a growing number of applications.

- ***A credit card service company*** has linked thousands of point-of-sale card readers to its computerized database for credit card authorization and transaction processing. Times have been reduced from an average of more than 30 seconds to less than two seconds. Costs have been reduced from an average of about $.05 to less than a penny per transaction.

- ***Several major oil companies*** are testing ISDN telephone lines to link gas pumps, cash registers and even vending machines into nationwide data networks. Central computers authorize credit purchases, control inventory, and schedule just-in-time replenishment of everything from gasoline and oil to candy and potato chips.

- ***A number of health maintenance organizations*** use point-of-sale card readers and ISDN with X.25 D-channel packet switching telephone lines to authorize medical insurance benefits and issue payment requests to a range of health-care insurers.

- ***Many state agencies*** are using food stamp credit cards to reduce or eliminate the fraud-prone use and collection of paper food stamps. A magnetic card is inserted into the standard card-swipe terminals now appearing in many supermarkets. They quickly authorize a purchase and automatically deduct the amount from the cardholder's account.

- ***A growing number of banks*** are now linking remote automatic teller machines to a central computer through ISDN with X.25 D-channel packet switching. The D-channel connections eliminate the

need for dedicated lines to the ATM, and make it economical to serve many more locations.

- In several tests, ***insurance and real estate agents*** are now able to access records from a range of computers. Insurance agents, for example, can retrieve policy information from several participating companies and real estate agents can often tap into home-for-sale listings from neighboring towns and cities.

- ***Several state lottery agencies*** are experimenting with ISDN-based approaches to playing state lottery and numbers games. The attraction of ISDN with X.25 D-channel packet switching is that it uses existing telephone lines and thus reduces the current dependence on dedicated connections to these statewide systems. It would make lotto terminals much more widely available, to almost any public location that had phone service.

- ***At many corporate and government locations***, low-cost X.25 D-channel connections are being used for entry to buildings ,laboratories, warehouses and other restricted areas, as well as for security and other forms of telemetry.

13.12 Pacific Bell as a Partner

Whether you're interested in ISDN for new applications, or as an extension of existing facilities, Pacific Bell is ready to help with a growing level of support and service. From the smallest, single-line system to full nationwide or worldwide networks, the expertise of Pacific Bell is available to help you choose the right combination of lines and services, equipment and connections to make ISDN a productive, cost-efficient tool.

Pacific Bell resources can also help with the management and control of your system. For smaller users, detailed monthly invoices provide complete time, duration and cost information for every voice or data call, through both B and D channels. For larger customers, ISDN billing becomes an integral part of Pacific Bell's useful and comprehensive itemized statements, which include valuable management reports, and

options for detailed breakouts of project, customer or departmental billing.

For most corporate ISDN orders, we also assign one or more ISDN specialists to work closely with your regular Pacific Bell account team. These specialists bring extensive knowledge of ISDN functions and requirements to every installation, as well as full understanding of equipment, cabling, power and other needs. In short, Pacific Bell is committed to bringing the performance and value of ISDN is ready today.

13.14 Perspective on N-ISDN

N-ISDN was a massive attempt to replace the analog telephone system with a digital one suitable for both voice and non voice traffic . Achieving worldwide agreement on the interface standard for the basic rate was supposed to lead to a large user demand on the interface for ISDN equipment ,thus leading to mass production economics of scale, and inexpensive VLSI ISDN chips. Unfortunately, the standardization process took years and the technology in this area moved very rapidly . so that once the standard was finally agreed upon ,it was obsolete .
for whom use ,the largest demand for new service will undoubtedly by for video in demand.

Unfortunately, ISDN basic rate lacks the necessary bandwidth by two order of magnitude .for business use, the situation is even bleaker. Currently available LANs offer at least 10-Mbps and are now being replaced by 100-Mbps LANs . offering 64-kbps service to business in the 1980s was serious proposition in the 1990s, it is as a joke.

Oddly enough, ISDN my yet be saved ,but by totally unexpected application Internet access. Varies companies now sell ISDN adapters that combine 2B +D channel. Many Internet service providers also support these adapters. The result is that people can access the Internet over a 144-kbps fully digital link ,instead of 28.8-kbps analog modem link. For many Internet user s, gaining a factor of five for downloading world wide web pages full of graphics is a service worth having .while B-ISDN at 144 KBPS is here now for an affordable price ,and that may be its main niche for the next few years.

