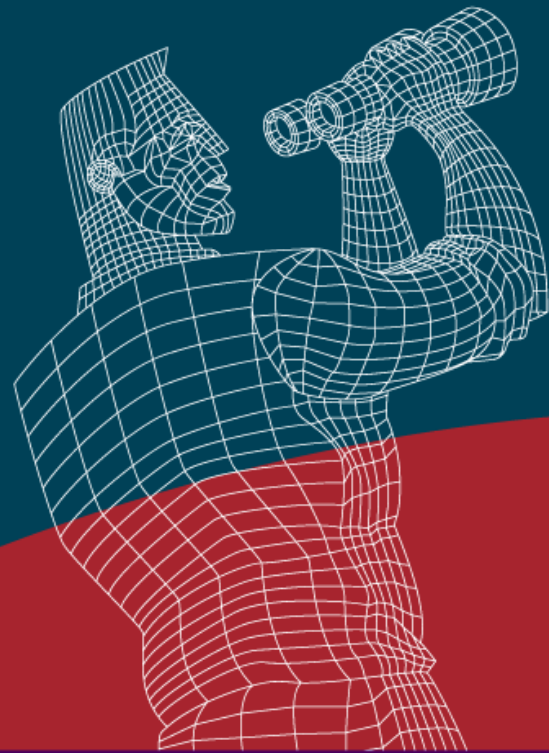
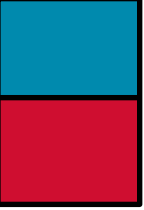


**Networkers**



# Introduction to ATM



# Agenda

## Introduction

## ATM Fundamentals

Rudimentary ATM Concepts

ATM Reference Model

ATM Service Categories

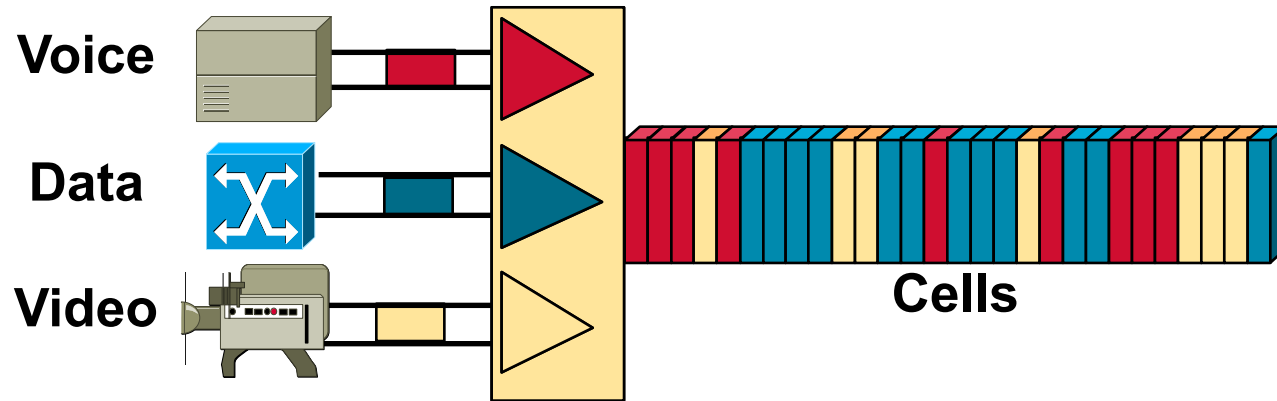
Traffic Management

## ATM Transport Standards

Campus ATM Internetworking

Wrap Up

# Characteristics of ATM



**Uses small, fixed-sized cells**

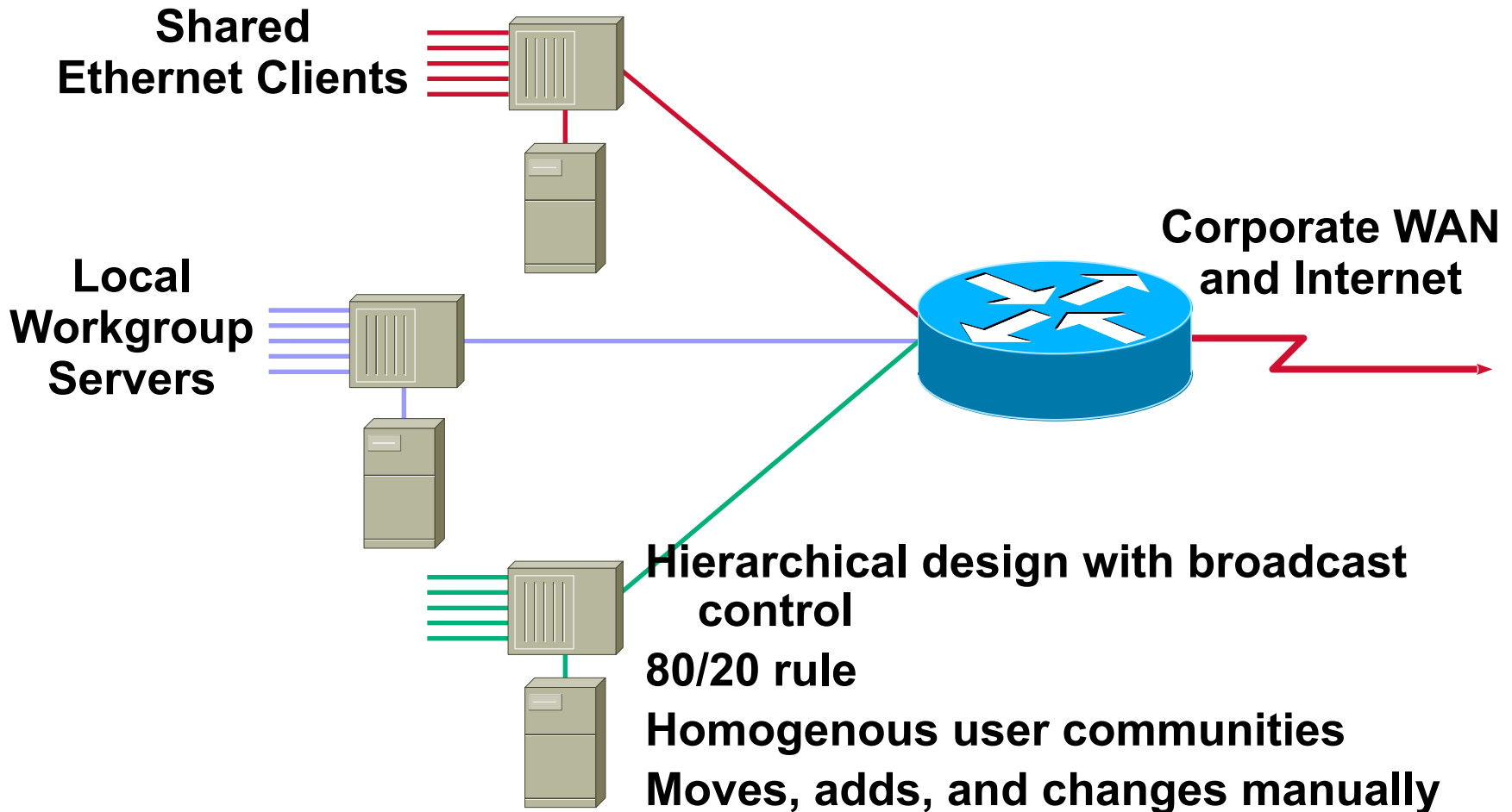
**Connection-oriented**

**Supports multiple service types**

**Applicable to LAN and WAN**

# Campus Networking Evolution

## Traditional Network

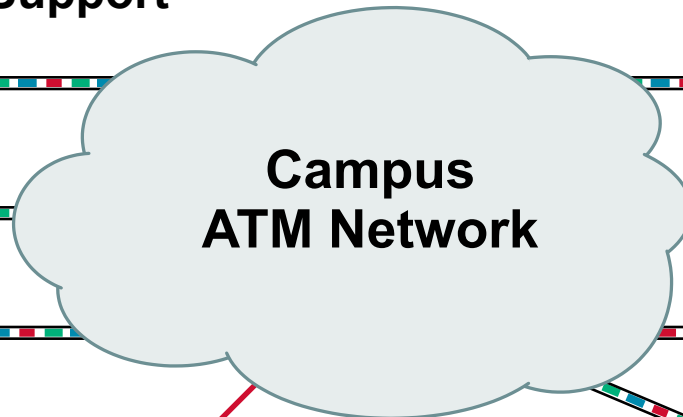


# Campus Networking Evolution

## Contemporary Network

Switched  
Ethernet  
Clients

Ethernet Switch  
with VLAN Support



ATM-Attached  
Station(s)



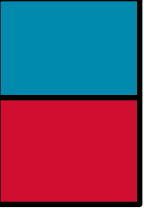
Corporate WAN  
and Internet



Centralized  
High-Performance  
Servers



Network hierarchy maintained  
Traffic patterns migrating  
Client and server performance increases  
Moves, adds, and changes automated



# The Wonderful World of Acronyms

**AAL—ATM Adaptation Layer**

**AAL1—See CBR**

**AAL2—See VBR**

**AAL3/4—See UBR**

**AAL5—See ABR**

**ABR—Available Bit Rate**

**API—Application Programmer Interface**

**B-ICI—B-ISDN Inter-Carrier Interface**

**BUS—Broadcast and Unknown Server**

**CAC—Connection Admission Control**

**CBR—Constant Bit Rate**

**CCITT—Consultative Committee for International Telephony and Telegraph**

**CDVT—Cell Delay Variation Tolerance**

**CLP—Cell Loss Priority**

**CLR—Cell Loss Ratio**

**CS—Convergence Sublayer**

**EFCl—Explicit Forward Congestion Indicator**

**ELAN—Emulated LAN**

**GCRA—Generic Cell Rate Algorithm**

**GFC—Generic Flow Control**

**HEC—Header Error Check**

**IISP—Interim Inter-Switch Signaling Protocol**

**ILMI—Interim Local Management Interface**



# The Wonderful World of Acronyms

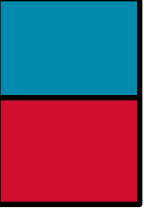
**IPD—Intelligent Packet Discard**  
**LANE—Local Area Network Emulation**  
**LEC—LAN Emulation Client**  
**LES—LAN Emulation Server**  
**LECS—LAN Emulation Configuration Server**  
**LIS—Logical IP Subnet**  
**MBS—Maximum Burst Size**  
**MCR—Minimum Cell Rate**  
**MCTD—Maximum Cell Transfer Delay**  
**MPC—MPOA Client (aka Edge Device)**  
**MPOA—Multi-Protocol Over ATM**  
**MPS—MPOA Server (aka Router Server)**  
**NNI—Network-to-Network Interface**  
**OC—Optical Carrier**  
**PCR—Peak Cell Rate**  
**PMD—Physical Media Dependent**  
**PNNI—Private Network-to-Network Interface**  
**PTI—Payload Type Identifier**  
**PVC—Permanent Virtual Circuit**  
**Q.SAAL—aka Q.2100—Signaling ATM Adaptation Layer**  
**RFC1483—Multiprotocol Encapsulation over AAL5**  
**RFC1577—Classical IP and ARP over ATM**  
**RM—Resource Management**



# The Wonderful World of Acronyms

**SAR**—Segmentation and Reassembly  
**SDH**—Synchronous Digital Hierarchy  
**SONET**—Synchronous Optical Network  
**STM**—Synchronous Transport Mode  
**STS**—Synchronous Transport Signal  
**SCR**—Sustained Cell Rate  
**SVC**—Switched Virtual Circuit  
**SSCOP**—Signaling Specific Convergence Protocol  
**TC**—Transmission Convergence  
**UBR**—Unspecified Bit Rate  
**UNI**—User-to-Network Interface  
**UPC**—Usage Parameter Control  
**VBR-NRT**—Variable Bit Rate-Non-Real Time  
**VBR-RT**—Variable Bit Rate-Real Time  
**VC**—Virtual Circuit (or sometimes Virtual Connection)  
**VCC**—Virtual Channel Connection  
**VCI**—Virtual Channel Identifier  
**VC Switch**—Virtual Circuit Switch  
**VP**—Virtual Path  
**VPC**—Virtual Path Connection  
**VPI**—Virtual Path Identifier  
**VP Switch**—Virtual Path Switch  
**VS/VD**—Virtual Source/Virtual Destination





# Agenda

**Introduction**

**ATM Fundamentals**

**Rudimentary ATM Concepts**

**ATM Reference Model**

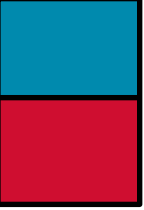
**ATM Service Categories**

**Traffic Management**

**ATM Transport Standards**

**Campus ATM Internetworking**

**Wrap Up**



# Rudimentary ATM Concepts

**Physical layer**

**Signaling**

**Cell format**

**Connection types**



# ATM Transmission Media

## ATM SDH/SONET Rates Chart

SDH	SONET	Rate—Mbps
	STS-1/OC-1	51.84
STM-1	STS-3/OC-3	155.52
STM-4	STS-12/OC-12	622.08
STM-8	STS-24/OC-24	1,244.16
STM-16	STS-48/OC-48	2,488.32

