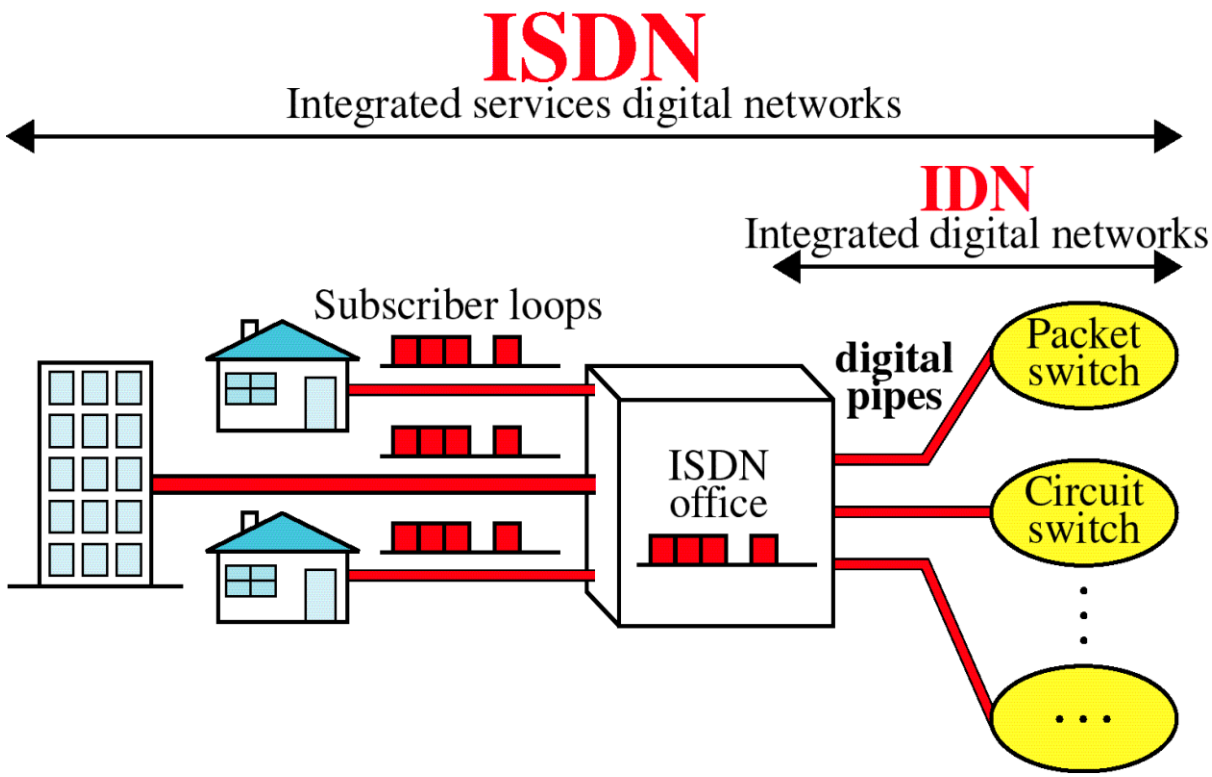
Integrated Services Digital Network



- ISDN integrates customer services with IDN.
- To require access to a variety of networks , such as packet switched networks and circuit switched networks , the telephone companies created Integrated Digital Networks.
- An IDN is a combination of networks available for different purposes.
- Access to these networks is by digital pipes , which are time multiplexed channels sharing very high speed paths.

Subscriber access to the ISDN

- To allow flexibility , digital pipes between customers and the ISDN office(The subscriber loops) are organized into multiple channels of different sizes.
- The ISDN Standard defines three channel types , Each with a different transmission rate:

Channel	Data Rate(Kbps)
Bearer channels(B)	64
Data channels(D)	16,64
Hybrid(H)	384,1536,1920

B channels

- It is the basic user channel and can carry any type of digital information in full duplex mode as long as the required transmission rate does not exceed 64 Kbps.

D-Channels

- The primary function of D channel is to carry control signalling for the B channels.
- A D channel carries the control signalling for all of the channels in a given path , using a method called common channel signalling.

H Channels

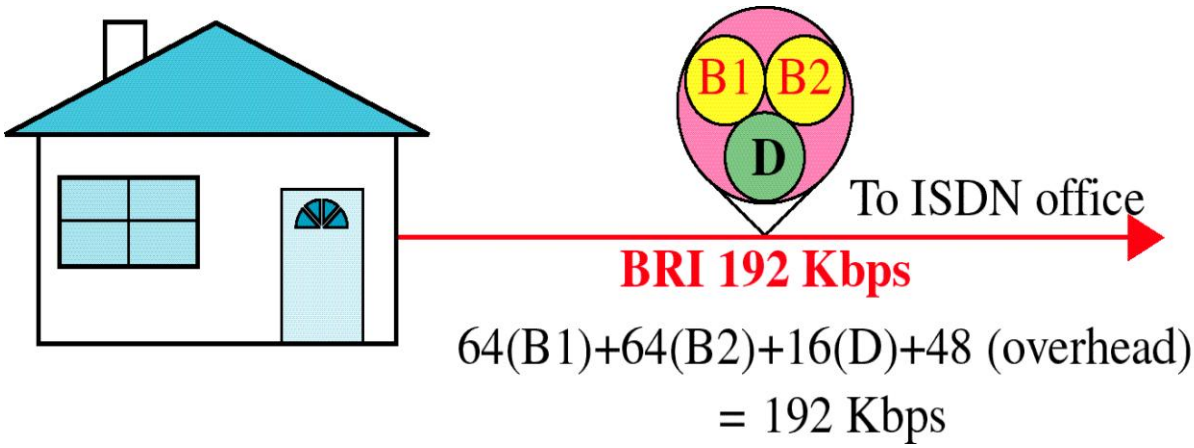
- H channels are available with data rates of 384 Kbps(H0) , 1536 Kbps(H11) or 1920 Kbps(H12).
- These rates suits H channels for high data rate applications such as video , teleconferencing and so on.

USER INTERFACES

- Digital subscriber loops are of two types**:**

1. Basic rate Interface(BRI)
2. Primary rate Interface(PRI)

Basic Rate Interface

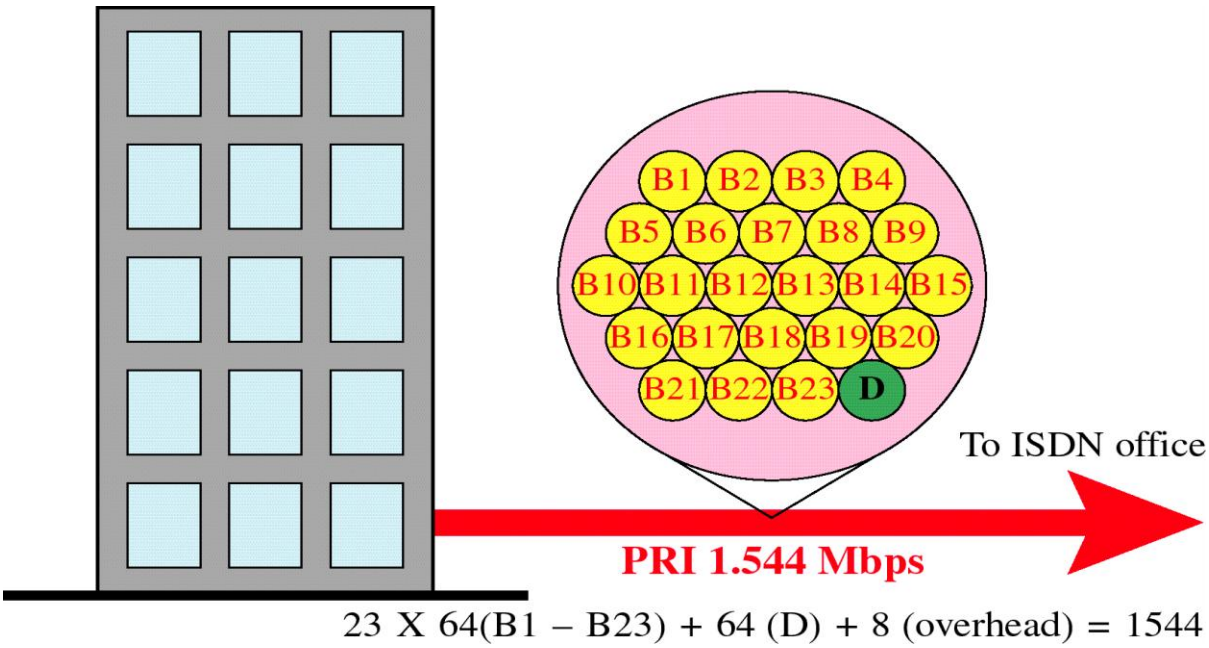


BRI

- The BRI specifies a digital pipe consisting of two B channel(64 KBPS) and one 16 Kbps D Channel and 48 Kbps of operating overhead.

- BRI requires a digital pipe of 192 Kbps.
- The BRI is designed to meet the needs of residential and small office customers.

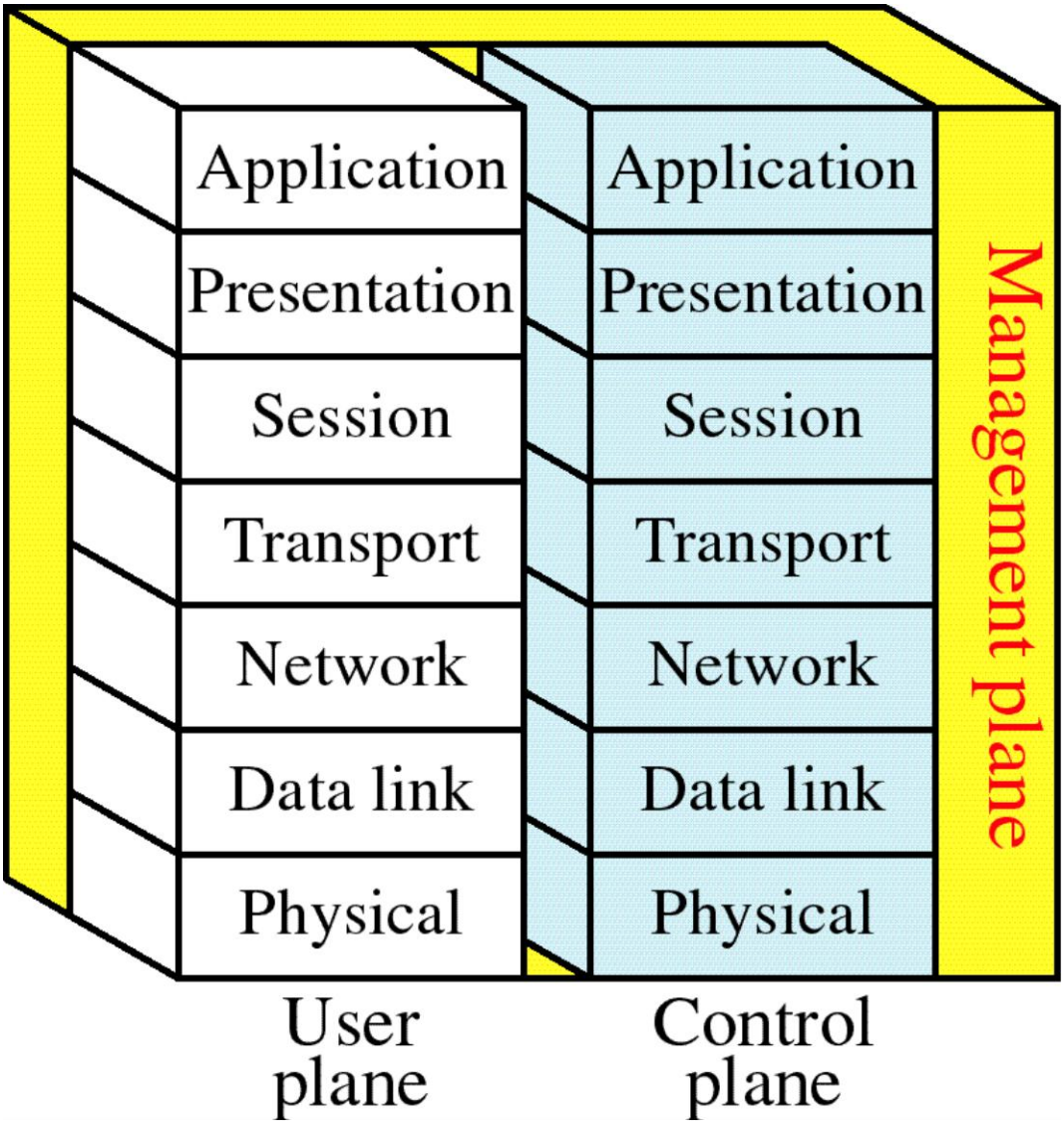
Primary rate Interface



PRI

- The usual primary rate Interface(PRI) specifies a digital pipe with 23 B Channels and one 64 Kbps D channel and 8 Kbps of overhead providing 1.536 Mbps.
- PRI therefore requires a digital pipe of 1.544 Mbps.
- One PRI can provide full duplex transmission between as many as 23 sources and receiving nodes.

ISDN LAYERS



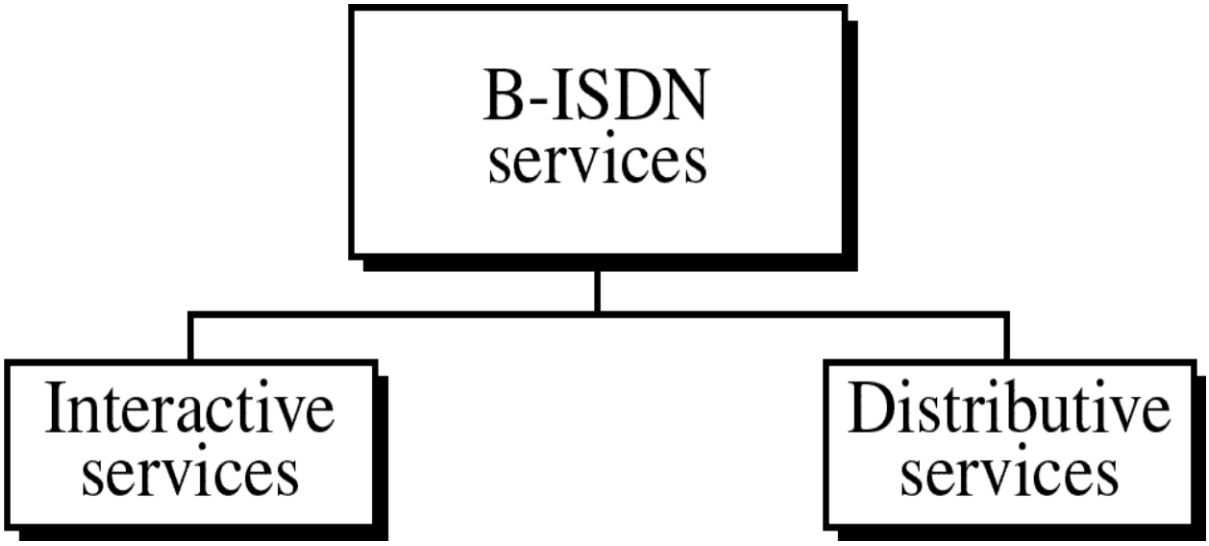
- The ISDN differs from the OSI standard in its management needs.
- A primary consideration of ISDN is global integration.
- Maintaining the flexibility required to keep the network truly integrated using public services requires a great deal of management.
- The ITU-T has devised an expanded model for ISDN layers.
- The ISDN is defined in three separate planes :

The user plane , the control plane ,and the management plane.

All three planes are divided into 7 layers that correspond to the OSI model

BROADBAND ISDN

- A ‘Baseband’ Network is one in which the cable or other network medium can carry only a single signal at any one time.
- A ‘Broadband’ network on the other hand can carry multiple signals simultaneously, (using a discrete part of the cables bandwidth for each signal.)
- As an example of broadband network, consider the cable television service that you probably have in your home.
- Although only one cable runs at your TV, it supplies you with dozens of channels of programming at the same time.
- Based on the transmission & switching capabilities the ISDNs are currently of two types – 1) Narrowband ISDN 2) Broadband ISDN
- ‘Narrowband ISDN’ is based on 64 Kbps bit-stream that are combined into higher capacity ‘trunks’ using time- division multiplexing. For e.g. 32 64 – Kbps channels can be combined into one 2 Mbps channel.
- The narrowband ISDN, however cannot support the requirements of several types of data services, especially those needed for multimedia applications. For e.g. – the bandwidth required for full definition digital video is in the 100 Mbps range.
- To handle this sort of traffic as well as bursts of data traffic from computer ‘broadband ISDN’ (B-ISDN) was introduced.
- B-ISDN is based on optical fibre's & asynchronous time- division multiplexing.
- The advantage of asynchronous time-division multiplexing over conventional time-division multiplexing is that it allows the total bandwidth available to be divided between different activities in a much more flexible way.
- With the advanced applications using telecommunications networks ,the data rates of 64 Kbps to 1.544 Mbps proved inadequate to support many applications.
- The bit rates required for different applications are beyond the capacities of BRI and PRI.
- To provide for the needs of the next generation technology, an extension of ISDN called Broadband ISDN is developed.
- BISDN provides the subscribers to the network with data rates in the range of 600 Mbps , almost 400 times faster than the PRI rate.



