Department of Electronics & Communication Engg.

Course : High Performance Computer Networks - 10EC834.

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Course Coordinator:

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Asynchronous transfer mode (ATM) Networks

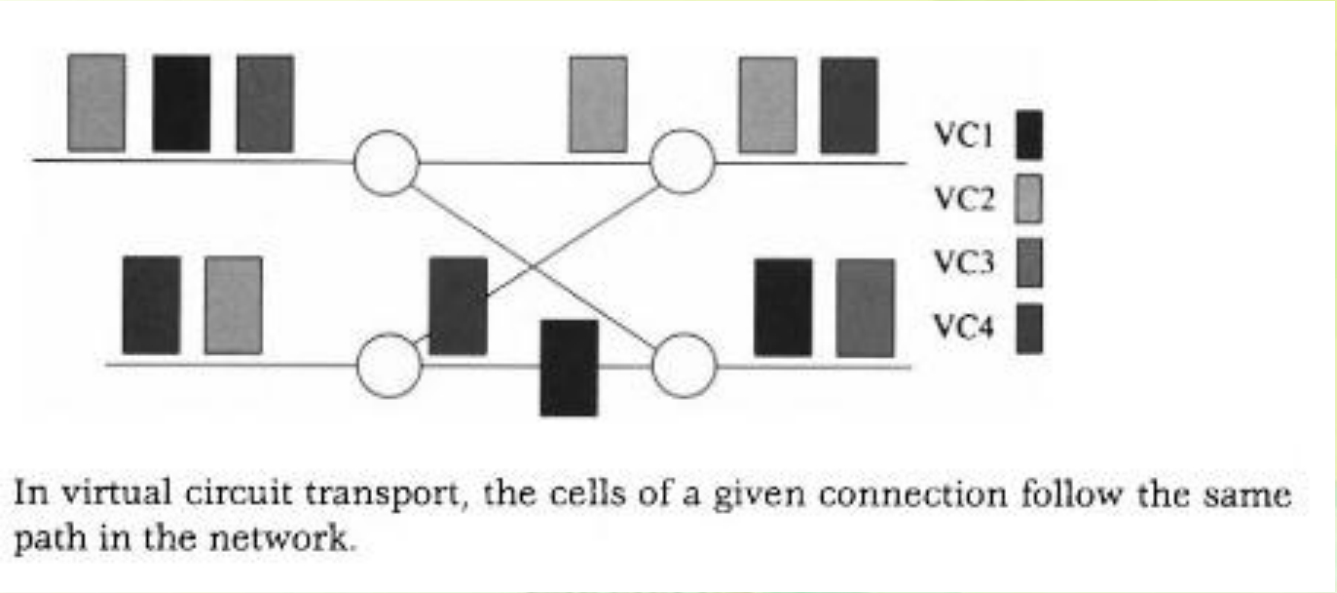
MAIN FEATURES OF ATM

1. Service is connection oriented. With data transferred over a virtual circuit(VC)
2. Data transferred in 53 byte packet called *cells.*
3. Cell from different VC's occupy the same channel or link are statistically multiplexed.
4. ATM switches may treat the cell stream from different VC connections unequally over the same channel in order to provide different quality of service (qos)

CONNECTION-ORIENTED SERVICE

1. In a connection oriented service over a virtual circuit the data stream from origin to destination follows the same path.
2. Data from different connections is distinguished by means of VIRTUAL PATH IDENTIFIER (VPI) and VIRTUAL CHANNEL IDENTIFIER (VCI).
3. Connection over a virtual circuit is called virtual channel in the ATM technology.
4. Cell consist of overhead corresponding to the length of VPI/VCI.
5. Cell in the same connection reach the destination in the order they sent from source.
6. ATM switches can identify different connection by their VPI/VCI.
7. Switches potentially discriminate data among different connections.

CONNECTION-ORIENTED SERVICE



In virtual circuit transport, the cells of a given connection follow the same path in the network.

Fig: VIRTUAL CIRCUIT TRANSPORT
(CONNECTION-ORIENTED SERVICE)

CONNECTION-ORIENTED SERVICE

Switches potentially discriminate data among different connections
This potential can be used in many ways :

1. Admission control (refusing certain connections if sufficient network resources are unavailable)
2. Congestion control (limiting the amount of traffic accepted from a connection)
3. Resource allocation (negotiating the bandwidth and buffers allocated to a connection)ATM switches can identify different connection by their VPI/VCI
4. Policing (monitoring and average the rate of traffic in connection)

- DISADVANTAGES
- Link or node failure terminates the virtual connection.
- Connection setup problem when only few cell.

ATM NETWORK SERVICES

- FIVE CATEGORIES

1. Constant bit rate (CBR)
2. Variable bit rate-real time (VBR-RT)
3. Available bit rate (ABR)
4. Variable bit rate-non real time (VBR-NRT)
5. Unspecified bit rate(UBR)

These services differ in the parameter of traffic and quality of service. The parameters of traffic are defined by an algorithm-called the generalized cell rate algorithm (GCRA) that controls arrival times of cell.

Parameters Used To Categories ATM Network Services

1. **Peak cell rate (PCR):**is the reciprocal of minimum time between two cell
2. **Sustained cell rate (SCR):**long –term average cell rate
3. **Initial cell rate (ICR):is** the rate at which a source should send after an idle period.
4. **Cell delay variation tolerance (CDVT):** it measures the permissible departure from traffic.
5. **Burst tolerance(BT):** it measures the maximum number of cells in a back-to-back cells.
6. **Minimum cell rate(MCR):** is the reciprocal of the maximum time between two cells

- CBR Traffic include PCR,CDVT Parameter
- VBR Traffic include SCR and BT Parameter
- ABR Traffic include MCR and PCR Parameter
- UBR Traffic no parameter are controlled but no QOS

QUALITY OF SERVICE (QOS) PARAMETER

- Cell loss ratio (CLR)
- Cell delay variation (CDV)
- Peak-to-Peak cell delay variation (Peak-to-Peak CDV)
- Maximum cell transfer delay (Max CTD)
- Mean cell transfer delay (Mean CTD)

ATM Layer Service Characteristics						
Attribute	CBR	VBR(RT)	VBR(NRT)	ABR	UBR	Parameter
CLR	Specified	Specified	Specified	Specified	Unspecified	QoS
CTD, CDV	CDV and Max CTD	CDV and Max CTD	Mean CTD only	Unspecified	Unspecified	QoS
PCR, CDVT	Specified	Specified	Specified	Specified	Specified	Traffic
SCR, BT	n/a	Specified	Specified	n/a	n/a	Traffic
MCR	n/a	n/a	n/a	Specified	n/a	Traffic
Congestion control	No	No	No	Yes	No	

STATISTICAL MULTIPLEXING

- Virtual circuit specifies a path from source to destination going through several links and switches. Many virtual circuit occupy the same link. A switch has ports terminating several incoming and outgoing links.

- Five tasks that a switch carries out.

1. Multiplexing
2. Demultiplexing
3. Routing through switch (VCIin, input port, VCIout, output port)
4. Buffering
5. Discarding)

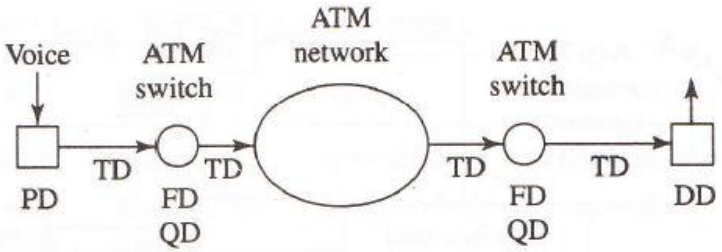
ALLOCATING RESOURCES

- ATM networks offer to transfer cell streams from source to destination, under a range of quality of service, to meet the varying needs of application.
- The network guarantees the service parameters (delay CTD and loss rate CLR), provided the cell stream emitted by the user conforms to the traffic parameters (such as average rate SCR and burstiness BT).
- In order to meet its obligations under such contracts, the network takes certain actions.

Actions Taken to Allocate Resources

1. Exercises admission control.
2. Selects the route (virtual channel path) of admitted connections.
3. Allocates bandwidth and buffers separately to each connection.
4. Selectively drops low priority cells.
5. Asks sources to limit the cell stream rate (for ABR service).

ATM CELL DELAY



Assumptions
Voice transmission (64 Kbps)
Transmission rates = 155 Mbps
Length of path = 1,000 km
Path goes through 5 nodes

Delay	Value in μs
PD = Packetization delay	6,000
TD = Transmission delay (including propagation)	5,000
FD = Fixed processing delay	280
QD = Queuing delay	70
DD = Depacketization delay	70
Total delay	11,420
Delay jitter	70

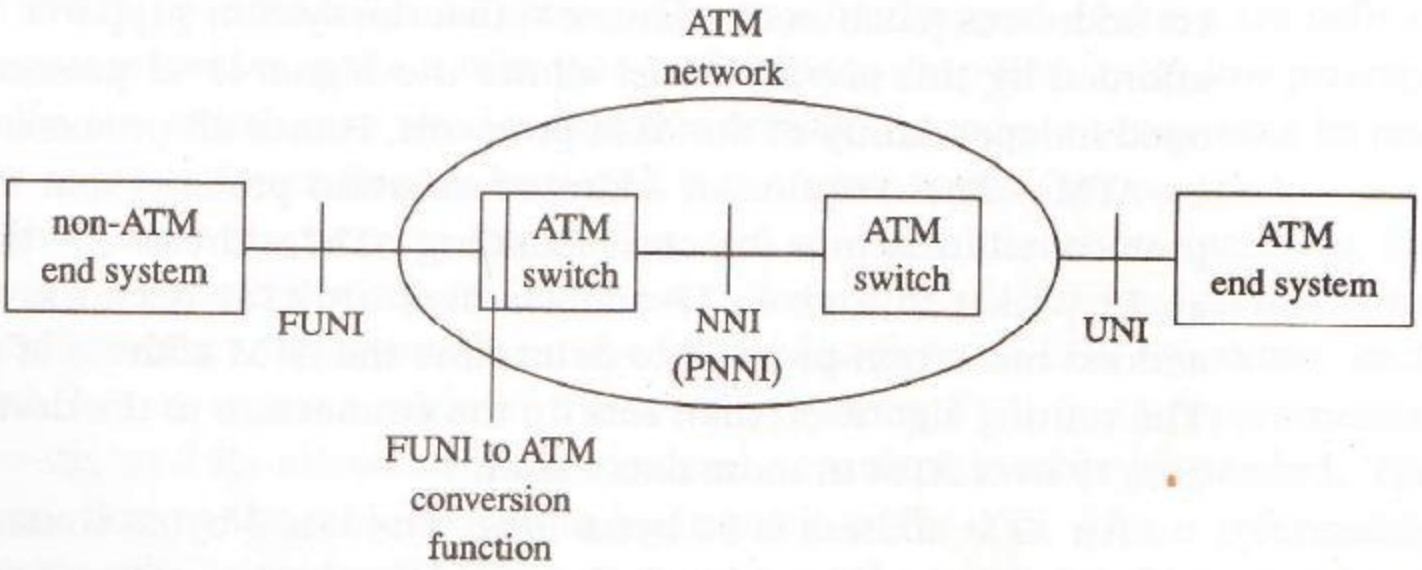
Five types of delays are encountered by ATM cells. The table gives typical values of these delays for a voice conversation.

CELL ENCOUNTER 5 TYPES OF DELAY

ATM ADDRESSING

1. It is based on E.164 international standard for 15-digit numbering plan used in public ISDN
2. ATM forum defined ATM addressing
3. Each ATM system is assigned with an address
4. ATM forum define address mechanism by using ILMI(INTEGRATED LOCAL MANAGEMENT PROTOCOL)
5. ATM GROUP ADDRESS represent collection of end system.
6. ATM address indicates ATM INTERFACE in NETWORK TOPOLOGY
7. Prefix of an address is associated with group of interfaces with same prefix
8. Prefix are used in call routing
9. To send a IP packet to a given IP address over ATM network router use ARP PROTOCOL to determine destination ATM address, the routing algorithm then setup the connection to destination.
10. The only ATM FORUM defined service using group addressing is ANYCAST SERVICE defined in UNI 4.0 & PNNI 1.0
11. ANYCAST is useful mechanism for NETWORK MECHANISM.

ATM SIGNALLING



UNI is the interface between an ATM end system and an ATM switch, NNI is the interface between two ATM switches, and FUNI is the frame interface between a non-ATM end system and an ATM switch.

ATM SIGNALLING

There are two basic types of connection:

1. Point to Point connection – unidirectional.
2. Point to multipoint connection-single root connection to many leaves. These connections are unidirectional root can send to leaves but not leaves.
3. Signaling procedures are defined in terms of message type and information element these provide QOS
4. Signaling requests are carried across UNI (VPI= 0, VCI=5) specification is based on Q.2931
5. ISDN protocol for signaling between end system to public network.

PNNI ROUTING

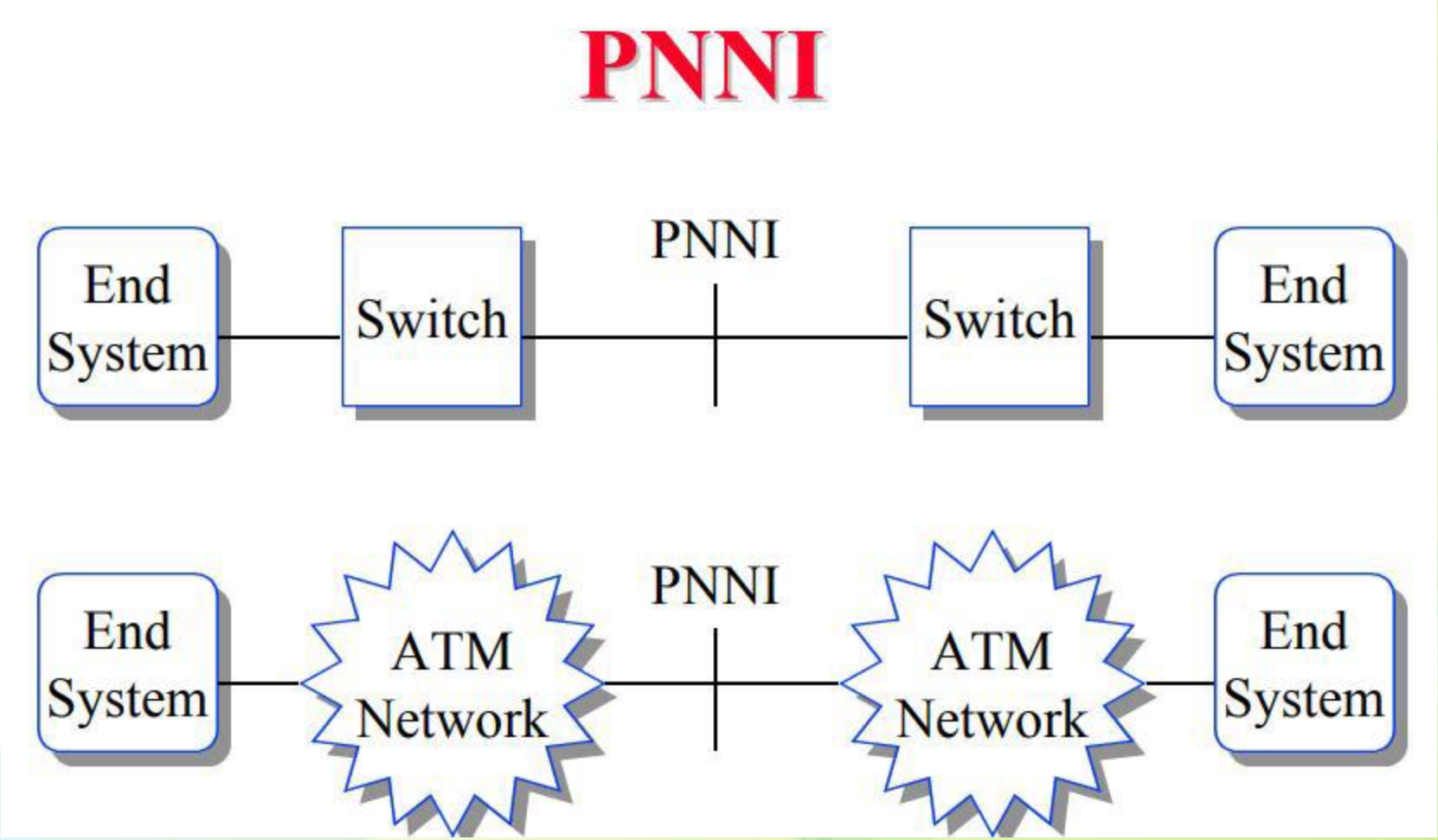


Fig. PNNI Routing

PNNI ROUTING

Features of PNNI:

1. Point-to-point and point-to-multipoint connections.
2. Can treat a cloud as a single logical link.
3. Multiple levels of hierarchy = Scalable for global networking.
4. Reroutes around failed components at connection setup.
5. Automatic topological discovery = No manual input required.
6. Connection follows the same route as the setup message (associated signaling).
7. Uses: Cost, capacity, link constraints, propagation delay constraints and also uses: Cell delay, Cell delay variation, Current average load Current peak load constraints.
8. Uses both link and node parameters.
9. Supports transit carrier selection.
10. Supports anycast.

INTERNETWORKING WITH ATM

- ATM network can be used to interconnect various **LANs or IP network.**
- Internetworking take place at **data link layer(bridging) or at network layer (routing).**
- Two basic tasks are required for internetworking

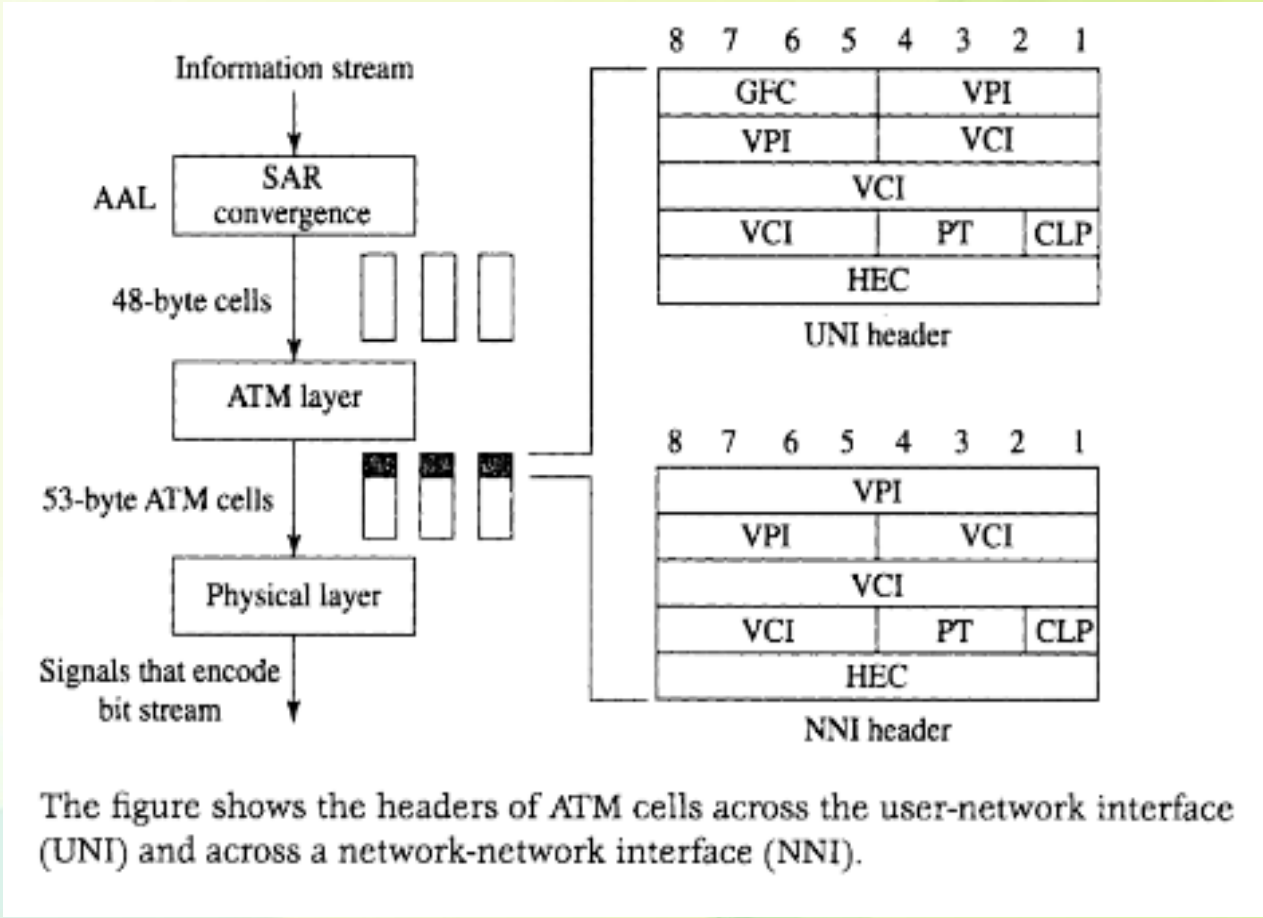
  1. Encapsulation of protocol data units(PDUs)
  2. Routing or bridging of these PDUs

INTERNETWORKING WITH ATM

- Routing itself consist of **route calculation and switching of packet. Route calculation** necessitates are -- **address resolution plus a routing algorithm. The address** resolution maps the protocol address (such as IP, MAC, FR, or SMDS) Into an ATM address. The routing algorithm calculates the routes through the network.

1. MULTIPROTOCOL ENCAPSULATION OVER AAL5
2. LAN EMULATION OVER ATM
3. IP OVER ATM
4. MULTIPROTOCOL OVER ATM (MPOA)
5. FR AND SMDS OVER ATM

ATM CELL HEADER STRUCTURES



The figure shows the headers of ATM cells across the user-network interface (UNI) and across a network-network interface (NNI).

Fig: ATM Cell Header Format

ATM CELL HEADER FIELDS

- An ATM cell header can be one of two formats: UNI or NNI.
- The UNI header is used for communication between ATM endpoints and ATM switches in private ATM networks.
- The NNI header is used for communication between ATM switches.
- In addition to GFC and VPI header fields, several others are used in ATM cell header fields. The following descriptions summarize the ATM cell header fields illustrated in the figure:

1. **Generic Flow Control (GFC)-** Provides local functions, such as identifying multiple stations that share a single ATM interface. This field is typically not used and is set to its default value of 0 (binary 0000).

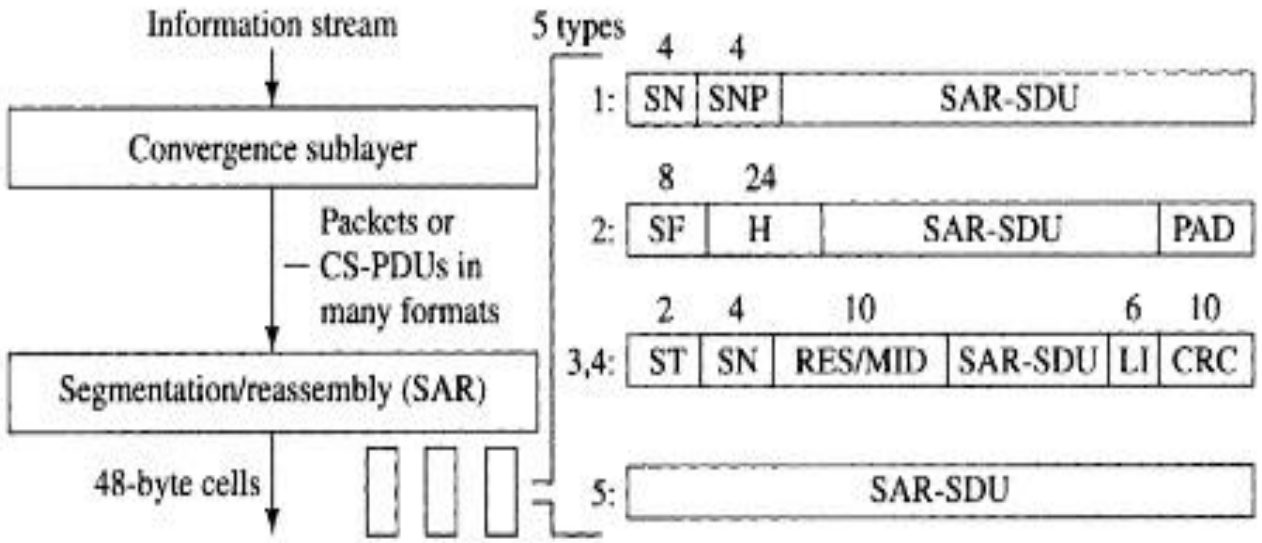
ATM CELL HEADER FIELDS

2. **Virtual Path Identifier (VPI)-**In conjunction with the VCI, identifies the next destination of a cell as it passes through a series of ATM switches on the way to its destination. Virtual Channel Identifier (VCI)-In conjunction with the VPI, identifies the next destination of a cell as it passes through a series of ATM switches on the way to its destination.
3. **Cell Loss Priority (CLP)-**Indicates whether the cell should be discarded if it encounters extreme congestion as it moves through the network. If the CLP bit equals 1, the cell should be discarded in preference to cells with the CLP bit equal to 0.
4. **Header Error Control (HEC)-**Calculates checksum only on the first 4 bytes of the header. HEC can correct a single bit error in these bytes, thereby preserving the cell rather than discarding it. Source: http://datacombasic.blogspot.in/search/label/ATM%20

ATM CELL HEADER FIELDS

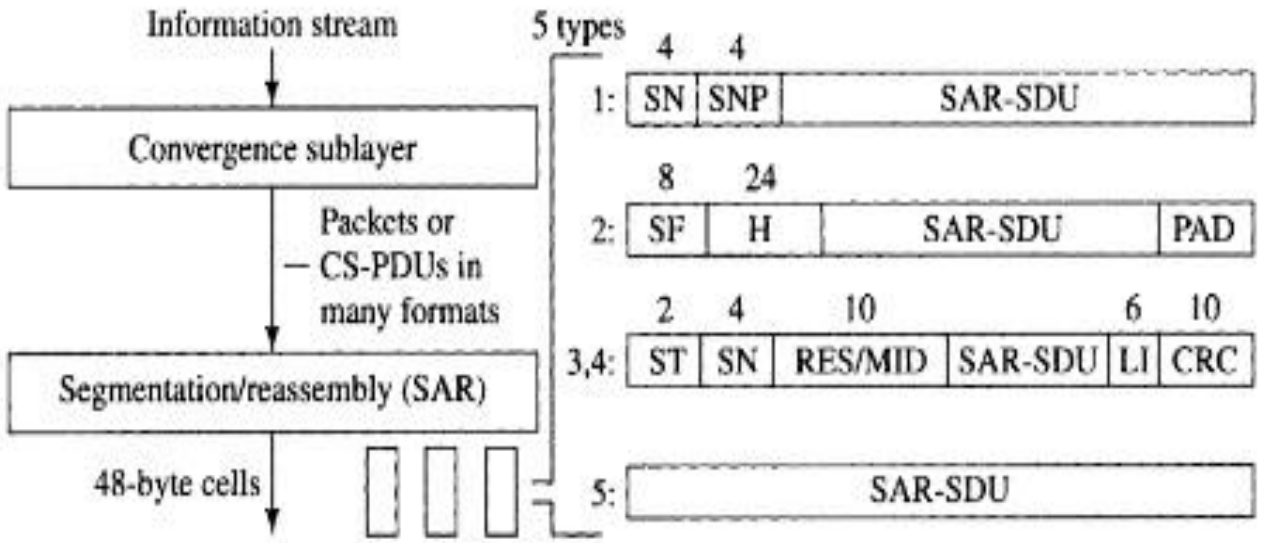
5. **Payload Type (PT)-**Indicates in the first bit whether the cell contains user data or control data. If the cell contains user data, the bit is set to 0. If it contains control data, it is set to 1. The second bit indicates congestion (0 = no congestion, 1 = congestion), and the third bit indicates whether the cell is the last in a series of cells that represent a single AAL5 frame (1 = last cell for the frame).

