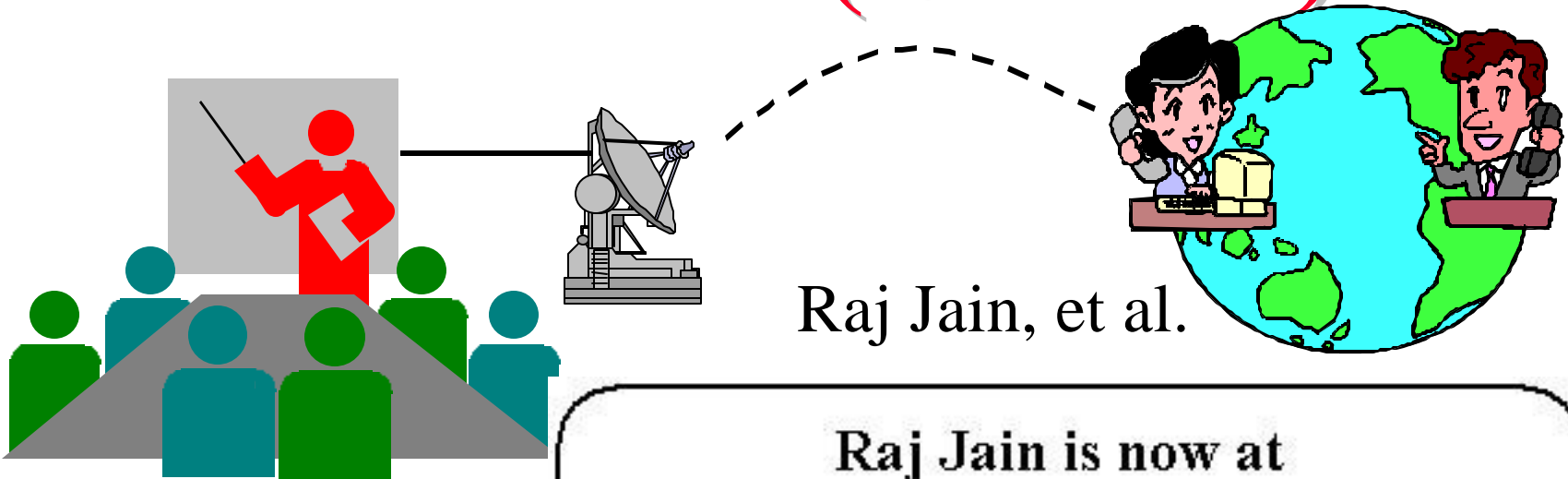


Ohio Distance Education Network (ODEN)



Raj Jain, et al.

