CSS2C08

COMPUTER NETWORKS

MODULE 4

1. LINK LAYER SERVICES
2. ERROR DETECTION AND CORRECTION
3. MULTIPLE ACCESS PROTOCOLS
4. LAN ADDRESS
5. ARP
6. ETHERNET
7. HUBS ,BRIDGES and SWITCHES
8. WIRELESS LINKS
9. PPP
10. ATM

Asynchronous Transfer Mode (ATM)

- ATM stands for Asynchronous Transfer Mode.
- It is a switching technique that uses time division multiplexing (TDM) for data communications.
- ATM networks are connection oriented networks for cell relay that supports voice, video and data communications.
- It encodes data into small fixed - size cells so that they are suitable for TDM and transmits them over a physical medium.

➢ Design Goals

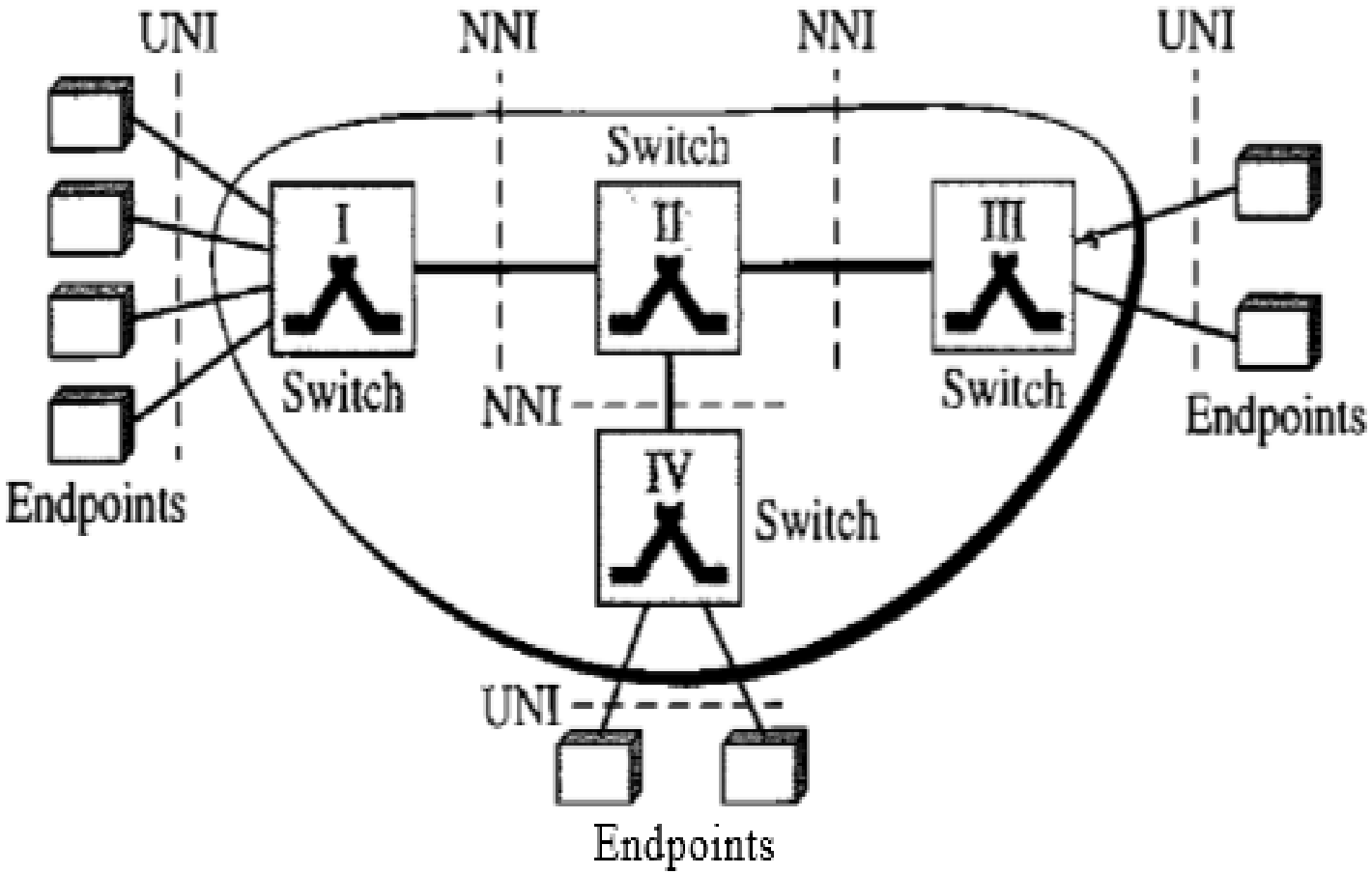
The challenges faced by the designers of ATM, are:

1. The need for a transmission system to optimize the use of high-data-rate transmission media, in particular optical fiber. In addition to offering large bandwidths, newer transmission media and equipment are dramatically less susceptible to noise degradation. A technology is needed to take advantage of both factors and thereby maximize data rates.

2. The system must interface with existing systems and provide wide-area interconnectivity between them without lowering their effectiveness or requiring their replacement.
3. The design must be implemented inexpensively. If ATM is to become the backbone of international communications, as intended, it must be available at low cost to every user who wants it.
4. The new system must be able to work with and support the existing telecommunications hierarchies (local loops, local providers, long-distance carriers, and so on).

5. The new system must be connection-oriented to ensure accurate and predictable delivery.
6. Last but not least, one objective is to move as many ofthe functions to hardware as possible (for speed) and eliminate as many software functions as possible (again for speed).

- **Architecture:**
  - ATM is a cell-switched network.
  - The user access devices, called the endpoints, are connected through a user-to-network interface (UNI) to the switches inside the network.
  - The switches are connected through network-to-network interfaces (NNIs).


UNI
NNI
NNI
UNI
Switch
I
II
III
Switch
NNI
Switch
Endpoints
Endpoints
IV
Switch
UNI
Endpoints

- **ATM endpoints:** It contains ATM network interface adaptor. Examples of endpoints are workstations, routers, CODECs, LAN switches, etc.
- **ATM switch :**It transmits cells through the ATM networks. It accepts the incoming cells from ATM endpoints (UNI) or another switch (NNI), updates cell header and retransmits cell towards destination.
- **Virtual Connection:**
  - Connection between two endpoints is accomplished through transmission paths (TPs), virtual paths (VPs), and virtual circuits (VCs).

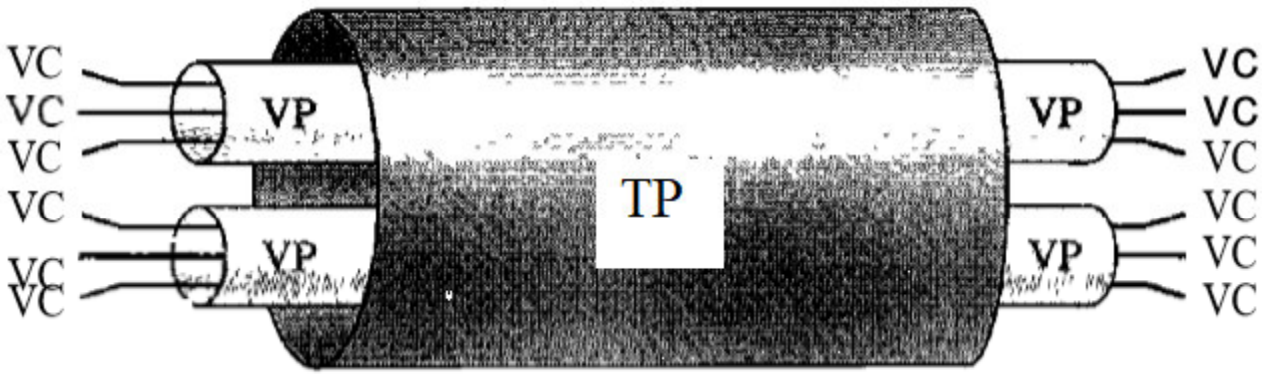
1. **A transmission path (TP) :**
   - It is the physical connection (wire, cable, satellite, and so on) between an endpoint and a switch or between two switches.
   - Think of two switches as two cities. A transmission path is the set of all highways that directly connect the two cities.
   - A transmission path is divided into several virtual paths.

2. **Virtual paths:**

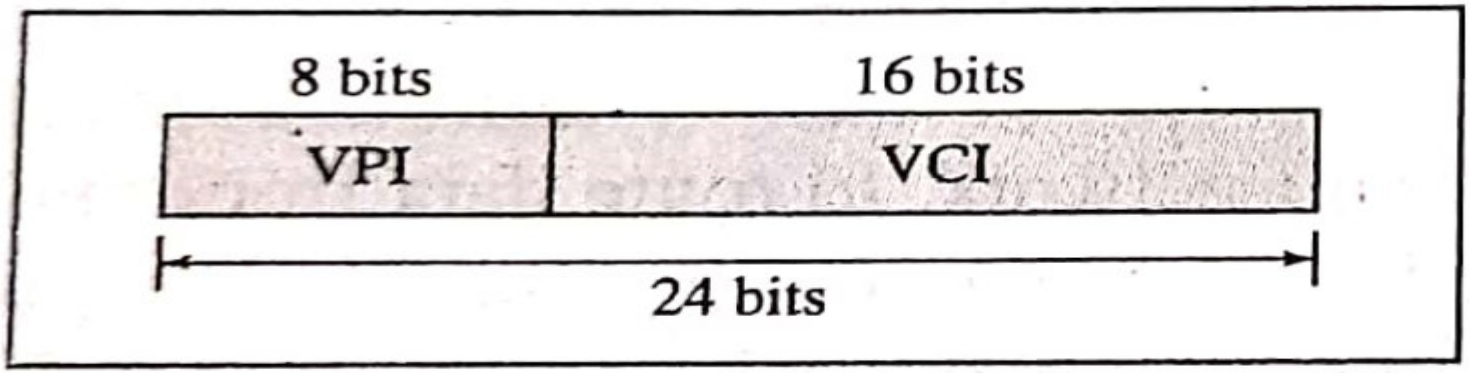
   - A virtual path (VP) provides a connection or a set of connections between two switches. Think of a virtual path as a highway that connects two cities. Each highway is a virtual path; the set of all highways is the transmission path.

3. **Virtual Circuits(VCs):**

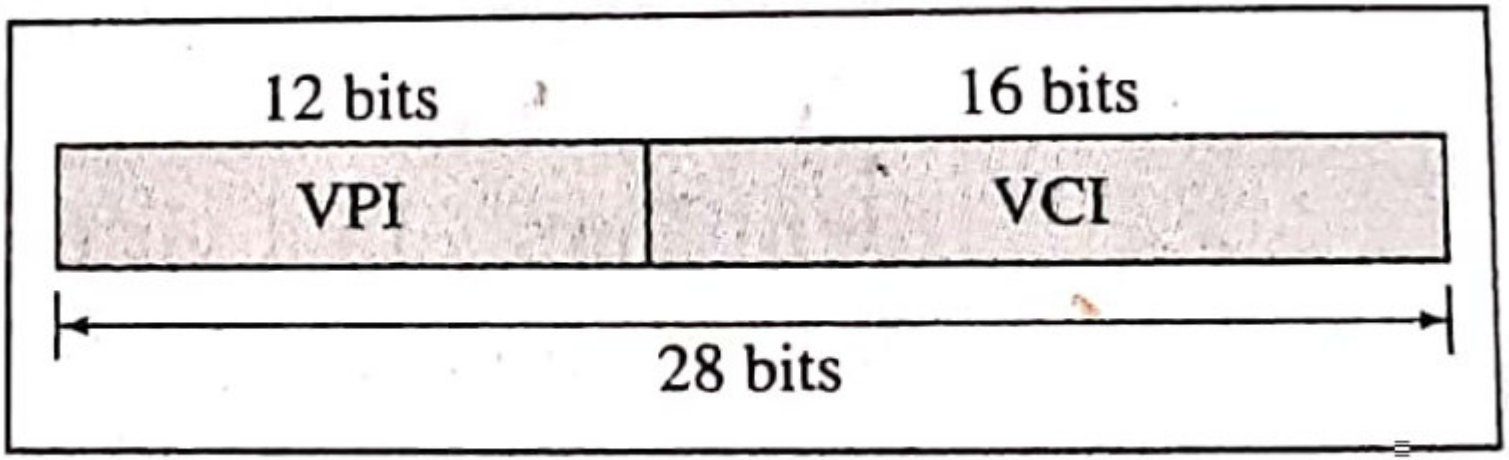
   - Cell networks are based on virtual circuits (VCs). All cells belonging to a single message follow the same virtual circuit and remain in their original order until they reach their destination. Think of a virtual circuit as the lanes of a highway (virtual path).


VC
VC
VC
VC
VC
VC
VP
VP
TP
VP
VP
VC
VC
VC
VC
VC
VC

- **Virtual connection identifiers in UNIs and NNIs**
  - A virtual connection is defined by a pair of numbers: the VPI (virtual path identifier)and the VCI(virtual-circuit identifier).
  - The VPI defines the specific VP, and the VCI defines a particular VC inside the VP.
  - The lengths of the VPIs for UNIs and NNIs are different.
  - In a UNI, the VPI is 8 bits, whereas in an NNI, the VPI 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 and by 28 bits in an NNI .

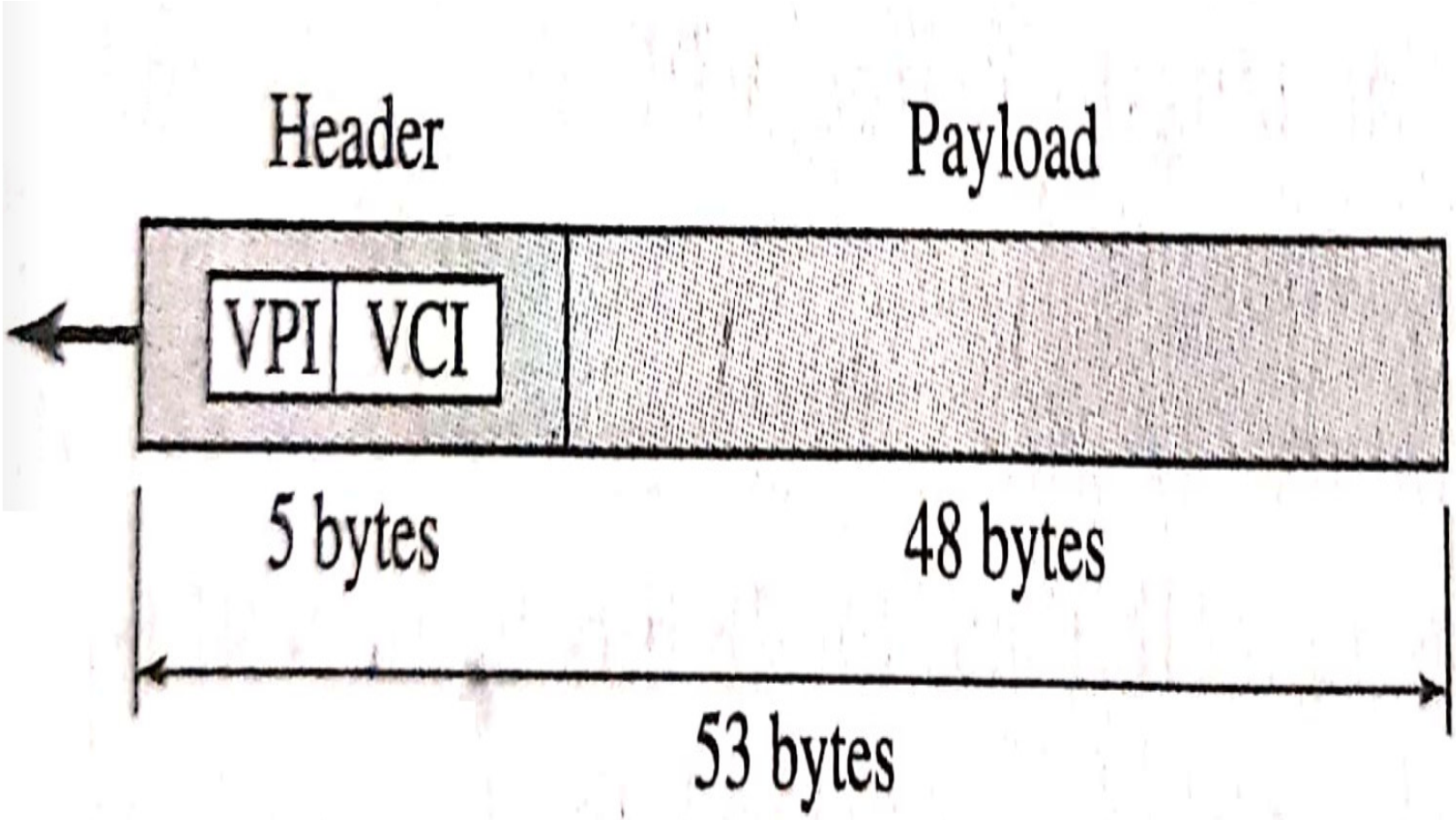


a. VPI and VCI in a UNI



b. VPI and VCI in an NNI

- **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 the header and 48 bytes carrying the payload (user data may be less than 48 bytes).
  - The header is occupied by the VPI and VCI that define the virtual connection through which a cell should travel from an endpoint to a switch or from a switch to another switch.


Header
Payload
VPI
VCI
5 bytes
48 bytes
53 bytes

❖ Connection Establishment and Release

ATM uses two types of connections: PVC and SVC:

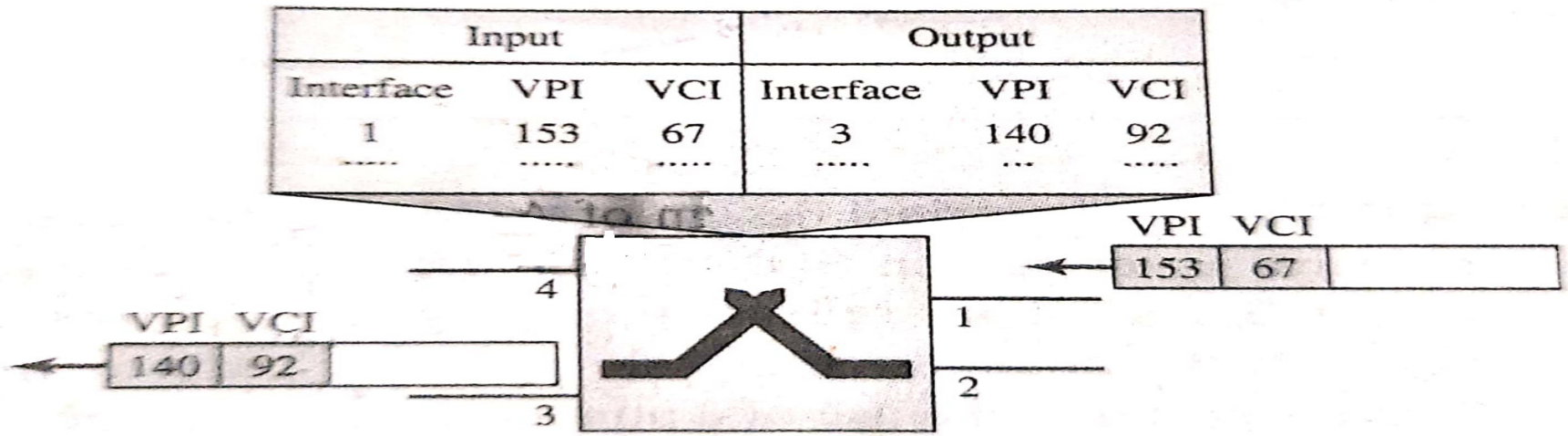
1.PVC:

- A permanent virtual-circuit connection is established between two endpoints by the network provider.
- The VPIs and VCIs are defined for the permanent connections, and the values are entered for the tables of each switch.

2. SVC:

- In a switched virtual-circuit connection, each time an endpoint wants to make a connection with another endpoint, a new virtual circuit must be established.
- ATM cannot do the job by itself, but needs the network layer addresses and the services of another protocol (such as IP).
- The signaling mechanism of this other protocol makes a connection request by using the network layer addresses of the two endpoints. The actual mechanism depends on the network layer protocol.

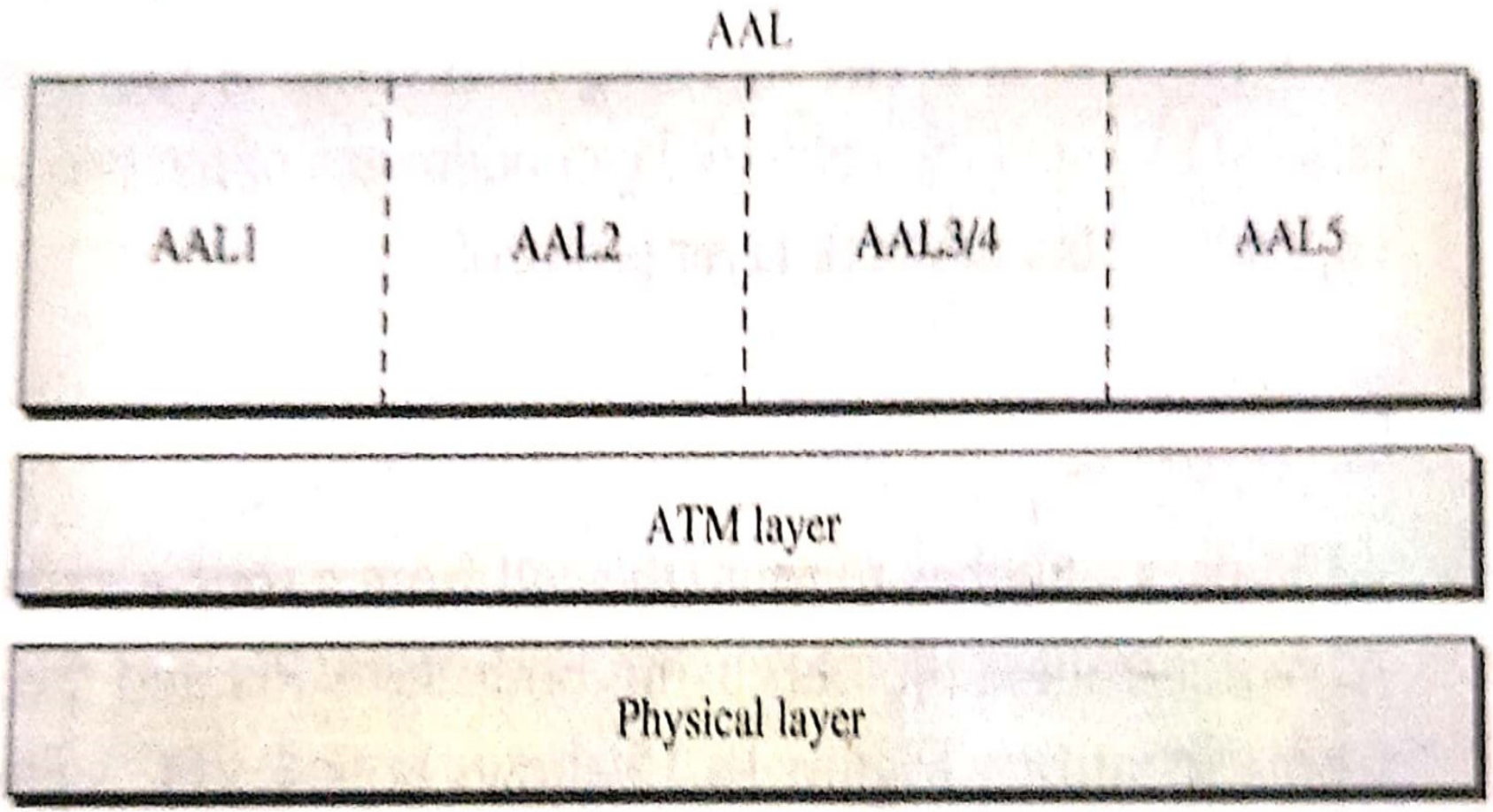
- **Switching:**
  - ATM uses switches to route the cell from a source endpoint to the destination endpoint.
  - A switch routes the cell using both the VPIs and the VCIs. The routing requires the whole identifier.

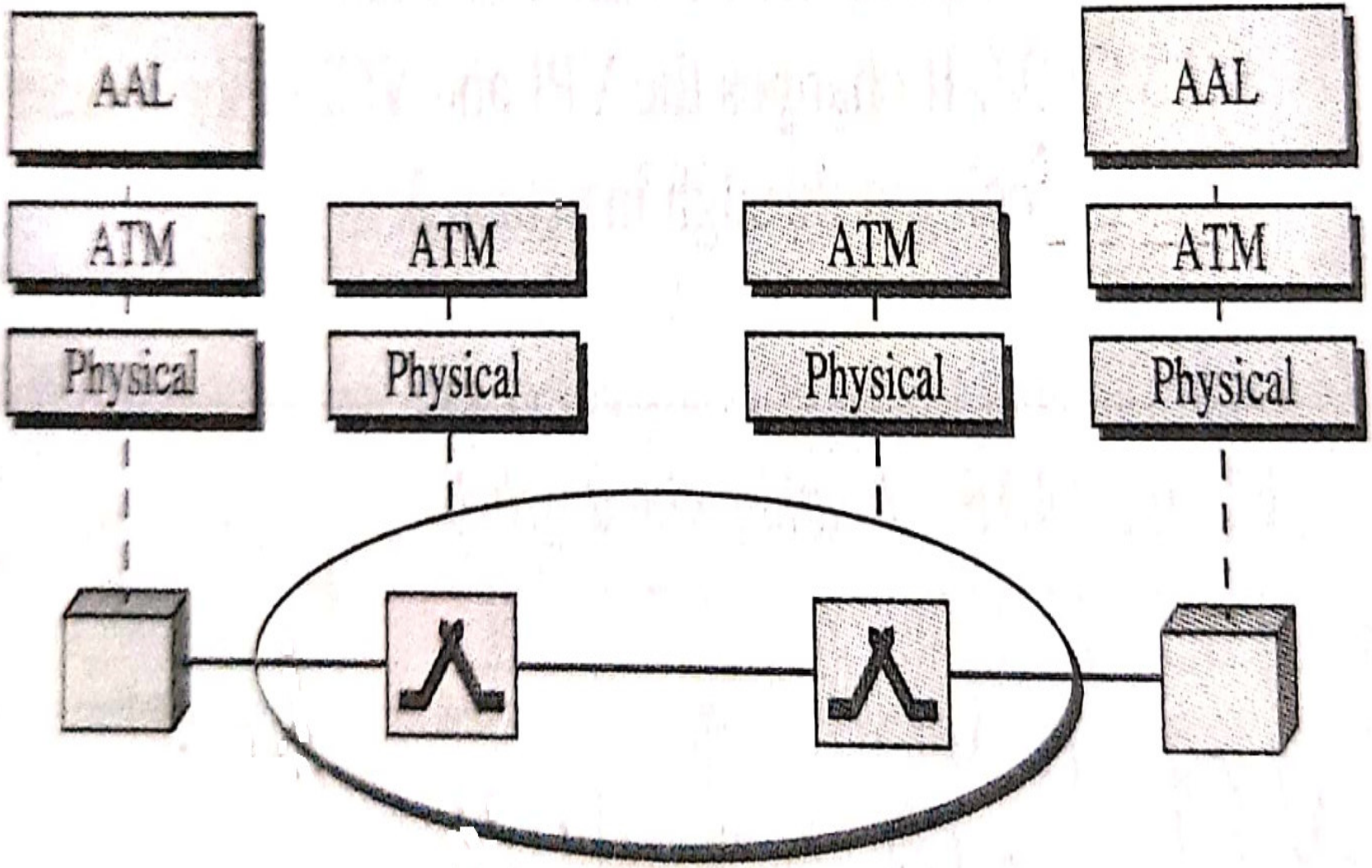


- A cell with a VPI of 153 and VCI of 67 arrives at switch interface (port) 1.
- The switch checks its switching table, which stores six pieces of information per row: arrival interface number, incoming VPI, incoming VCI, corresponding outgoing interface number, the new VPI, and the new VCI .
- The switch finds the entry with the interface 1, VPI 153, and VCI 67 and discovers that the combination corresponds to output interface 3, VPI 140, and VCI 92.
- It changes the VPI and VCI in the header to 140 and 92, respectively, and sends the cell out through interface 3.

➢ ATM Layers

- ❖ The ATM standard defines three layers. They are, from top to bottom, the application adaptation layer, the ATM layer, and the physical layer.
- ❖ The endpoints use all three layers while the switches use only the two bottom layers .

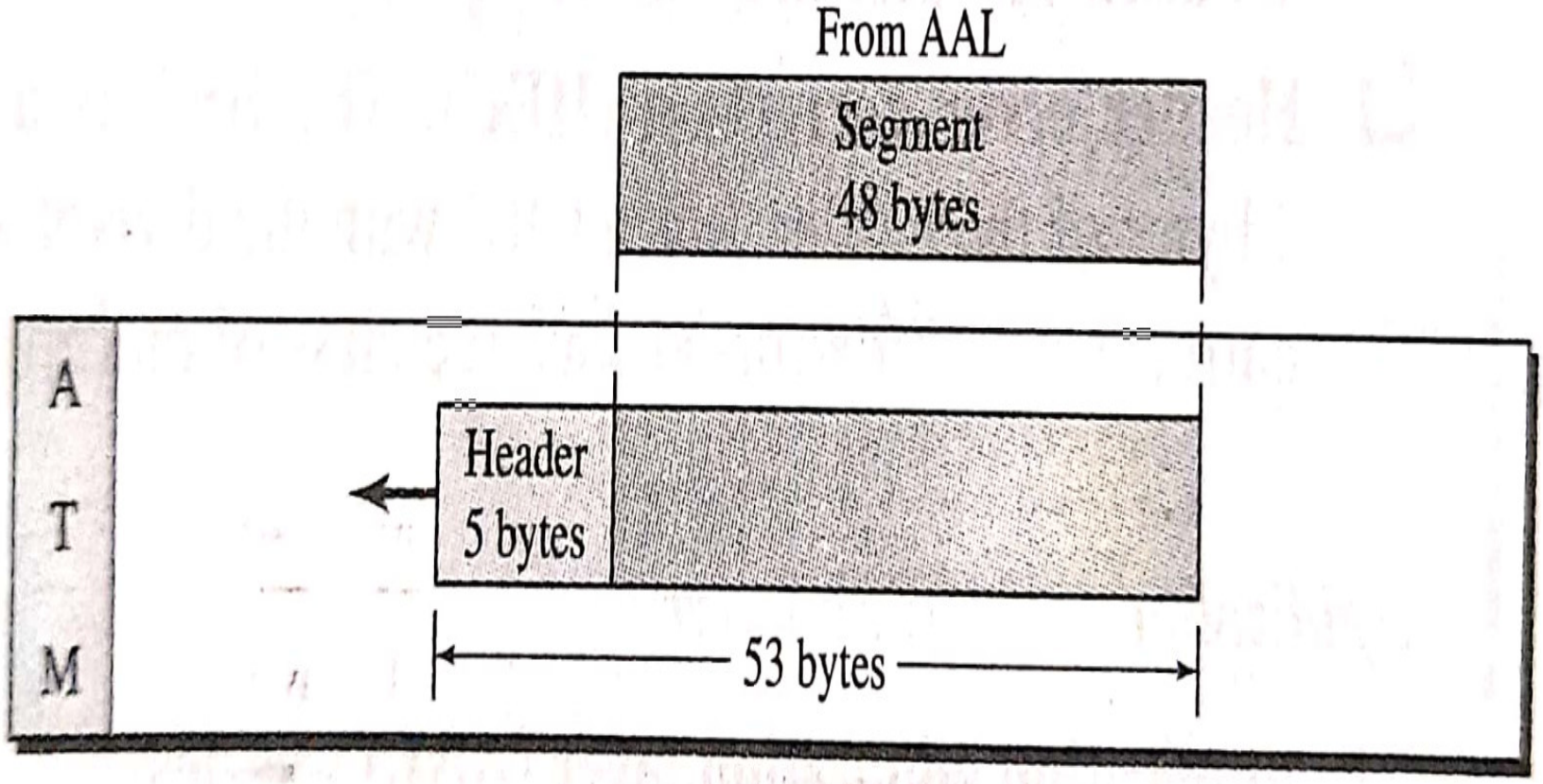

AAL
AAL1
AAL2
AAL3/4
AAL5
ATM layer
Physical layer


AAL
ATM
Physical
ATM
Physical
ATM
Physical
AAL
ATM
Physical

1. **Physical Layer**
   - This layer corresponds to physical layer of OSI model. At this layer, the cells are converted into bit streams and transmitted over the physical medium.
   - ATM cells can be carried by any physical layer carrier.
   - SONET: The original design of ATM was based on SONET as the physical layer carrier.

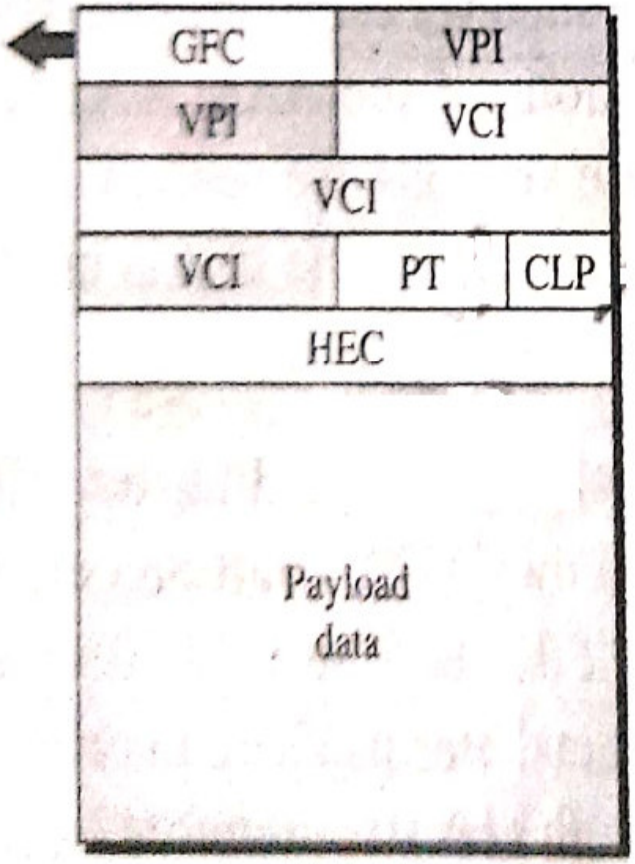
2. ATM Layer:

- The ATM layer provides routing, traffic management, switching, and multiplexing services.
- It processes outgoing traffic by accepting 48-byte segments from the AAL sublayers and transforming them into 53-byte cells by the addition of a 5-byte header .
- **Header Format:**
  - ATM uses two formats for this header, one for user-to-network interface (UNI) cells and another for network-to-network interface (NNI) cells.

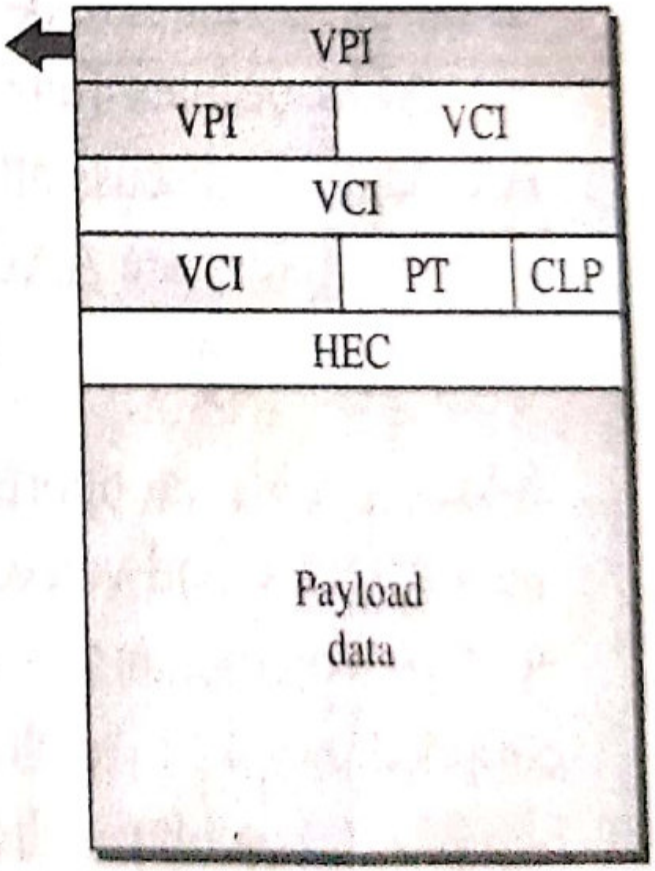

From AAL
Segment
48 bytes
A
T
M
Header
5 bytes
53 bytes

GFC: Generic flow control
VPI: Virtual path identifier
VCI: Virtual circuit identifier

PT: Payload type
CLP: Cell loss priority
HEC: Header error control



UNI cell



NNI cell

- **Generic flow control (GFC):** The 4-bit GFC field provides flow control at the UNI level. The ITU-T has determined that this level of flow control is not necessary at the NNI level. In the NNI header, therefore, these bits are added to the VPI. The longer VPI allows more virtual paths to be defined at the NNI level. The format for this additional VPI has not yet been determined.

- **Virtual path identifier (VPI):** The VPI is an 8-bit field in a UNI cell and a 12-bit field in an NNI cell.
- **Virtual circuit identifier (VCI):** The VCI is a 16-bit field in both frames.
- **Payload type (PT):** In the 3-bit PT field, the first bit defines the payload as user data or managerial information. The interpretation of the last 2 bits depends on the first bit.
- **Cell loss priority (CLP):** The 1-bit CLP field is provided for congestion control.
- **Header error correction (HEC):** The HEC is a code computed for the first 4 bytes of the header.

3. Application Adaptation Layer:

- The application adaptation layer (AAL) was designed to enable two ATM concepts:
  a) ATM must accept any type of payload, both data frames and streams of bits. A data frame can come from an upper-layer protocol that creates a clearly defined frame to be sent to a carrier network such as ATM. A good example is the Internet.
  b) ATM must also carry multimedia payload. It can accept continuous bit streams and break them into chunks to be encapsulated into a cell at the ATM layer.
- AAL uses two sublayers to accomplish these tasks.

- Whether the data are a data frame or a stream of bits, the payload must be segmented into 48-byte segments to be carried by a cell.
- At the destination, these segments need to be reassembled to recreate the original payload.
- The AAL defines a sublayer, called a segmentation and reassembly (SAR) sublayer, to do so.
- Segmentation is at the source; reassembly, at the destination.
- ATM defines four versions of the AAL: AAL1, AAL2, AAL3/4, and AAL5.