

Asynchronous Transfer Mode (ATM)



Advanced Computer Networks

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.
- commonly used to implement WANs.
- DSL uses ATM for multiplexing and switching.
- used as a backbone in IP networks and Internet.

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Issues Driving LAN Changes

- Traffic Integration
 - Voice, video and data traffic
 - **Multimedia** became the 'buzz word'
 - 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"

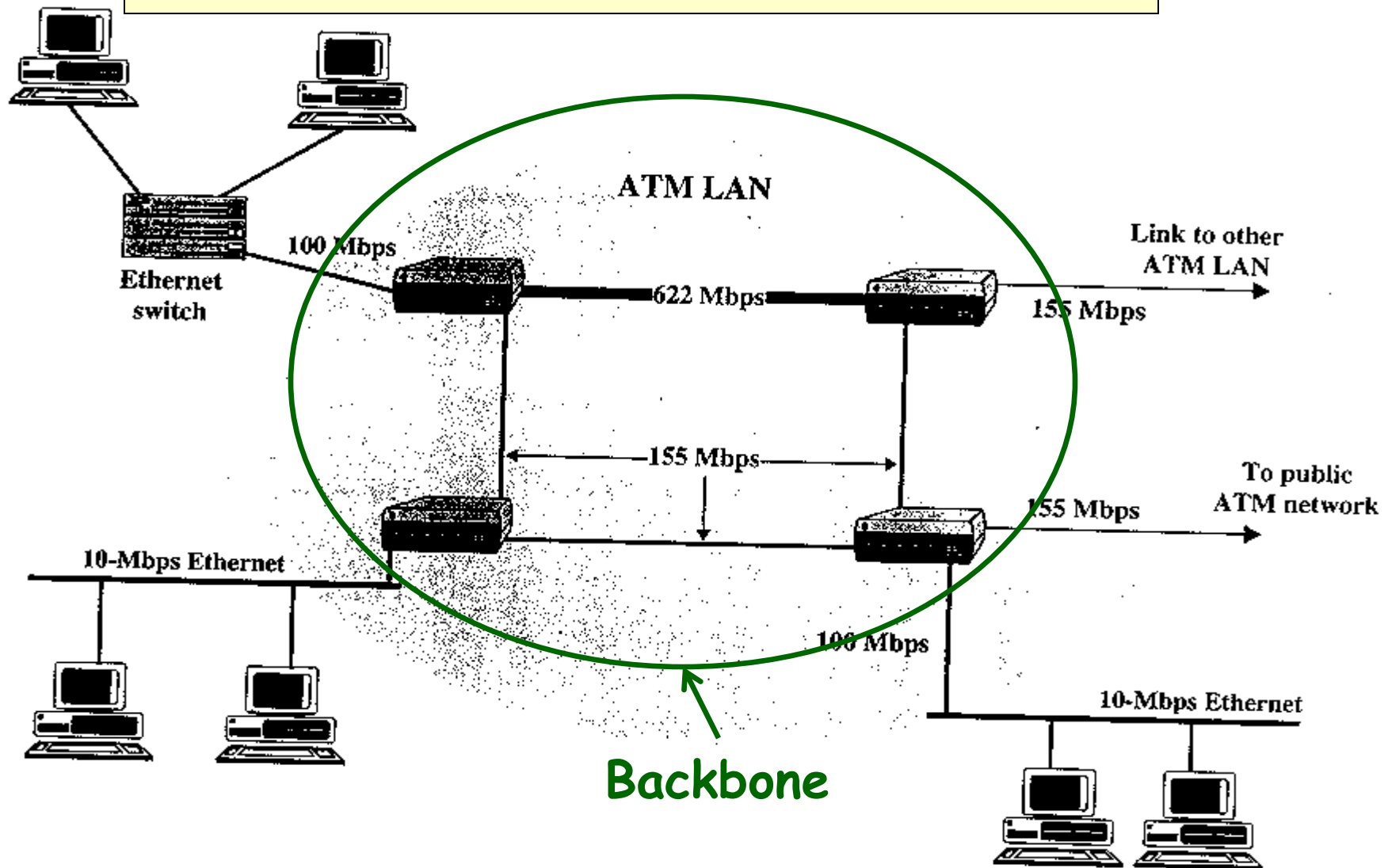


Figure 5.9 Example ATM LAN configuration.

Stallings' "High Speed Networks"

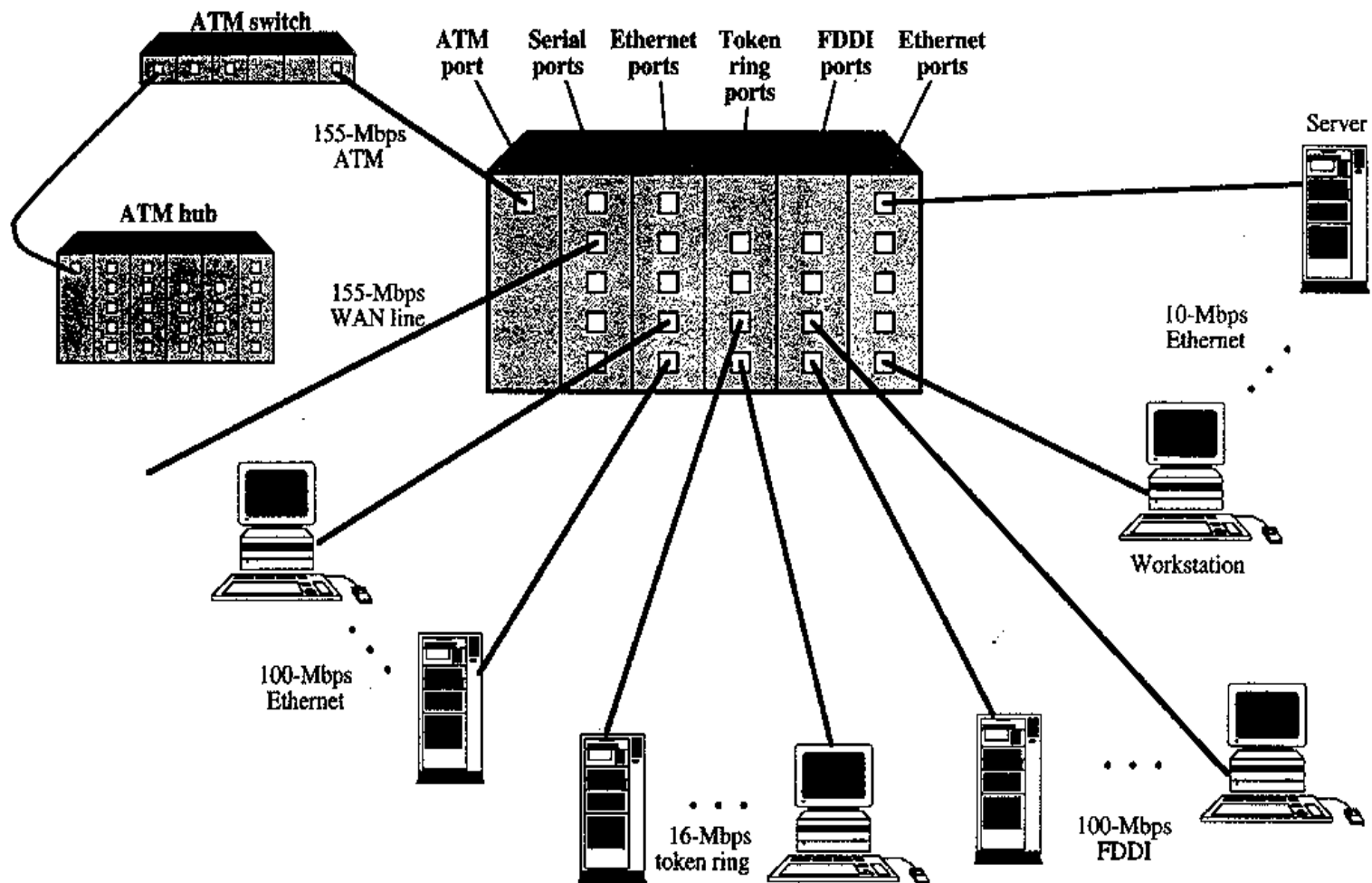
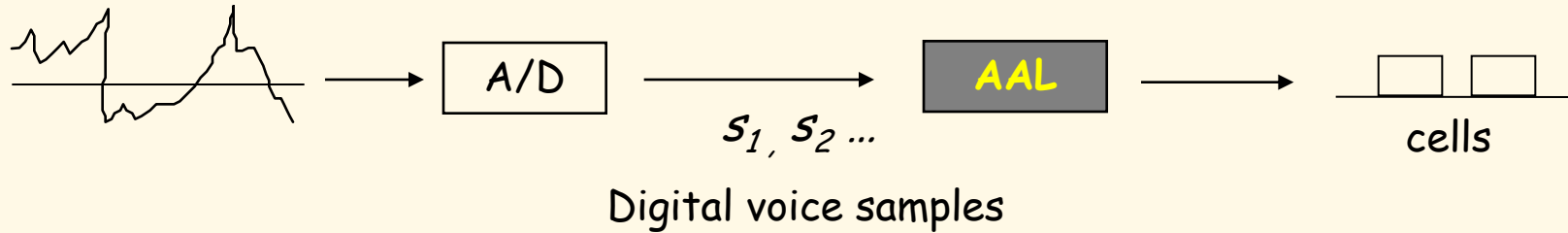


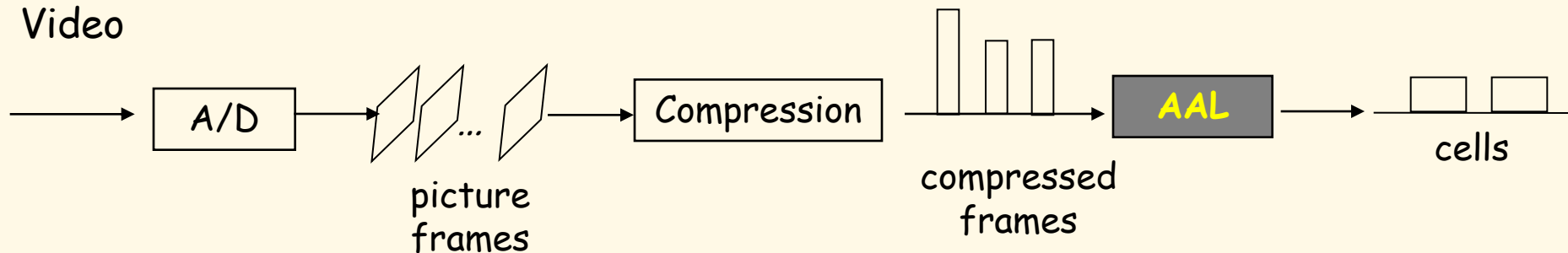
Figure 5.10 ATM LAN hub configuration.

