LESSON 38:
FIBER OPTIC NETWORKS AND ISDN

Objective
To provide a detailed understanding of the concepts of fiber optic networks and ISDN

Introduction
The field of fibre optics communications has exploded over the past two decades. Fibre is an integral part of modern day communication infrastructure and can be found along roads, in buildings, hospitals and machinery. The fibre itself is a strand of silica-based glass, it's dimensions similar to those of a human hair, surrounded by a transparent cladding. Light can be transmitted along the fibre over great distances at very high data rates providing an ideal medium for the transport of information. This section will provide explanations for some of the terms associated with the field of fibre optic engineering for telecommunications.

What are Optical Fibres?
Optical Fibres are fibres of glass, usually about 120 micrometers in diameter, which are used to carry signals in the form of pulses of light over distances up to 50 km without the need for repeaters. These signals may be coded voice communications or computer data.

History
Interest in the use of light as a carrier for information grew in the 1960's with the advent of the laser as a source of coherent light. Initially the transmission distances were very short, but as manufacturing techniques for very pure glass arrived in 1970, it became feasible to use optical fibres as a practical transmission medium. At the same time developments in semi-conductor light sources and detectors meant that by 1980 worldwide installation of fibre optic communication systems had been achieved.

Advantages

1. Capacity

Optical fibres carry signals with much less energy loss than copper cable and with a much higher bandwidth. This means that fibres can carry more channels of information over longer distances and with fewer repeaters required.

2. Size and Weight

Optical fibre cables are much lighter and thinner than copper cables with the same bandwidth. This means that much less space is required in underground cabling ducts. Also they are easier for installation engineers to handle.

3. Security

Optical fibres are much more difficult to tap information from undetected; a great advantage for banks and security installations. They are immune to Electromagnetic interference from radio signals, car ignition systems, lightning etc. They can be routed safely through explosive or flammable atmospheres, for example, in the petrochemical industries or munitions sites, without any risk of ignition.

4. Running Costs

The main consideration in choosing fibre when installing domestic cable TV networks is the electric bill. Although copper coaxial cable can handle the bandwidth requirement over the short distances of a housing scheme, a copper system consumes far more electrical power than fibre, simply to carry the signals.

Disadvantages

1. Price

In spite of the fact that the raw material for making optical fibres, sand, is abundant and cheap, optical fibres are still more expensive per meter than copper. Having said this, one fibre can carry many more signals than a single copper cable and the large transmission distances mean that fewer expensive repeaters are required.

2. Special Skills

Optical fibres cannot be joined (spliced) together as a easily as copper cable and requires additional training of personnel and expensive precision splicing and measurement equipment

Areas of Application

1. Telecommunication's

Optical fibres are now the standard point-to-point cable link between telephone substations.

2. Local Area Networks (LAN's)

Multimode fibre is commonly used as the "backbone" to carry signals between the hubs of LAN's from where copper coaxial cable takes the data to the desktop. Fibre links to the desktop, however, are also common.

3. Cable TV

As mentioned above domestic cable TV networks use optical fibre because of its very low power consumption.

4. CCTV

Closed circuit television security systems use optical fibre because of its inherent security, as well as the other advantages mentioned above.

5. Optical Fibre Sensors

Many advances have been made in recent years in the use of Optical Fibres as sensors. Gas concentration, chemical concentration, pressure, temperature, and rate of rotation can all be sensed using optical fibre. Much work in this field is being done at the University of Strathclyde.

FIBRE OPTIC NETWORKS (FONS)

Optical fibre networks possess following characteristics:

(1) High speed operation: Typically 100 Mbps or more.

