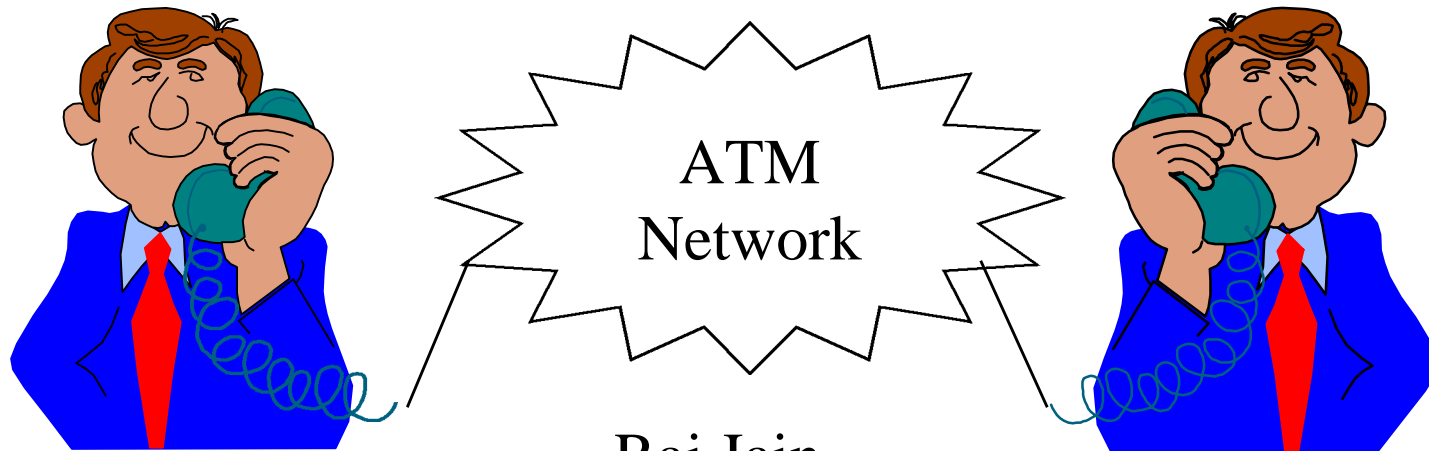


Voice Over ATM (VOA)



