Motivation and History

A long time ago, the entire telephone network was analog. This was bad, because as a voice went farther down the line, and through more switches, the quality became worse and worse as noise crept in. And there was no way to eliminate the noise, no way to know what the signal was supposed to be. Digital encoding promised a way to encode the audio such that you'd know what the signal was supposed to be. As noise crept in, you could eliminate it through the phone network, assuming it wasn't worse than the variation between different digital encoding levels.

With the transistor revolution, this theory became possible, and the phone companies began converting their own networks over to digital. Today, you have to search pretty hard to find a phone company switch that isn't digital. They call their network the Integrated Digital Network, or IDN.

This solved many of the phone company's problems. However for a variety of reasons, it has been attractive to make the phone network completely digital, from end to end. For computer users, this is ideal, because we can eliminate those clumsy modems, and will hopefully benefit from higher speed. For the phone companies, they can eliminate the last of the noise and loss from the audio data. And for dreamers, this will enable a wide variety of different services to be delivered to the customer over a single interface.

- The first service was introduced by British Telecom in June 1985.
- Another early pre-standard ISDN service was project Victoria, offered by Pacific Bell in 1986 in Danville, California.
- ISDN availability is just over 70% in North America.
What is ISDN?

ISDN stands for Integrated Services Digital Network. It is a design for a completely digital telephone/telecommunications network. It is designed to carry voice, data, images, video, everything you could ever need. It is also designed to provide a single interface (in terms of both hardware and communication protocols) for hooking up your phone, your fax machine, your computer, your videophone, your video-on-demand system (someday), and your microwave. ISDN is about what the future phone network, and information superhighway, will look like (or would have looked like).

ISDN was originally envisioned as a very fast service, but this was a long time ago when it was hoped to have fiber all the way to your house. It turned out that running all that fiber would be too expensive, so they designed ISDN to run on the copper wiring that you already have. Unfortunately, that slowed things down considerably - too slow for quality video, for instance.

ISDN has been very slow in coming. The standards organizations have taken their time in coming up with the standards. In fact, many people consider them to be out of date already. But on the other side of the coin, the phone companies (especially in the U.S.) have been very slow at designing products and services, or marketing them with ISDN in mind.

Things are starting to pick up, but still very slowly. ISDN is available now in many places, but it is not widely used. Further most of the products and services that people have forecast for ISDN still aren't available. For this reason many people say that ISDN also stands for "It Still Does Nothing".

Integrated Services Digital Network (ISDN) is a set of communications standards for simultaneous digital transmission of voice, video, data, and other network services over the traditional circuits of the public switched telephone network.
Another Definition of ISDN

A network, in general evolving from a telephony Integrated Digital Network (IDN), that provides end to end digital connectivity to support a wide range of services, including voice and non voice services, to which users have access by a limited set of standard multi purpose user network interfaces. by CCITT

Prior to ISDN, the phone system was viewed as a way to transport voice, with some special services available for data. The key feature of ISDN is that it integrates speech and data on the same lines, adding features that were not available in the classic telephone system. There are several kinds of access interfaces to ISDN defined as Basic Rate Interface (BRI), Primary Rate Interface (PRI) and Broadband ISDN (B-ISDN).

ISDN is a circuit-switched telephone network system, which also provides access to packet switched networks, designed to allow digital transmission of voice and data over ordinary telephone copper wires, resulting in potentially better voice quality than an analog phone can provide. It offers circuit-switched connections (for either voice or data), and packet-switched connections (for data), in increments of 64 kilobit/s. A major market application for ISDN in some countries is Internet access, where ISDN typically provides a maximum of 128 kbit/s in both upstream and downstream directions. ISDN B-channels can be bonded to achieve a greater data rate, typically 3 or 4 BRIs (6 to 8 64 kbit/s channels) are bonded.

ISDN should not be mistaken for its use with a specific protocol, such as Q.931 whereby ISDN is employed as the network, data-link and physical layers in the context of the OSI model. In a broad sense ISDN can be considered a suite of digital services existing on layers 1, 2, and 3 of the OSI model. ISDN is designed to provide access to voice and data services simultaneously.

However, common use has reduced ISDN to be limited to Q.931 and related protocols, which are a set of protocols for establishing and breaking circuit switched connections, and for advanced call features for the user. They were introduced in 1986.
In a videoconference, ISDN provides simultaneous voice, video, and text transmission between individual desktop videoconferencing systems and group (room) videoconferencing systems.

**Two kinds of ISDN**

**N-ISDN** provides lower speed services (56Kbps - 2.0Mbps).

Narrowband ISDN as a means of switched WAN access in data networks, it has fast call setup, flexibility in support different services and ability to support existing WAN protocols. Frame Relay & X.25.

**B-ISDN** provides high speed services (2 – 600 Mbps)

ATM (Asynchronous Transfer Mode technology) is the basis for broadband ISDN, will be ideal for carrying various types of multimedia traffic in the next few years.

**B-ISDN** is Broadband ISDN. (The older ISDN is often called Narrowband ISDN.) This is not simply faster ISDN, or ISDN with the copper to your home finally upgraded to fiber. B-ISDN is a complete redesign. It is still capable of providing all the integrated services (voice, data, video, etc.) through a single interface just like ISDN was supposed to. But it will do it a lot faster than ISDN could. Of course, that copper to your house will still have to be replaced with fiber. But B-ISDN is still in development - it seems to be moving faster than ISDN, but it is still quite a ways off.

**ISDN elements**

Integrated services refers to ISDN's ability to deliver at minimum two simultaneous connections, in any combination of data, voice, video, and fax, over a single line. Multiple devices can be attached to the line, and used as needed. That means an ISDN line can take care of most people's complete communications needs at a much higher transmission rate, without forcing the purchase of multiple analog phone lines.

**About modern telephony**

In order to understand what ISDN is, you have to understand a bit about modern telephony. You'll invariably find lots of buzzwords, or in most cases buzz-acronyms, that seem to overlap in a terribly complex way. That's because they do overlap considerably. Nevertheless you can
generalize about how certain things fit together. Hopefully I can sum it all up in a few almost correct categories.

There are two parts of a telephone network: the phone company's part, and the customer's part. The customer's part today is largely just the telephone, some house wiring, and some connectors. The phone company's part is lots more wire, fiber, switches, computers, and lots of expensive and complicated stuff.

ISDN is concerned (almost) entirely with the customer's part of the network. ISDN gets the data from you, to the phone company in a standard way. What they do with it in order to get it to its destination is entirely up to them. This is a very simple, important concept. If you understand this, then when someone says something like "SONET is the future of the modern telephone network" you'll know that they're talking (mostly) about what goes on inside the phone company, and between phone companies. They are probably right, but it is also true that "ISDN is the future of the modern telephone network" especially if you mean B-ISDN. They're just the future of different parts of the telephone network.

Access Interfaces Provided

You might be tempted to call these the "services" provided by the phone company, but you have to be careful using the word service with ISDN, because it means things like audio, video, etc. - higher level services. What you can get from the phone company in terms of service are varying data rates, and various combinations of separate channels for data and signaling. These are access interfaces.

ISDN was designed around the notion of separate channels at 64Kbps. This number springs from the fact that that is essentially the data rate at which the analog lines are sampled at (8000 samples per second, 8 bits per sample) for the phone company's IDN. ISDN is essentially combinations of these channels, and also slower 16Kbps channels used only for signaling. The 64Kbps channels are called B channels. The 16Kbps channels are called D channels.

The names of the channels allegedly spring from analog circuits being called A-channels (A for analog). The next type of channel to come along got labeled B, which also happily can stand for binary (some also say it is
the Bearer channel). The D channels were at one time called delta channels, because of their relationship to the B channels, but that particular greek symbole being hard to type, it became D.

There are two main interfaces, Basic Rate, and Primary Rate. The Basic Rate Interface is intended for home use, and Primary Rate is intended for businesses.

The Basic Rate Interface (BRI) is designed to carry the most data you can possibly send to the home through existing copper phone lines. It turns out that they found you could reasonably squeeze about 160Kbps into those lines. With this, the phone company can provide two B channels, one D channel, and still have 16Kbps for the overhead (data framing, maintenance, and control) of communicating with your house's phone network.

The entry level interface to ISDN is the Basic Rate Interface (BRI), a 128 kbit/s service delivered over a pair of standard telephone copper wires. The 144 kbit/s rate is broken down into two 64 kbit/s bearer channels ('B' channels) and one 16 kbit/s signaling channel ('D' channel or delta channel).

BRI is sometimes referred to as 2B+D

The interface specifies the following network interfaces:

- The U interface is a two-wire interface between the exchange and a network terminating unit, which is usually the demarcation point in non-North American networks.
- The T interface is a serial interface between a computing device and a terminal adapter, which is the digital equivalent of a modem.
- The S interface is a four-wire bus that ISDN consumer devices plug into; the S & T reference points are commonly implemented as a single interface labeled 'S/T' on an NT1
• The *R interface* defines the point between a non-ISDN device and a terminal adapter (TA) which provides translation to and from such a device.

BRI-ISDN is very popular in Europe but is much less common in North America. It is also common in Japan - where it is known as INS64.

**Basic Rate Interface (BRI)** *It consists of two 64 Kbps B channel and one 16 Kbps D channel for a total of 144 Kbps. (2B+D).*

**The Primary Rate Interface** is designed for businesses with larger data needs, or with the need to set up their own local phone system. It is generally just a much faster connection to the phone company, with several B channels. In the U.S. the most common Primary Rate Interface (PRI) is designed for 23 B channels and 1 D channel, which is the equivalent of a U.S. DS1 service. In Europe, the most common PRI is 30 B channels, and one D, which is the equivalent of their E1 service.

With a PRI, you also have the option of combining several B channels into one bigger fatter channel called an H channel. There are several different speeds of H channel. The most common, H0, is 384Kbps, or 6 B channels. H11 is 24 B channels, or the equivalent of DS1 service. H12 is 30 B channels, or European E1 service. Above that, H21 provides 32Mbps (512 B channels); H22 provides 44Mbps (690 B channels); and H4 provides 135Mbps (2112 B channels), and is anticipated for use with compressed HDTV.

In practice, the phone company will probably be able to provide any combination of B, D, and H channels that it thinks it can make a buck off of.

**Primary Rate Interface (PRI) is intended for users with greater capacity requirements. Typically, the channel structure is 23B channels plus one 64 Kbps D channel for a total of 1536 Kbps**
ISDN Logical Channels

In ISDN and other digital TDM environments, a channel generally refers to a time slot on transmission facility and is full duplex.

**ISDN defines two types of logical channels:**

- **B (bearer) channel**
- **D (data) channel**

**B - Channel**

Transmit at 64 kbps and carry circuit-mode or packet-mode user information such as voice, data, fax, and user-multiplexed information stream.

All network services are available through B-channel.

*The primary purpose of the B-channel, is to carry the user’s voice, audio, image, data, and video signals. No Service requests from the user are sent on the B-channel.*

**D – Channel**

Transmits at 16 Kbps for BRI and 64 Kbps for PRI. It carries call signaling and setup information to establish a network connection.
request network services, route data over B channels, and teardown the call when complete.

The network and user equipment exchange all service requests and other signaling messages over the ISDN Dchannel.

*The D-channel’s primary function is for user-network signaling, the transport of packet mode data is the secondary function of the D-channel.*

**Other Channel H-Channel**

A user application requesting a bit rate higher than 64Kbps may be obtained by using wideband channels, or Hchannel, which provide the bandwidth equivalent of a group of B-channels.

H0 channel, the first designated higher-rate channel, which has a data rate of 384 Kbps. This is equivalent to logically grouping six B-channel together.

H1 channel, it comprises all available time slots at a single user interface employing a T1 or E1 carrier. An H1 channel operates at 1.536Mbps and is equivalent to 24 time slots (24 B-Channels) for compatibility with the T1 carrier.

**The ISDN Reference Configurations**

You can't talk about ISDN without knowing about the reference configurations. This gives you the basic vocabulary for talking about all of the pieces of ISDN. There are reference configurations for all different pieces of the ISDN network, and lots of different configurations. The following diagram shows two of the most commonly referred to configurations. The networks will actually look more complicated than this; the diagram just serves to apply standard labels to the different parts of the network you'll encounter.
Here's a quick glossary of some of the things shown:

<table>
<thead>
<tr>
<th>Function group</th>
<th>Description</th>
<th>Example</th>
</tr>
</thead>
</table>
| **NT1**        | - Network Termination type 1. This is the end of the line for the local phone company, and the beginning of your house's phone network.  
- Line transmission termination at the customer premise, the ISDN line is terminated by an NT1  
- multiplexing combines the 2 B Channels and the D channel into a single bit stream at the physical level (layer 1)  
- power transfer  
- interface termination capable of supporting more than one device attached to an ISDN line : multidrop termination | ![NT1 glossary](image1.jpg) |
| **NT2**        | - Network Termination type 2. In most homes, this won't exist. If you were a big company with your own private telephone system, then this would be the guts of that telephone system.  
- switching  
- concentration | digital PBX, terminal controller, LAN |
<p>| <strong>TE1</strong>        | Terminal Equipment type 1. This is the ISDN telephone. Or computer. Or ISDN FAX machine. Or whatever it is that you've hooked up to the ISDN phone | digital telephone, integrated voice/ data terminal, digital |</p>
<table>
<thead>
<tr>
<th>ISDN and B-ISDN</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISDN line. ISDN compatible devices</td>
</tr>
<tr>
<td>TA</td>
</tr>
<tr>
<td>TE2</td>
</tr>
<tr>
<td>LT</td>
</tr>
<tr>
<td>ET</td>
</tr>
<tr>
<td>non-ISDN equipment : RS232, computer with X.25 interface</td>
</tr>
</tbody>
</table>

The difference between TE1 and TA is subtle but significant. If you buy an ISDN card for your computer, and device drivers that tell it how to speak ISDN, you've turned your computer into a TE1. However, if you buy an ISDN device that lets you plug your computers ethernet into an ISDN box, then you're computer is a TE2, and the box you bought is a TA. However, the difference isn't in the physical location, but more in the software. Specifically in whether there is any conversion going on anywhere.

For instance, you could conceivably buy a card that plugs into your computer and utilizes the device drivers for ethernet, and the card would convert the ethernet requests into an ISDN data stream. In this case, the
card would be a TA, and your computer would be a TE2. The card has to worry about converting one protocol to another.

Note the letters, R, S, T, U, and V in the diagram. These are reference points that everyone uses to talk about each of these parts of the network. For instance, the R reference point is the interface between an old-style telephone and Terminal Adaptor equipment. Since most homes won't have any NT2 equipment, the S and T reference points are usually one and the same, and are sometimes called the S/T bus.

The point to all of this is that different things happen in different parts of the network. What goes on along reference point U is completely different that at the S/T reference point - different wiring requirements, different data speeds, different encoding, etc.

Notice that reference point V, and the LT and ET equipment are in the phone company's domain. I lied when I told you that ISDN defines only the customer's part of the phone network, but I only lied a little. This portion of ISDN is seldom discussed, and still largely left up to the telephone companies.

**ISDN Protocol Architecture:**

Like other telecommunication networks, ISDN employs a number of protocols. Message between the user and the network as well as end-user data all flow simultaneously over the ISDN access channels. End-user data and user-network signaling information use different sets of protocols, although they share the same physical medium.

**Layer 2 Q.921**

Describes the procedures to ensure error-free communication over the physical link and defines the logical connection between user and network.

**Layer 2 Frame Format:**

| Flag || Address || Control || Information || FCS || Flag |

"Flag" – Start of frame (end of previous frame)

"Address" – logical address including Terminal endpoint identifier

"Control" – Identifies type of frame
"Information- Layer 3 Information

"FCS-Frame Check Sequence

"Flag-End of frame (start next frame)

Layer Q.931

Defines the signaling messages used to request services form the network.

The ISDN Layer 1 protocol defines the physical connection between TE (TE1 or TA) and network termination equipment (NT2 or NT1).

The ISDN Layer 2 and 3 protocols define the logical link and signaling protocols, respectively, between ISDN TE (TE1 or TA) or customer premises switching equipment.

S/T reference points:

The phone "network" inside of your house will be somewhat more complicated with ISDN than it is today, in that it will be a true data network. This network is often called the customer-premises installation or CPI. This network will typically consist of telephones, computers, fax machines, videophones, and an endless list of pie-in-the-sky applications, like controlling your thermostat thru ISDN.

Hardware:

This is layer 1 (the physical layer) of the S/T bus. This defines the physical network in your home. The most obvious things this defines, as far as a customer is concerned, are wiring, connectors, and power, so I'll talk about those first.

ISDN uses a phone jack that looks just like the standard phone jacks in use today, except that it is a bit wider. Instead of the older 4-pin jacks (which only used two wires), ISDN uses an 8-pin jack (which only uses four wires). The CPI is based on a four wire scheme, two wires for transmitting, and two for receiving (which means you'll probably have to rewire your house). These wires are typically copper wiring of some sort, and can be longer than most users will ever need.
ISDN and B-ISDN

(Note that each connection shown is a two-wire pair.)

If you are using ISDN with a single device (for instance, your computer is hooked up to ISDN, and your phones are still hooked up the old way), then you can have up to a kilometer (thereabouts) in your home for typical copper wiring. This is called a point-to-point configuration. But in most cases, you'll be using ISDN to hook up several devices, as shown in Figure 2, above. This is a multipoint configuration. With the standard ISDN equipment, up to eight different devices can be hooked up to the S/T bus. With this configuration the total length can be about 200 meters, and each device can be connected to the bus with up to 10 meters of wire. Devices can be placed anywhere on the bus under this setup.

This can also be modified somewhat, to extend the S/T bus up to about 500 meters. To do this, all of the devices must be connected close to the bus termination end of the bus. Further, each device on the bus must be 25-50 meters apart.

Eight devices might seem a bit low if you have an active imagination, but some of these devices could actually be brokers for other things -- for instance it is more likely that you’d have a single device that could simultaneously control your microwave, furnace, A/C, alarm clock, and house lights. Even though you can only hook up eight devices, you have an almost unlimited number of addresses (i.e. phone number extensions) for each of those devices, so it is likely that one ISDN TE1 would be used for several different purposes. On the other hand, you can't simultaneously use more devices than the available number of B-channels; for most customers this means only 2 devices can be in operation at once. In fact, with some ISDN provider's switches, you can only hook up two devices period, one assigned to each B-channel. This isn't the way things are supposed to work, but that's how a particular piece of phone company equipment works (specifically, the DMS-100 switch)(actually, it's more complicated than that - DMS-100s can work
(almost) correctly with the right software, but sometimes they still use older software).

**Power**

One important issue of ISDN that we aren’t used to worrying about is power. Currently the analog phone system provides its own power - if the power goes out, your phone still works. However, ISDN requires more power than the phone company is in the habit of providing. Because of this, each of your ISDN devices must get its power some other way. Under normal circumstances, what will happen is that your NT1 will be plugged in to your house’s power. All the ISDN devices in your home will get power from the NT1. This is one of the reasons that ISDN uses a four wire system for the network - it allows separate lines for receiving and transmitting and at the same time allows for transmission of power.

Also, those other four unused wires in the 8-pin ISDN jack are specified in the standard to be used for alternate power supplies. Whether these will actually be used remains to be seen, but it is possible that a UPS (uninterruptible power supply) could be added to your NT1, and it could use these auxiliary lines to provide guaranteed power. Note that one of these alternate power supplies is designed to go from the TE to the NT.

If you are outside of North America, and your power DOES go out, you are still covered though. The phone company will still provide the same power levels they used to. This should be sufficient to keep at least one TE1 device in operation. The assumption is that this would be your telephone, so that you could still call the power company and complain about your loss of power. The NT1 notifies all devices on the S/T bus of the power failure by reversing the polarity of the receive and transmit line pairs. All non-essential devices are supposed to respond by shutting themselves off. As I implied, this standard has not been used in North America - if your power goes out here, you have no phone. Don't ask me why.

**Network Operation**

All traffic on the S/T bus flows in 48 bit frames, at a transmission rate of 192 Kbps. You might notice that this is higher than the 160 Kbps that I said could be sent between you and the phone company. This is because the CPI covers shorter distances, and is presumed to be more modern, and can therefore run as fast as is needed. So 144 Kbps is used for the 2B+D channels, leaving 48 Kbps for overhead. Since the S/T bus has to worry
about network contention in addition to other issues, it needs all of this extra bandwidth to keep things running smoothly.

The encoding on the S/T bus is a pseudoternary line code, known as modified alternate mark invert (MAMI). In this encoding, ones are represented by a zero voltage, and zeros are represented by a pulse, which is alternately either positive or negative:

Figure 3. MAMI encoding

U reference point

Outside of the U.S., the T reference point defines how the customer talks to the phone company. This is because the phone company owns and operates the NT1 equipment, even though it is located on the customers property. Because of this, while there may be standards and recommendations regarding the setup of the U reference point, it's design is largely left up to the phone companies.

In the U.S., however, it was decided that the NT1 equipment should be the customer's responsibility. This meant that what happens at the U reference point must be carefully defined in the U.S. so that the different vendor's products will all properly talk to the phone company.

