Networking Research At OSU

Raj Jain

P...es

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Our Team

- **Faculty**:
  - Dr. Raj Jain
  - Dr. Steve Lai
  - Dr. Gojko Babic
  - Dr. Mike Liu
  - Dr. Wu-Chi Feng
  - Dr. Arjan Durresi
- **Ph.D. Students**:
  - Rohit Goyal
  - Bobby Vandalore
  - Rizwan Mir
  - Sonia Fahmy
  - X. Cai
- **M.S. Students**:
  - Justin Dolske
  - S. Varadarajan
  - Sohail Munir
  - J. Iyer
  - Mukul Goyal

Networking Research at OSU

- ATM Networks
  - Raj Jain and Gojko Babic
- Wireless Networks
  - Steve Lai
- Multimedia Networking
  - Wu Chi Feng and Raj Jain
- Protocol Engineering - Mike Liu

Overview

- Networking Trends
- ATM Traffic Management
- OSU National ATM Performance Testing Lab
- OCARnet: Ohio University Network
- Voice/Video over ATM

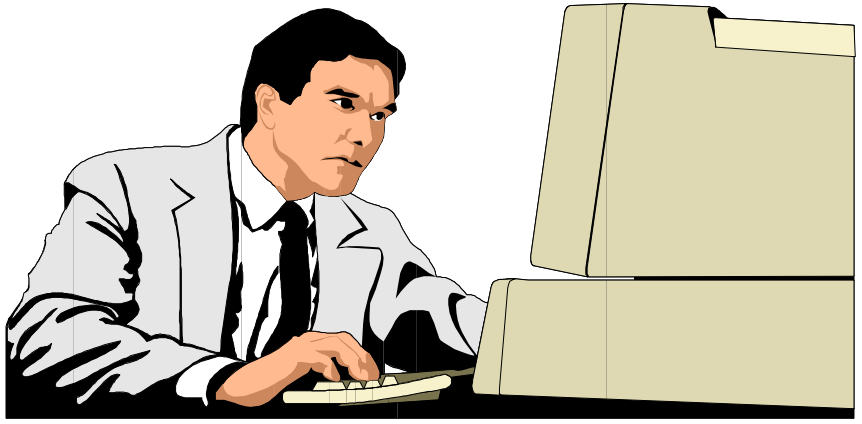
Trends

- Communication is more critical than computing
  - Greeting cards contain more computing power than all computers before 1950.
  - Genesis's game has more processing than 1976 Cray supercomputer.
- Internet: 0.3 M hosts in Jan 91 to 9.5 M by Jan 96
  $\Rightarrow$ More than 5 billion (world population) in 2003

Stone Age to Networking Age

- Microwave ovens, stereo, VCRs, had some effect. But, Stone, iron, …, automotive, electricity, telephone, jet plane,…, networks caused a fundamental change in our life style
- In 1994, 9% of households with PC had Internet link. By 1997, 26%. Soon 98% … like TV and telephone.
- URL is more important than a company's phone number. (54 URLs in first 20 pages of March'97 Good Housekeeping.)
- Better communication ⇒ Distance not important