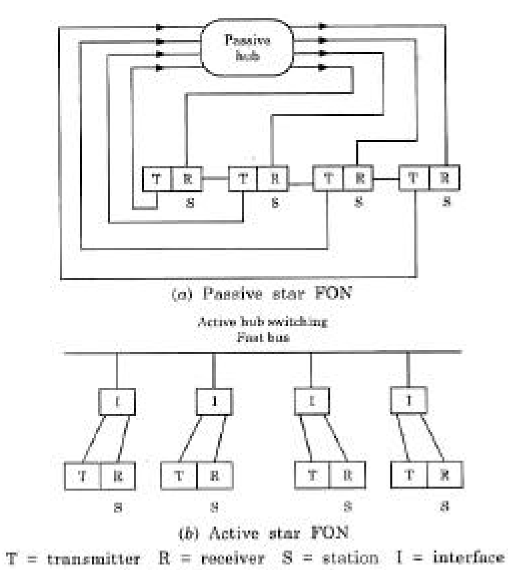
(2) Ability to span large distances: 100-200 km

(3) Ability to support a moderate number of stations. Typically 10 to a few hundred stations are supported with a maximum limit around 1000.

These characteristics make the fiber optic networks suitable for high speed LANs and MANs with limited number of stations. Fiber optic networks may be configured around a star, ring or bus structure. The number of stations that can be supported in a star or a bus structure is relatively low compared to that in a ring configuration.

Optical fibers are inherently unidirectional. This influences the way in which the network structures are realized and the consideration of medium access. .

The central hub in a star Fiber Optic Network (FON) may be passive or active. These networks are shown in Fig. 38.1.



(a) Passive star FON

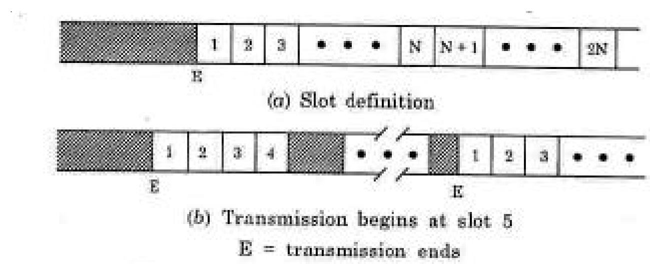
(b) Active star FON

T = transmitter R = receiver S = station I = interface

The passive hub is usually a silica cylinder. The incoming fibers are focused to one end of the cylinder and outgoing fibers to the other end. The light emitted by the transmitters (LEDs) of the stations diffuses inside the passive hub illuminating all the receivers (photodiodes). The incoming energy is divided among all the outgoing lines. The output power of the transmitter and the sensitivity of the receiver would determine the number of nodes that can be connected to the passive hub.

The limited number of stations in passive star FONs permits a simple medium access protocol to be used. Following the end of a transmission, a fixed number of time slots usually equal to or twice the number of stations, is defined. It is shown in Fig. 38.2.

Each station is assigned one or two slots. As the case may be, in which it may start transmission provided no other station prior to it has started transmission.



(a) Slot definition

(b) Transmission begins at slot 5

E = transmission ends

In Fig. 38.2 (b) the station assigned to slot 5 (station 5) starts transmission and all stations after slot 5 will have to wait until the end of transmission by station 5, when the cycle repeats.

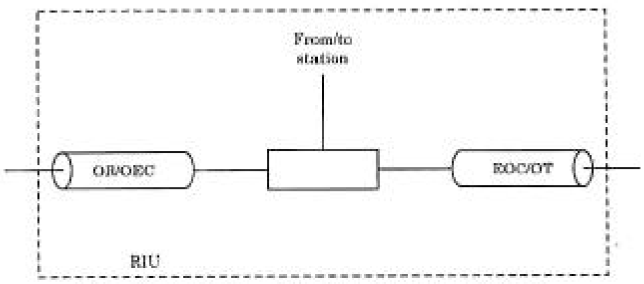
Obviously, stations allotted to earlier slots attain priority over other stations, resulting in an unfair access scheme. For bringing about fairness in access, 2N slots are used where a station is allotted two slots; one is the lower half (i.e. in the range 1 to N) and other in the upper half (i.e. in the range (N + 1) to 2N). A station is required to transmit alternatively in the lower and the upper half. Carrier sensing is possible in a passive star because the transmitted signal would return to the station after the round trip propagation delay. This opens up the possibility of contention protocols with collision detection feature for transmission.

