ATM Networks: An Overview

Raj Jain

Professor of Computer and Information Sciences

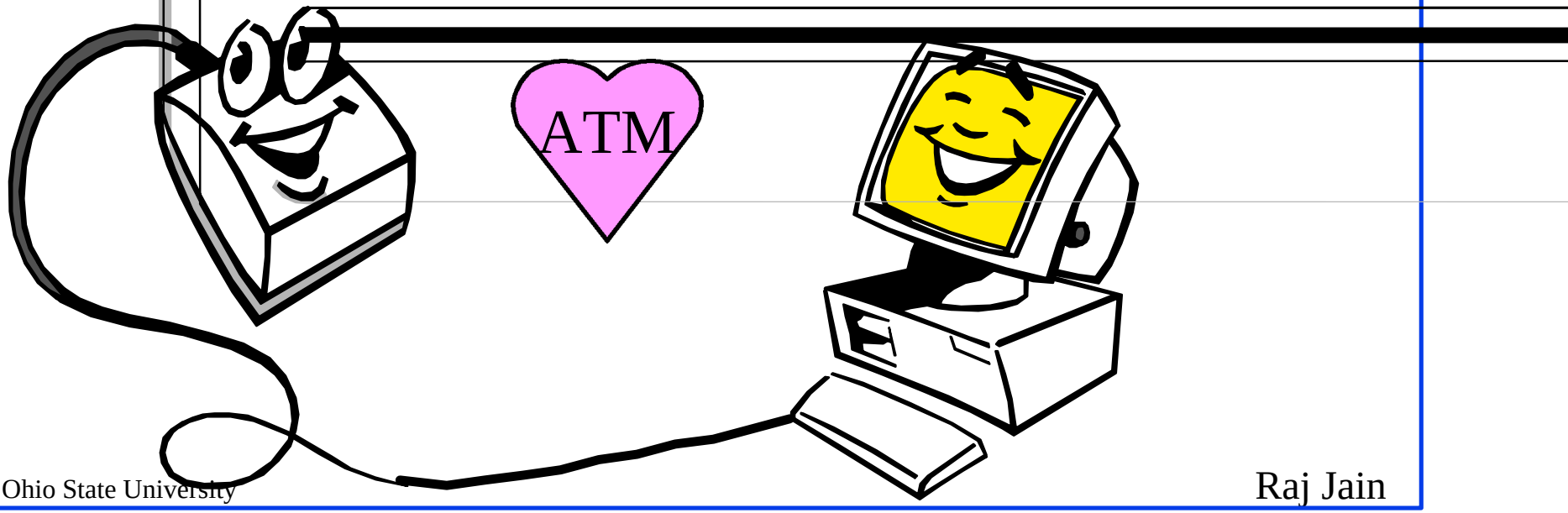
Raj Jain is now at
Washington University in Saint Louis
Jain@cse.wustl.edu
http://www.cse.wustl.edu/~jain/

Overview

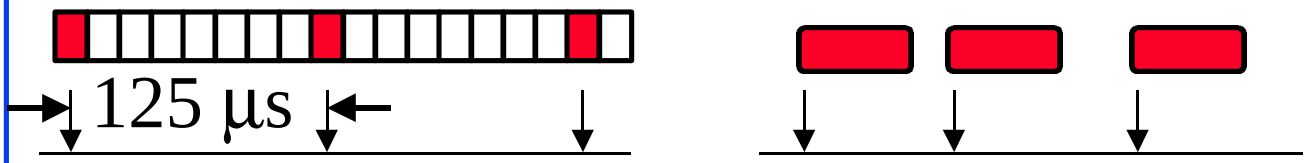
- ATM vs Phone Networks and Data Networks
- ATM Protocol Layers
- Cell Header Format, AALs
- Physical Media

ATM

- Asynchronous Transfer Mode
- ATM Net = Data Net + Phone Net
- Combination of Internet method of communication (packet switching) and phone companies' method (circuit switching)