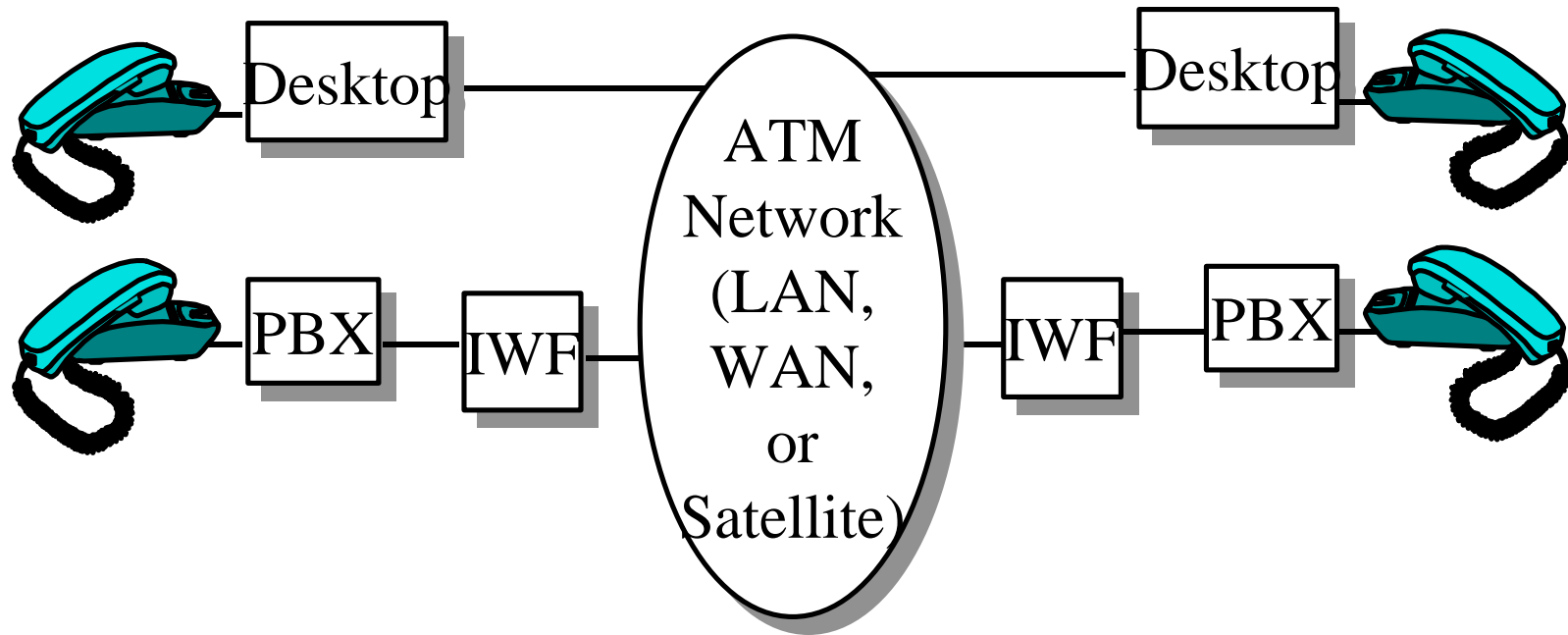
Raj Jain

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

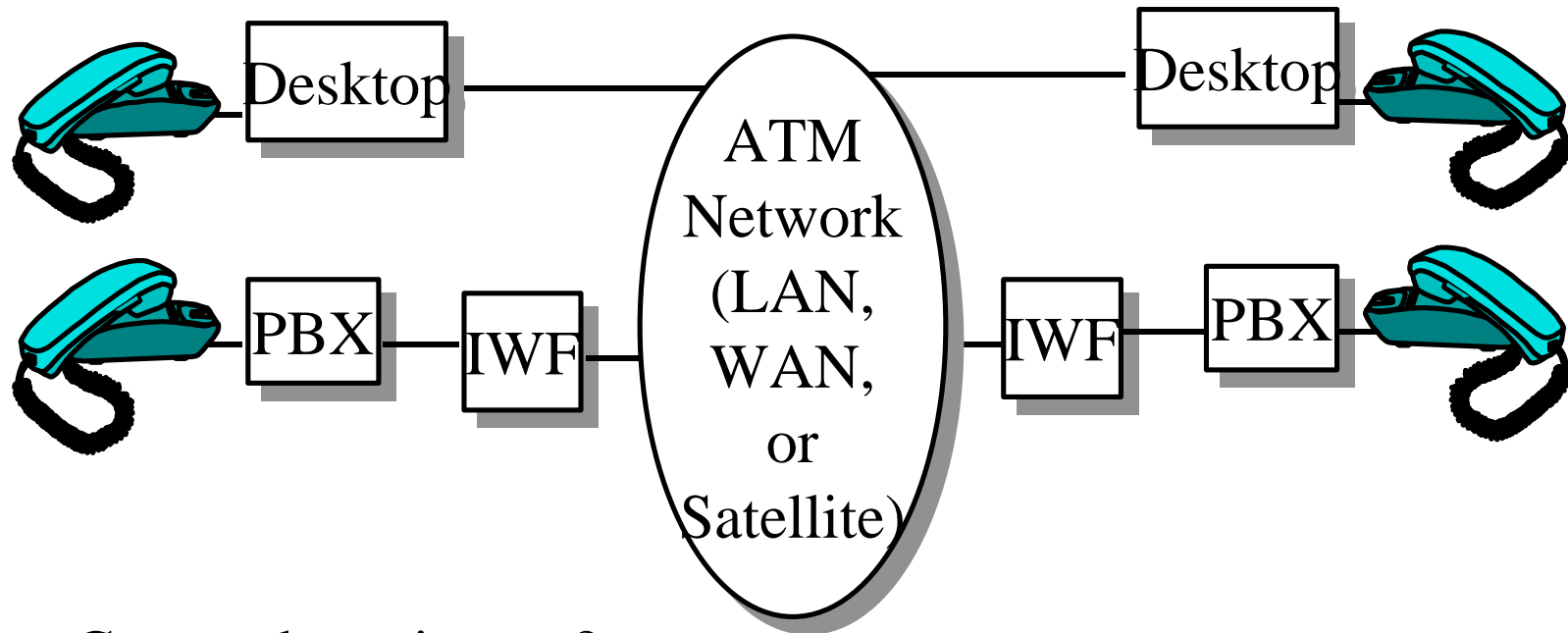


- q ATM Forum Activities:
 - q Subgroups
 - q Status of Subgroups
 - q New AAL
- q Our Efforts:

VOA

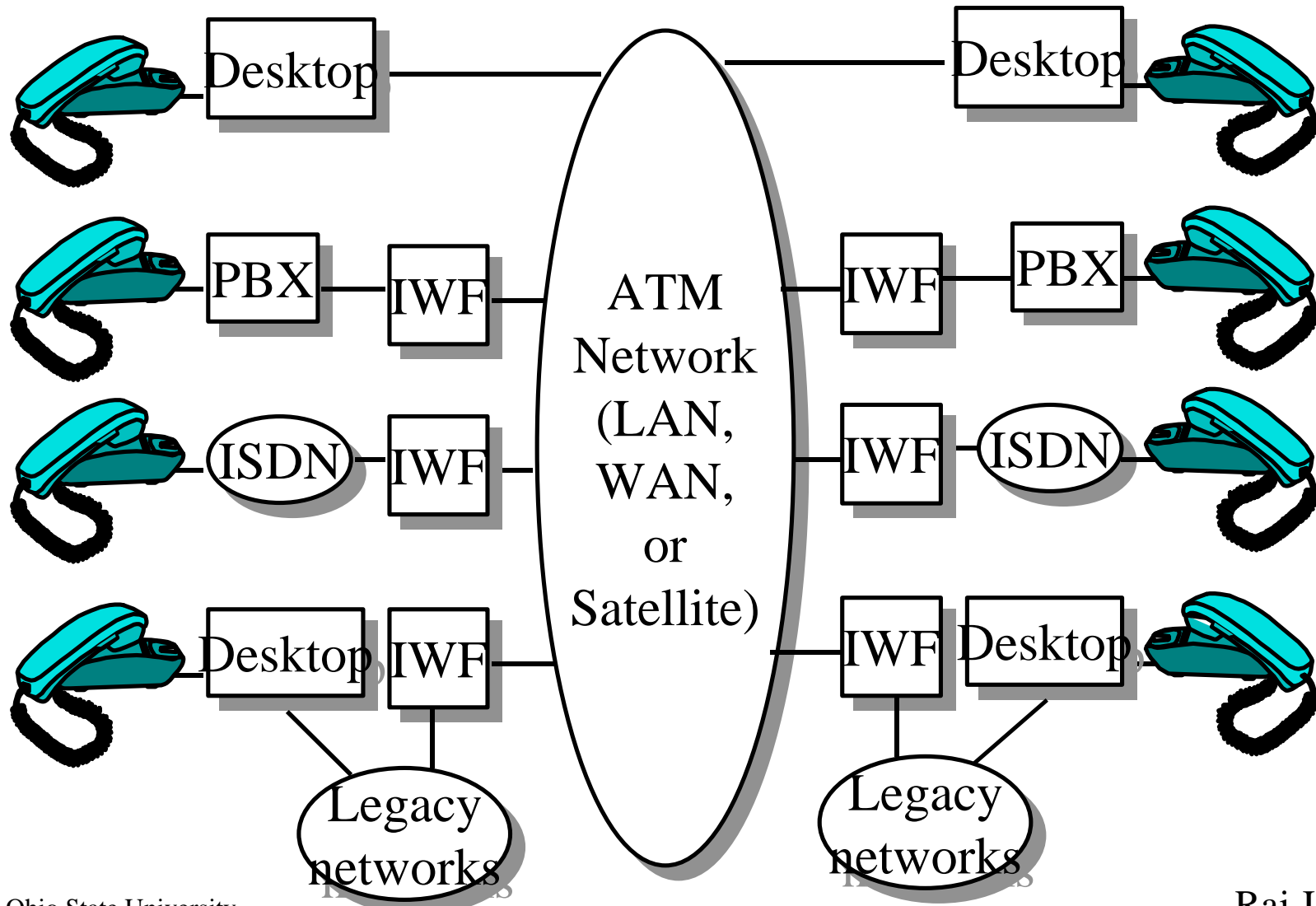


Voice over ATM



- q Can we have it now?
 - q No standards.
 - q No appropriate AAL.
 - q Cheaper alternatives available.
 - q Traffic management and scheduling

A More General View



ATM Forum VTOA Subgroups

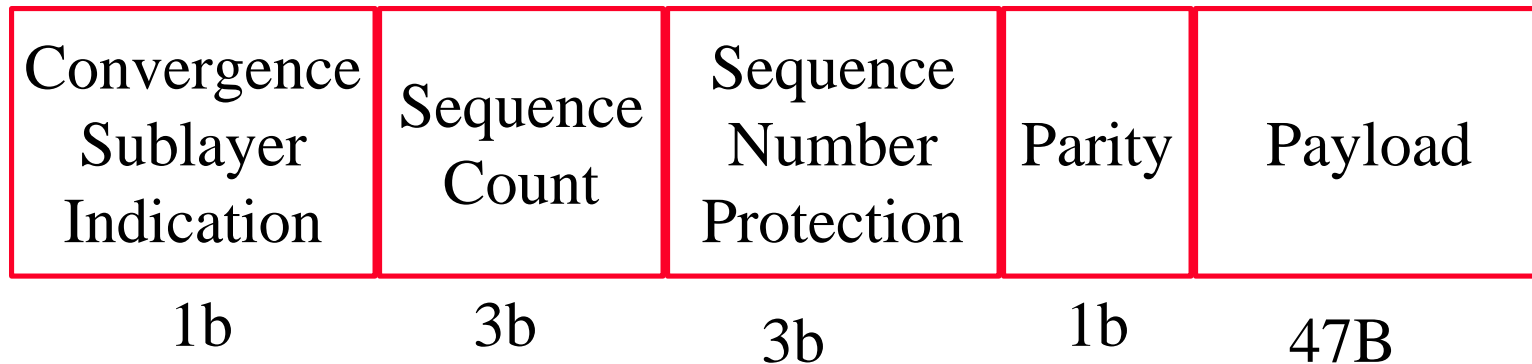
- q ATM Trunking for Narrowband Services
 - q Phase 1 forwarded for straw vote (Oct 96)
 - q Switched trunking for 64 kbps circuits
 - q Narrowband signaling interworking
- q Voice and Telephony to the Desktop
 - q Phase 1 in straw vote (Dec 96)
 - q Single 64 kb/s PCM voice to the desktop
 - q Interworking with ISDN and PBXs
 - q Basic supplementary services supported by UNI 4
 - q Compressed voice with silence removal in Phase 2