ATM Adaptation Layers

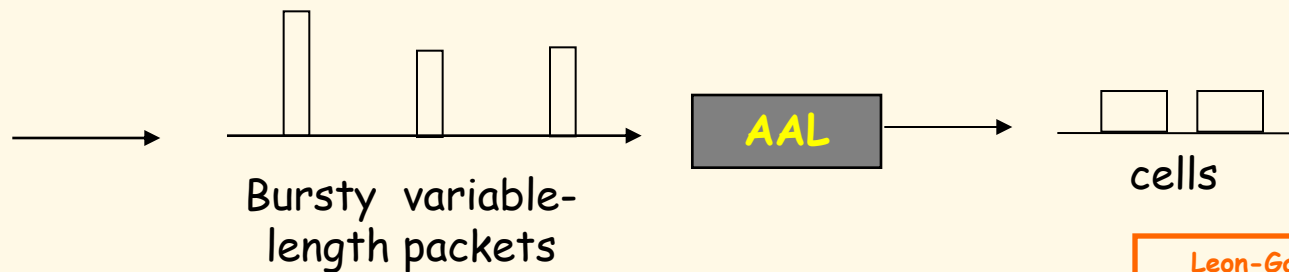
Voice



Video

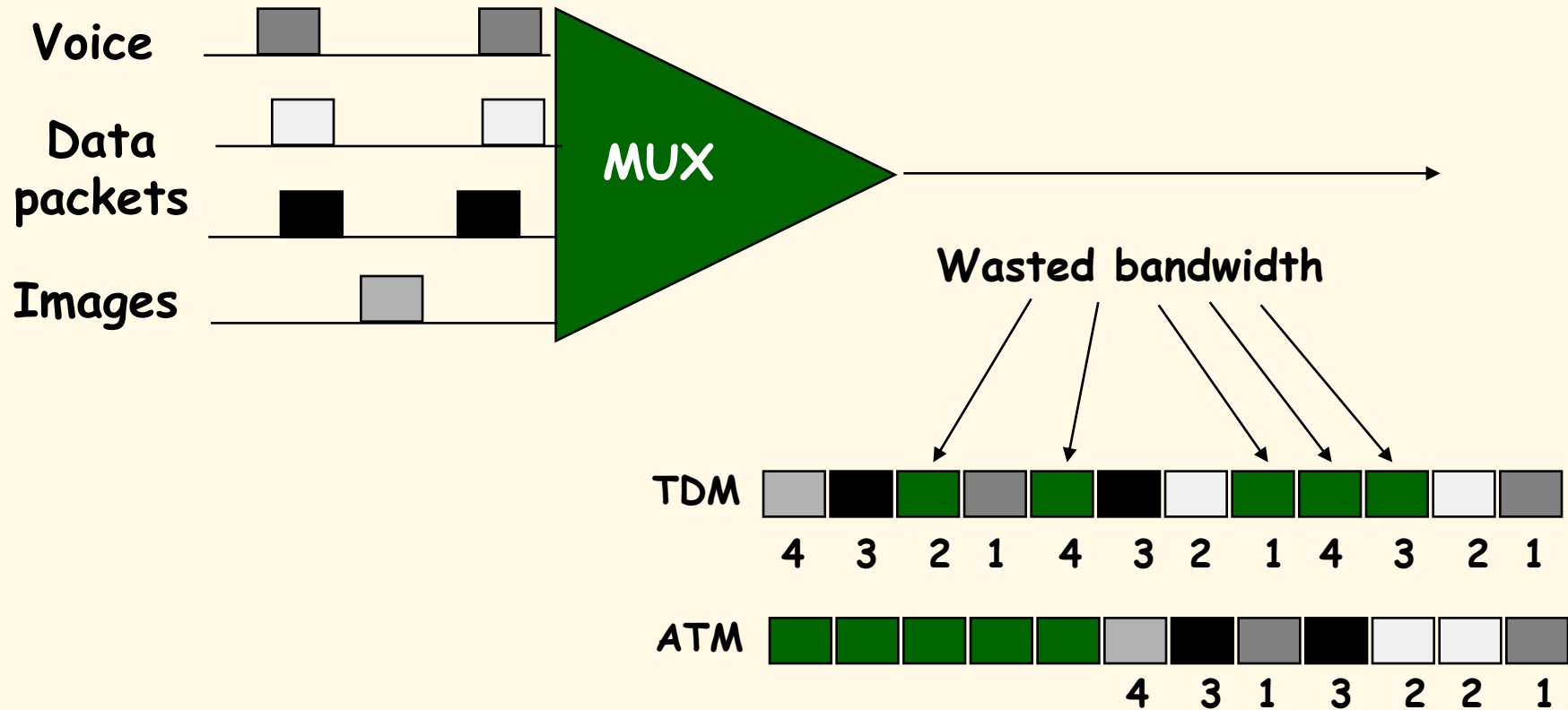


Data



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Asynchronous Transfer Mode (ATM)