Phon

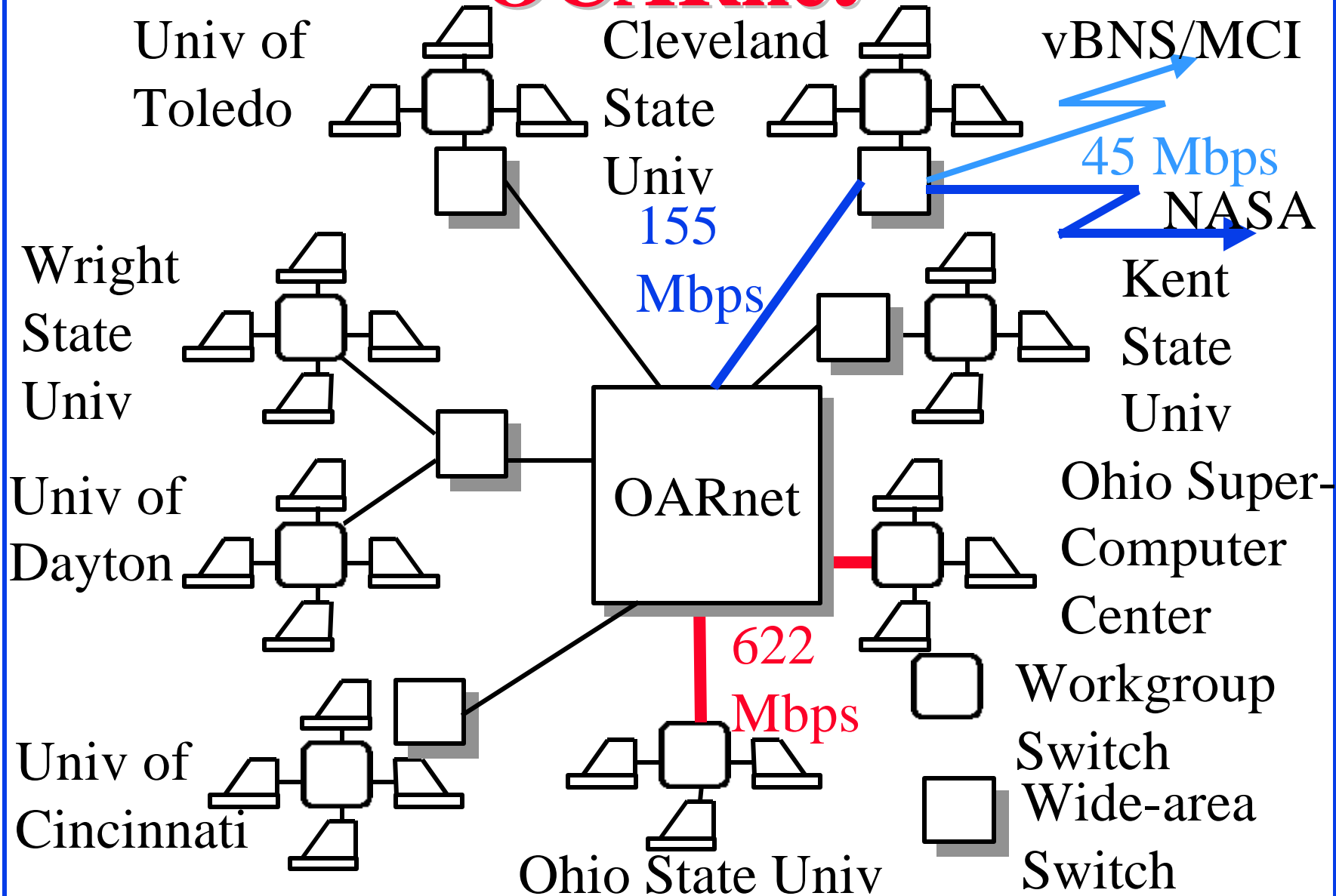
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What is ODEN?

- q Multi-institution test bed for experimentation/research on transmission of voice, video, and data
- q Six Institutions: OSU, KSU, CLS, UD, OSC, OARnet
- q Builds on Ohio Computing and Research Network

OCARnet



OARnet Achievements

- q ATM Forum standard on ATM Performance Testing
- q Obtained approximately \$5M from non-state sources in two years = $2.5 \times$ OBR Investment
- q National Recognition for Ohio:
- q Active in Internet2: OSU, Kent, OU, CWRU, WSU,
- q Real-time medical Internet-2 demo
- q Abilene (Internet-2) Test and Evaluation Center
- q Shared virtual environments demo
- q Allowed OARnet to move to ATM 2 years ahead

ODEN Goals

- q Research on network transmission of video, voice, data (multimedia)
- q Deploy facilities for network applications research
- q Leverage OCARnet investment: Extend high-speed connection with user equipment
- q Primary Application: Distance Education
Other Applications: Collaboration, Remote diagnosis.
- q Technology transfer/demo of research results
- q Allow us to lead not follow the coming revolution
- q Spawn funding from other sources

ODEN Non-Goals

We do not want to:

- q Implement best known method
- q Provide a distance education service
- q Study non-computer science issues:
Video production, accounting, billing,
pedagogical issues