Social Impact of Networking

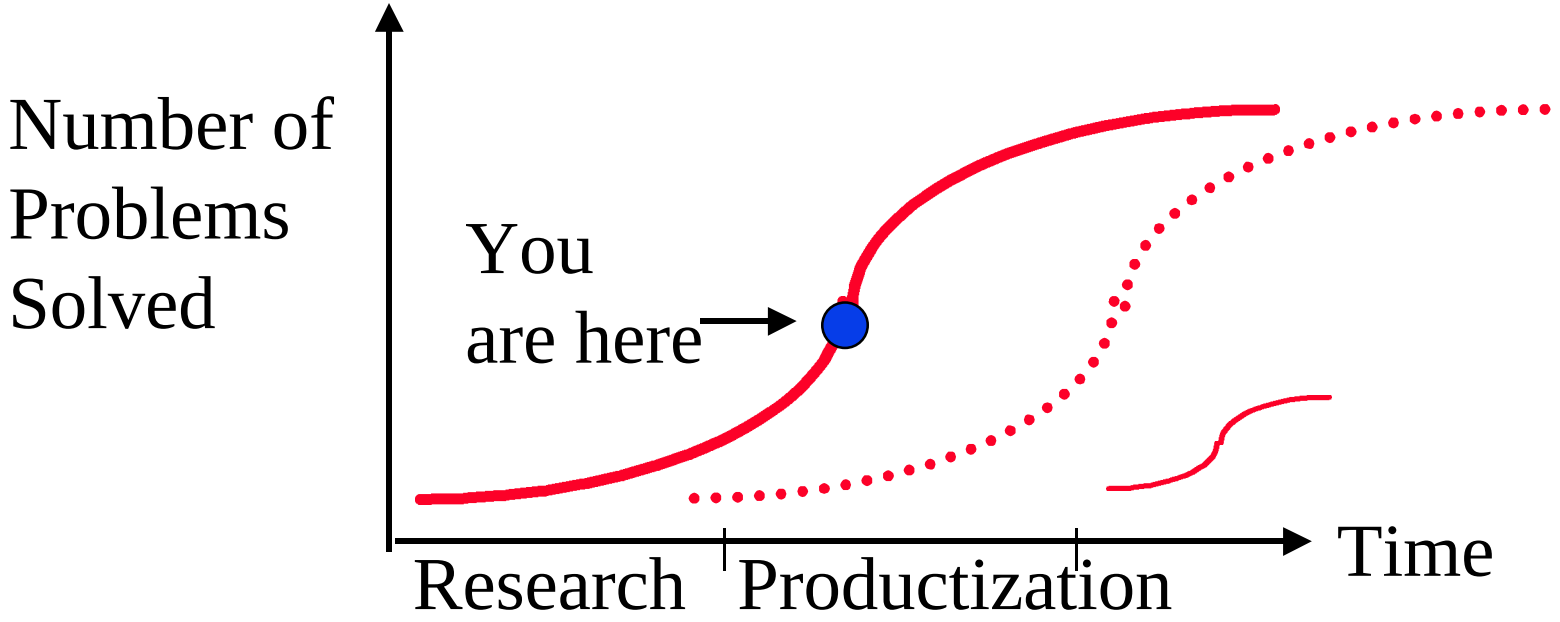


- No need to get out for
  - Office
  - Shopping
  - Education
  - Entertainment
- Virtual Schools
- Virtual Cash
- Virtual Workplace

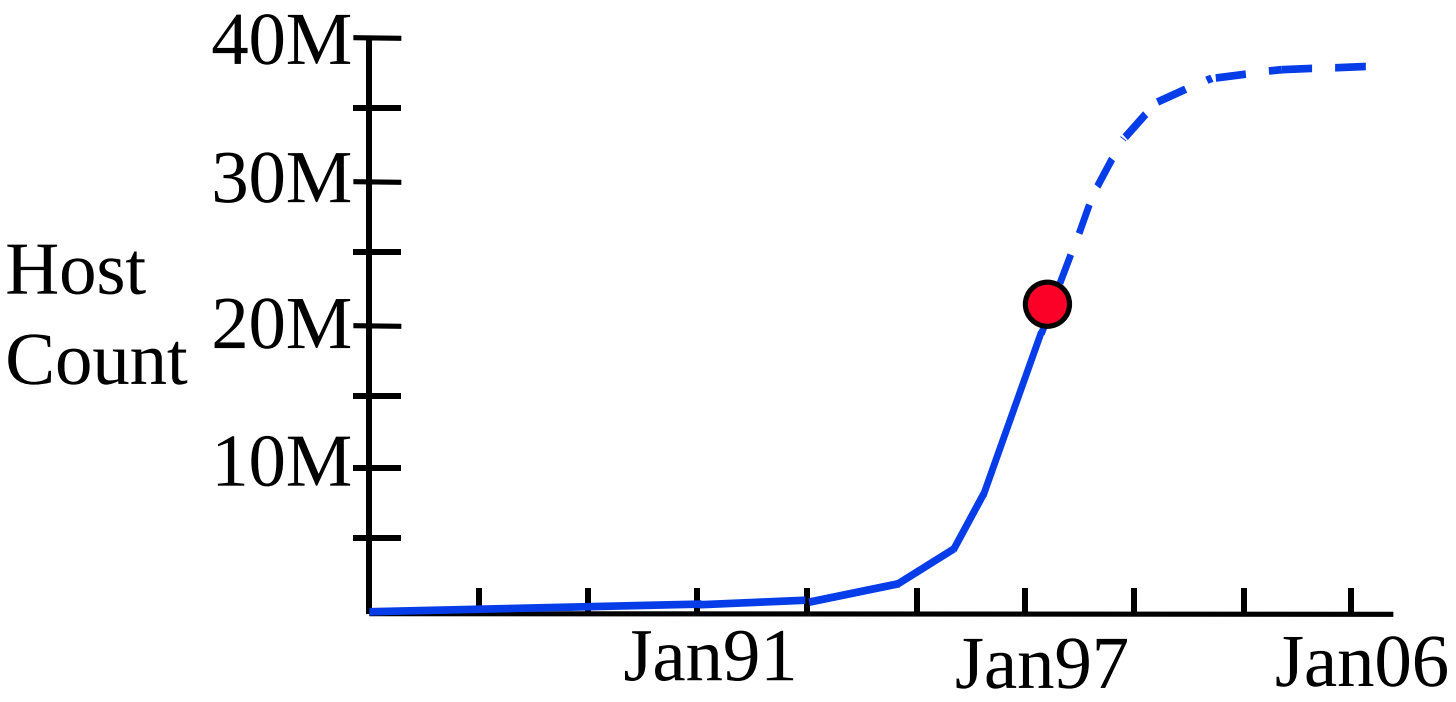
(55 Million US workers will work remotely by 2000)