- q VTOA Mobile Trunking: Low bit rate voice
 - q Work started in April 1996
 - q A new AAL is being defined
 - q AAL CU format agreed at ATM Forum
 - q ITU will freeze the text in Feb 97
- q DS3/E3 Circuit Emulation Service
 - q Straw vote comments being resolved

Current Desktop Standard

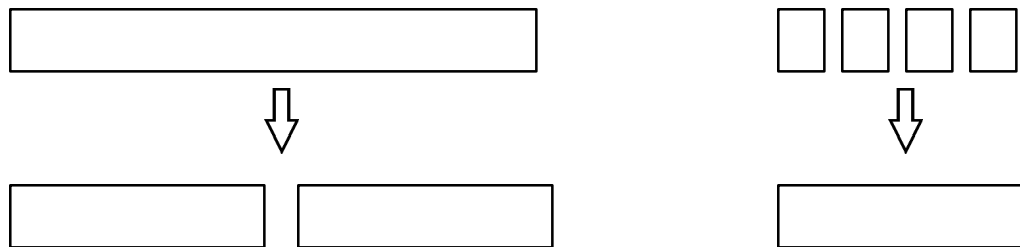
- q Using AAL1: 47 bytes of payload. (AAL5 also allowed)
- q No forward error correction
- q No partial fill
- q Does detect cell loss

| ← Sequence Number → |



Delay

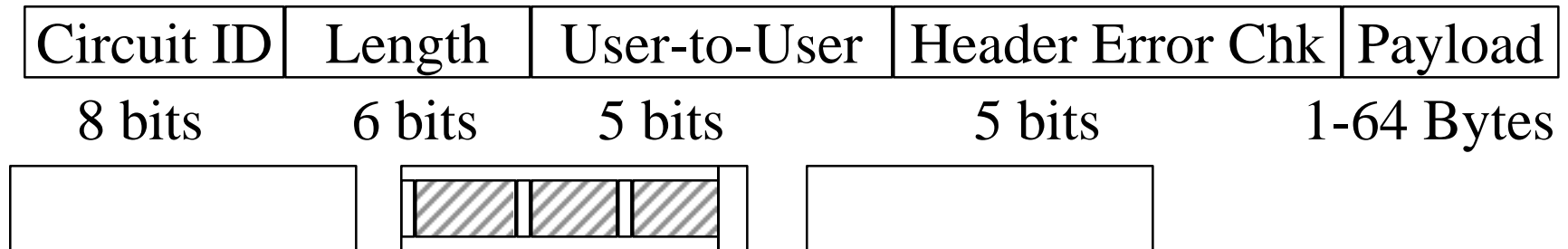
- q 48 bytes at 64 kbps = 6 ms \Rightarrow Need Echo cancelers
- q 48 bytes at 16 kbps = 24 ms \Rightarrow too long
- q Can't fill a cell completely
- q Current AALs allow segmentation (long packets to multiple cells).
- q Do not allow blocking (short packets in one cell)



Key Requirements for New AAL

- q Allow transfer of short variable length packets
- q Allow packets with variable inter-arrival times
- q Allow packets to cross ATM cell boundaries
- q Allow for partially filled cells
- q Resynchronize under loss or errors
- q Allow multiple connections to be multiplexed on one VC
- q Allow clock recovery
- q Allow inband signaling

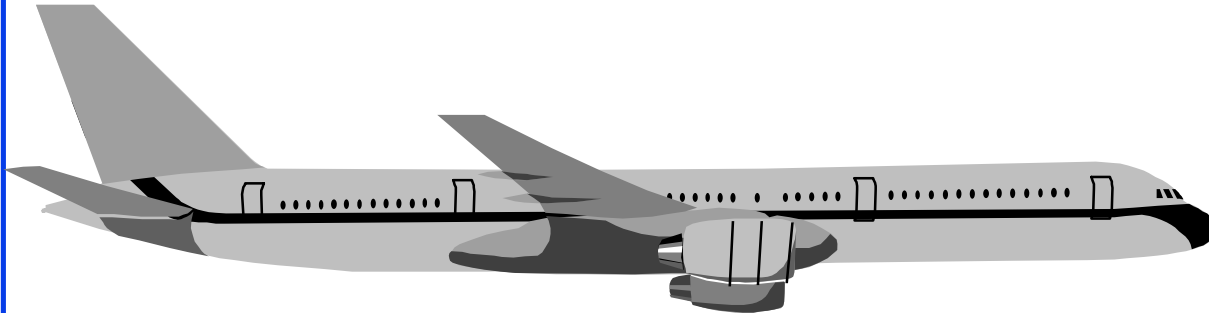
New AAL



- q AAL-CU (T1S1): 3 octet packet header
CU stands for Composite Users (ITU SG 13 terminology)
 - q 3 octets of overhead for one voice channel per VC
 - q 1 Octet per cell overhead (47 bytes for packets) + 5 byte ATM header

Traffic Management

- q Traffic management is the key to delay and bandwidth guarantees
- q ATM Forum has developed a very sophisticated traffic management standard for data
 - q Four classes of service
 - q Seven different ways