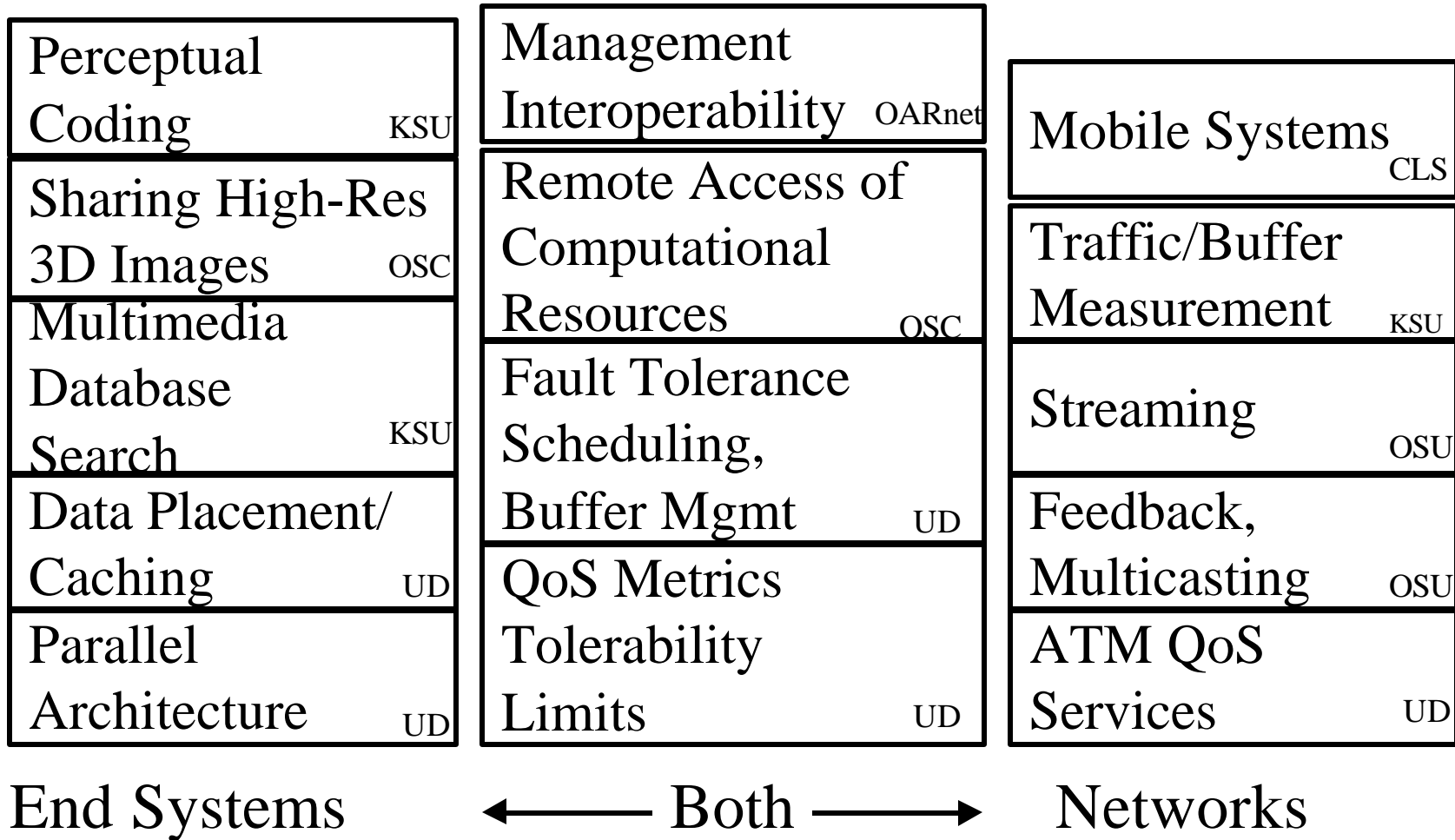
Note 1: These may benefit from our facilities and

Note 2: All departments of educational institutions will benefit from the results. Not just computer science.