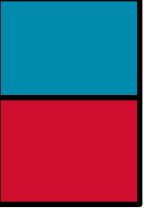
**CCITT (Consultative Committee for International  
Telephony and Telegraph)**

**ITU (International Telecommunications Union)**

# ATM Physical Interface Rates

Framing	Data Rate (Mbps)	Media					
		Multi-Mode Fiber	Single-Mode Fiber	Coaxial Cable	UTP-5	UTP-3	STP
DS1	1.544						(TP)
E1	2.048			✓			
J2	6.23						(TP)
<b>DS3</b>	<b>45</b>			✓			
<b>E3</b>	<b>34</b>			✓			
E4	139			X			
ATM25	25.6					✓	
STS 1	51.8					✓	
<b>STS3c/STM1</b>	<b>155</b>	✓	✓		✓	<b>X</b>	
<b>STS 12c/STM4</b>	<b>622</b>	✓	✓				
4B/5B (TAXI)	100	✓					
8B/10B	155	✓					
(Fiberchannel)							✓

✓ Standardized    X= Proposed/In Progress



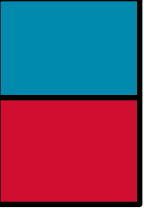
# Rudimentary ATM Concepts

**Physical layer**

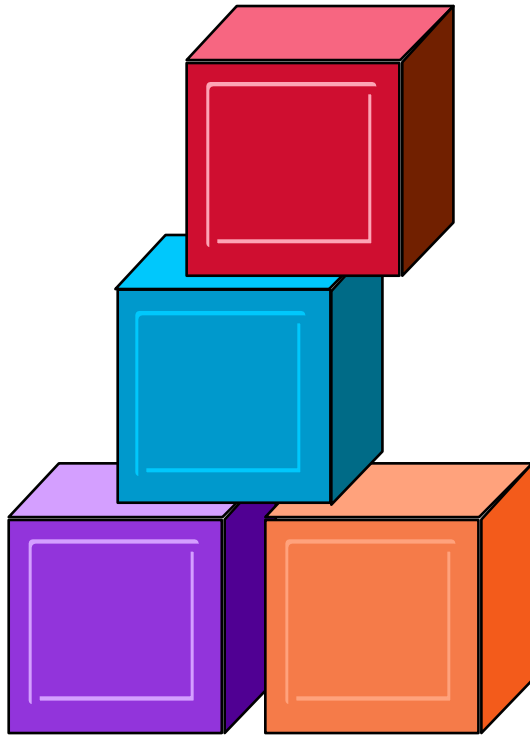
**Signaling**

**Cell format**

**Connection types**



# ATM Building Blocks



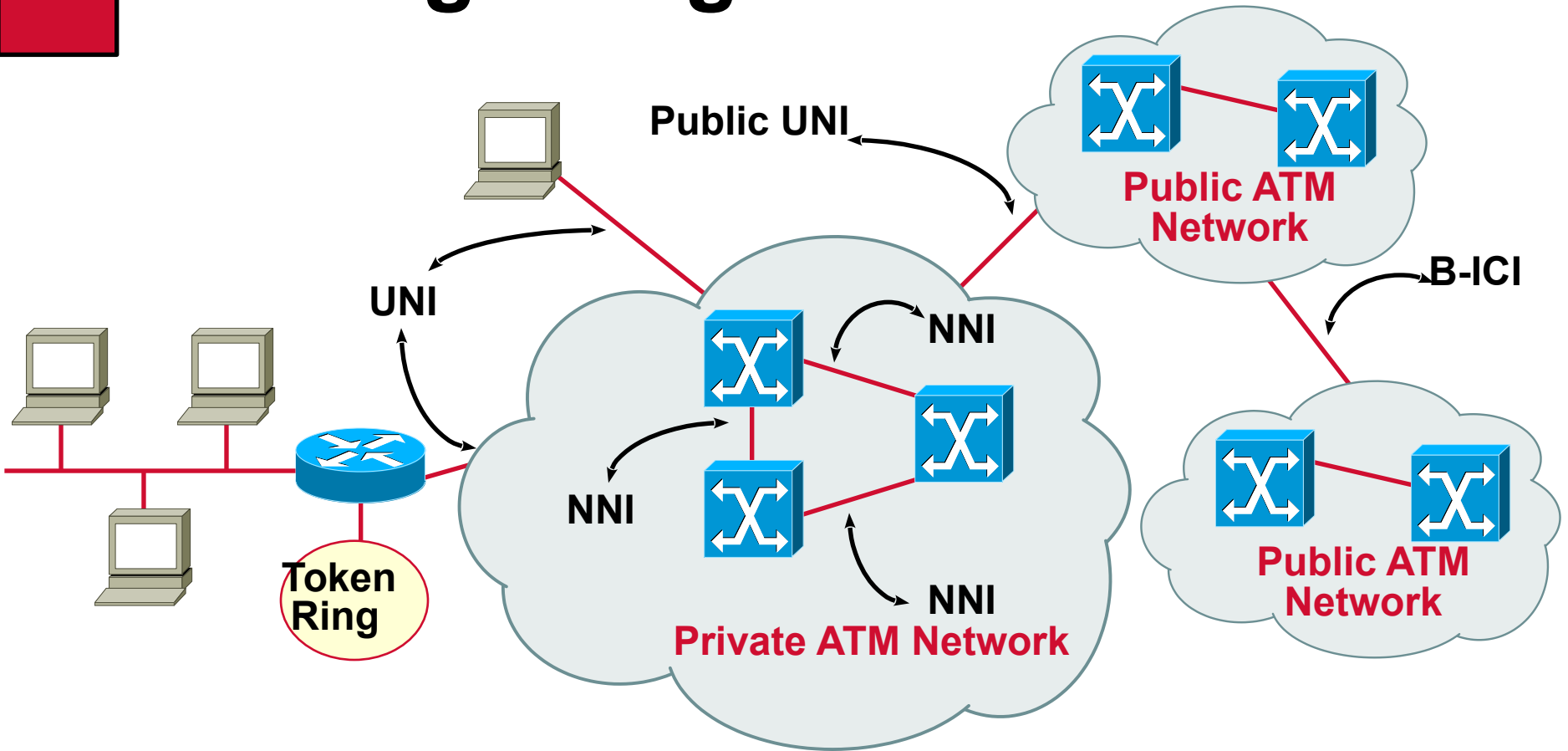
**ATM signaling**

**UNI and NNI**

**Virtual connections**

**VCC, VP, and VC**

# ATM Signaling



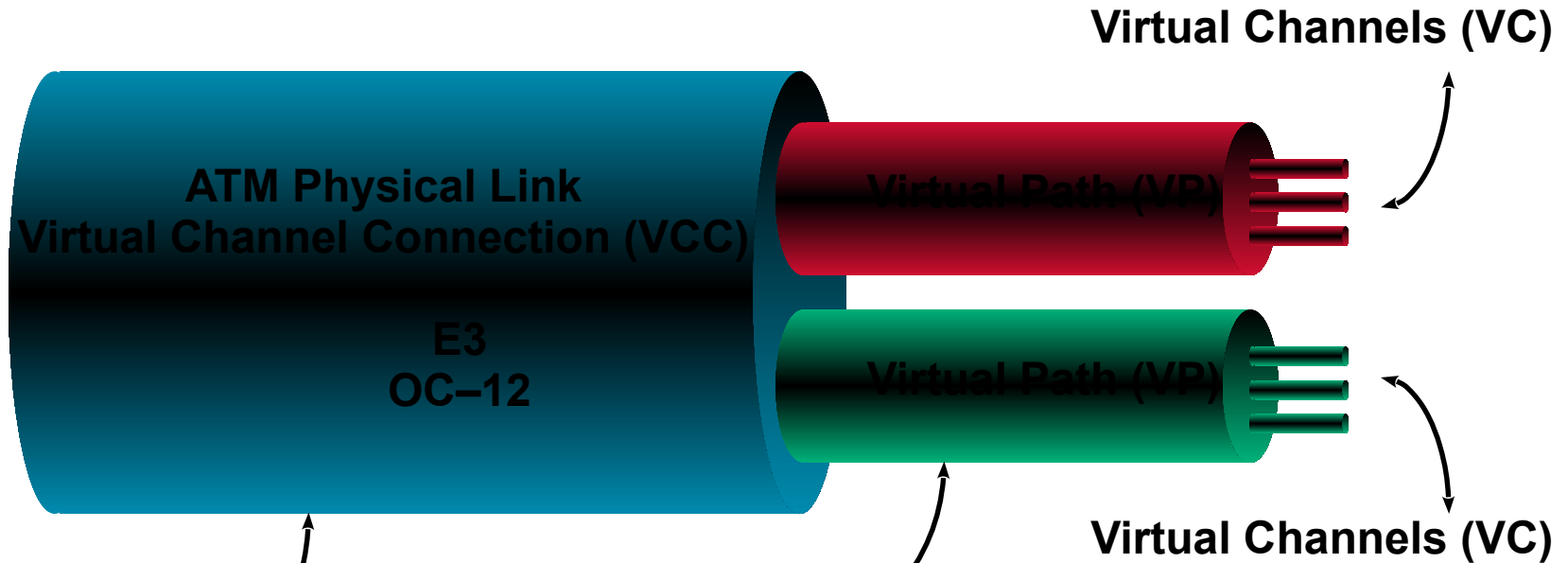
**UNI = User-to-Network Interface**

**NNI = Network-to-Network Interface**

**Cell header content varies depending on who's talking to whom**



# Virtual Path and Virtual Channels



**Virtual Channel Connection (VCC)**  
Contains Multiple VPs

**Virtual Path (VP)**  
Contains Multiple VCs

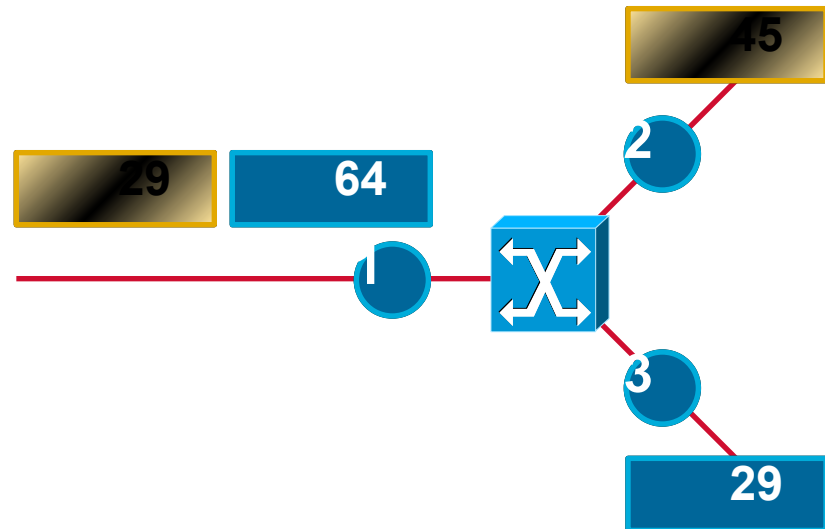
**Virtual Channel (VC)**  
Logical Path  
Between ATM End Points

**Connection Identifier = VPI/VCI**



# ATM Switches

Input		Output	
Port	VPI/VCI	Port	VPI/VCI
1	29	2	45
2	45	1	29
1	64	3	29
3	29	1	64



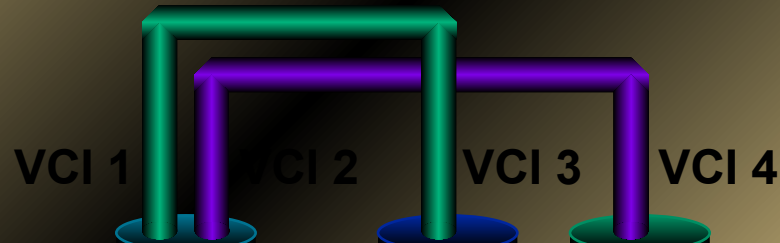
**ATM switches translate VPI/VCI values**