Cave Persons of 2050

Life Cycles of Technologies



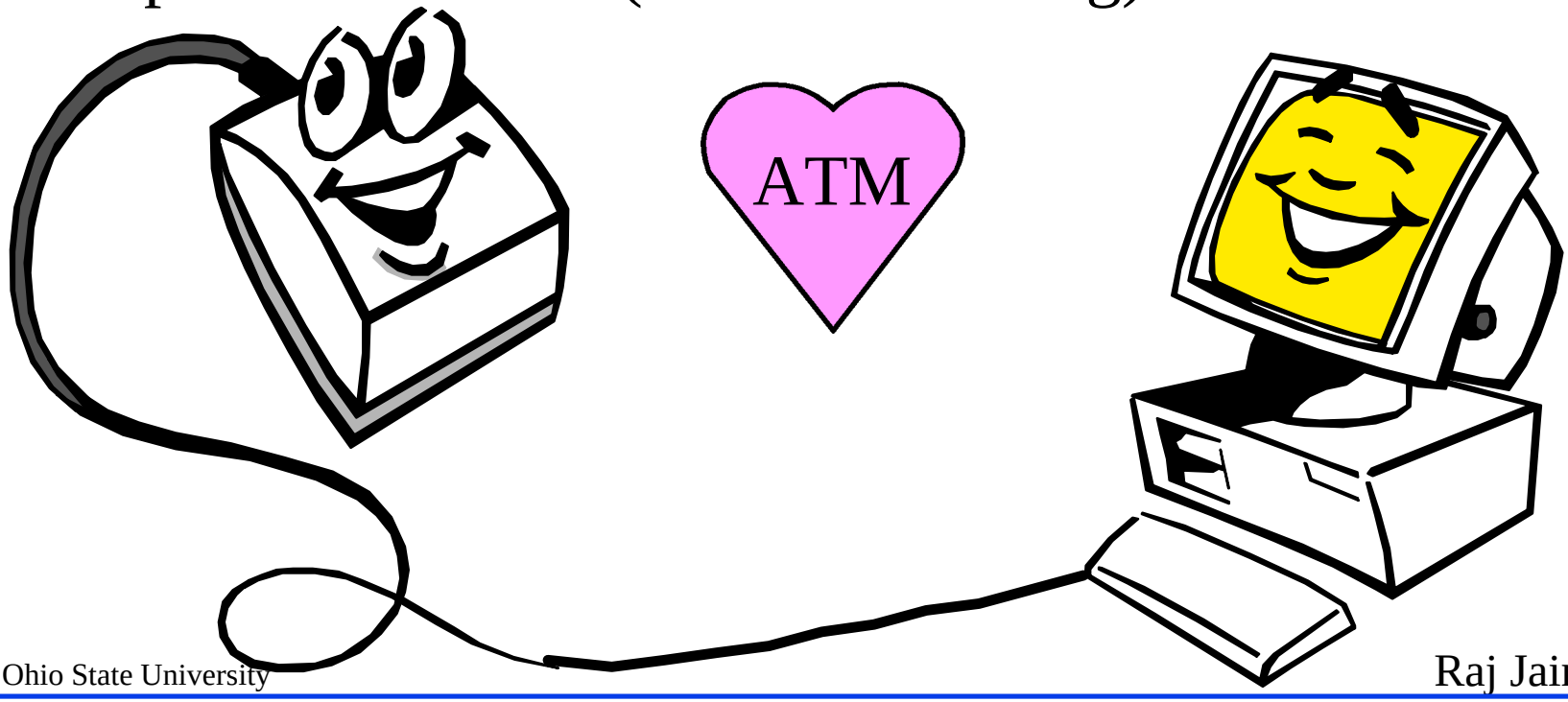
Internet Technology



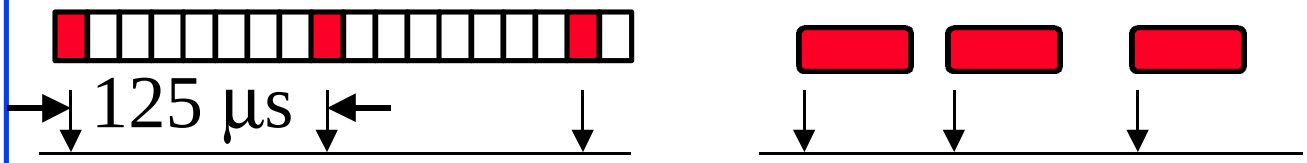
- **New Challenges**: Exponential growth in number of users. Exponential growth in bandwidth per user. Traffic management, Security, Usability, ...