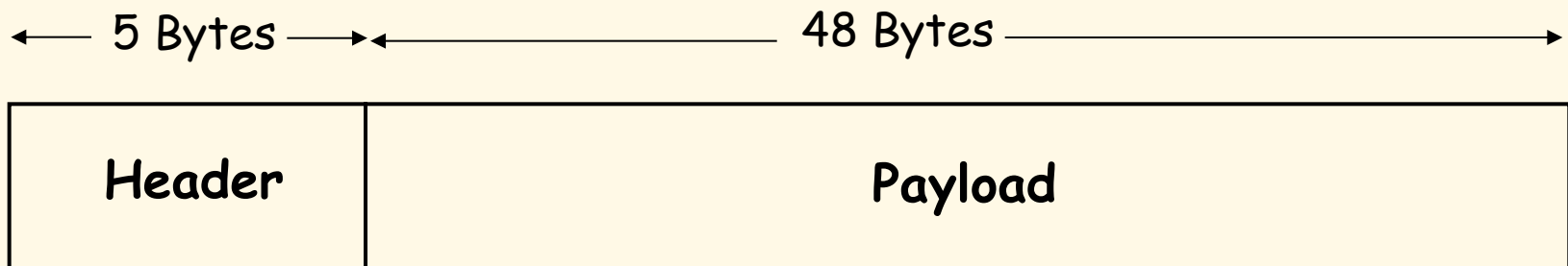


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ATM

- 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

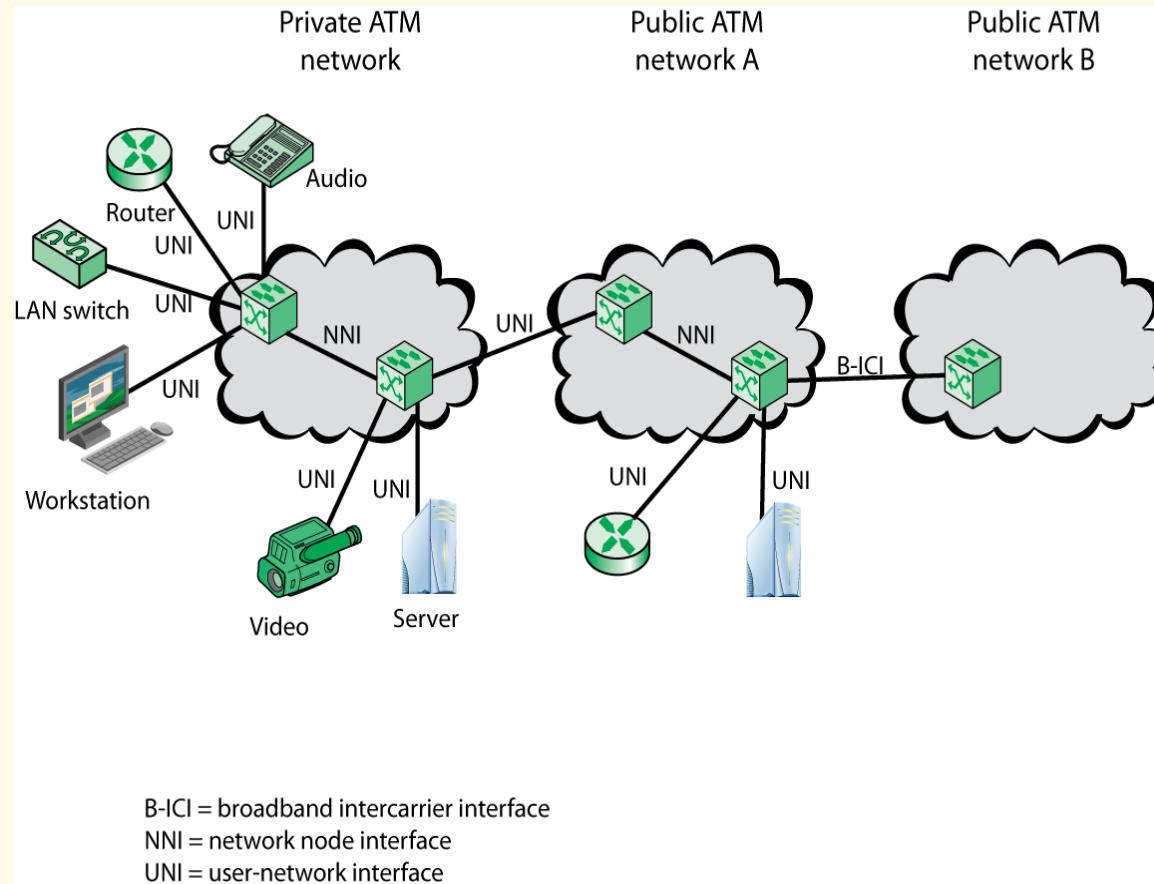


Figure 11.3 ATM Interfaces

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ATM Connections

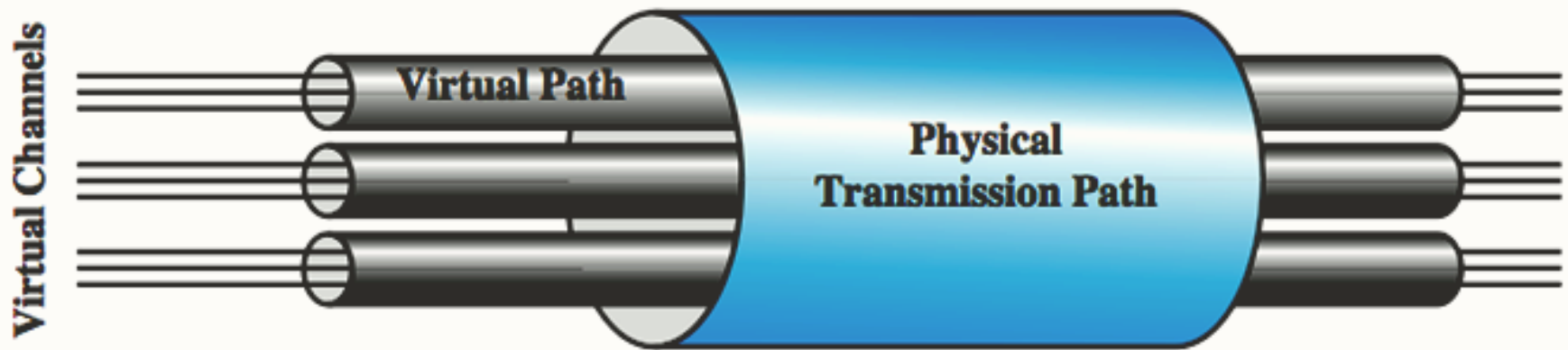
- two levels of ATM connections:
 - virtual path connections (VPC)
 - virtual channel connections (VCC)
- indicated by two fields in the cell header:

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.



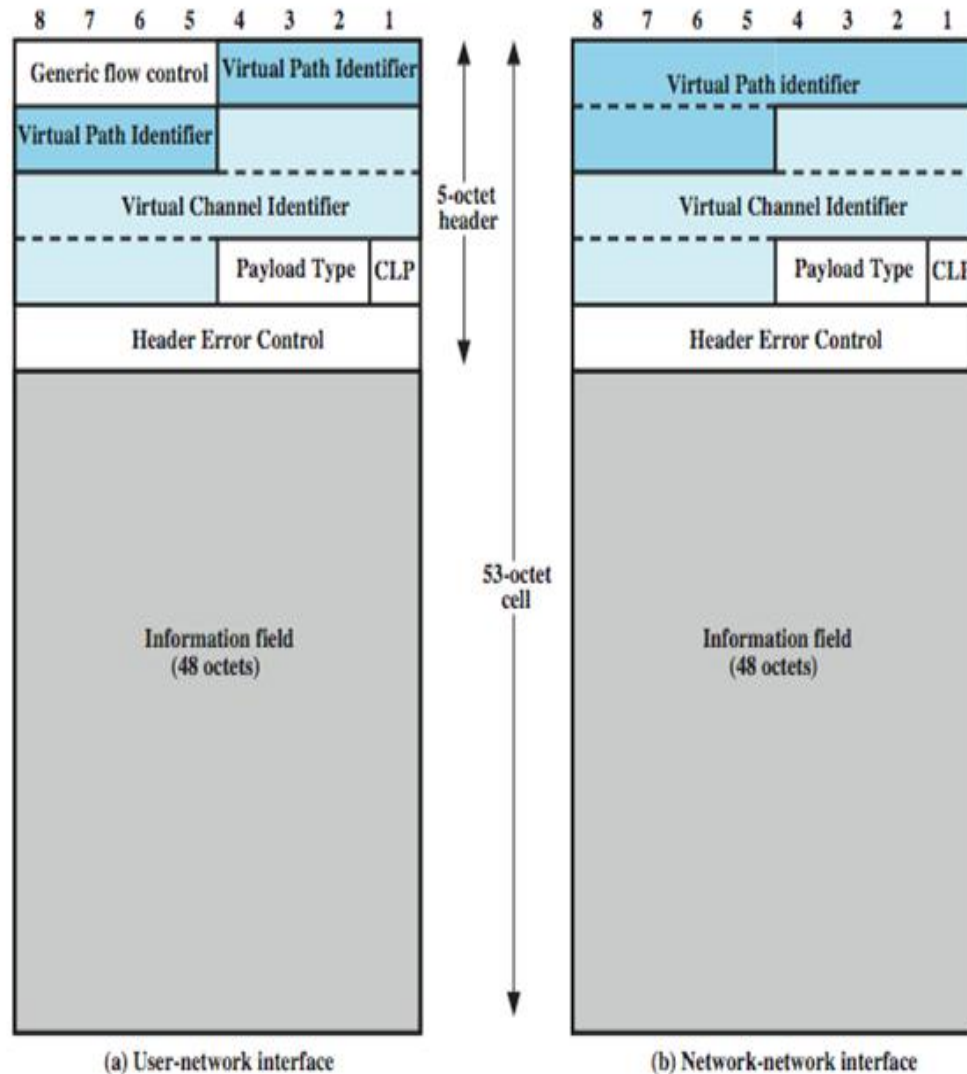
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ATM Conceptual Model

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



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Payload Type (PT) Field Coding

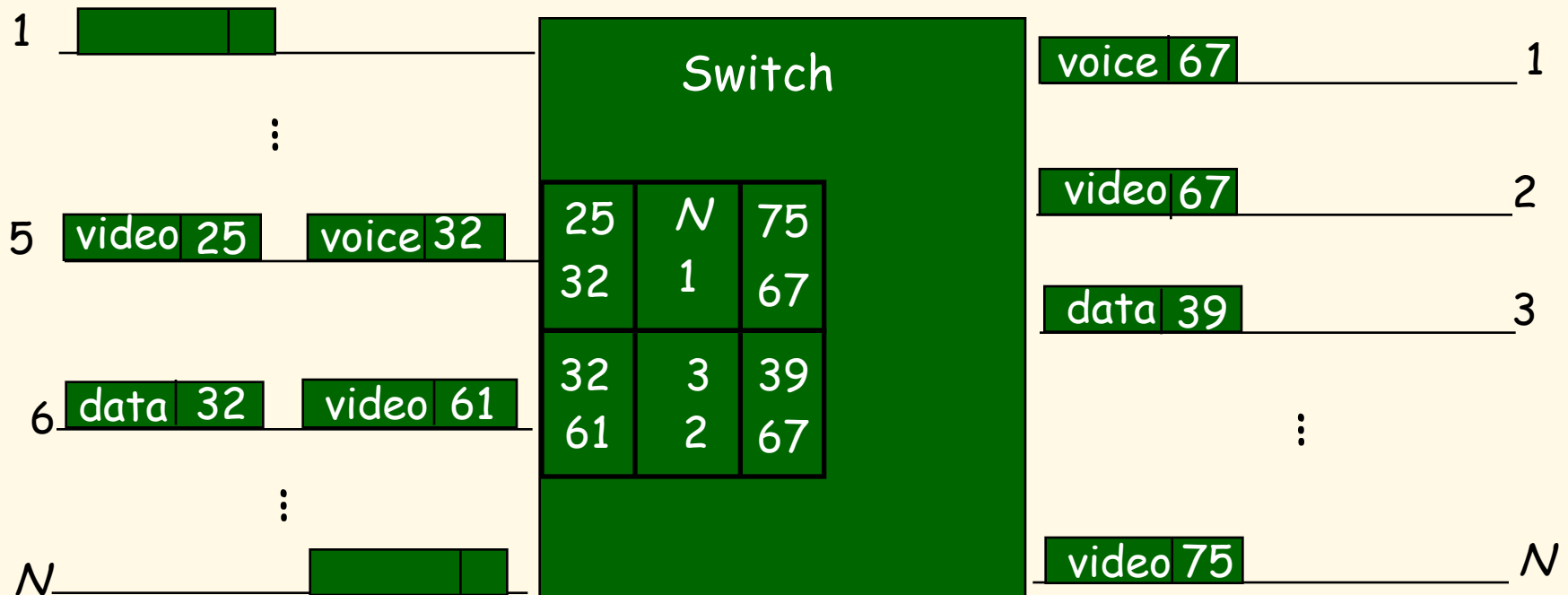
PT Coding	Interpretation
0 0 0	User data cell, congestion not experienced, SDU-type = 0
0 0 1	User data cell, congestion not experienced, SDU-type = 1
0 1 0	User data cell, congestion experienced, SDU-type = 0
0 1 1	User data cell, congestion experienced, SDU-type = 1
1 0 0	OAM segment associated cell
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