Distance Education: Current Status

- q Point-to-point, dedicated, high-speed links
- q Limited Scale, homogeneous, centralized, special
⇒ High-cost
- q Specific applications ⇒ Video for education only
- q No quality of service (QoS) in Internet protocols
- q ATM has partial implementations ⇒ Unsolved problems
- q Even low-speed 28.8-kbps is not guaranteed

Research Issues



Technology Transfer

- q Letters of Support/participation from:
 - m Dayton Area Graduate Studies Institute (DAGSI)
 - m OhioLink Library Consortium
 - m Goodyear Electronic Classroom
 - m Davey Tree Company - Largest nationwide video

- ⇒ Members of ODEN Curriculum Committee
- q Kent's Office of Learning Technologies and Network

- q OSU University and Technology Services is matching 10% of OSU's share (\$100k)

Why Ohio?

- q Ohio researchers have Facilities, Synergy, and
- q OCARnet \Rightarrow High-speed interconnection.
Model for other states.
- q OCARnet quarterly meetings
 \Rightarrow Synergy among computer science researchers

Expertise

- q OSU is the world leader in network traffic management and quality of service. Also distance ed.
- q OSC participated in DARPA ACTS gigabit satellite.
- q OARnet - One of the largest gigaPOPs for Internet-2. Manages 82+ universities.
- q Kent State's Liquid Crystal Institute is unique in visualization research
- q Cleveland State University CS/EE dept have well-established wireless networking research programs
- q Univ of Dayton Research Institute (UDRI) is the largest university-associated research organization

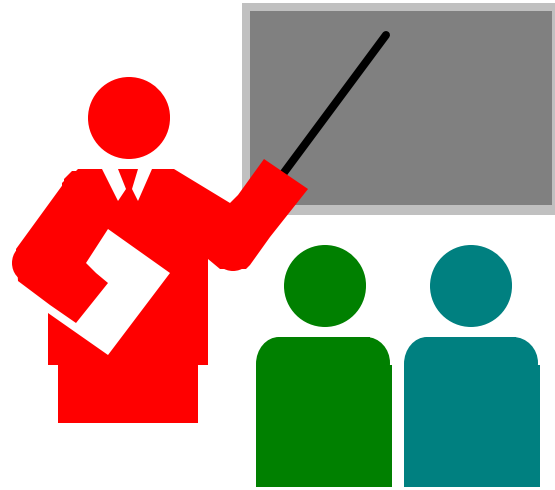
Relationship to Other Efforts

- q Many Ohio universities planning distance education:
 - m Kent, OSU/UTS, WSU, UD learning village
 - m OAI (UD, WSU, OSU, CSU)
 - m Cuyahoga Community College (3 campuses)
- q Numerous distance education consortia in the nation:
 - m Video Development Initiative (ViDe):
Georgia Tech + others, <http://vide.utk.edu>
- q All of these are pilot programs
- q ODEN is aimed at scientific expertise in the technical areas underpinning the distance education

Why Fund ODEN?

- q Significant investment by state in distance education. These will benefit from ODEN research results.
- q Technology transfer/collaboration with those responsible for distance education
- q Ohio industry will benefit from virtual classrooms.
- q OBOR Doctoral program review strongly recommended funding to "*enhance research infrastructure, including strong networking facilities among CS departments to allow sharing...*"
- q \$366M increase in 2000 Federal budget for Information Technology.

Summary



- q Equipment for Research on Networked Video
For distance education, collaboration, medical, ...
- q Research test bed not a pilot
- q Leverage OCARnet investment
- q Ohio has expertise, facilities, and synergy
- q Investment is small compared to total on distance ed

Thank You!



Reviewers' Questions

- q Need to distinguish between research and implementation of known methods; lacks focus; little recognition of what has been done elsewhere.

ODEN is a research test bed leading to better protocols and implementation.

Reviewers' Questions (Cont)

q Although the test bed will likely be successful, does the proof of concept require this large of an

m *Testbed is for research and not a pilot.*

m *At this stage of technology, Video equipment is expensive. \$2M is small compared to several hundred millions being spent on distance ed. Will*

Reviewers' Questions (Cont)

- q Since it seems leveraging will depend on applications and probably more on the next phase of the project rather than the test bed, is there sufficient outside support (OCARnet, OSC) for a project of this
 - m *See slide on technology transfer*

Reviewers' Questions (Cont)

- q Besides advances in distance education, is there sufficient coordination/integration with organizations responsible for delivering such services?
 - m *OSU/UTS, Kent/Learning Services, DAGSI, and several other delivery organizations are involved.*

