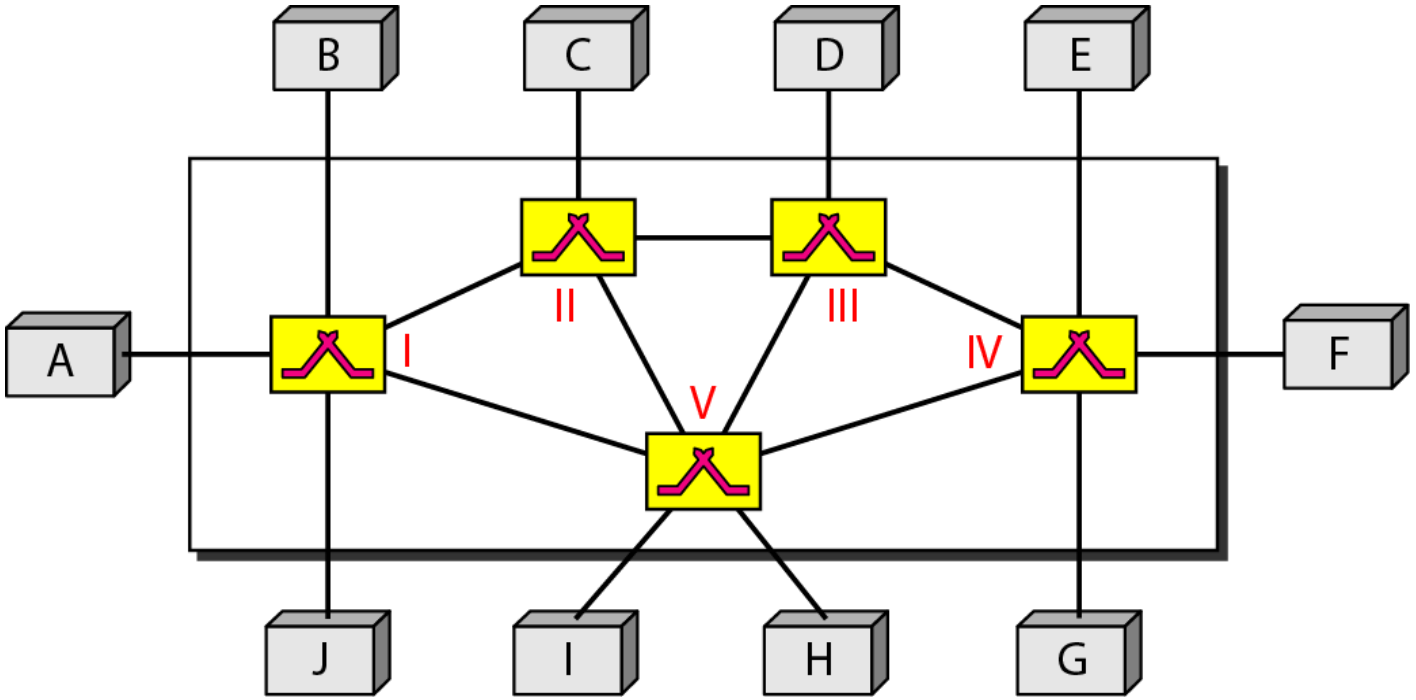
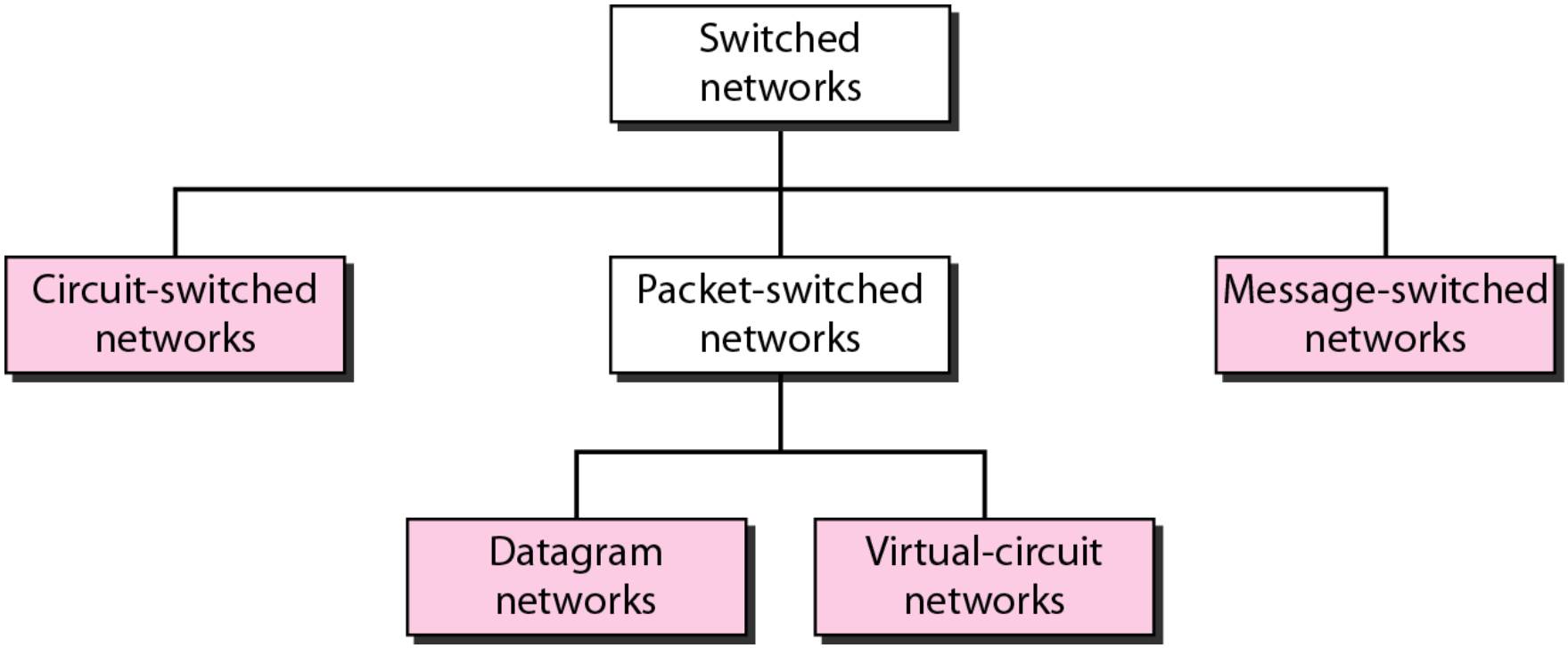
Virtual-Circuit Networks: Frame Relay and ATM

Switched network (Switching)



Taxonomy of switched networks



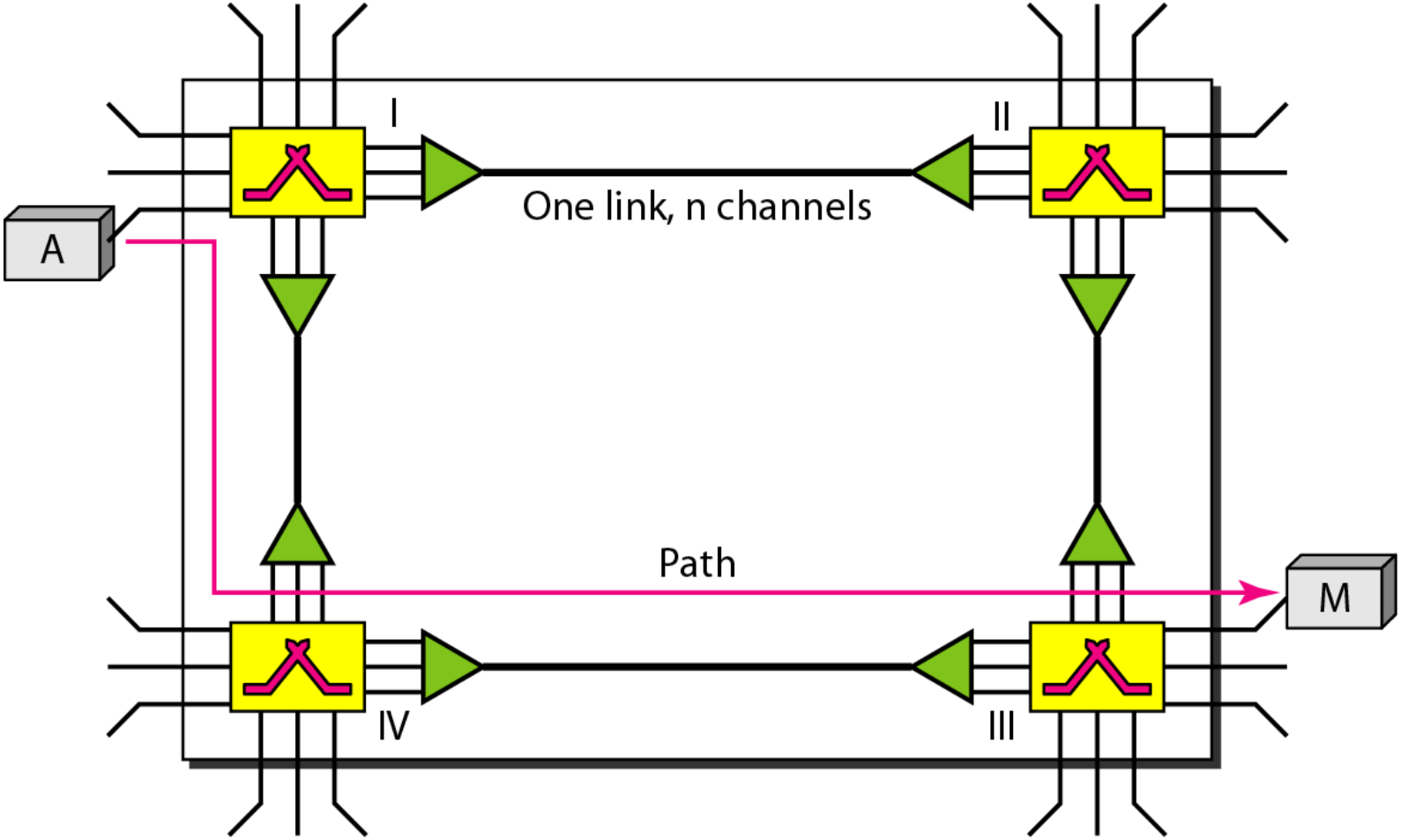
CIRCUIT-SWITCHED NETWORKS

A circuit-switched network consists of a set of switches connected by physical links. A connection between two stations is a dedicated path made of one or more links. However, each connection uses only one dedicated channel on each link. Each link is normally divided into n channels by using FDM or TDM.

