ASYNCHRONOUS TRANSMISSION MODE (ATM)

ECE 422 – DATA COMMUNICATION & COMPUTER NETWORKS

Tuesday, 14 April 2026

WHERE ARE WE IN THE SYLLABUS…

Course Content:

Introduction: Overview of Data Communications and Networking.

Physical Layer: Analog and Digital, Analog Signals, Digital Signals, Analog versus Digital, Data Rate Limits, Transmission Impairment, More about signals.

Digital Transmission: Line coding, Block coding, Sampling, Transmission mode.

Analog Transmission: Modulation of Digital Data; Telephone modems, modulation of Analog signals.

Multiplexing: FDM, WDM, TDM.

Transmission Media: Guided Media, Unguided media (wireless).

Data Link Layer: Error Detection and correction - Types of Errors, Detection, Error Correction; Data Link Control and Protocols-Flow and Error Control, Stop-and-wait ARQ. Go-Back-N ARQ, Selective Repeat ARQ, HDLC. Point-to-Point Access- Point–to-Point Protocol (PPP), PPP Stack, Multiple Access Random Access, Controlled Access, Channelization.

Network Layer: Host to Host Delivery: Internetworking, addressing and Routing Network Layer Protocols: ARP, IPV4, ICMP, IPV6 and ICMPV6

Transport Layer: Process to Process Delivery: UDP; TCP congestion control and Quality of service.

Application Layer: Client Server Model, Socket Interface, Domain Name System (DNS): Electronic Mail (SMTP) and file transfer (FTP) HTTP and WWW.

Local area Network: Ethernet - Traditional Ethernet, Fast Ethernet, Gigabit Ethernet; Token bus, token ring; Wireless LANs - IEEE 802.11, Bluetooth virtual circuits: Frame Relay and ATM.

Industrial Communication and Control Networks: Transmission methods, Network topology, Contemporary networks – Profibus, Controller Area Network (CAN), DeviceNet, CANopen, Actuator Sensor Interface (AS-1),Industrial Ethernet.

ASYNCHRONOUS TRANSFER MODE (DEFINITION)

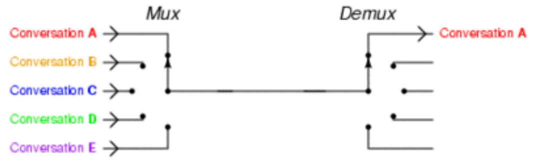
1. **Asynchronous transfer mode (ATM)** is a switching technique used by telecommunication networks that uses asynchronous time-division multiplexing to encode data into small, fixed-sized cells.

2. **ATM** was the core protocol used over the synchronous optical network (SONET) backbone of the integrated digital services network (ISDN)

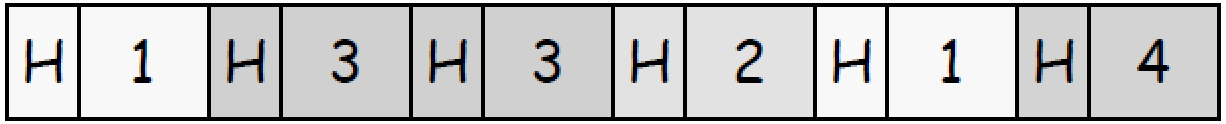
SYNCHRONOUS VS ASYNCHRONOUS

SYNCHRONOUS

1. Uses Time Division Multiplexing (TDM).
2. Each source gets period assignment of bandwidth
   - It is **good** because it has fixed delays and little or no overhead
   - It is **bad** because of poor channel utilization for bursty sources