**VPI/VCI value unique only per interface—  
e.g.: locally significant and may be re-used  
elsewhere in network**

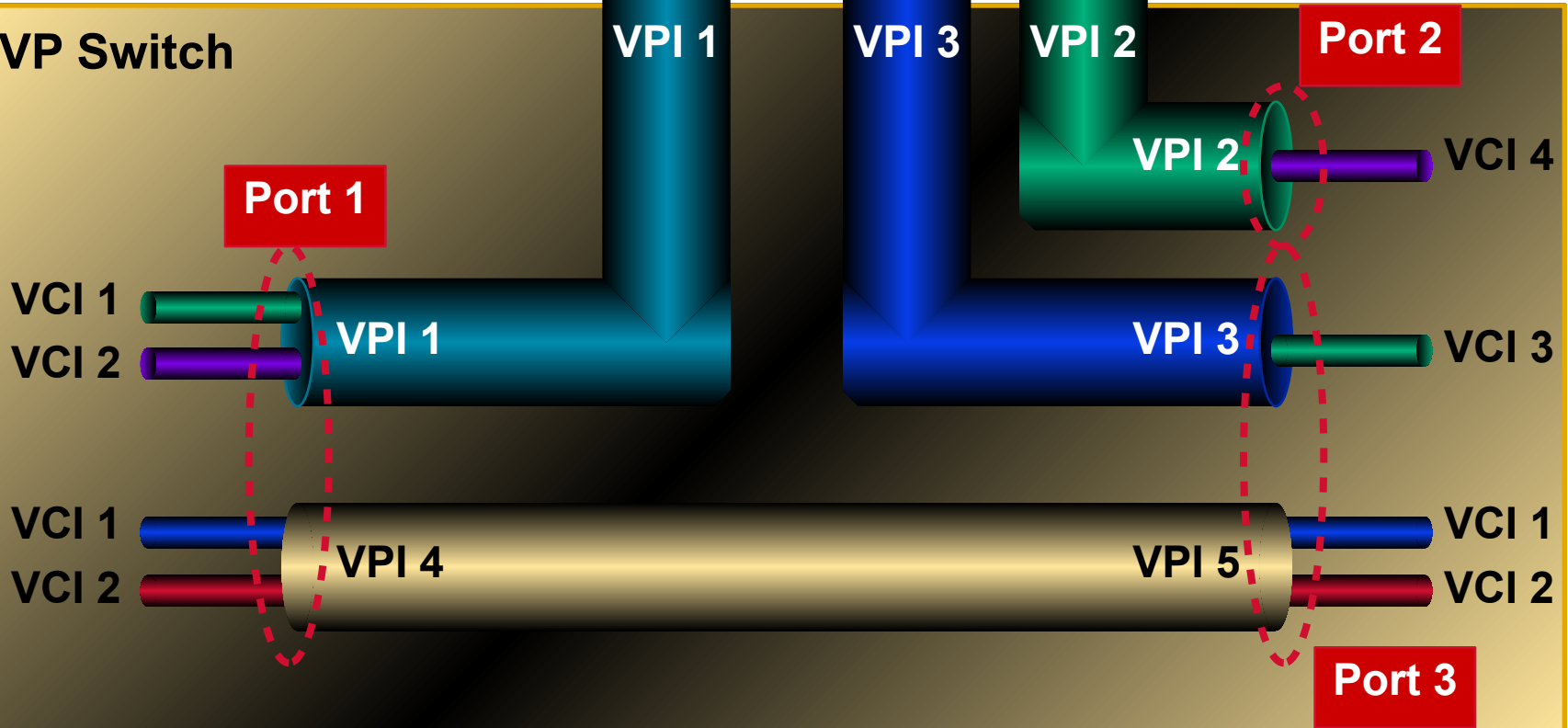


# VP and VC Switching

VC Switch

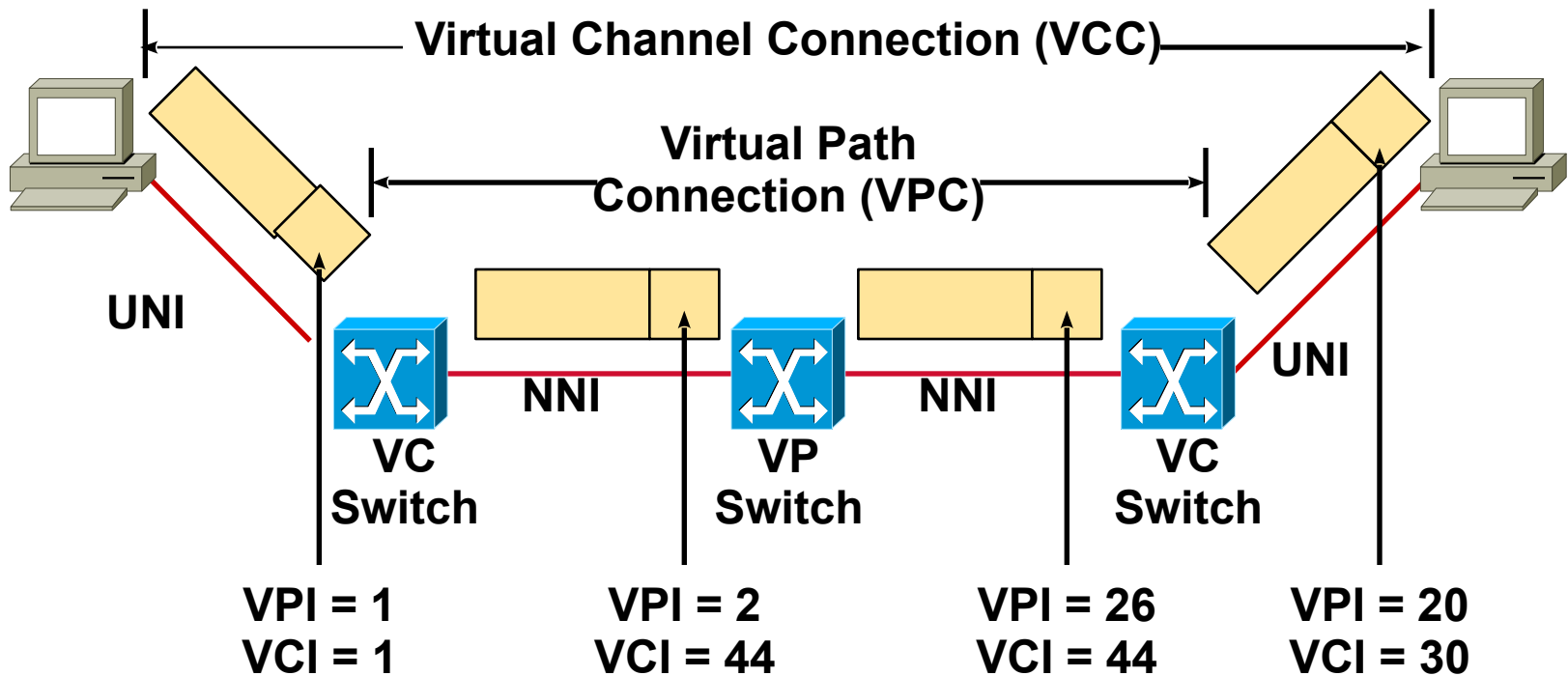


VP Switch





# Virtual Channels and Virtual Paths



This hop-by-hop forwarding is known as cell relay



# Rudimentary ATM Concepts

**Physical layer**

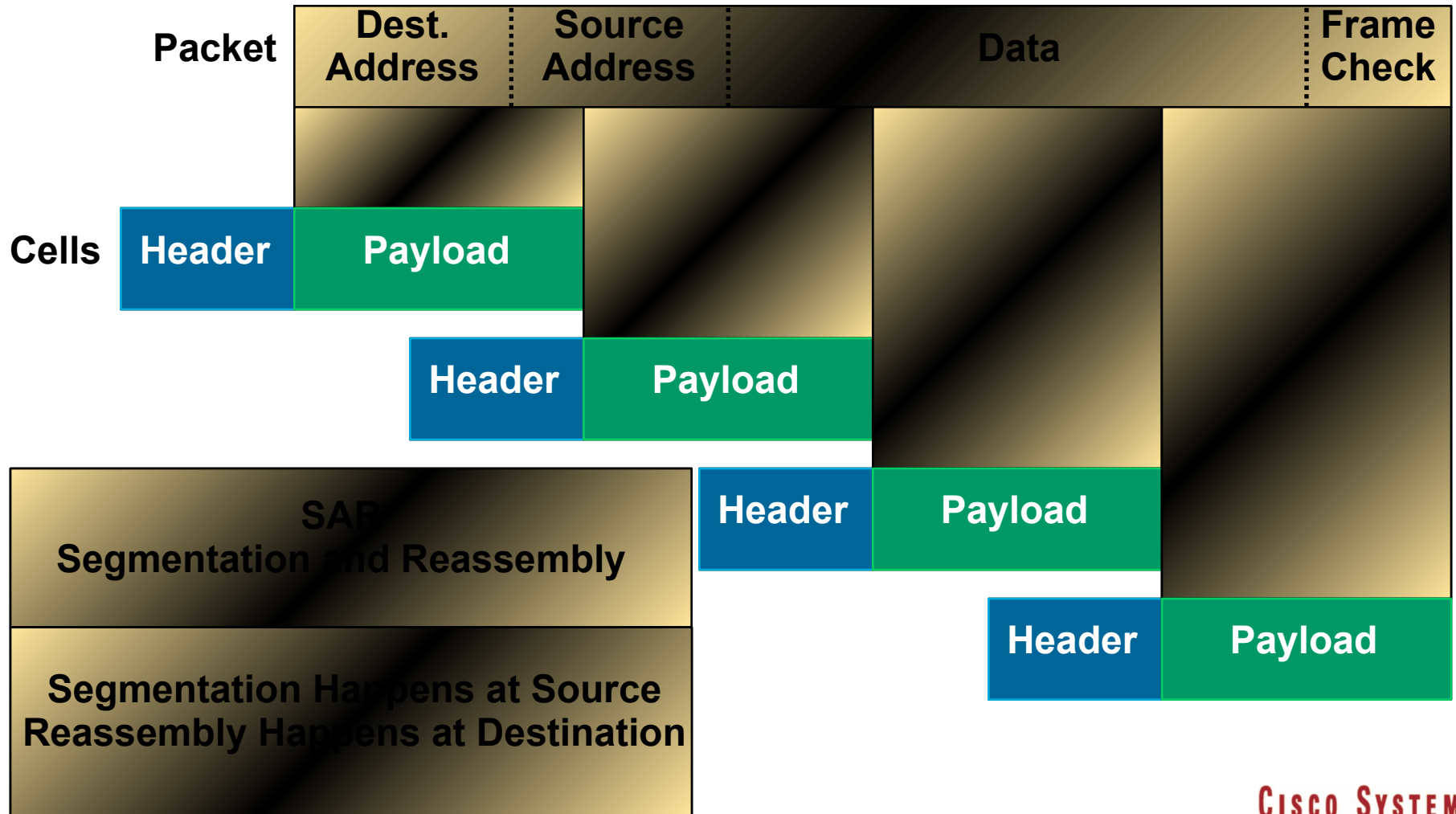
**Signaling**

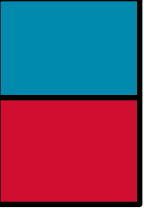
**Cell format**

**Connection types**

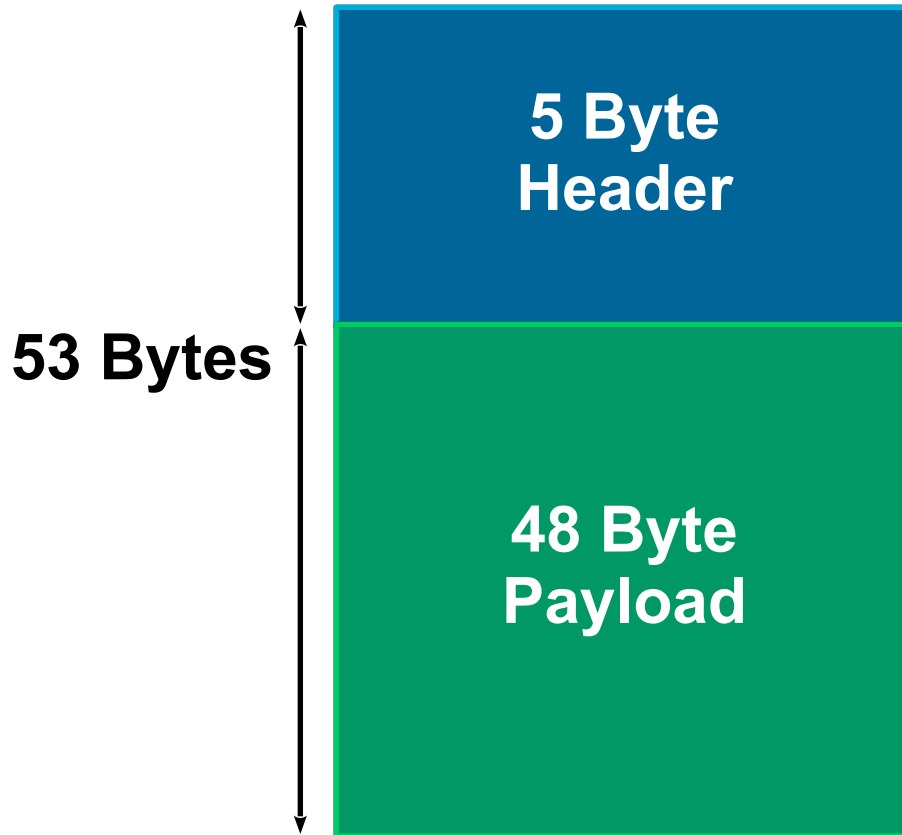


# Creating Cells from Packets



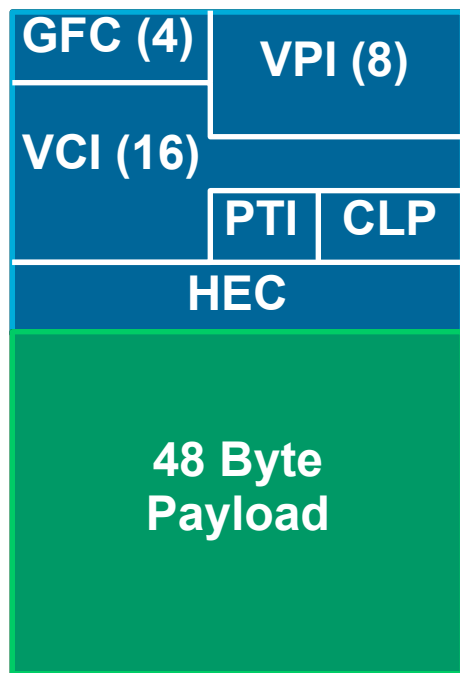


# ATM Cell Header



**ATM Cell**

# ATM Cell Header Details



ATM **UNI** Cell



**GFC**

Generic Flow Control  
UNI Cells Only!