Note

A circuit-switched network is made of a set of switches connected by physical links, in which each link is divided into *n* channels.

Figure 8.3 *A trivial circuit-switched network*



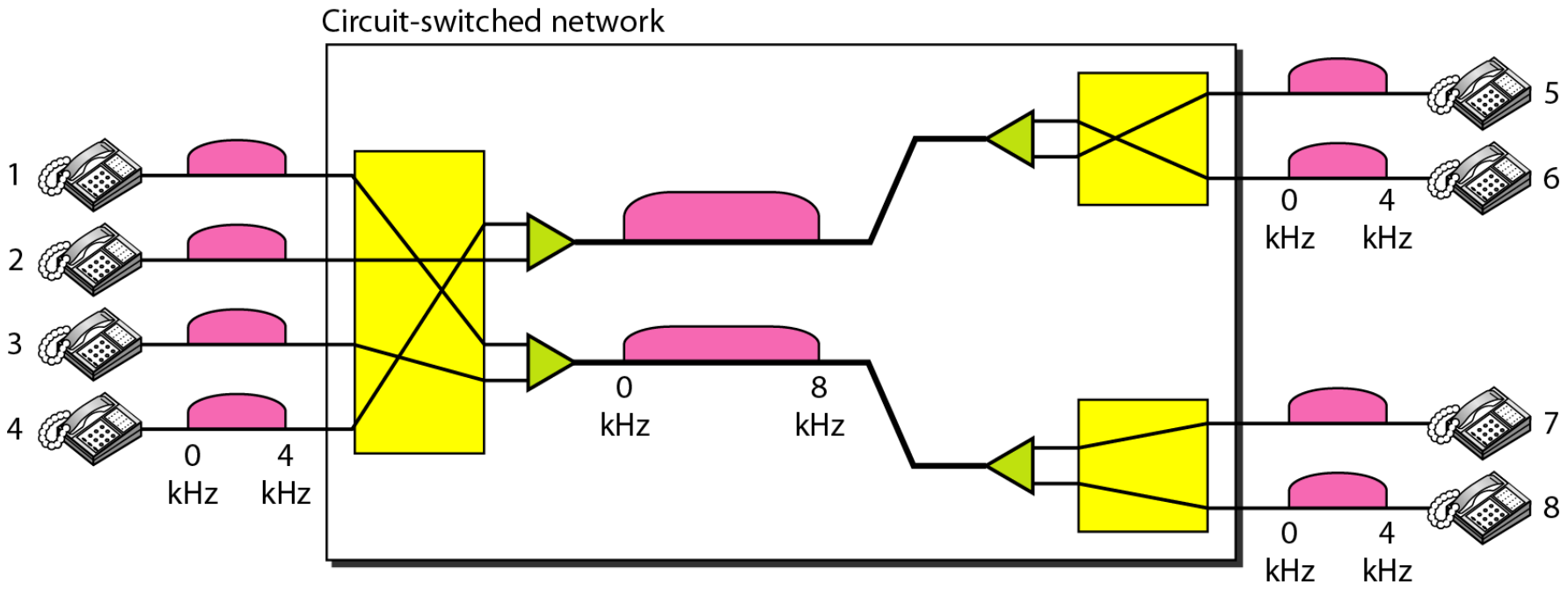
Note

In circuit switching, the resources need to be reserved during the setup phase; the resources remain dedicated for the entire duration of data transfer until the teardown phase.

Example 8.1

As a trivial example, let us use a circuit-switched network to connect eight telephones in a small area. Communication is through 4-kHz voice channels. We assume that each link uses FDM to connect a maximum of two voice channels. The bandwidth of each link is then 8 kHz. Figure 8.4 shows the situation. Telephone 1 is connected to telephone 7; 2 to 5; 3 to 8; and 4 to 6. Of course the situation may change when new connections are made. The switch controls the connections.

Figure 8.4 *Circuit-switched network used in Example 8.1*



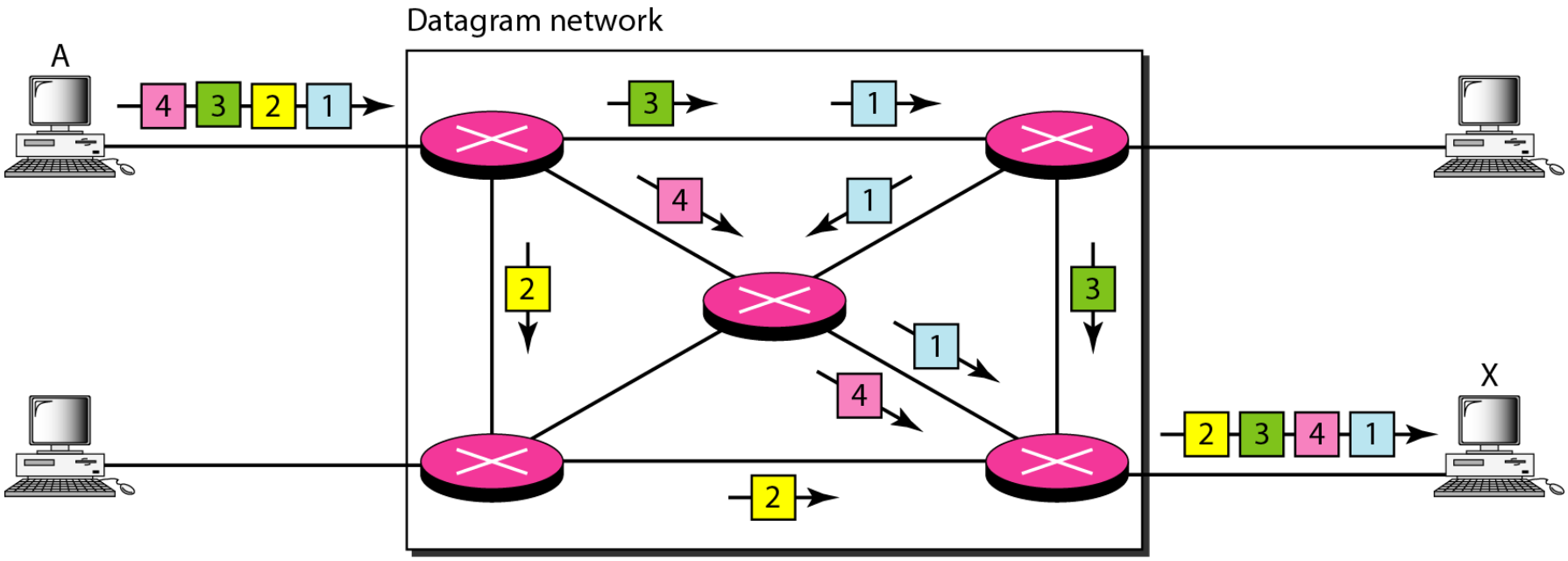
DATAGRAM NETWORKS

In data communications, we need to send messages from one end system to another. If the message is going to pass through a packet-switched network, it needs to be divided into packets of fixed or variable size. The size of the packet is determined by the network and the governing protocol.

Note

In a packet-switched network, there is no resource reservation; resources are allocated on demand.

A datagram network with four switches (routers)



Virtual-Circuit Networks: Frame Relay and ATM

FRAME RELAY

FRAME RELAY

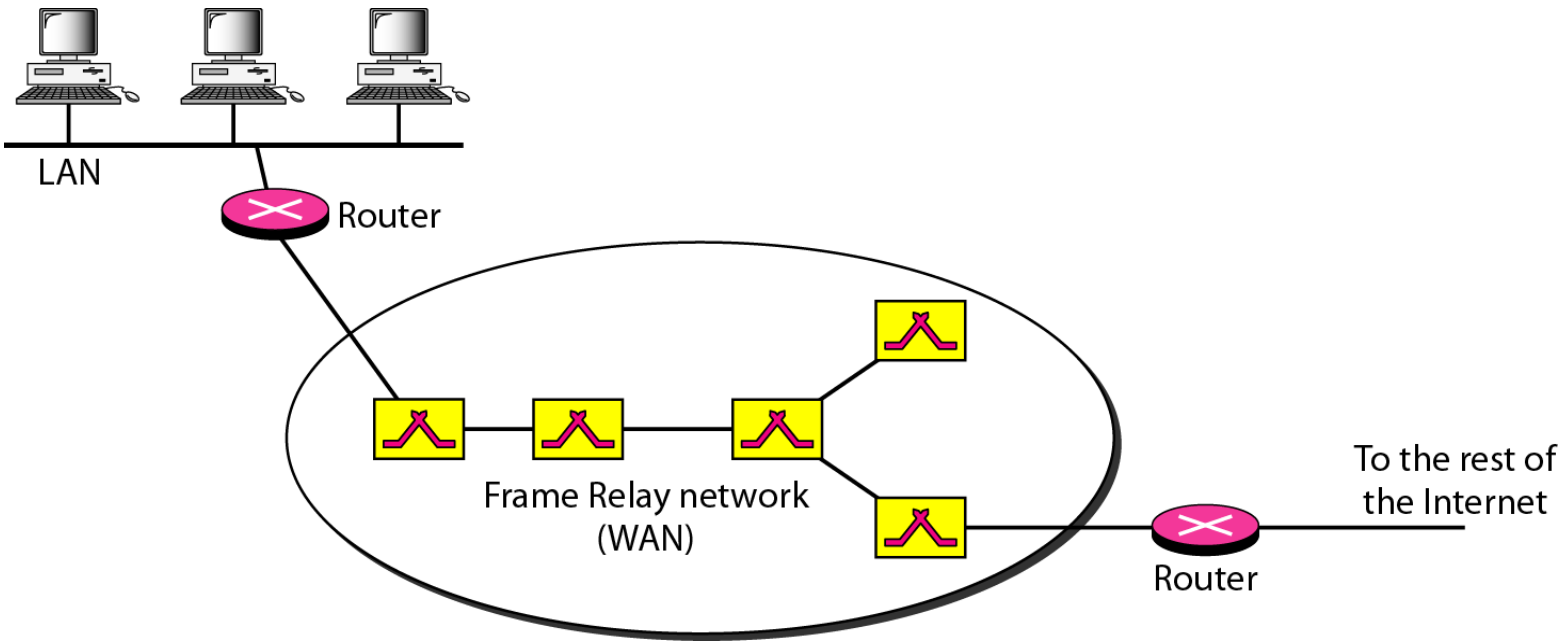
Frame Relay is a virtual-circuit wide-area network that was designed in response to demands for a new type of WAN in the late 1980s and early 1990s.

Prior to Frame relay, Some organizations were using a virtual circuit network called X.25 that performed switching at network layer.

X.25 has several drawbacks.

1. ***X.25 has law 64-kbps data rate.***
2. ***X.25 has extensive flow and error control***
3. ***Originally X.25 was designed for private use.***

Architecture : *Frame Relay network*



Frame relay provides permanent virtual circuits and switched virtual circuits.

VCI: Virtual circuits Identifier
DLCIs :Data link connection Identifier

Note

VCIs in Frame Relay are called DLCIs.

Frame Relay is a virtual circuit network. A virtual circuit in a frame relay is identified by a number called a DLCI

Permanent Versus Switched Virtual Circuits

A source and a destination may choose to have a permanent virtual circuit (PVC).
In this case :
The connection setup is simple.
An outgoing DLCI is given to the source, and an incoming DLCI is given to the destination.

PVC connections have two drawbacks.

First, they are costly because two parties pay for the connection all the time even when it is not in use.

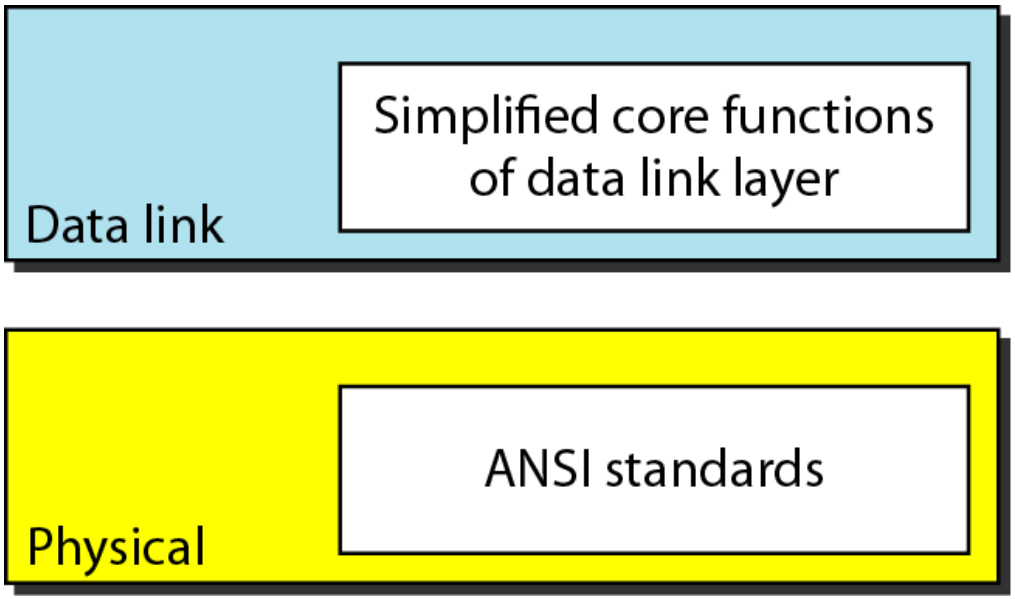
Second, a connection is created from one source to one single destination. If a source needs connections with several destinations, it needs a PVC for each connection.

An alternate approach is the switched virtual circuit (SVC).
The SVC creates a temporary, short connection that exists only when data are being transferred between source and destination.

An SVC requires establishing and terminating phases

Frame Relay layers

Data Link Layer : At the data link layer, Frame Relay uses a simple protocol that does not support flow or error control. It only has an error detection mechanism

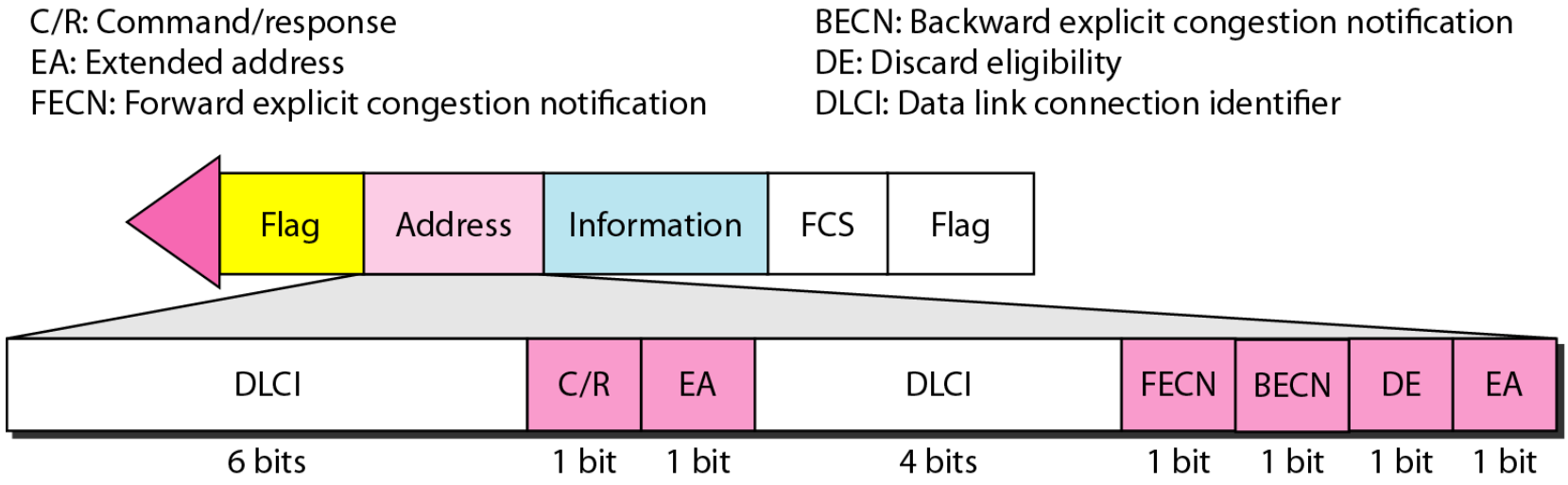


American National Standards Institute - ANSI

Note

Frame Relay operates only at the physical and data link layers.

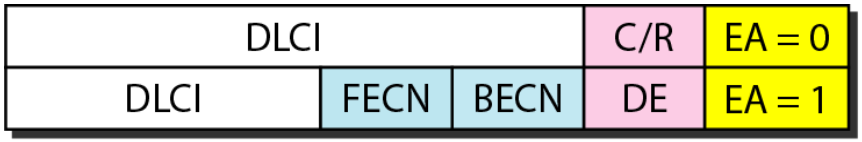
Figure 18.3 *Frame Relay frame*



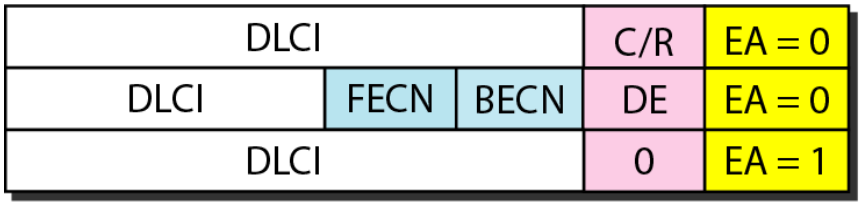
Note

Frame Relay does not provide flow or error control; they must be provided by the upper-layer protocols.

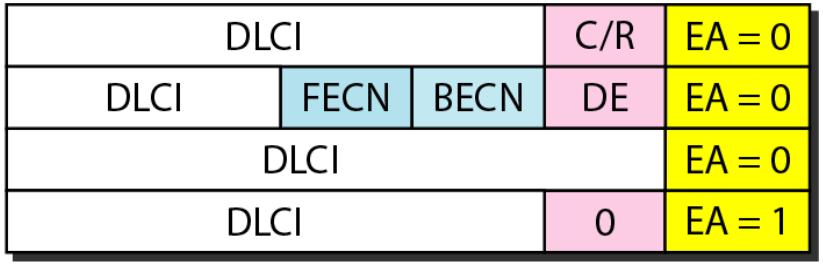
Extended Address : *Three address formats*



a. Two-byte address (10-bit DLCI)



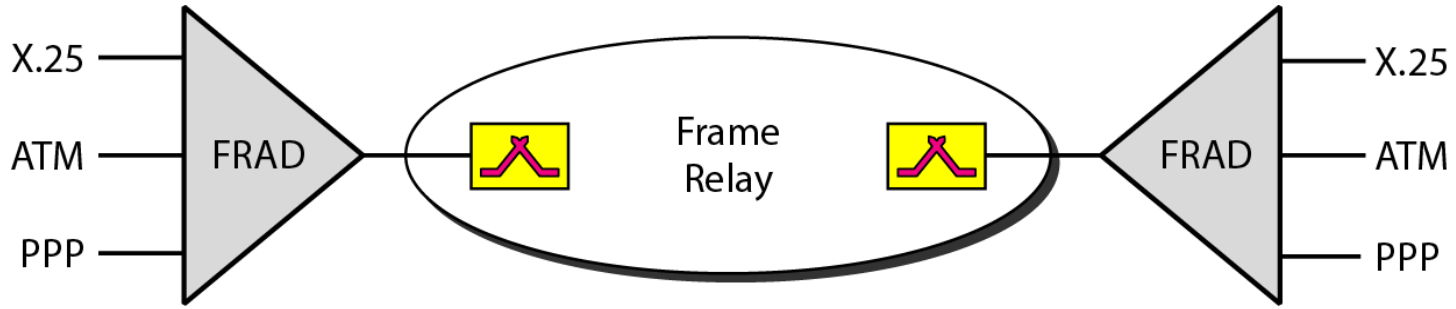
b. Three-byte address (16-bit DLCI)



c. Four-byte address (23-bit DLCI)

FRAD

FRAD : Frame Relay Assembler / Dissembler



ATM (*Asynchronous Transfer Mode)*

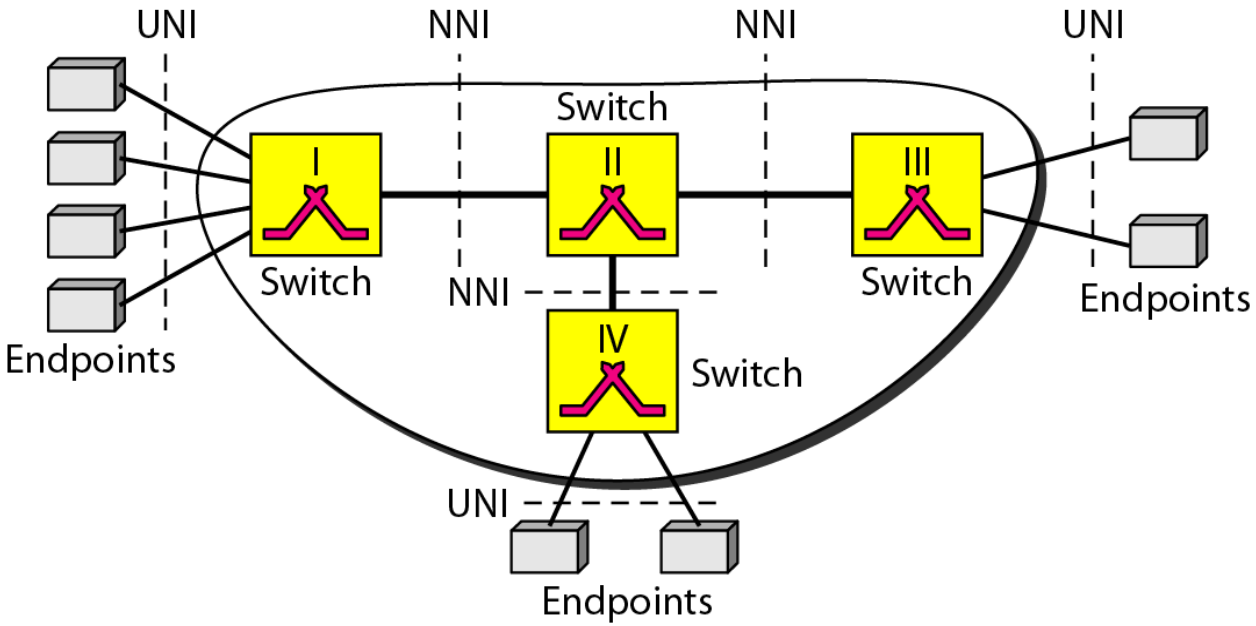
Asynchronous Transfer Mode (ATM) is the cell relay protocol designed by the ATM Forum and adopted by the ITU-T.

ATM is a cell switched network.

Note

A cell network uses the cell as the basic unit of data exchange.
A cell is defined as a small, fixed-size block of information.

Figure *Architecture of an ATM network*



UNI : User to network Interface

*End points are connected through **UNI** to the switches in the network.*

NNI : Network to Network

The Switches are connected through NNI.

Figure *TP, VPs, and VCs*

Connection b/w two end point is accomplished through

TP: Transmission Path

VP: Virtual Path

VC: Virtual Circuits

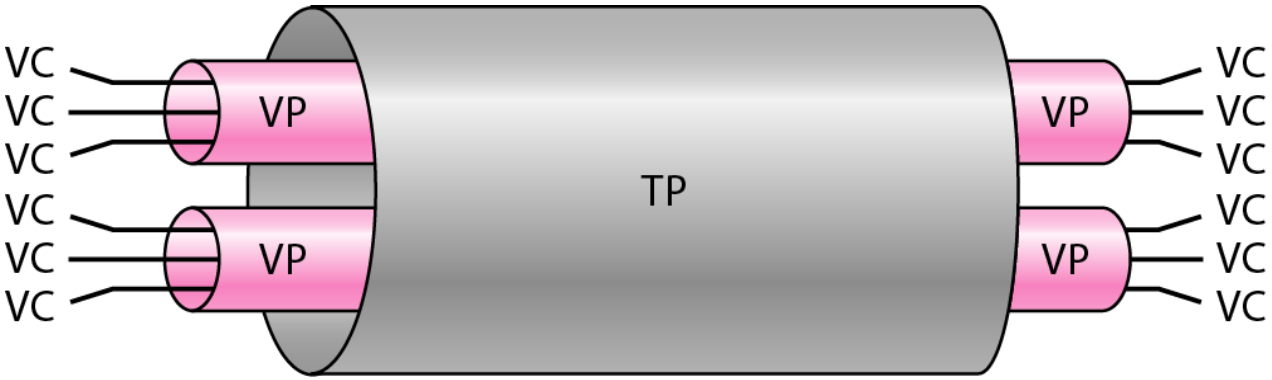
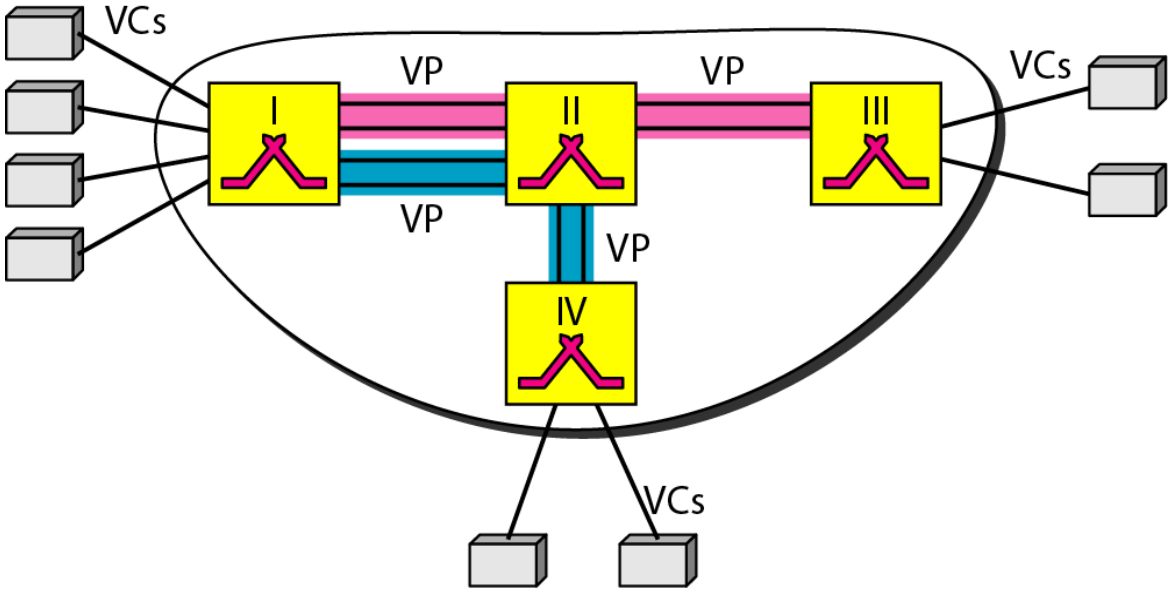


Figure *Example of VPs and VCs*



Note

Note that a virtual connection is defined by a pair of numbers: the VPI and the VCI.

Figure *Connection identifiers*

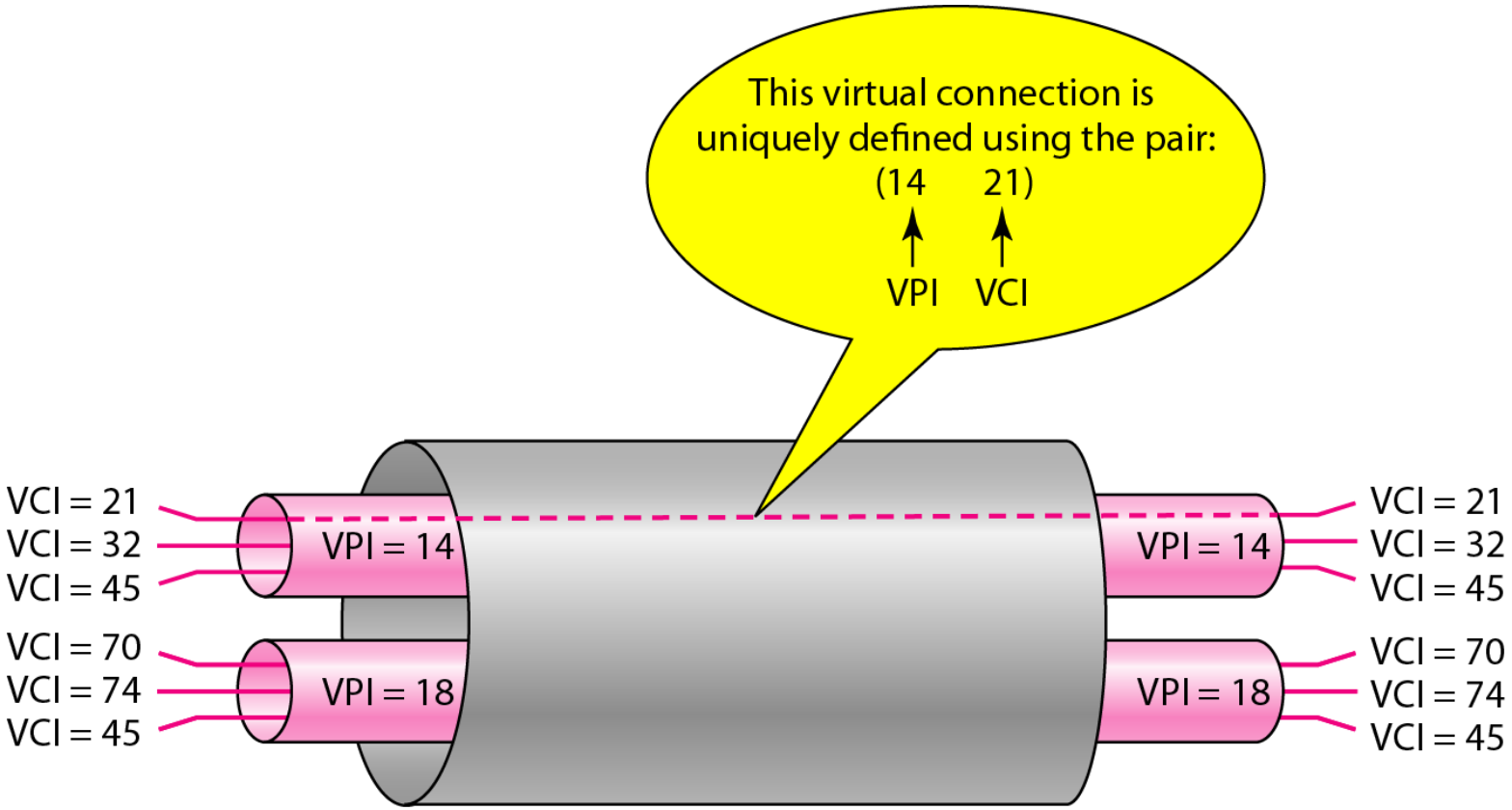
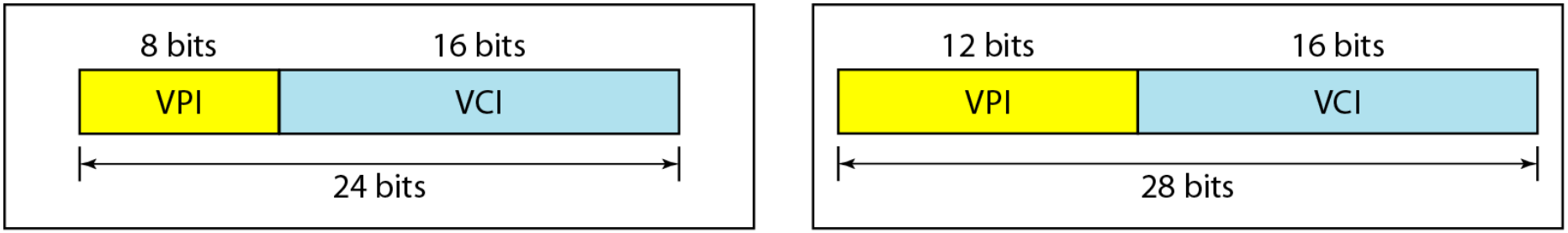


Figure *Virtual connection identifiers in UNIs and NNIs*



a. VPI and VCI in a UNI

b. VPI and VCI in an NNI

Figure *An ATM cell*

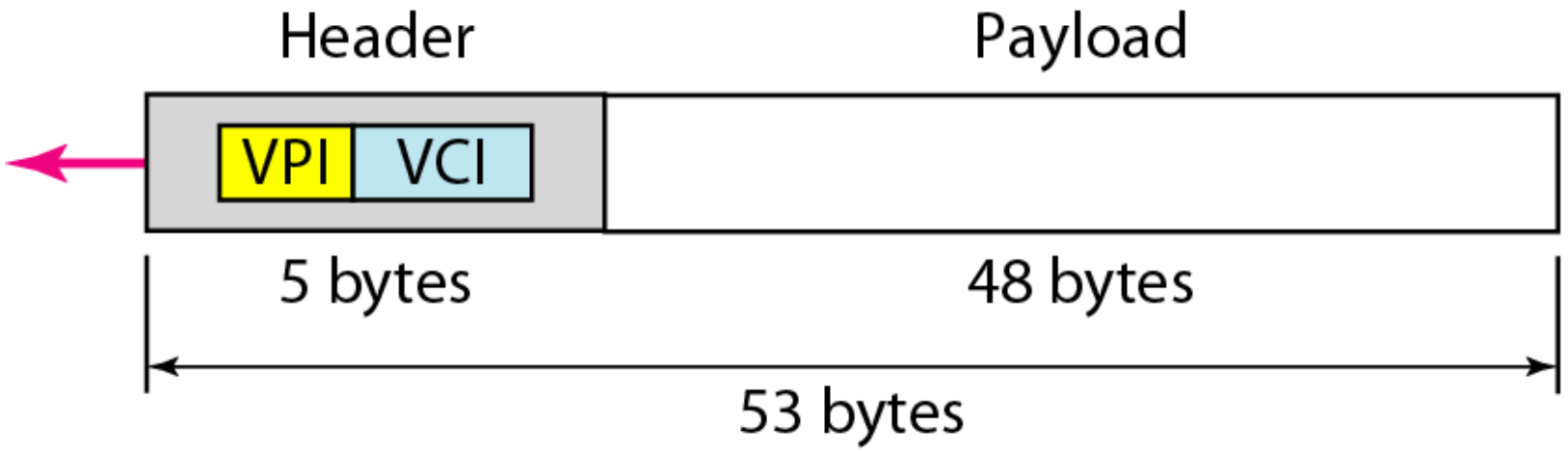


Figure *Routing with a switch*

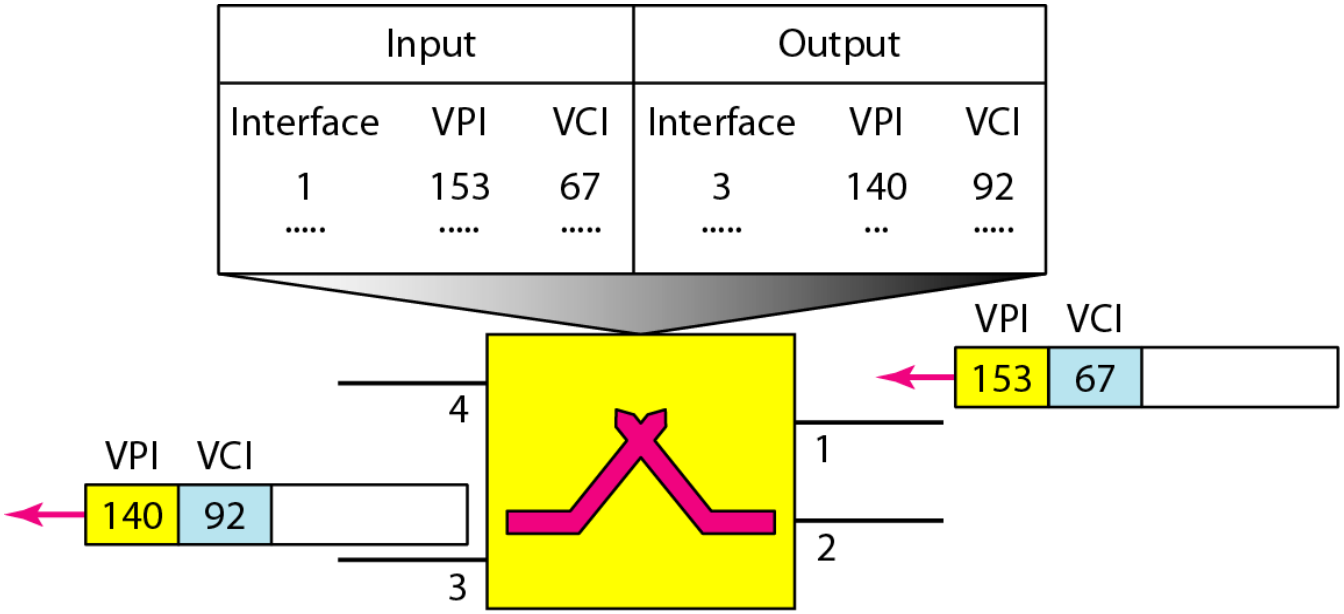


Figure *ATM layers*

AAL : Application Adaptation Layer

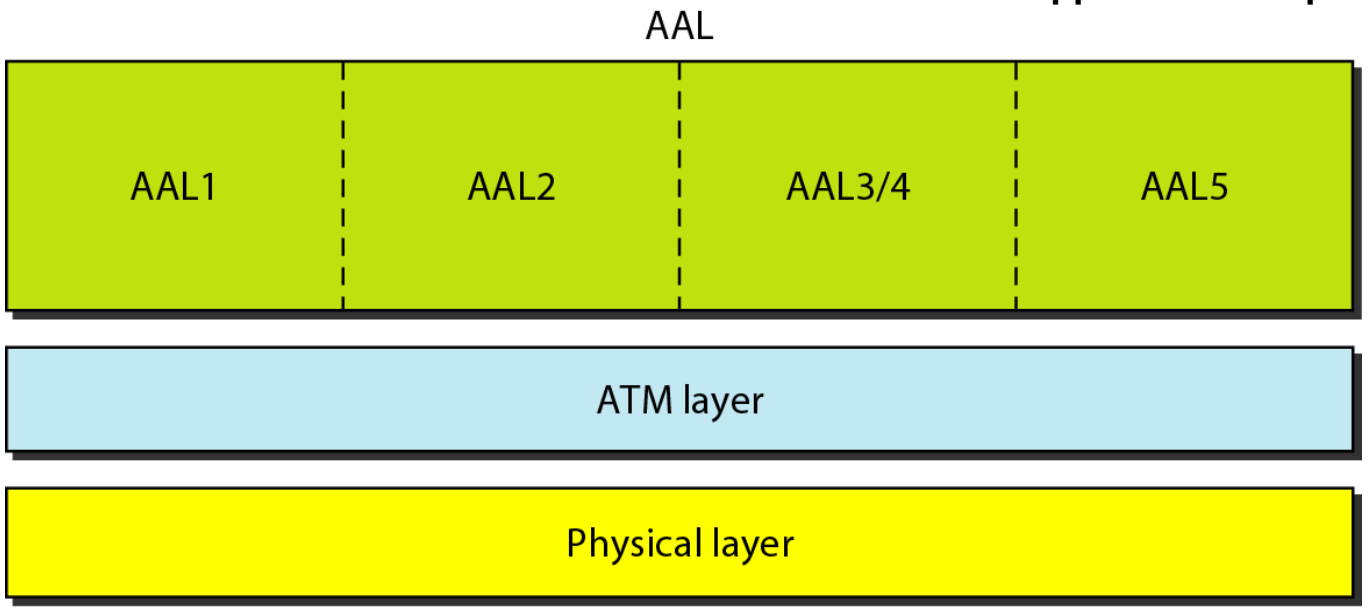


Figure *ATM layers*

AAL : Application Adaptation Layer

Physical Layer
Like Ethernet and wireless LANs, ATM cells can be carried by any physical layer carrier.

ATM Layer
The ATM layer provides routing, traffic management, switching, and multiplexing services.

Application Adaptation Layer:
ATM defines four versions of the AAL: AALl, AAL2, *AAL3/4, and AAL5*

Figure *ATM layers in endpoint devices and switches*

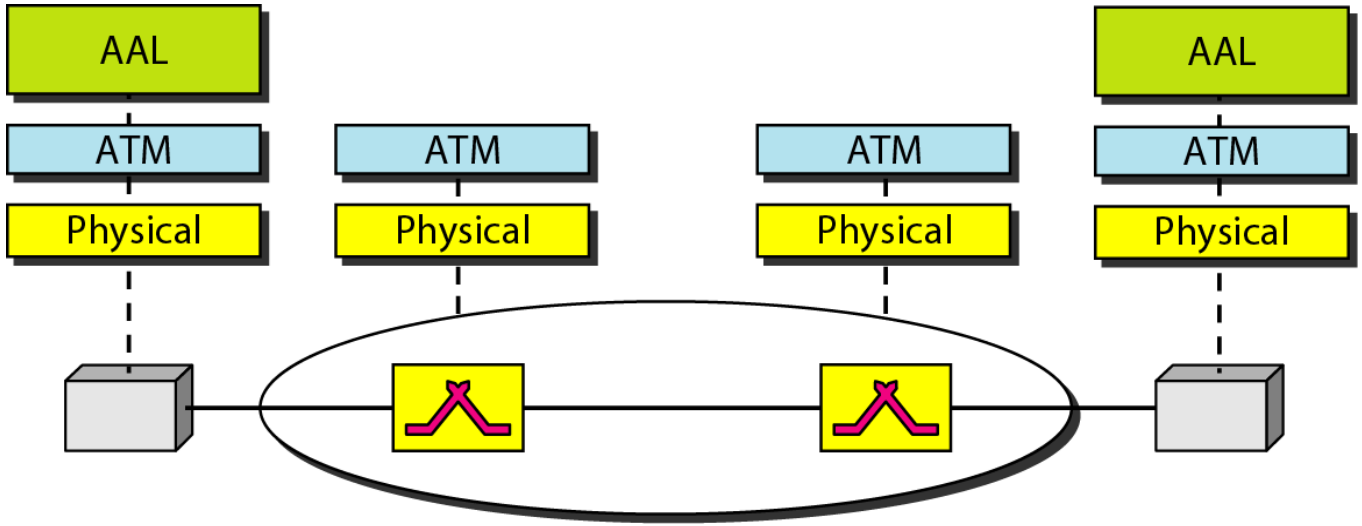


Figure *ATM layer*

The ATM layer provides routing, traffic management, switching, and multiplexing services.

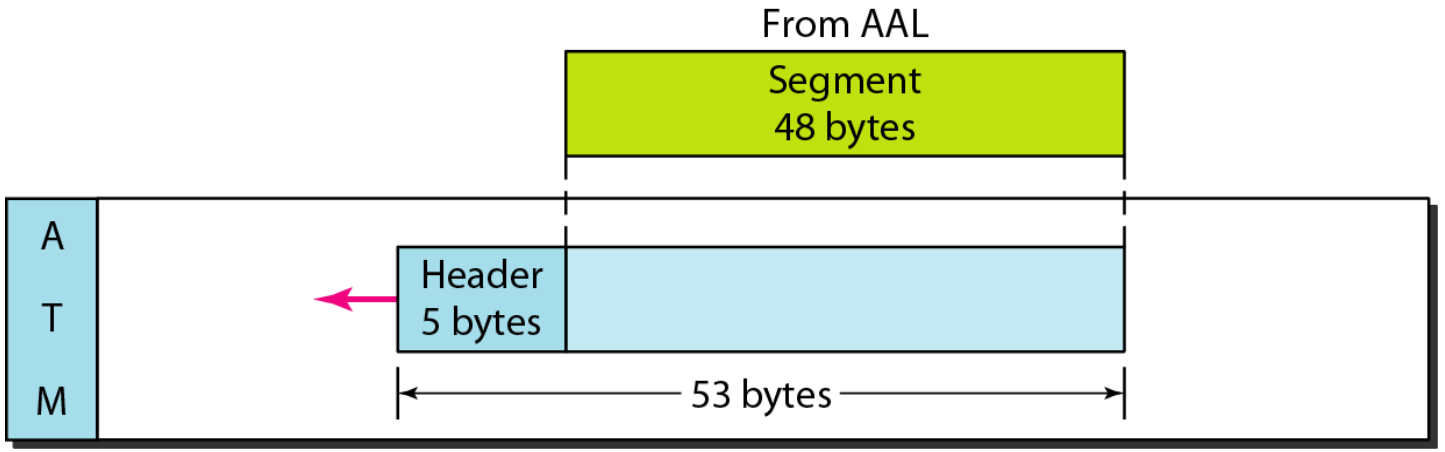


Figure *ATM headers*

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

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

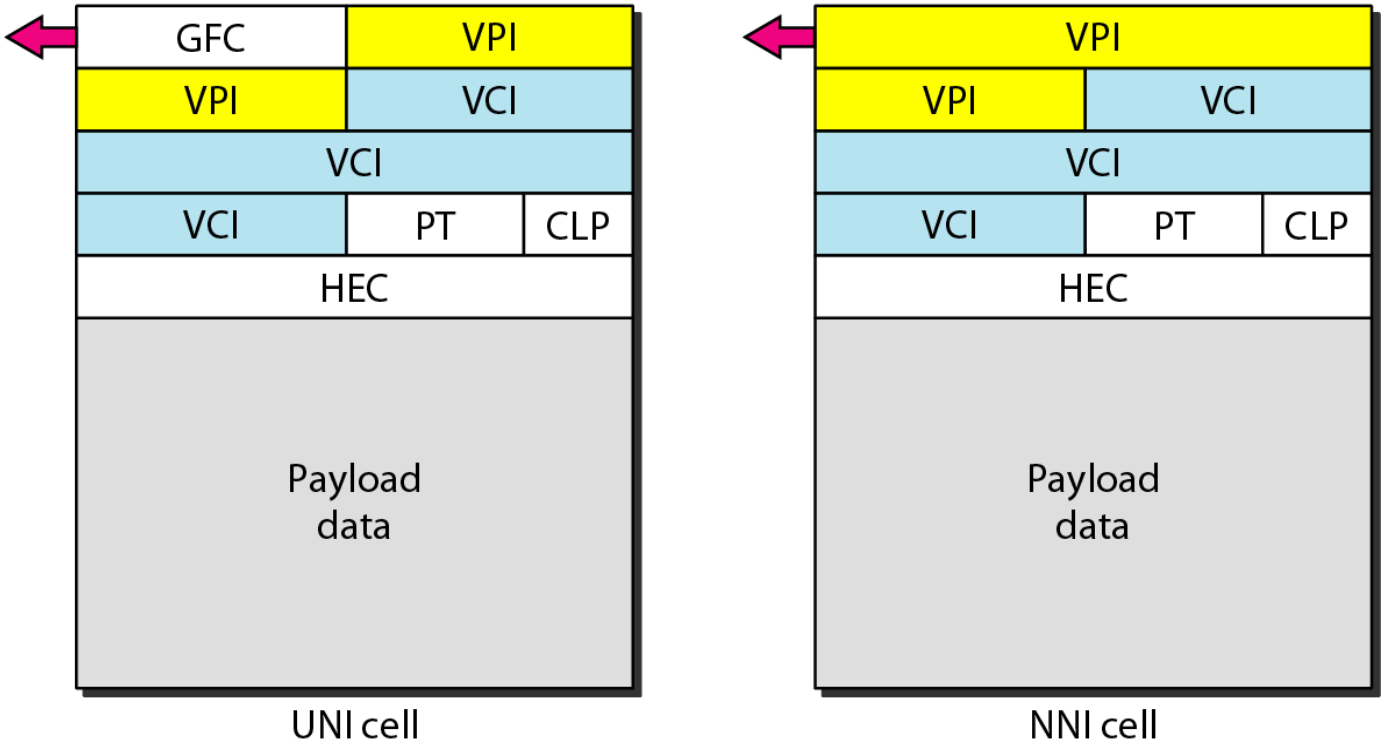


Figure *AAL1*

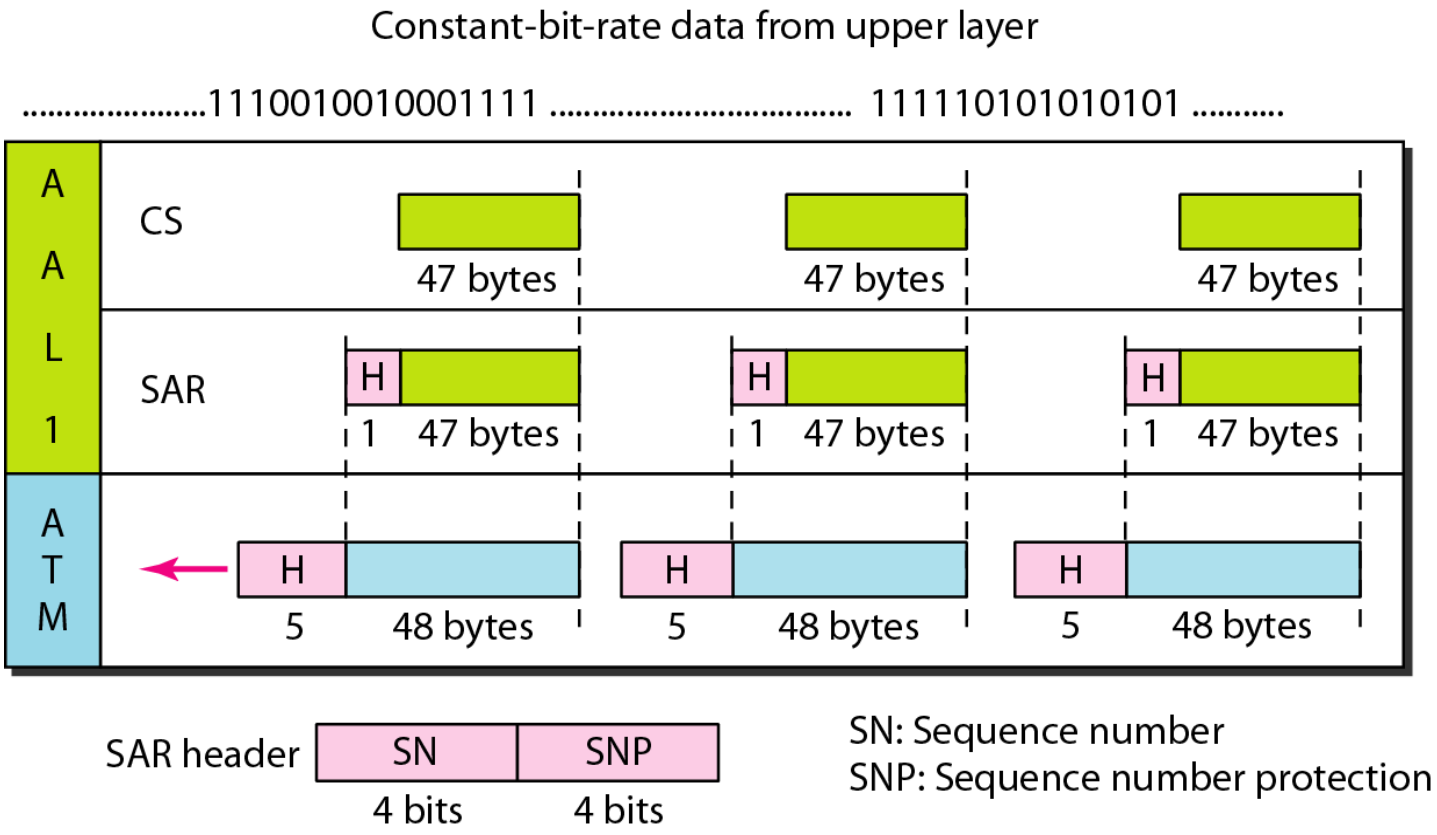

Constant-bit-rate data from upper layer
.....1110010010001111 ..... 111110101010101 .....
AAL1
ATM
CS
SAR
47 bytes
47 bytes
47 bytes
H
1
47 bytes
H
1
47 bytes
H
1
47 bytes
H
5
48 bytes
H
5
48 bytes
H
5
48 bytes
SAR header
SN
SNP
4 bits
4 bits
SN: Sequence number
SNP: Sequence number protection

Figure *AAL2*

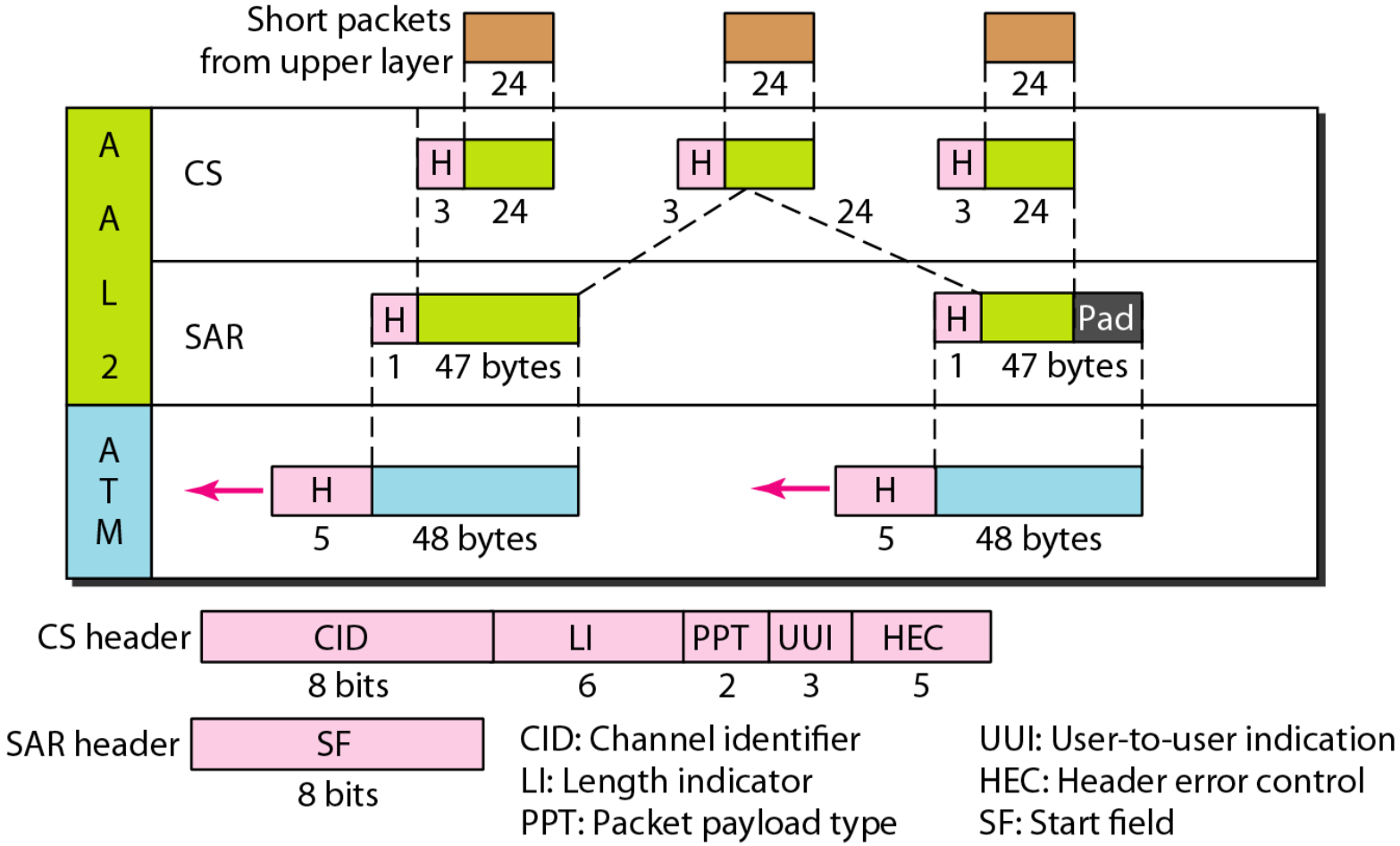
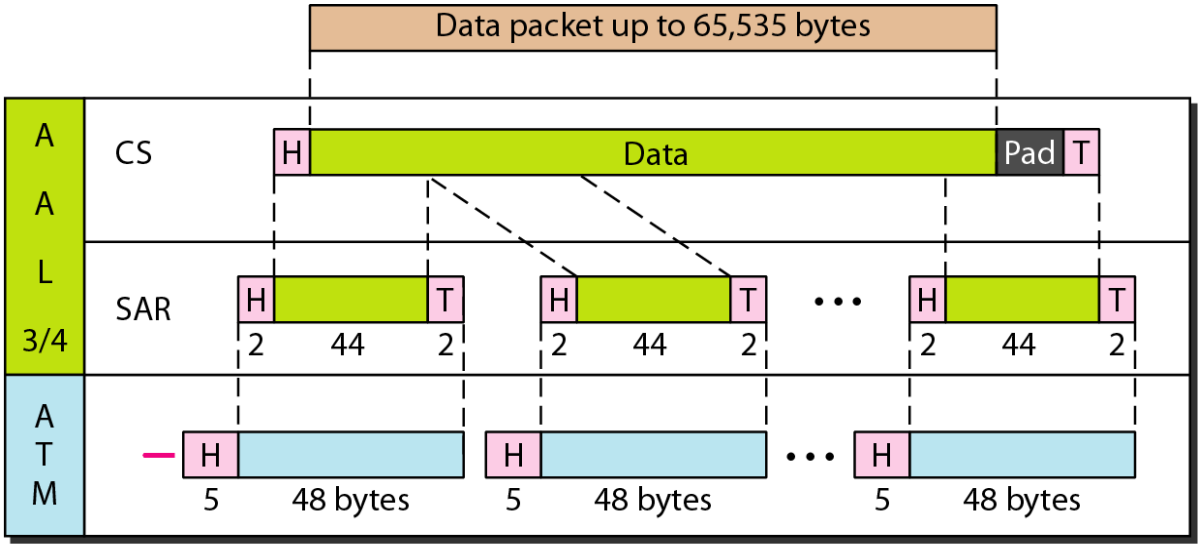
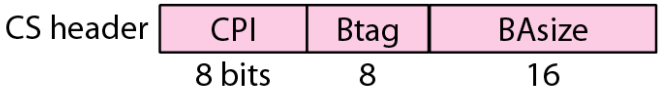
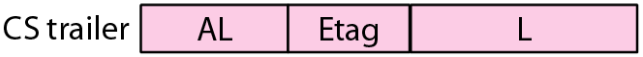

Short packets
from upper layer
24
24
24
AAL2
CS
SAR
ATM
H
3
24
1
47 bytes
Pad
5
48 bytes
CS header
CID
LI
PPT
UUI
HEC
8 bits
6
2
3
5
SAR header
SF
8 bits
CID: Channel identifier
LI: Length indicator
PPT: Packet payload type
UUI: User-to-user indication
HEC: Header error control
SF: Start field

Figure *AAL3/4*

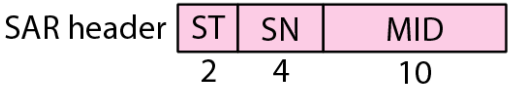




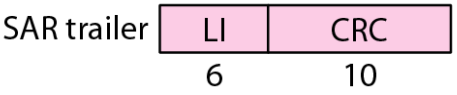
CPI: Common part identifier
Btag: Beginning tag
BAsize: Buffer allocation size



AL: Alignment
Etag: Ending tag
L: Length

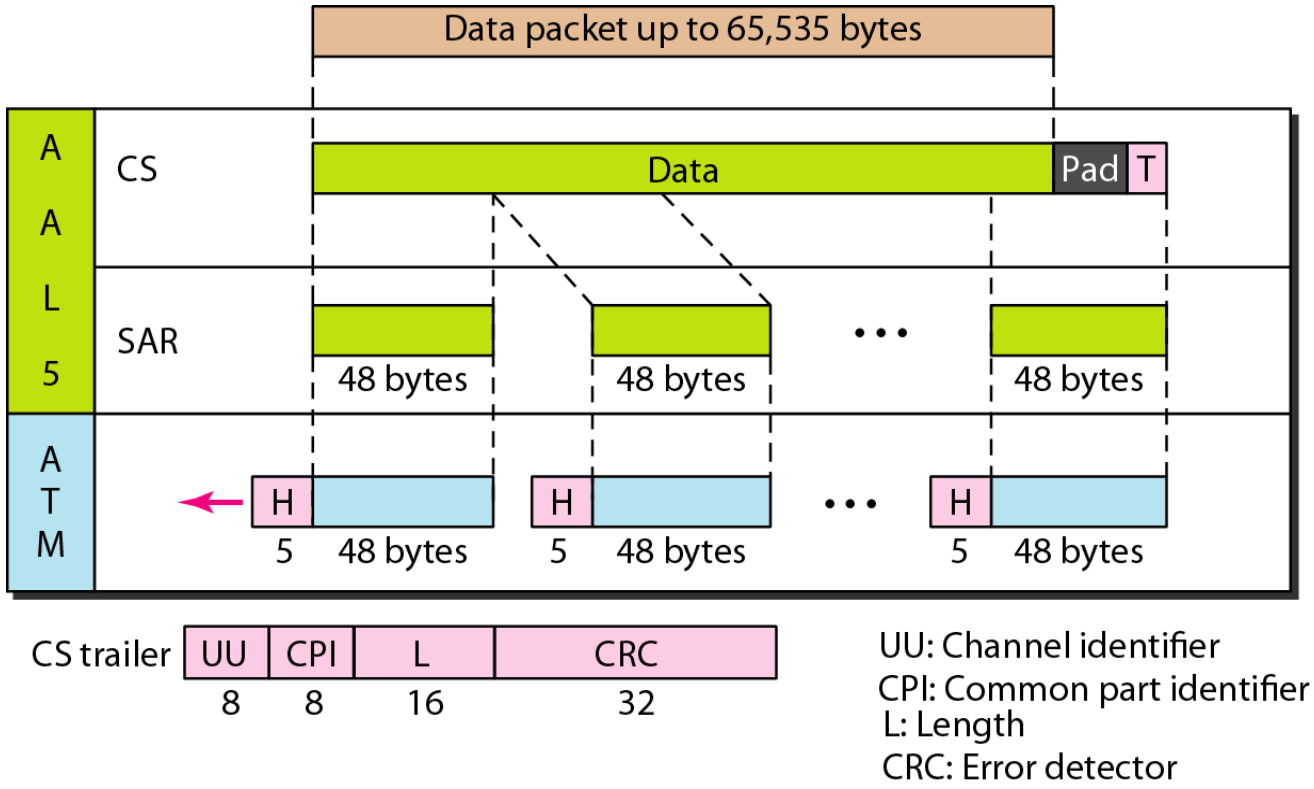


ST: Segment type
SN: Sequence number
MID: Multiplexing identifier



LI: Length identifier
CRC: Error detector

Figure *AAL5*


Data packet up to 65,535 bytes
AAL5
CS
Data
Pad
T
SAR
48 bytes
48 bytes
48 bytes
ATM
H
5
48 bytes
CS trailer
UU
CPI
L
CRC
8
8
16
32
UU: Channel identifier
CPI: Common part identifier
L: Length
CRC: Error detector