ATM vs Phone Networks

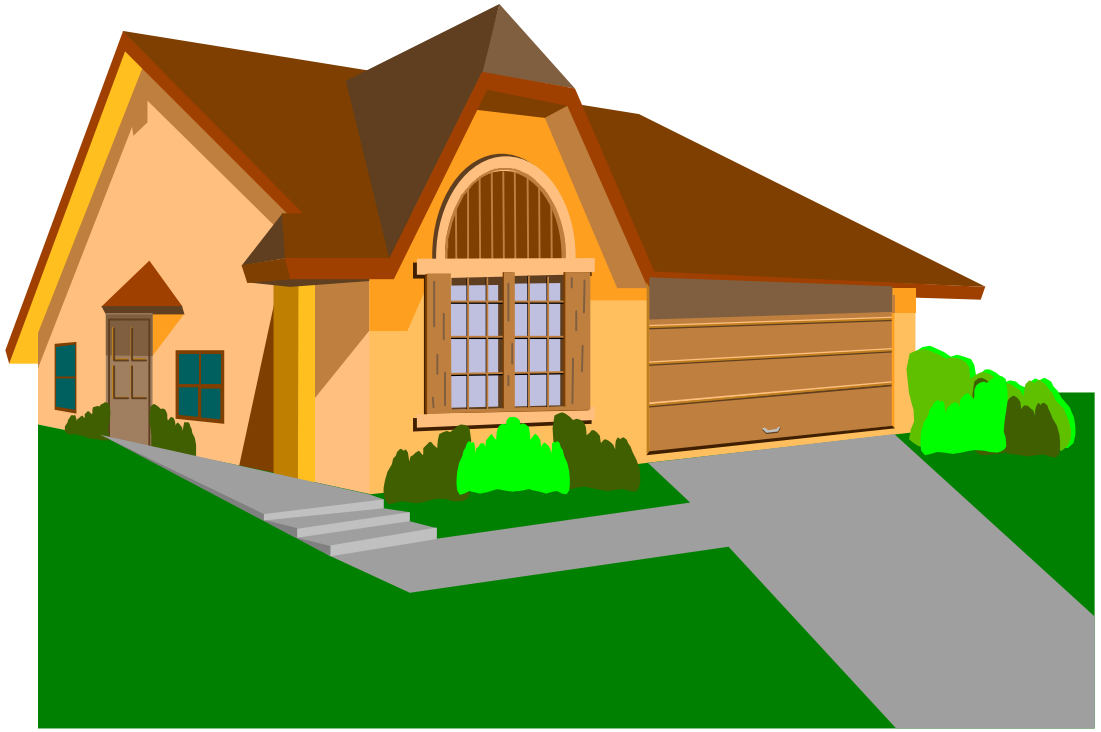


- Current phone networks are synchronous (periodic).
  ATM = Asynchronous Transfer Mode
- Phone networks use circuit switching.
  ATM networks use "Packet" Switching
- In phone networks, all rates are multiple of 8 kbps.
  With ATM service, you can get any rate.
  You can vary your rate with time.
- With current phone networks, all high speed circuits are manually setup. ATM allows dialing any speed.

ATM vs Data Networks

- Signaling: Internet Protocol (IP) is connectionless.
  You cannot reserve bandwidth in advance.
  ATM is connection-oriented.
  You declare your needs before using the network.
- PNNI: Path based on quality of service (QoS)
- Switching: In IP, each packet is addressed and processed individually.
- Traffic Management: Loss based in IP.
  ATM has 1996 traffic management technology.
  Required for high-speed and variable demands.
- Cells: Fixed size or small size is not important

Old House vs New House

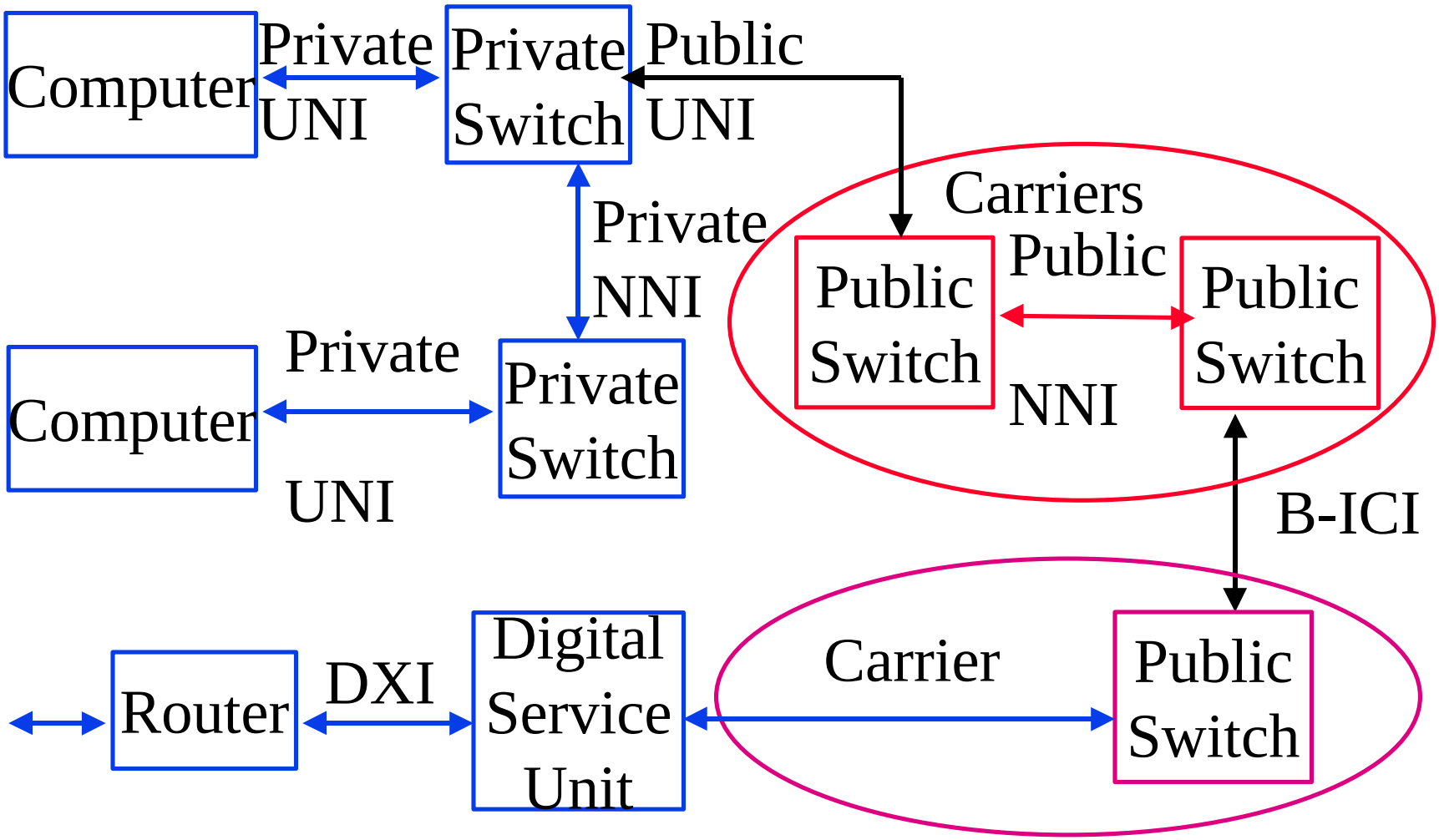


- New needs:

  Solution 1: Fix the old house (cheaper initially)

  Solution 2: Buy a new house (pays off over a long run)