ATM

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



ATM vs Phone Networks

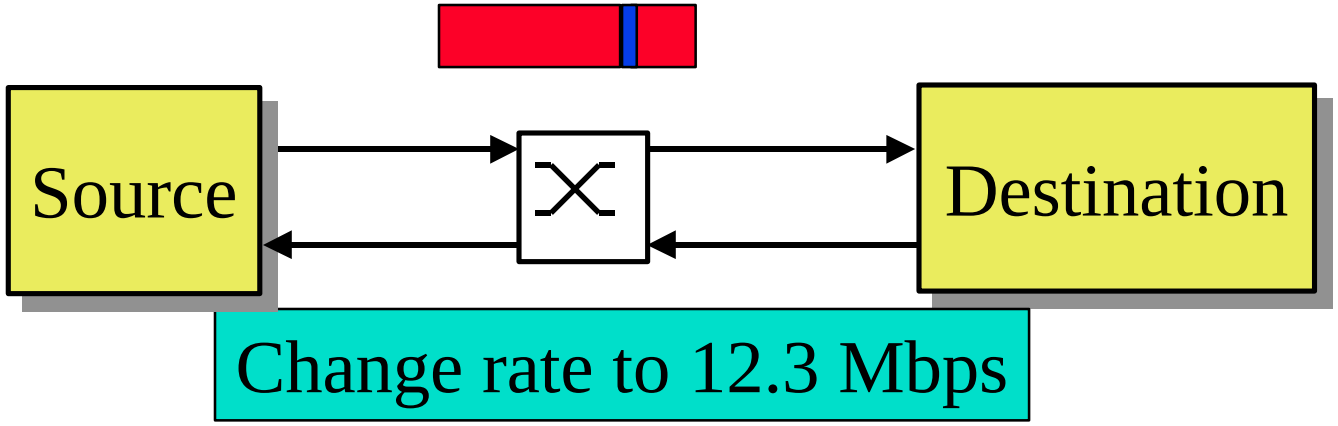


- Current phone networks are synchronous (periodic).
  ATM = Asynchronous Transfer Mode
- Phone networks use circuit switching.
  ATM networks use "Packet" Switching
- In phone networks, all rates are multiple of 8 kbps.
  With ATM service, you can get any rate.
  You can vary your rate with time.
-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

ATM vs Data Networks

- Internet Protocol (IP) is connectionless.
  You cannot reserve bandwidth in advance.
  ATM is connection-oriented.
  You declare your needs before using the network.
- Routers cannot guarantee bandwidth or delay.
  ATM networks reserve bandwidth and buffers.
- In IP, each packet is addressed and processed individually. Inefficient for continuous medi
- IP has little traffic management.
  ATM has 1996 traffic management technology.
  Required for high-speed and variable demands.