Standby



Guaranteed



Joy Riders



Confirmed

Classes of Service

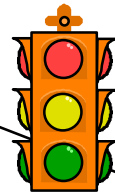
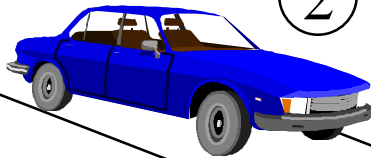
- q **CBR** (Constant bit rate): User declares required rate. Throughput, delay and delay variation guaranteed.
- q **VBR** (Variable bit rate): User declares average and max rate.
 - q **rt-VBR** (Real-time variable bit rate): Conferencing. Max delay and delay variation guaranteed.
 - q **nrt-VBR** (non-real time variable bit rate): Stored video. Mean delay guaranteed.
- q **ABR** (Available bit rate): Follows feedback instructions. Network gives maximum throughput with minimum loss.
- q **UBR** (Unspecified bit rate): User sends whenever it wants. No feedback mechanism. No guarantee. Cells may be dropped during congestion.

Traffic Management on the Information Superhighway

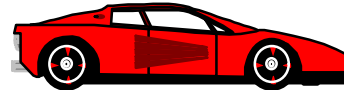
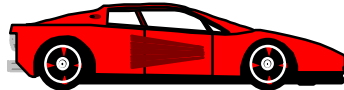
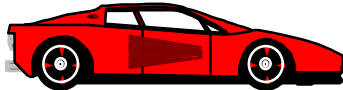
① CAC



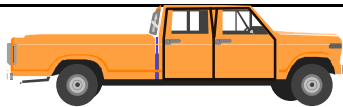
② Shaping



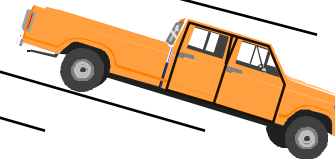
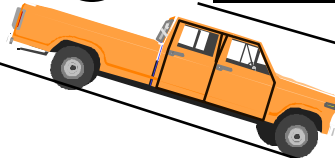
③ UPC