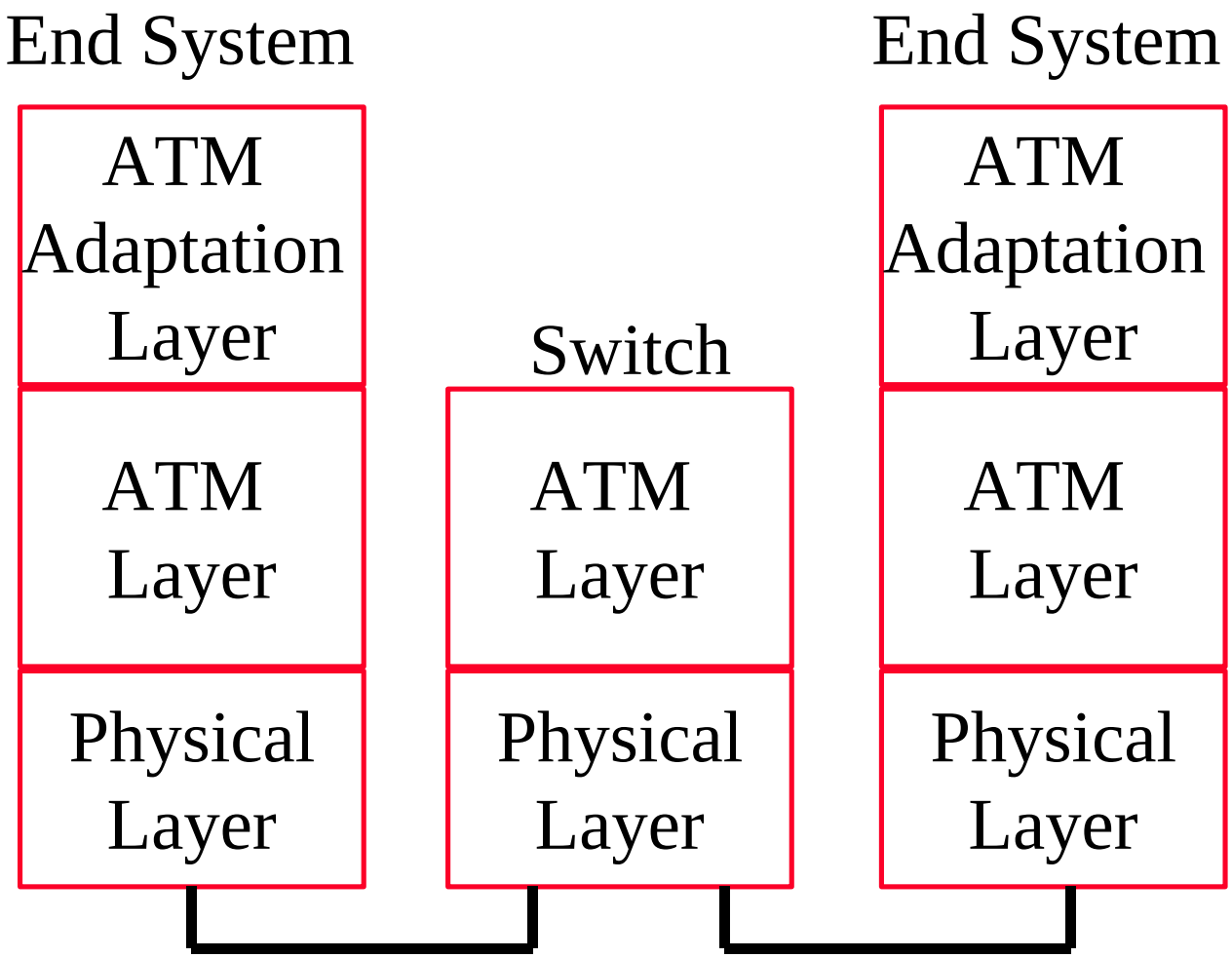
ATM Interfaces



ATM Interfaces

- User to Network Interface (UNI):
  Public UNI, Private UNI
- Network to Node Interface (NNI):
  - Private NNI (P-NNI)
  - Public NNI =Inter-Switching System Interface (ISSI)
    Intra-LATA ISSI (Regional Bell Operating Co)
  - Inter-LATA ISSI (Inter-exchange Carriers)
    $\Rightarrow$ Broadband Inter-Carrier Interface (B-ICI)
- Data Exchange Interface (DXI)
  Between routers and ATM Digital Service Units (DSU)

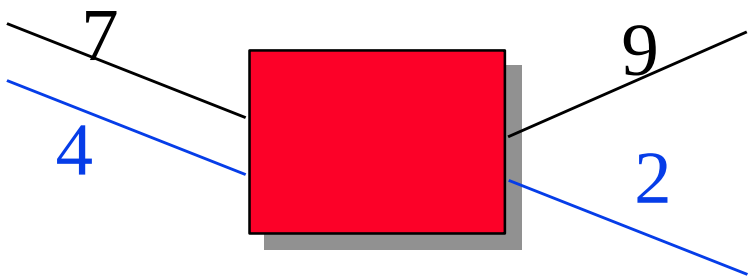
Protocol Layers



Protocol Layers

- The ATM Adaptation Layer
  - How to break messages to cells
- The ATM Layer
  - Transmission/Switching/Reception
  - Congestion Control/Buffer management
  - Cell header generation/removal at source/destination
  - Cell address translation
  - Sequential delivery

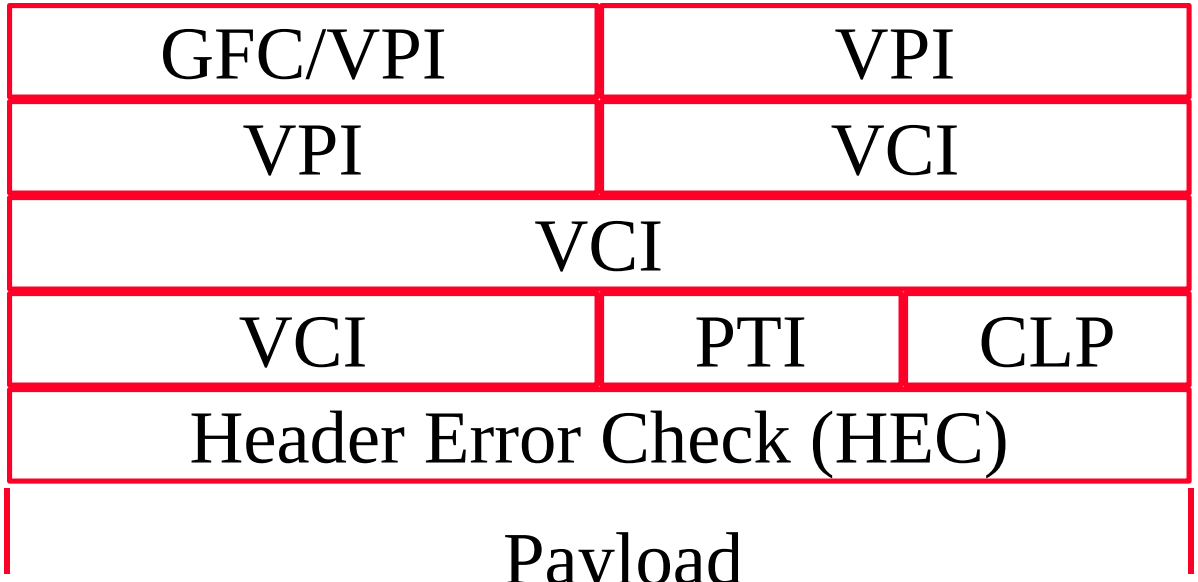
Virtual Circuit Switching



- Circuit Switching: bits coming on wire 4 go on wire 2
- Virtual Circuit Switching: Cells coming on VCI=4 go on VCI=2

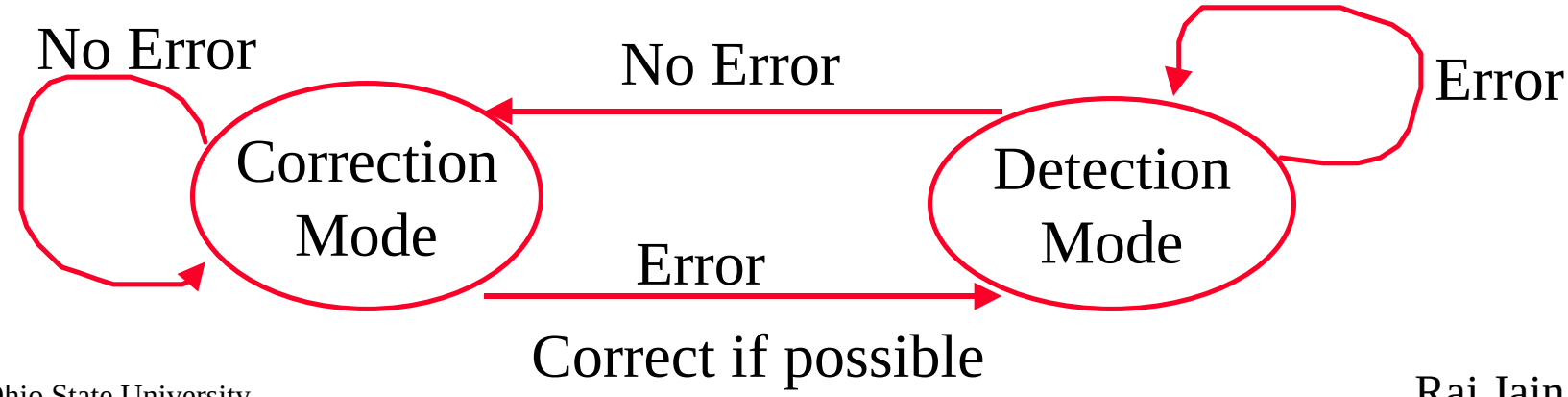
Cell Header Format

- GFC = Generic Flow Control
  - (Was used in UNI but not in NNI)
- VPI/VCI = 0/0 ⇒ Idle cell; 0/n ⇒ Signaling



Header Error Check (HEC)

- $1 + x + x^2 + x^8$
- Protects header only
- Optional Correction mode: Correct one bit errors if no earlier errors
- Discard cells with bad HEC
- Recalculated on each hop



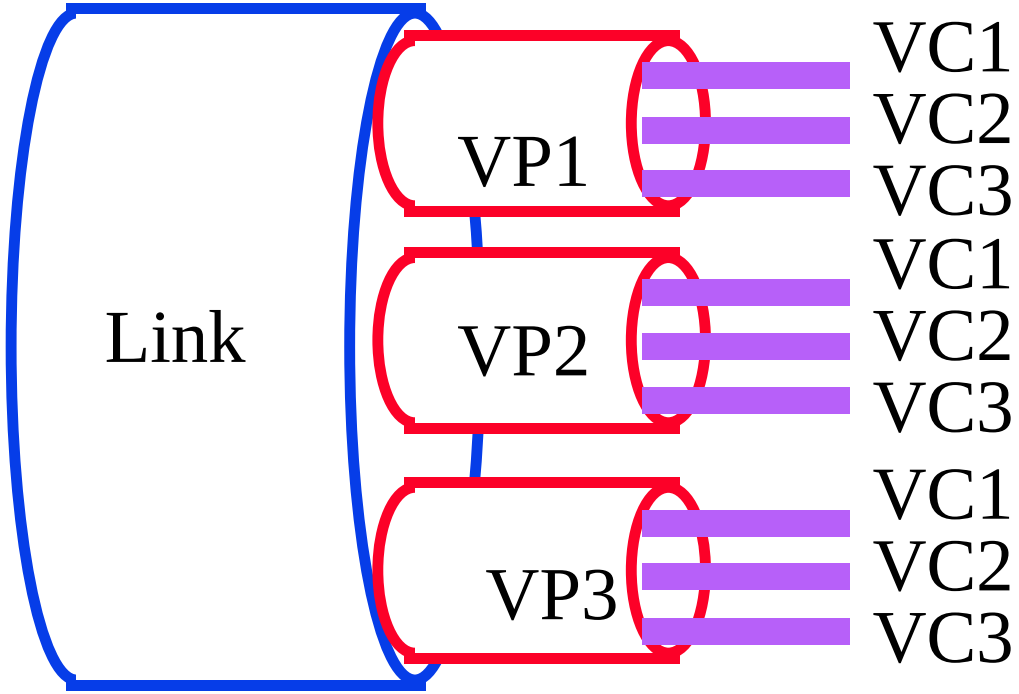
Payload Type Field Coding

- 000 User data cell, no congestion, AAU = 0
- 001 User data cell, no congestion, AAU = 1
- 010 User data cell, congestion, AAU = 0
- 011 User data cell, congestion, AAU = 1
- 100 Segment Operation and management (OAM) cell
- 101 End-to-end OAM cell
- 110 Resource management cell
- 111 Reserved

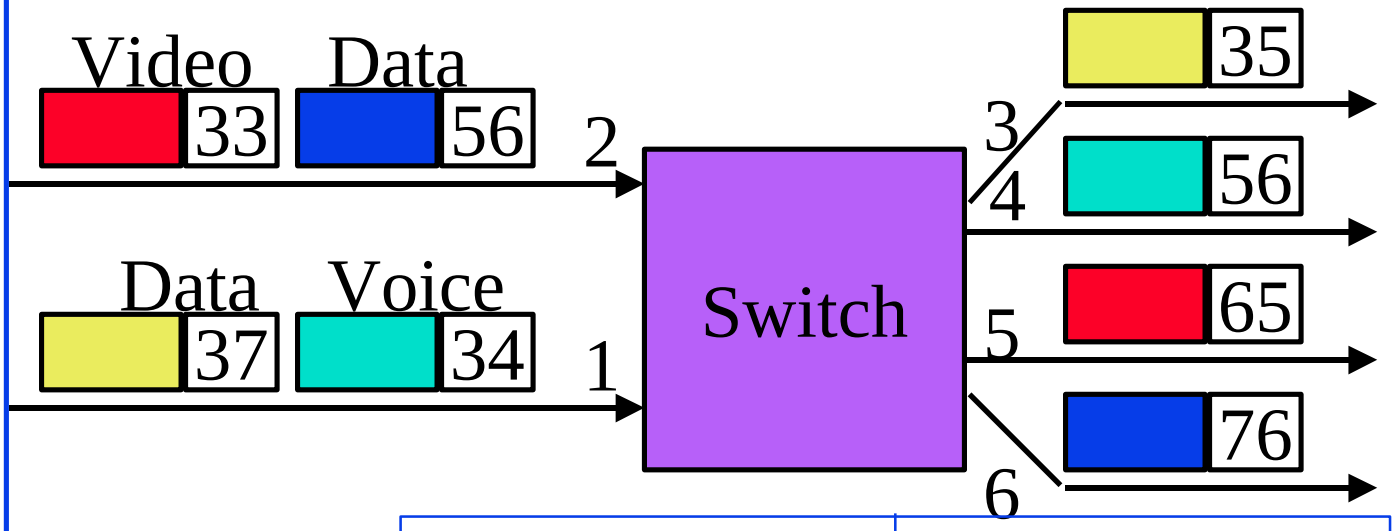
ATM-user-to-ATM-user (AAU) bit available for user-to-user indication

Path vs Channels

- 24/28-bit connection identifier
  First 8/12 bits: Virtual Path,
  Last 16 bits: Virtual Circuit
- VP service allows new VC's w/o orders to carriers



VP/VC Assignment/Use



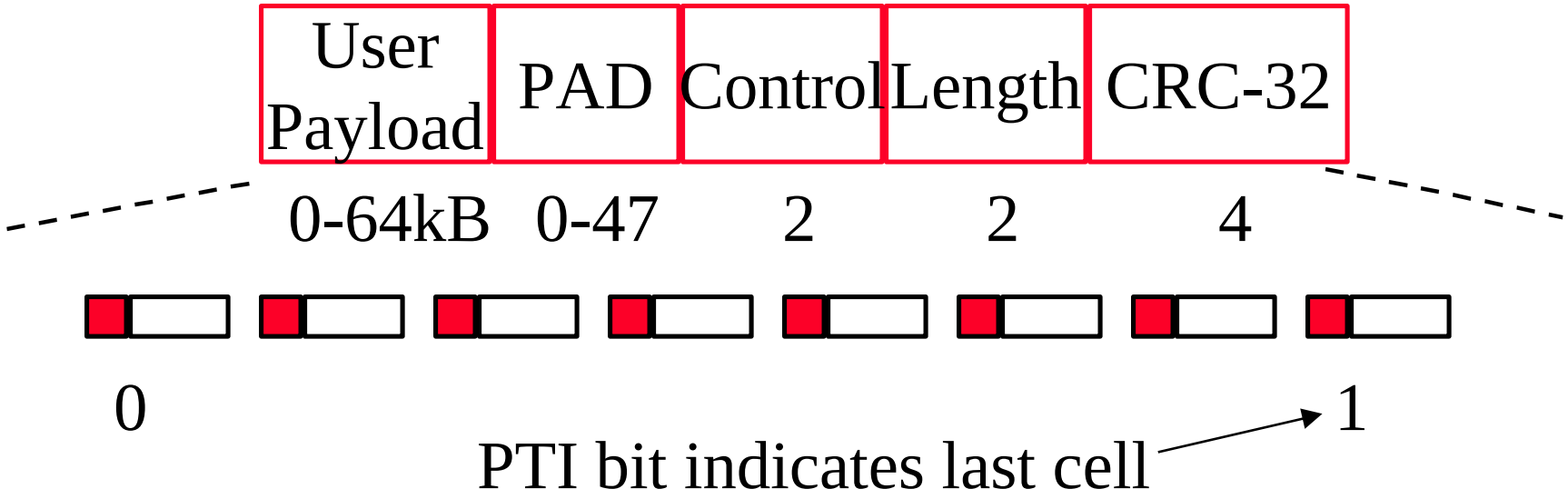
In		Out	
Port	VPI/VCI	Port	VPI/VCI
1	0/37	3	1/35
1	0/34	4	0/56
2	0/33	5	0/65
2	0/56	6	4/76

Original Classes of Traffic

	Class A	Class B	Class C	Class D
Time Sync	Yes	Yes	No	No
Bit Rate	Constant	Variable	Variable	Variable
Connection-Oriented	Yes	Yes	Yes	No
Examples	Circuit Emulation	Comp. Video	Frame Relay	SMDS
AAL	AAL1	AAL2	AAL3	AAL4

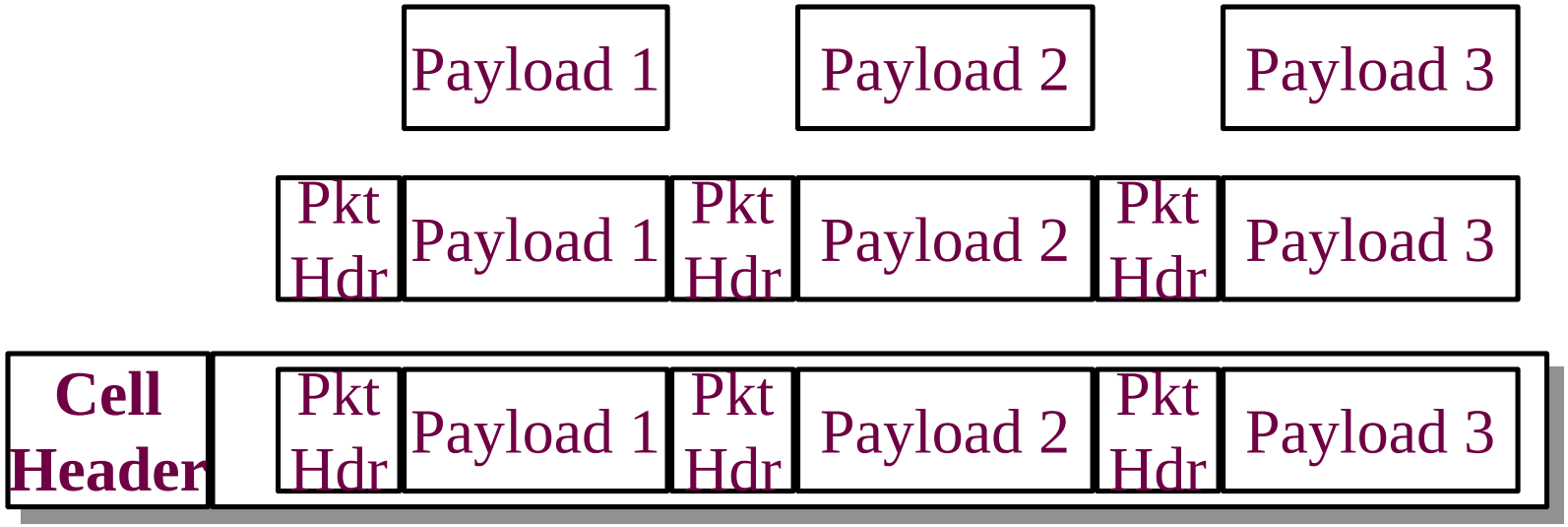
AAL 5

- Designed for data traffic
- Less overhead bits than AAL 3/4
  $\Rightarrow$ Simple and Efficient AAL (SEAL)
- No per cell length field, No per cell CRC



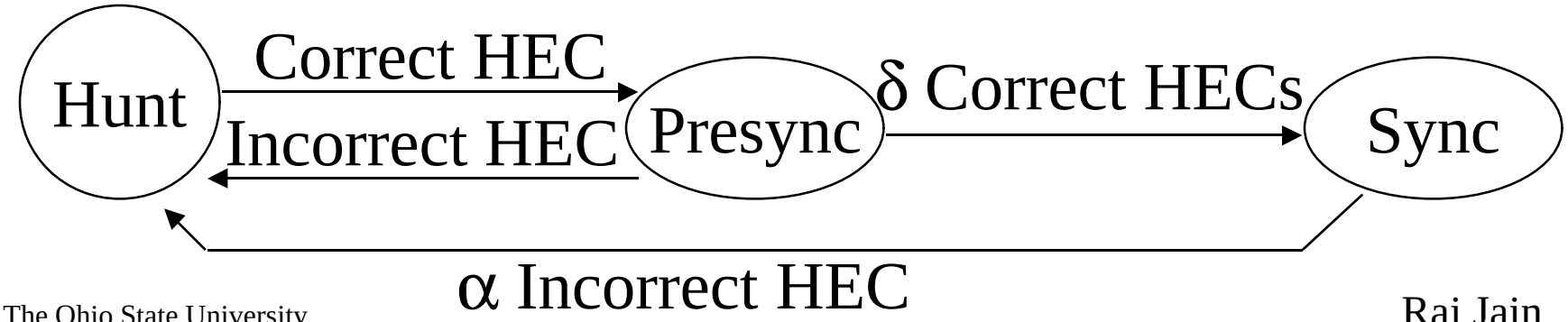
AAL2

- Ideal for low bit rate voice
- Variable/constant rate voice
- Multiple users per VC
- Compression and Silence suppression
- Idle channel suppression