Traffic Management

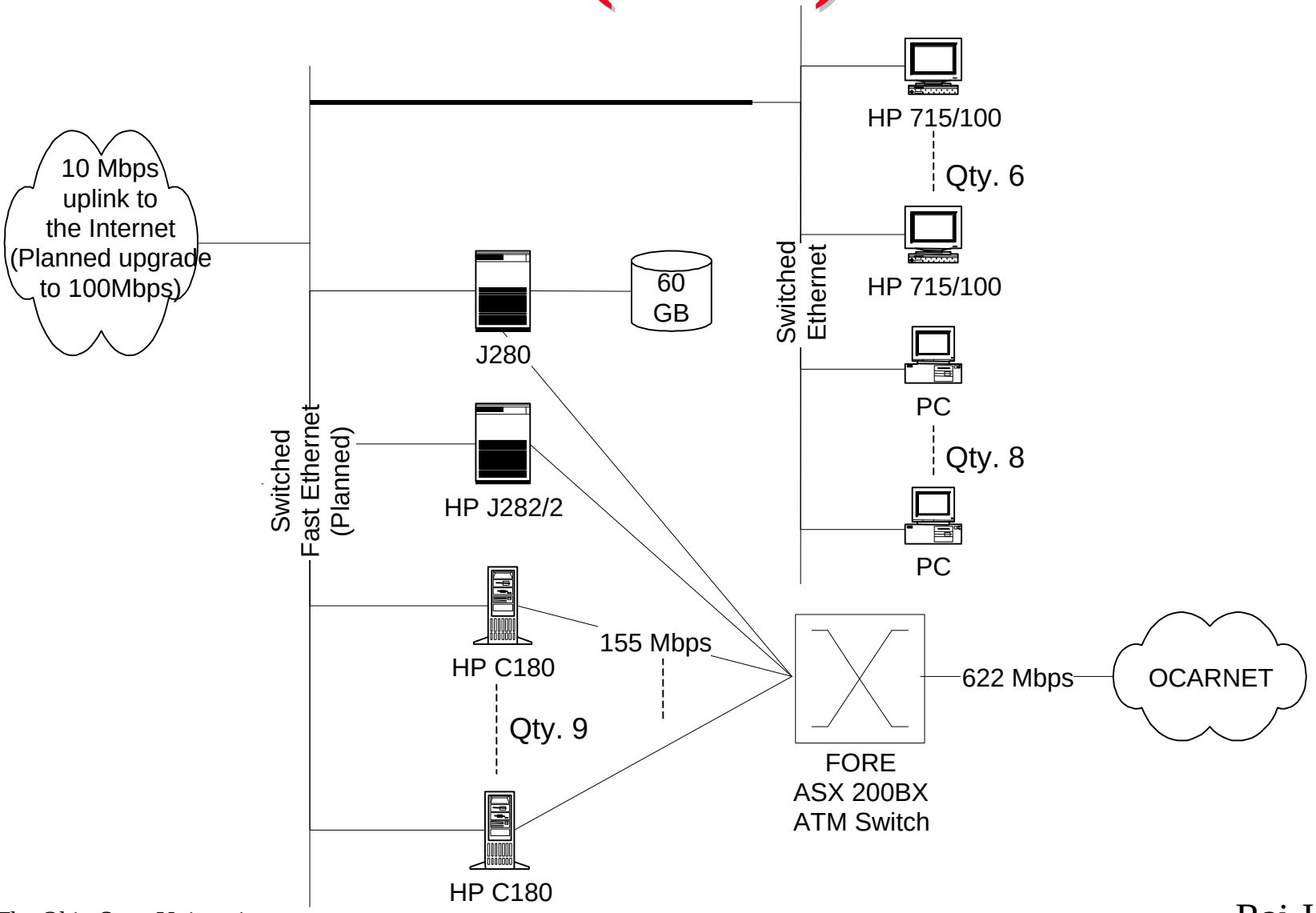


- Invented DECbit scheme in 1986: Bit ⇒ Go up/Down
  - Used now in Frame Relay (FECN)
  - Used in ATM (EFCI)
- In July 1994, we proposed Explicit Rate Approach. Current standard.
- Two patents. Collaboration with industry.

Computation Facilities

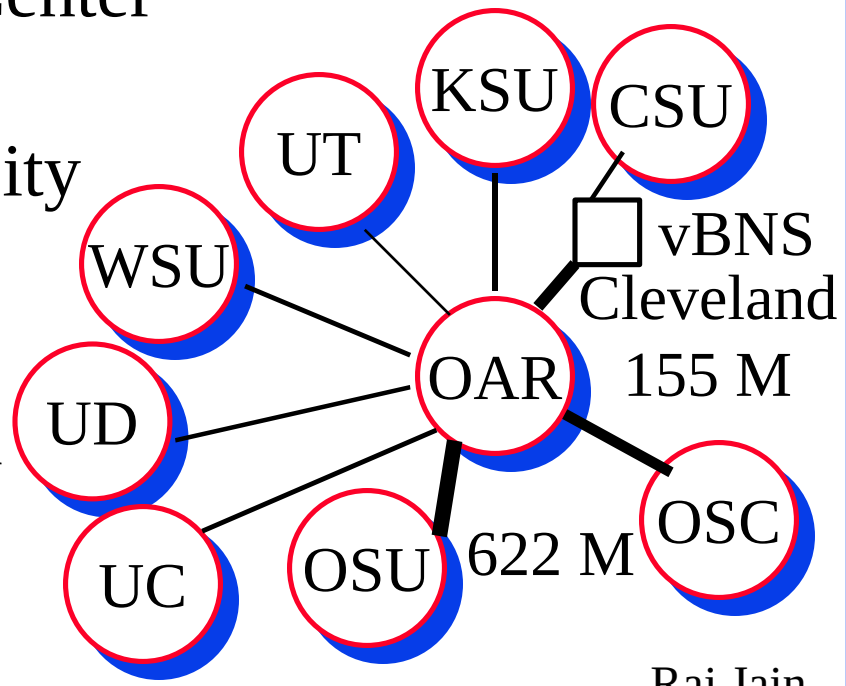
- Numerous high-powered computers:
  1×715/64 (2.6 FP95) 6×715/100 (4.3 FP95),
  9×C180s (18.7 FP95), 1×J282/2 (19.3 FP95)
  6 P5-200 Desktops + 9 Laptop PCs
- J-280 fileserver with 64 GB
- 100 Mbps Ethernet and 155 Mbps ATM
- 622 Mbps Connection to OCARnet testbed
- Several switches with speeds from 25 to 622 Mbps
- World-class ATM Testing Lab with 25, 155, and 622 Mbps testing monitors

