Asynchronous Transfer Mode (ATM)

ATM is the cell relay protocol designed by the ATM forum and adopted by ITU-T. The combination of ATM and B-ISDN will allow high speed speed interconnection of all the world's networks. In fact, ATM can be thought of as the highway of the information superhighway. In ATM, some software functions have moved to hardware; this can increase the data rate.

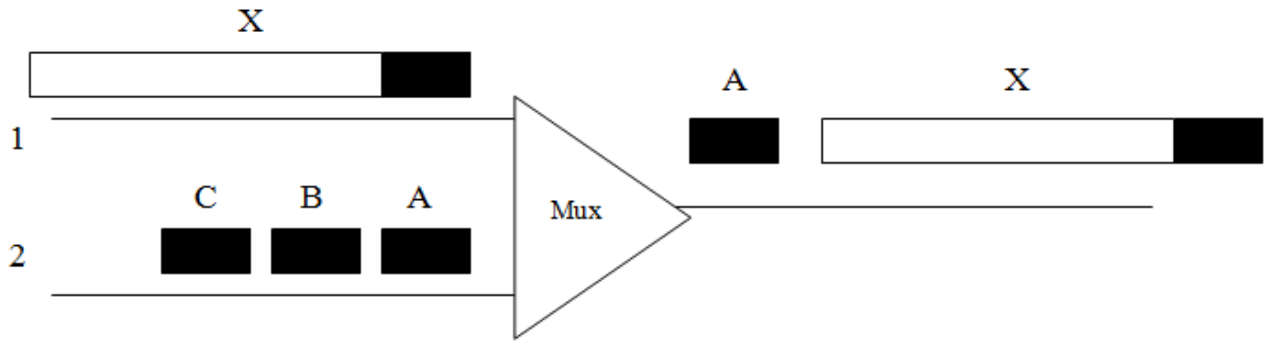
Packet Networks:

Data communications today are based on packet switching and packet networks. A packet is a combination of data and overhead bits that can be passed through the network as a self contained unit. The overhead bits, in the form of a header and trailer, act as envelope that provides identification and addressing information as well as the data required for routing, flow control, and so on. Different protocols use packets of varying size.

Mixed Network Traffic:

As you can imagine, the variety of packet sizes makes traffic unpredictable. Switches, multiplexers, and routers must incoprate software systems to manage the various sizes of packets. Internetworking among the different packet networks is slow and expensive at best.

Another problem is that providing cosistent data rate delivery when packet sizes are unpredictable and can vary so dramtically. To get the most out of broadband technology, traffic must be time division multiplixed onto shared paths. Imagine the packet designs onto one link as shown in figure below:



If packet X arrives at line 1 of multiplexer even a moment earlier than line 2's packets, the multiplexer puts packet X onto the new path first. Packet A must therefore wait for the entire X bit stream to move into place before it can follow.

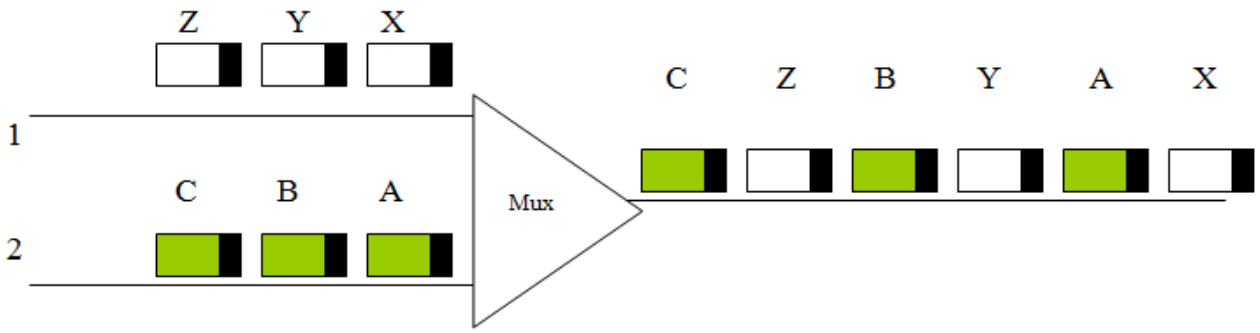
Because audio and video packets ordinarily are small, mixing them with conventional data traffic often creates unacceptable delays of this type and makes shared packets links unusable for audio and video information. Traffic must travel over different paths. But to fully utilize broad bandwidth links, we need to be able to send all kinds of traffic over the same links.