**VPI/VCI**

Identifies Virtual  
Paths and Channels

**PTI**

Payload Type Identifier  
3 Bits:

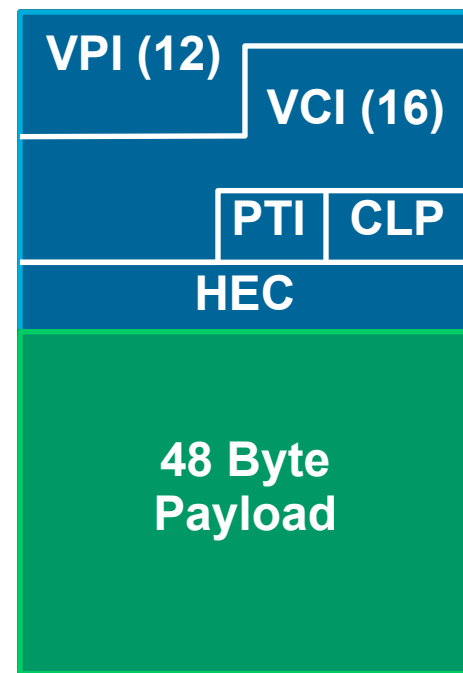
1. User/Control Data
2. Congestion
3. Last Cell

**CLP**

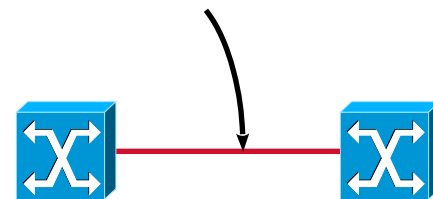
Cell Loss Priority Bit

**HEC**

Header Error Check  
8 Bit CRC



ATM **NNI** Cell





# Rudimentary ATM Concepts

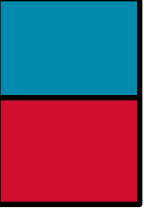
**Physical layer**

**Signaling**

**Cell format**

**Connection types**





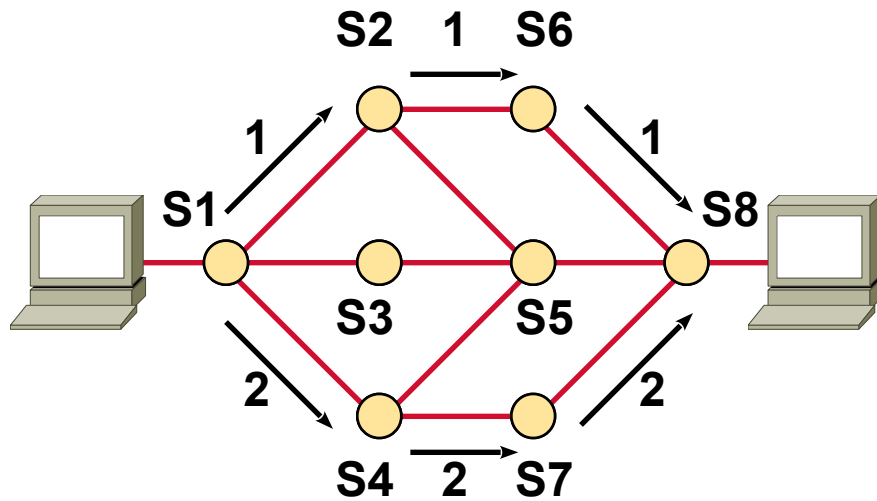
# ATM Connection Types

**PVC**

**SVC**

**Soft PVC**

# Connection Types

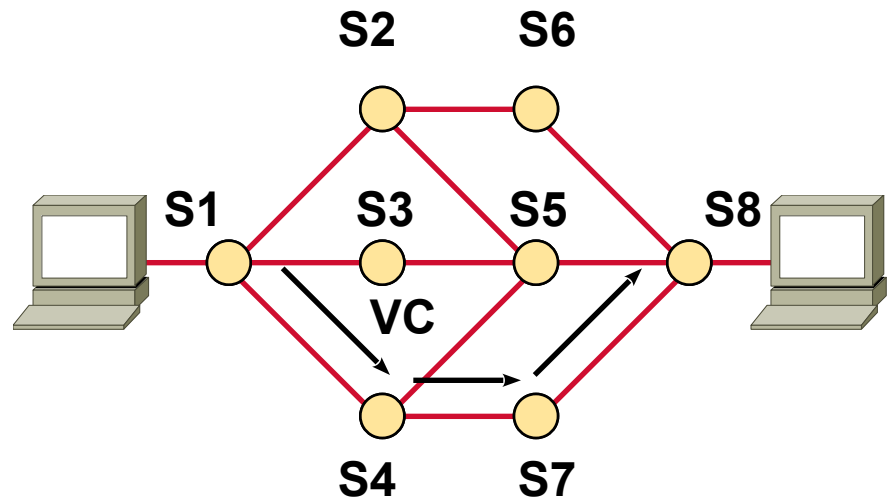


## Connectionless: Packet Routing

Path 1 = S1, S2, S6, S8

Path 2 = S1, S4, S7, S8

Data can take different path  
and can arrive out of order

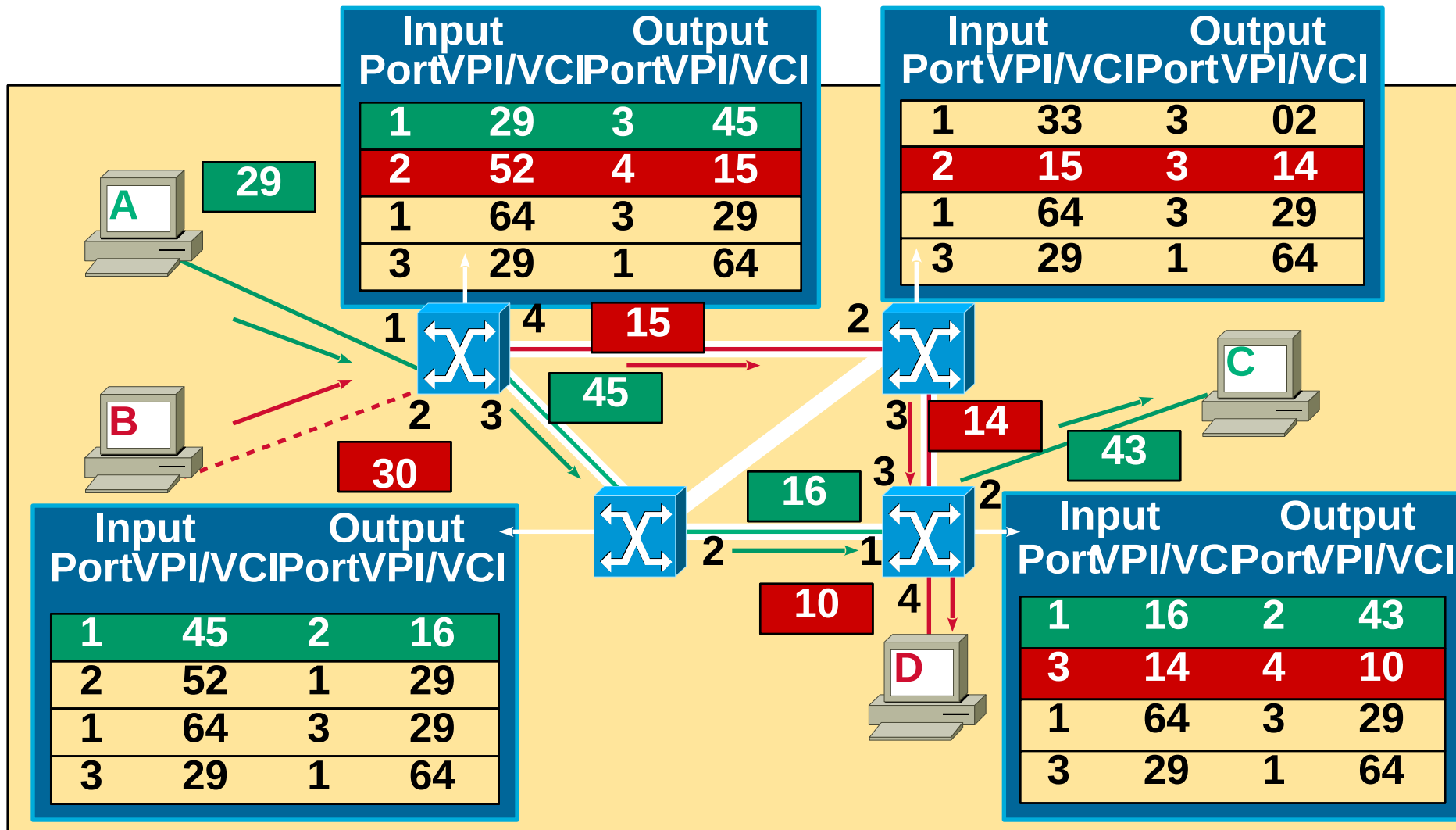


## Connection Oriented: Cell Switching

VC = S1, S4, S7, S8

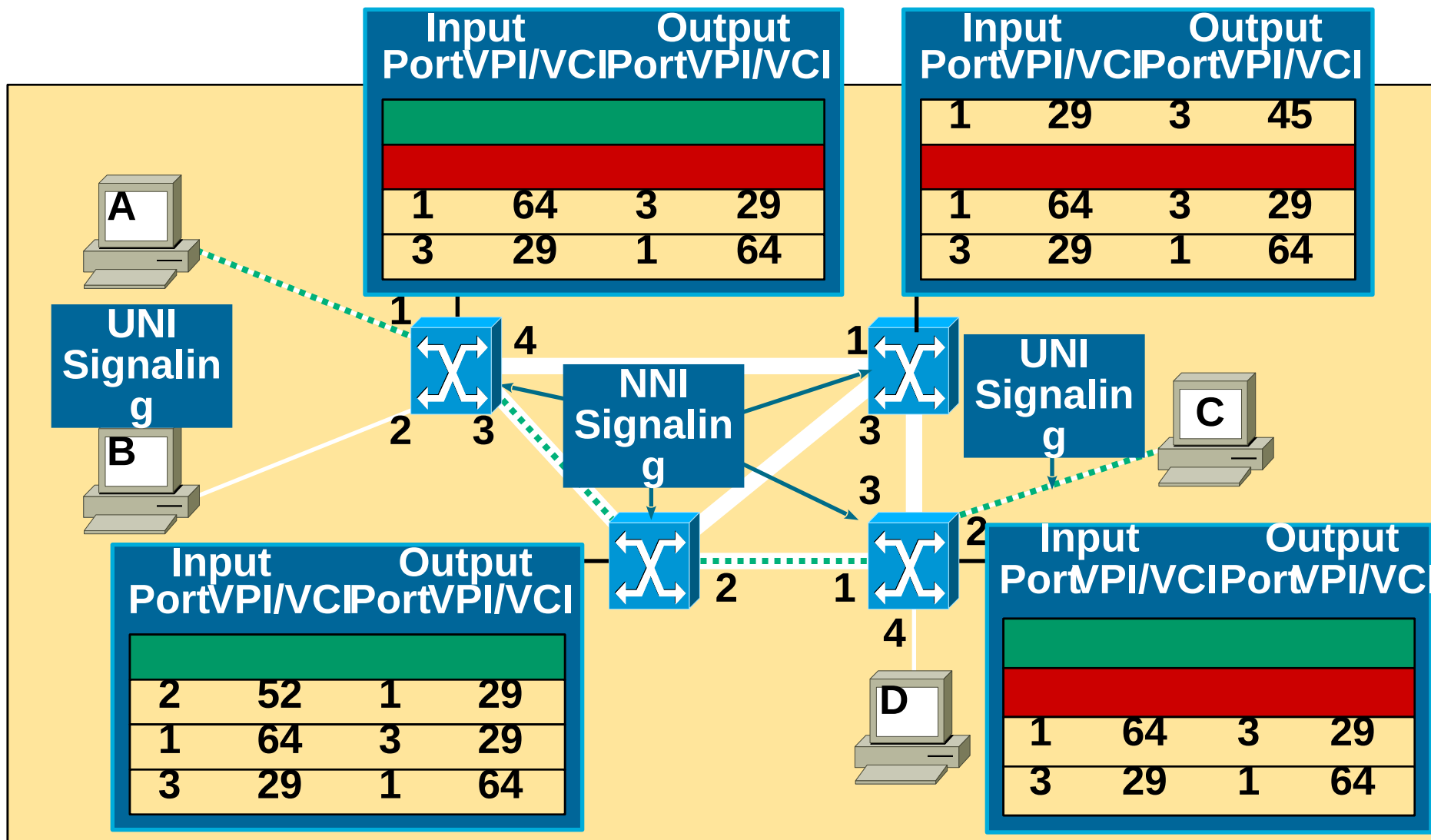
Data takes the same path  
and arrives in sequence