- BISDN is based on a change from metal cable to fiber-optic cable at all levels of telecommunications.

Services

1.Interactive services:

- Interactive services are those that require two way exchanges either between two subscribers or a subscriber and a service provider.
- These services are of three types:

Conversational: Those services, such as telephone calls, that supports real time exchanges.

- These real time services can be used for telephony, video telephony, video conferencing, data transfer and so on.

Messaging: Store and forward exchanges**.**

- These services are bidirectional, meaning that all parties in an exchange can use them at the same time.
- These services include voice mail, data mail, and video mail.

Retrieval: Those services used to retrieve information from a central source called an information centre.

- They must allow public access and allow users to retrieve information on demand.
- For example a videotext that allows subscriber to select video data from online library.
- The service is bidirectional because it requires action on both part of both the requester and provider.

Distributive services

- Unidirectional services, sent from a provider to subscribers without the subscriber having to transmit a request each time a service is desired.
- These services can be without or with user control.

1. **Without user control:** These are broadcast to the user without user‘s having requested them or having control over broadcast channel or content. Example is commercial TV.
2. **With User Control:** Broadcast to user in round robin manner. Services are repeated periodically to allow user a choice of time during which to receive them . Examples are Educational broadcasting, tele-advertising and pay TV.

Asynchronous Transfer Mode (ATM)

- Asynchronous Transfer Mode (ATM) is, according to the ATM Forum, "a telecommunications concept defined by ANSI and ITU (formerly CCITT) standards for carriage of a complete range of user traffic, including voice, data, and video signals".
- ATM was developed to meet the needs of the Broadband Integrated Services Digital Network, as defined in the late 1980s and designed to unify telecommunication and computer networks.
- The reference model for ATM approximately maps to the three lowest layers of the ISO-OSI reference model: network layer, data link layer, and physical layer.
- ATM is a high-performance, cell-oriented switching and multiplexing technology that utilizes fixed-length packets to carry different types of traffic.
- ATM provides functionality that is similar to both circuit switching and packet switching networks: ATM uses asynchronous time-division multiplexing and encodes data into small, fixed-sized packets (ISO-OSI frames) called cells.
- This differs from approaches such as the Internet Protocol or Ethernet that use variable sized packets and frames.

- It can be offered as an end-user service by service providers, or as a networking infrastructure
- It is a set of international interface and signaling standards defined by ITU-T Standards Sector
- It is designed for high-performance multimedia networking.
- It enables carriers to transmit voice, video, and future media applications.
- It's suitable for bursty traffic.
- It allows communication between devices that operate at different speeds.

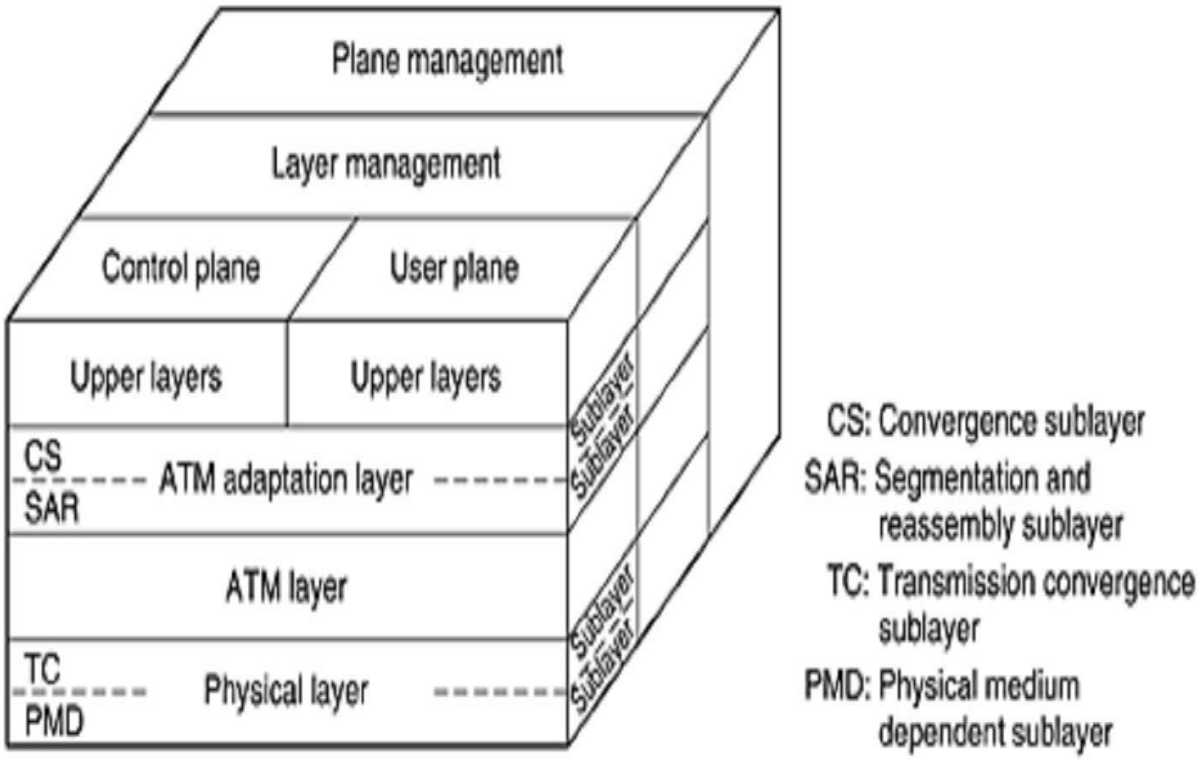
So far, ATM has been implemented in :