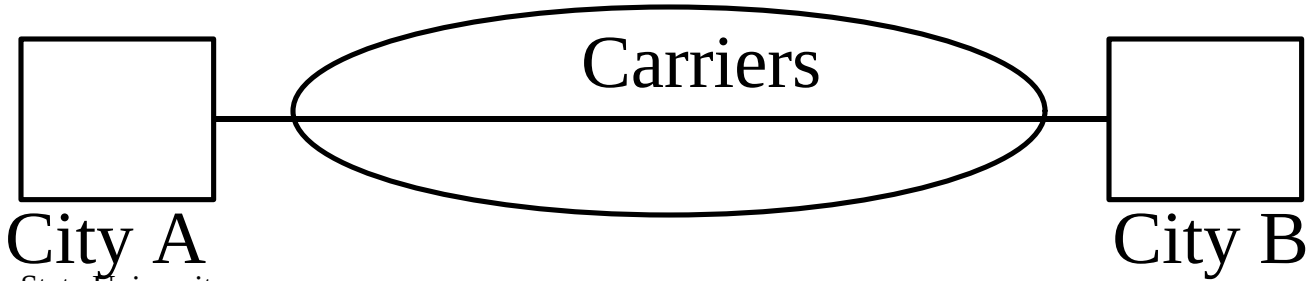
Cell-Stream Phy

- Continuous stream of cells. No framing.
- Hunt bit-by-bit for correct header.
- Look for δ correct headers before entering synch state
- α incorrect headers ⇒ resynchronize
  α and δ are parameters.



SONET

- Synchronous optical network
- Standard for digital optical transmission (bit pipe)
- Developed originally by Bellcore.
  Standardized by ANSI T1X1
  Standardized by CCITT
  $\Rightarrow$ Synchronous Digital Hierarchy (SDH)
- You can lease a SONET connection from carriers



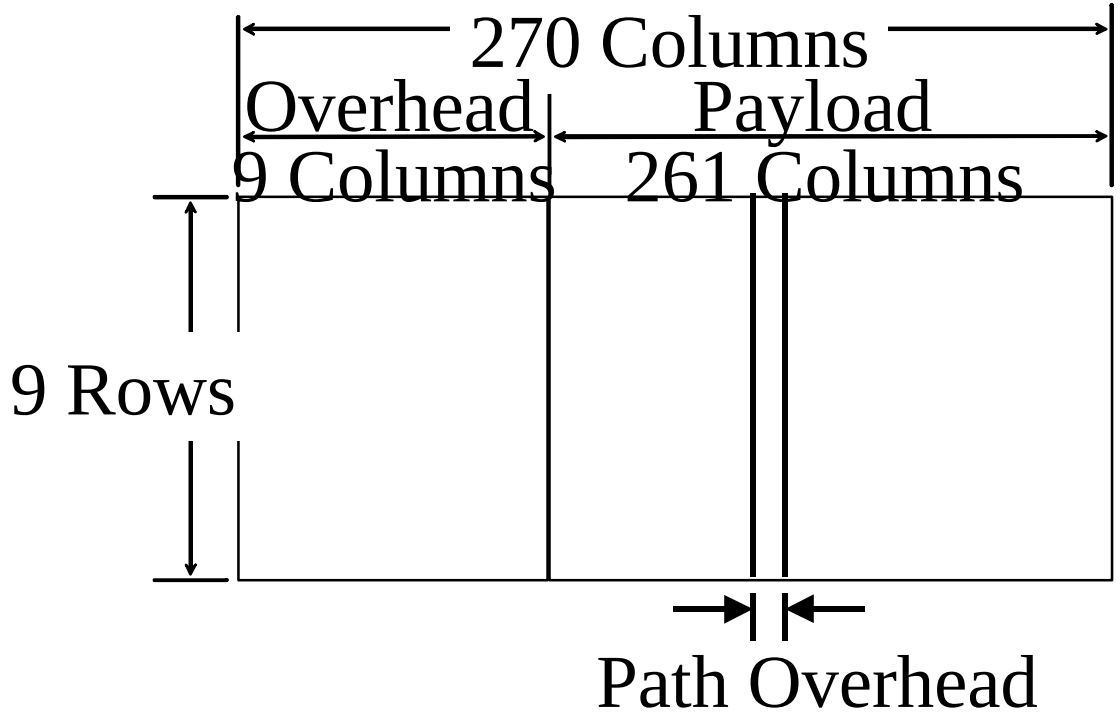
Signal Hierarchy

Synchronous Transport Signal Level n = STS-n = $n \times 51.84$ Mbps
STM=Synchronous Transport Module, OC=Optical Carrier level

ANSI Designation	Optical Signal	CCITT Designation	Data Rate (Mbps)	Payload Rate (Mbps)
STS-1	OC-1		51.84	50.112
STS-3	OC-3	STM-1	155.52	150.336
STS-9	OC-9	STM-3	466.56	451.008
STS-12	OC-12	STM-4	622.08	601.344
STS-18	OC-18	STM-6	933.12	902.016
STS-24	OC-24	STM-8	1244.16	1202.688
STS-36	OC-36	STM-12	1866.24	1804.032
STS-48	OC-48	STM-16	2488.32	2405.376
STS-96	OC-96	STM-32	4976.64	4810.176
STS-192	OC-192	STM-64	9953.28	9620.928