In an active-star FON shown in Fig. 38.1 (b), the optical signals are converted to electrical domain arid a fast switching is organised with in the hub.

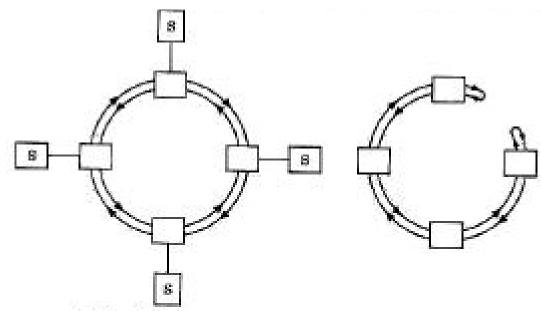
Medium access mechanism is not related to the switching mechanism in the hub. Fig. 38.1 (b) shows a fast switching hub. This uses parallel paths for data transfer.

The working principle of a fiber optic ring network is very similar to the cable-based ring LAN. The differences between ring FON and ring LAN are given as follows:

The ring interface units (RIUs) in a FON perform all the functions carried out by the RIUs in the cable LAN. In addition, they are required to convert optical signals to electrical domain for processing and reconverting them to optical domain for transmission. It is shown in Fig. 38.3



OR = optical receiver   OEC = optical to electrical converter
EOC = electrical to optical converter   OT = optical transmitter



(a) Dual ring   (b) Folded ring

Token passing is popularly used as the fiber access scheme in the Ring FONs. The physical length of the fiber optic ring being large (up to 200 km), the token reintroduction requires consideration.

Example 38.1 Here, we have a fiber optic token ring with a physical length of 100 km, an operating speed of 100 Mbps and having 100 stations each introducing 1-bit delay.

Find the maximum ring utilisation if the free token were to be introduced after the first bit arrives at the source. Assume a frame length of 1000 bits and the stations are equally spaced.

Solution:

Walk time is the time taken by a bit to travel around the ring and is given by,

$$W = t_p L + (N/R),\ \mu s \qquad \ldots\ldots\ldots\ldots\text{Eq.1}$$

Where, t_p = Propagation Delay in µs/km
L = Physical length of the ring in km
R = Data Rate in Mbps.

The term (N / R) gives the delay introduced by the stations in the ring with each station contributing 1-bit delay.

t_p = 3.3 µs per km for optical fiber.

Hence, $W = 3.3 \times 100 + (100 / 100)$
$= 330 + 1$
$= 331\ \mu s.$

Frame time, $t_f = \frac{\text{Frame length}}{\text{Operating speed}} = \frac{1000}{100 \times 10^6}$
$= 10 \times 10^{-6}$
$= 10\ \mu s$

There is a transmission for 10 µs for every 331 µs.
Therefore,
Maximum ring utilisation

$$= \frac{10\ \mu s}{331\ \mu s} = 0.03$$

In order to improve the channel utilisation, the free token is introduced immediately after a transmission As a consequence; multiple frames may be present on the ring at any point of time.

Token passing Fiber Optic network (FON) is being standardised under an IEEE project. This standard is known as Fiber Distributed Data Interface (FDDI). The FDDI proposes a dual ring configuration as shown in Fig. 38.4 for better fault tolerance.

A station may connect to only one of the rings or both the rings depending on the criticality operation. If either one of the rings breaks, the other can be used as a back up. If both of them break at the same point due to fire or accident in the cable duct etc., the rings can be looped back as shown in Fig.38.4 (b) to form a single ring of approximately twice the length.