Facilities (Cont)

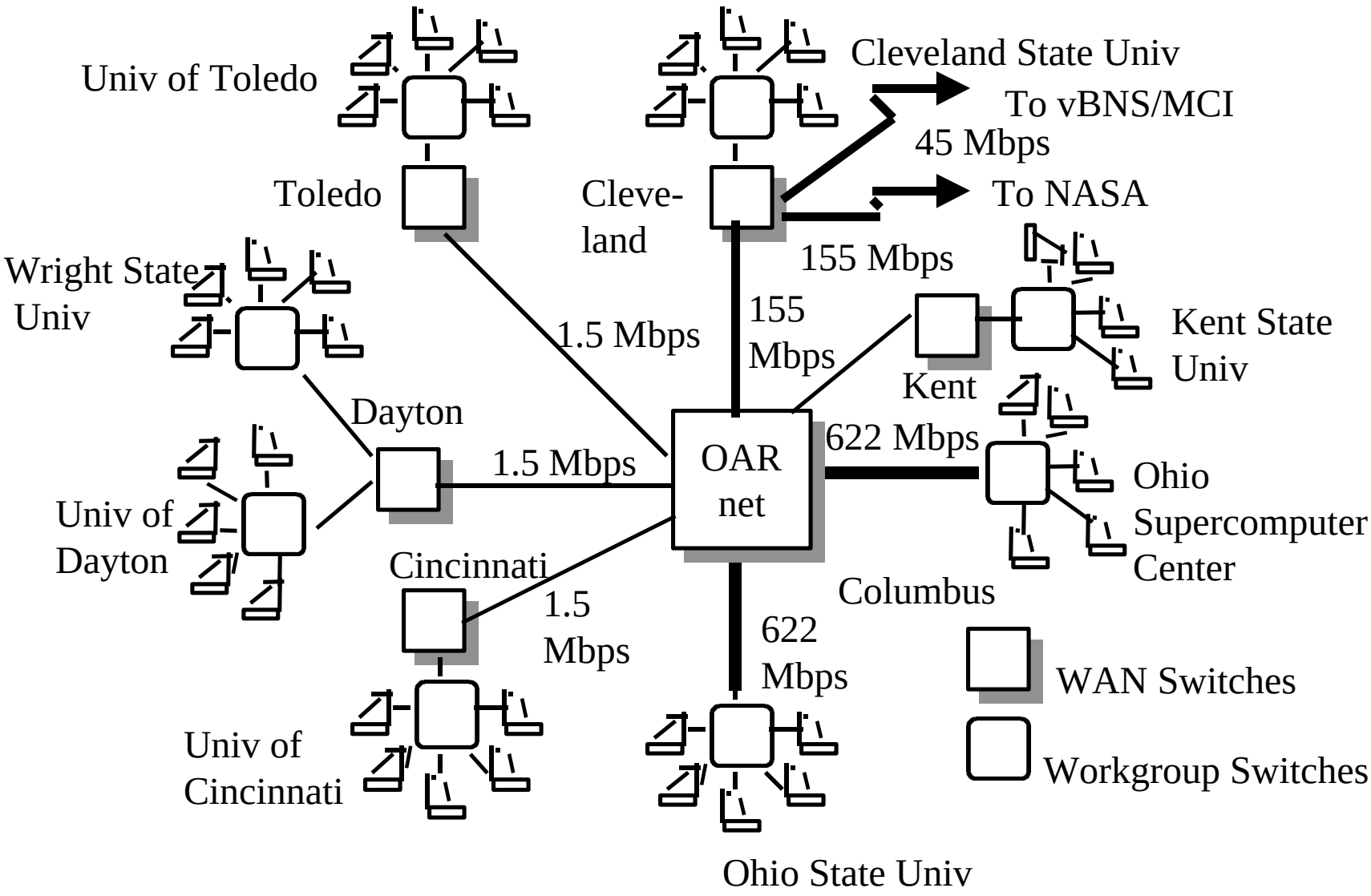


OCARnet

- Ohio Computing and Communications ATM Research Network
- Nine-Institution consortium lead by OSU
  - Ohio State University
  - Ohio Super Computer Center
  - OARnet
  - Cleveland State University
  - Kent State University
  - University of Dayton
  - University of Cincinnati
  - Wright State University
  - University of Toledo