- PC, workstation, and server network interface cards
- Switched-Ethernet and token-ring workgroup hubs
- ATM enterprise network switches
- ATM multiplexers
- ATM-edge switches
- ATM-backbone switches

Main features of ATM

- Service is connection oriented, with data transferred over a Virtual Circuit.
- A cell-switched network (architecture).
- Fixed-size cell (53-Bytes)
- Uses Asynchronous time-division multiplexing (Asynchronous TDM)
- The Quality of Service (QofS) enable carriers to transmit voice, data, and video.
- ATM is independent of the transmission medium. ATM cells can be sent on a wire or fiber, and can also be packaged inside the payload of other carrier system.

ATM Technology Reference Model



The ATM Reference Model

- ATM has its own reference model, different from the OSI model and also different from the TCP/IP model.
- It consists of three layers, the physical, ATM, and ATM adaptation layers(AAL) plus whatever users want to put on top of that.
- The ATM model is defined as being three-dimensional, as shown in the figure.
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- **Control**

Responsible for generating and managing signaling request (connection management).

- **User**

Deals with data transport, flow control, error correction, and other user functions.

- **Layer Management**

Manages layer-specific functions (detection of failures and protocol problems)

- **Plane Management**

Manages and coordinates functions related to the complete system.

Functions of the layers

- The physical layer deals with the physical medium: voltages, bit timing, and various other issues.
- ATM has been designed to be independent of the transmission medium.
- ATM cells can be sent on a wire or fibre by themselves.

Physical Medium-Dependent (PMD)

- Synchronizes transmission and reception by sending and receiving a continuous flow of bits with associated timing information.
- Specifies the physical media for the physical medium used, including connector type and cable

Transmission Convergence (TC)

- Cell delineation, generating cell boundaries.
- Header error control (HEC) sequence generation and verification
- Cell-rate decoupling, maintaining synchronization and inserting or suppressing idle ATM cells to rate of valid ATM cells to the payload capacity of transmission system.
- Transmission frame adaptation, packaging cells into frame acceptable to the particular physical layer implementation.

ATM Layer Provides

  - Defining cells layout
  - Defining header
  - Routing

    - Establishment and release VC.
    - Switching
    - Multiplexing
    - Congestion control.

- The ATM layer deals with cells and cell transport. It defines the layout of a cell and tells what the header fields mean.
- It also deals with establishment and release of virtual circuits
- A layer above the ATM layer has been defined to allow users to send packets larger than a cell.
- The ATM interface segments these packets, transmits the cells individually, and reassembles them at the other end.
- This layer is the AAL (ATM Adaptation Layer).

ATM Adaptation Layer (AAL)

- Enables ATM to accept any type of payload, both data frames and streams of bits
- Fragments them into small and fixed-size Cells
- Reassembles Cells
- The physical and AAL layers are each divided into two sublayers:

Convergence sub layer (CS): prepares data to ensure their integrity, providing standard interface.