Cell Networks:

Many of the problems associated with packet internetworking are solved by adopting a concept called cell networking. A cell is a small data unit of fixed size. In cell networks, which use the cell as the basic unit of data exchange, all data are loaded into identical cells that can be transmitted with complete predictability and uniformity. As packets of different sizes and formats reach the cell network from a tributary network, they are split into multiple small data units of equal length and loaded into cells. The cell is the same size and all are small, the problems associated with multiplexing different sized packets are avoided.

Advantages of Cells:

1- The following figure shows the multiplexer from previous figure.



With the two lines sending cells instead of packets. Packet X has been segmented into three cells: X, Y, and Z. The cells from the two lines are interleaved so that none suffers a long delay.

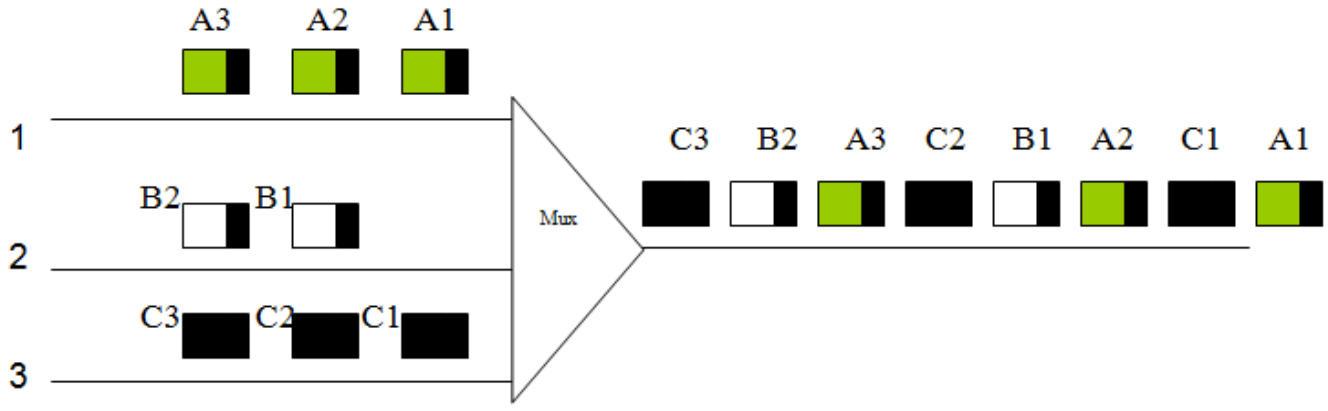
2- The high speed of the links coupled with small size of the cells. In this way, a cell network can handle real time transmissions, such as a phone call.

3- In cell network the smallest unit is a cell, not a bit. This distinction makes network operation not only more efficient but also cheaper. Switching and multiplexing can be