Scheduling ④

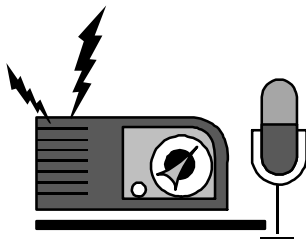


⑤ Selective



⑥

Frame Discard



⑦

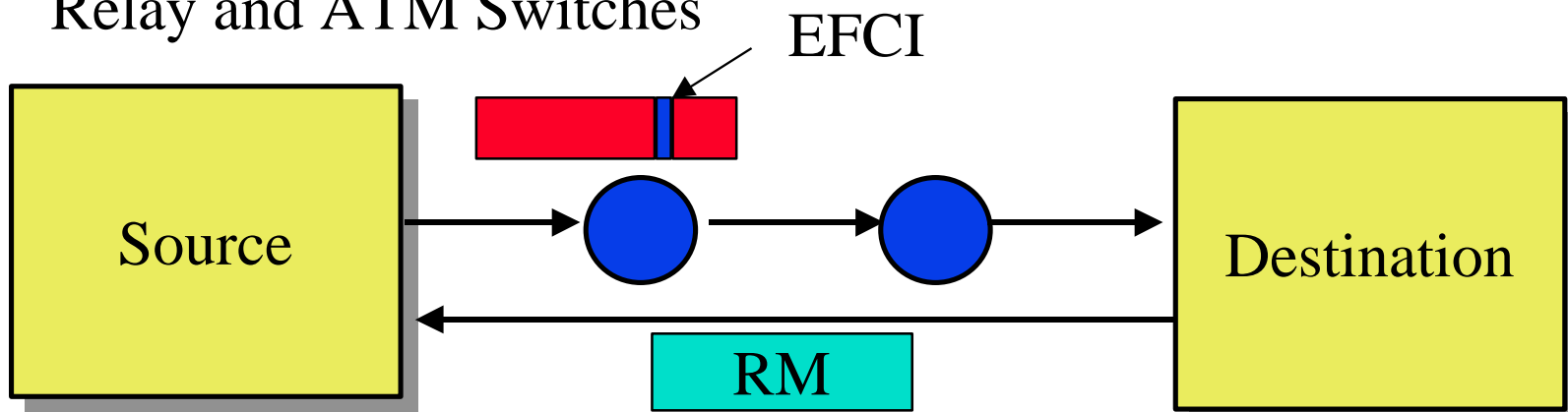
Traffic Monitoring and feedback

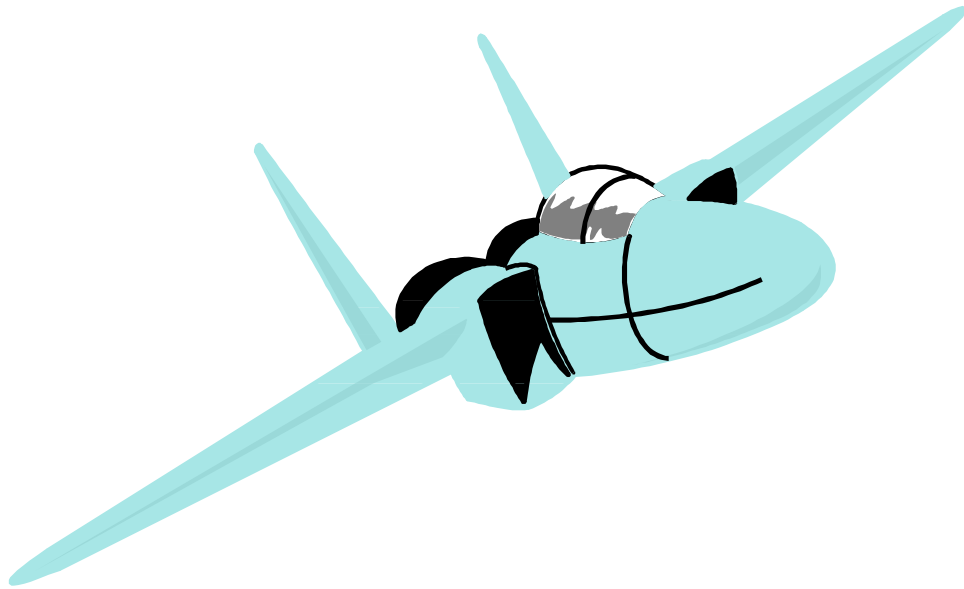
Traffic Management Functions

- q Connection Admission Control (CAC):
Can requested bandwidth and quality of service be supported?
- q Traffic Shaping: Limit burst length. Space-out cells.
- q Usage Parameter Control (UPC):
Monitor and control traffic at the network entrance.
- q Network Resource Management:
Scheduling, Queueing, virtual path resource reservation
- q Selective cell discard:
Cell Loss Priority (CLP) = 1 cells may be dropped
Cells of non-compliant connections may be dropped
- q Frame Discarding
- q Feedback Controls: Network tells the source to increase or decrease its load.

Traffic Management

- q Participation in ATM Forum since its inception
- q DECbit scheme (1986)
- q Explicit Feedback Congestion Indication (EFCI) in Frame Relay and ATM Switches



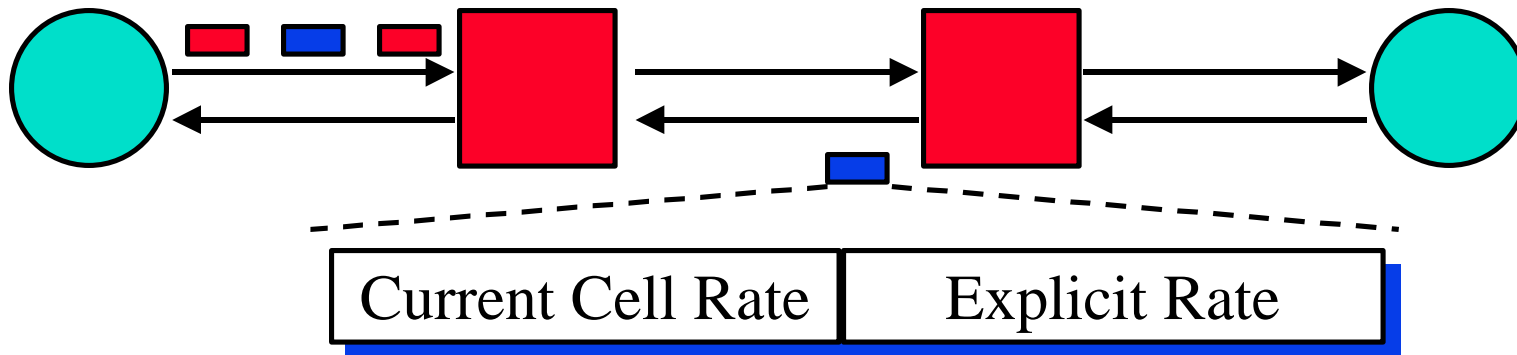


Go
30 km East
35 km South



Go left

Explicit Rate Scheme



- q Explicit Rate Indication for Congestion Avoidance (ERICA) Switch Algorithm
- q ERICA+ : 100% utilization and low delay
- q Three patents
- q Multiclass scheduling

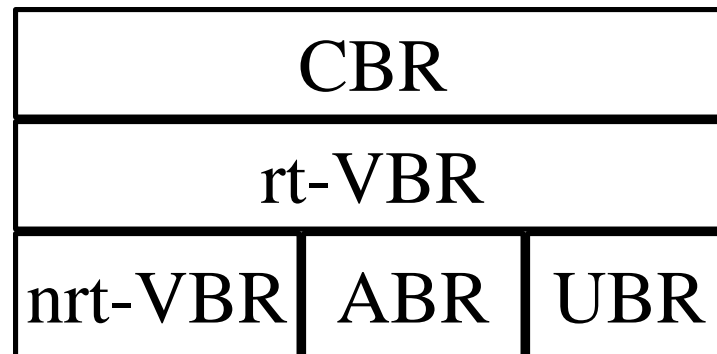
Traffic Management

- q ERICA
- q TCP/IP over ATM
- q Multiclass scheduling
- q VS/VD
- q Point to multipoint
- q Connection admission control

ERICA Switch Algorithm

- q Each manufacturer will have its own explicit rate switch algorithm
- q Explicit Rate Indication for Congestion Avoidance (ERICA) is the most thoroughly analyzed algorithm among disclosed algorithms
- q Shown to be efficient, fair, fast transient response, able to handle bursty TCP traffic
- q ERICA+ allows low delay even at 100% utilization and provides stability in the presence of high frequency VBR background traffic
- q Being implemented by several vendors

Multiclass Scheduling



- q Ensure *no-starvation* for all classes even under overload.
- q Each class has a guaranteed *allocation*
- q Some classes need minimum delay \Rightarrow have *priority*.
- q Some classes are greedy: They will send more than allocated and will want to use all left-over.
- q Left-over capacity must be *fairly* allocated.
- q ERICA scheduler achieves all these goals.