Reviewers' Questions (Cont)

- q What is the overall Ohio plan for universities and K-12?
 - m OH Dept of Administrative Services is investing \$50-60M for state-wide video backbone (Ohio Learning Network)
 - m Schoolnet pilot project will connect 127 schools \$8M

Reviewers' Questions (Cont)

- q Why is so little support from OCARnet and OSC
 - m *OARnet/OSC and other OCARnet partners will continue to support lines and maintain OCARnet*
 - m *OARnet will provide 24X7 operation.*
 - m *OSC/OARnet will match with additional networked-video equipment*
 - m *These are not shown in cost numbers.*

Reviewers' Questions (Cont)

- q Is the requested Equipment for distance learning the most appropriate to achieve the project's objectives?
 - m *Yes, researchers have requested equipment required to conduct their part of the research.*

Reviewers' Questions (Cont)

- q Since Ohio may be a bit behind in this area, would this be more than an incremental advance?
 - m *In networking research Ohio is ahead of many other states. We would like to maintain and improve our leadership.*
 - m *Just the seed. Expect to get more from other*
 - m *Will lay foundation for further research on multimedia networking.*

Budget

Name of University/Inst.	University/Inst. Cost Share	Capital Funds Requested	Research Contact (PI)	Department
Ohio State U.	\$199,200	\$996,000	W. Feng R. Jain	CIS. CIS
Kent State U.	\$71,900	\$719,000	P. Farrell J. Khan H. Peyravi	MCS MCS MCS
Cleveland State U.	\$28,823	\$174,000	P. Chu, J. Sang	CIS ECE
U. of Dayton	\$16,800	\$168,000	M. Atiquzzaman Y. Pan J. Seitzer	ECE CS CS
Ohio Supercomputer Center	\$8,760	\$38,000	S. Gordon A. Stutz	
OARnet	\$37,500	\$375,000	D. Gale G. Wallis	
Total 6	\$362,983	\$2,470,000	14 Investigators	

Equipment Requested

Equipment	Cost	OSU	KSU	CLS	UD	OARnet	OSC	Total
LAN ATM Switches	\$20,000	4	1					5
LAN 10/100 Switch	\$10,000		1					1
WAN ATM Switches	\$40,000					2		2
ATM Video Capture Device	\$4,000		2	1	1			4
H.320 to H.323 Gateways	\$50,000				1	1		2
ISDN to ATM Gateways	\$25,000					1		1
Multipoint Control Units	\$200,000	1				1		2
MCU Blades OC3	\$30,000		1					1
Video Engine	\$17,000		1					1
323 Gateway Blade	\$15,000		1					1
High-end Video Workstations	\$28,000	7	6				1	14
High-end PC Video Clients	\$10,000	12	6	2	3	2	1	26
Wireless PC's with Video	\$8,000	10	3	1				14
High-Resolution Cameras	\$20,000	2	2	1				5
High-resolution Monitors	\$2,000	2	3	1				6
High Resolution Projectors	\$20,000	2	1					3
PC Projectors	\$8,000	2	1					3
Video Cache Servers	\$50,000	2	1	1				4
Video Broadcast Servers	\$50,000	2	1	1	1			5
Network Monitor	\$150,000		1					1
DV Recorder	\$3,000		1					1
Traffic Analyzer	\$34,000				1			1
Gaze Tracking Equipment	\$30,000		1					1
Wireless Bridge	\$10,000	2	1	2				5
Total Requested Funds		\$996,000	\$719,000	\$174,000	\$168,000	\$375,000	\$38,000	\$2,470,000
Matching Fund for Link Cost			\$10,800	\$14,000	\$10,800		\$3,360	\$38,960
Other Matching Funds		\$199,200	\$61,100	\$14,823	\$6,000	\$37,500	\$5,400	\$324,023
Total Matching Funds		\$199,200	\$71,900	\$28,823	\$16,800	\$37,500	\$8,760	\$362,983
Total Project Cost								\$2,832,983