Segmentation and Reassembly (SAR): Segments the payload into 48-byte cells, and at the destination, reassemble them to recreate the original payload.

ATM Benefits

- Revenue opportunities
- Reduces infrastructure costs through efficient bandwidth management, operational simplicity, and the consolidation of overlay networks.
- High performance via hardware switching
- Dynamic bandwidth for bursty traffic

SWITCHING

- In the switched network methodology, the network consists of a set of inter-connected nodes called switches, among which the information is transmitted from source to destination via different routes.
- The transmission is controlled by the switching mechanism.
- **Switch:** A network switch is a small hardware device that joins multiple computers together within one local area network.

Key features of switched networks

- Network topology is not regular
- Uses TDM and FDM for node to node communication
- There exists multiple paths between a source-destination pair
- The switching method does not concern about the content of data.

TYPES OF SWITCHING METHODS

- The switching performed by different nodes can be categorized into following three types:
  - **CIRCUIT SWITHING**
  - **PACKET SWITCHING**
  - **MESSAGE SWITCHING**

Circuit Switching

- In circuit switching, a physical circuit (or channel) is established between the source and destination of the message before the delivery of the message.
- After the circuit is established, the entire message is transformed from the source to the destination.
- In circuit switching, the whole message is sent from the source to the destination without being divided into packets.
- A good example of a circuit-switched network is telephone systems in which the path was established between a caller and a callee when the telephone number of the callee was dialled by the caller.

Packet Switching

- The second solution to switching is called packet switching.

- In this type of network, a message from the upper layer is divided into manageable packets and each packet is sent through the network.
- The source of the message sends the packets one by one; the destination of the message receives the packets one by one
- The destination waits for all packets belonging to the same message to arrive before delivering the message to the upper layer.
- Every packet contains some control information in the header, which is required for routing and other purposes.
- There are two basic approaches commonly used to packet switching:
    - Virtual circuit packet switching
    - Datagram packet switching

    Virtual circuit packet switching networks establishes a logical connection between the sending and receiving devices called virtual circuit.

    - All the packets travel through the logical connection established between the sending device and receiving device.

    In datagram packet switching network, a message is divided into a stream of packets referred to as datagrams.

- Each packet is treated as an individual and its header contains full information about the destination of the packet.
- In this method the packets don’t follow a pre-established route , packets can follow different routes to the destination and delivery of message is not guaranteed.

Message switching

was the precursor of packet switching, where messages were routed in their entirety, one hop at a time.

- Message switching systems are mostly implemented over packet-switched or circuit-switched data networks.
- Each message is treated as a separate entity. Each message contains addressing information, and at each switch this information is read and the transfer path to the next switch is decided.
- Each message is stored before being transmitted to the next switch. Because of this it is also known as a 'store-and-forward' network. Email is a common application for Message Switching

Difference between circuit switching packet switching an message switching

SNO	Parameter	Message switching	Circuit switching	Packet switching
1	**Multiplexing scheme**	Character or message multiplexing	Circuit multiplexing	Packet multiplexing shared media access networks
2	**Routing**	Manual	Selected during call setup	Each packet route independently
3	**Information type**	Morse code ,ASCII	Analog voice or PCM digital voice	Binary Information
4	**Addressing**	Geographical address	Hierarchical numbering plan	Hierarchical address space
5	**Transmission media**	Digital data over different transmission media	Analog and digital transmission over different transmission media	Digital data over different transmission media

SNO	Parameter	Message switching	Circuit switching	Packet switching
6	**End terminal**	Telegraph	Telephone	computer
7	**Application**	Telegraph networks for transmission of telegrams	Public Service Telephone networks	Internetworking
8	**Bandwidth available**	Limited	Fixed	dynamic
9	**Dedicated physical path**	No	Yes	No
10	**Call setup**	Not needed	Required	Not needed
11	**Congestion**	Heavy traffic	Less congestion	Comparably less congestion
12	**Transparency**	No	Yes	No

SNO	Parameter	Message switching	Circuit switching	Packet switching
13	**Type of message**	Message is in form of blocks	Message in form of frames	Message in the form of packets
14	**Efficiency**	Less efficient	Efficient	More efficient
15	**Transmission delay**	Involves propagation delay and queuing delay	Involves a call setup delay	Reduces delay through store and forward method
16	**Storage required**	Require disks to buffer long blocks	Requires temporary storage	Packets are buffered in main memory
17	**Service provided**	Connection less	Connection oriented	Both connection less and connection oriented