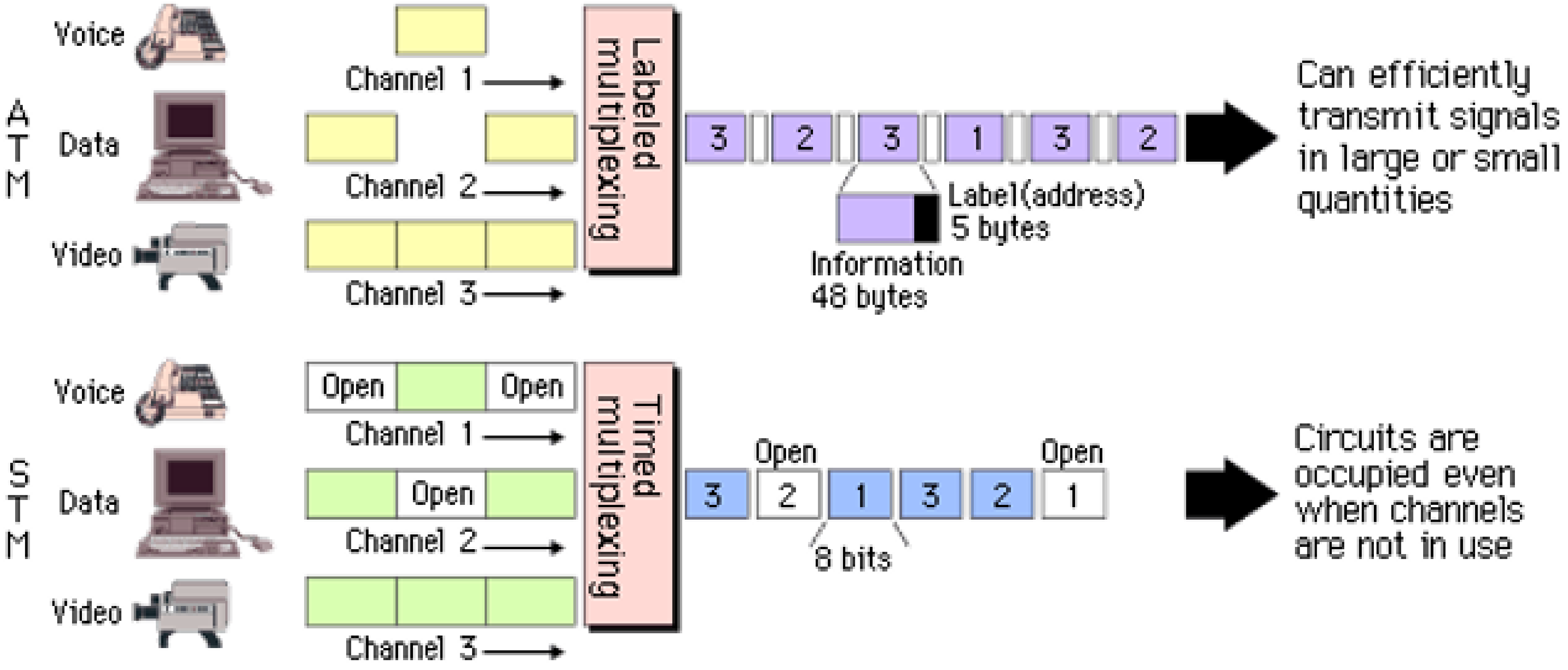


ASYNCHRONOUS



1. Uses statistical multiplexing
2. Each sources packetize data. Packets are sent only if there is data.
   a) It is **good** because no bandwidth is used when source is idle
   b) It is **bad** because
      i. it uses packet headers which are overheads,
      ii. It employs buffering which lead to multiplexing delay

ASYNCHRONOUS TRANSFER MODE Vs SYNCHRONOUS TRANSFER MODE



WHY WAS IT NECESSARY TO INTRODUCE ASYNCHRONOUS TRANSFER MODE ?

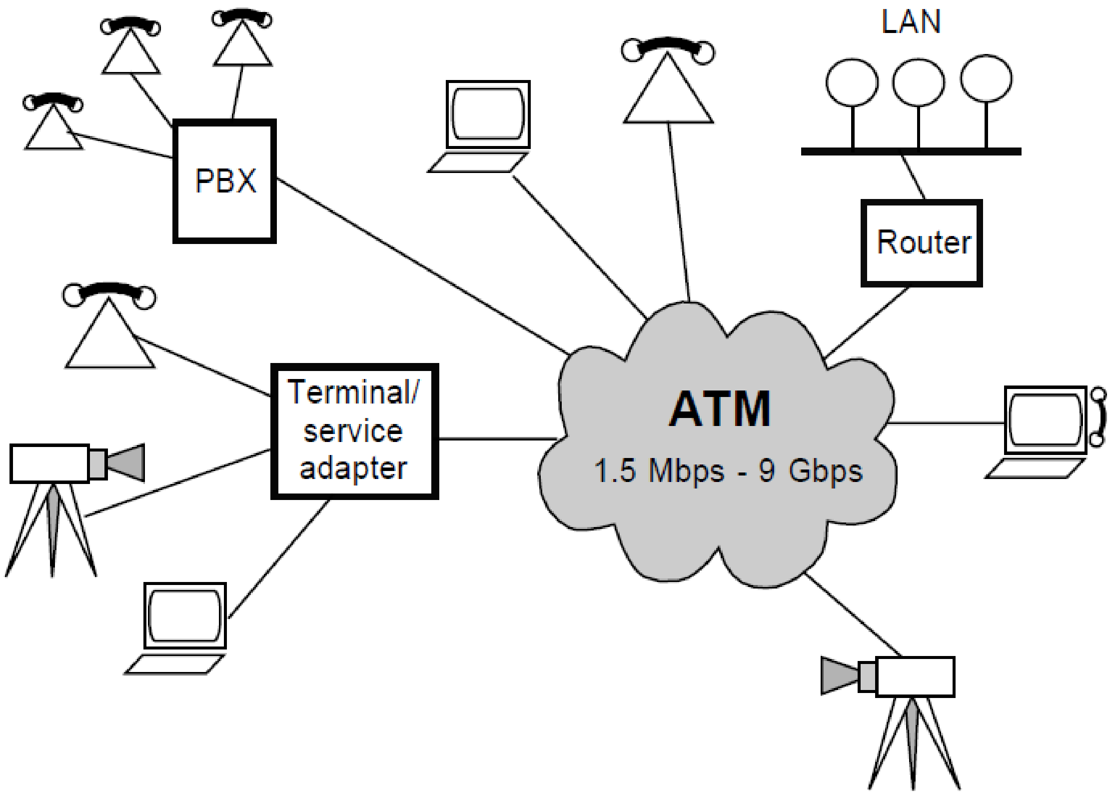
To support any type of traffic:

