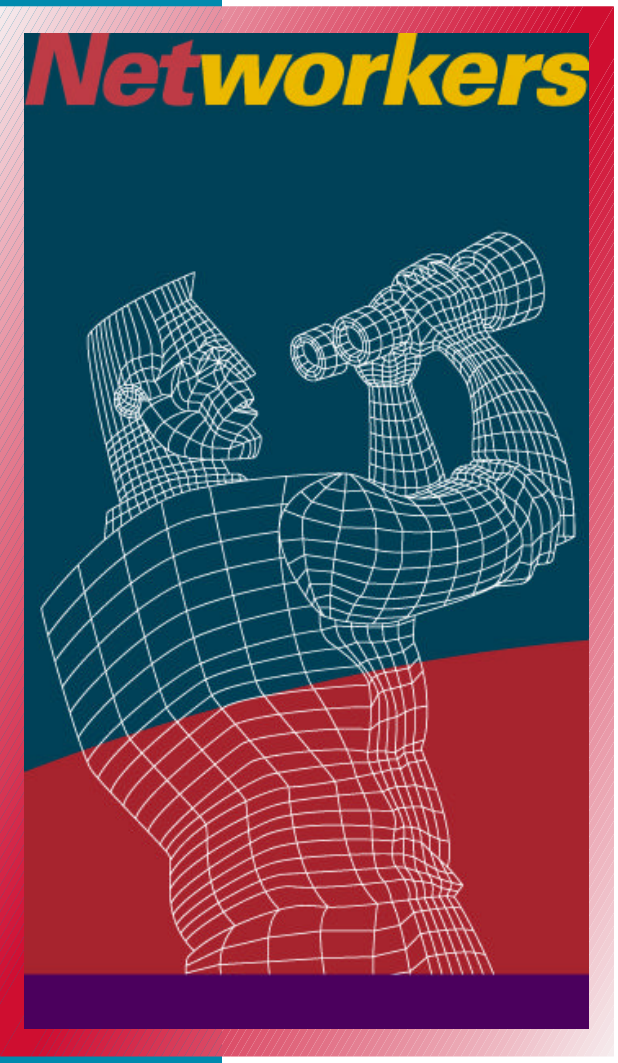

Introduction to ATM

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Agenda

- Introduction
- ATM Fundamentals
  - Rudimentary ATM Concepts
  - ATM Reference Model
  - ATM Service Categories
  - Traffic Management
- ATM Transport Standards
- Campus ATM Internetworking
- Wrap Up

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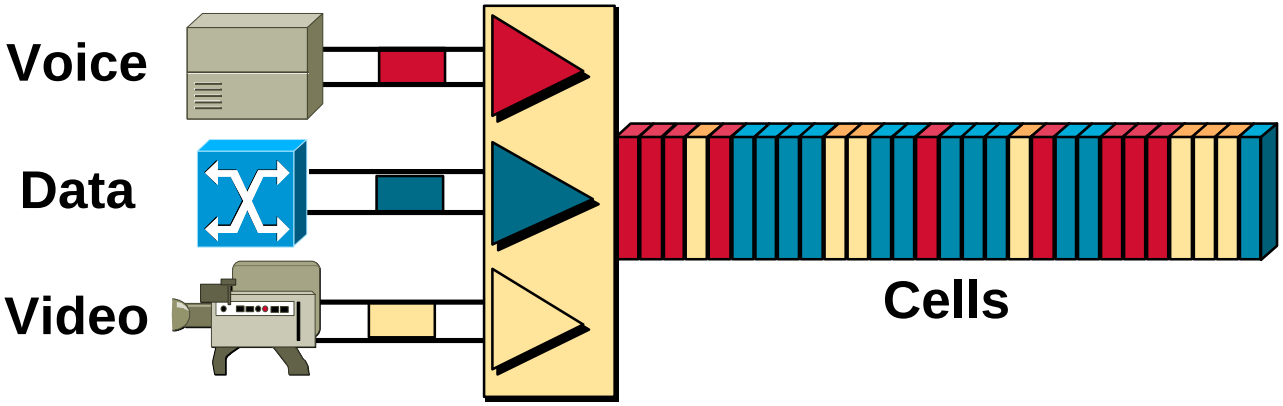
Characteristics of ATM



- Uses small, fixed-sized cells
- Connection-oriented
- Supports multiple service types
- Applicable to LAN and WAN

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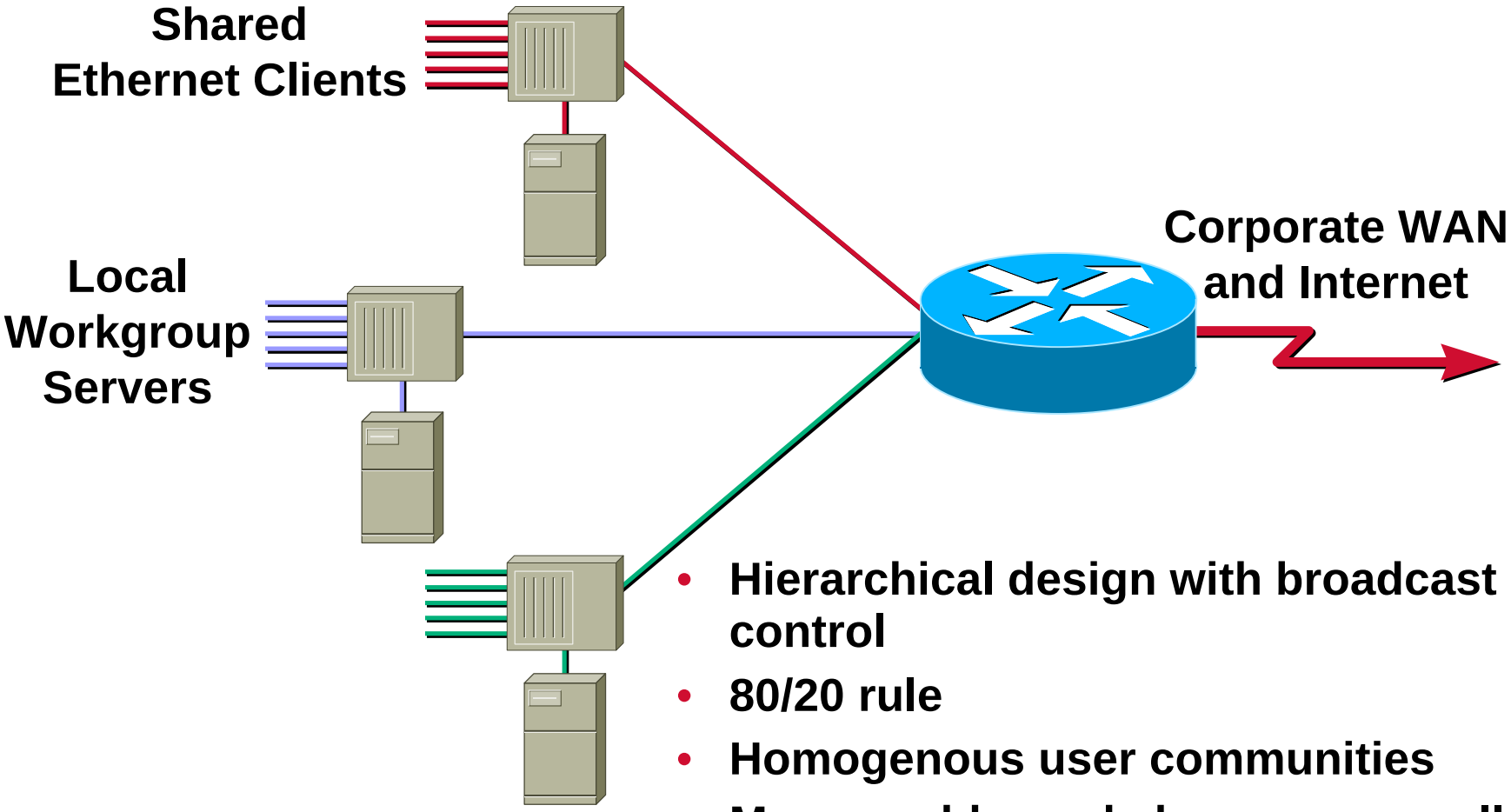
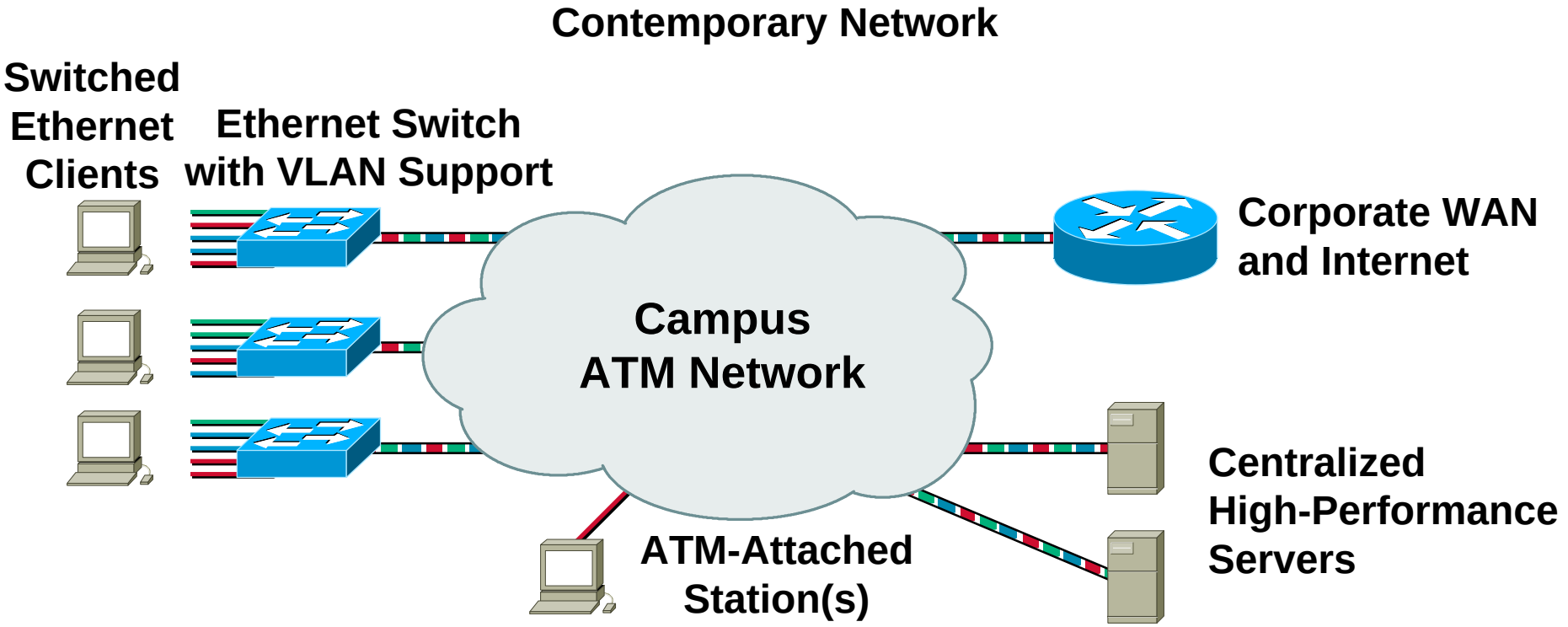
Campus Networking Evolution

Traditional Network



- Hierarchical design with broadcast control
- 80/20 rule
- Homogenous user communities
- Moves, adds, and changes manually

Campus Networking Evolution



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

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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
EFCI—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

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Rudimentary ATM Concepts

- Physical layer
- Signaling
- Cell format
- Connection types

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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)
DS3	45			✓			
E3	34			X			
E4	139						
ATM25	25.6					✓	
STS 1	51.8					✓	
STS3c/STM1	155	✓	✓		✓	X	
STS 12c/STM4	622	✓	✓				
4B/5B (TAXI)	100	✓					
8B/10B (Fiberchannel)	155	✓					✓

✓ = Standardized X = Proposed/In Progress

Rudimentary ATM Concepts

- Physical layer
- Signaling
- Cell format
- Connection types

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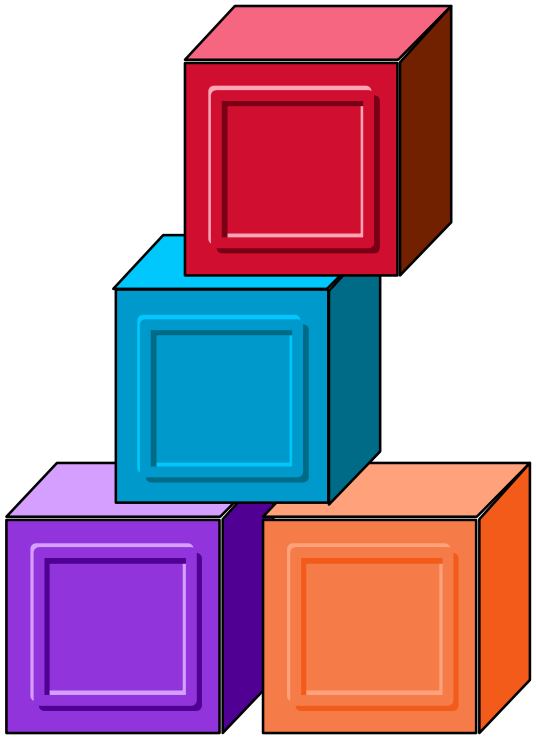
ATM Building Blocks



- **ATM signaling**
  - **UNI and NNI**
- **Virtual connections**
  - **VCC, VP, and VC**

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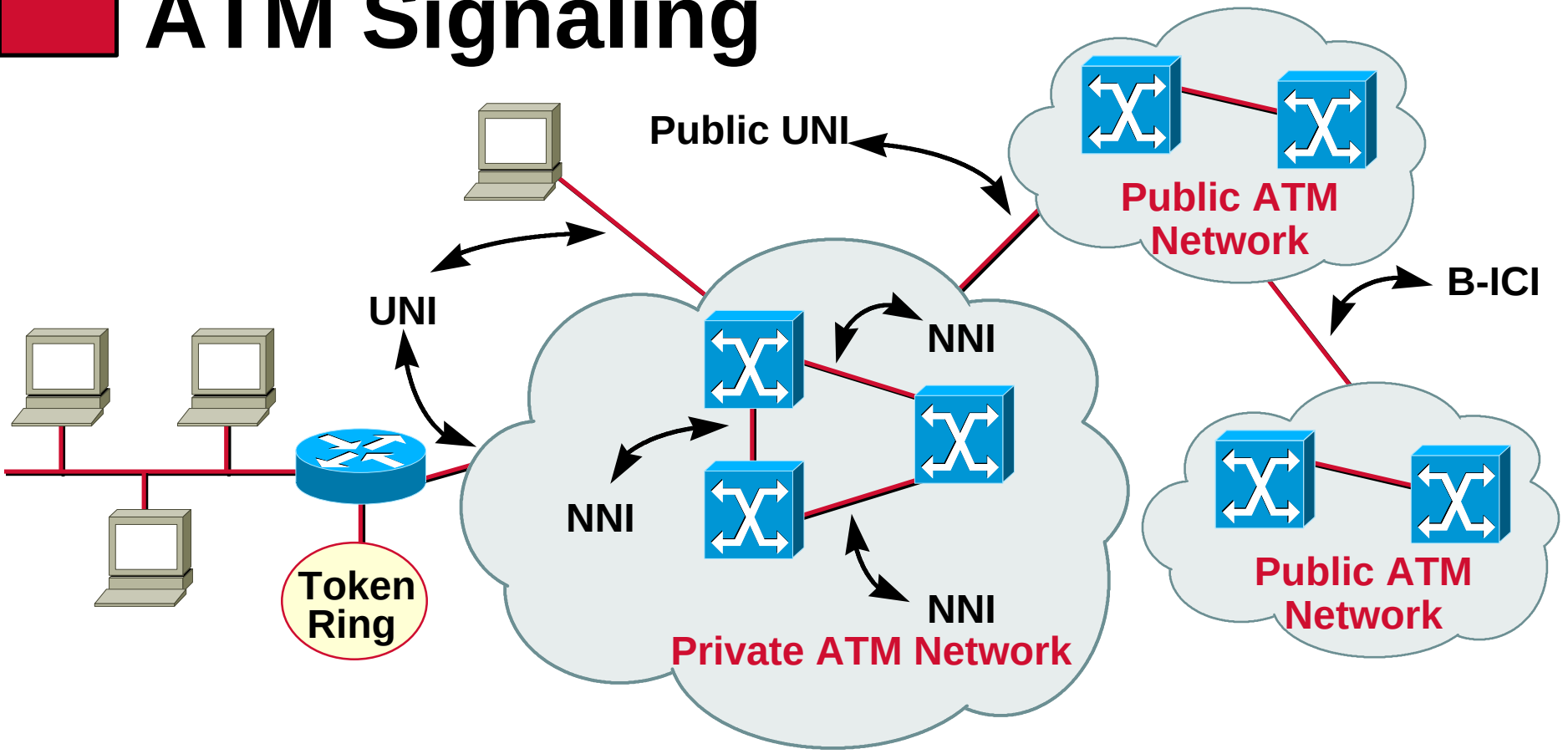
ATM Signaling



- UNI = User-to-Network Interface
- NNI = Network-to-Network Interface
- Cell header content varies depending on who's talking to whom

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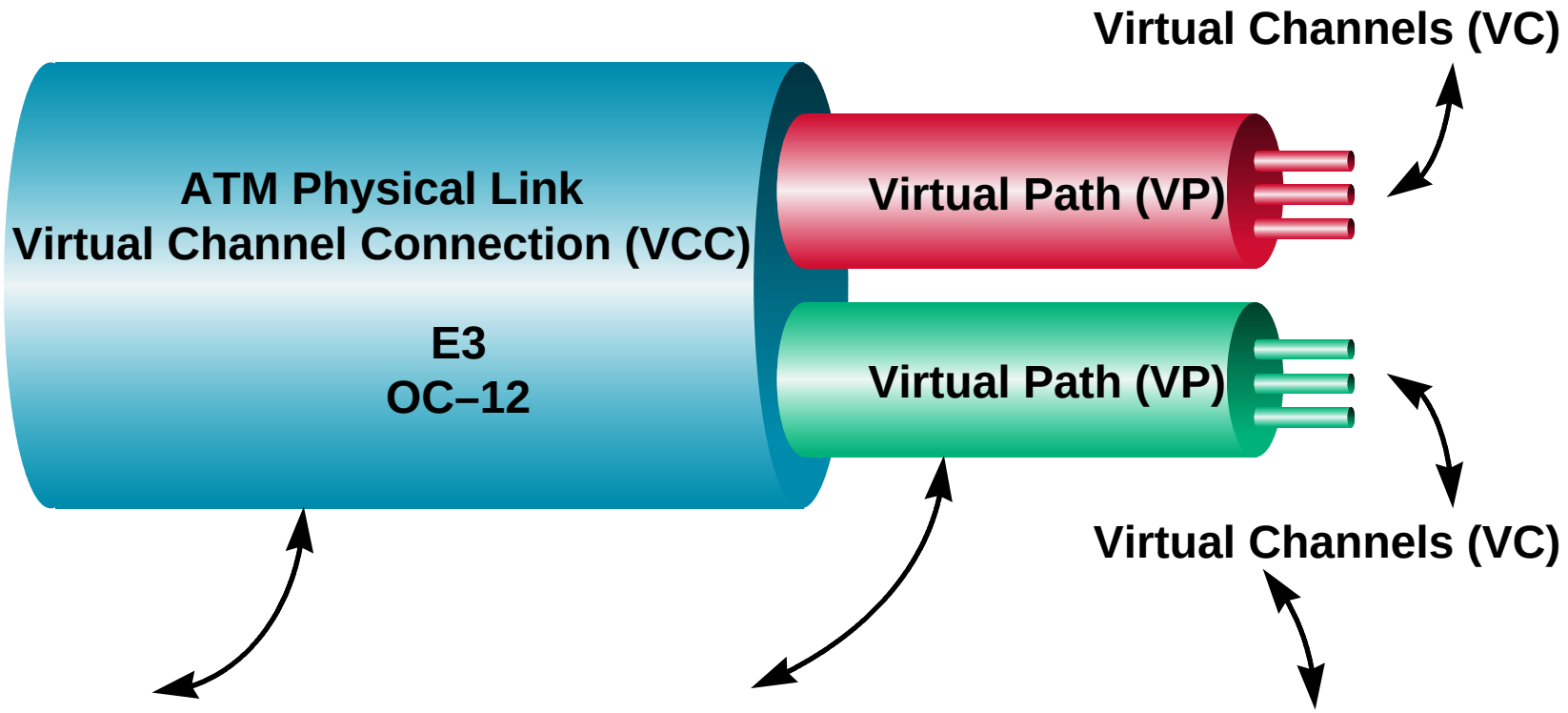
Virtual Path and Virtual Channels

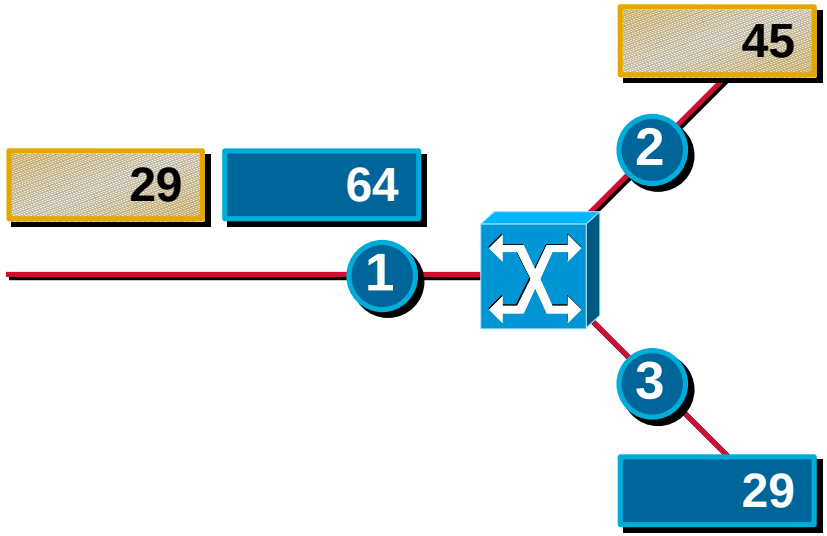


Virtual Channel Connection (VCC) Contains Multiple VPs	Virtual Path (VP) Contains Multiple VCs	Virtual Channel (VC) Logical Path Between ATM End Points

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

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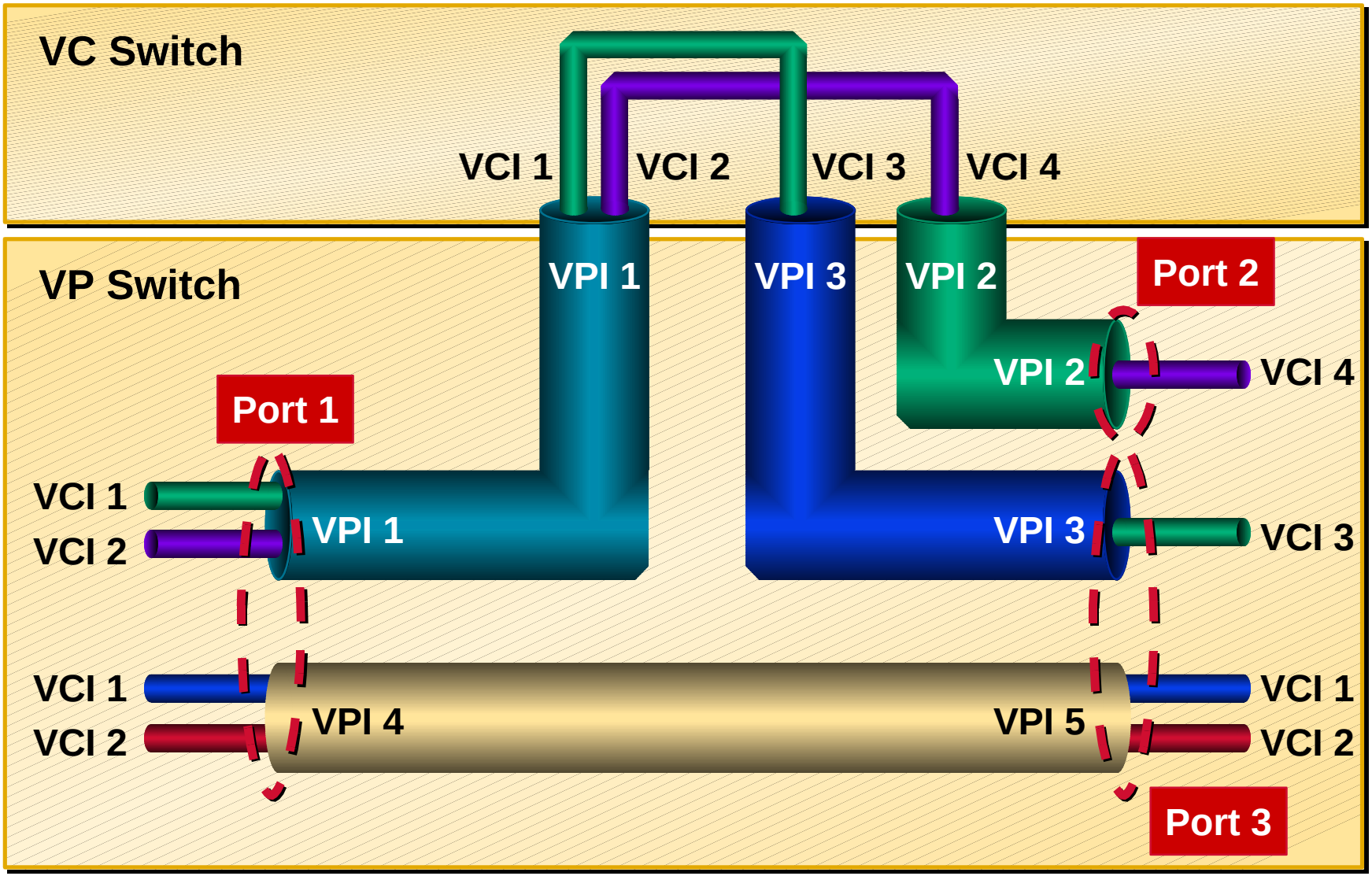
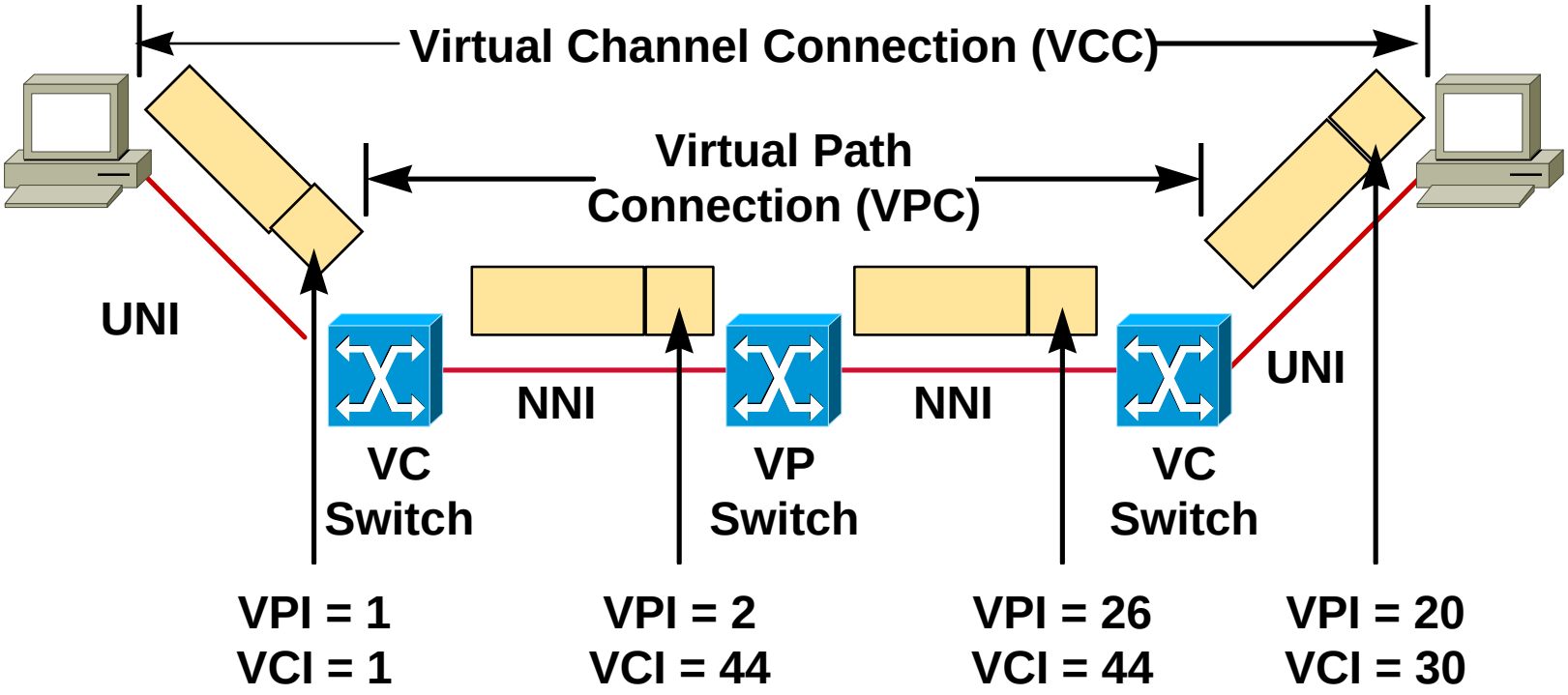
VP and VC Switching



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

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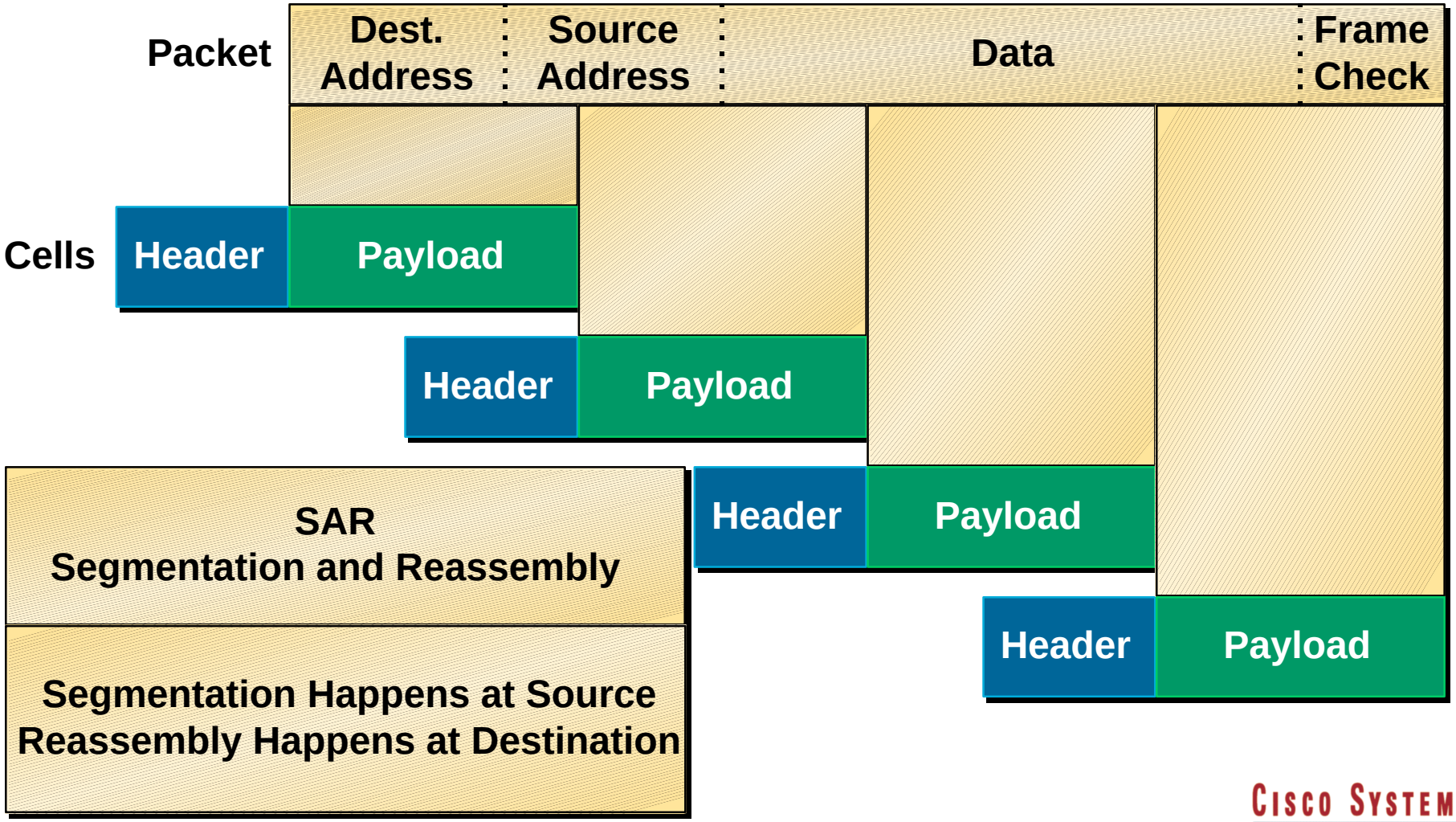
Creating Cells from Packets



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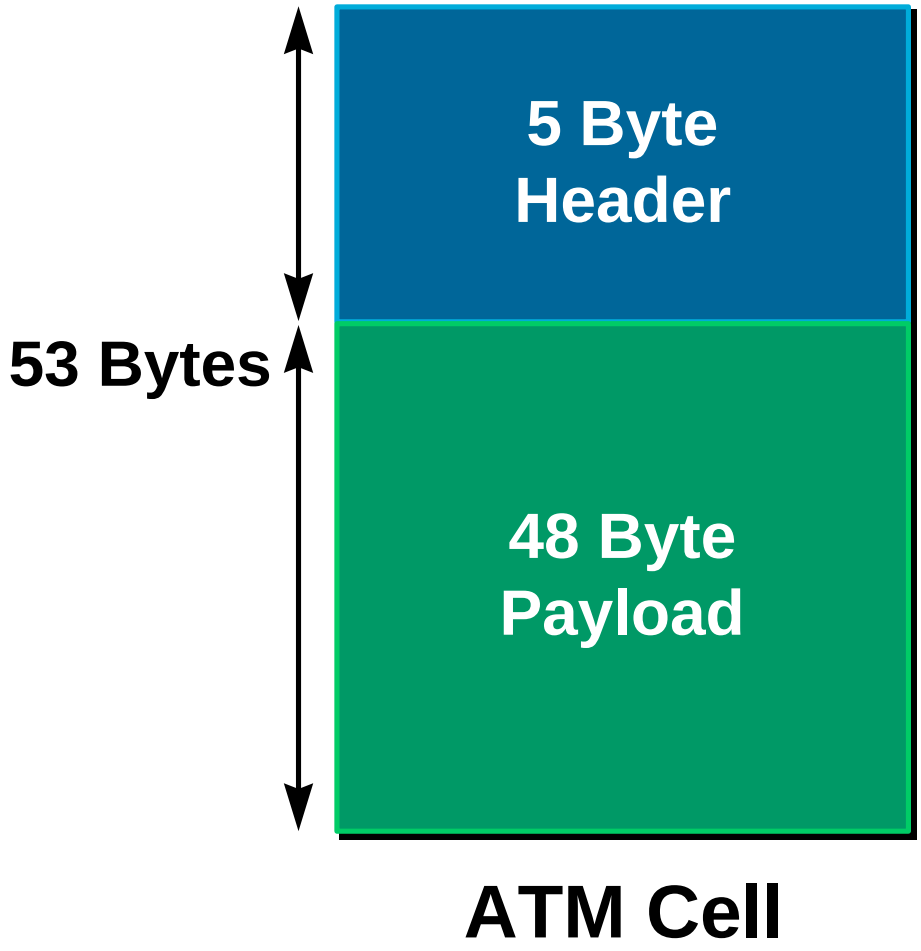
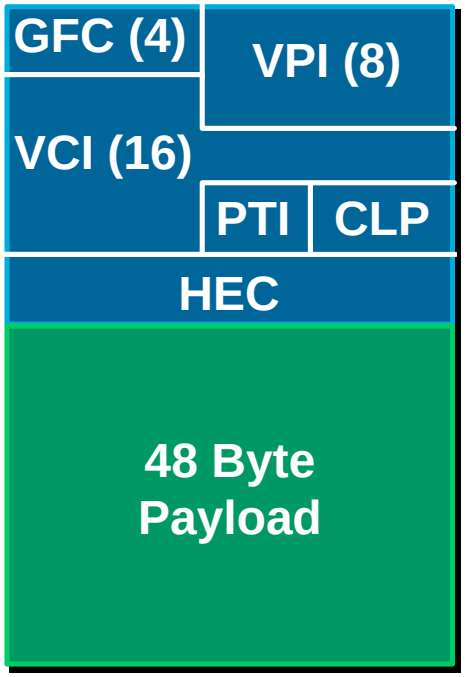
ATM Cell Header