Connection Admission Control

- q What should the voice sources demand to get a desired loss rate?
- q What should the switches ensure to meet a given guarantee?
- q Should a switch accept all data connection requests?
- q Number of data connections on a link and the distances the connections are going to affect the performance of voice connections.

Other Related Projects at OSU

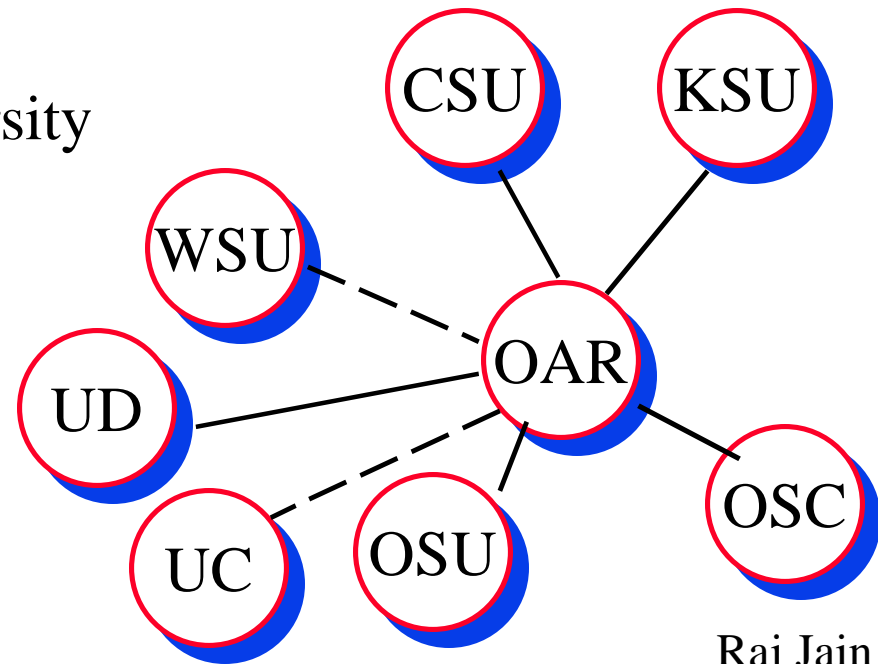
- q OCARnet
- q National ATM Benchmarking Lab