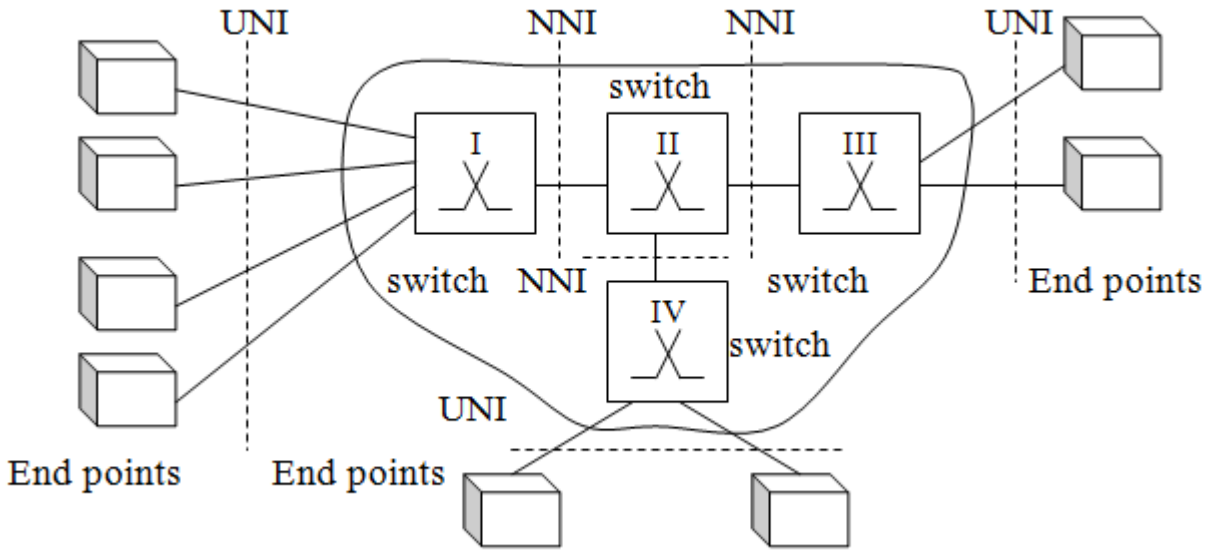
implemented in hardware rather than software, resulting in devices that are less expensive both to produce and to maintain.

Asynchronous TDM:

ATM uses asynchronous time division multiplexing, that is why it is called Asynchronous Transfer Mode. ATM multiplexers fill a slot with a cell from any input channel that has a cell; the slot is empty if none of the channels has a cell to send. The following figure shows how cells from three inputs are multiplexed.



ATM is a cell switched network. The user access devices, called the end points, connected through as a user to network interface (UNI) to the switches inside the network. The switches are connected through network to network interface (NNIs). The following figure shows an example of an ATM network

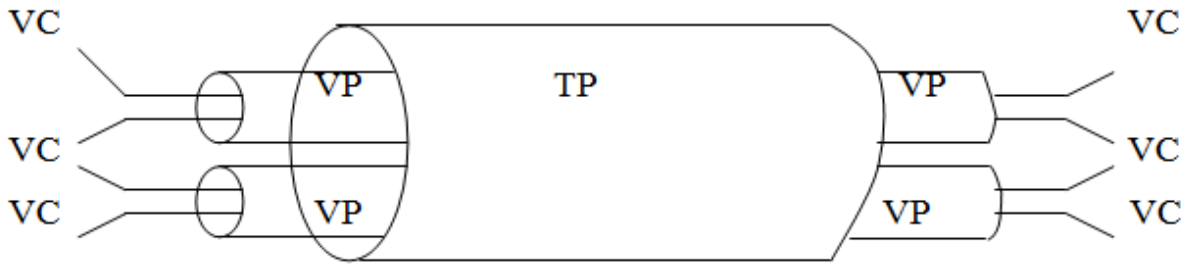


Virtual Connection:

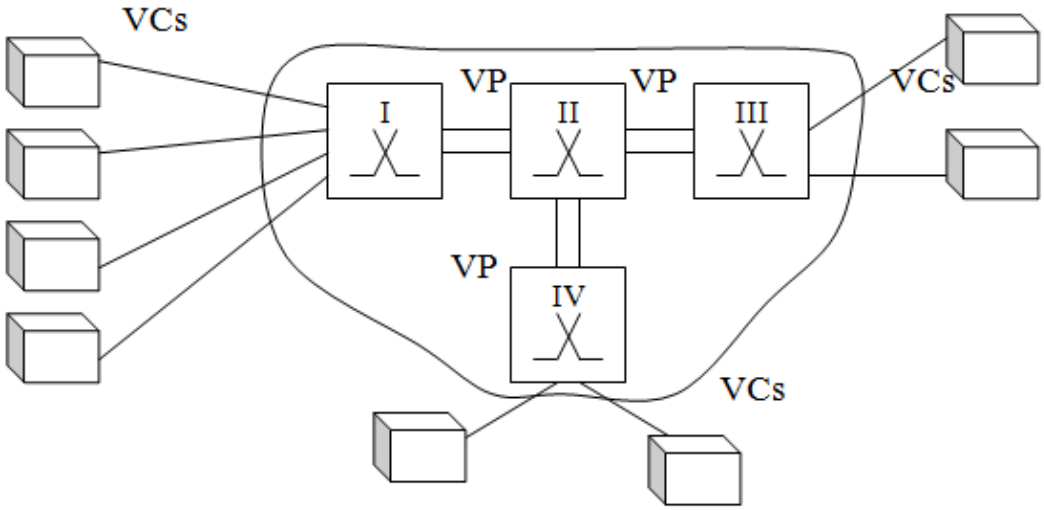
Connection between two end points is accomplished through transmission paths (TPs), virtual paths (VPs), and virtual circuits (VCs). A transmission path (TP) is the physical connection (wire, cable, satellite, and so on) between an end point and a switch or between two switches.

A transmission path is divided into several virtual paths. A virtual path (VP) provides a connection or a set of connections between two switches.

Cell networks are based on virtual circuits (VCs). All cells belonging to a single message follow the same virtual circuit and remain in their original order until they reach their destination. The following figure shows the relationship between a transmission path, virtual paths, and virtual circuits.