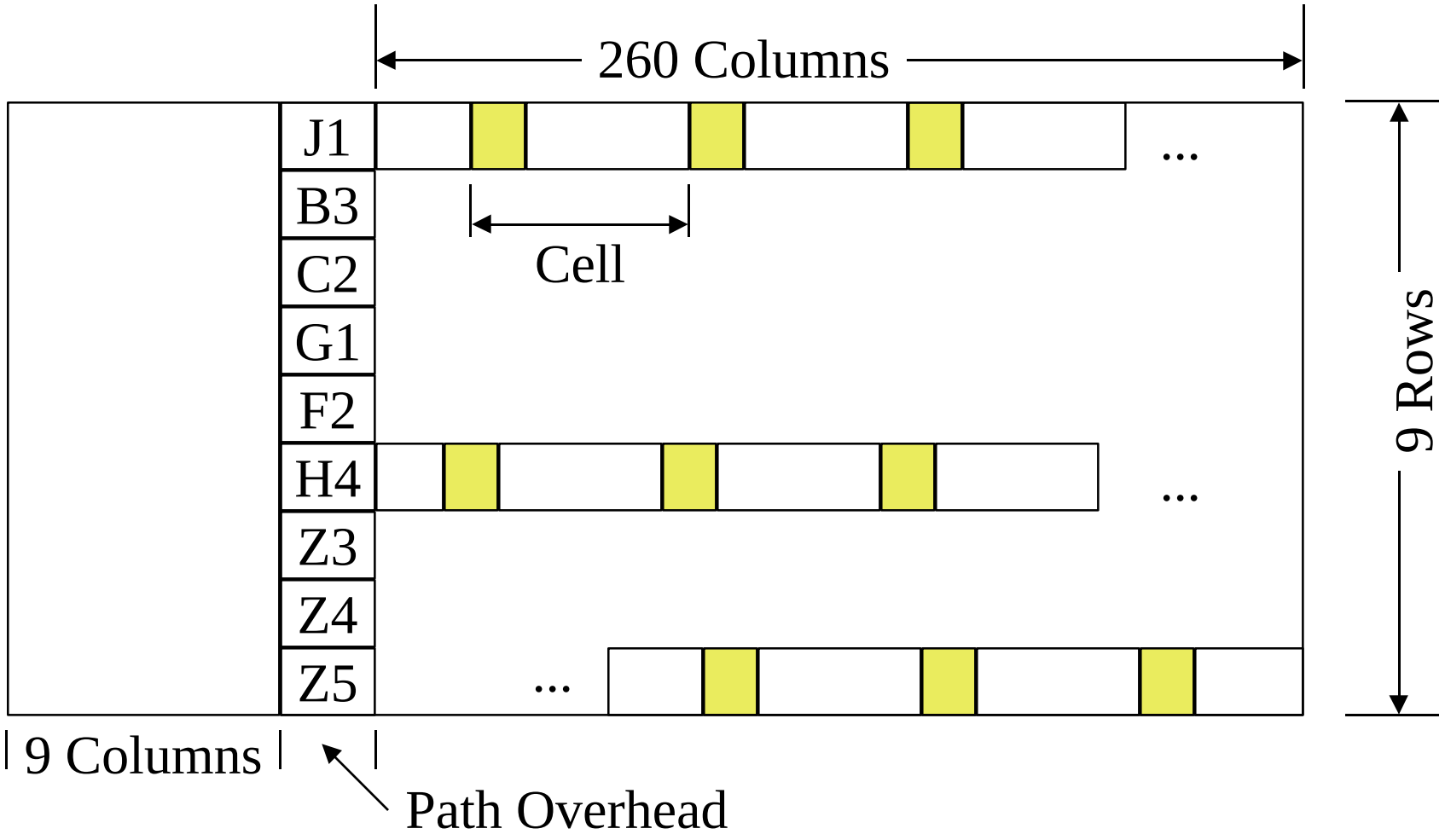
STS-3c Frame Format

- STS-3c is similar to STM-1
- 125 μs = 2430 bytes at 155.54 Mbps



- Note: All sizes are multiples of 3

SONET/SDH Phy



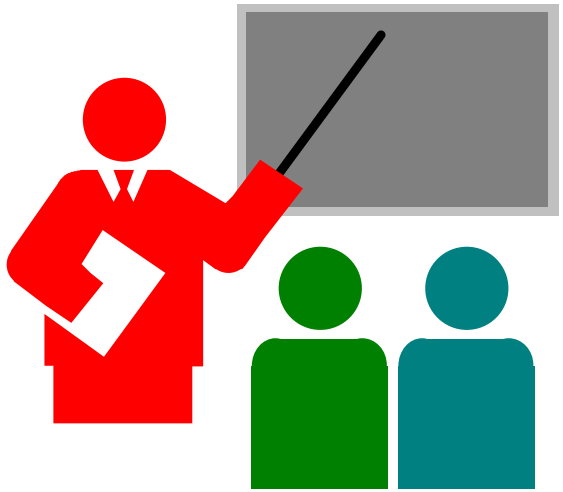
SONET STS-3c

- Payload rate = 9 × 260 × 8/125 = 149.76 Mbps
- Cell payload rate = 135.63 Mbps
- Cell delineation using HEC.
  - Look for 5-byte blocks with HEC separated by 48 bytes
- Cells are packed one after another ⇒ One can send 127 bits matching the scrambling sequence resulting in all 1's or 0's.
  Scramble by dividing by $1 + x^{43}$.
  Only one in 2^{43} patterns will cause all 1's or 0's.

Physical Media

- Multimode Fiber: 100 Mbps using 4b/5b, 155 Mbps SONET STS-3c, 155 Mbps 8b/10b
- Single-mode Fiber: 155 Mbps STS-3c, 622 Mbps
- Plastic Optical Fiber: 155 Mbps
- Shielded Twisted Pair (STP): 155 Mbps 8b/10b
- Coax: 45 Mbps, DS3, 155 Mbps
- Unshielded Twisted Pair (UTP)
  - UTP-3 (phone wire) at 25.6, 51.84, 155 Mbps
  - UTP-5 (Data grade UTP) at 155 Mbps
- DS1, DS3, STS-3c, STM-1, E1, E3, J2, n × T1

Summary



- ATM Overview: History, Why and What
- Protocol Layers: AAL, ATM, Physical layers, Cell format
- Interfaces: PNNI, NNI, B-ICI, DXI

Homework

- Read Sections 11.1-11.6 of Stallings's sixth edition
- Submit answer to Exercise 11.3