13.15 Ameritech ISDN

With Integrated Services Digital Network (ISDN), you or your business can access data and information at much higher rates than with conventional (analog) communication lines. ISDN enables you to cost effectively transmit and receive data, voice, and video simultaneously. With ISDN, voice and data utilize the same pair of copper wires, resulting in fewer lines and lower costs.
ISDN is a switched service, much like regular telephone lines, but unlike most regular telephone lines, ISDN is fully digital. Because ISDN is digital, it supports much higher transmission rates than is practical with analog lines. With ISDN, you could transmit nearly TEN TIMES the data transmission capacity of 14.4 Kb modem on an analog line.

13.16 TECHNICAL FEATURES

Three key ISDN communication capability could be used to defined the user's perception of an 'ISDN service': the provision of end-to-end connectivity end users, the provision of multiple-access channels; and intelligent out-band (common channel) signaling and user control. The end-to-end digital connectivity will provide large bandwidths, better signal qualities and better error rates then most of the present networks. Multiple access channels will provide more flexibility in the use of the total bandwidth available at user-network interfaces; to this end the CCITT has defined different channel types and interface structures. The new common channel signaling scheme has been chosen so as to allow the user to control both the network connections and the delivery of user services and applications independently of this user information paths in an effective manner.

13.17 Service aspects

Service provided by ISDN s have been divided into two broad categories: bearer services and Tele services. The bearer service is a type of telecommunications service that provides the capability for the transmission of signals between user-network interfaces and as such conveys information between users in real-time and without alteration to the information 'message'. The Tele service is a type of telecommunication service that provides the complete capability, including terminal equipment functions, for communication

between users according to protocols established by agreement between administrations.

13.18 Network aspects

Theses cover the network functional principles ,the ISDN Protocol Reference Model(PRM), numbering, addressing routing principles, connection types and performance objectives.

The ISDN-PRM, which is based on the principles of OSI-RM, allocates functions in a modular fashion that facilitates the definition of telecommunications protocol and standards.

The ISDN-PRM extends the OSI model beyond the traditional point-to-point, user-net wok-user, in-band signaling, data-only communications. This extension includes the separation of signaling and management operations from the few of application information within a pieces of equipment; definition of communication contexts which may operate independently from each other; and the application of the above internal network components.

This separation leads to the definition of independent communications contexts. Each context can be modeled individually and use independent protocols.

The ISDN-PRM refers to two distance logic planes: user (U) and control (C) planes.

The layering principles apply to each of these planes ; each one can potentially accommodate a seven-layer protocol stack (CCITT 1988a; Duc and chew 1985 ; Potter 1985) .

Alpine management function is required to allow co-ordination between the activities in different planes .further study is needed to specially the types of layer services required to describe a telecommunications service data flow modeling and ISDN management .

The relationship between the OSI-PRM and ISDN-PRM is shown in the figure.

Numbering principles within the ISDN (1.330) will be based on the expansion of the international PSTN numbering plan (1.331/E.164).An ISDN adders is composed of an international ISDN number and an ISDN

sub address of up to 15 decimal digits and 40 decimal digits (20 octets) respectively (CCITT 1988a). the ISDN address may be of variable length, and all ISDN s will be capable of conveying the ISDN sub address transparently.

This other privet networking arrangements. In order to identify different OSI network layer OT relate the ISDN number to the OSI network layer address.

The performance objectives regarding propagation delays, availability and errors were not dealt with in full during the 1980-4 period these have been extended further in the blue book. However, the specification is still by no means complete.

Currently, provisional performance values are quoted ,while the actual target values are left for further study.

13.19 National ISDN

Because of the breadth of the international ISDN standards, there are a number of implementation choices that vendors of ISDN equipment can make. Given the number of choices vendors can make, different vendors equipment may not inter operate. In the United States, Bellcore as released a series of specifications to try to avoid these interoperability problems. These are the National ISDN specifications.

13.20 The NIUF

North American ISDN Users Forum (NIUF) is an org. of ISDN-interested parties, coordinated by NIST (National Institute of Stds. and Tech.)

The currently approved documents for the Application Software Interface (ASI) from the North American ISDN User's Forum (NIUF) are available via anonymous FTP from dsys.ncsl.nist.gov. The documents are in Postscript and found in uncompressed ASCII (foo.ps), compressed (foo.Z) and zipped (foo.zip) files.

These documents describe the Implementation Agreements made by the NIUF for an API to ISDN services.

The file sizes are approximate and intended to help determine space requirements for transfer.

13.21 ATM

ATM (Asynchronous Transfer Mode) is a switching/transmission technique where data is transmitted in small, fixed sized cells (5 byte header,48 byte payload).

The cells lend themselves both to the time-division- multiplexing characteristics of the transmission media, and the packet switching characteristics desired of data networks. At each switching node, the ATM header identifies a "virtual path" or "virtual circuit" that the cell contains data for, enabling the switch to forward the cell to the correct next-hop trunk. The "virtual path" is set up through the involved switches when two endpoints wish to communicate. This type of switching can be implemented in hardware, almost essential when trunk speed range from 45Mb/s to 1Gb/s.

One use of ATM is to serve as the core technology for a new set of ISDN offerings known as Broadband ISDN (B-ISDN).

13.22 B-ISDN

Broadband ISDN refers to services that require channel rates greater than a single primary rate channel. While this does not specifically imply any particular technology, ATM will be used as the switching infrastructure for B-ISDN services.

B-ISDN services are categorized as:

INTERACTIVE

Conversational -- such as video telephony, videoconferencing, ...
Messaging -- such as electronic mail for images, video, graphics,...
Retrieval -- such as Tele shopping, news retrieval, remote education,...

DISTRIBUTION

Without user presentation control -- electronic newspaper, electronic newspaper, TV distribution. With user presentation control -- remote education, Tele advertising, news retrieval .

BONDING

An inverse multiplexing method of the Bandwidth ON Demand Interoperability Group, implemented by most (all?) inverse multiplex vendors to inter operate with inverse multiplexes of other vendors.

BONDING is a set of protocols developed by U.S. inverse multiplex that supports communication over a set of separate channels as if their bandwidth were combined into a single coherent channel. For example it supports a single 384 kb/s data stream over 6 64 kb/s channels.

The specification defines a way of calculating relative delay between multiple network channels and ordering data such that what goes in one end comes out the other.

Most (all?) vendors also have their own proprietary methods that usually add features and functions not present in BONDING mode 1. Mode 1 is the mode used for recent interoperability testing between vendors.

Chip Sharp at Tele Os has made available electronic copies of the BONDING (Bandwidth on Demand Interoperability Group) 1.0 and 1.1 specifications. The specs are available via WWW, gopher, anonymous.

13.23Data Encapsulation for IP over ISDN

A decision was made at the Amsterdam IETF to state that all systems wishing to guarantee IP interoperability should implement PPP. Such systems may also implement the Frame Relay or X.25 encapsulations, and an RFC will be published delineating how, when it is known that the encapsulations are limited to that set of three, they may be distinguished by examination of the first correctly check summed and HDLC bit-stuffed packet.

Many implementations are using PPP so that they can negotiate compression and/or multi link operation.

There is an Internet Draft from the Point-to-Point Protocol Working Group of the Internet Engineering Task Force that describes the use of PPP over ISDN. This draft is named draft-ietf-pppext-isdn-NN.txt in the internet-drafts Shadow Directories on nic.ddn.mil, nnsc.nsf.net, nic.nordu.net, ftp.nisc.sri.com, munnari.oz.au, Germany.EU.net and on many, many other mirror archives. This is also discussed in RFC 1356 by Malis, et. al.

A common practice in most European countries is raw IP packets delimited by HDLC flags. Another common practice is an encapsulation using simple HDLC in layer 1, X.75 (LAPB, usually I-frames) in layer 2 and, sometimes, T.70 in layer 3. PPP is used instead of HDLC/X.75/T.70 when the network doesn't provide the callers telephone number e.g. when emulating a modem or the callers number is lost on telephone company borders. In this case, caller authentication is done via PAP/CHAP instead.

13.24Full Motion Video over ISDN

In ISDN, video isn't a "service being offered" - at least not for low/midrange quality. You buy the proper equipment for both subscribers, plug it in, and place the call. Just like speaking French on ISDN isn't something being offered - it is something you just do, yourself. Video telephony over narrow band ISDN is governed by a suite of ITU-T (formerly CCITT) interoperability standards. The overall video telephony suite is known informally as p * 64 (and pronounced

'p star 64'), and formally as standard H.320. H.320 is an "umbrella" standard; it specifies H.261 for video compression, H.221, H.230, and H.242 for communications, control, and indication, G.711, G.722, and G.728 for audio signals, and several others for specialized purposes. A common misconception, exploited by some equipment manufacturers, is that compliance with H.261 (the video compression standard) is enough to guarantee interoperability.

Bandwidth can be divided up among video, voice, and data in a bewildering variety of ways. Typically, 56kbps might be allocated to voice, with 1.6kbps to signaling (control and indication signals) and the balance allocated to video.

An H.320-compatible terminal can support audio and video in one B channel using G.728 audio at 16 kb/s. For a 64 kb/s channel, this leaves 46.4 kb/s for video (after subtracting 1.6 kb/s for H.221 framing).

The resolution of a H.261 video image is either 352x288 (known as CIF) or 176x144 (known as quarter-CIF or QCIF). The frame rate can be anything from 30 frames/second and down. Configurations typically use a 2B (BRI) or a 6B (switched-384 or 3xBRI with an inverse multiplexed) service, depending on the desired cost and video quality. In a 384kbps call, a video conferencing system can achieve 30 frames/second at CIF, and looks comparable to a VHS videotape picture. In a 2B BRI call, a standard video phone can achieve 15 frames/second at CIF.

Those who have seen the 1B video call in operation generally agree that the quality is not sufficient for anything useful like computer based training - only for the social aspect of being able to *see* Grandma as well as hear her (sort of like the snapshot pictures you make with that $5 camera with no controls).

A 2B picture, on the other hand, is for all practical purposes sufficient for remote education, presentations etc. Rapidly changing scenes are still not very well handled, but as soon as the picture calms down, the sharpness and color quality are impressive (considering that only two plain phone channels are being used). With 2B+D being the standard BRI, this kind of picture phone will be usable "everywhere" (including private homes).

However, it should still be noted that 6xB or H0 does allow for dramatic improvement in picture quality compared to 2xB. In particular, H.320 video/audio applications will often allocate 56kbps for audio, leaving only 68.8kbps for video when using 2xB. On the other hand, using H0 would get you 326.4kbps for video with 56kbps for audio. Alternative audio algorithms can improve picture quality over 2xB by not stealing as many bits. Note that 6B is not identical to H0; the latter is a single channel which will give you 80kbps above that of six separate B channels. Inverse multiplexes can be used to combine B channels.

13.25 What is a SPID? How come my ISDN device won't work without one?

SPID s are Service Profiles IDs. SPID s are used to identify what sort of services and features the switch provides to the ISDN device. Currently they are used only for circuit-switched service (as opposed to packet-switched). Annex A to ITU recommendation Q.932 specifies the (optional) procedures for SPID s. They are most commonly implemented by ISDN equipment used in North America.

When a new subscriber is added, the Tel co personnel allocate a SPID just as they allocate a directory number. In many cases, the SPID number is identical to the (full ten digit) directory number. In other cases it may be the directory number concatenated with various other strings of digits, such as digits 0100 or 0010, 1 or 2 (indicating the first or second B channel on a non-Centrex line), or 100 or 200 (same idea but on a Centrex line) or some other, seemingly arbitrary string. Some people report SPID s of the form 01nnnnnnn0 for AT& T custom and 01nnnnnnn011 for NI-1, where n is the seven digit directory number. It is all quite implementation dependent.

The subscriber needs to configure the SPID into their terminal (i.e. computer or telephone, etc., not their NT-1 or NT-2) before they will be able to connect to the central office switch.

When the subscriber plugs in a properly configured device to the line, Layer 2 initialization takes place, establishing the basic transport

mechanism. However if the subscriber has not configured the given SPID into their ISDN device, the device will not perform layer 3 initialization and the subscriber will not be able to make calls. This is, unfortunately, how many subscribers discover they need a SPID.

Once the SPID is configured, the terminals go through an initialization/identification state which has the terminal send the SPID to the network in a Layer 3 Information message whereby the network responds with an INFO message with the EID information element (i.e.). Thereafter the SPID is not sent again to the switch. The switch may send the EID or the Called Party Number (CDPN) in the SETUP message to the terminal for the purpose of terminal selection.

SPID s should not be confused with TEI s (terminal endpoint identifiers). EI s identify the terminal at Layer 2 for a particular interface (line).

EI s will be unique on an interface, whereas SPID s will be unique on the whole switch and tend to be derived from the primary directory number of the subscriber. Although they are used at different layers, they have a 1-to-1 correspondence so mixing them up isn't too dangerous.

TEI s are dynamic (different each time the terminal is plugged into the switch) but SPIDS are not. Following the initialization sequence mentioned above the 1-to-1 correspondence is established.

EI s are usually not visible to the ISDN user so they are not as well known as SPID s.

The "address" of the layer 3 message is usually considered to be the Call Reference Value (also dynamic but this time on a per call basis) as opposed to the SPID, so the management entity in the ISDN device's software must associate EID/CDPN on a particular TEI and Call Reference Number to a SPID.

There are some standards that call for a default Service Profile, where a terminal doesn't need to provide a SPID to become active. Without the SPID however, the switch has no way of knowing which terminal is which on the interface so for multiple terminals an incoming call would be offered to the first terminal that responded, rather than to a specific terminal.

13.26 Will ISDN terminal equipment that works in one country work properly when it is installed in another country?

There are four major problem areas:

The first has to do with voice encoding, and is only a problem if the equipment is a telephone. Equipment designed for use in North America and Japan uses mu -law encoding when converting from analog to digital, whereas the rest of the world uses A-law. If the equipment has a switch for selecting one or the other of these encoding types, then there will not be a problem with the voice encoding.

The second has to do with the way the equipment communicates with the telephone exchange. There are interoperability problems because * there are so many different services (and related parameters) that the user can request and each country can decide whether or not to allow the telephone exchange to offer a given service and * the specifications that describe the services are open to interpretation in many different ways. So, as with other interoperability problems, you must work with the vendors to determine if the equipment will inter operate. This is a basic problem; it impacts all ISDN equipment, not just voice equipment.

The third has to do with Homo location, or regulatory approval. In most countries in the world the manufacturer of telephone equipment must obtain approvals before the equipment may be connected to the network. So, even if the equipment works with the network in a particular country, it isn't OK to hook it up until the manufacturer has jumped through the various hoops to demonstrate safety and compliance. It is typically more expensive to obtain world-wide Homo location approvals for a newly-developed piece of ISDN equipment than it is to develop it and tool up to manufacture it.

A fourth issue is in the US the TA and NT1 are both provided by the customer, while in Europe the NT1 is provided by telephone company. Stated differently, if you walk into a store in the US and buy something to plug into an ISDN line it may be designed as a one-piece unit that connects to point U. In Europe you would get something that plugs into point T. Thus you might take a piece of US-originated equipment to Europe and find that it won't work because the jack in

Europe is a T interface and the plug on your US equipment is a U interface.

There are attempts to remedy this situation, particularly for BRI ISDN. In North America, the National ISDN User's Forum is coming up with standards that increase the uniformity of ISDN services. In Europe, a new standard called NET3 is being developed.

13.27 Will ISDN terminal equipment that works with one vendor's ISDN switch work properly when used with another vendor's switch?

When the National ISDN-1 standard is implemented, there will be a single standard for how TE communicates with the CO (the call setup dialogue).

Until that time, you may encounter two different varieties of CO equipment, each with its own call setup dialogue:

- ATT 5ESS
- Northern Telecom DMS100

Some ISDN TE equipment can be configured to communicate with either; some works with only one variety.

Do different manufacturers' Terminal Adapters inter operate when used asynchronously?

There is a standard up to 19.2k (V.110) but above that there is no real standard implemented. However, in practice there is a fair degree of interoperability (even when the TA's manual tells you otherwise) because many TA s use the same chip set (supplied by Siemens) which happily goes up to 38.4. TA s from different suppliers that are using the Siemens chips have a fair chance of inter operating at up to 38.4k.

13.28Why do I get only about 19.2k throughput from my TA?

The problems in using TA's are the same as those in using fast modems. You only get the throughput that your serial port can handle. The serial ports of many machines struggle to receive at 19.2k. Sending is easier to implement efficiently. Many machines will happily send data to a TA at 38.4, but choke down to around 19.2k or lower when receiving (with lots of retries on ZMODEM file transfer).

13.29 How long should call setup take when using a TA?

The "less than a second" call setup sometimes claimed seems to be rare. TA s have a negotiation phase and it typically takes around 4 seconds to get through to the remote site.

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