OSU National ATM Benchmarking Lab

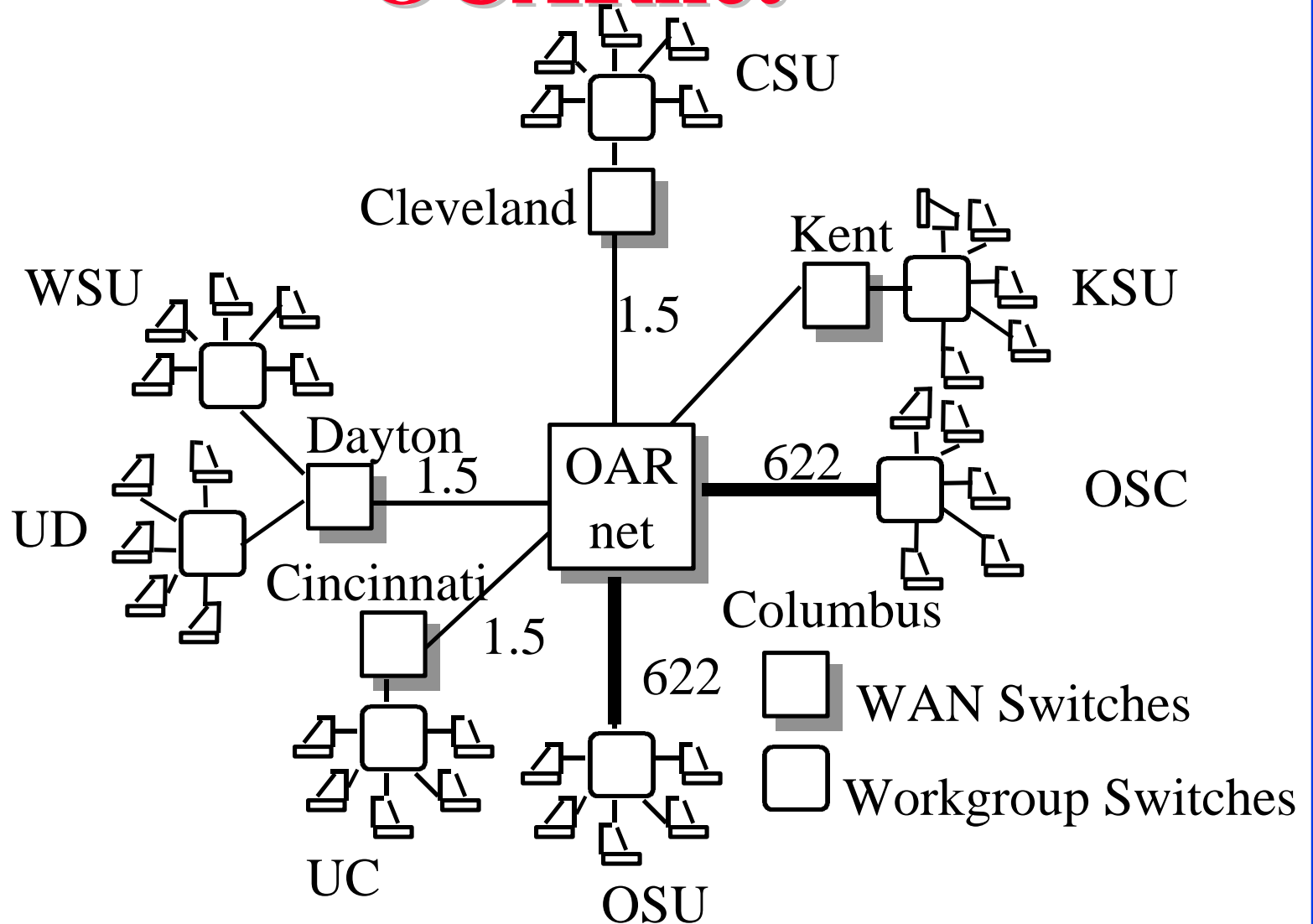
- q “The Art of Computer Systems Performance Analysis” + ATM Forum involvement
⇒ ATM benchmarking at OSU
- q Modeled after Harvard lab for routers
- q Benchmarks run in our lab
- q Benchmark scripts can be run by any manufacturer
- q Presentations at N+I Atlanta (Sep 1995)
- q Leading the work at ATM Forum since Oct 1995
- q Currently defining metrics and measurement methodology

OCARNet

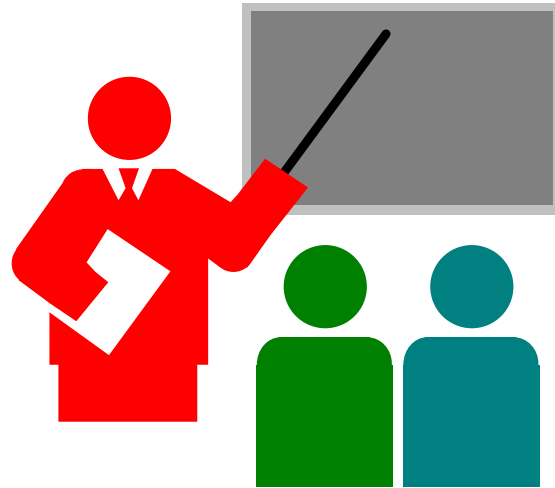
- q Ohio Computing and Communications Research Network
- q Six (soon eight) Institution consortium lead by OSU
 - q Ohio State University
 - q Ohio Super Computer Center
 - q OARnet
 - q Cleveland State University
 - q Kent State University
 - q University of Dayton
 - q *University of Cincinnati*
 - q *Wright State Univer*



OCArnet



Summary



- q Three activities: VTOA to Desktop, ATM Trunking of narrowband, and Low bit rate voice
- q VTOA over Desktop and ATM Trunking group are using AAL1
- q Low bit rate voice is planning a new AAL

References: VTOA

- q "Voice and Telephony over ATM to the Desktop Specification" Version 0.0, ATMF/95-0917R5, June 1996.
- q M. Duault, "Baseline text for voice and telephony over ATM -ATM Trunking for Narrowband Services," ATMF/95-0446R6, April 1996.
- q J. Hopkins, "Comparison of AAL-CU Protocols," ATMF/96-0846, June 1996
- q T1S1-5/95.001.Revision 1, "Short Multiplexed AAL (SMAAL) - An AAL for transporting short multiplexed Packets Baseline Document."

References: Traffic Management

- q All our papers and contributions are available **on-line**:
<http://www.cis.ohio-state.edu/~jain/>
- q R. Jain, "Congestion Control in ATM Networks: Recent Advances and a Survey," Computer Networks and ISDN Systems, November 1996. Available on
<http://www.cis.ohio-state.edu/~jain/>
- q ATM Forum Traffic Management Specification Version 4.0, available at <ftp://ftp.atmforum.com/pub/approved-specs/af-tm-56.000.ps>
- q Raj Jain, Shiv Kalyanaraman, Sonia Fahmy, Rohit Goyal, S. Kim, "Source Behavior for ATM ABR Traffic Management: An Explanation," IEEE Communications Magazine, November 1, 1996, http://www.cis.ohio-state.edu/~jain/papers/src_rule.ps