# Permanent Virtual Circuit (PVC)



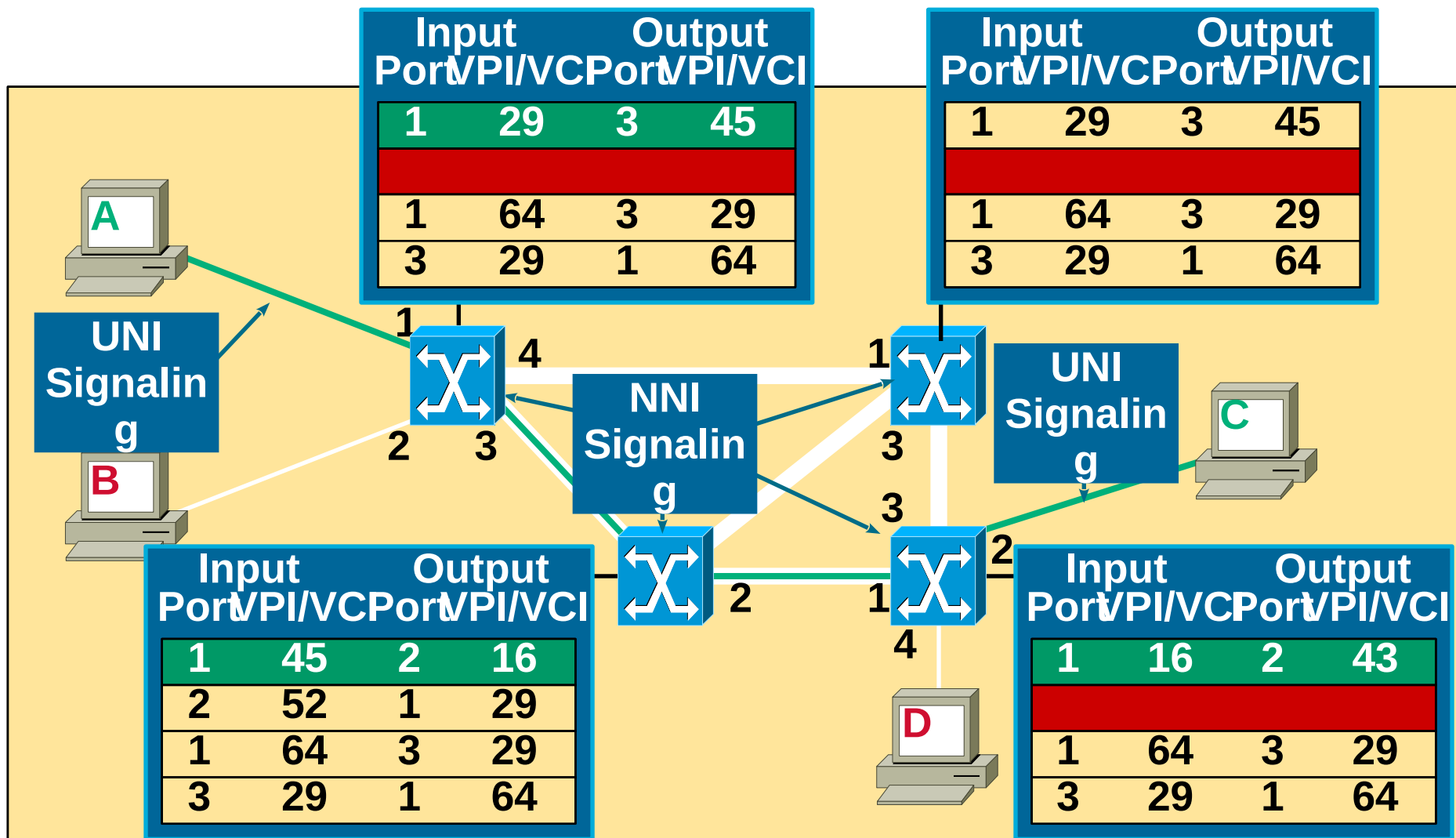
VPI/VCI tables in network equipment updated by administrator

# Switched Virtual Circuit (SVC)



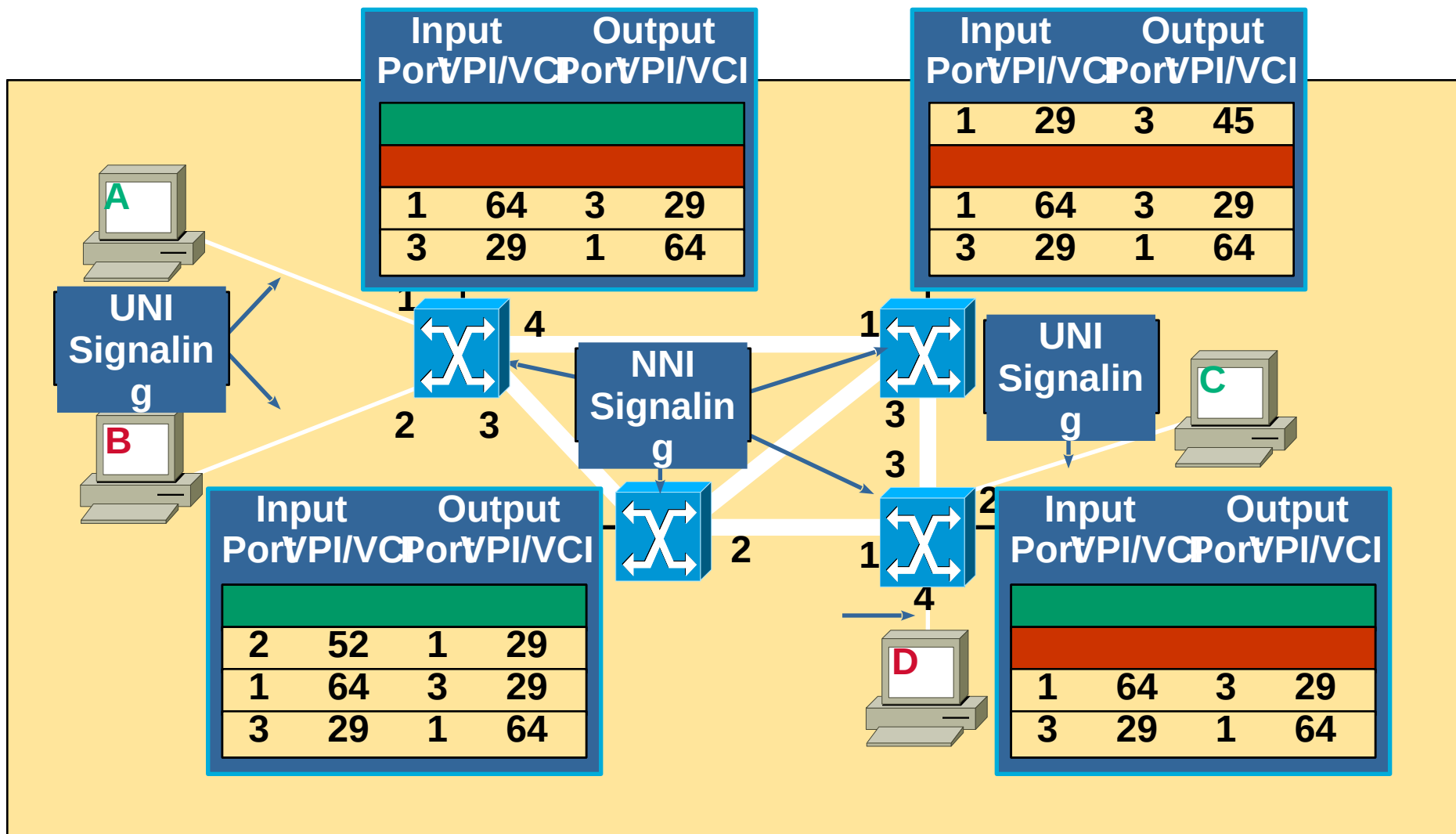
Dynamically set up connections via signaling

# Switched Virtual Circuit (SVC)



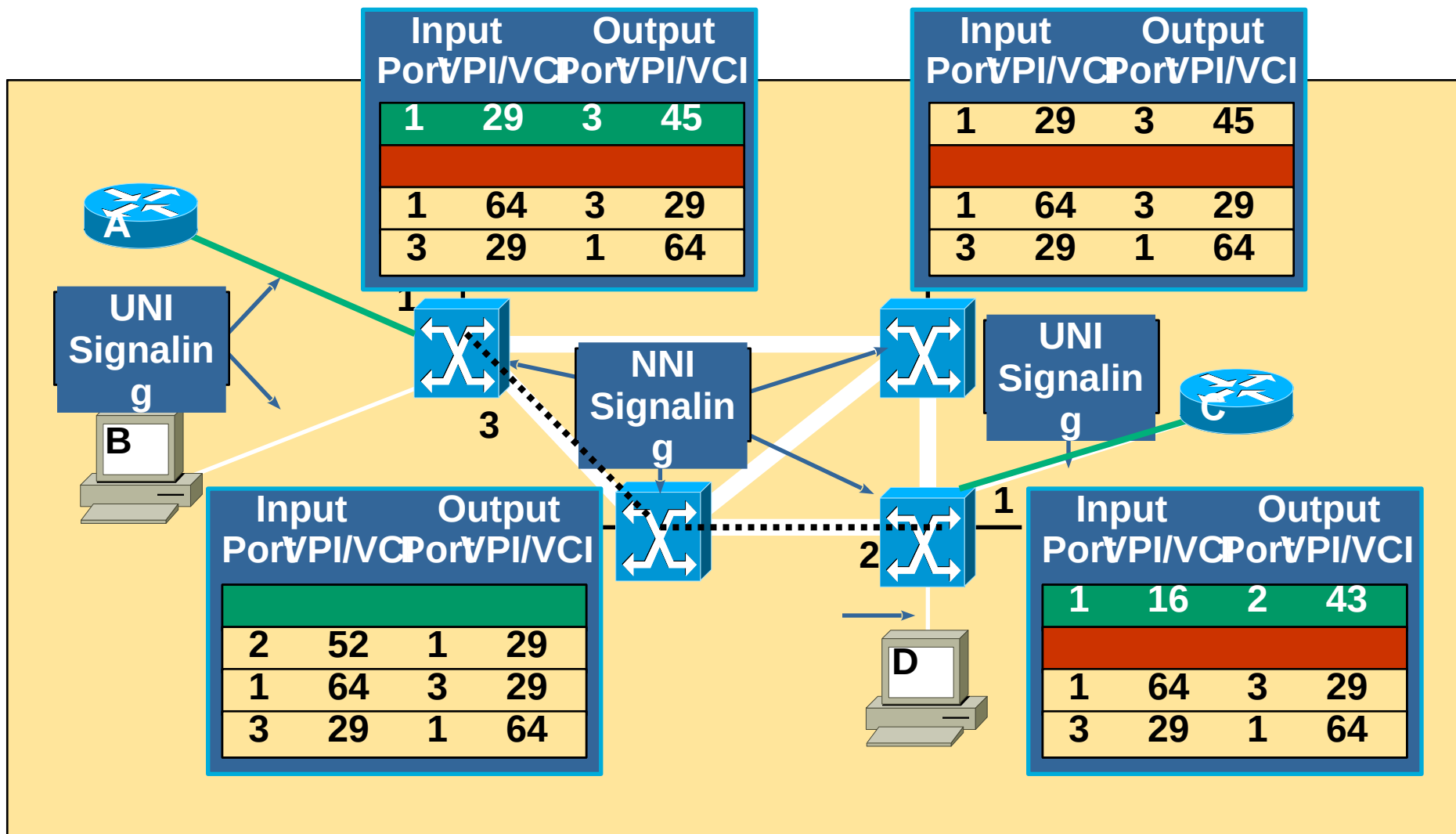
Transfer data over newly established link

# Switched Virtual Circuit (SVC)



Dynamically tear down connections via signaling

# Switched Virtual Circuit (SVC)



PVC established manually across **UNI** and dynamically across **NNI**



# Agenda

**Introduction**

**ATM Fundamentals**

**Rudimentary ATM Concepts**

**ATM Reference Model**

**ATM Service Categories**

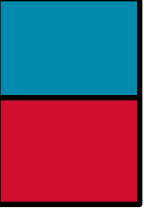
**Traffic Management**

**ATM Transport Standards**

**Campus ATM Internetworking**

**Wrap Up**





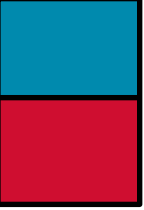
# ATM Reference Model

**Physical layer**

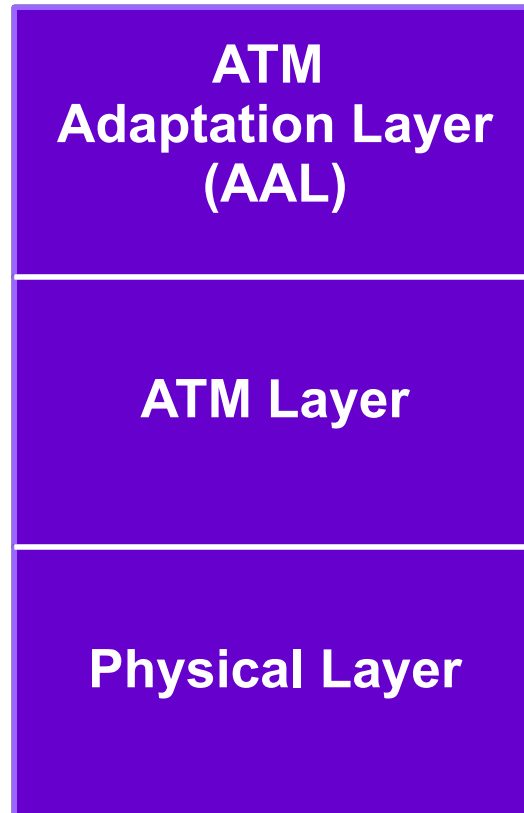
**ATM layer**

**ATM adaptation layer**

**A day in the life of a cell**



# ATM Reference Model





# ATM Reference Model

## Physical Layer

**Two Sublayers:**

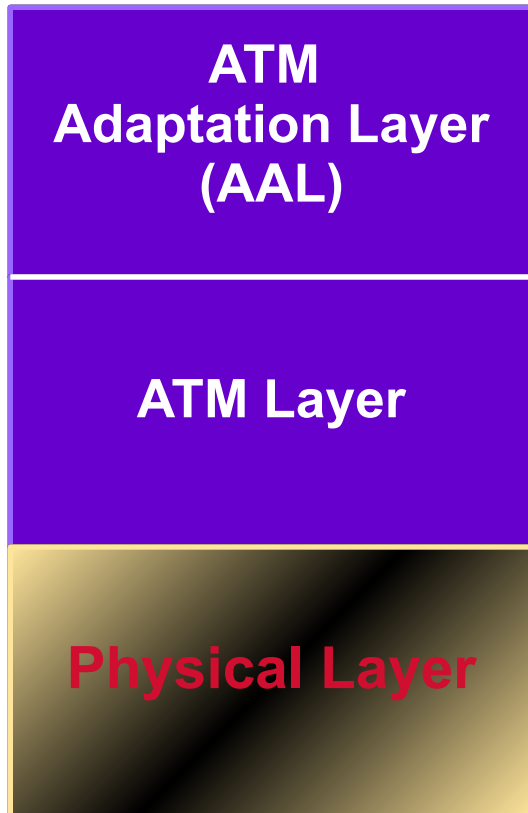
**Transmission Convergence (TC)**

Framing

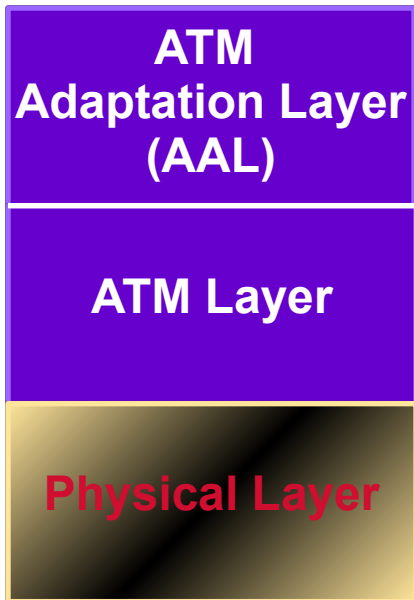
HEC

**Physical Media Dependent (PMD)**

Physical media coding



# Physical Layer



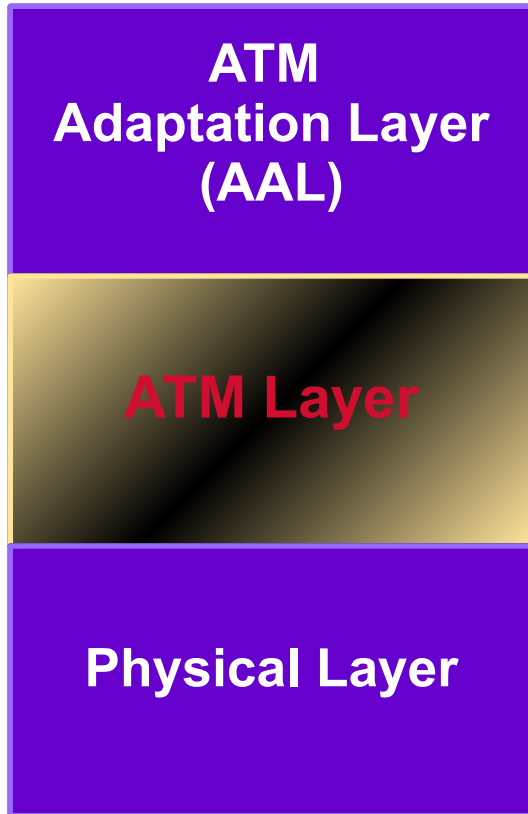
Framing	Data Rate (Mbps)	Media					
		Multi-Mode Fiber	Single-Mode Fiber	Coaxial Cable	UTP-5	UTP-3	STP
DS1	1.544						(TP)
E1	2.048			✓			(TP)
J2	6.23						
DS3	45			✓			
E3	34			✓			
E4	139			X			
ATM25	25.6					✓	
STS 1	51.8					✓	
STS3c/STM1	155	✓	✓		✓	X	
STS12c/STM4	622	✓	✓				
4B/5B (TAXI)	100	✓					
8B/10B	155	✓					
(Fiberchannel)							✓

✓ = Standardized    X = Proposed/In Progress



# ATM Reference Model

## ATM Layer

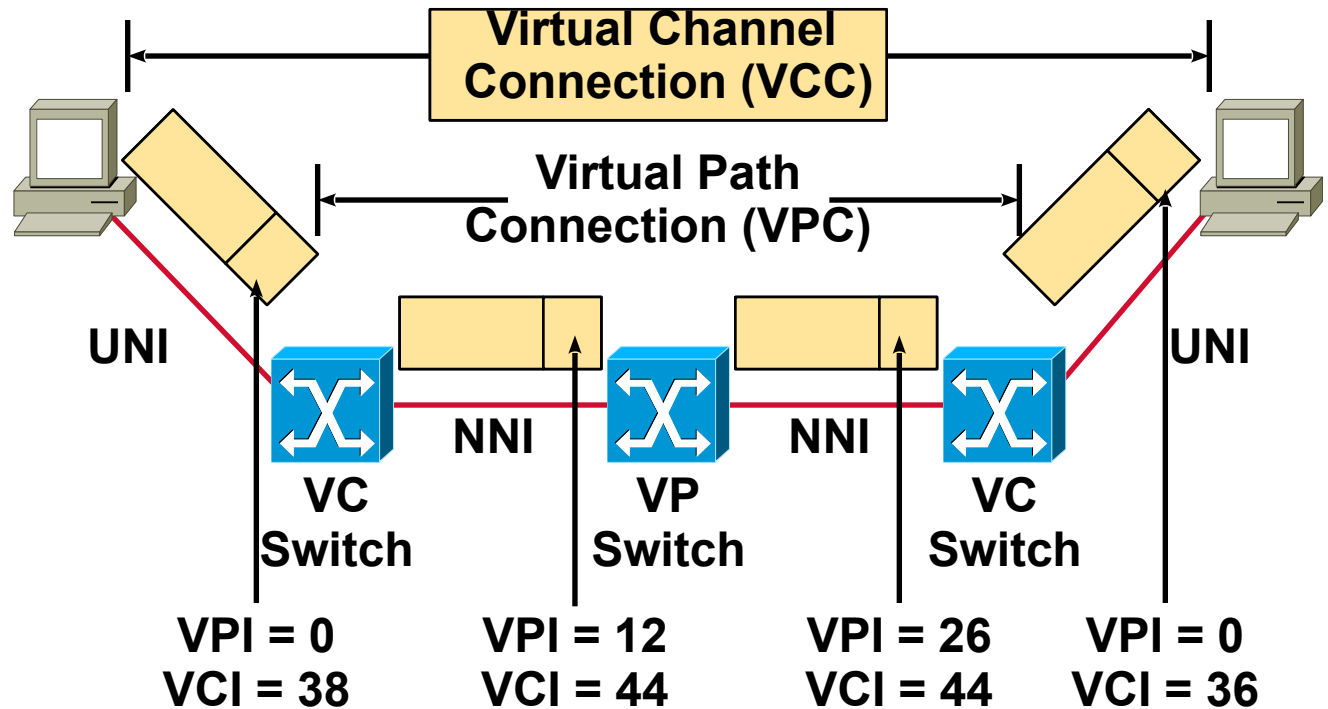
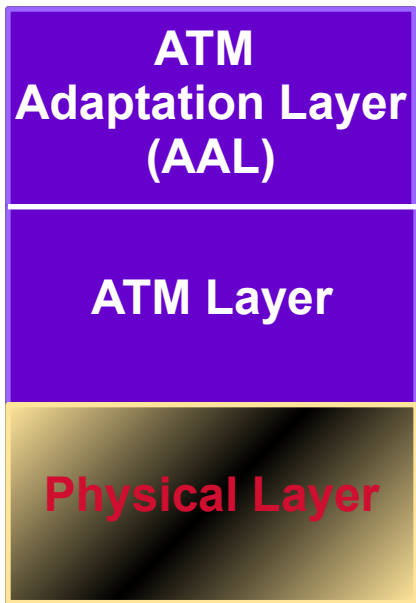


**Cell header insertion/removal**

**Cell Relay**

**Multiplexes/demultiplexes cells  
of different connections**

# ATM Layer



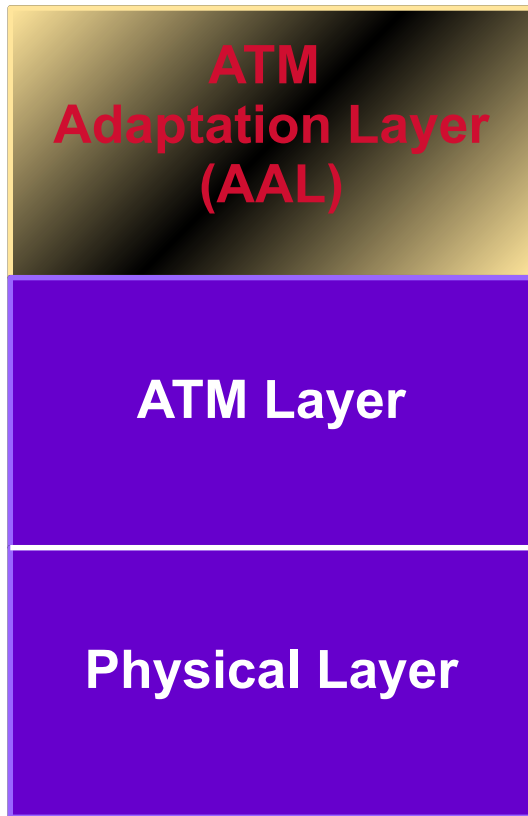
Provides VPI/VCI values in header

Ensures that cells stay in the correct order



# ATM Reference Model

## ATM Adaptation Layer (AAL)

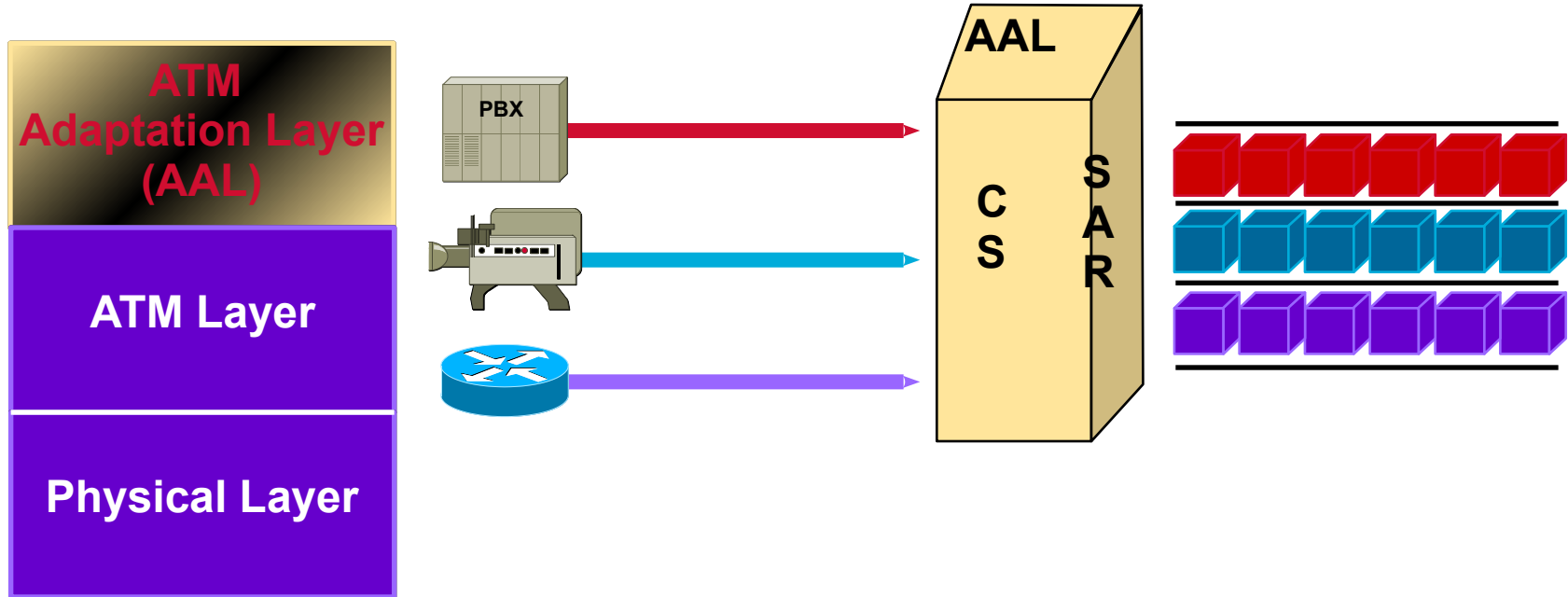


**Two Sublayers:**

**Convergence Sublayer (CS)**

**Segmentation and  
Reassembly (SAR)**

# ATM Adaptation Layer—AAL



$$\text{AAL} = \text{CS} + \text{SAR}$$

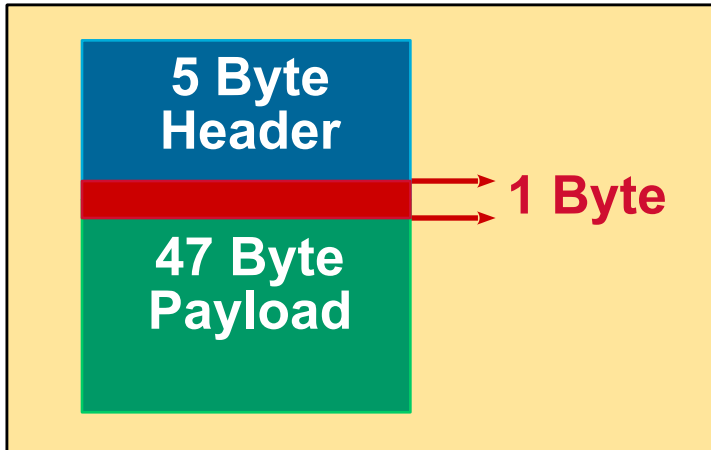
CS—cell tax

SAR—cell  $\leftrightarrow$  packet

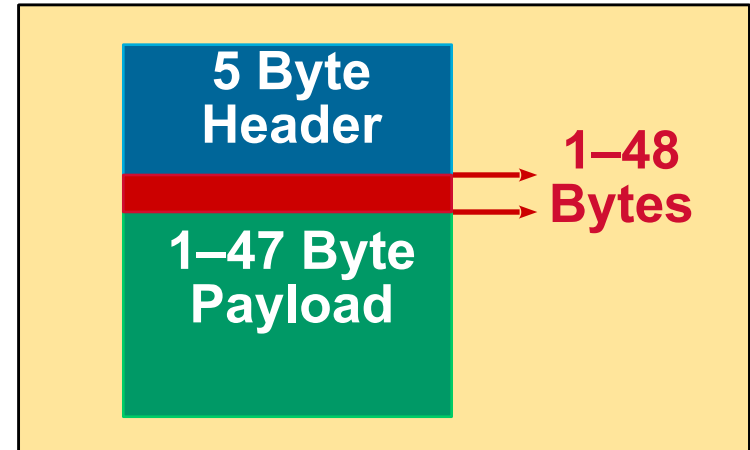


# AAL Cell Tax

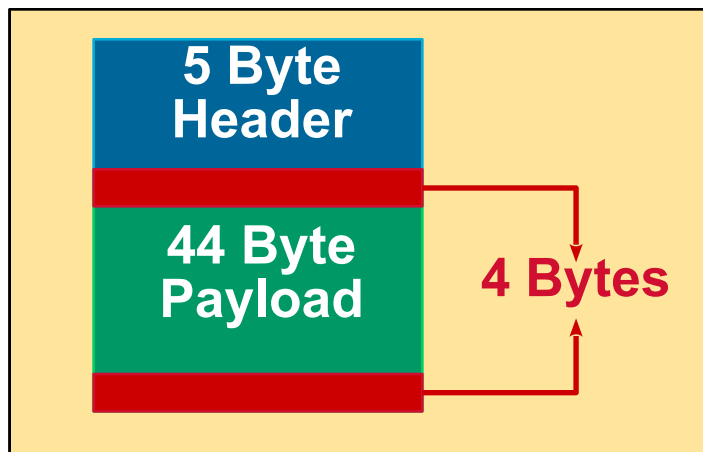
**AAL-1 Cell Tax**



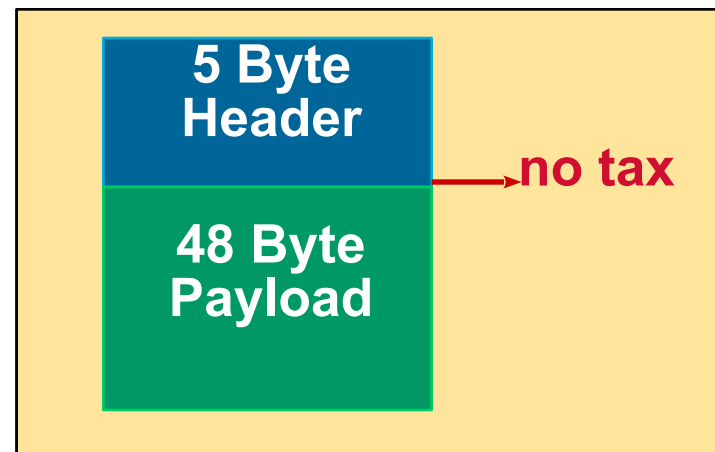
**AAL-2 Cell Tax**

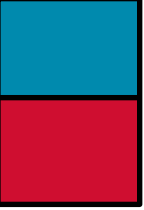


**AAL-3/4 Cell Tax**



**AAL-5 Cell Tax**





# ATM Reference Model

**Physical layer**

**ATM layer**

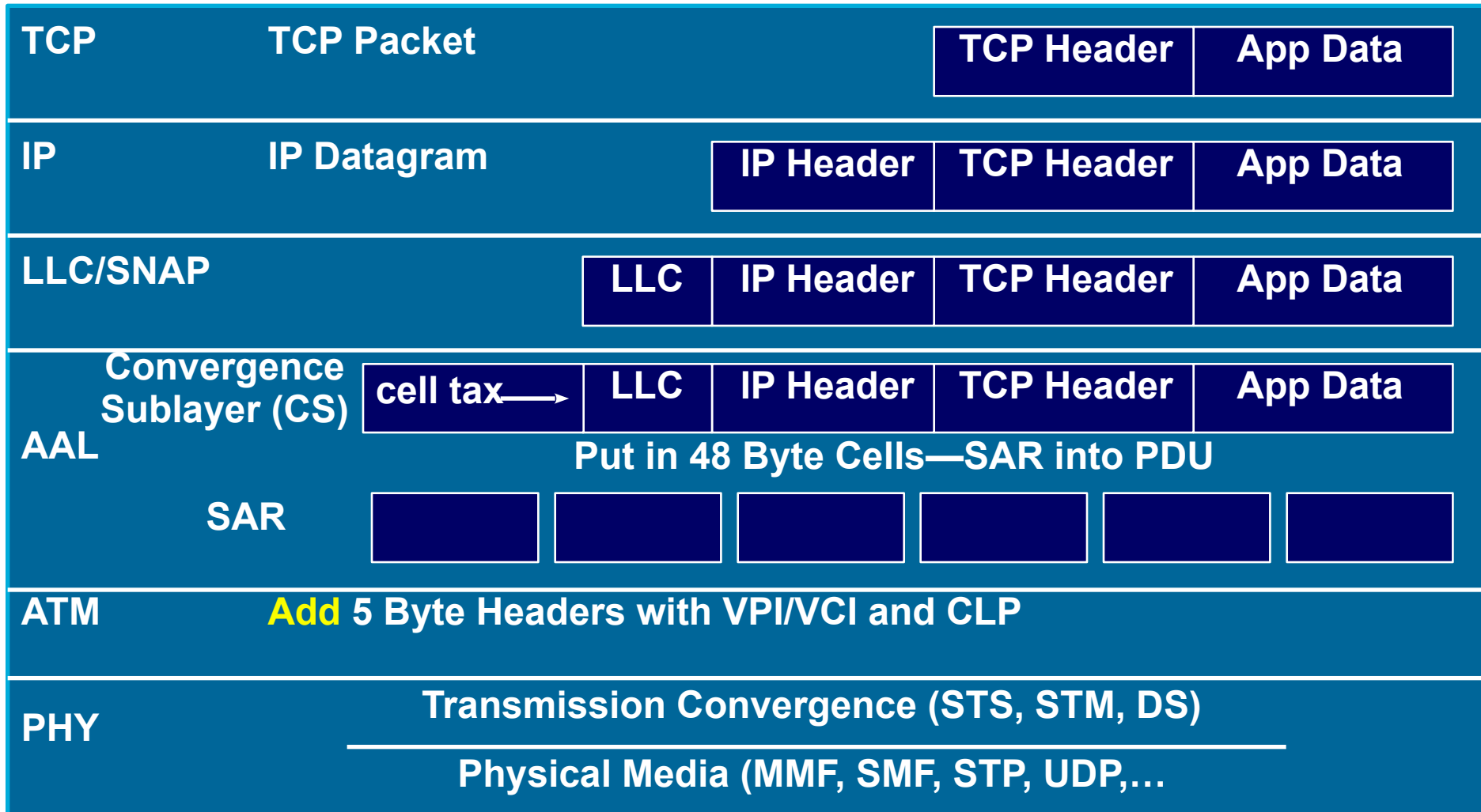
**ATM adaptation layer**

**A day in the life of a cell**



# A Day in the Life of a Cell

## ATM Payload Processing





# Agenda

**Introduction**

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**ATM Reference Model**

**ATM Service Categories**

**Traffic Management**

**ATM Transport Standards**

**Campus ATM Internetworking**

**Wrap Up**



# ATM Service Categories

## Service Criteria

**Traffic descriptors**

**QoS parameters**

## Service Categories

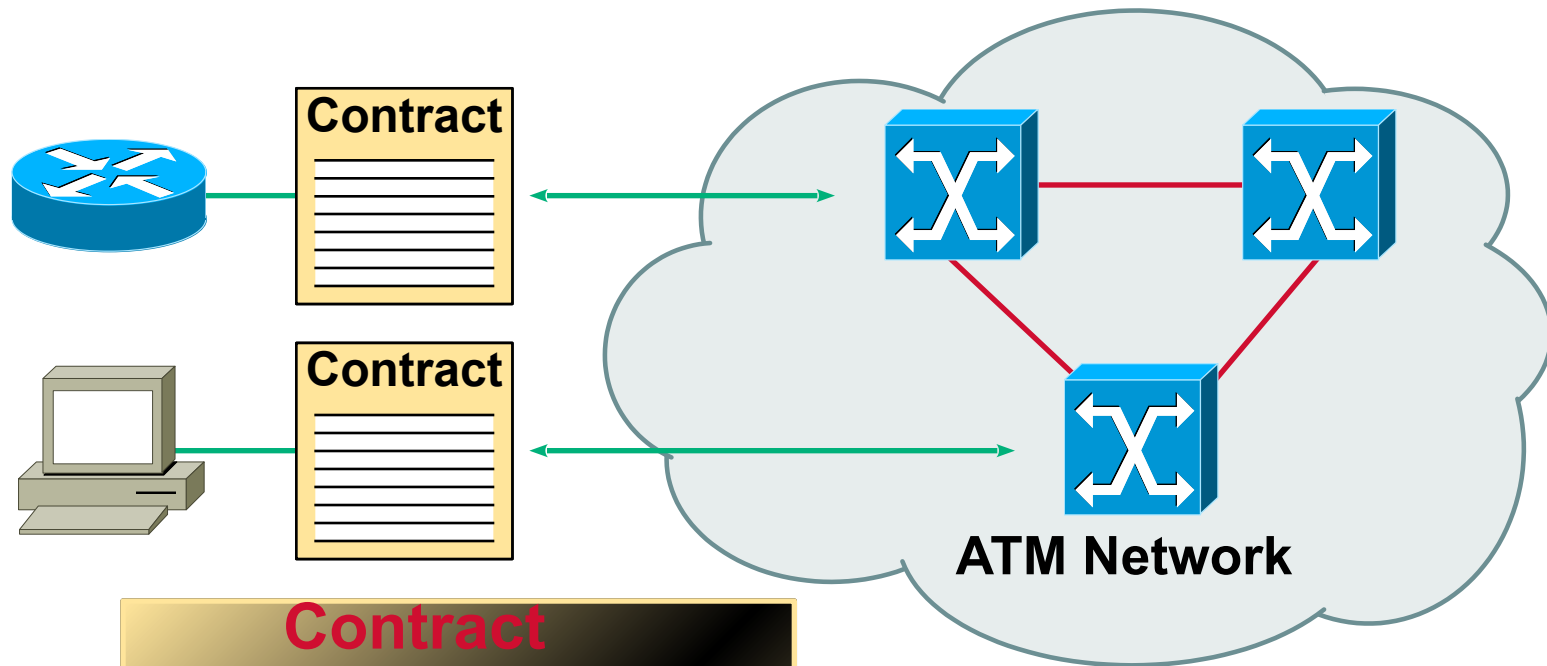
**Constant Bit Rate (CBR)**

**Variable Bit Rate (VBR)**

**Unspecified Bit Rate (UBR)**

**Available Bit Rate (ABR)**

# ATM Service Criteria



## Contract

### Traffic Descriptors

- Peak cell rate
- Sustainable cell rate
- Maximum burst size
- Minimum Cell Rate

### Quality of Service

- Delay
- Cell loss