A fiber optic bus Network or Bus FON may use two independent buses with an active head end. It is similar to MAN configuration or without a head end. A single bus may be used in a folded fashion, either U or S shaped as shown in Fig.38.5. All stations transmit on the upstream and receive on the down stream. There is a provision to sense the presence of transmission on the upstream. Tops on the bus drain away the optical power. Hence the bus configuration is not capable of supporting a large number of stations. The main difference between the U and the S shaped configurations is that in the S-shaped configuration the stations have uniform propagation delay for the signals to travels from their transmit tops to their respective tops. The S-shaped configuration is employed in medium access strategy.

In the S-configuration, transmission of frames takes place in a cyclic manner. The cycle is initiated by the station that is ready to transmit and is closest to upstream termination end. A new cycle is started by observing the end of the previous cycle on the downstream. This will be first observed by the station that is closest to the upstream termination end.

Once initiated, other stations follow one after another by sensing the end of a frame on the upstream. If a station senses incoming traffic on the upstream, while it transmits its own frame, it immediately aborts its transmission and lets the transmission which must be originated from a station closer to upstream termination end than itself, to proceed. Its own packet is sent after the upstream becomes quiet. The example of network which uses S-shaped network configuration is EXPRESSNET.

Introduction To ISDN

The data communications field is in a continual state of flux. New standards and communication network facilities are constantly being introduced and implement. Many of the older standards are being updated to accommodate current technology. A comparatively new integrated public service is among the latest network systems currently in the process of implementation by the telephone company. Thus service, called integrated services digital network (ISDN), incorporates voice, data, video, and facsimile information on the same common carrier. The system utilizes existing public networks to bring these various services to subscribers. Additionally, ISDN uses numerous established local area networks (LANs), wide area networks (WANs), metropolitan area networks (MANs), private branch exchanges (PBXs), and so on, interconnecting them via common public carriers. The benefits of using an integrated network such as ISDN include line sharing, high data throughput, easy identification of data packets, and error recovery. The establishment and termination of calls are done the same regardless of the originating station's configuration.

Integrating Services

Numerous types of information, including voice, video, and data, are combined or integrated into a single channel. There are a number of types of ISDN data channels used for this purpose, which are detailed in international consultative committee for telegraphy and telephony (CCITT) specifications for ISDN networks. The current type being implemented is the full-duplex transparent basic (B) channel. Data from several devices are circuit switched into the B channel for transmission to a receiver at a 64-kbps rate. B channels carry voice, digital, and or high-speed data transmissions.

A D channel, operating at 8 or 16 kbps, is used for control signalling or low-speed packet-switching transmissions. Specific uses of the D channel include call setup and termination and system maintenance control. Use of packet-switched data on the D channel provides a means for telemetry information to be passed along while integrated data travel on the B channel. Telemetry data include low scan alarm, energy monitoring, and security data.

Two established forms of ISDN service are commonly available, the basic rate interface (BRI), consisting of two B channels and one D channel (2B + D) and a primary rate interface (PRI). In North America, Japan, and Korea, the primary rate interface consists of twenty-three B channels and one D channel (23B + D). In Europe and the rest of the world, the primary rate interface uses thirty B channels and one D channel. Basic rate interface systems require bandwidths that can accommodate 144 kbps to handle the two 64-kbps B channels (B1 and B2) and the 16-kbps D channel. Primary rate interface systems, because of the larger number of B channels, need bandwidths of 1.544 Mbps for North American applications and 2.048 Mbps for European systems.

Data, in any form originating at a subscriber (customer or user), are converted into ISDN form by a terminal adapter (TA), transported onto the common carrier (telephone system), and delivered to the destination station. On the receiving side, the process is reversed, returning the data to a form usable by the receiving customer. Because of the use of terminal adapters, the sending and receiving customers do not have to use the same type of networking or protocols at their sites. Essentially, the communications methodology is transparent to the user. When happens to the messages along the way is insignificant to the user as long as the data are successfully communicated.