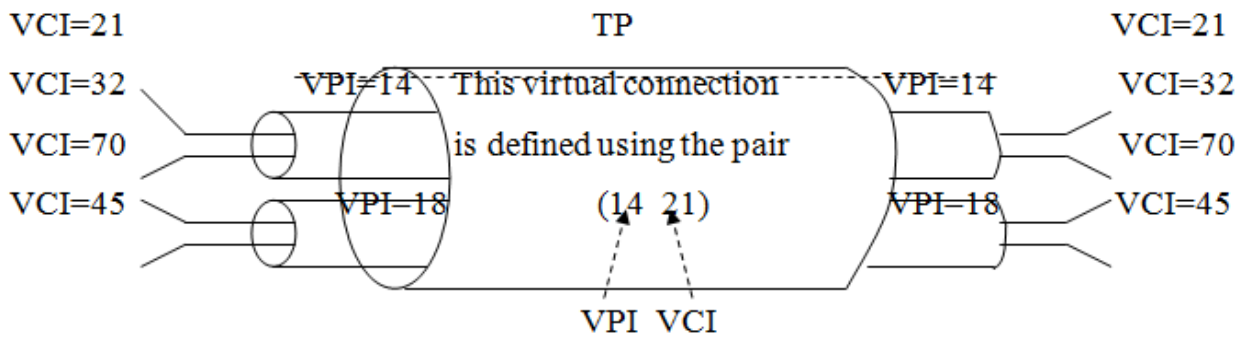


To better understand the concept of VPs and VCs, look at the following figure

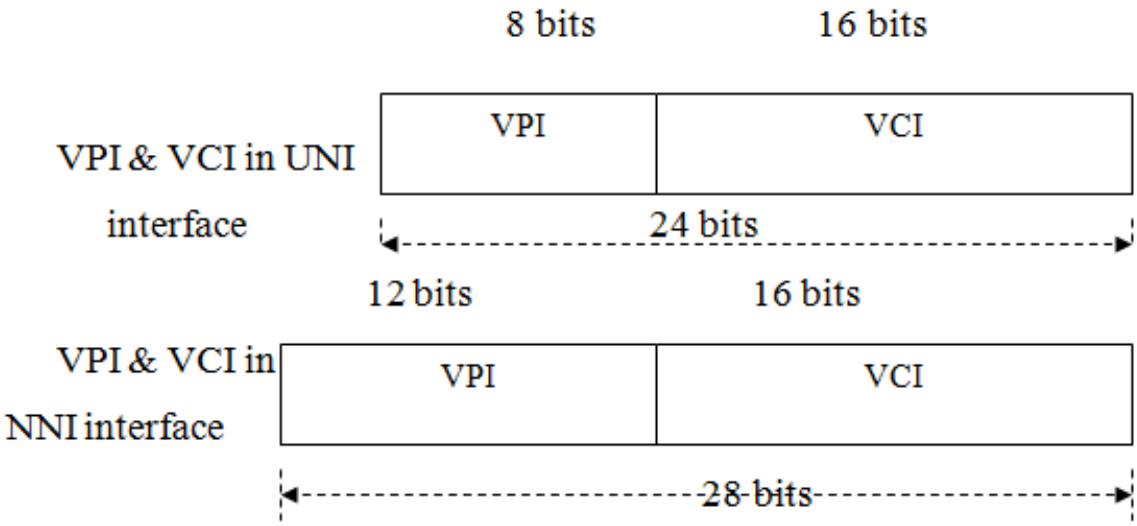


Identifiers:

In a virtual circuit network, to route data from one end point to another, the virtual connections needs to be identified. For this purpose, the designers of ATM created a hierarchical identifier with two levels: a virtual path identifier (VPI) and a virtual circuit identifier (VCI). The VPI is the same for all virtual connections that are bundled into one VP. The following figure shows the VPIs and VCIs for a transmission path (TP).

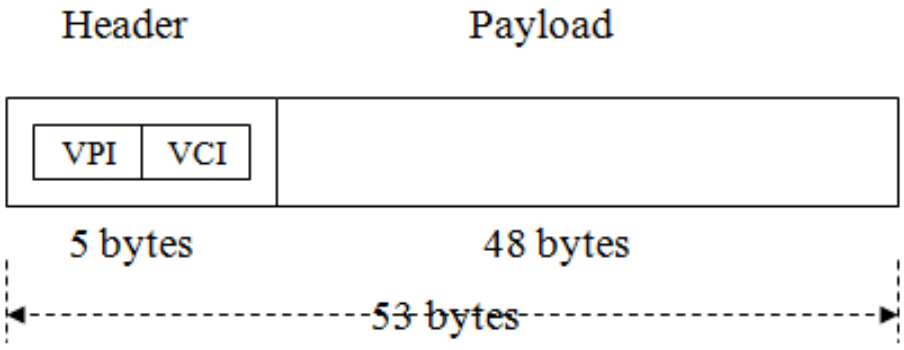


The lengths of the VPIs for UNI and NNI are different. In a UNI interface, the VPI is 8 bits, whereas in an NNI is 12 bits. The length of the VCI is the same in both interfaces (16 bits). We therefore can say that a virtual connection is identified by 24 bits in a UNI interface and by 28 bits in an NNI interface.



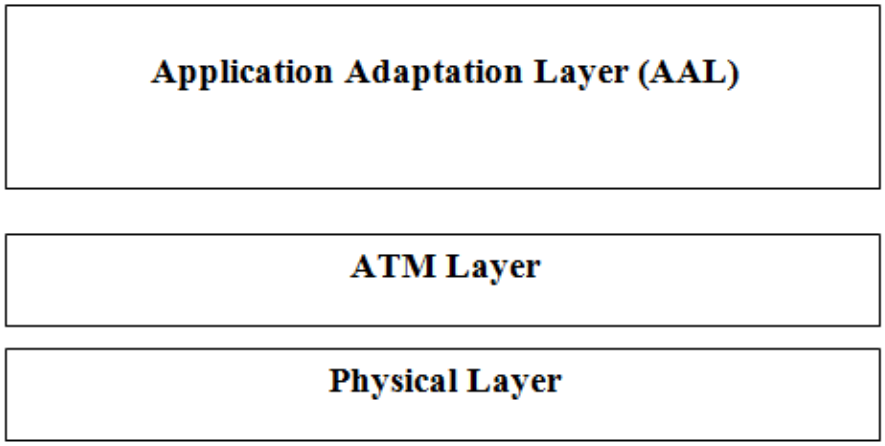
Cells:

The basic data unit in an ATM network is called a cell. A cell is only 53 bytes long with 5 bytes allocated to header and 48 bytes carrying payload (user data may be less than 48 bytes). Most of the header is occupied by the VPI and VCI that define the virtual connection through which a cell should travel from an end point to a switch or from a switch to another switch. The following figure shows the cell structure:



ATM Layers:

The ATM standard defines three layers. They are, from top to bottom, the application layer adaptation layer, the ATM layer, and the physical layer as shown in figure below:

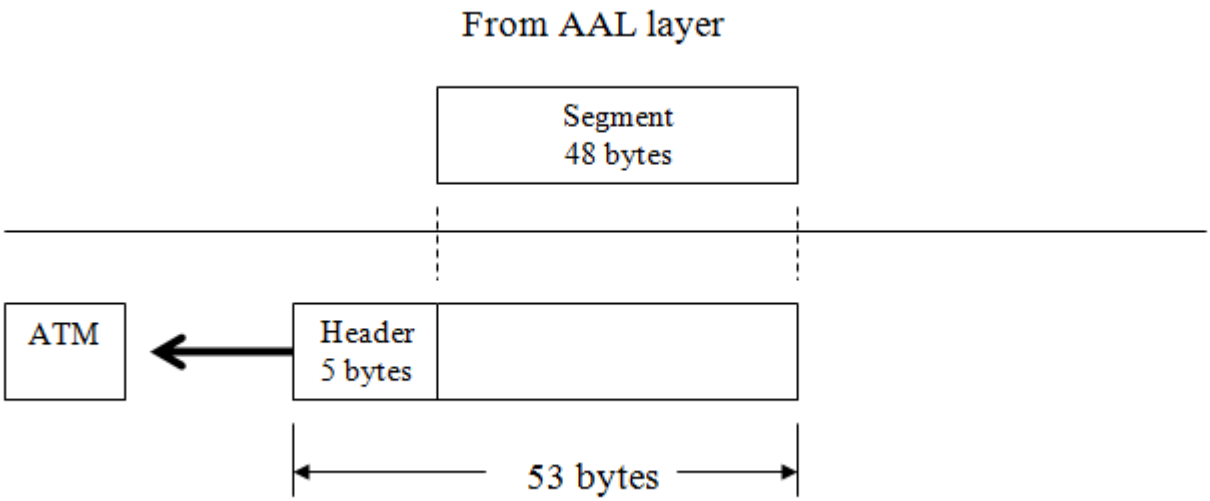


Application Adaptation Layer (AAL):

The AAL allows existing networks (such as packet networks) to connect to ATM facilities. AAL protocols accept transmissions from upper layer services (e.g., packet data) and map them into fixed sized ATM cells. These transmissions can be of any type (voice, data, audio, and video) and can be of variable or fixed rates. At the receiver, the process is reversed – segments are reassembled into their original formats and passed to the receiving service.

ATM Layer:

The ATM layer provides routing, traffic management, switching, and multiplexing services. It processes outgoing traffic by accepting 48 byte segments from the AAL and transforming them into 53 byte cells by the addition of a 5 byte header as shown in figure below:



Physical Layer:

The physical layer defines the transmission medium, bit transmission, encoding, and electrical to optical transformation. It provides convergence with physical transport protocols, as well as the mechanism for transforming the flow of cells into a flow of bits. The ATM has left most of the specifications for this level to the implementer.

ATM Applications:

ATM WANs:

ATM is basically a WAN technology that delivers cells over long distances. In this type of application, ATM is mainly used to connect LANs or other WANs together. A router between the ATM network and the other network serves as an end point. The router has two stacks of protocols one belonging to the ATM and the other belonging to the other protocol.

ATM LANs:

ATM was originally designed as WAN technology. However, the high data rate of the technology (155 and 622 Mbps) has attracted the attention of designers who are looking for more and more speed in LANs. For example at Ethernet LANs, ATM switch is used instead of Ethernet switch.

LANE (Local Area Network Emulation):

LANE enables an ATM switch to behave like a LAN switch. It based on client/server approach: all stations use LANE client (LEC) software and two servers use two different LANE server software called LES and BUS, as shown below: