Asynchronous Transfer Mode (ATM)

ATM Outline

- ATM Introduction
  - Motivation for ATM Architecture
- Design Assumptions
- ATM Adaptation Layers
- Old ATM Design
- Revised ATM Design
- AAL Details
- MPLS

ATM Introduction

- ITU-T lead the standards development.
- ATM Forum ensures interoperability among private and public ATM implementations.
- ATM commonly used to implement WANs.
- DSL uses ATM for multiplexing and switching.
- ATM still used as a backbone in some IP networks.

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Issues Driving LAN Changes

- Traffic integration
  - Voice, video and data traffic
  - Multimedia became the 'buzz word' in the 1990s
    - One-way batch — Web traffic
    - Two-way batch — voice messages
    - One-way interactive — Mbone broadcasts
    - Two-way interactive — video conferencing
- Quality of Service guarantees (e.g. limited jitter, non-blocking streams)
- LAN interoperability
- Mobile and wireless nodes

Stallings' "High-Speed Networks"

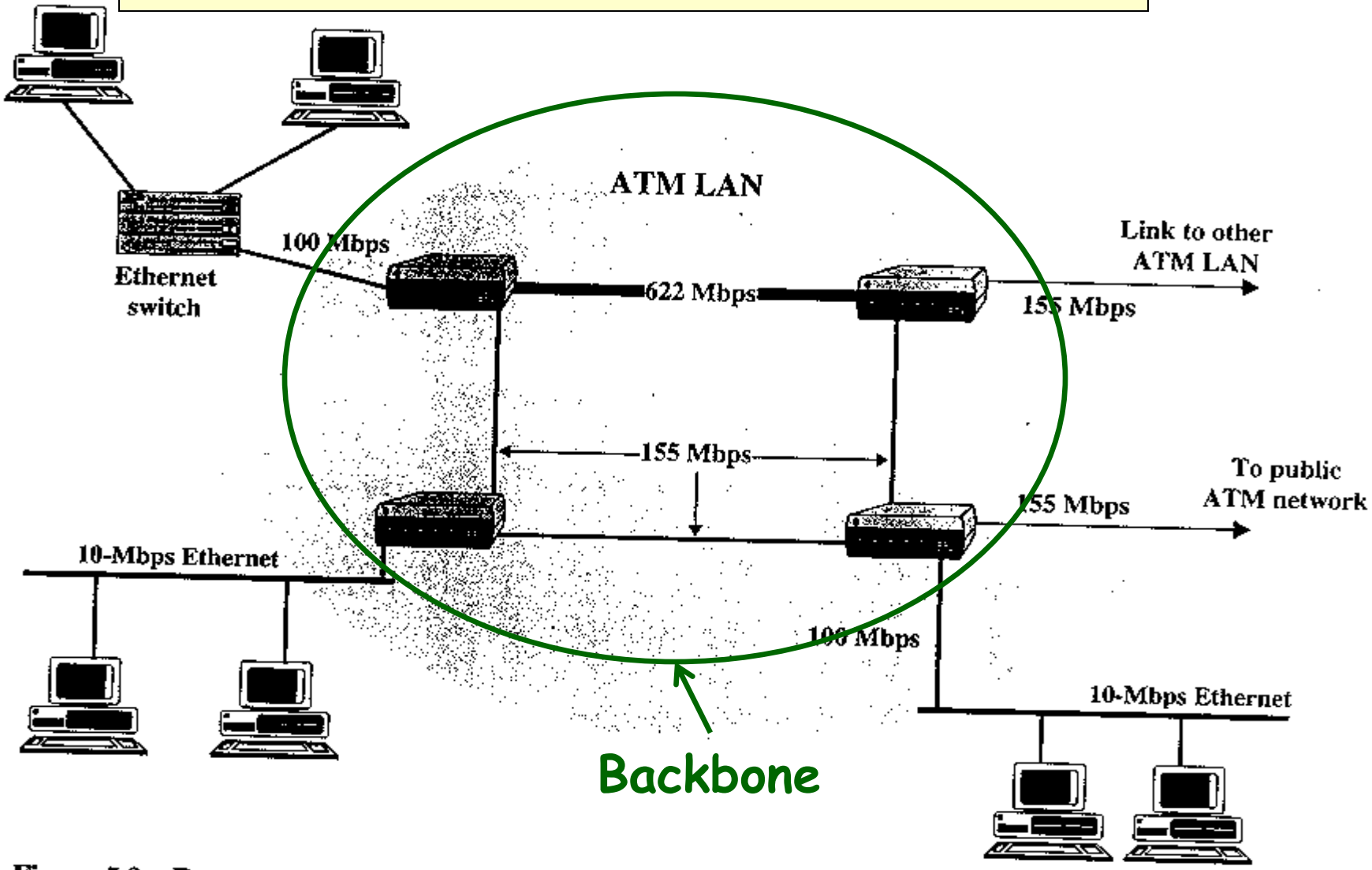


Figure 5.9 Example ATM LAN configuration.

Stallings' "High Speed Networks"

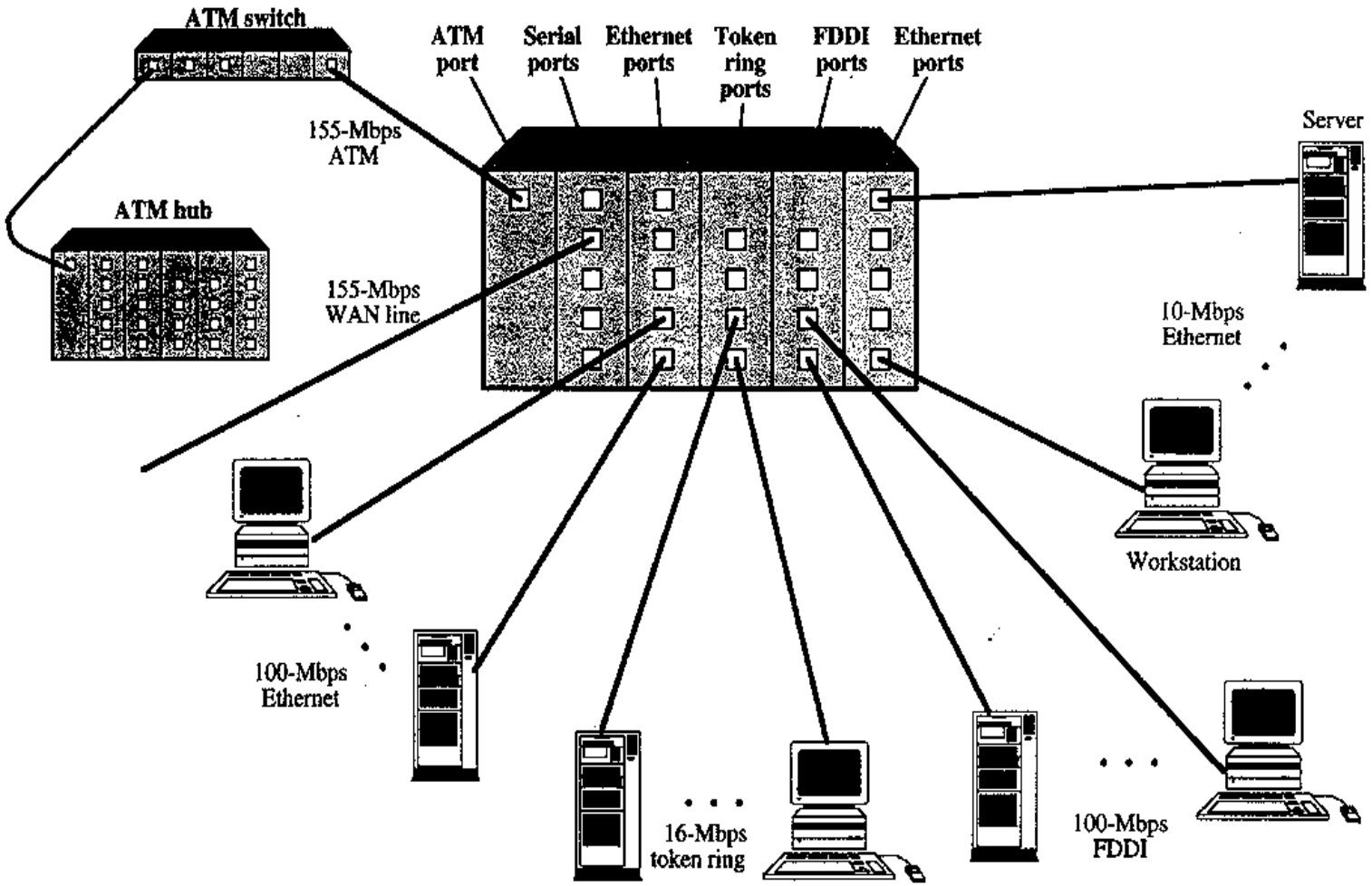
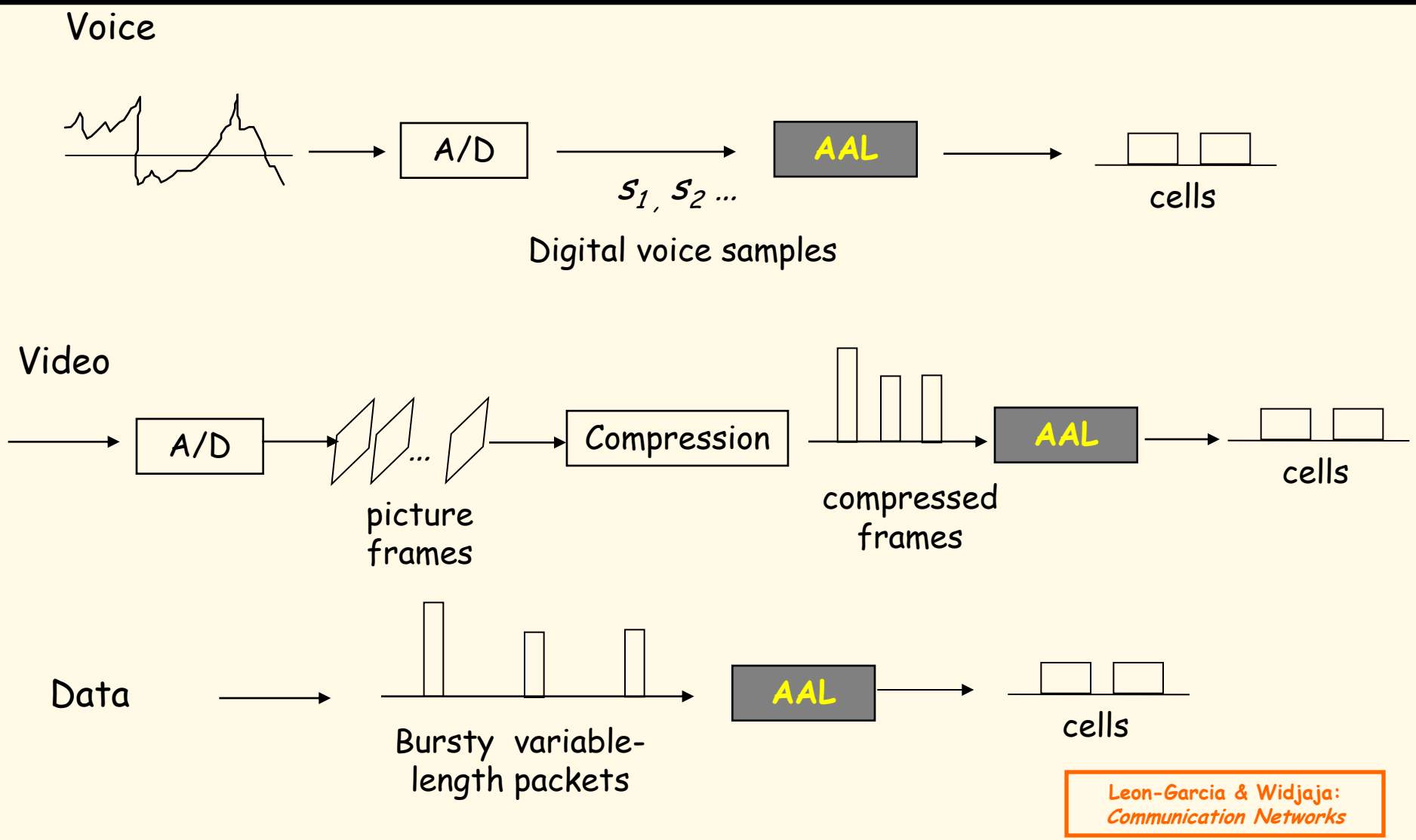


Figure 5.10 ATM LAN hub configuration.

ATM Adaptation Layers



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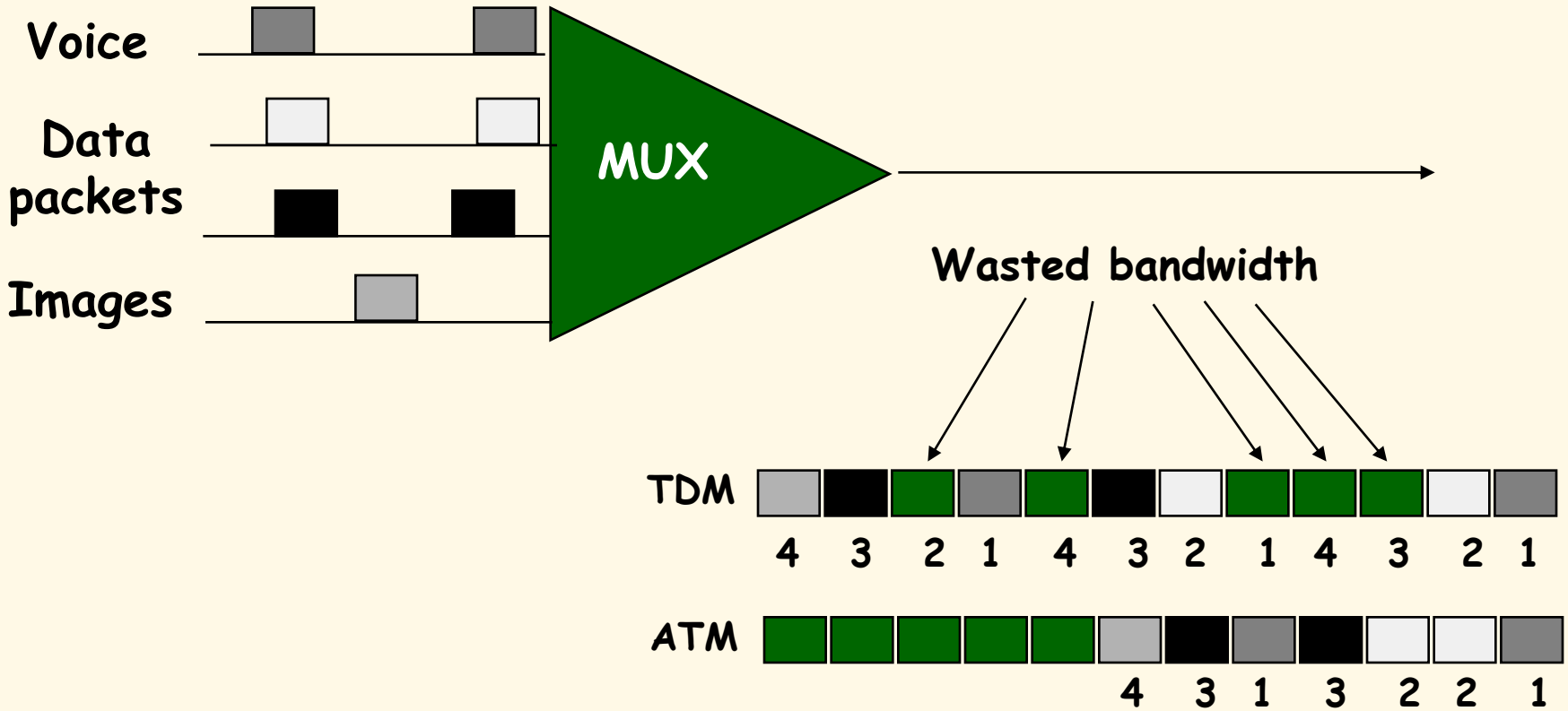
Asynchronous Transfer Mode (ATM)



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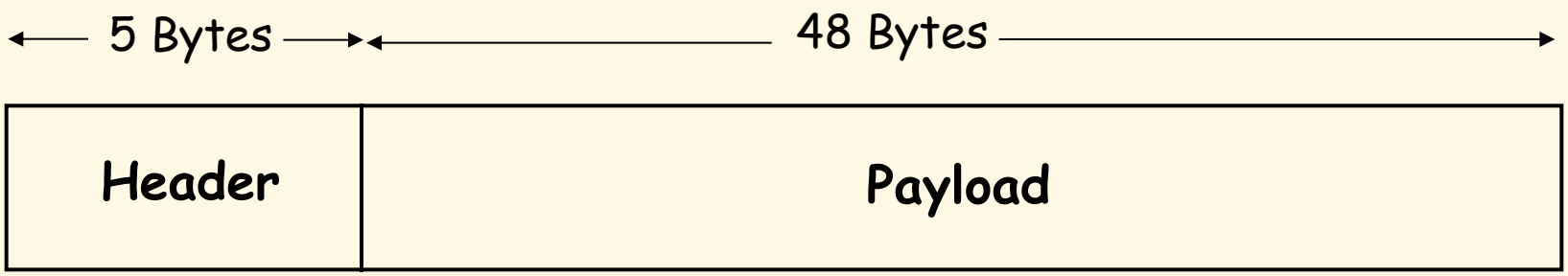
ATM

- ATM standard (defined by CCITT) was widely accepted by common carriers as mode of operation for communication (particularly BISDN).
- ATM is a form of cell switching using small fixed-sized packets.

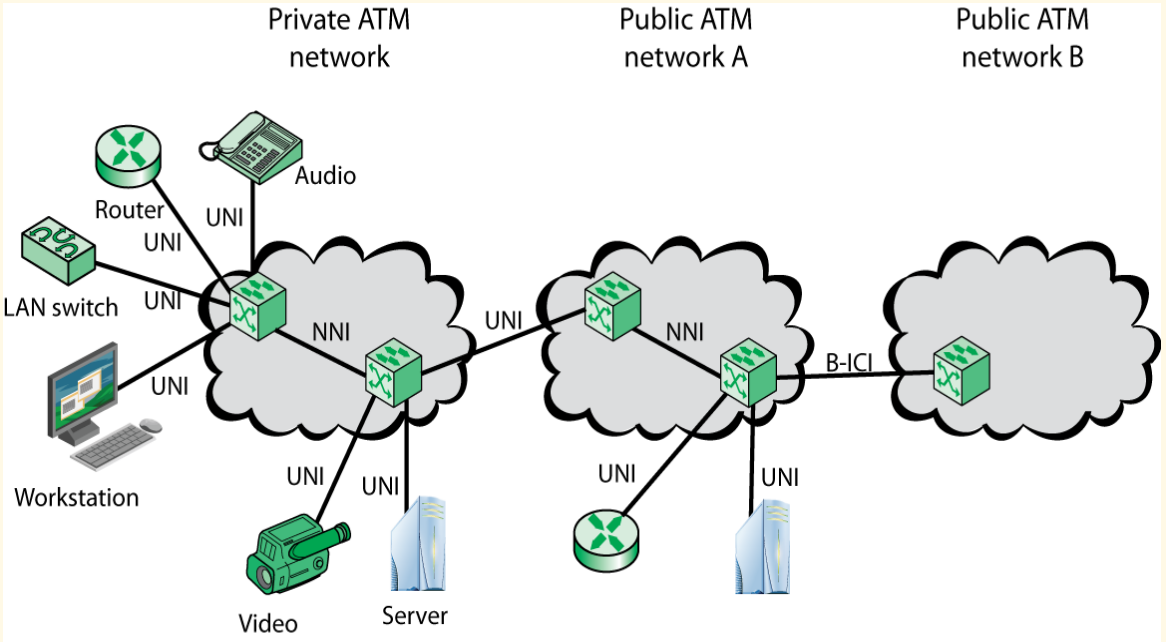
Basic ATM Cell Format



ATM Conceptual Model
Four Design Assumptions

1. ATM network will be organized as a hierarchy.
   - User's equipment connects to networks via a UNI (User-Network Interface).
   - Connections between provided networks are made through NNI (Network-Network Interface).
2. ATM will be connection-oriented.
   - A connection (an ATM channel) must be established before any cells are sent.

ATM Interfaces



B-ICI = broadband intercarrier interface
NNI = network node interface
UNI = user-network interface

Figure 11.3 ATM Interfaces

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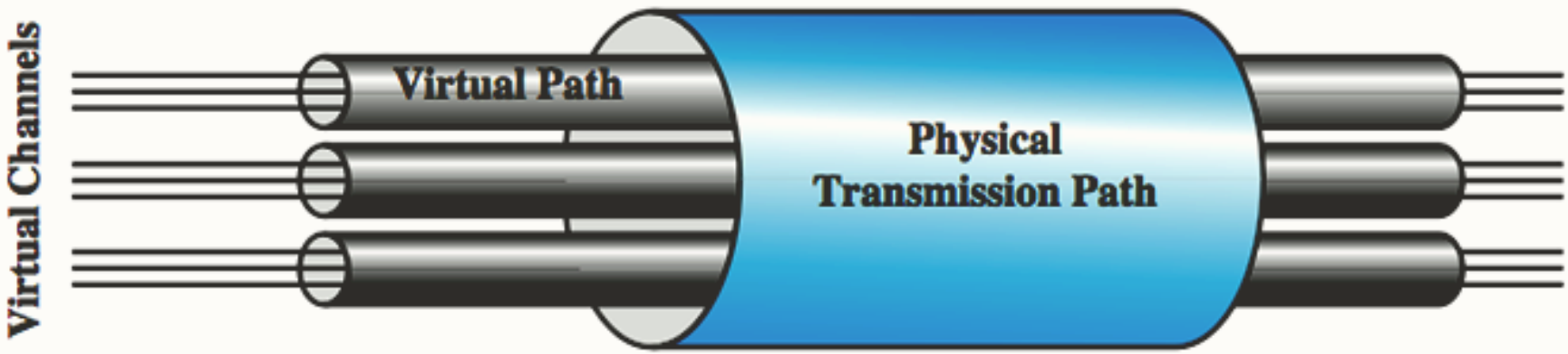
ATM Connections

- two levels of ATM connections:
  - virtual path connections (VPC)
  - virtual channel connections (VCC)
- indicated by two fields in the cell header:
  - *virtual path identifier* VPI
  - *virtual channel identifier* VCI

ATM Virtual Connections

- Virtual Path Connection (VPC)
  - bundle of Virtual Channel Connections (VCC) with same end points.



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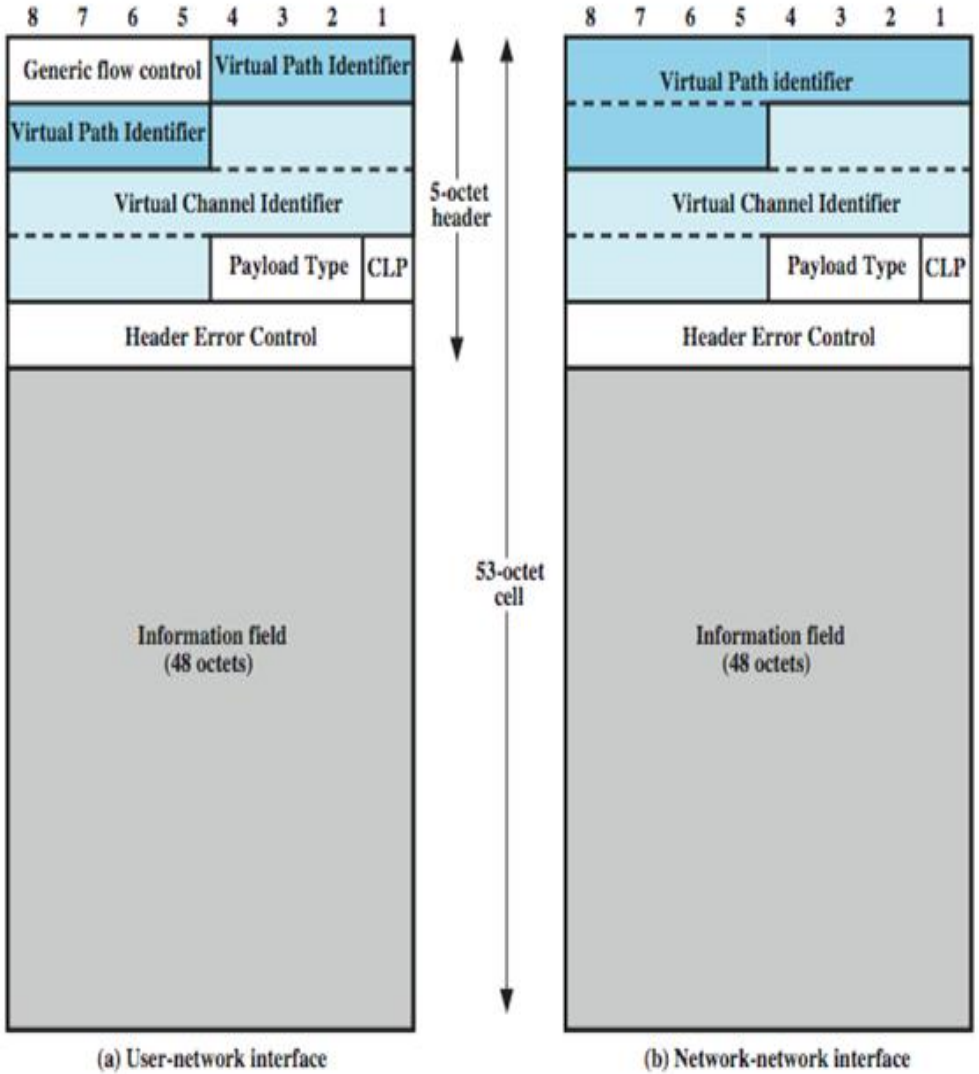
ATM Conceptual Model Assumptions (cont.)

3. Vast majority of ATM networks will run on optical fiber networks with extremely low error rates.
4. ATM must support low cost attachments.
   - This decision lead to a significant decision: to prohibit cell reordering in ATM networks.

     ➔ ATM switch design is more difficult.

ATM Cell Formats



(a) User-network interface

(b) Network-network interface

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Payload Type (PT) Field Coding

PT Coding	Interpretation		
0 0 0	User data cell,	congestion not experienced,	SDU-type = 0
0 0 1	User data cell,	congestion not experienced,	SDU-type = 1
0 1 0	User data cell,	congestion experienced,	SDU-type = 0
0 1 1	User data cell,	congestion experienced,	SDU-type = 1
1 0 0	OAM segment associated cell		
1 0 1	OAM end-to-end associated cell		
1 1 0	Resource management cell		
1 1 1	Reserved for future function		

SDU = Service Data Unit
OAM = Operations, Administration, and Maintenance

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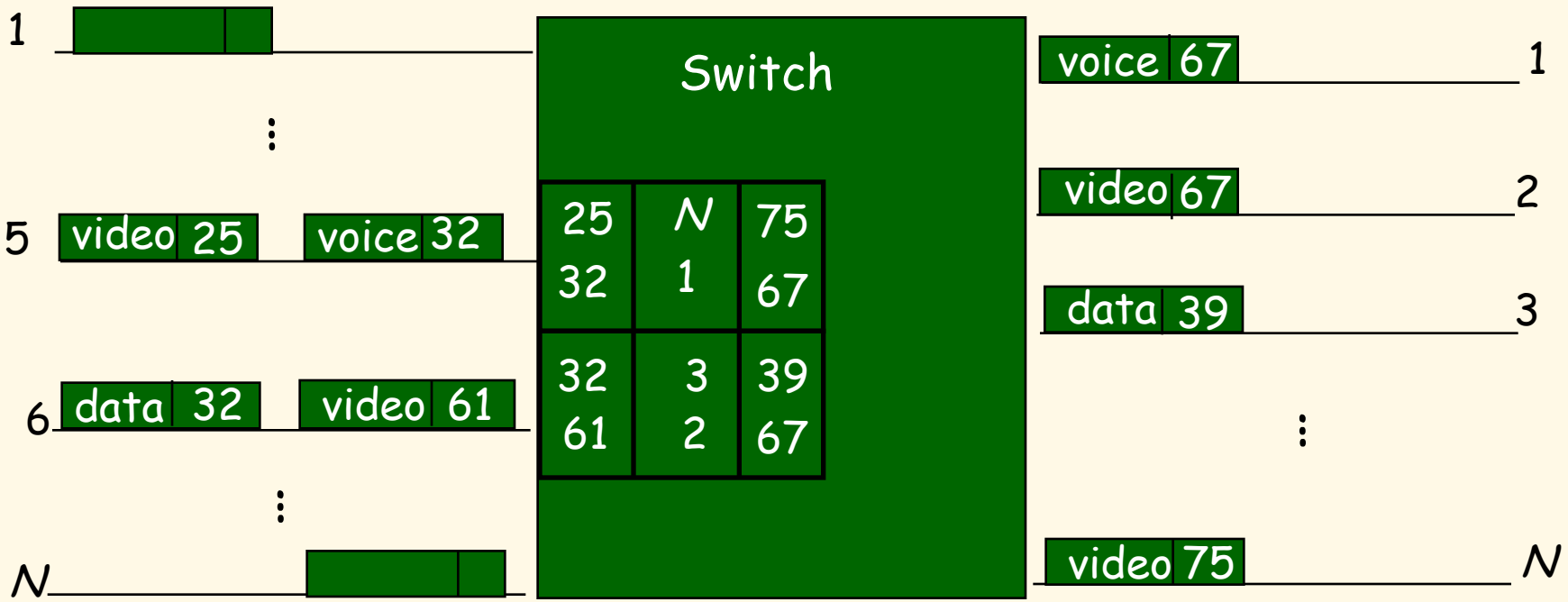
ATM Cell Switching



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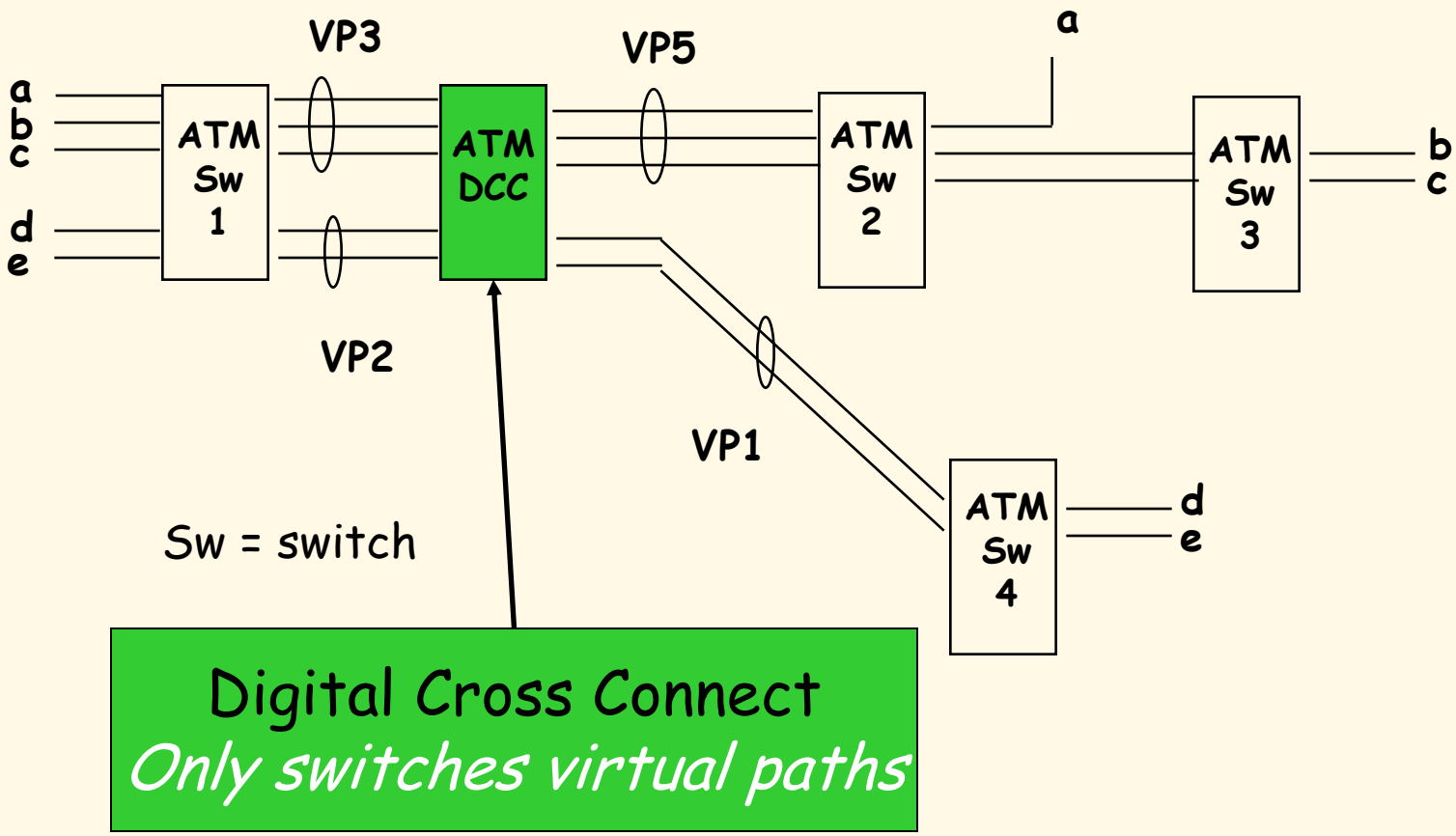
Two Levels of ATM Switches



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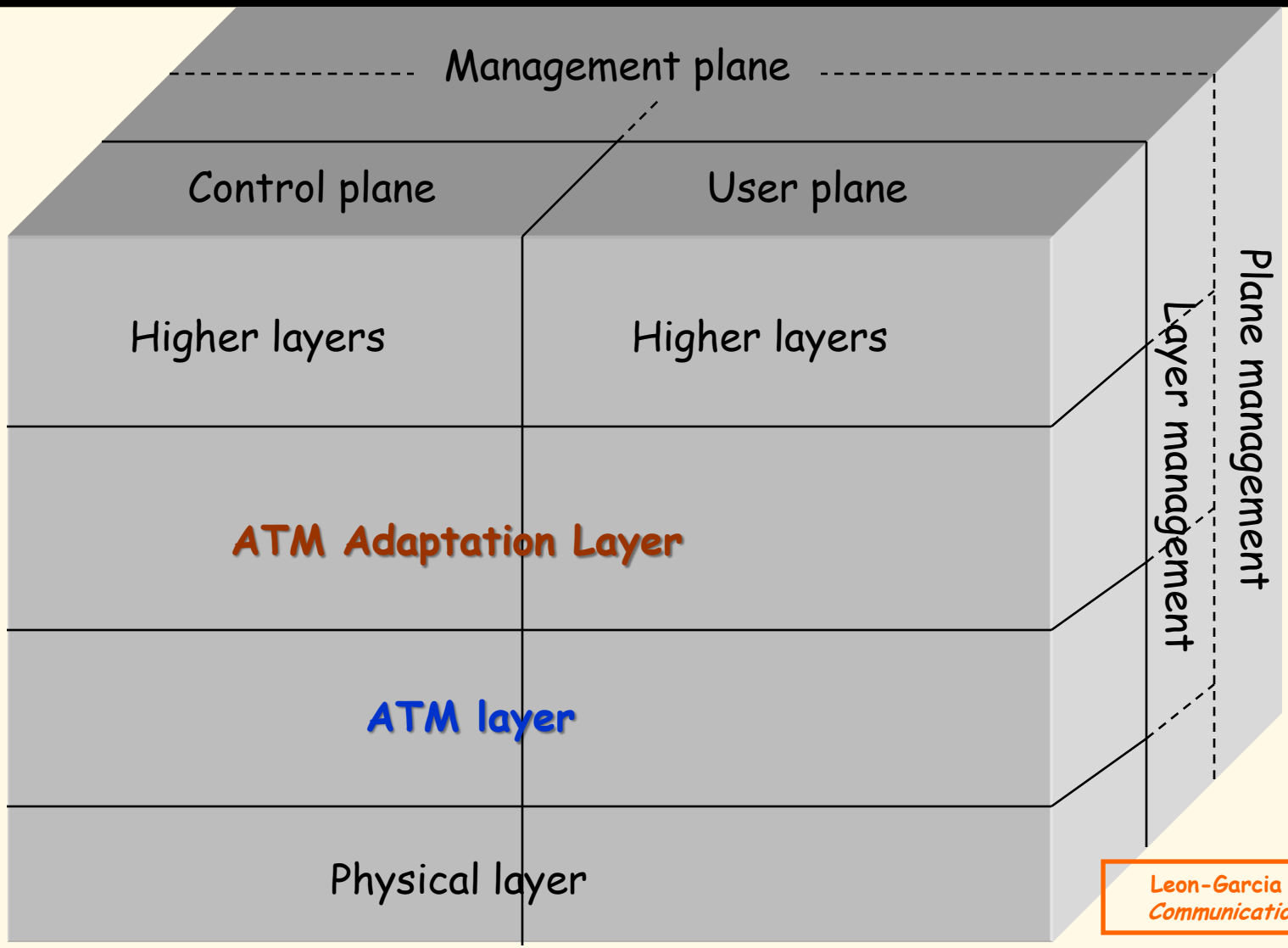
ATM Protocol Architecture

- ATM Adaptation Layers (AAL) – the protocol for packaging data into cells is collectively referred to as AAL.
- Must efficiently package higher level data such as voice samples, video frames and datagram packets into a series of cells.

Design Issue: How many adaptation layers should there be?

ATM Protocol Architecture



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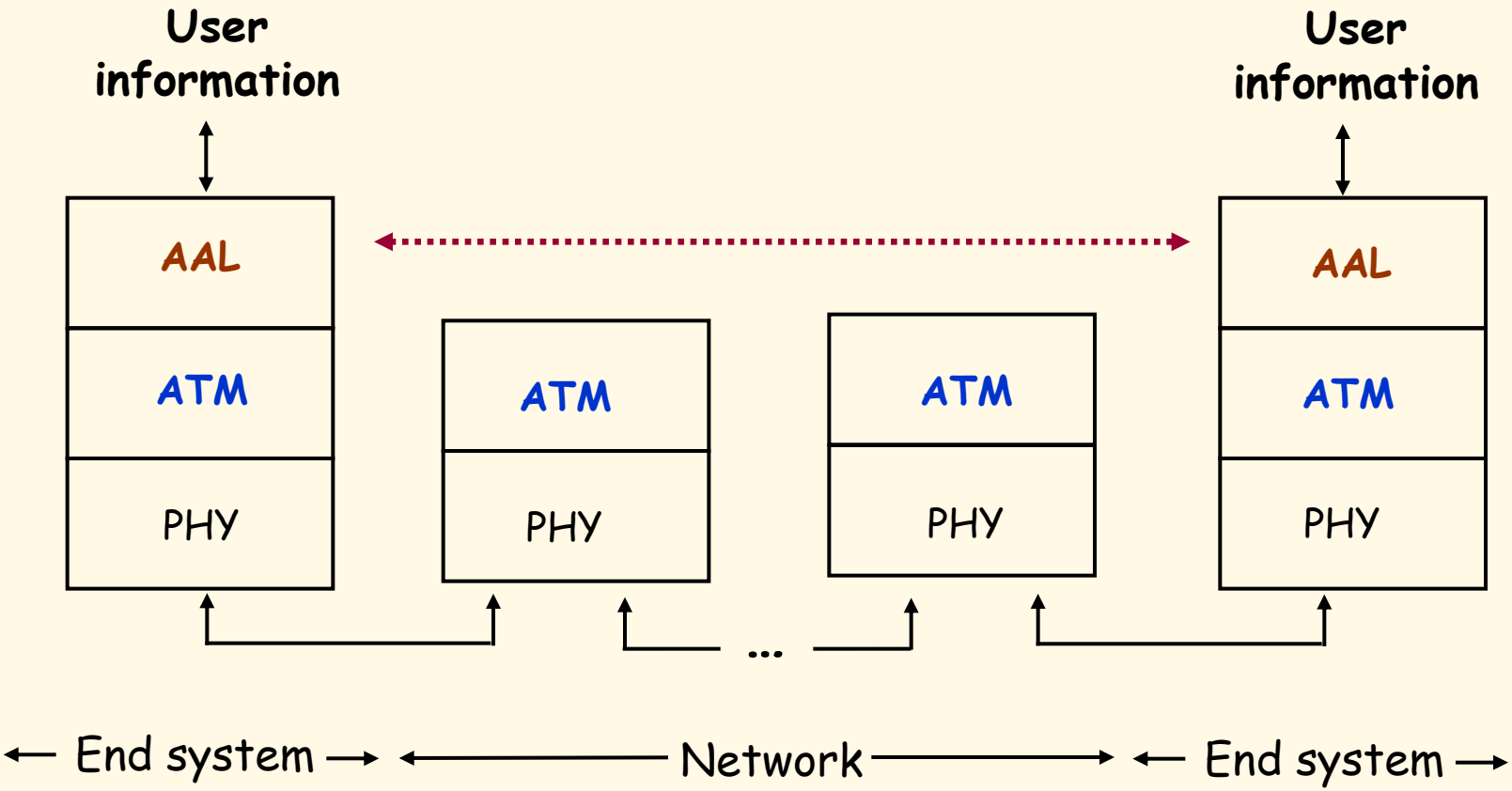
ATM in the Protocol Stack