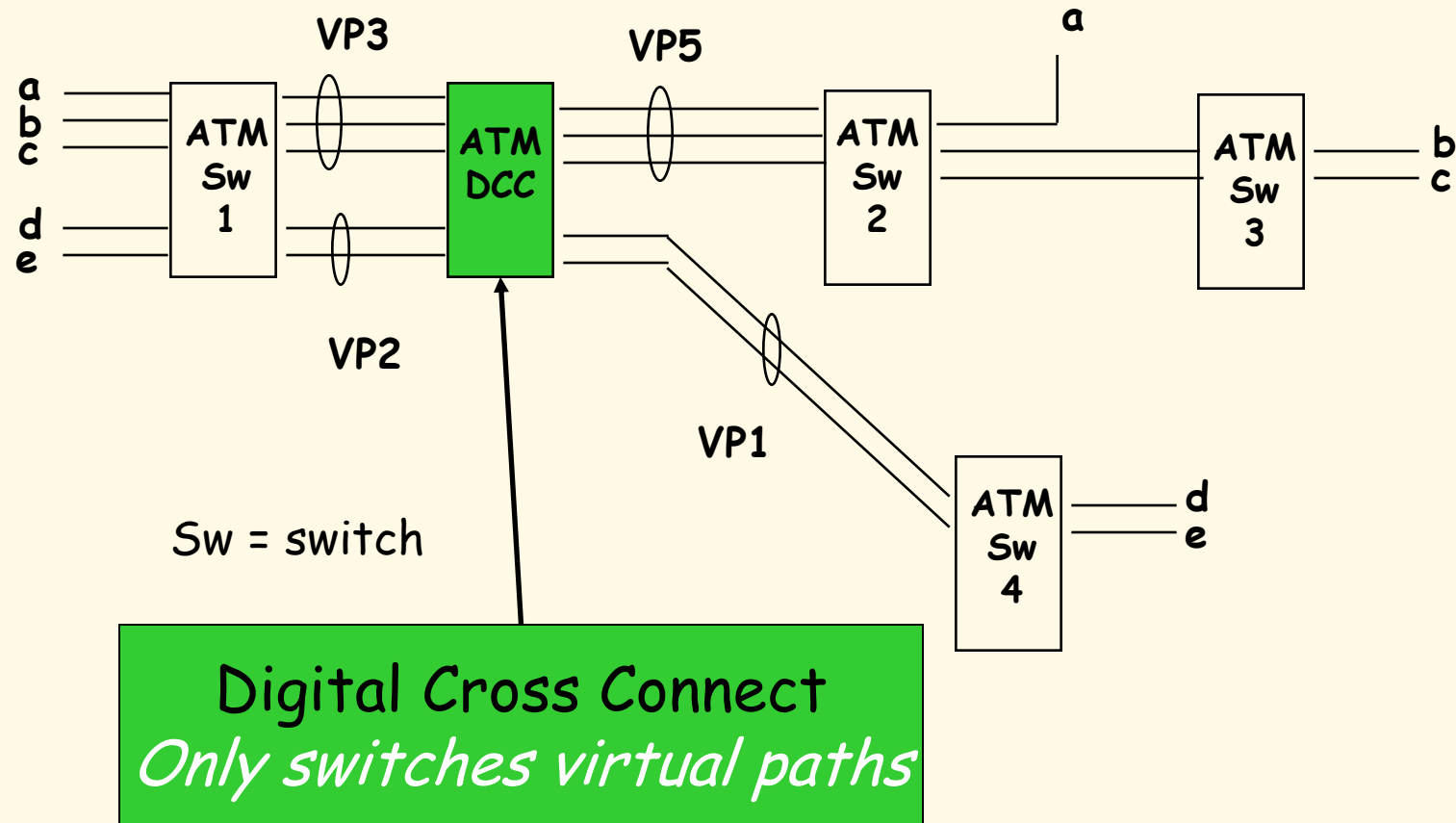
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ATM Cell Switching



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Two Levels of ATM Switches



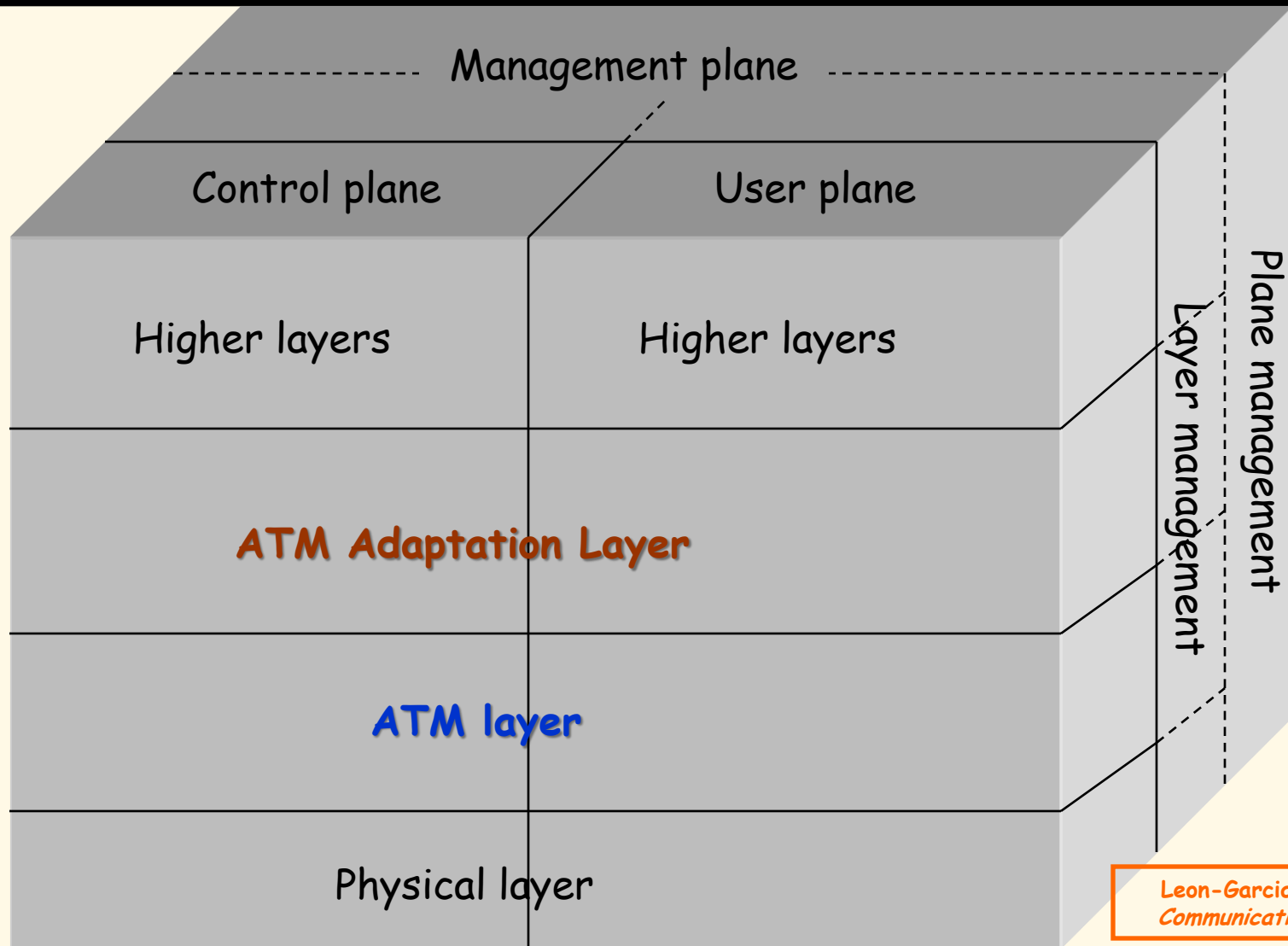
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ATM Protocol Architecture

- 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.

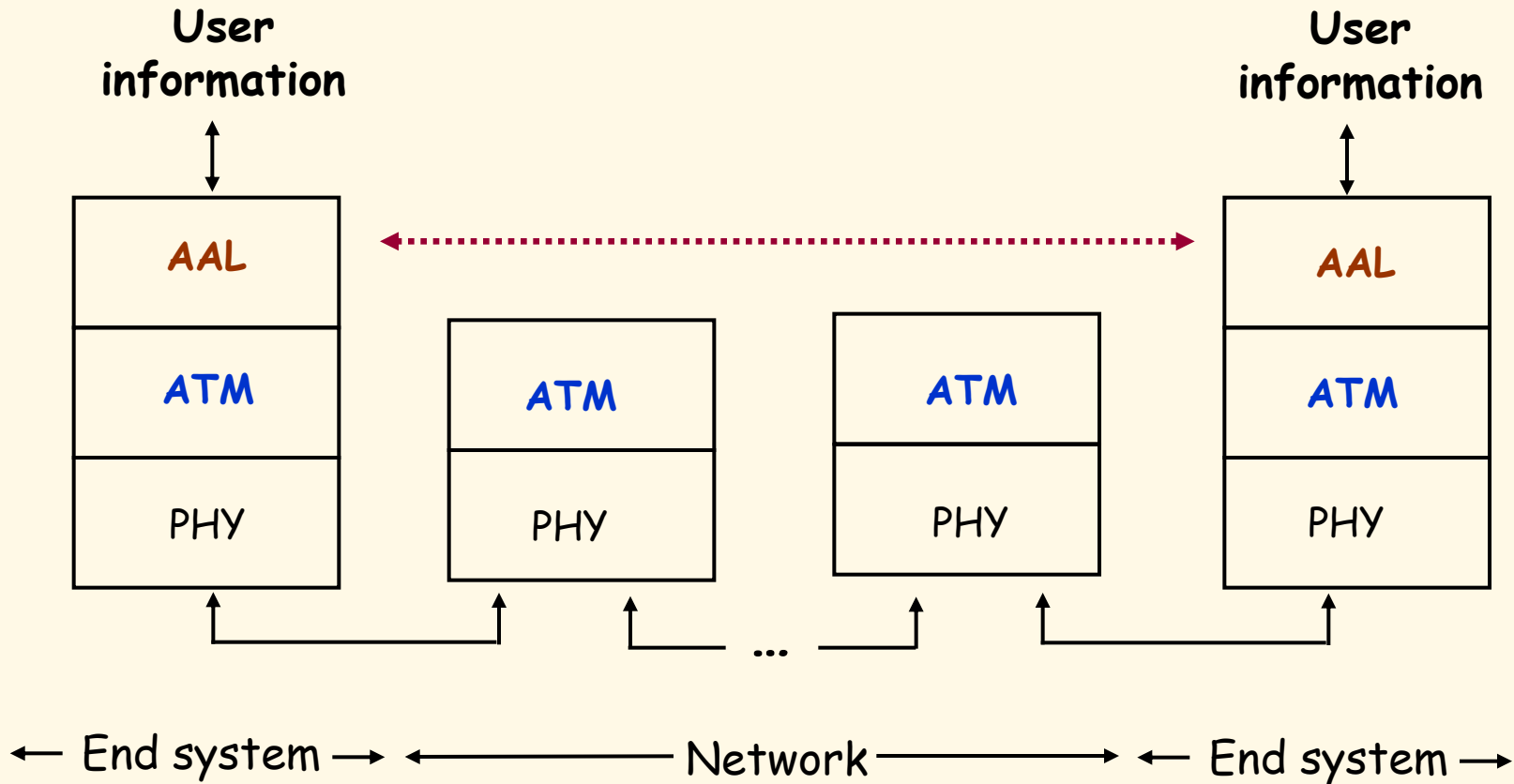
Design Issue: How many adaptation layers should there be?