ISDN Connections and Interfaces

ISDN units and interfaces throughout the network are clearly defined by function and reference in the network. Users may access the network through one of the categories of entry terminal devices, terminal equipment 1 (TE1) and terminal equipment 2 (TE2). Terminal equipment 1 units contain standard ISDN interfaces and require no data protocol translation. Raw data are entered and immediately configured into ISDN protocol format. TE1s are illustrated in Fig.38.6 as a terminal and digital telephone. Non-ISDN terminals are classified as TE2. They are connected to the system via physical interfaces such as RS23 2C and X.21. Terminal adapters (TA) are required to perform the required transaction between the non-ISDN data protocol and the ISDN network protocol format. TAs translates user data rates into ISDN's 64-kbps B channel or 16-kbps D channel rates. X.25 packets, if used, are converted to ISDN packet formats, and any additional signalling required is added by the terminal adapter. These terminal adapter support analog phones a facsimile, as well, by use of a 3.1 kHz audio bearer service channel. These audio signals are digitized and formatted into ISDN and seen into the network. The entry point of the TE2 device to the terminal adapter is referenced by the letter R. An S is used to designate entry points of the terminal adapter TE1 units into the ISDN lines.

S reference points indicate interface lines that are presently in ISDN format. They supply the 2B + D data at 192 kbps for the basic rate to network termination 1 (NT1) units. These units supply the physical interface between the customers to the common carrier at reference points designated by the letter T. As such these units are often called customer exit/entry nodes. An additional network termination unit, the NT2, may be used to terminate several S point connections, providing local switching, NT2s may also include protocols for data line and network layers of the open systems interconnection (OSI) model to complete the interface between the common carrier local loop and the central office (U reference point). NT2s also perform two-wire to four-wire conversion for ISDN basic rate access to the common carrier.

The loop is the media interface point between NT1 and the central office. U loops are terminated at the central office by a line termination (LT) unit, which corporate physical layer interfacing between the central office transceiver and the loop lines. The LT unit is connected at reference point V to an exchange termination (ET) unit such as a PBX that routes the data, through local network, to an outgoing channel or to a central office user.

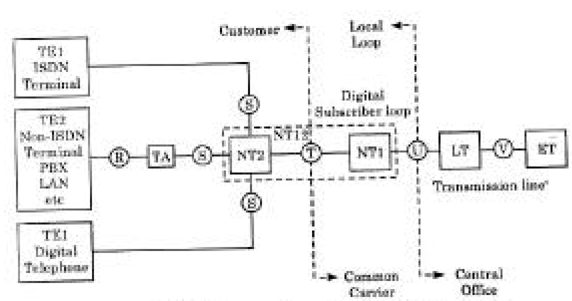


Fig.38.6 ISDN connections and reference points.

Additional ISDN channel types

The preceding discussion was limited to two types of transmission channels, Band D. These are the channels in current use by existing ISDN subscribers. Additional channels specified by the ISDN system are presently usable or still in the development stages. They include the following:

- A channel - Conventional analog voice
- HO channel - Six-channel circuit switch at 64 kbps per channel used for high-speed data or signal imaging
- H11 channel - Twenty-four-channel switch at 64 kbps per channel a, for a total data rate of 1.536 Mbps on the channel
- H12 channel - European version of HI 1 using 30 channels instead of 24 for a total rate of 1.92 Mbps
- E channel - Packet switched using 64 kbps similar in function to the D channel.

The common T1 channel can be implemented on ISDN using various combinations of the channels described earlier. The most direct definition is supplied by the H11 channel, which is designed principally for the twenty-four-channel T1 carrier. However, T1 can also be implemented using 23B + D or 24B channels, 3HO + D or, 4HO. The main difference in these is whether or not the communications link requires a signalling (D) channel or not.

ISDN Physical Layer Frame Formats

ISDN specifications define a network architecture modelled according to the open systems interconnection (OSI) layer network model. The network termination units address the physical layer by describing the interfaces required by users to access the system. Devices included as part of a network termination 1 (NT1) are transceivers, modems, , interfaces (such as RS232C), and network media (such as twisted pair cutting).

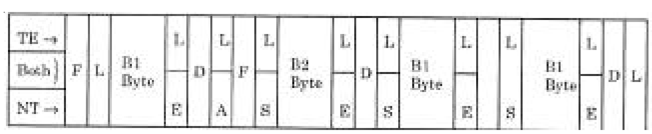


Fig.38.7 Basic rate interface (BRI) frames

Figure 40.7 illustrates the frame format for the basic rate interface (BRI) as it applies to the physical entry and exit (S) points to the network. There are two frame formats. Terminal equipment (TE), defining those sent by terminal equipment to the network (entry), and network termination (NT) frames, defining frames sent the opposite way (exit). The first two bits of these frames (F; framing; L; DC balancing) are used for synchronization. Each B channel information byte following the F and L bits is followed by D channel bit information. Additional Land F bits are used to maintain framing and synchronization. A bit in the network termination frame activates or deactivates terminal equipment, putting this equipment on-line or removing it from the network.

Line arbitration for the sending of D channel control information by a terminal is achieved through use of the E bit in the network termination frames, which is a copy of the previous terminal equipment frame D bit information. 8 bits are undefined at this time. When a terminal has D information to send, it first observes the E bits of the NT frames. A specified consecutive number of E bits must be high before the station can send its D information. The consecutive high states of the E bits indicate that no D control information has been sent in any previous terminal equipment frames and the station can now send a terminal equipment frame with D control information.

Network termination and terminal equipment frames are transmitted, at a rate of 4,000 frames per second. Each frame contains 48 bits, thus making the data rate 192 kbps. In contrast, primary rate interfaces transfer data at 1.544 Mbps (North America) and 2.148 Mbps (Europe), which are the rates specified by the T1 channel specification. The North American version of a primary rate interface (PRI) frame (Fig.38.8 contains a framing bit followed by twenty three or twenty-four B channel fields and a D channel bit.

The European primary rate interface frame also begins with a framing bit but is followed by sixteen B channel fields, a D channel bit, and fifteen more B channels. Frames are transmitted at a rate of 8,000 frames per second, resulting in the different data rates for U.S. and European primary rate interface frame transmissions.

ISDN Data Link Layer

The protocol used by ISDN at the data link layer is closely related to the high-level data link control (HDLC) protocol and is called link access protocol for D channel (LAPD) and LAPB for B channels. The basic LAPD frame (Fig.38.9) is identical to the HDLC frame. It starts with the 7E flag, followed by an address field. The use of this field differs from the HDLC basic form by including a service access point (SAP) address and a terminal end point (TEP) address. An additional bit in the address field, called the command/response (CIR) bit, is used to identify the frame as a command (0 for traffic from terminals, 1 for traffic from the network) or a response (opposite states) message. The control fields identify the type of frame and keep track of the frame sequence for SDLC and HDLC protocols. Information supervisory, and unnumbered control fields are the same as their HDLC counterparts with the following exceptions. The set normal response unnumbered frame is replaced with set asynchronous balanced mode extended. It functions similarly to the set normal response mode by establishing a data link for acknowledged data transfers (information frames). An additional unnumbered frame Transfer ID (XID) is included to allow stations to identify themselves for line management purposes.

LAPB frames are similar to those of LAPD. XID and unnumbered information (UI) frames are not used with LAPB. Also, the frame numbers are restricted to modulo 8 (E-bit frame numbers) while LAPD uses modulo 128 (7-bit frame numbers). Network layer specifications are included in the LAPD protocol.