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Original ATM Architecture

- CCITT envisioned four classes of applications (A-D) requiring four distinct adaptation layers (1-4) which would be optimized for an individual application class:

A. Constant bit-rate applications CBR

B. Variable bit-rate applications VBR

C. Connection-oriented data applications

D. Connectionless data application

ATM Architecture

An AAL was further divided into:

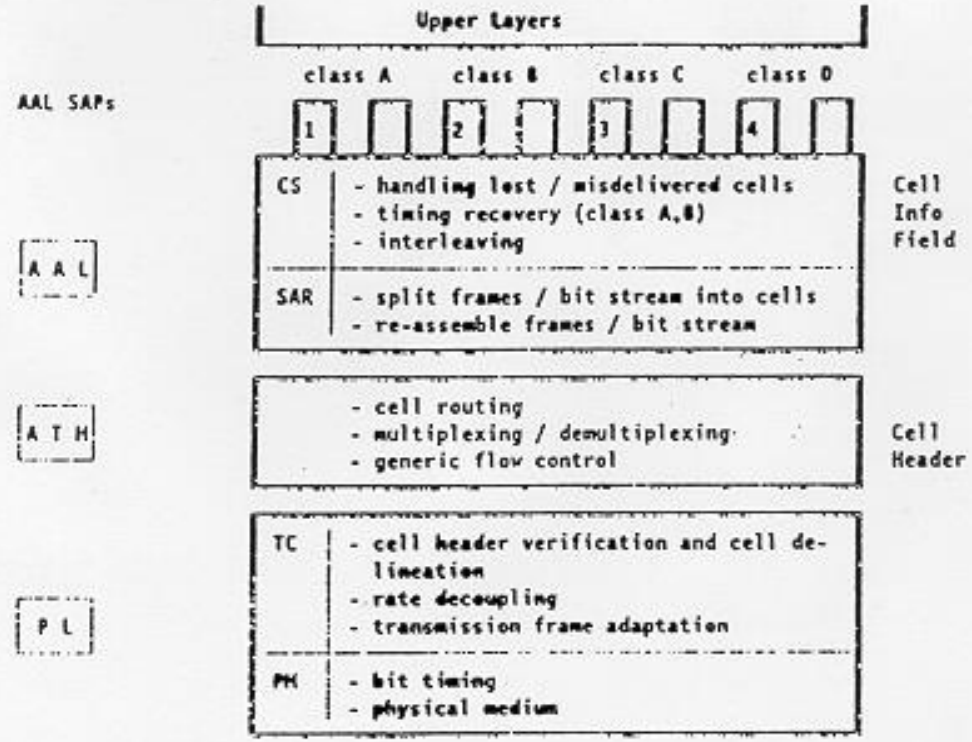
Convergence Sublayer (CS)

manages the flow of data to and from **SAR** sublayer.

Segmentation and Reassembly Sublayer (SAR)

breaks data into cells at the sender and reassembles cells into larger data units at the receiver.

Original ATM Architecture



Abbreviations

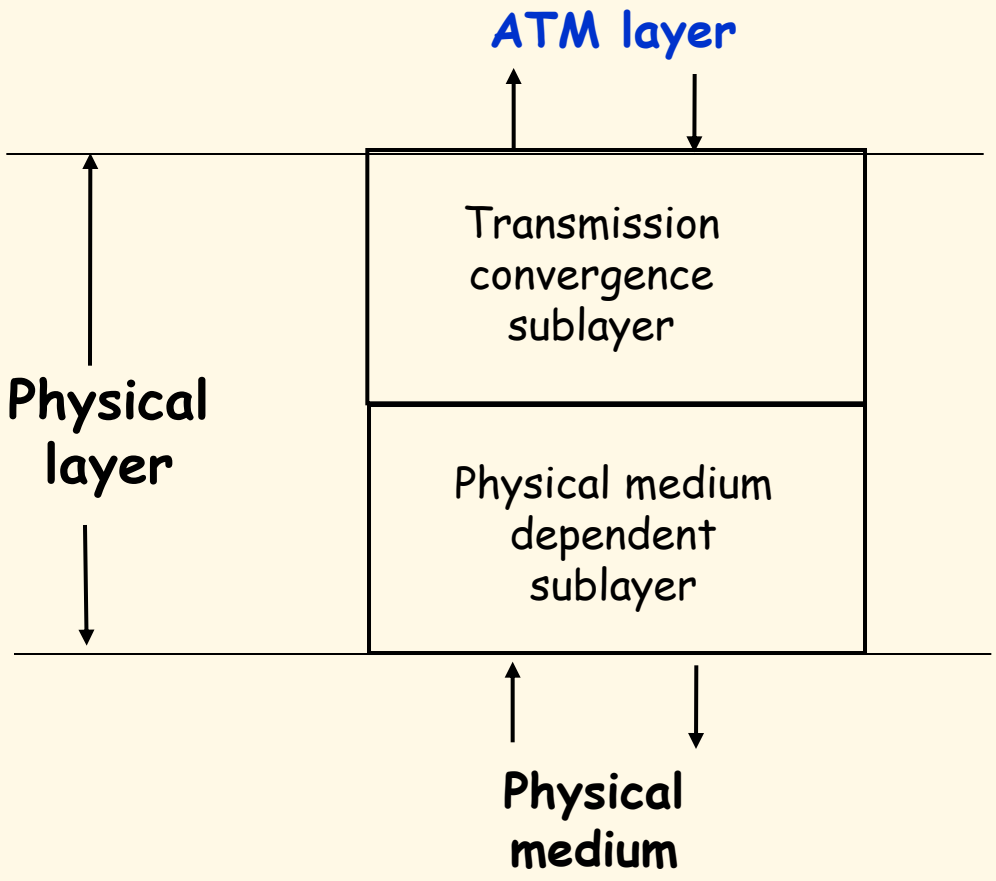
AAL	ATM Adaptation Layer
SAR	Segmentation And Reassembly
CS	Convergence Sub-layer
PL	Physical Layer
TC	Transmission Convergence
PM	Physical Medium

SERVICE CLASSES for AAL

classe	type
A	Constant Bit Rate
B	Variable Bit Rate
C	Connection Oriented Data
D	Connectionless Data

1. Protocol Reference Model in the User Plane. See Section 4.1 for AAl SAP classes (A to D) and values (1 to 4).

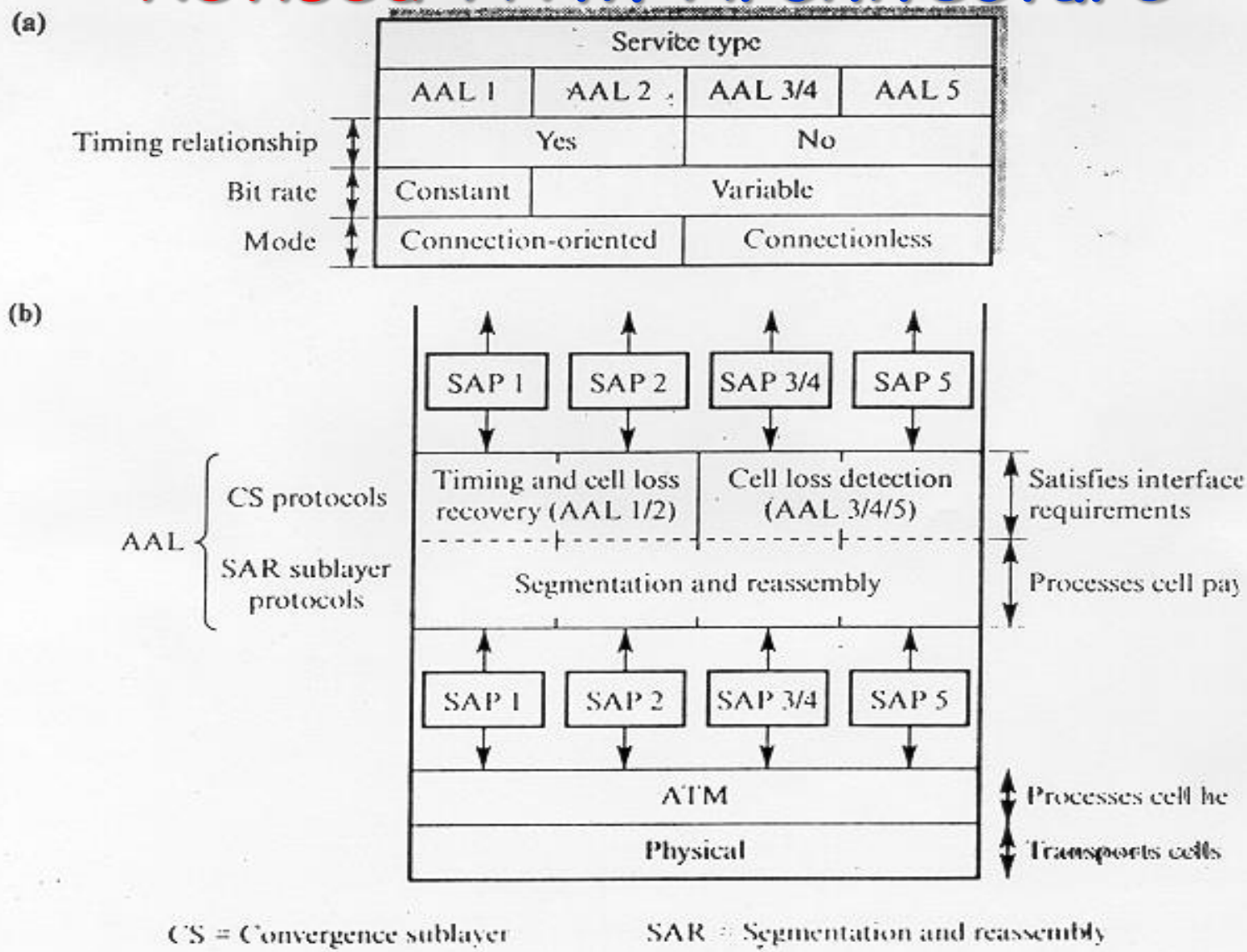
Physical Layer ATM Adjustments



Original ATM Architecture

- The AAL interface was initially defined as classes A-D with SAP (Service Access Points) for AAL1-4.
- AAL3 and AAL4 were so similar that they were merged into AAL3/4.
- The data communications community concluded that AAL3/4 *was not suitable* for data communications applications. They pushed for standardization of AAL5 (also referred to as SEAL – the Simple and Efficient Adaptation Layer).
- AAL2 was not *initially* deployed.

Revised ATM Architecture



Revised ATM Service Categories

Class	Description	Example
CBR	Constant Bit Rate	T1 circuit
RT-VBR	Real Time Variable Bit Rate	Real-time videoconferencing
NRT-VBR	Non-real-time Variable Bit Rate	Multimedia email
ABR	Available Bit Rate	Browsing the Web
UBR	Unspecified Bit Rate	Background file transfer

QoS, PVC, and SVC

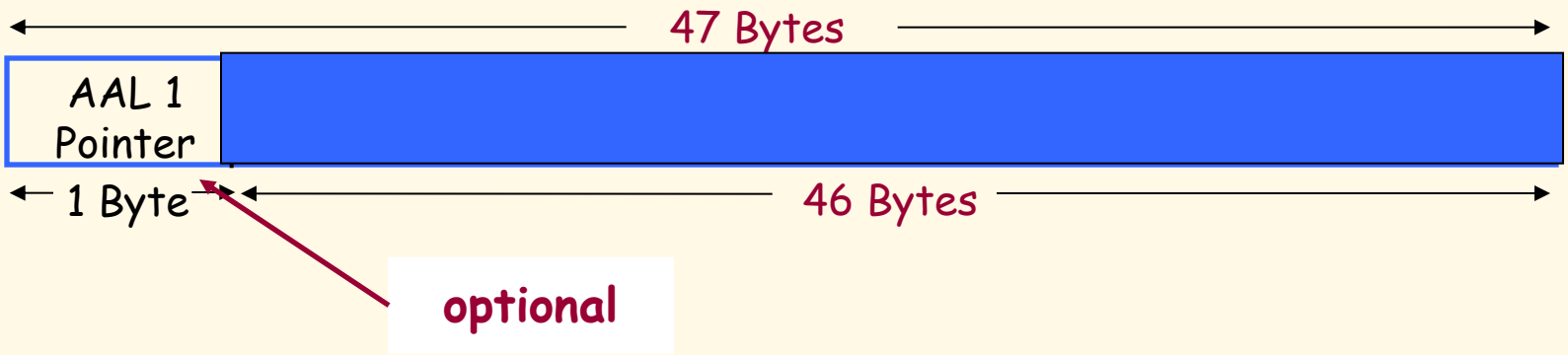
- Quality of Service (QoS) requirements are handled at connection time and viewed as part of signaling (e.g., RSVP).
- ATM provides permanent virtual connections and switched virtual connections.
  - Permanent Virtual Connections (PVC)

    permanent connections set up *manually* by network manager.
  - Switched Virtual Connections (SVC)

    set up and released *on demand* by the end user via signaling procedures.

AAL 1

(b) CS PDU with pointer in structured data transfer



(a) SAR PDU header

CSI	Seq. Count	SNP
1 bit	3 bits	4 bits

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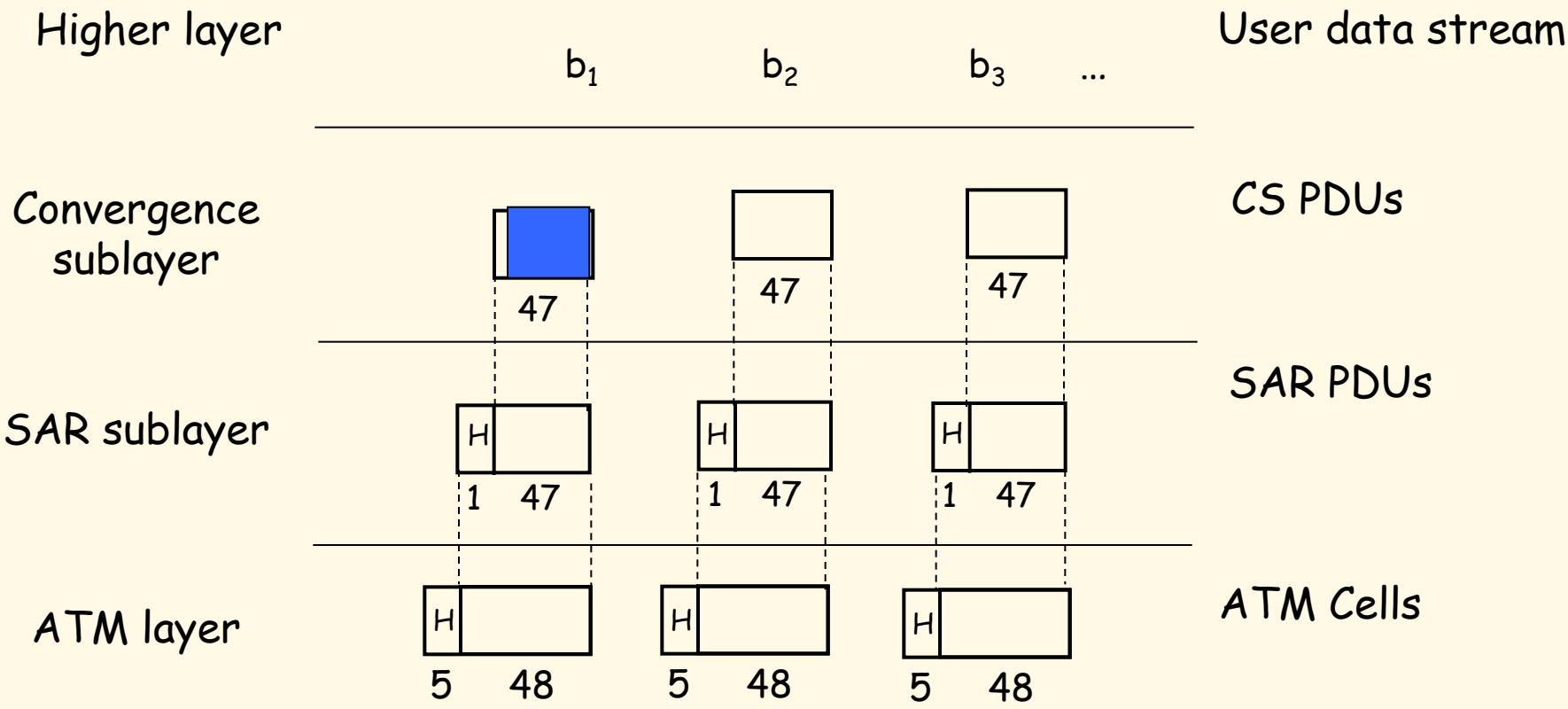
AAL 1



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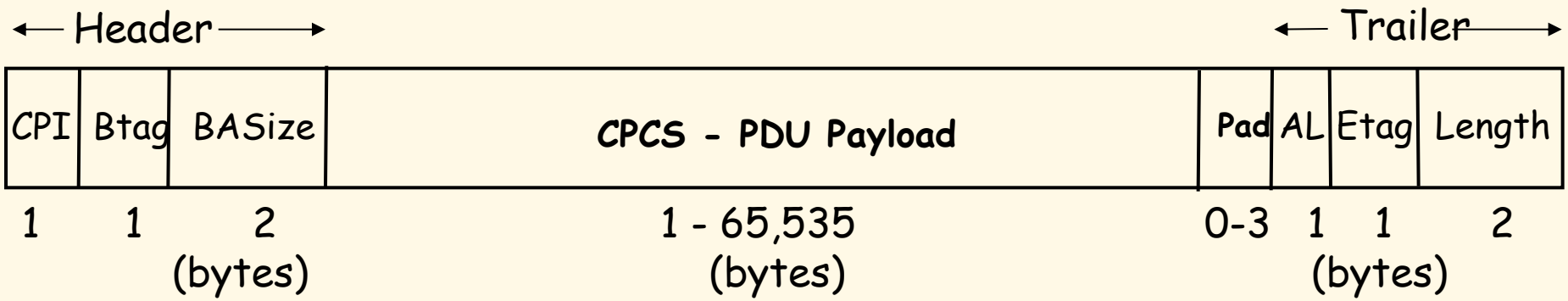
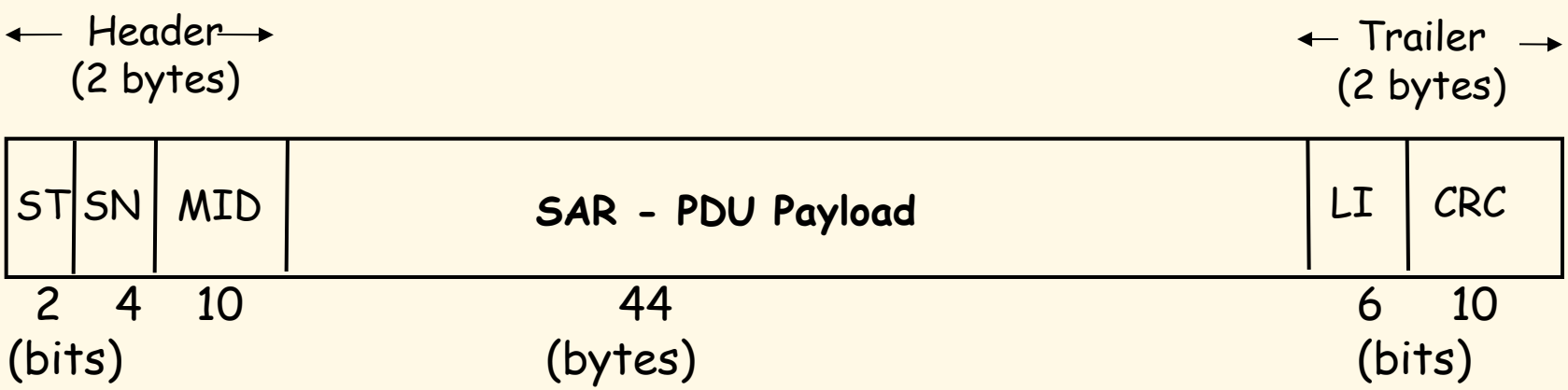
AAL 3/4 CS and SAR PDUs

(a) CPCS-PDU format



(b) SAR PDU format



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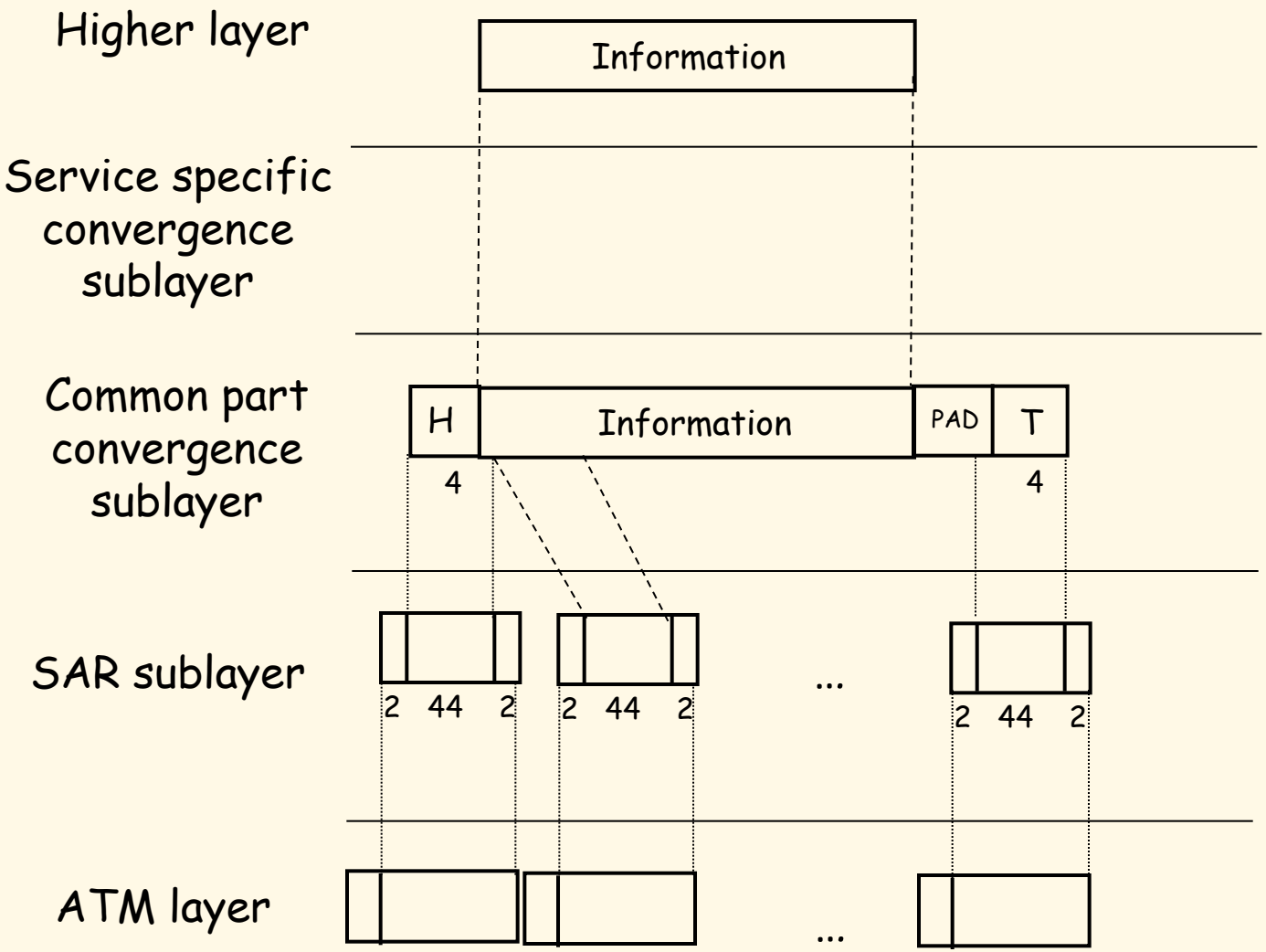
AAL 3/4



User message

Assume null

Pad message to multiple of 4 bytes. Add header and trailer.

Each SAR-PDU consists of 2-byte header, 2-byte trailer, and 44-byte payload.

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AAL 5

Convergent Sublayer Format

Information	Pad	UU	CPI	Length	CRC
0 - 65,535 (bytes)	0-47	1	1	2 (bytes)	4

SAR Format

ATM Header	48 bytes of Data

1-bit end-of-datagram field (PTI)

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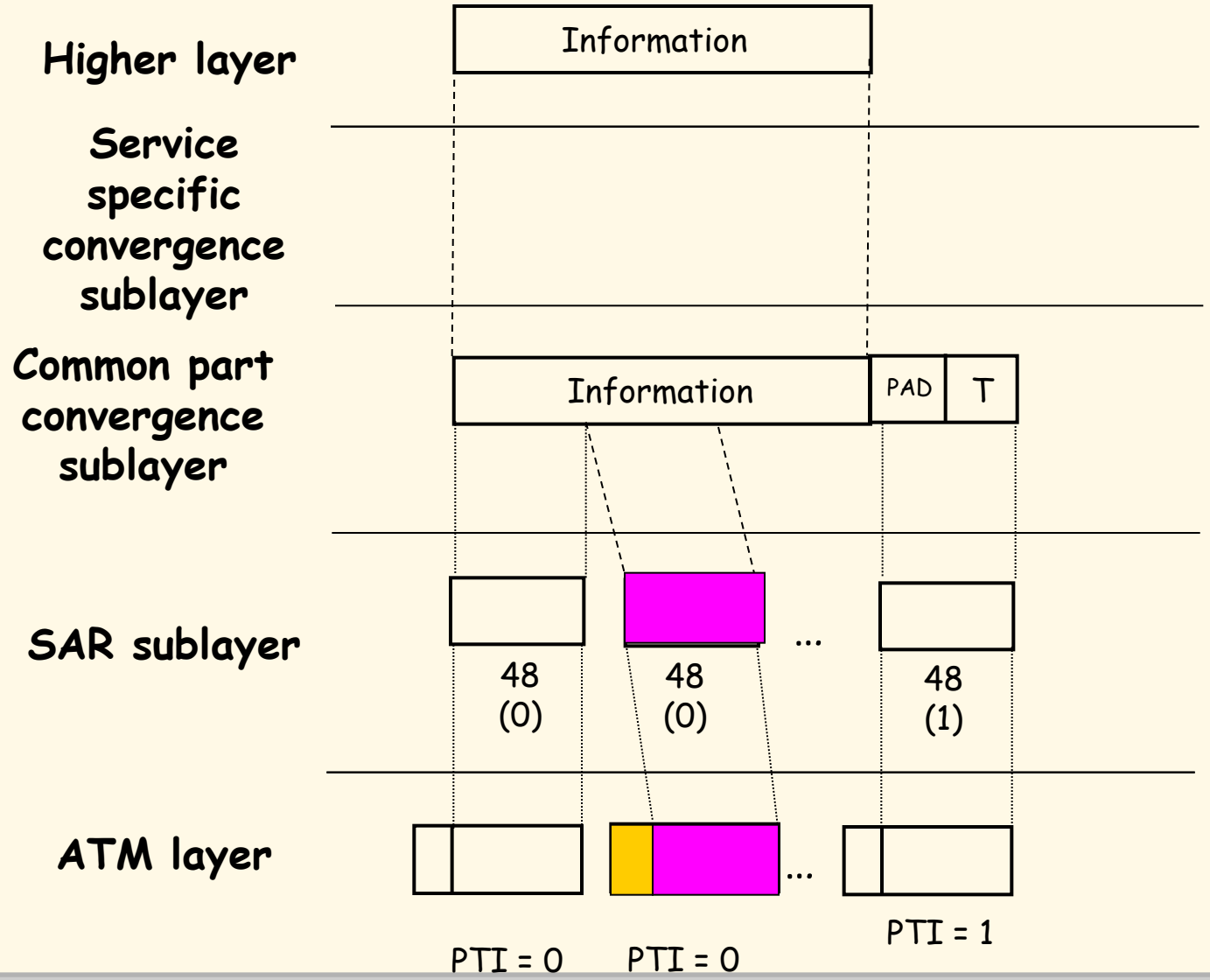
AAL 5



Assume null

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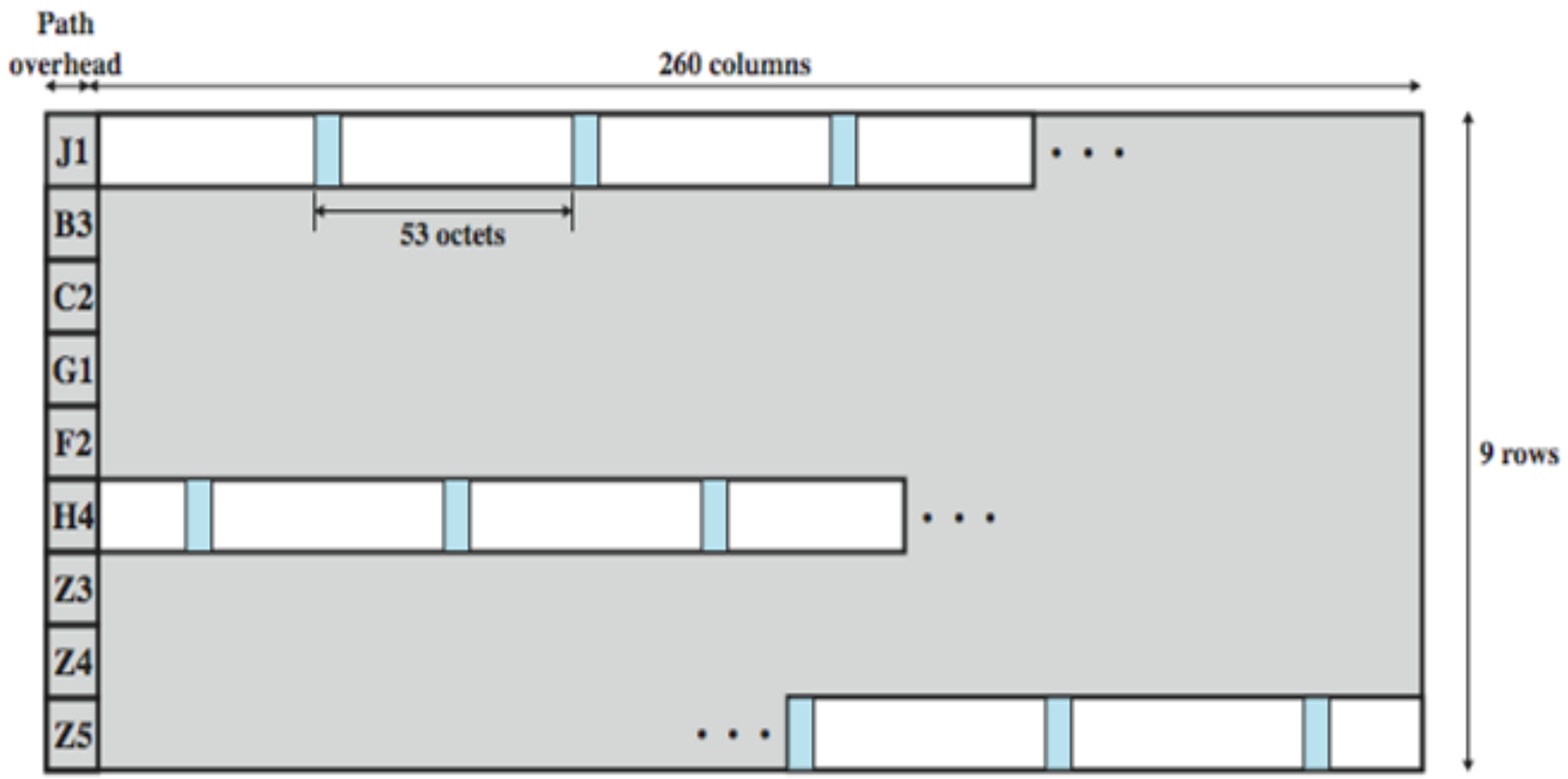
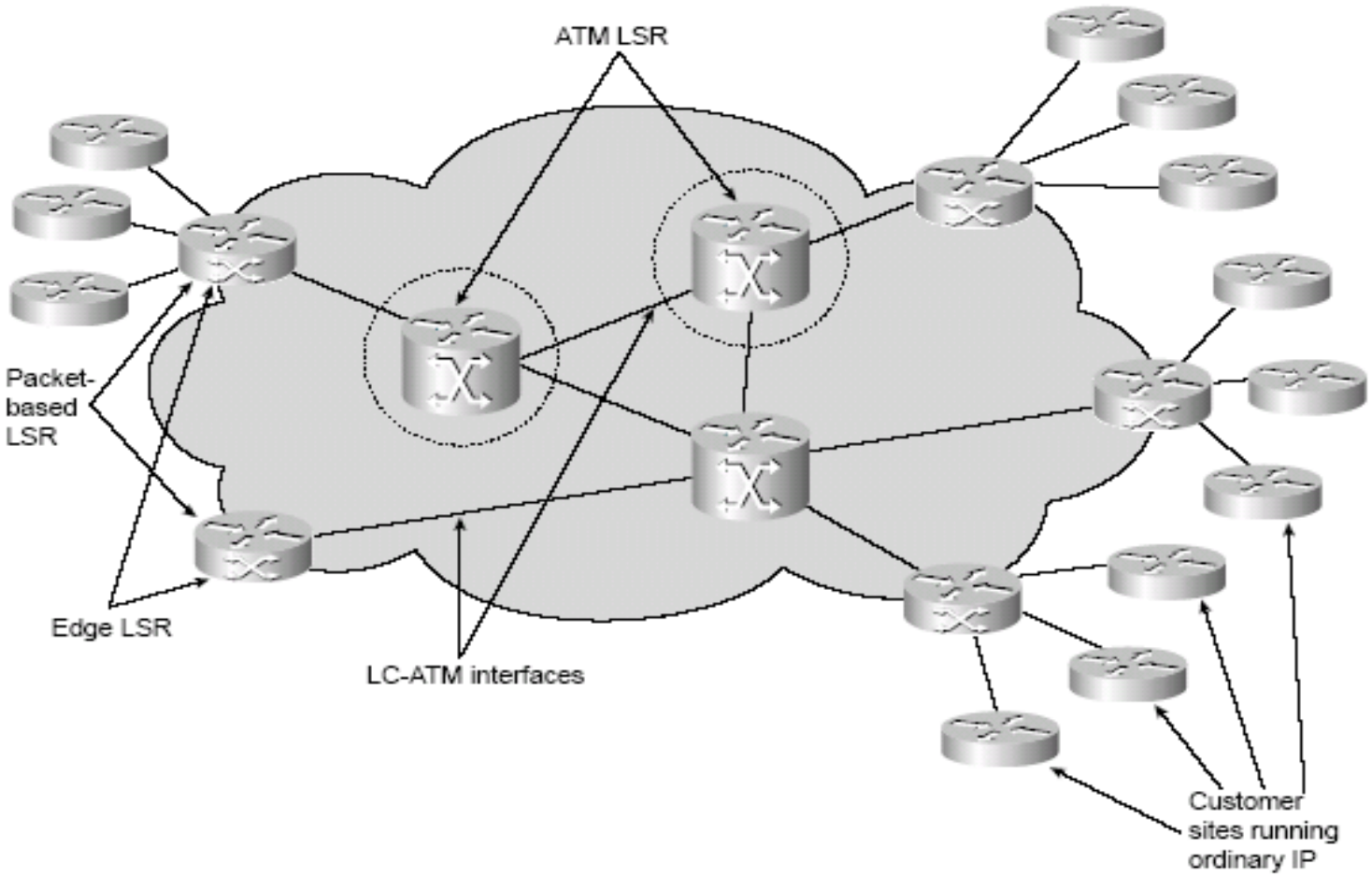
STM-1 (STS-3) Payload for SDH-Based ATM Cell Transmission



MPLS (Multi Protocol Label Switching)

Figure 6-1 *MPLS Network Elements*



The Nortel Networks Passport 8600 Routing Switch

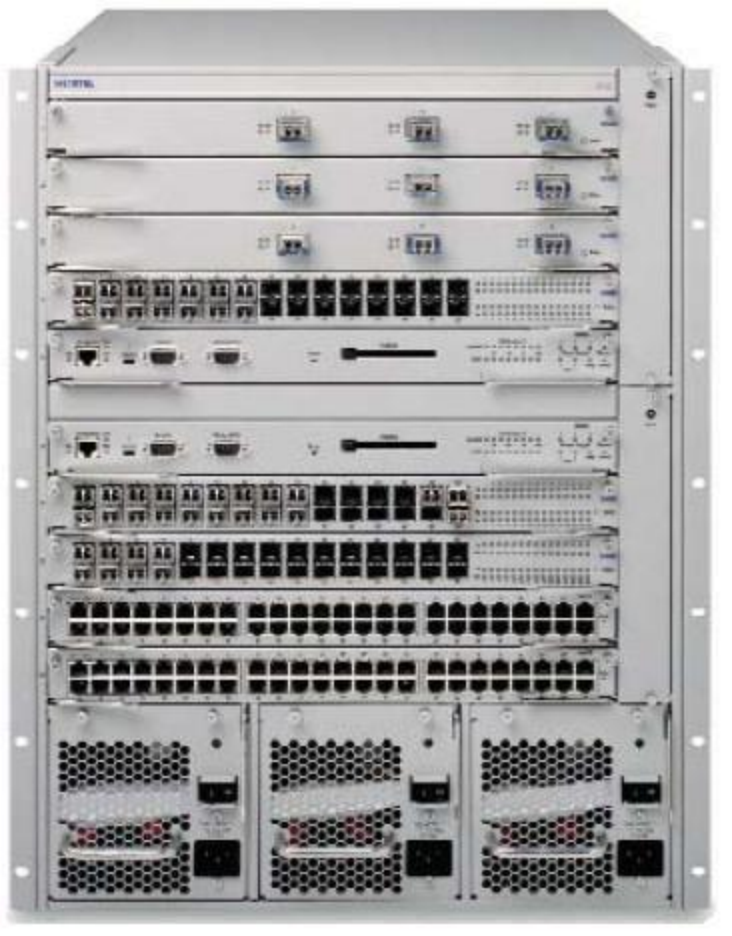
- designed for high-performance Enterprise, carrier, and service provider networks.
- As a chassis based Ethernet switching platform, the Passport 8600 series provides wire speed L2-L7 traffic classification, filtering, forwarding and routing. Hardware based wire speed performance enables fast and efficient traffic classification, policy enforcement and filtering.
- Provides wire speed L2- L7 traffic classification.

The Nortel Networks Passport 8600 Routing Switch

- Multi-layer redundancy with five 9's reliability
- Integrated intelligent bandwidth connectivity for 10/100/1000 Ethernet, ATM, PoS,10 Gig and WDM
- Seamless LAN/MAN/WAN connectivity
- Eight policy enabled hardware queues per port
- 512 Gigabits per second backplane switch capacity.

Nortel Ethernet Routing Switch 8600

- **Avaya Switch ERS 8600**
- Configurable as a 1.440 Terabit Switch cluster using SMLT
- **10 Gigabit Ethernet**
- **Packet Over SONET**
  6 OC-3 or 3 OC-12 ports
- ATM
- 4 firewall or IDS



ATM Summary

- Motivation for ATM Architecture
- Four Design Assumptions
- ATM Hierarchy
  - UNI,NNI, VPI, VCI, two switch levels
- Old ATM Design
  - Convergence Sublayer (CS), Segmentation and Reassembly Sublayer (SAR)
- ATM Adaptation Layers
  - AAL1-4

ATM Summary

- New ATM Design
  - PVC, SVC
- AAL Details
  - AAL1, AAL3-4, AAL5
- Multi-Protocol Layer Switching (MPLS)
  - Passport Switch