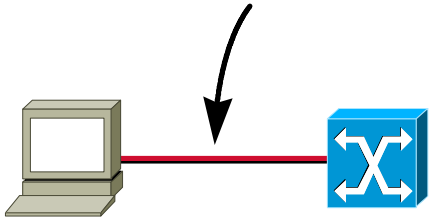


ATM Cell

ATM Cell Header Details



ATM UNI Cell



GFC Generic Flow Control
UNI Cells Only!

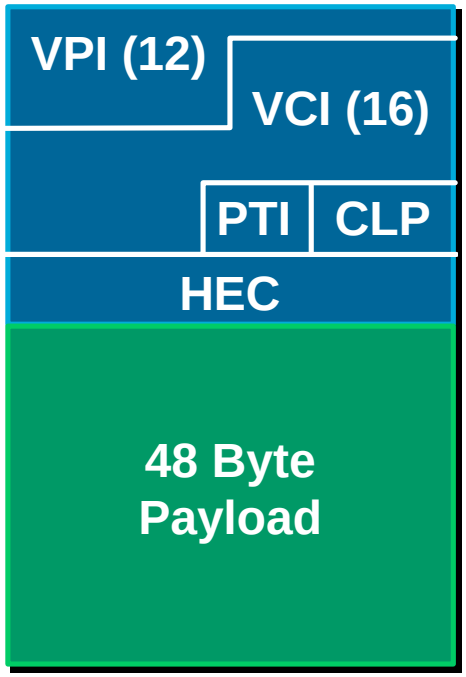
VPI/VCI Identifies Virtual Paths and Channels

PTI Payload Type Identifier
3 Bits:

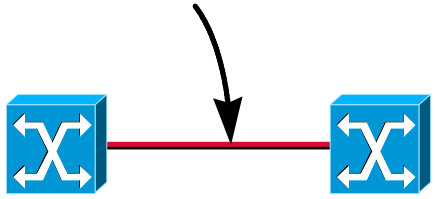
1. User/Control Data
2. Congestion
3. Last Cell

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

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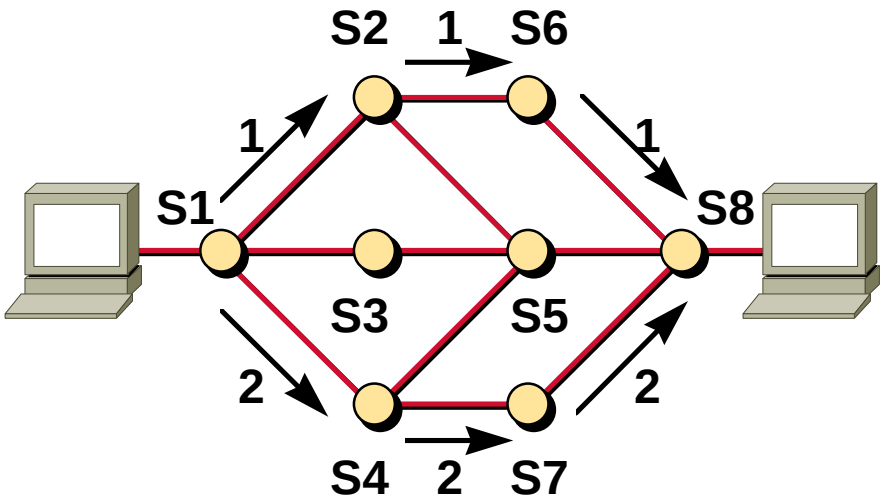
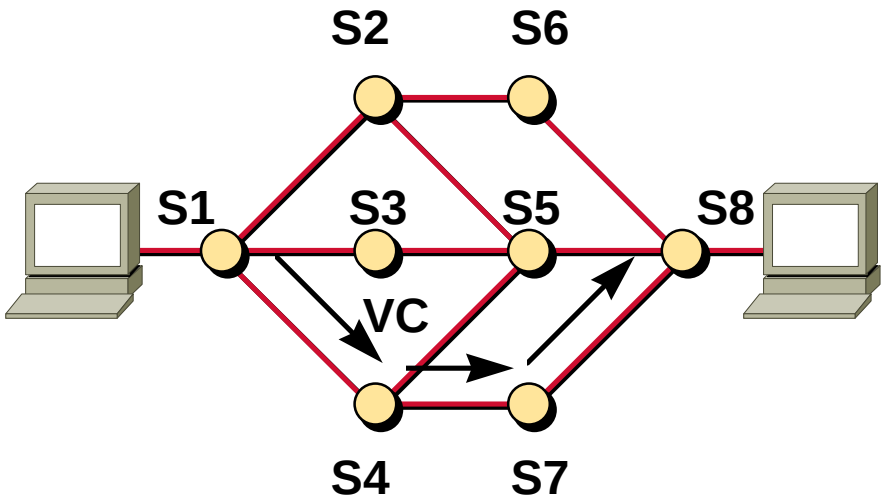
ATM Connection Types

- 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**

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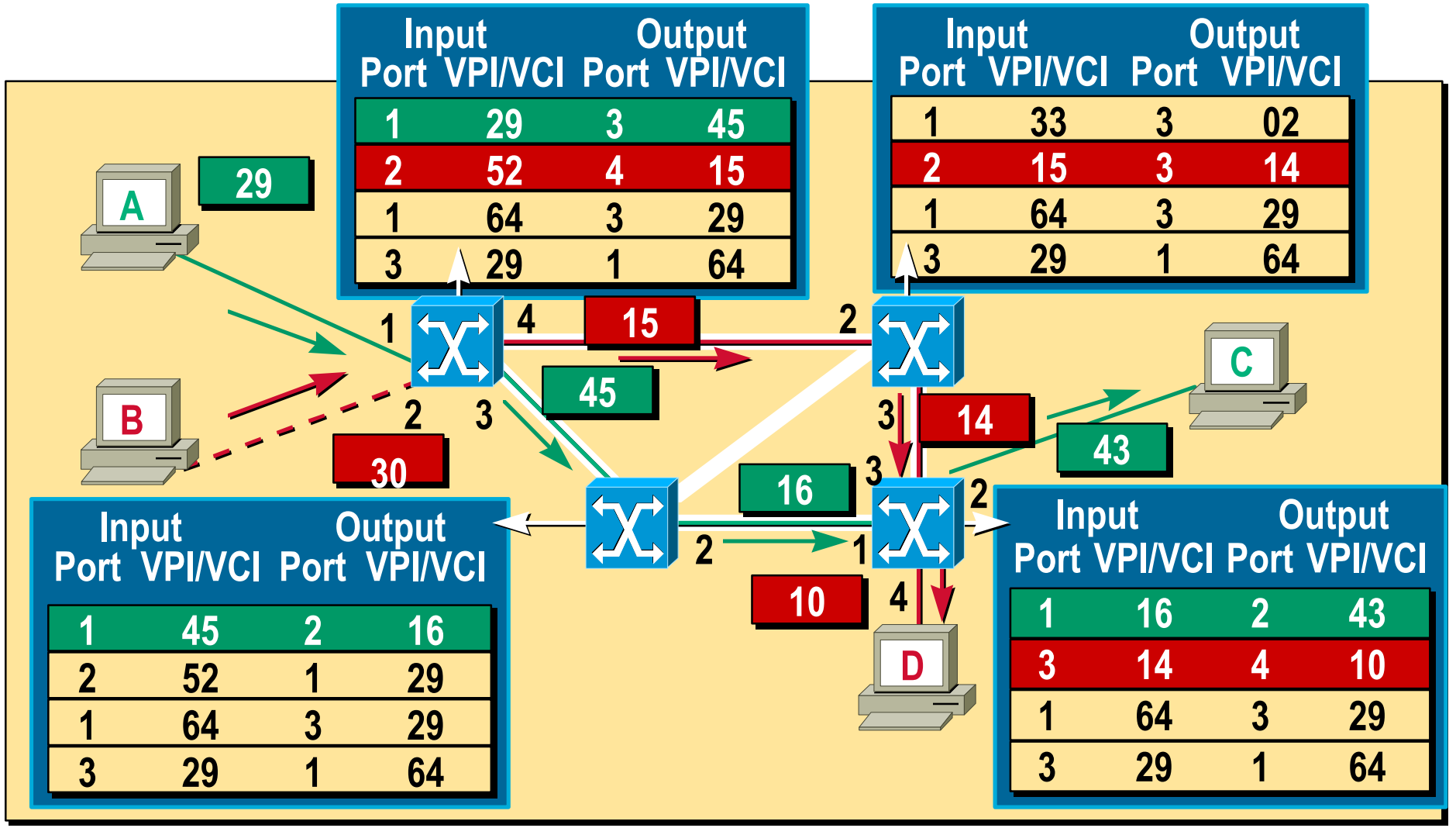
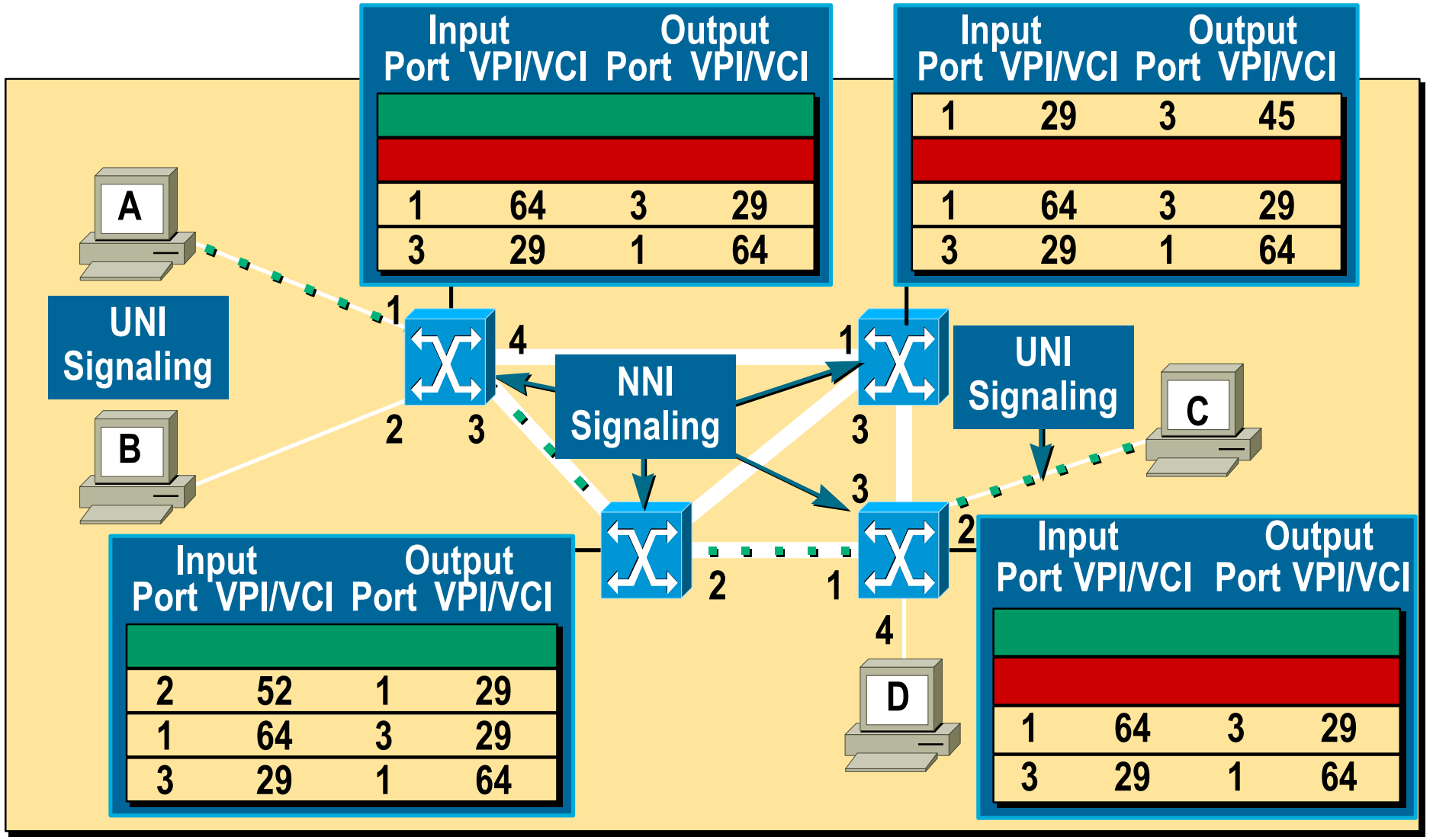
Permanent Virtual Circuit (PVC)



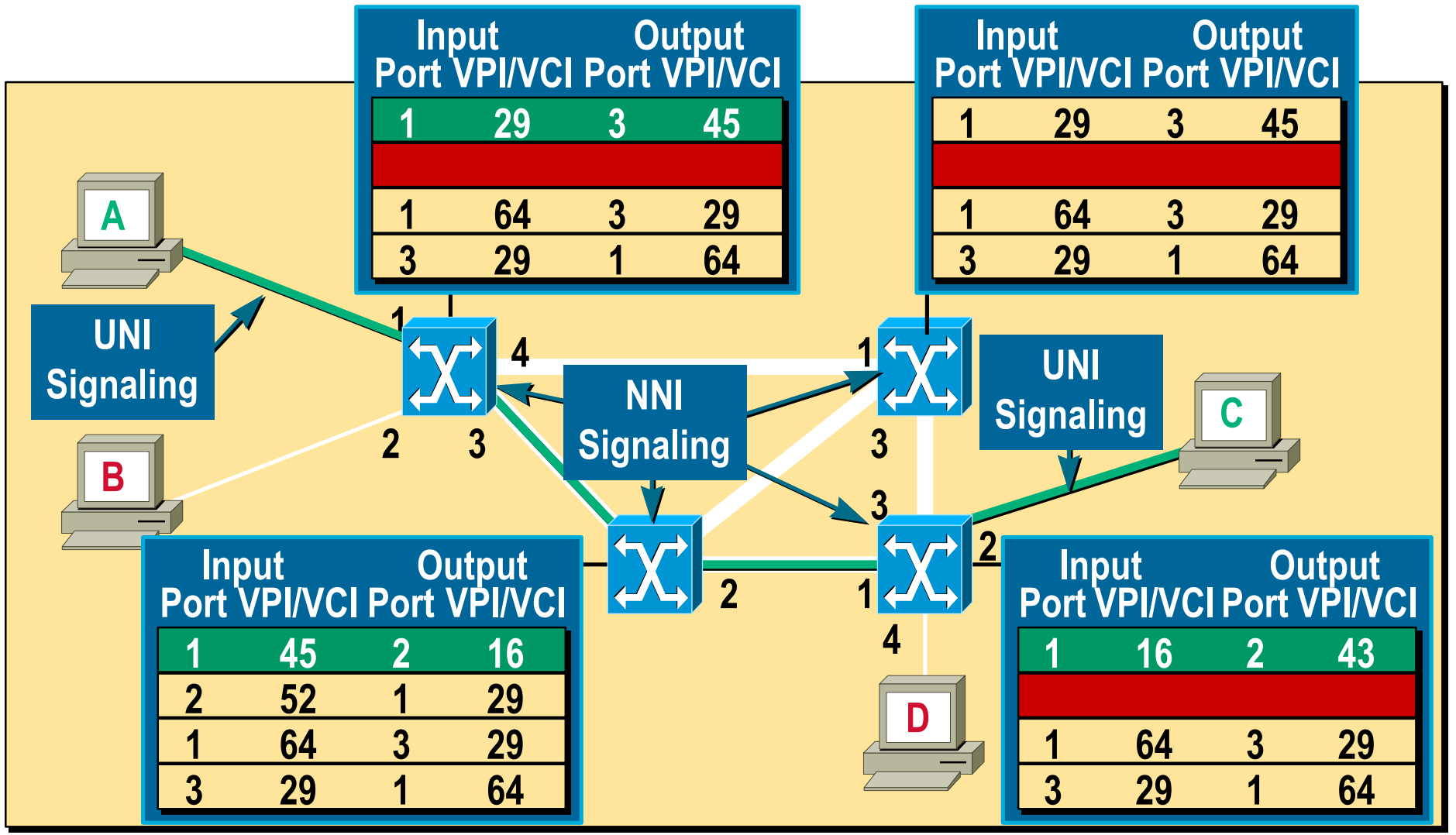
- VPI/VCI tables in network equipment updated by administrator

Switched Virtual Circuit (SVC)



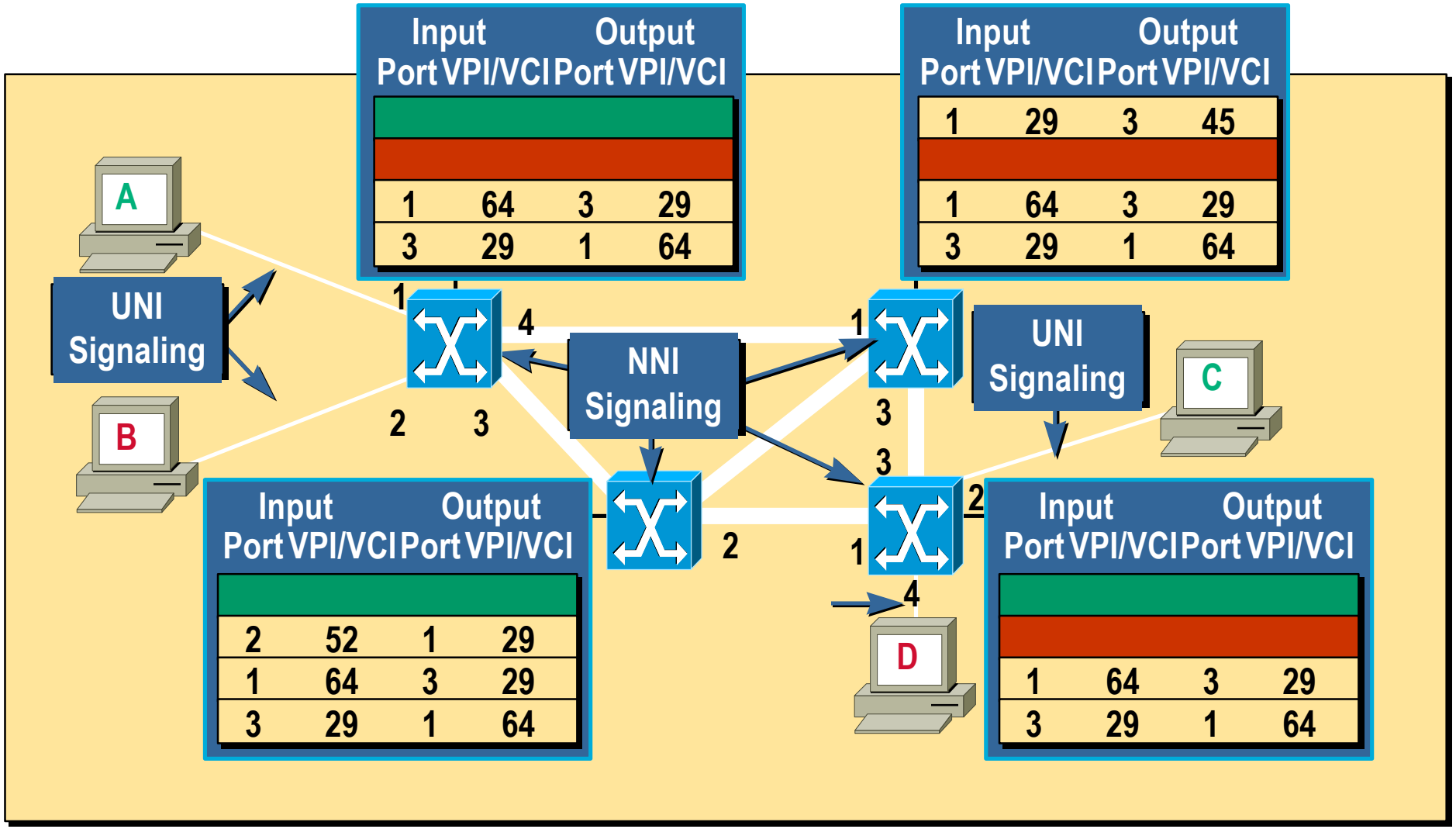
- Dynamically set up connections via signaling

Switched Virtual Circuit (SVC)



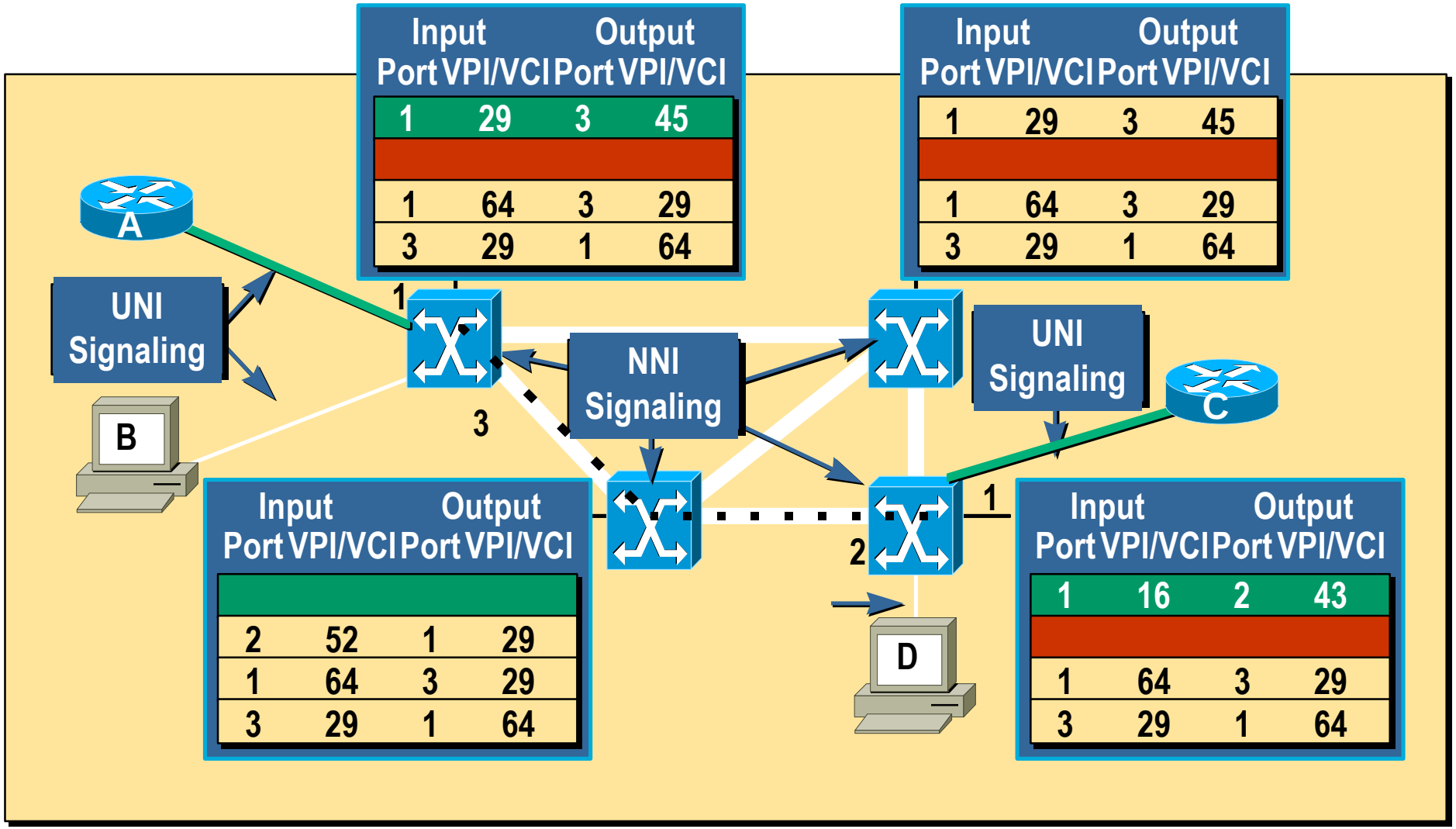
- Transfer data over newly established link

Switched Virtual Circuit (SVC)



- Dynamically tear down connections via signaling

Switched Virtual Circuit (SVC)



- PVC established manually across UNI and dynamically across NNI

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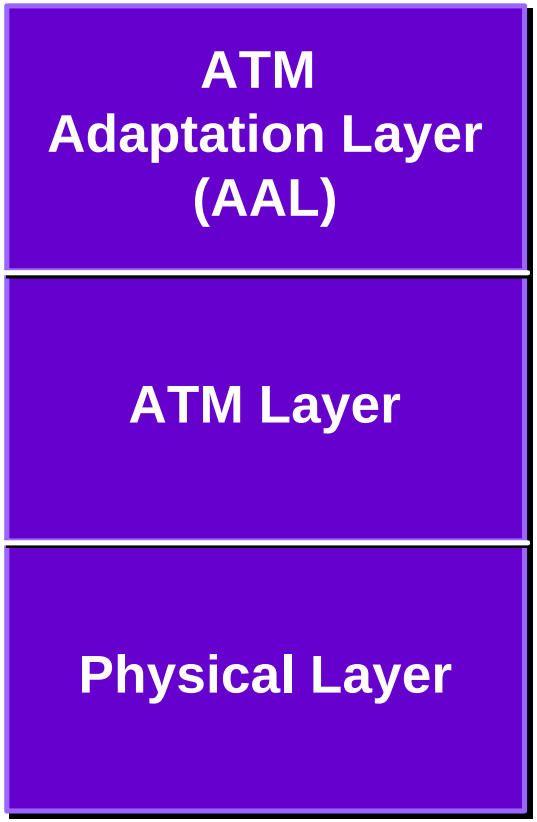
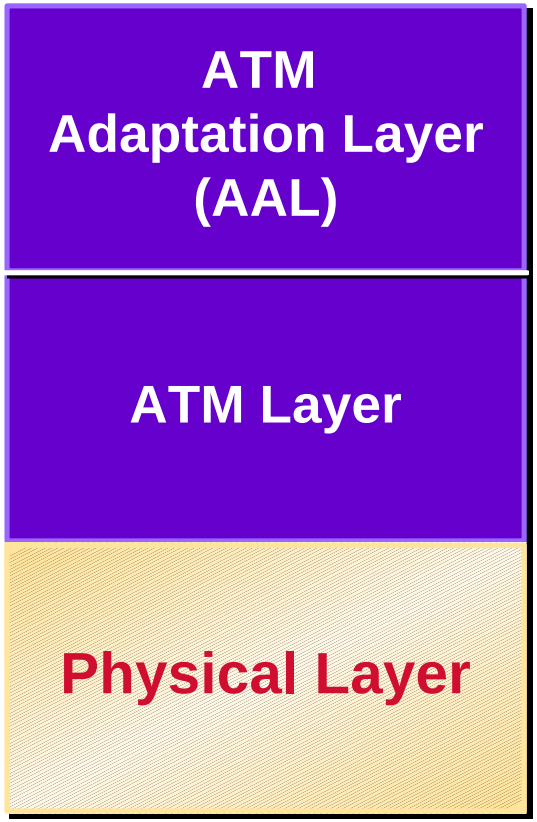
ATM Reference Model

- 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

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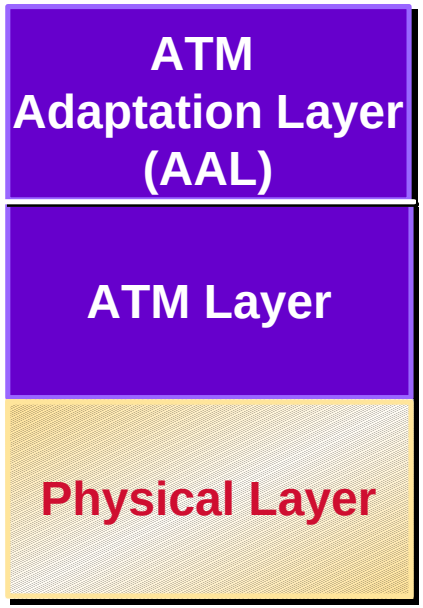
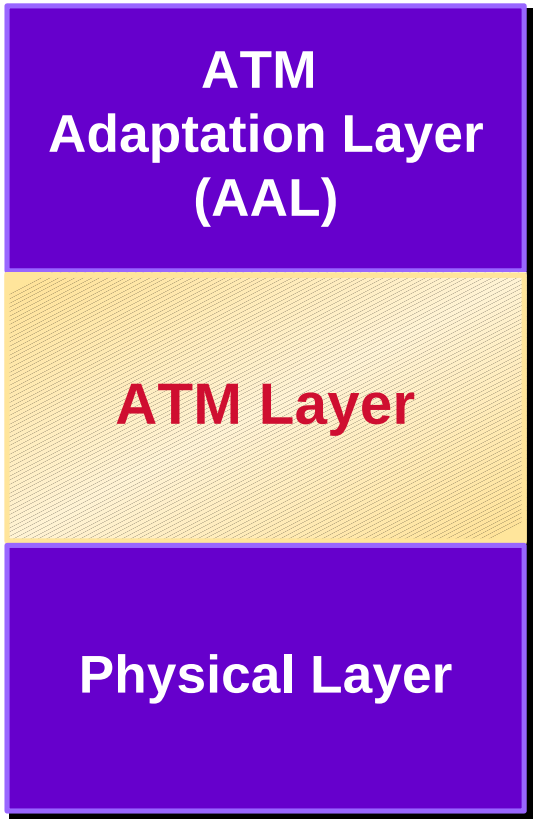
Physical Layer



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			√			
J2	6.23						(TP)
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 (Fiberchannel)	155	√					√

√ = Standardized X = Proposed/In Progress

ATM Reference Model



ATM Layer

- Cell header insertion/removal
- Cell Relay
- Multiplexes/demultiplexes cells of different connections

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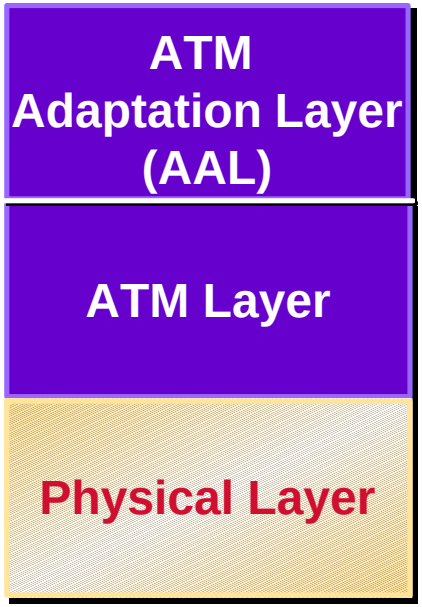
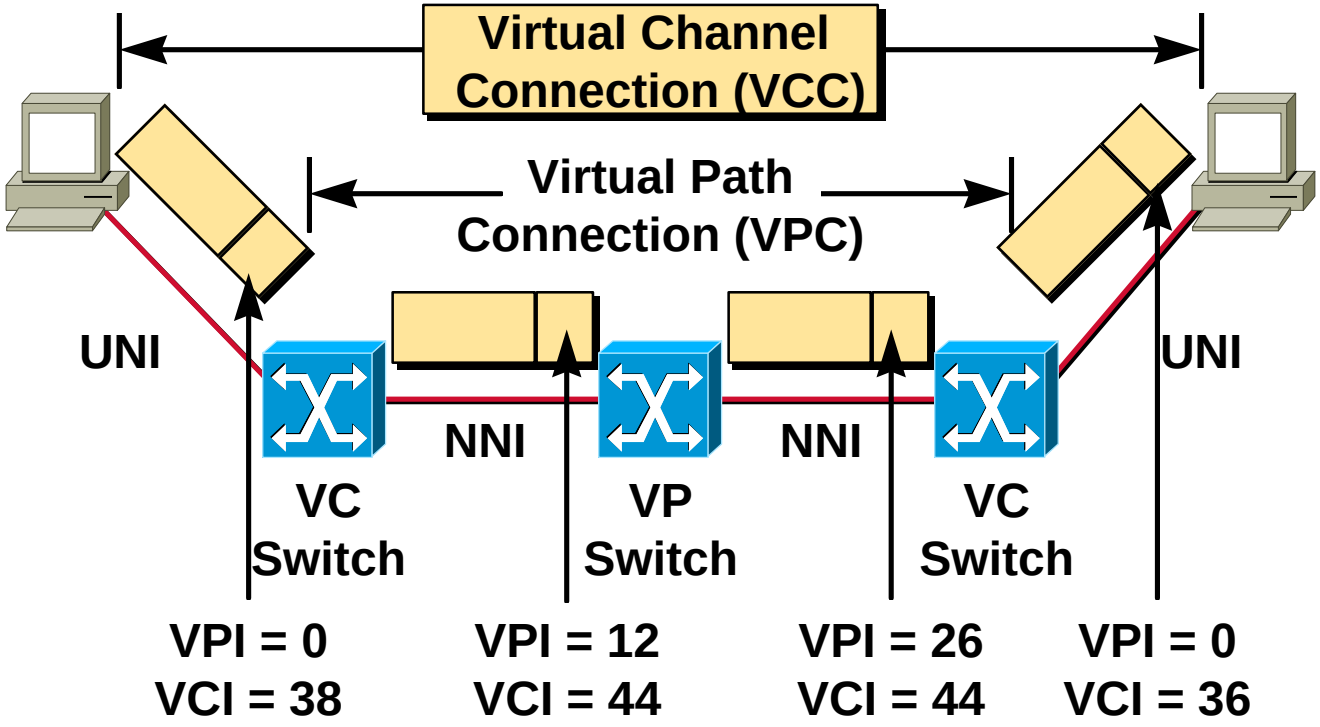
ATM Layer





- Provides VPI/VCI values in header
- Ensures that cells stay in the correct order

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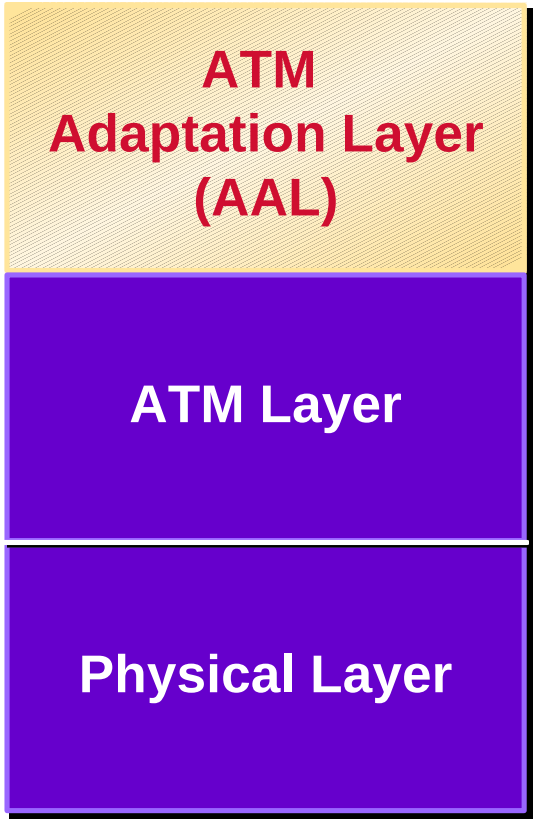
ATM Reference Model

ATM Adaptation Layer (AAL)



Two Sublayers:

- **Convergence Sublayer (CS)**
- **Segmentation and Reassembly (SAR)**

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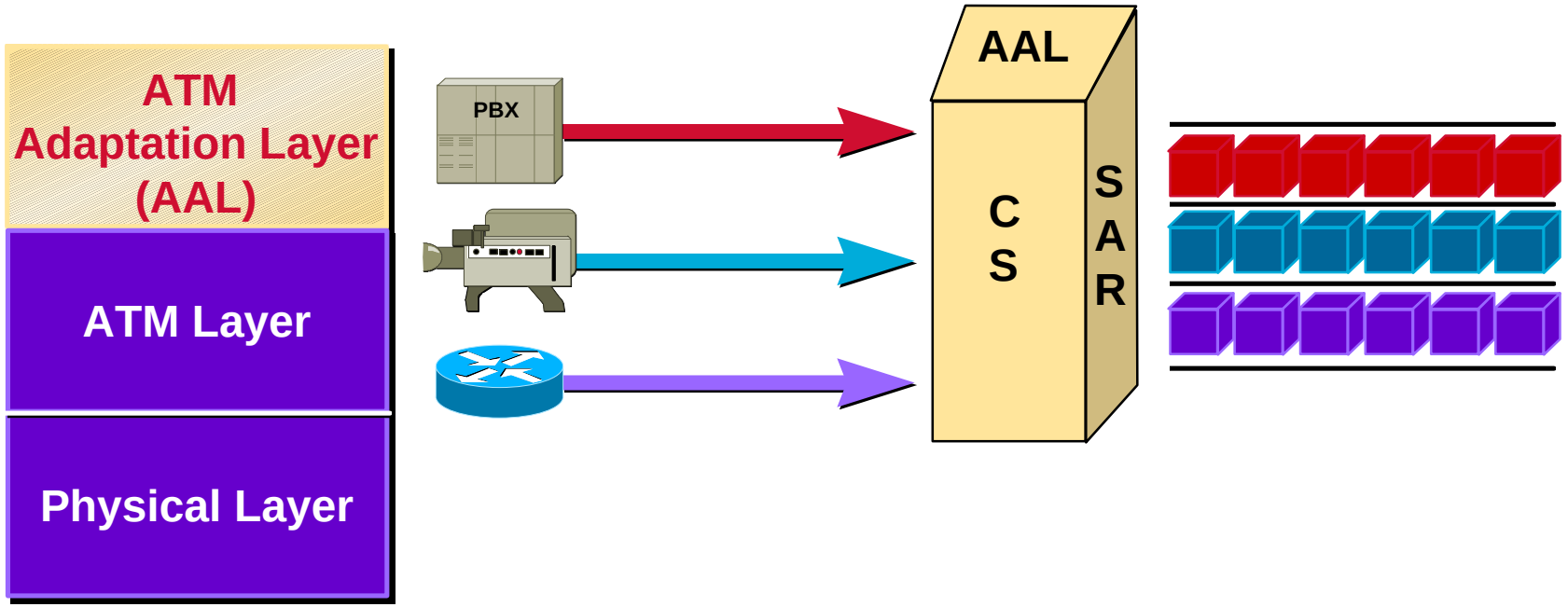
ATM Adaptation Layer—AAL



AAL = CS + SAR

- **CS—cell tax**
- **SAR—cell <-> packet**

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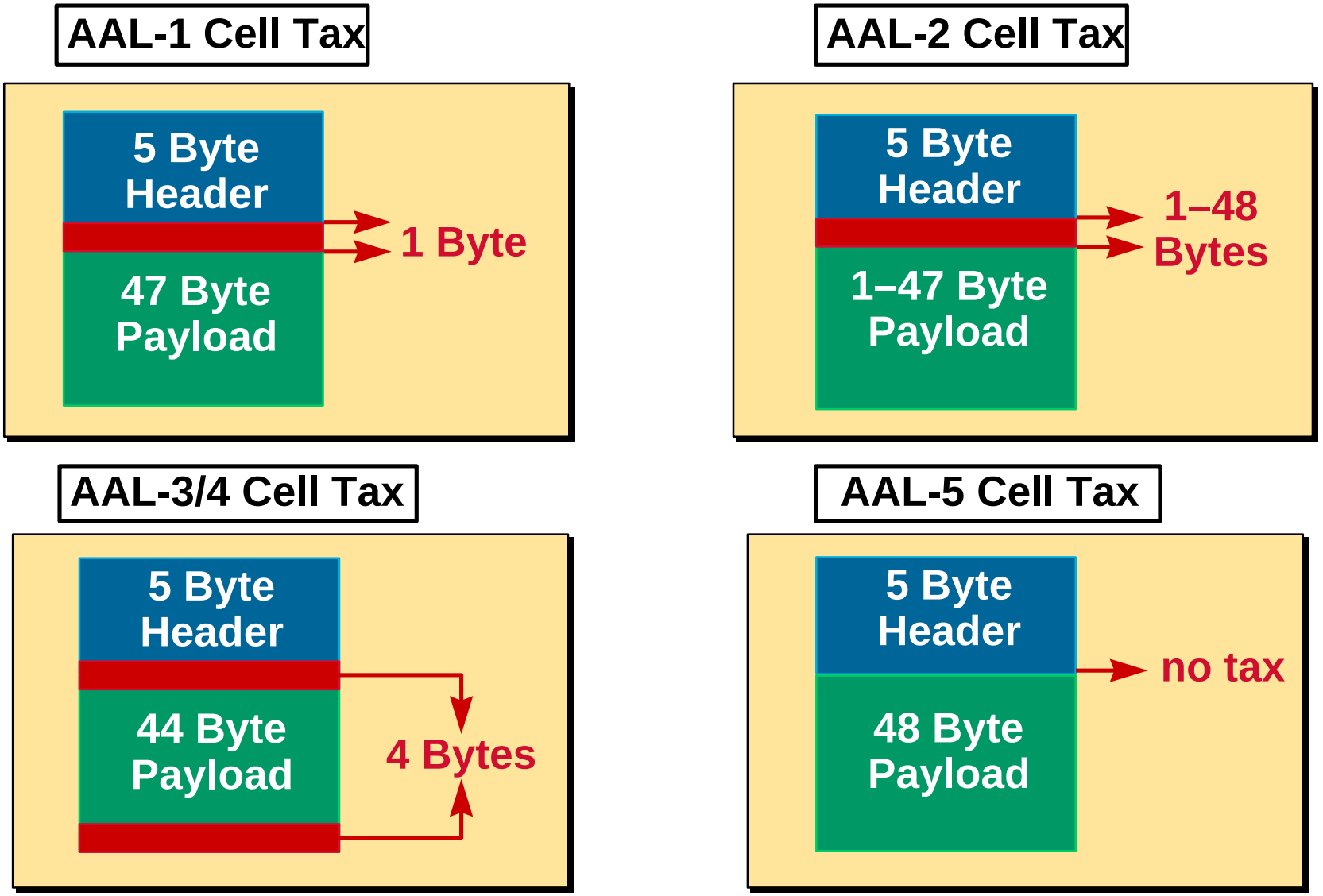
AAL Cell Tax

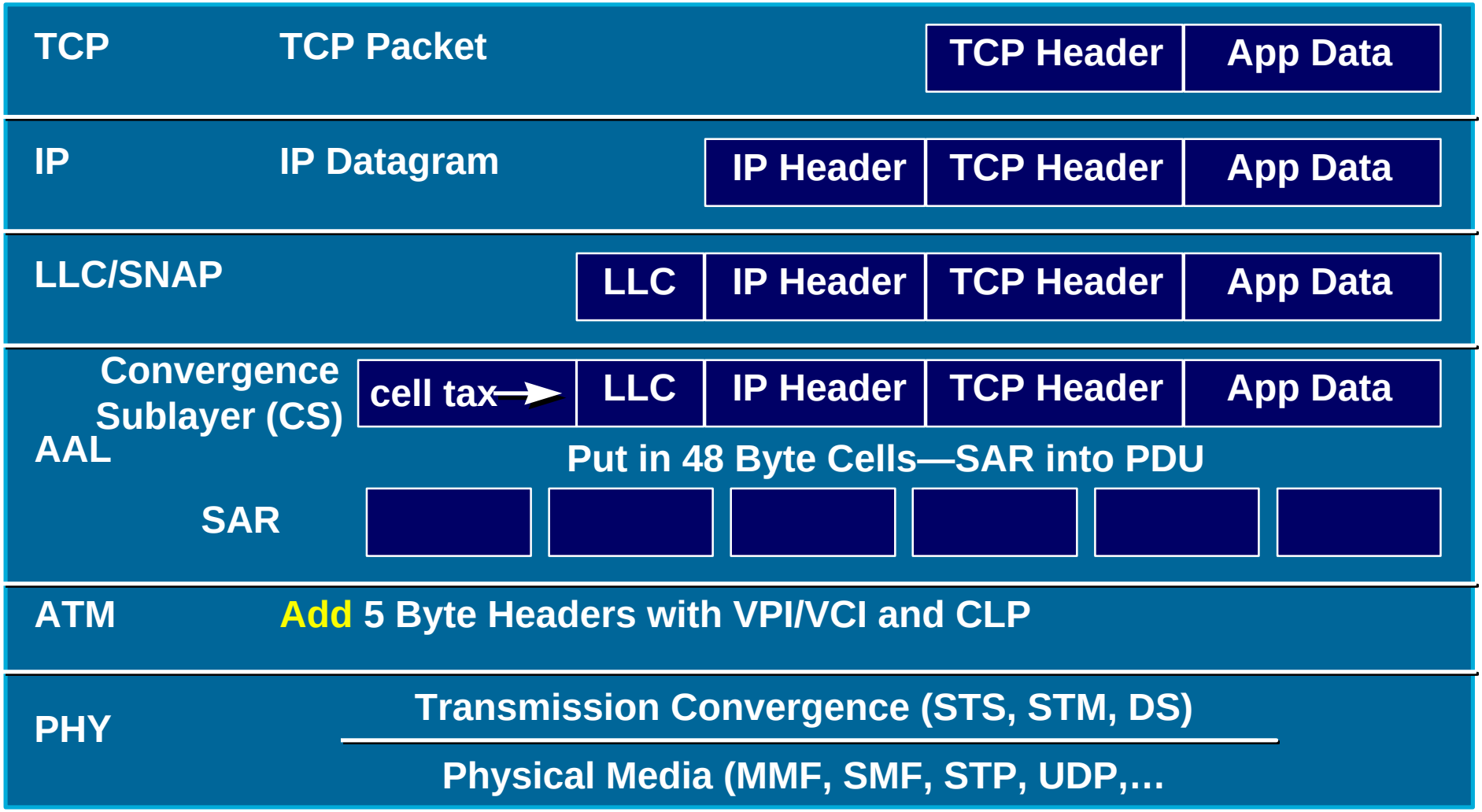

AAL-1 Cell Tax
5 Byte Header
47 Byte Payload
1 Byte
AAL-2 Cell Tax
5 Byte Header
1–47 Byte Payload
1–48 Bytes
AAL-3/4 Cell Tax
5 Byte Header
44 Byte Payload
4 Bytes
AAL-5 Cell Tax
5 Byte Header
48 Byte Payload
no tax