1. Burtsy data is nowadays running into multimegabit rates and consisting of files, images, multimedia content. Examples:
   a) intermittent data (interactive systems, low rate, delay intolerant)
   b) voice (sustained data rate, 64 kbps)
   c) video (sustained data rate, multimegabit rates)
2. To support transactions that use data, voice, and video simultaneously
3. To provide high bandwidth, which can't be found in other technologies
4. To provide a uniform architecture for fast LANs and scalable WANs of unrestricted sizes
5. To provide bandwidth on demand (pay per use)
6. To support multicast operations (video conferencing)
7. To provide guaranteed quality of service
8. To provide a unified approach in network management

WHY WAS IT NECESSARY TO INTRODUCE ATM?

1. Unified approach in network management.

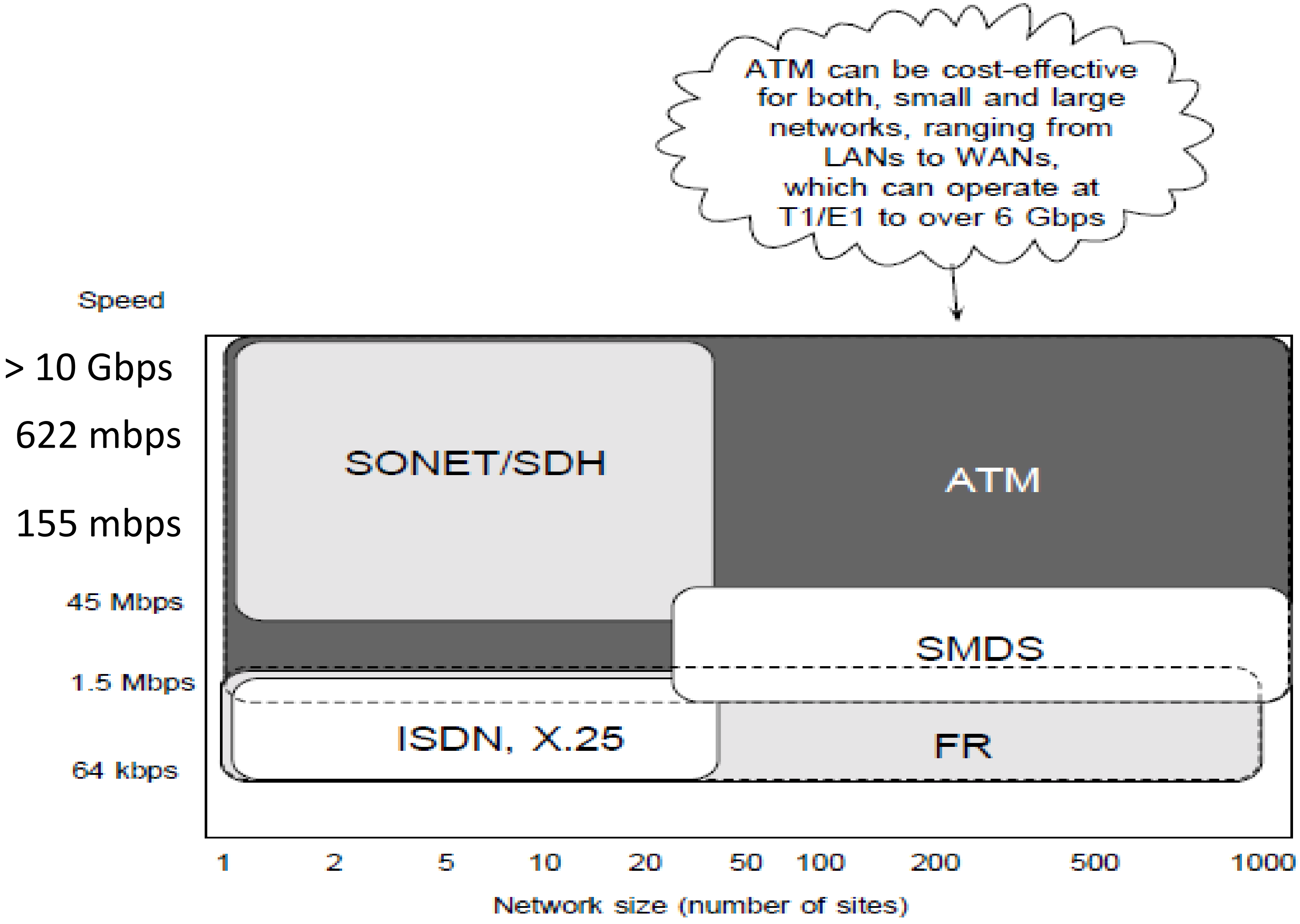
2. Suited for burtsy data (to multimegabit rates: files, images, multimedia)



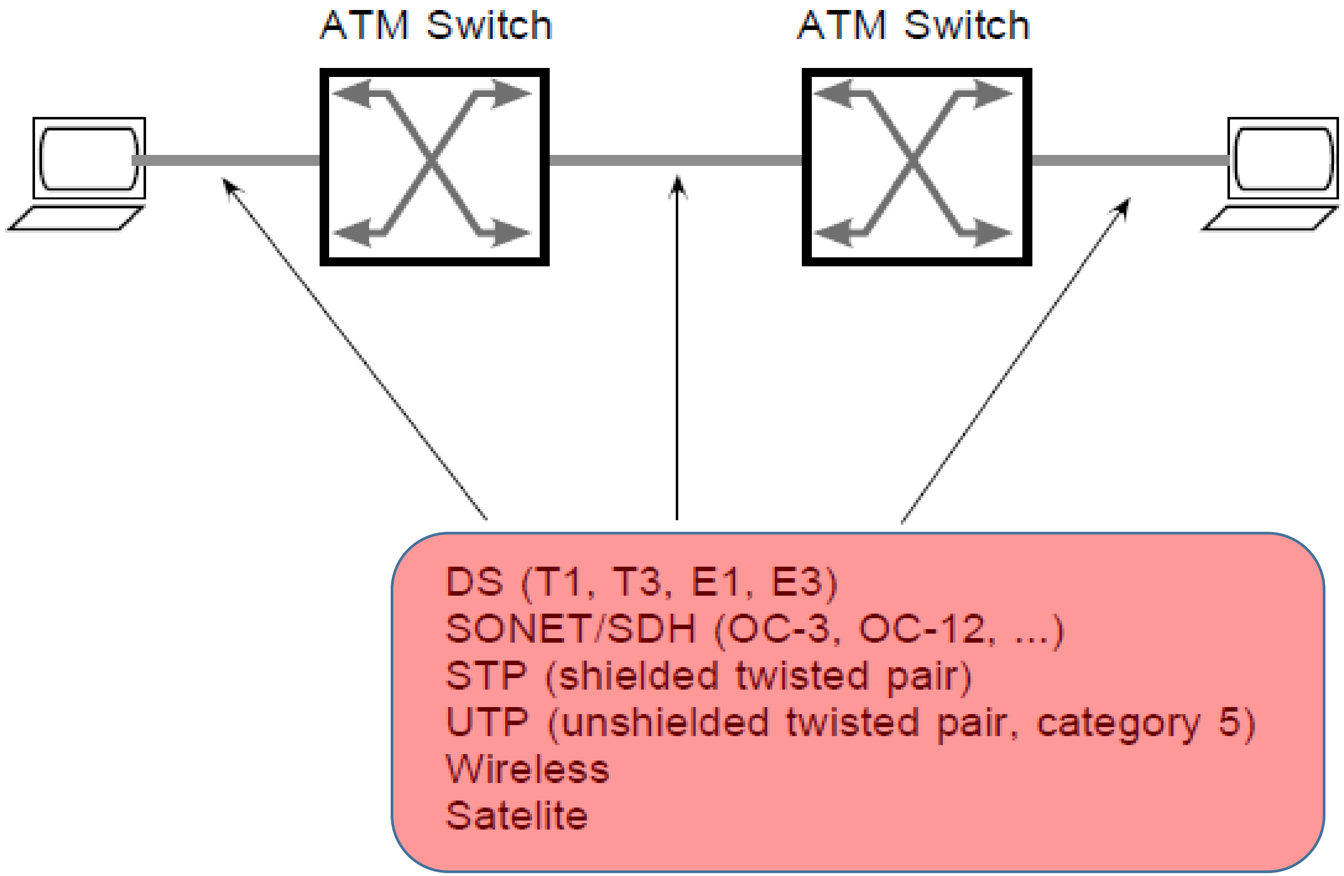
3. Allows transactions that use data, voice, and video simultaneously

4. Supports high bandwidth

ADVANTAGES OF ATM – SPEED Vs SIZE

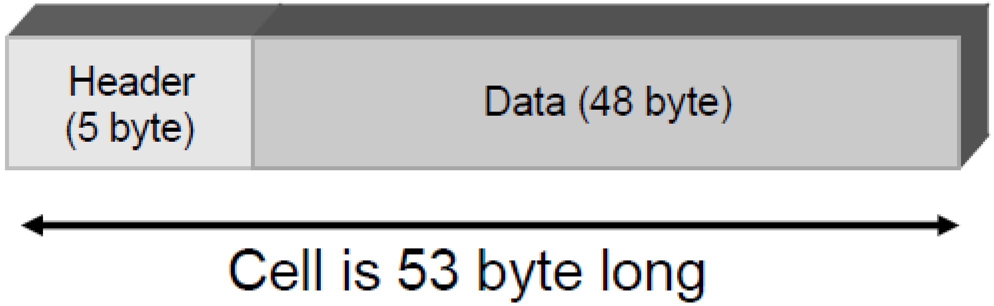


ATM CAN TAKE DATA FROM MANY SOURCES



ATM CELLS

1. The main characteristics of ATM are small fixed-size cells (53 bytes/octets as follows:
   - 5 bytes overhead
   - 48 bytes data (payload)



2. This gives the following advantages:
   - Predictable delay of cells
   - Can implement cell switching entirely in hardware
   - Smaller packetization delay, better support for voice and video

WHY DOES ATM USE 53 BYTES?

1. A 48 byte payload was the result of a compromise between a 32 and a 64.
2. Japan and USA wanted 64 byte payload while the rest of the world through ITU wanted 32 byte payload.
3. The compromise as (64+32)/2 = 96/2 = 48 bytes.

Advantages

- Low packetization delay for continuous bit rate applications (video, audio)
- Processing at switches is easier

Disadvantages

- High overhead (5 Bytes per 48)
- Poor utilization on links with lower data rates.

ATM CELL HEADER

ATM cell header has two formats, i.e

1. **User Network Interface (UNI)** used for communication between ATM endpoints and ATM switches in private ATM networks.

2. **Network to Network Interface (NNI)** used for communication between ATM switches.

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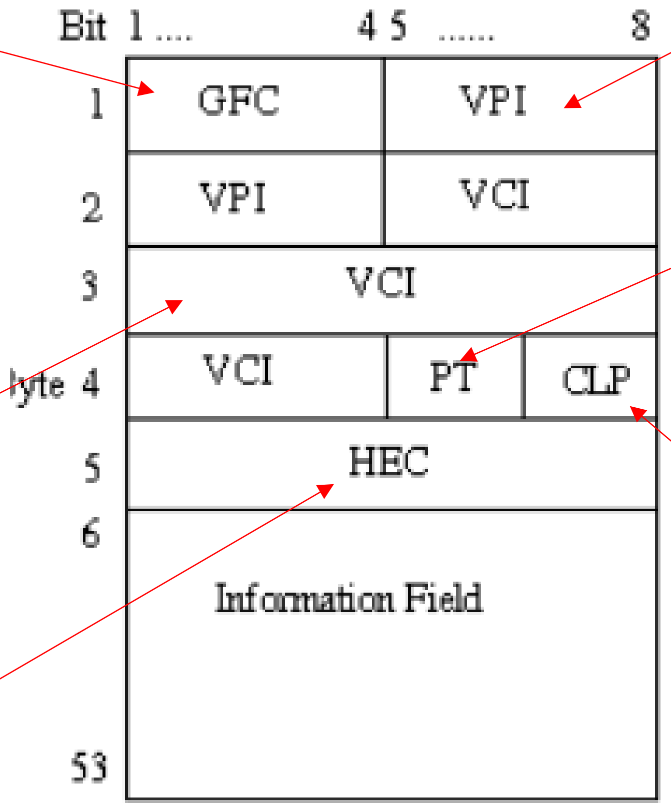
USER NETWORK INTERFACE (UNI)

Generic Flow Control (GFC)
Used to sequence the cell contents

Virtual Channel Identifier (VCI)
Used to identify a particular channel used to transmit user data

HEC
Checksum over the header

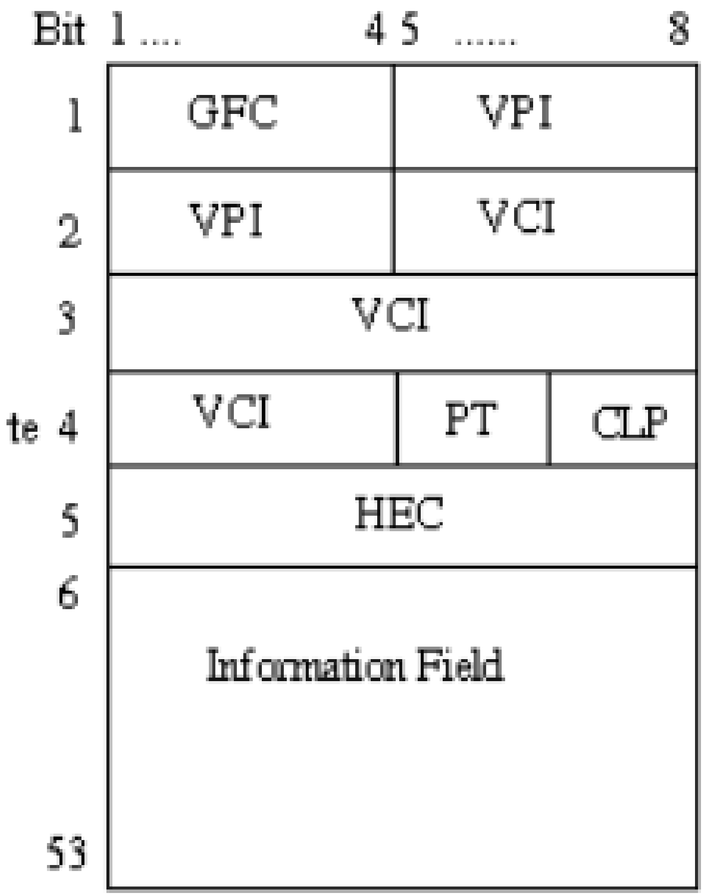


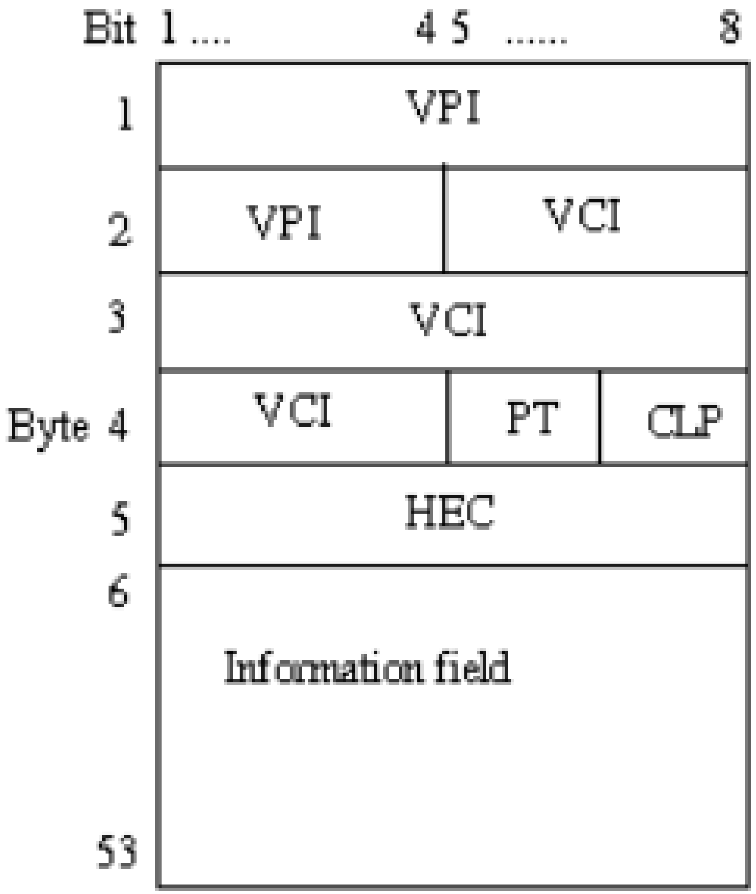
Virtual Path Identifier (VPI)
Integer representing a particular virtual path

Paylod Type (PT) field
Defines the type of payload

Cell Loss Priority (CLP)
Probability of a cell being discarded if the network becomes congested. CLP of zero is for insured traffic- unlikely to be dropped.

DIFFERENCES BETWEEN UNI & NNI CELL FORMATS

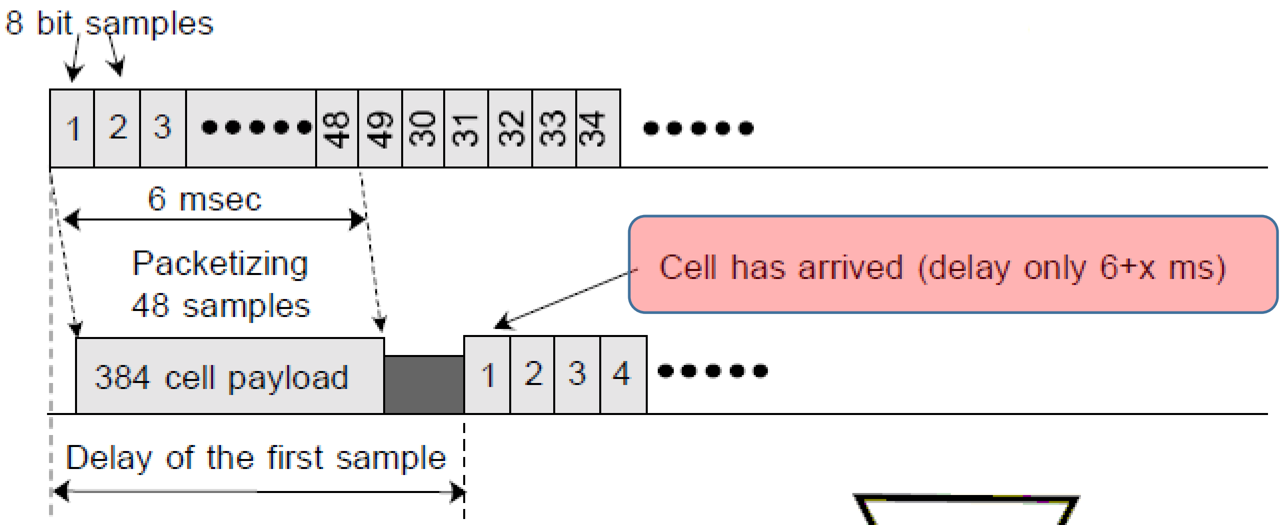


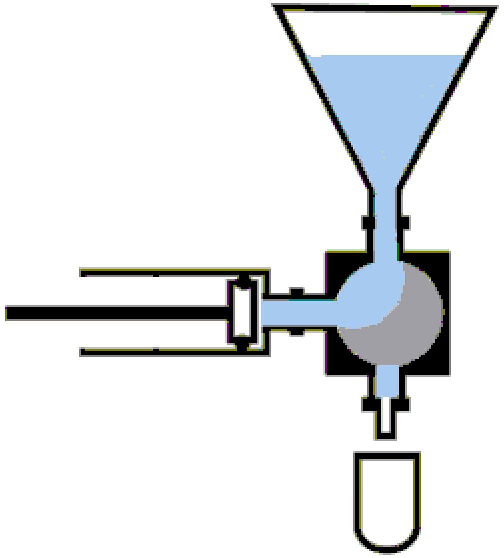


Network to Network Interface (NNI) does not have a GFC field.
The GFC field is discarded when the cell enters the NNI interface.

PACKETIZATION DELAY

- Packetization delay is as a result of not sending the packets before the cell is filled with data.





WORKED EXAMPLE 1

<u>QUESTION</u>

Consider sending a digitally encoded voice signal directly over ATM with the source encoded at a constant rate of 64 Kbps.

If each cell is entirely filled before the source sends the cell into the network then, in terms of the data payload of L bytes, determine the packetization delay in milliseconds.

<u>SOLUTION</u>

Packetization delay in seconds = $\frac{8L}{64{,}000} = \frac{L}{8{,}000}\ sec = \frac{L}{8}\ msec$

Delays of more than 20 msec can result in noticeable and unpleasant echoes.

WORKED EXAMPLE

QUESTION:

Calculate the store-and-forward delay at a single ATM switch for a link rate of R=155Mbps if the data payload length is

(a) L= 1,500 bytes

(b) L = 48 bytes.

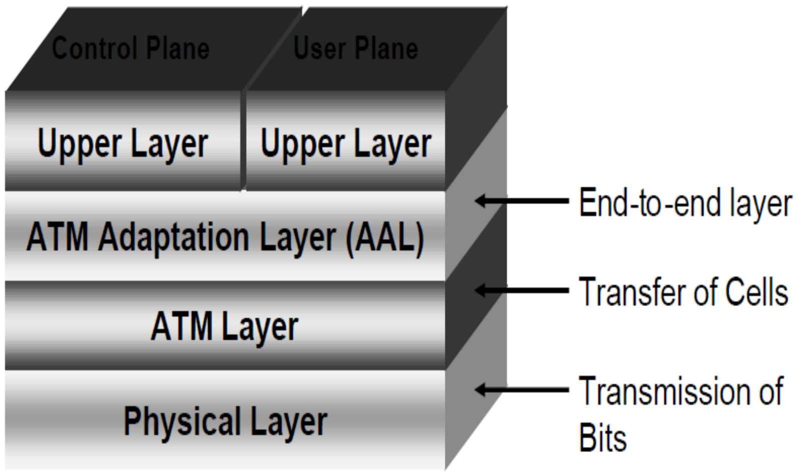
SOLUTION:

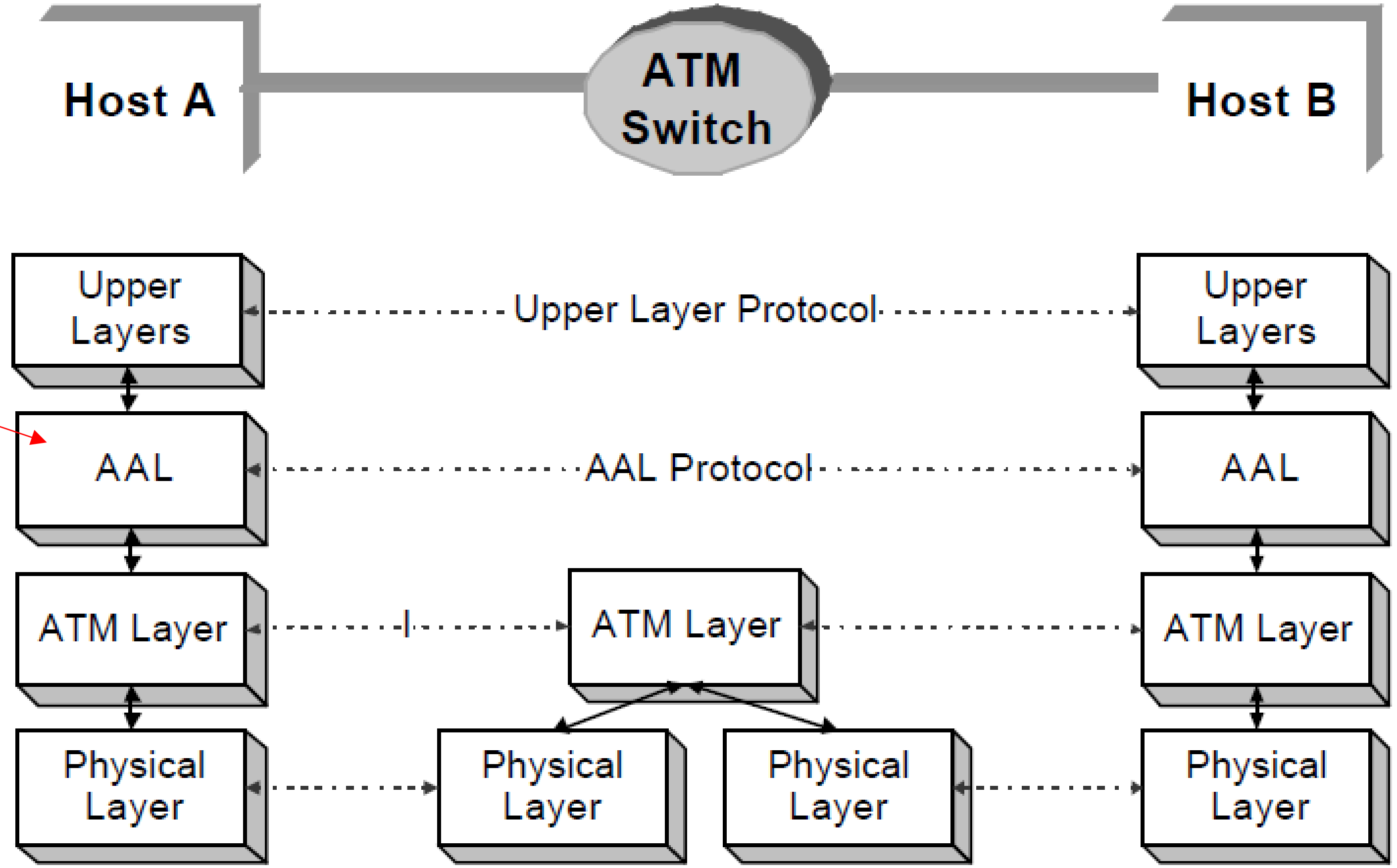
(a) If L= 1,500 bytes, then Delay = $\frac{8L}{R} = \frac{8 \times 1{,}500}{155 \times 10^6} = 7.74 \times 10^{-5}$ sec

(b) L = 48 bytes, then Delay = $\frac{8L}{R} = \frac{8 \times 48}{155 \times 10^6} = 2.47 \times 10^{-6}$ sec

ATM & ISO-OSI

AAL
ATM Adaptation Layer





EXAMPLE OF USE OF ATM