Operating Plan

- q Technical management by OSU
- q OSC/OARnet will provide 7-day 24-hour/day operational management of the shared networking
- q Each institution will manage its equipment and
- q Three Committees:
 - m Technical Committee: Researchers
 - m Administrative Committee: Network managers
 - m Curriculum Committee: Potential Users

Partners

- q Six Organizations and 14 investigators
- q **Ohio State University:** W. Feng and R. Jain
- q **Kent State University:** P. Farrell, J. Khan, H. Peyravi
- q **Cleveland State University:** P. Chu, J. Sang
- q **University of Dayton:** M. Atiquzzaman, Y. Pan, J. Seitzer
- q **Ohio Supercomputer Center:** S. Gordon, A. Stutz
- q **OARnet:** D. Gale, G. Wallis

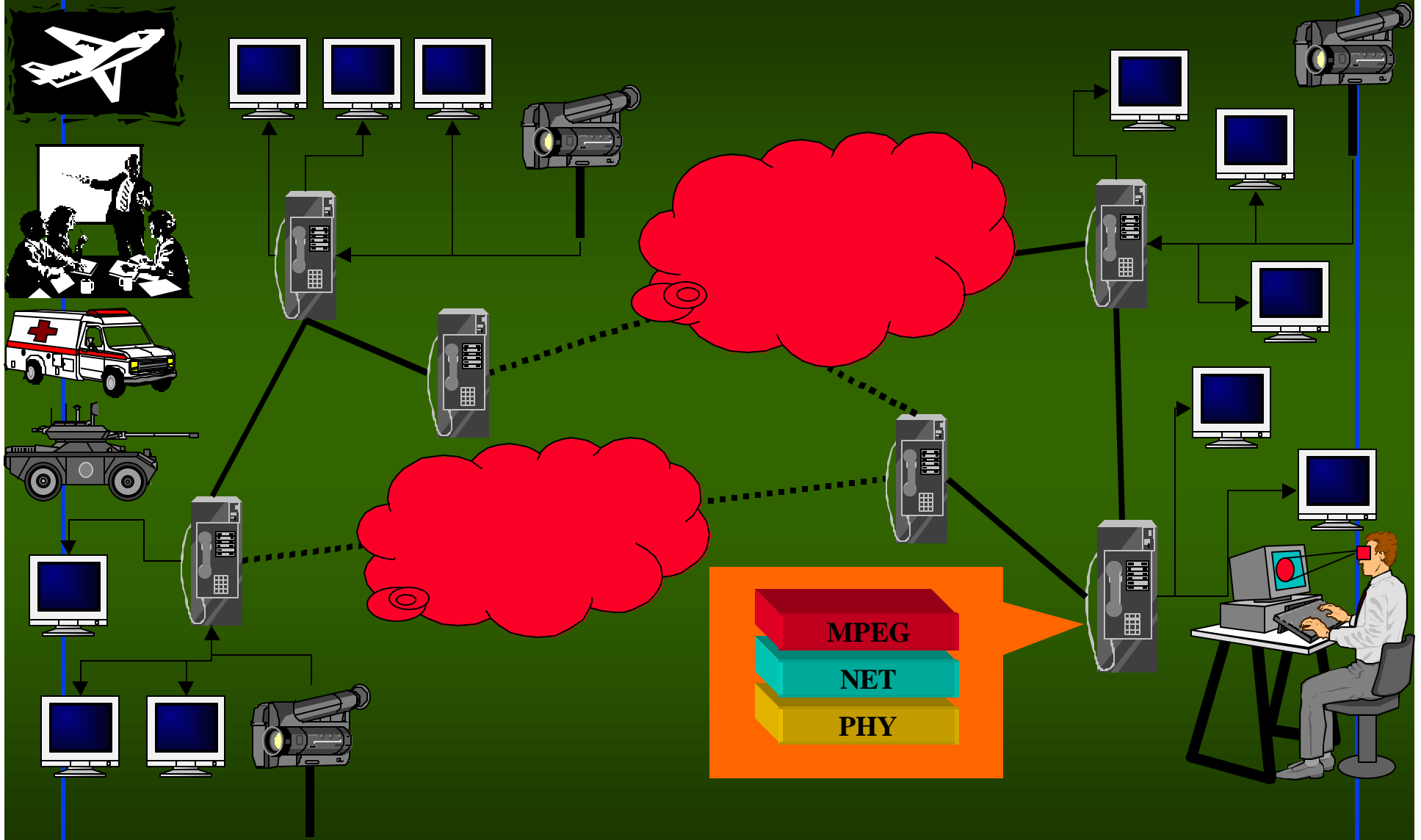
Traffic Management and Multicasting

- q Raj Jain/OSU
- q Facilities for Video archival storage and high-speed
- q Develop techniques for congestion feedback
- q Adjust video compression based on feedback
- q Extend this to multicasting environment

Multimedia Networking

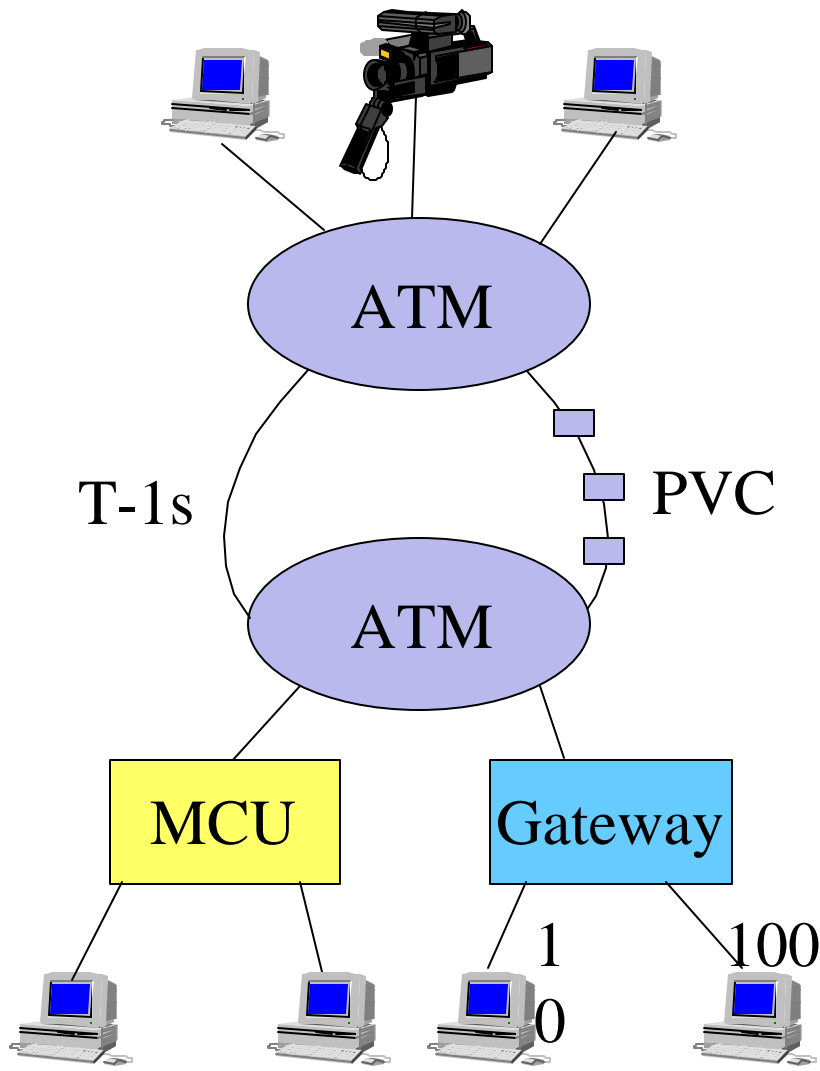
- q Dr. Wu Feng, Ohio State University
- q Problem: *How do we efficiently balance the tension between video compression algorithms (like MPEG, H.261) with networking technologies*
- q Solution approach
 - m Stored video streaming algorithms that minimize the amount of resources required for video playback by examining a priori information
 - m Adaptive stored video streaming algorithms that take advantage of a priori information to maximize the video quality over larger time
 - m Multidifferential coding techniques to minimize the effect of variable-bit-rate video on networking infrastructures

PERCEPT MULTIMEDIA COMMUNICATION



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Performance in a Heterogeneous Environment



- q P. Farrell/KSU
- q Interoperability & performance issues
- q Standards based and proprietary systems
- q QoS over heterogeneous networks
 - m ATM for WAN
 - m Dedicated v PVCs
 - m Ethernet to the desktop
- q QoS over IP, I2 DiffServ

The Role of QoS

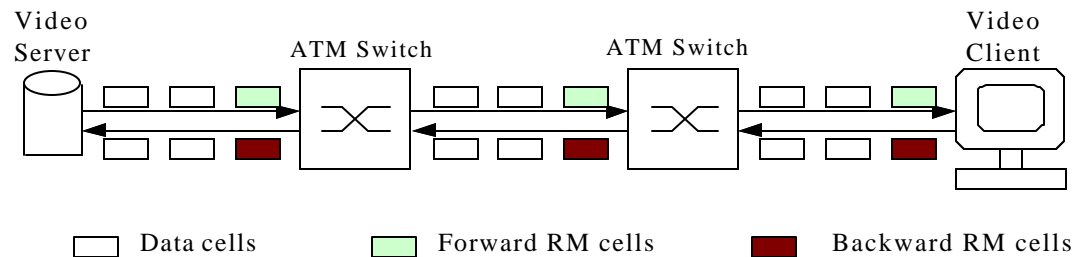
- q Dr. Hassan Peyravi/KSU
- q Detrimental factors in QoS
 - m Packet delay and Packet loss
- q Problem
 - m Sensitivity of the buffer occupancy to uncertainty in the traffic distributions
- q Tools needed to evaluate and improve QoS
 - m A testbed for realistic traffic (e.g., ODEN)
 - m A set of monitoring devices and end equipment
 - m Design and analysis of intelligent buffer management

New Parallel Architectures and Algorithms

- q Yi Pan/UD
- q Video on demand services allow users to search for videos and lectures stored on a digital video server.
- q The requirements for such systems are:
 - m 1. provide high speed real time video data to large number of users interactively.
 - m 2. must be capable of providing continuous high quality video (high CPU power),
 - m 3. large number of streams (high bandwidth),
 - m 4. high availability (fault tolerance),
 - m 5. quality of service
 - m 6. low cost.
- q The architecture of the server must be capable of handling the following tasks efficiently:
 - m 1) identify which processor is suitable to respond a request (closest to the appropriate memory);
 - m 2) execute high layer of network protocol and set up communication links;
 - m 3) provide many simultaneous video stream;
 - m 4) execute system software.
- q The parallel nature of the application and its need for high performance lends itself to parallel processing. In this project, we plan to examine the architecture that a VoD server should have to be capable of fulfilling all the above requirements.
 - m 1. we will examine existing architectures, and propose new novel architectures which are suitable for VoD applications
 - m 2. study their performance in a VoD environment, compare their performance;
 - m 3. study the fault tolerance properties and estimate the possible bandwidth to the network and the number of video
 - m 4. Analytical and simulation models of the architectures will be used to validate our results obtained.
 - m 5. Parallel algorithms related to scheduling, data partitioning, and video placement will also be investigated.

Video on Demand over ABR

- q M. Atiquzzaman/UD
- q Objectives: Investigate the suitability of ABR service class to run Interactive Video on Demand for distance education.
- q Issues:
 - m Measurement of interactive video traffic characteristic.
 - m Buffering requirements at the client.
 - m Setting ABR parameters during connection setup.
- q Significance:
 - m Reduce operational cost
 - m Promote use of video in distance education.



Mobile Agents and QoS Management

- q J. Sang & P. Chu/ Cleveland State University
- q A mobile agent acts on behalf of an application and carries a QoS contract and travels from agency to agency to acquire resources and establish
- q **Advantages:**
- q Reduce the amount of communications by moving processing functions close to where the information is stored
- q Increase the degree of asynchrony for the client
- q Outperform RPC and message passing in real-time applications