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



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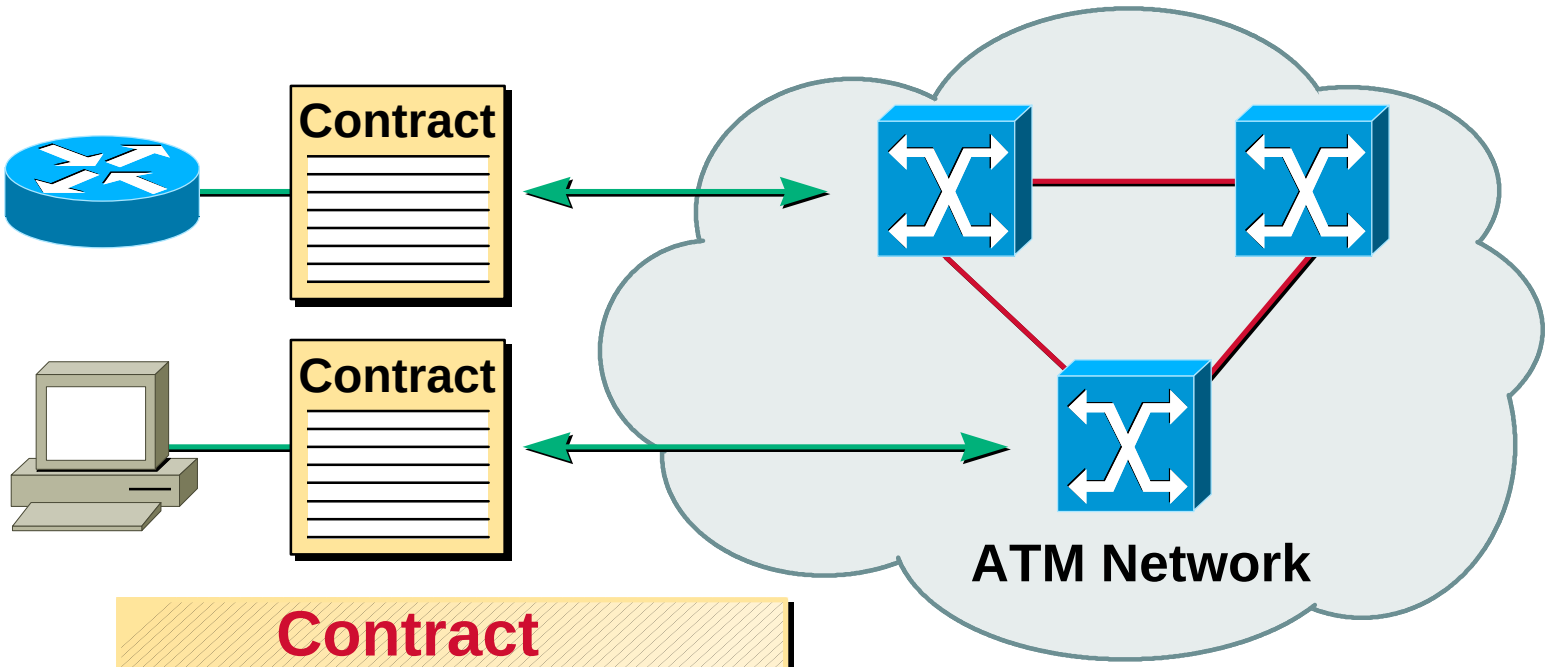
ATM Service Categories

- **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

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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

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ATM Service Categories

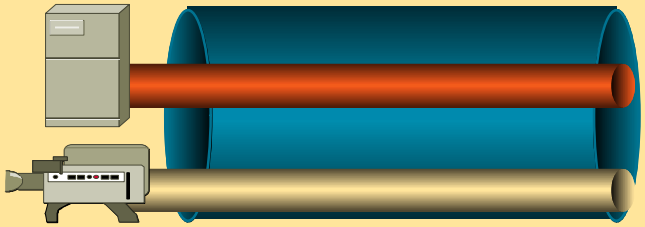
- **Service Criteria**
  - **Traffic parameters**
  - **QoS parameters**
- **Service Categories**
  - **Constant Bit Rate (CBR)**
  - **Variable Bit Rate (VBR)**
  - **Unspecified Bit Rate (UBR)**
  - **Available Bit Rate (ABR)**

ATM Service Categories

Constant Bit Rate (CBR)

Application

Real Time Voice and Video

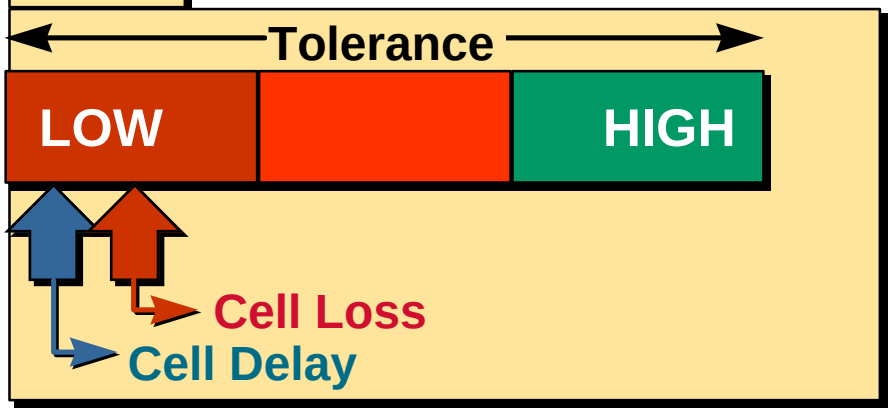


Traffic Descriptor

PCR

Peak Cell Rate

QoS

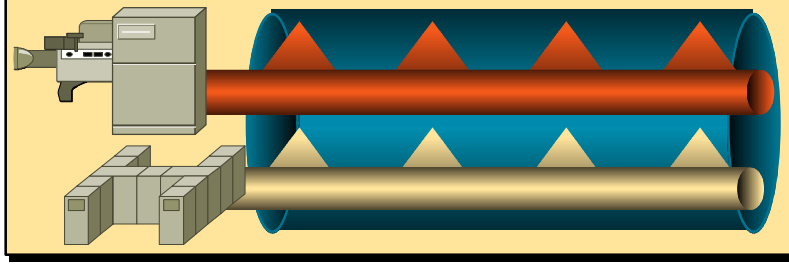


ATM Service Categories

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

Application

Packetized Voice/Video, SNA



Traffic Descriptor

PCR

Peak Cell Rate

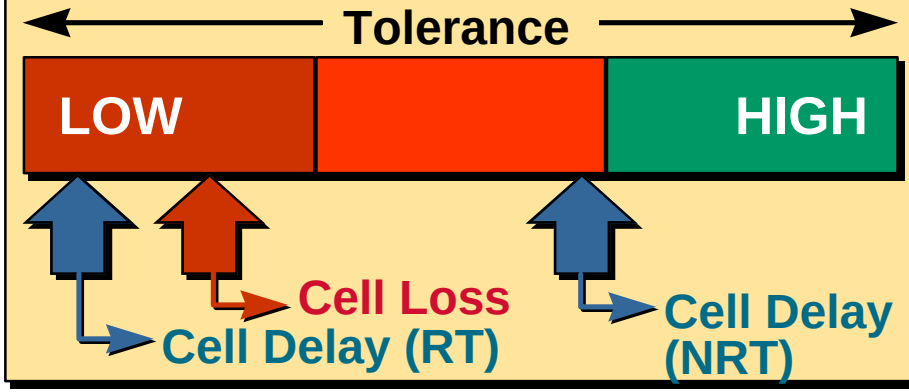
SCR

Sustainable Cell Rate

MBS

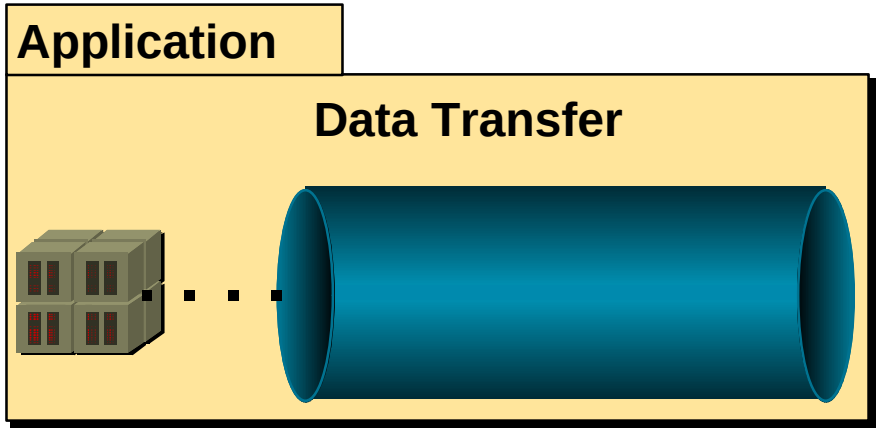
Maximum Burst Size

QoS



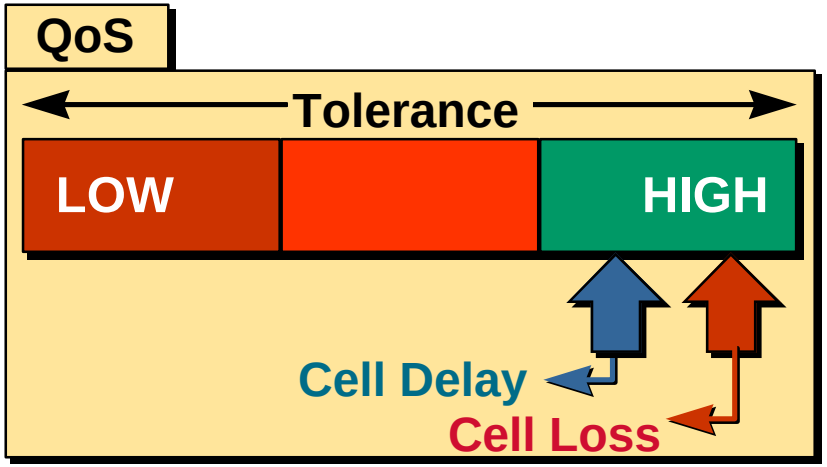
ATM Service Categories

Unspecified Bit Rate (UBR)



Traffic Descriptor

No Guarantees
Send and Pray

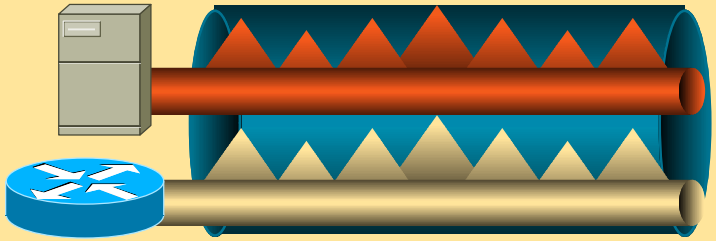


ATM Service Categories

Available Bit Rate (ABR)

Application

LAN Interconnect for Data



Traffic Descriptor

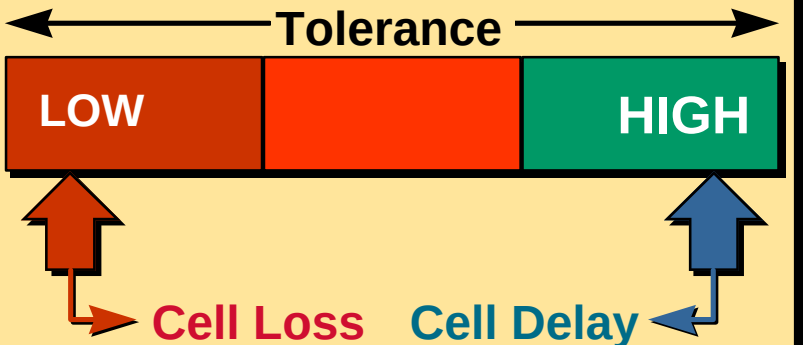
PCR

Peak Cell Rate

MCR

Minimum Cell Rate

QoS



Also uses Congestion Feedback Mechanisms

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(The length of this presentation made it necessary to split it in two parts. In all other cases, “next talk” takes you to the next presentation.)

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