# ATM Service Criteria

## Traffic Descriptors

**Peak Cell Rate—PCR—Maximum data rate a connection can handle without losing data**

**Sustainable Cell Rate—SCR—Average ATM cell throughput the application is permitted**

**Maximum Burst Size—MBS—Size of the maximum burst of contiguous cells that can be transmitted**

**Minimum Cell Rate—MCR—Rate of an application's ability to handle latency**



# ATM Service Criteria

## QoS—Delay

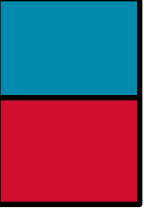
### Maximum Cell Transfer Delay—**MCTD**

How long the network can take to transmit a cell from one endpoint to another

### Cell Delay Variation Tolerance—**CDVT**

Line distortion caused by change in interarrival times between cells aka jitter





# ATM Service Criteria

**QoS—Cell Loss**

**Cell Loss Ratio—CLR**

**Acceptable percentage of cells that  
the network can discard due to  
congestion**



# ATM Service Categories

## Service Criteria

Traffic parameters

QoS parameters

## Service Categories

Constant Bit Rate (CBR)

Variable Bit Rate (VBR)

Unspecified Bit Rate (UBR)

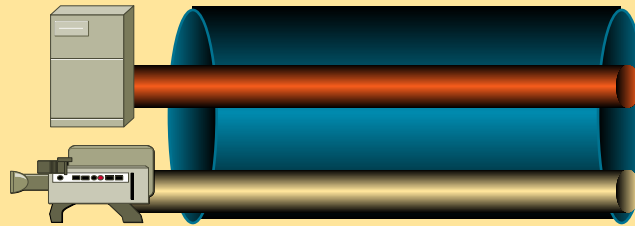
Available Bit Rate (ABR)

# ATM Service Categories

## Constant Bit Rate (CBR)

### Application

Real Time Voice and Video



### Traffic Descriptor

PCR

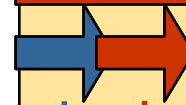
Peak Cell Rate

### QoS

Tolerance

LOW

HIGH



Cell Loss

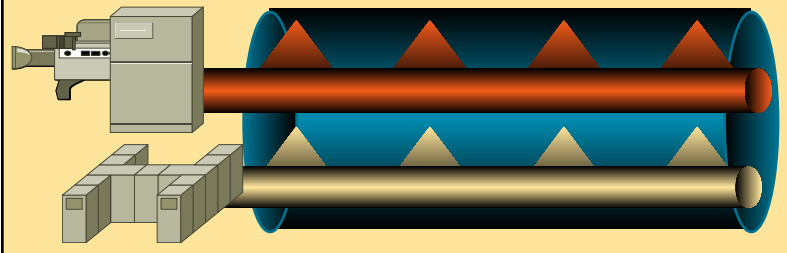
Cell Delay

# ATM Service Categories

## Variable Bit Rate (VBR-RT/VBR-NRT)

### Application

Packetized Voice/Video, SNA



### Traffic Descriptor

**PCR**

Peak Cell Rate

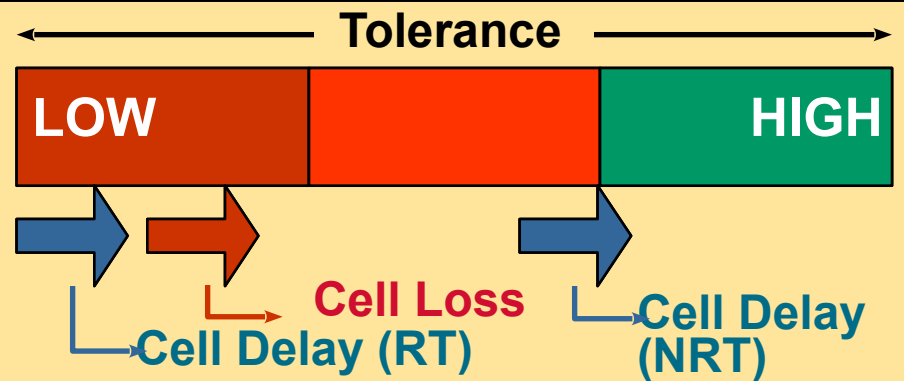
**SCR**

Sustainable Cell Rate

**MBS**

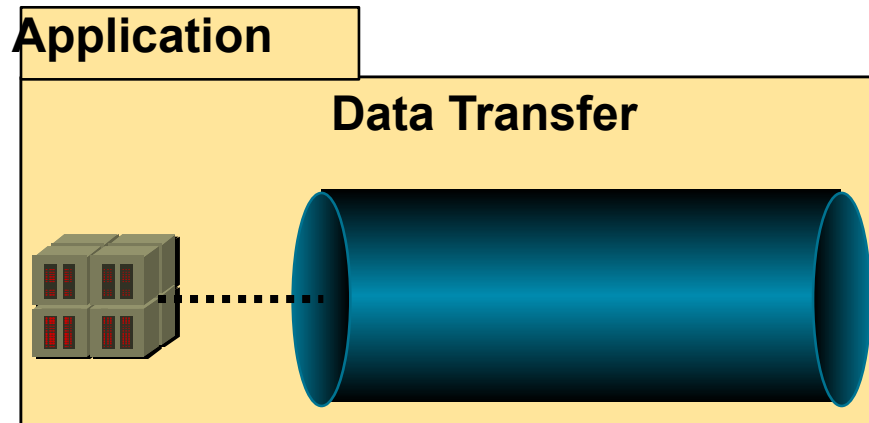
Maximum Burst Size

### QoS



# ATM Service Categories

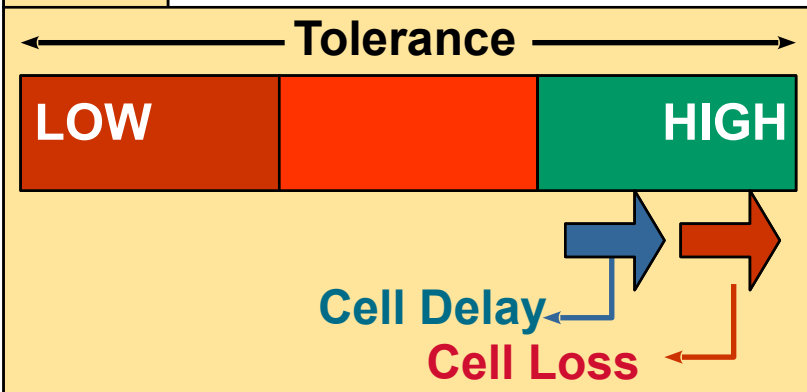
## Unspecified Bit Rate (UBR)



### Traffic Descriptor

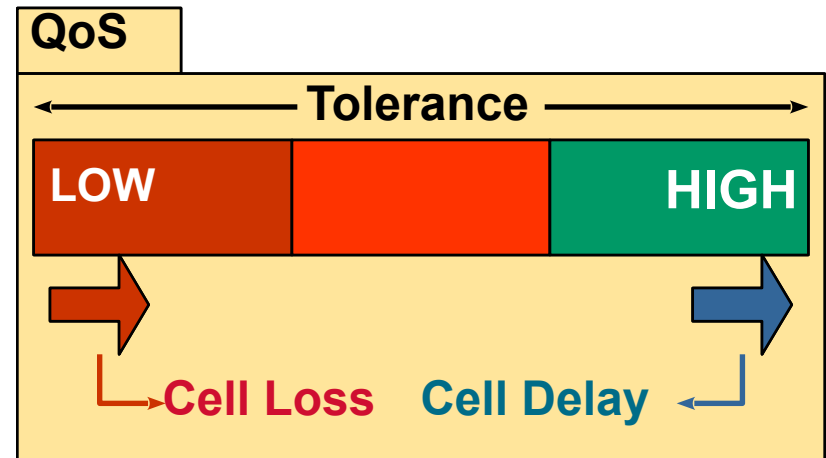
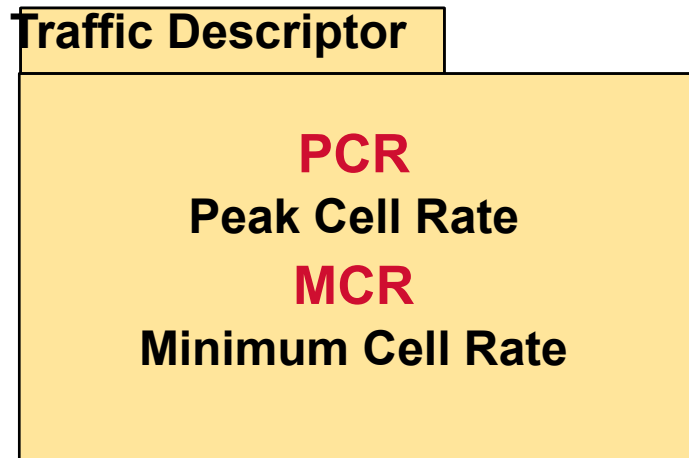
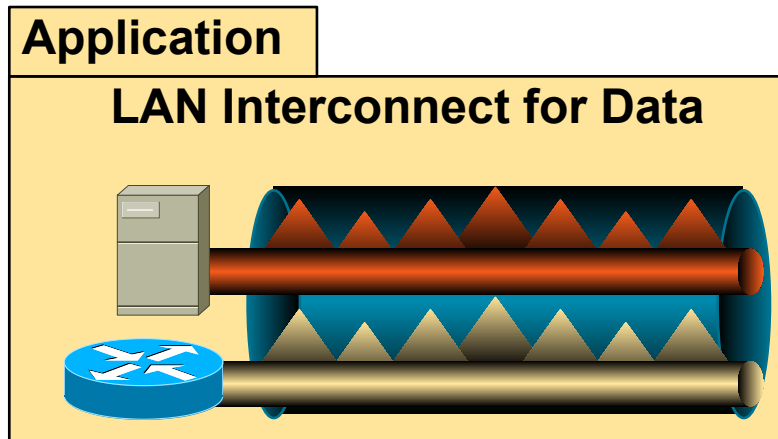
**No Guarantees  
Send and Pray**

### QoS



# ATM Service Categories

## Available Bit Rate (ABR)



**Also uses Congestion Feedback Mechanisms**



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