OCARnet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To NASA
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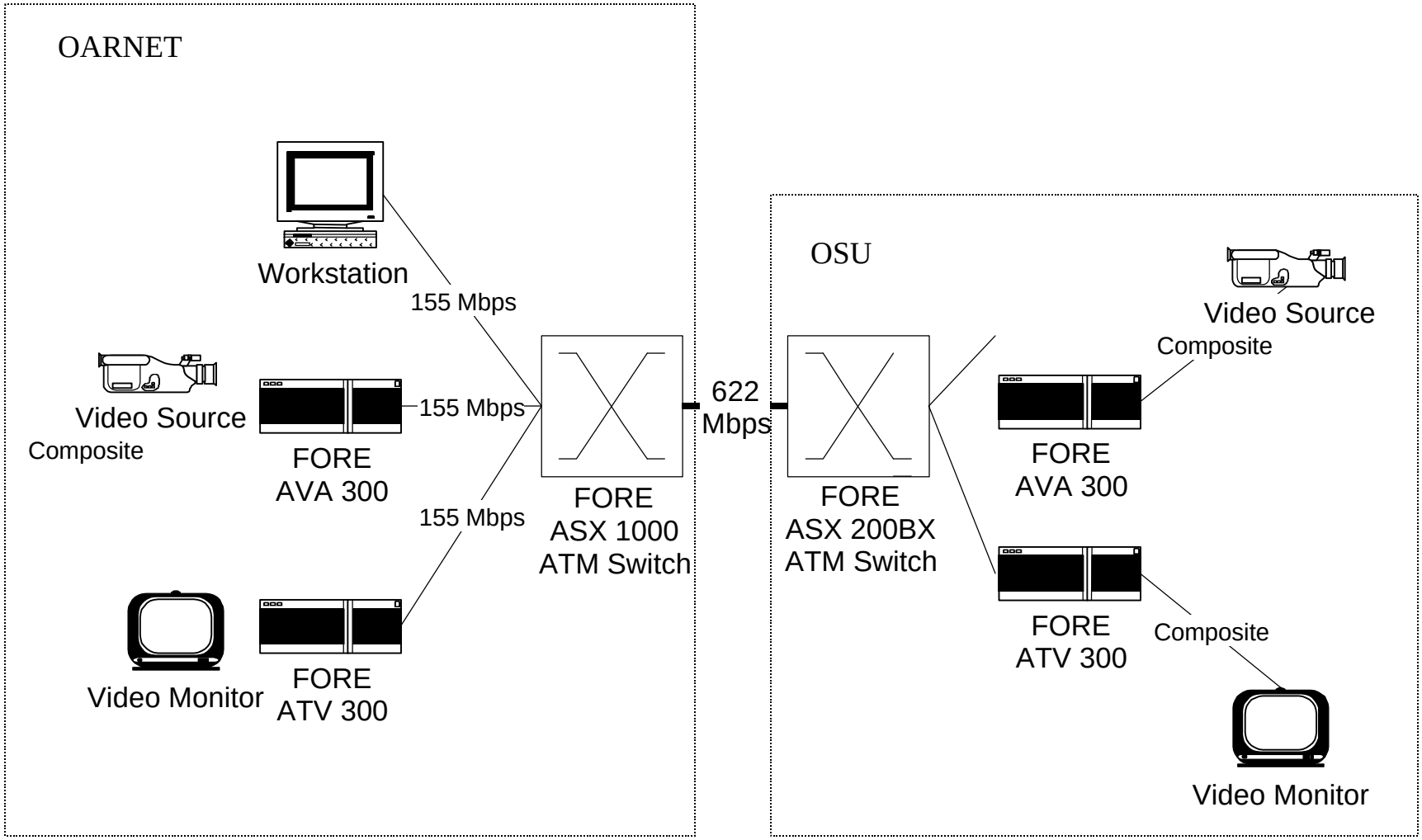
Ohio
Supercomputer
Center
Columbus
Cincinnati
1.5
Mbps
622
Mbps
WAN Switches
Workgroup Switches
Univ of
Cincinnati
Ohio State Univ

Voice/Video over ATM

- Speech suppression
  ⇒ Unused bandwidth can be used by data
  Cannot be used by voice.
- Hierarchical compression of Video
  Different users can see different bandwidth video
- Multipoint ABR
- Real-time ABR