ATM ADAPTATION LAYER



The ATM adaptation layer (AAL) converts the information stream into 48-byte cells. The AAL is decomposed into the convergence sublayer and the segmentation/reassembly sublayer.

ATM ADAPTATION LAYER



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ATM ADAPTATION LAYER

The main services provided by AAL (ATM Adaptation Layer) are:

1. Segmentation and reassembly
2. Handling of transmission errors
3. Handling of lost and miss inserted cell conditions
4. Timing and flow control

- ATM Adaptation Layer protocols (AALs) have been defined by the ITU-T.
- It is meant that these AALs will meet a variety of needs.
- The classification is based on whether a timing relationship must be maintained between source and destination, whether the application requires a constant bit rate, and whether the transfer is connection oriented or connectionless.

ATM ADAPTATION LAYER TYPES

1. **AAL Type 1** supports constant bit rate (CBR), synchronous, connection oriented traffic. Examples include T1 (DS1
2. **AAL Type 2** supports time-dependent Variable Bit Rate (VBR-RT) of connection-oriented, synchronous traffic. Examples include Voice over ATM. AAL2 is also widely used in wireless applications due to the capability of multiplexing voice packets from different users on a single ATM connection.
3. **AAL Type 3/4** supports VBR, data traffic, connection-oriented, asynchronous traffic or connectionless packet data (e.g. SMDS traffic) with an additional 4-byte header in the information payload of the cell. Examples include Frame Relay and X.25.

ATM ADAPTATION LAYER TYPES

4. **AAL Type 5** is similar to AAL 3/4 with a simplified information header scheme. This AAL assumes that the data is sequential from the end user and uses the Payload Type Indicator (PTI) bit to indicate the last cell in a transmission. Examples of services that use AAL 5 are classic IP over ATM, Ethernet Over ATM, SMDS, and LAN Emulation (LANE). AAL 5 is a widely used ATM adaptation layer protocol. This protocol was intended to provide a streamlined transport facility for higher-layer protocols that are connection oriented.

❖ AAL 5 was introduced to:

1. reduce protocol processing overhead.
2. reduce transmission overhead.
3. ensure adaptability to existing transport protocols.

ATM ADAPTATION LAYER FUNCTIONS

- The ATM Adaptation Layer (AAL) is designed to support different types of applications and different types of traffic, such as voice, video, imagery, and data
- Its basic function is the enhanced adaptation of services provided by the ATM layer to the requirements of the higher layer.
- It maps higher layer PDUs into the information field of the ATM cell.
- AAL is divided into the Convergence Sublayer (CS) and the Segmentation and Reassembly (SAR) Sublayer.
- The Convergence Sublayer is service dependent and provides the AAL services at the AAL-SAP.
- The functions of the SAR sublayer are segmentation of higher layer PDUs into a suitable size for the information field of the ATM cell (48 octets) at the transmitting end and reassembly of the information fields into higher layer PDUs at the receiving end.

Queries ...?