ISDN Applications

In 1984 the hamburger chain giant, McDonald's Corporation, headquartered in Oak Brook, Illinois, decided that there was a requirement to integrate their numerous network and communications needs a more efficient and cost effective system. Contracts between McDonald's and Illinois Bell Telephone and

AT&T were signed for the telephone companies to provide an integrated network based on the ISDN standard as specified by CCITT/ISDN standards. Locally, McDonald was divided between the home office (known as the Plaza), the Lodge, and Hamburger University. These facilities were up to 1.5 miles part, with most interconnecting communications being provided on leased lines or the public telephone system. Networks at the sites and other services included an IBM Systems Network Architecture (SNA) network, office automation (AO), UNIX-based network supporting the product development area, a CENTREX system handling regular telephone and Telex communications, and various leased lines and packet-switch facilities to interconnect the networks.

Illinois Bell offered to establish a centralized system based on ISDN to integrate the functions of the various networks into a single information-transport network. Employees at the home office were equipped with ISDN telephone sets that included ISDN data module that serves as an NT1 interface directly into the ISDN network automatic number identification (ANI) is included to display the caller's number before the call is answered. Employees can use this ability to either screen calls or to tap into a caller's database before actual dialogue is begun with the caller.

To manage the network AT&T provided a package called netpartener. This management software took the responsibility of maintaining the network from McDonald's and placed the maintenance and monitoring tasks onto AT&T. The network can still be monitored from a local terminal, but data are directly available to the AT&T support teams. NETPARTNER tests ISDN lines for integrity and reports any problems that are detected. Translations between ISDN and analog lines are also checked and/or changed as required.

Office automation (OA) users access the OA system by dialing a four-digit access number into either a X.25 packet-switched D channel or a B-channel circuit-switch connection. The McDonald's office automation system makes the following services available to their employees:

1. Word processing
2. Data base management
3. Graphics
4. Spread sheets
5. Electronic mail
6. Time management
7. Access into other ISDN services
8. Printer accesses to all areas to obtain hard copies quickly.

Printer interfaces throughout the system are served by a 9.6-kbps B-channel circuit switch connection allowing high-speed (eight to ten pages per minute) laser printer capability. No printer is more than 25 feed from employees. The quantity of printers coupled with the speed of printing results in efficient hard copy service. Other benefits of office automation via ISDN to McDonald's include:

1. Easily accessing multiple hosts and applications
2. Large and quick file transfer
3. Easy implementation of employee situation change-office location change, new hire, termination, and so on.

Use of IBM PC and facsimile services is also incorporated into the McDonald's ISDN network through terminal adapters (TA) that do the necessary conversion between IBM, facsimile, and ISDN formats and protocols.

McDonald's is noteworthy because it was the first large, nationwide business to incorporate the use of ISDN. The integrated nature of ISDN was used to consolidate existing services and to add many of the newer features described earlier. McDonald's is not the only large company using ISDN, but it is the first large company willing to invest money and time to reap the benefits provided by ISDN.

The Mellon Bank of Pittsburgh, Pennsylvania, uses ISDN to handle many services between its Pittsburgh and Philadelphia banks, using Bell Pennsylvania as a local carrier and MCI for long-distance connections.

The main application is for video reconferencing, transferring digitized video data at a rate of 112 kbps. Additional tests using ISDN with Mellon are being performed in the hopes of raising the rate of 128 kbps without degrading the resolution of the video.

Other uses of ISDN at Mellon are customer-related. Using a system called Global Cash Management Services. Mellon handles cash disbursements, collections, and electronic funds transfers using ISDN as the prime network. Mellon is also testing the use of automatic number identification (ANI) through the use of the D chance. Identification information about the calling party's number arrives on the D chance and is used to call up the customer's files to an agent's terminal before the voice call is connected through to that agent.

At October 1987 article in Data Communications entitled 'What ISDN Will Mean in Australia' detailed projections by Australia's Telecom service to implement ISDN throughout that country by early 1989. The plans included interconnecting PBXs to the public telephone network once ISDN adapters were put into place. Another large user that has plans to integrate ISDN into its nationwide communications facilities is the West German Bundespost.

The additional users of ISDN services, Shell Oil and Tenneco Corporation, receive the service from Southwestern Bell. Another major supplier, Southern Bell of Atlama provides commercial ISDN services for AT&T, Hayes Microcomputer Products Contel Corporation, Southwest Banks, and Digital Equipment Corporation (DEC).

A large number of users employ the ISDN network for teleconferencing, telemarketing, and to build not existing wide area networks (WANs). Eastman Kodak implemented ISDN in 1988 for voice teleconferencing. The list of ISDN keeps growing. The benefit of direct digital access to the Internet, the future growth of ISDN usage is assumed.

Broadband ISDN

Proposals by the CCITT to expand upon ISDN features to promote broadband communications in the form of a broadband ISDN (BISDN) are currently under discussion and development. The new standard is to be based upon the concept of an Asynchronous Transfer Mode (ATM) incorporating fiber came as the medium for data transfer. The BISDN specification sets a maximum length of 1 km per cable segment but is making provision for repeater type interface extensions. The data rate expected on the wider bandwidth fiber optic cables will be either 100, 155, or 600 Mbps, depending on application and point in the network.

In composing the new specification, the authors are required to meet existing ISDN interface specifications, as well as new broadband network needs. A typical network access arrangement is shown in Fig.38.10. A standard ISDN terminal for network interface and a broadband terminal interface (BTI) are serviced by the subscriber's premises network (SPN), which multiplexes the incoming data and transfers them to the broadband node, called a broadband network termination (BNT), which codes the information into packets used by the BISDN network. Data transfers to and from the BISDN network may be asymmetric. That is, access on and off the BISDN network may be done at different rates depending on system requirements. The illustration shows data entry to the network to be at 155 Mbps and from the network, 600 Mbps.

Subscriber's premises networks can be a private branch exchange (PBX), token ring, or order local area network configuration. The BNT interface with supporting software is to be capable of recognizing the protocols and frame formats of the data required by the interfacing network.

Asynchronous transfer mode

The Asynchronous Transfer Mode (ATM) is a method by which data enter and exit a network in an asynchronous fashion rather than a time-dependent synchronous arrangement. ATM uses labeled channels transferable at fixed rates, which can be set anywhere from 16 kbps up to a system's maximum rate. Data entering the network are transferred into fixed time slots called cells, which are identified by a label in the cell header Fig.38.11. The label defines a virtual channel identifier, which indicates the node source destination of the data packet. The channel is virtual rather than specific, allowing the actual physical routing and network entry and departure times to be determined based on network availability and access rights. Following the header label is the header error detection character, which could be a form of cyclic redundancy check (CRC) or any other error detection format. This error detection is for the header label only. Separate error-detection methods are employed for the data field. A third section in the header has yet to be fully formalized and remains unidentified at this time.

Virtual Channel Identifier (Label)	Header Error Detection	Not Yet Defined	Channel Data

Fig.38.11 ATM header cell

BISDN Configuration

A possible BISDN configuration Fig.38.12 begins with data supplied to the system through various peripheral devices or networks. Each is interfaced to the access node of a BISDN network through a broadband distant termination (BDT), which is responsible for electrical to optical conversions, multiplexing of peripherals, and maintenance of the local system. Access nodes concentrate several BDTs into a number of high-speed fiber lines directed through a feeder point into a service node. The service node manages the majority of control functions for system access. It handles call processing, administrative functions, switching, and maintenance functions. The service node uses distributed management through functional modules within its area of influence. These functional nodules are connected in a star configuration Fig.38.13 and include switching administrative, gateway, and maintenance modules. The central hub oversees are operation of the modules and acts as the end user interface for control signalling and traffic management.

User terminals close to the central office bypass the use of access nodes and are connected directly to the BISDN network through a service node Fig.38.13. The larger bandwidth of fiber cables allows for higher data rates and numerous channels handling capacity for the BISDN system. Once the specifications are completed applications and use are expected to follow quickly.