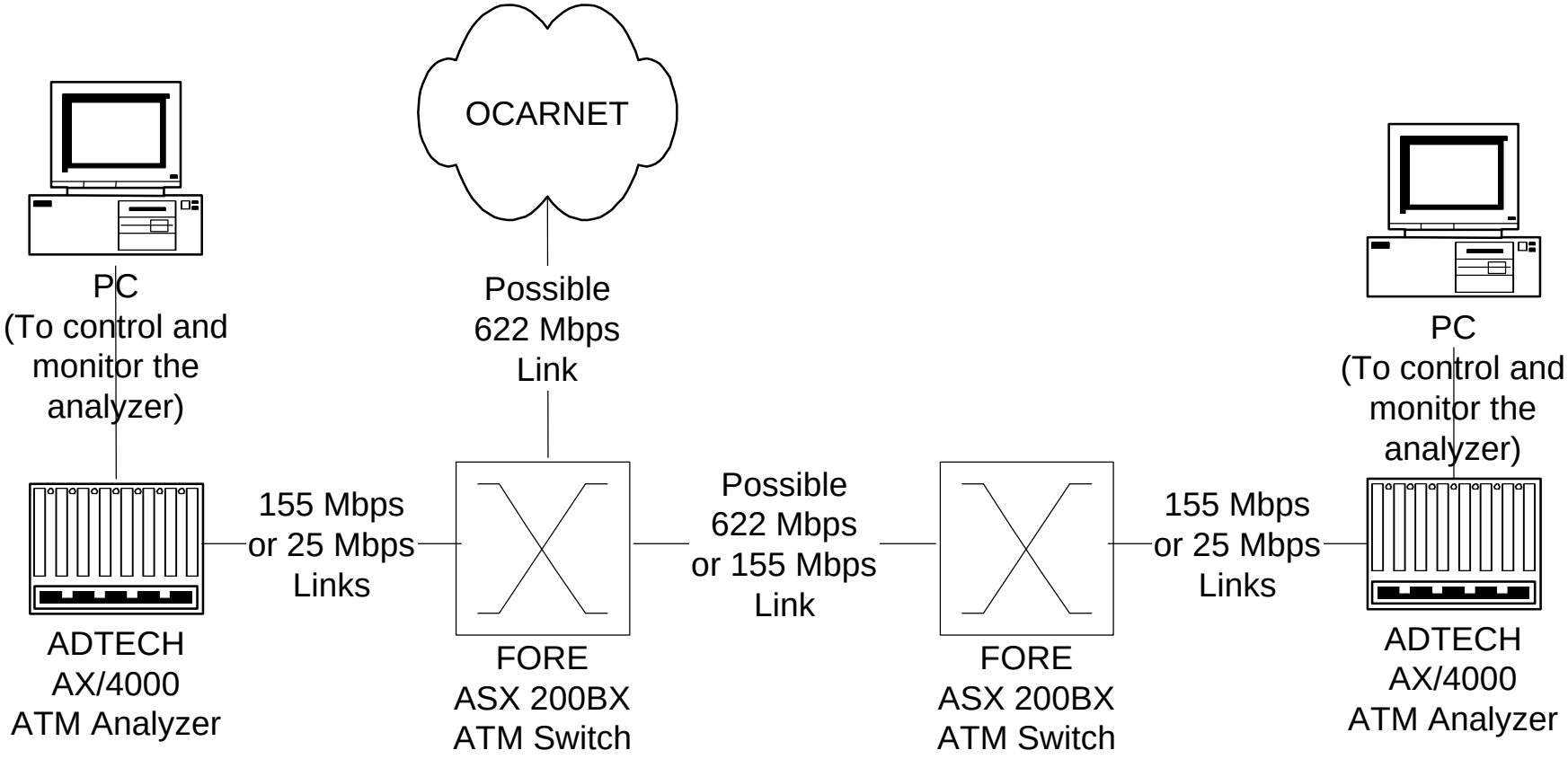
Video Testbed



OSU National ATM Benchmarking Lab

- Started a new effort at ATM Forum in October 1995
- Defining a new standard for frame based performance metrics and measurement methodologies
- We have a measurement lab with the latest ATM testing equipment. Funded by NSF and State of Ohio.
- The benchmark scripts can be run by any manufacturer/user in our lab or theirs.
- Modeled after Harvard benchmarking lab for routers

Performance Testing Facility



CIS Networking Courses

- CIS 677: Introduction to Networking
  - Offered every quarter
- CIS 678: Internetworking
  - Offered once a year - Winter quarter
- CIS 777: Telecommunication Networks
  - Offered once a year - Spring quarter
- CIS 788: Recent Advances in Networking (Raj Jain)
- CIS 788: Wireless Networking (Steve Lai)
- CIS788: Multimedia Networking (Wu-Chi Feng)
- CIS788: Protocol Engineering (Mike Liu)

Summary

- Leading the ATM traffic management
- Leading ATM Performance benchmarking
- Leading regional ATM networks
- Emphasizing topics of interest to industry
- Good computing/experimental resources

Our Publications

All our ATM Forum contributions and papers are available on-line at *http://www.cis.ohio-state.edu/~jain/*

- Specially see "Recent Hot Papers"

Thank You!