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 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:

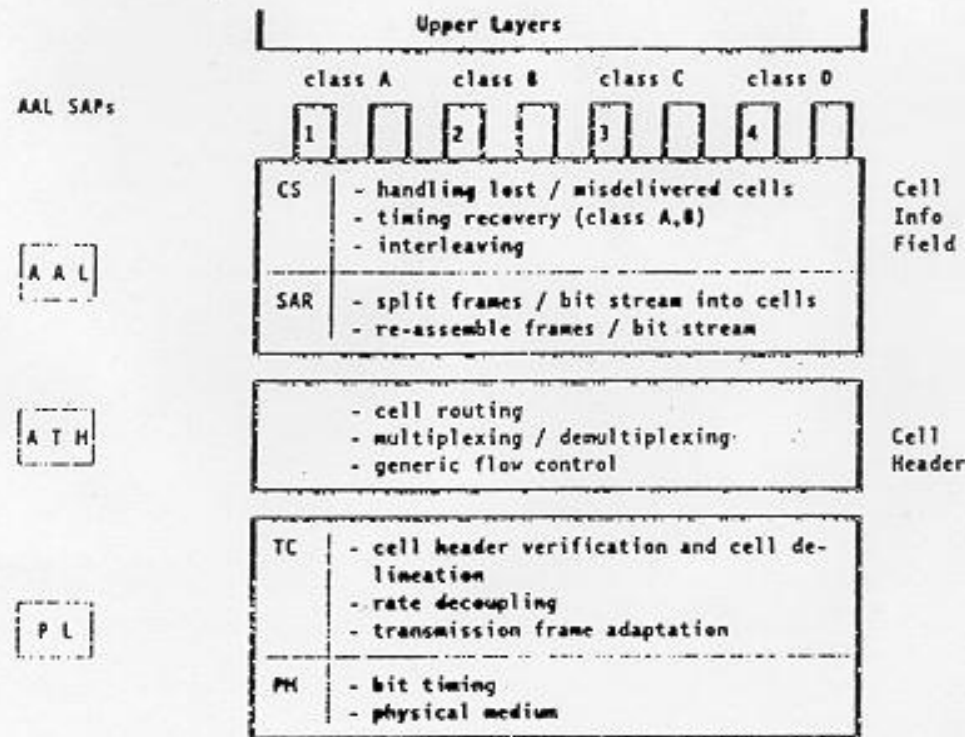
Convergence Sublayer (CS)

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

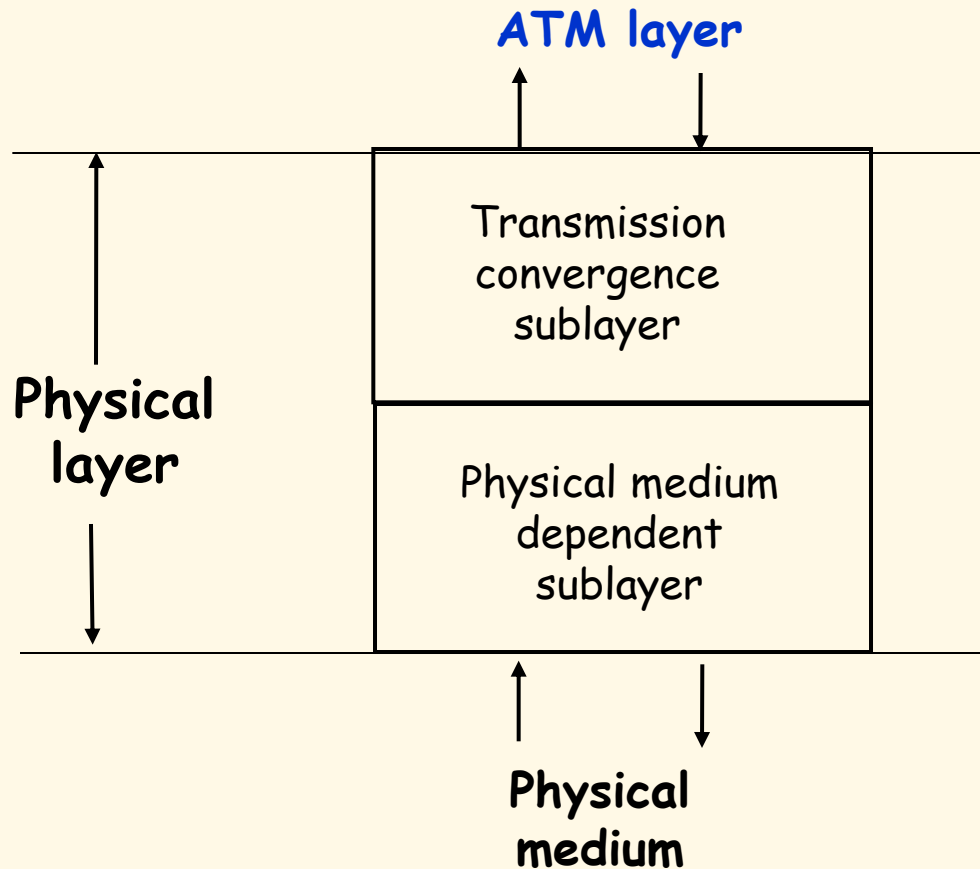
AAL	ATH Adaptation Layer
SAR	Segmentation And Reassembly
CS	Convergence Sub-layer
PL	Physical Layer
TC	Transmission Convergence
PM	Physical Medium

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

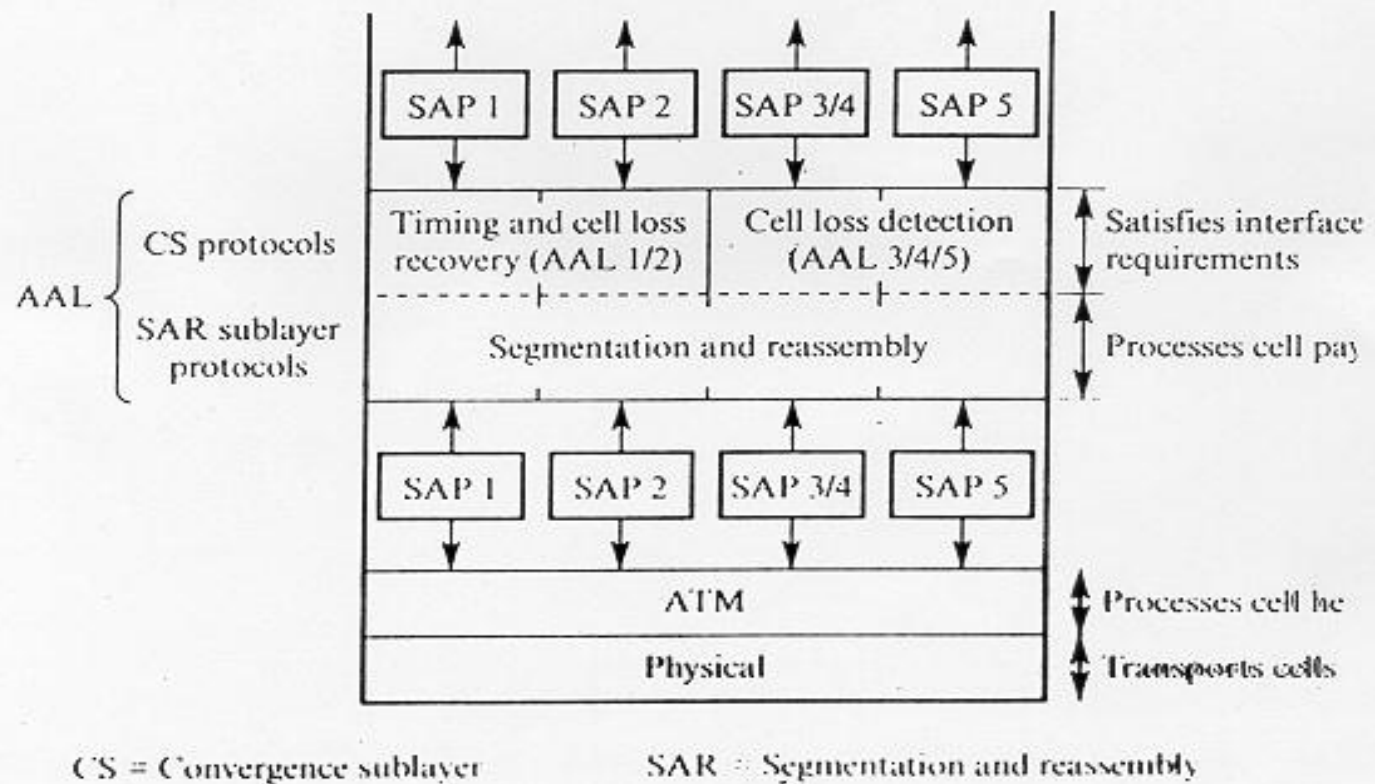
- The AAL interface was initially defined as classes **A-D** with SAP (Service Access Points) for **AAL1-4**.
- **AAL3** and **AAL4** were so similar that they were merged into **AAL3/4**.
- The data communications community concluded that **AAL3/4** *was not suitable* for data communications applications. 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

(a)

Service type	
AAL 1	AAL 2
AAL 3/4	AAL 5
Timing relationship	
Yes	No
Bit rate	
Constant	Variable
Mode	
Connection-oriented	Connectionless

(b)



Revised ATM Service Categories

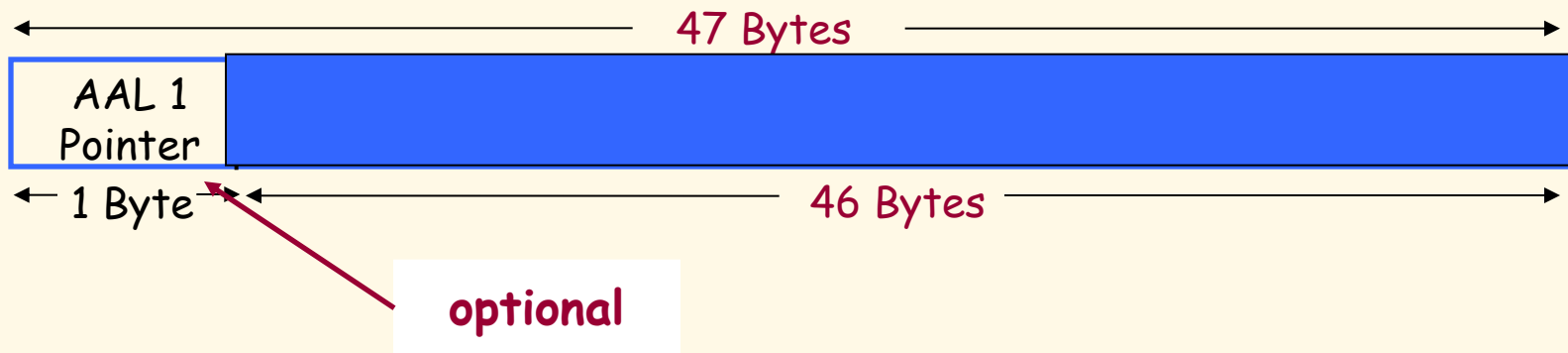
Class	Description	Example
CBR	Constant Bit Rate	T1 circuit
RT-VBR	Real Time Variable Bit Rate	Real-time videoconferencing
NRT-VBR	Non-real-time Variable Bit Rate	Multimedia email
ABR	Available Bit Rate	Browsing the Web
UBR	Unspecified Bit Rate	Background file transfer

QoS, PVC, and SVC

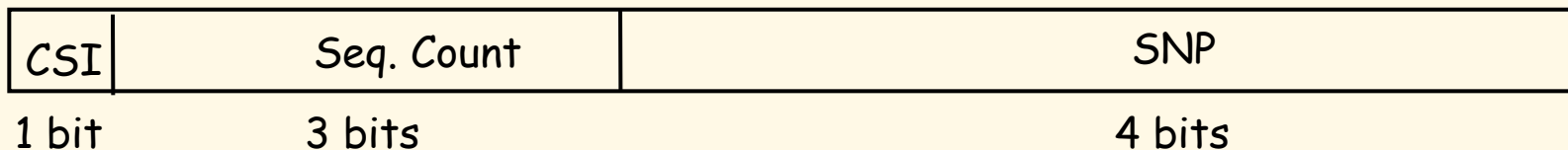
- Quality of Service (**QoS**) requirements are handled at connection time and viewed as part of **signaling (e.g., RSVP)**.
- ATM provides permanent virtual connections and switched virtual connections.
 - **Permanent Virtual Connections (PVC)**
permanent connections set up **manually** by network manager.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

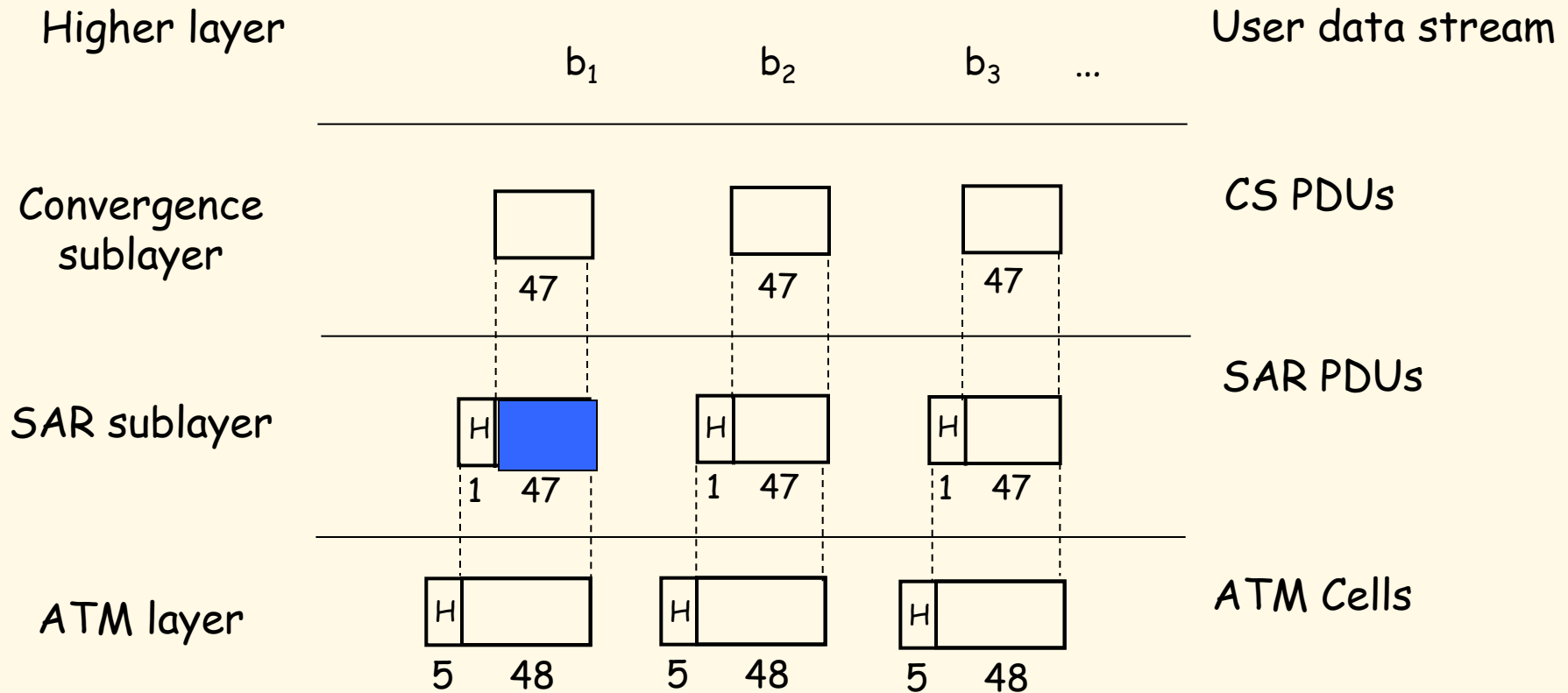


(a) SAR PDU header



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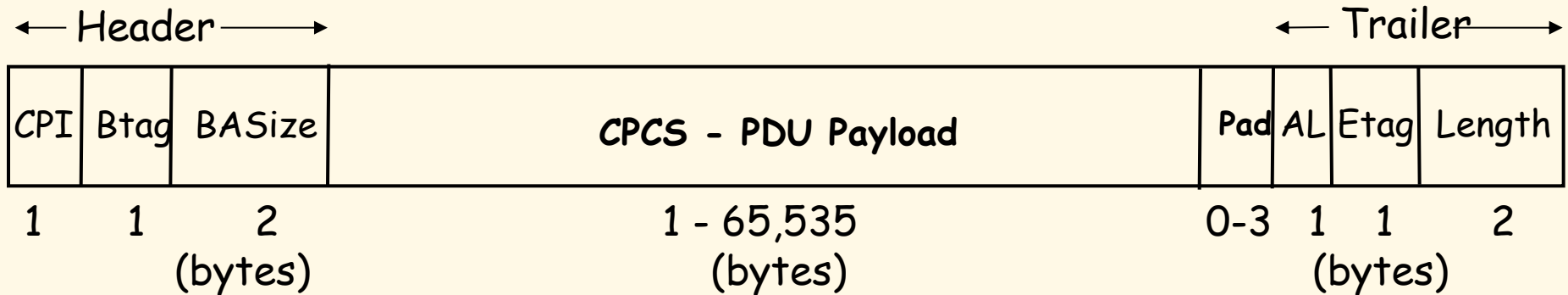
AAL 1



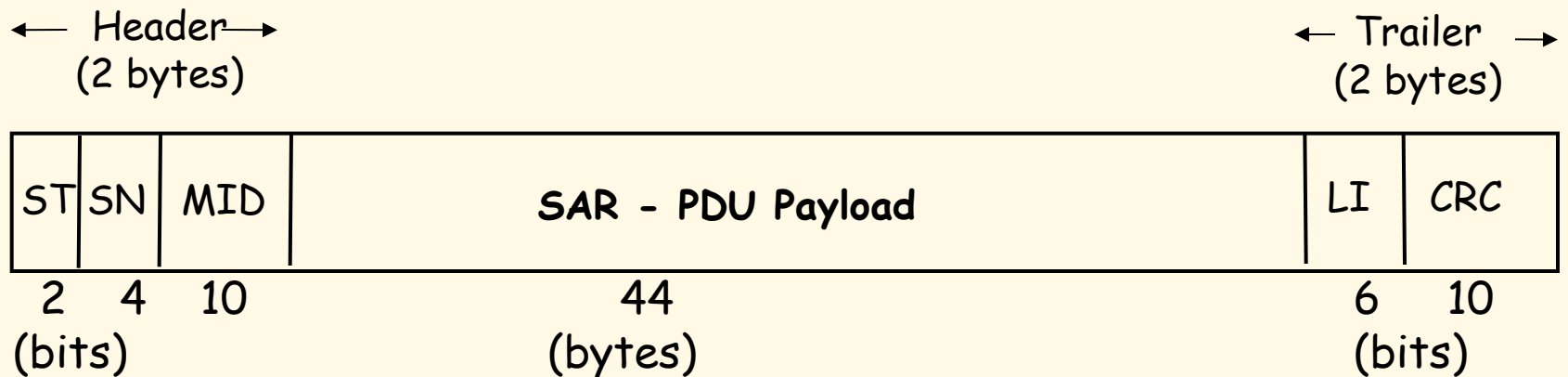
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AAL 3/4 CS and SAR PDUs

(a) CPCS-PDU format

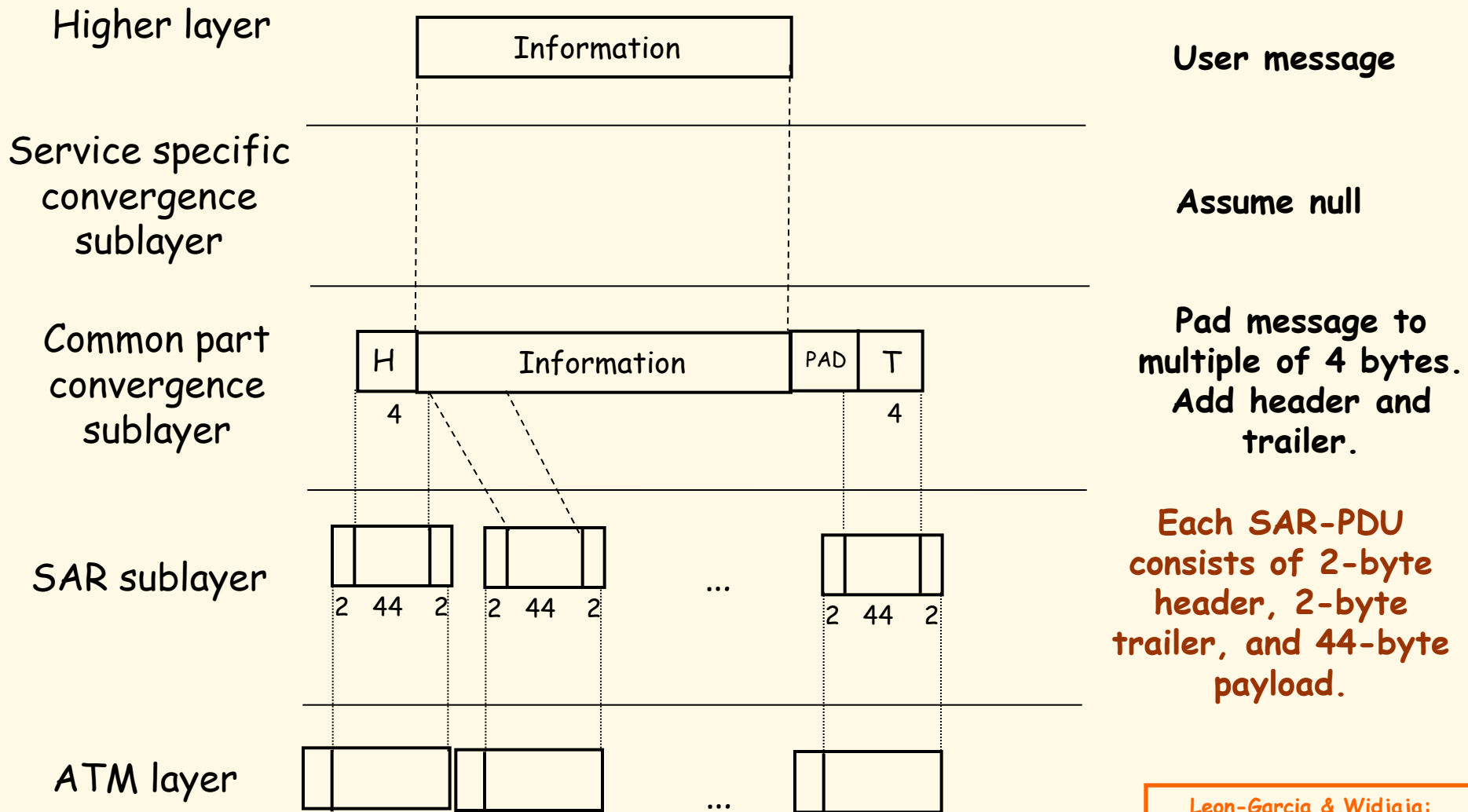


(b) SAR PDU format



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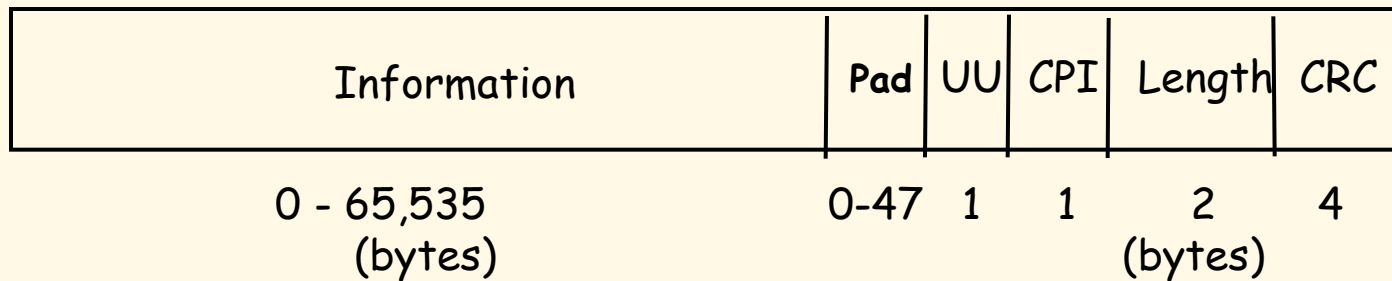
AAL 3/4



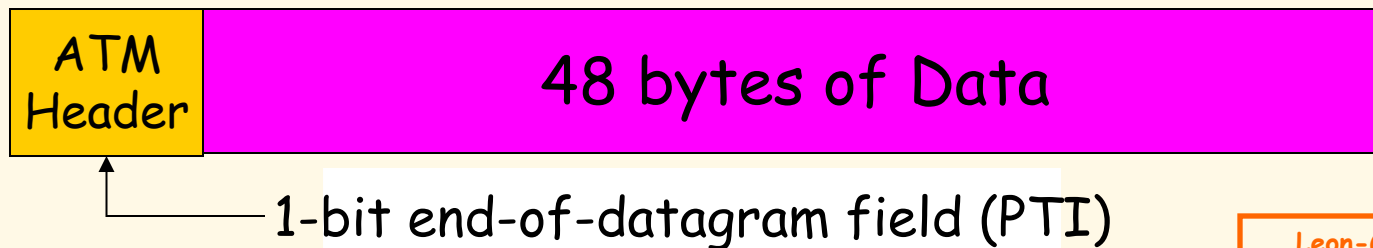
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AAL 5

Convergent Sublayer Format

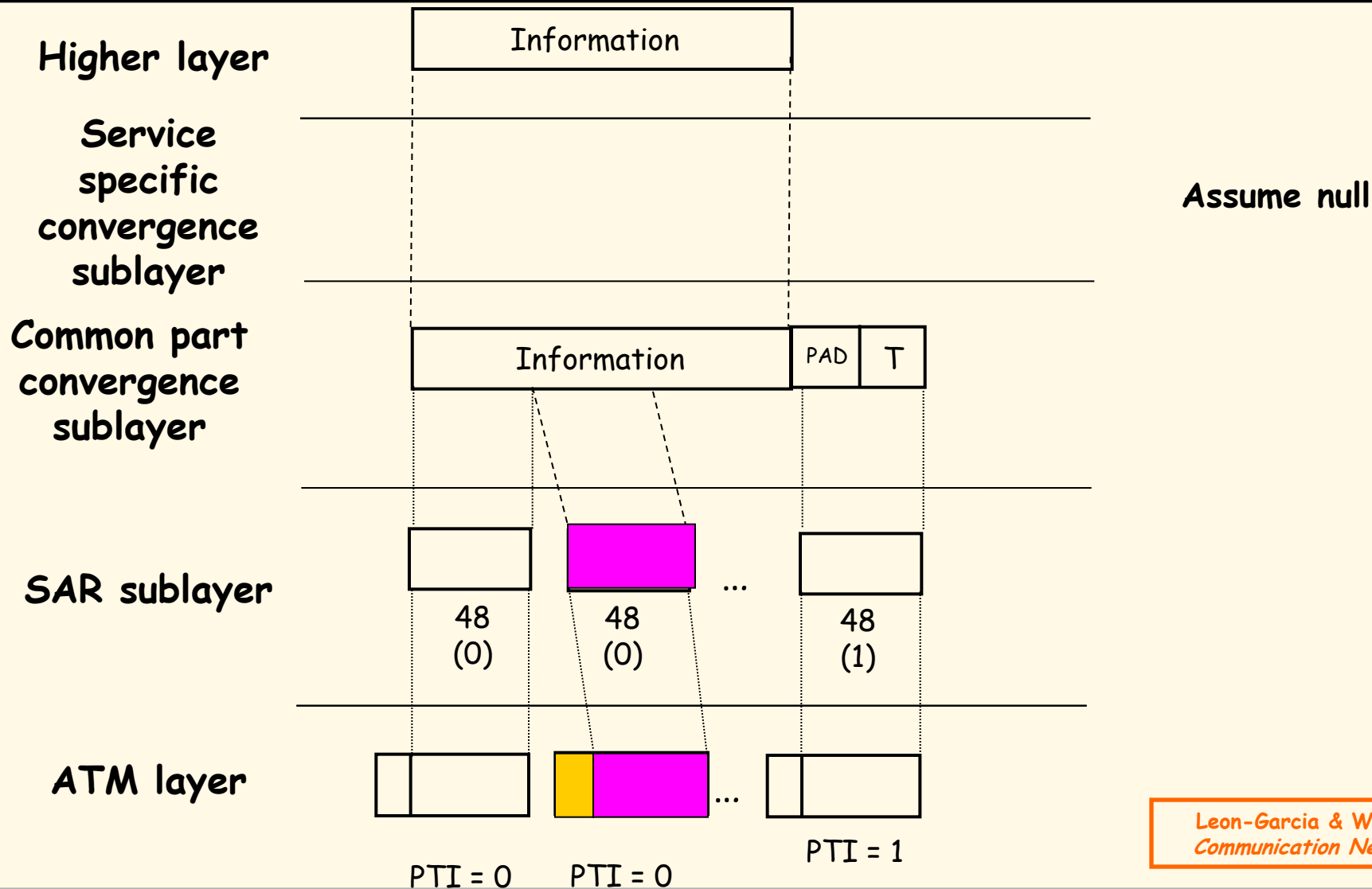


SAR Format



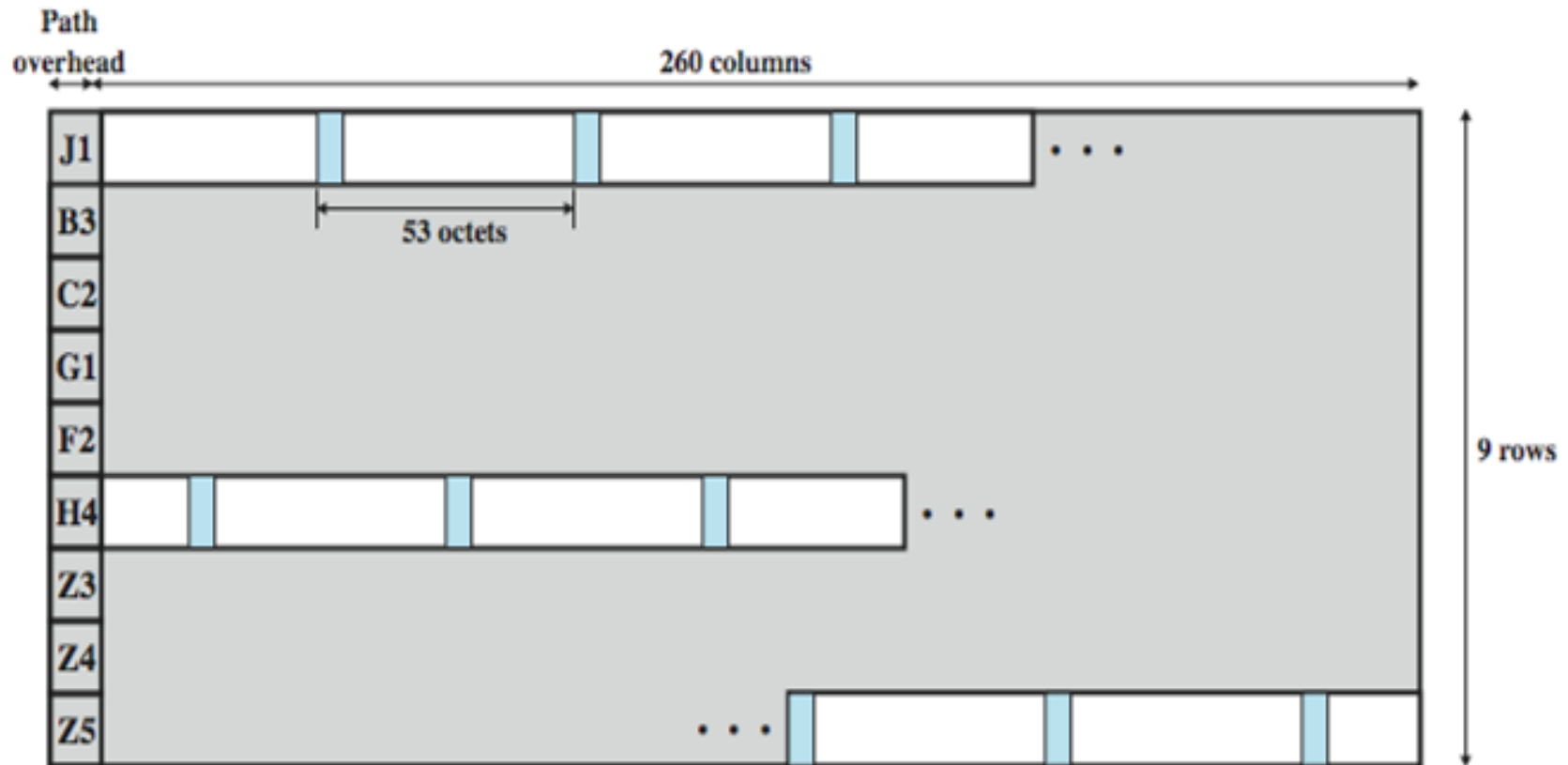
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AAL 5



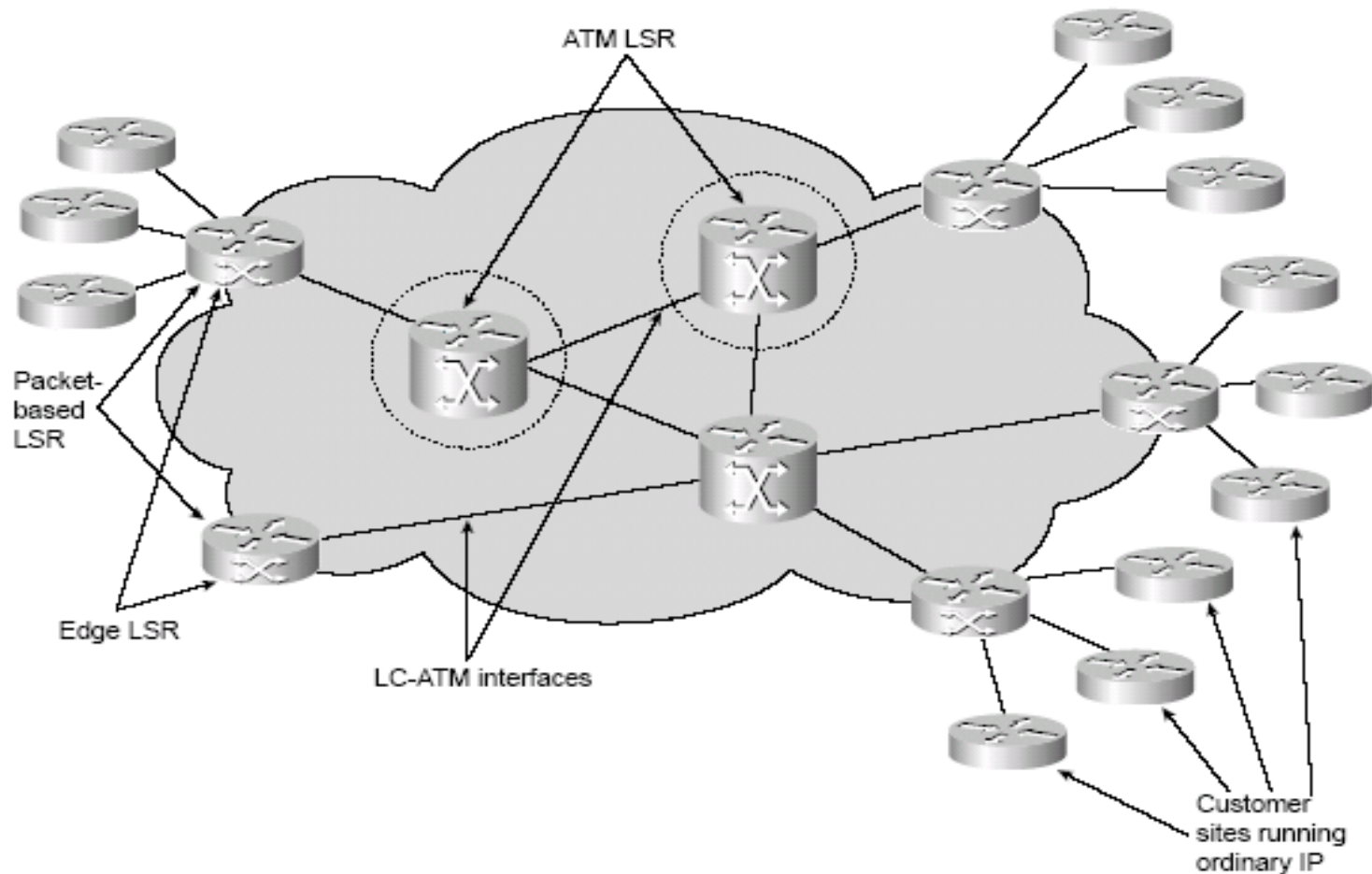
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STM-1 (STS-3) Payload for SDH-Based ATM Cell Transmission



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