Signaling

There are two different types of signaling used in ISDN. For communicating with your local phone company, ISDN uses the Digital Subscriber Signaling System #1 (DSS1). DSS1 defines what format the data goes in on the D-channel, how it is addressed, etc. It also defines message formats for a variety of messages used for establishing, maintaining, and dropping calls, for instance SETUP messages, SUSPEND and RESUME messages, and DISCONNECT messages.

Once your DSS1 signal makes it to the phone company, their own signaling system takes over to pass the call information within their system, and between other phone companies. Signaling System #7 (SS7) is supposed to be used for this. SS7 defines a communications protocol, and formats similar to DSS1, however SS7 is designed in a broader, more general way. DSS1 is specific to ISDN, however SS7 will handle the
signaling needs of ISDN as well as other older signaling systems and (hopefully) will adapt well to future needs.

One important feature of SS7 is providing CCS. This makes it harder for malicious users of the phone network to put one over on the phone company. It also improves the service, for instance by offering faster connection establishment. However, the phone companies haven't yet fully converted their equipment to use CCS. Older equipment still looks for the signaling information in the same channel as the voice, in the eighth bit of each piece of voice data. This is why many parts of the country only offer 56Kbps B-channels - they've lost 1/8 of their bandwidth to the older in-band signaling system.

Switching

With pure ISDN, switching shouldn't be a concern - it's basically the phone company's problem to solve as they please. So far though, they don't have it completely solved, so we need to mention it here. Traditional phone services is Circuit Switched Voice (CSV). Your voice goes through several switches before reaching its final destination. The phone company is pretty good at this. For point-to-point data connections, you need Circuit Switched Data (CSD) - the exact same thing with data instead of voice. The phone companies aren't prepared yet to dynamically provide whatever service you need right from the start, so they will want to know ahead of time what you are going to be using your ISDN channels for.

If you are using CSV, they are free to route your call through any type of switch, even the old analog switches (there are a few left here and there). Your digital channel may also be shared with other channels, in the moments when there is silence on your phone line. And the digital parts of a CSV call can go through noisy switches that might create an undetected error here or there - it's only voice and you won't hear it.

For CSD, they can't do any of these things - your call must be routed only on pieces of equipment that will give dependable full time data channels. So even though the service in ISDN is supposed to be transparent, for the time being you have to tell the phone company how you are going to be using your B-channels. This seems to be more of a problem in the U.S. than in Europe.

Typically, each B-channel is setup for only one of these types of data. There are actually a standard set of combinations defined for setting up
BRIs. These are called National ISDN Interface Groups (NIIGs), so there will be a limited menu of offerings available. Typically you can get both B-channels for data, or one for voice and the other for data, or one for voice and the other for either voice or data.

In order to facilitate this, North American phone companies use an optional part of the ISDN standard to identify each TE1 or TA you use. The phone company assigns a Service Profile IDentifier (SPID) to each of these devices, and you have to manually enter them into each device you use. The phone company then stores this data somewhere, and when you connect your machine to the network, it sends its SPID to the nearest phone company switch which identifies what type of connection the device needs and (therefore) how to route its calls. Presumably, the SPIDs have to refer to a configuration that matches one of the two B-channels you have.

By the way, the SPIDS are arbitrary numbers that refer to data stored by the phone company. The phone company often includes the phone number in the SPID for their own convenience, but in general you won't get anywhere trying to find significance in the patterns of SPIDs.

One older type of phone company switch, a DMS-100, was improperly designed with respect to the standards relating to SPIDs (the standards may not have been complete when the DMS-100 was designed). This switch misguidedly assigns one SPID to each B-channel that you use, rather than to each device. Therefore if your nearest switch is a DMS-100, you will only be able to hook up two devices to your CPI, rather than eight.

If you are only going to be hooking up a single device to your ISDN (i.e. setting it up in a point-to-point configuration, you might not need a SPID at all, as the phone company can identify your ISDN line as one particular type, full time. This depends on what equipment they have - the old DMS-100 switch will still require you to have a SPID.
ISDN and B-ISDN

**B - ISDN**

**Introduction:**

A Broadband Integrated Services Digital Network (BROADBAND ISDN) is a network designed to carry data, voice, images and video. The applications for such networks are designed to expand rapidly after such networks are available. Broadband ISDN is an effort to provide data rates that are high enough to comfortably handle image data in the future. The planned access rate for Broadband ISDN is 150 Mbit/sec that is adequate for image traffic and allows for the interconnection of high speed LAN’s. This access rate also allows video broadcast traffic, video conferencing and many potential new applications. The paper contains an overview of the technology involved. It also looks at the feasibility aspects of such networks with respect to networks based on other broadband technologies like DSL and Cable net. It also contains some of the current B-ISDN compatible products and services right now available.

**B-ISDN – Is it the future of Telecommunications?**

The technology is currently available for building such networks and the potential for the new applications is also very high. However the evolution form the networks of today to a full fledges Broadband ISDN will be very difficult. It is also debatable whether it is the right time to standardize the architectural details of such a network. The arguments for rapid standardization such as the current needs for these high data rates, including image transmission, accessing high speed LAN’s and accessing super-computers; the rapid development of such a network would meet these needs and also encourage new applications. Also the cost of networks that has traditionally been the ‘last mile’ (i.e. the access link to the user); optical fibers will be installed here. Also it would make economic sense if all the telecommunication services given to a user were given on a single fiber rather than on multiple networks with separate fibers. This is possible since multiplexing the access of several networks onto a single fiber is possible. There are also economies of scale involved since there will be a single network providing all the telecommunication services.
CCITT defined broadband with reference to ISDN as: …a service or system requiring transmission channels capable of supporting rates greater than the primary rate. It was first proposed that B-ISDN was to be an enhanced version of ISDN achieved by just adding broadband channels and broadband user-network interfaces to the existing ones. However concerns arose as to the suitability of this concept. The reason for this is that channels would have to be dimensioned fairly rigidly. Hence contemporary broadband services would have made these channels potentially unsuitable for any unforeseen future service. Also the CCITT could not come to a decision as to the traffic type orientation of the channels, i.e. whether they should have a circuit-type or burst-type traffic orientation.

The following factors influenced the overall design of B-ISDN:

- An emerging demand for broadband networking.
- An emerging availability of high-speed transmission switching technologies.
- Advances in software applications.
- The advantages of integrating services into one universal network.
- The need for flexibility with respect to handling different service types and qualities.

It was identified that B-ISDN should be an extremely flexible network capable of catering for the entire range of contemporary and potential future services. CCITT gave the following recommendation, which is a natural extension from ISDN:

‘A key element of service integration is the provision of a wide range of services to a broad variety of users utilizing a limited set of connection types and multipurpose user-network interfaces.’

The problems of the first technical concepts of B-ISDN were never resolved, since a different principle was put forward to be the solution for B-ISDN. CCITT abandoned the original concepts and eventually stated: Asynchronous transfer mode (ATM) is the transfer mode for implementing B-ISDN. ATM was this different principle, different because it was effectively wiping the ISDN slate clean and starting afresh with a more flexible solution. It was designed as a universal transfer mode with the capability to provide solutions to the following B-ISDN requirements:

- The ability to handle services of significantly different bit rates, and therefore different bandwidth requirements.
- The ability to support variable bit rate traffic efficiently.
• The ability to cope with both delay and loss sensitive applications.

All these developments are significant to the move towards the transmission of moving pictures as video signals through networks. The B-ISDN using ATM is designed to be able to provide widespread interactive video services as well as the distribution services common to the existing television distribution networks. This means that B-ISDN could provide a full range of video services to home and businesses, with the potential accessibility of the current telephone system.

**General Structure:**

On the face of it, the assembly of several 64kbps channels could be achieved with ordinary ISDN by setting up several 64kbps calls to the same destination on a primary rate interface and concatenating the channels at the terminal. The problem is that a uniform delay is not guaranteed; since channels do not follow the same path through the network; there is a different frame delay for each channel and sometimes a satellite link is involved for one or more channels.

There are two solutions for the problem:

*The Terminal Solution:* By using the appropriate buffers at the terminals, the delays in each channel can be padded to be equal. In order to establish these delays the terminals should do a prior investigation. An assumption that is usually made is that relative delays will not change during a call.

*The Network Solution:* In this case the exchange processors would ensure that all channels are kept within a single time division multiplex and therefore follow a common route.

**H-channels:**

CCITT has identified some specific rates above 64kbps:

a) H0 – 384kbps. This is specifically attractive for videoconference codex and hi-fi sound. There are some primary rates that can accommodate some H0 channels: 1.544Mbps – using 3 H0 channels. 2.048Mbps – using 5 H0 channels.

b) H1 – there are two forms of channels: H11 at 1.536Mbps and H12 at 1.920Mbps.

c) H21—around 34Mbps. H22 around 54Mbps. H4 around 135Mbps.

Higher rate interfaces

Optical fibers offer virtually unlimited bandwidth. There are still some technical and economic problems in providing these services to customers, but these problems can undoubtedly be overcome. For
example, if it is unacceptable to use one fiber per connection, then wavelength division multiplexing (WDM) offers enormous capacity. The concept of B-ISDN is that there should be a minimum number of interfaces identified so that wide range of compatible equipment should be available. That means that channel rates like those that have been specified above would not cause the creation of interfaces by the customer operating. So far only two interfaces have been identified – the basic rate interface and primary rate interface. On higher rates there is pressure to have only 2 mode interfaces at approximately 150Mbps and 600Mbps. This does not mean that only channels at those rates would be available. The plan is that many channels of a wide range of rates will be multiplexed onto these interfaces so that wide range of terminal equipment can be used. For example – 150Mbps rate can be used for all services except HDTV. 600Mbps could accommodate several standard TV channels for HDTV, simultaneously with lower rate services. The real problem is how services with a wide range of rates could be efficiently multiplexed according to a common bearer channel. Two solutions have been proposed for this:

* Synchronous multiplexing based – this demands a format that can be configured to match the needs of the user. This is called Synchronous Digital hierarchy – SDH.
* Asynchronous multiplexing – by using a very lightweight protocol called Asynchronous Transfer Mode (ATM). This protocol can be implemented at high speeds due to its simplicity.

**The future**

B-ISDN technology enables a wide range of communication applications, yet it is still not convenient enough for wide range domestic use. The aim of telecommunications has long been to simplify its use to the same level as that required for electric supply. That means that there will be a universal socket which could be used for anything from low speed data for telemetry and control, right up to high definition television. Broadband ISDN will enable this vision to become reality. The only question is when?
Speed of B-ISDN in relation to other communication mediums

The suggested architecture for the B-ISDN protocol is depicted in figure below.

The protocol for B-ISDN also adopts a layered approach, made up for four layers:
- Physical layer
- ATM layer
- ATM Adaptation Layer (AAL)
- Higher layers.

The higher layers would be a services layer for video, SMDS, Frame Relay and Access & Network Signaling.

ATM, asynchronous transfer mode, is often referred to as fast packet switching. For this it can be taken that B-ISDN will be a packet based network. However ITU-T recommendations state that B-ISDN needs to be able to handle both packet and circuit mode applications. Thus the use of an adaptation layer, the ATM Adaptation layer, is required. The AAL will, therefore, be required to handle non-ATM protocol, such as Link Access Protocol-D.

The ATM layer provides the packet transfer capabilities, while the physical layer provides the base network functions.

**Functions of B-ISDN Layers**

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CS – Convergence Sub-Layer
SAR – Segmentation and Reassemble Sub-layer
AAL – ATM Adaptation Layer
ATM – Asynchronous Control Sub-layer
TC – Transmission Control Sub-layer
PM – Physical Medium Sub-layer
CONCLUSIONS

Motivation and History

- The first service was introduced by British Telecom in June 1985.
- Another early pre-standard ISDN service was project Victoria, offered by Pacific Bell in 1986 in Danvilll, California.

ISDN availability is just over 70% in North America

What is ISDN?

Integrated Services Digital Network

Integrated Services Digital Network (ISDN) is a set of communications standards for simultaneous digital transmission of voice, video, data, and other network services over the traditional circuits of the public switched telephone network.

Two kinds of ISDN:

N-ISDN provides lower speed services (56Kbps - 2.0Mbps).
B-ISDN provides high speed services (2 – 600 Mbps)

Access Interfaces Provided

There are two main interfaces, Basic Rate, and Primary Rate. The Basic Rate Interface is intended for home use, and Primary Rate is intended for businesses.

Basic Rate Interface (BRI) It consists of two 64 Kbps B channel and one 16 Kbps D channel for a total of 144 Kbps. (2B+D).

Primary Rate Interface (PRI) is intended for users with greater capacity requirements. Typically, the channel structure is 23B channels plus one 64 Kbps D channel for a total of 1536 Kbps

ISDN defines two types of logical channels:

- B (bearer) channel
- D (data) channel
The primary purpose of the B-channel, is to carry the user’s voice, audio, image, data, and video signals. No Service requests from the user are sent on the B-channel.

The D-channel’s primary function is for user-network signaling, the transport of packet mode data is the secondary function of the D-channel.
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