Microscopy & Microanalysis over the Net

How would your Life be different if travel was free and instantaneous ?

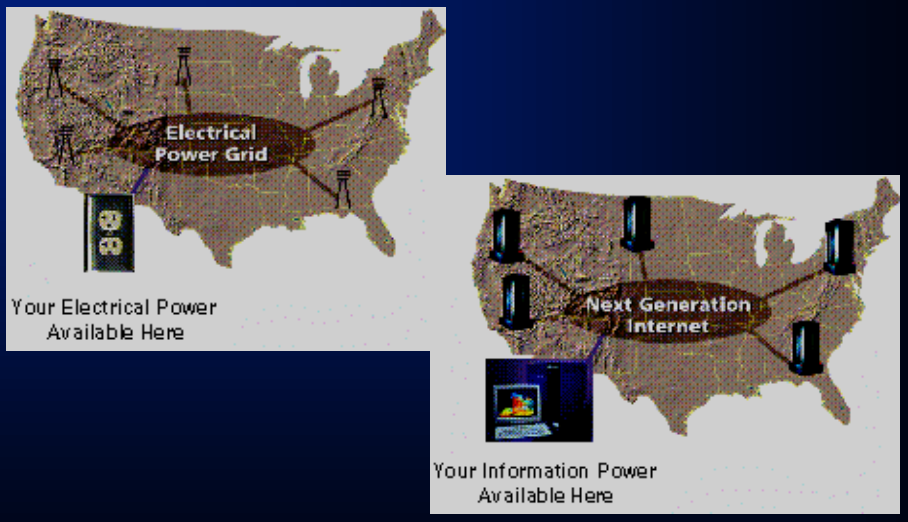
You would have a Star Trekkian Life Style

- **You Would Live Where You Want to**
- **You and Your Colleagues Would Meet in Interesting Places**
- **You Would Leave Your Things Where You Need or Use Them**
- **You Would Need to "Arrange" to Meet People in Certain Places at Certain Times**
- **You Would Need Mechanisms to "Locate" People and Things**
- **Security Might Be Problematic**

Telecommunications Trends

- Data traffic will exceed voice traffic in 3-5 years
- Voice traffic will become an small fraction within 10 years
- Bandwidth prices will eventually begin to follow Moore's law
  - 2X capability every 18 months
- Tele Co's need to become distributed services companies
  - collaboration
  - management and control of infrastructure, factories etc.
  - grid services (distributed information and computing services)
- Digital ecosystem within the global digital nervous system

The Emerging Concept of a National Scale Information Power Grid



From Supercomputer Centers to Today's Internet

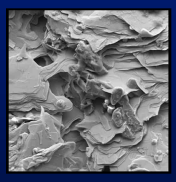
1987 - ISDN
56 Kb/s
1992 - T1
1.5 Mb/s
1994 - T3
45 Mb/s
1996 - ATM OC3
150 Mb/s
1998 - ATM OC12
600 Mb/s
2000 - ATM OC48
2.4 Gb/s
2002 - ATM OC192
10 Gb/s
2010 > 1 Tb/s

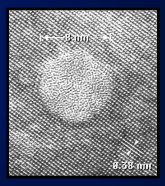
MicroCharacterization via Electron Microscopy

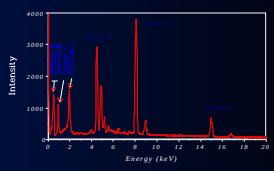
SEM
Scanning Electron Microscopy

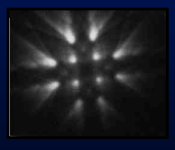
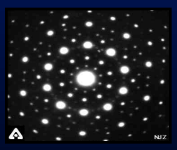
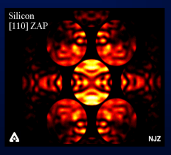
TEM - STEM - HREM
Transmission - Scanning Transmission - High Resolution Electron Microscopy

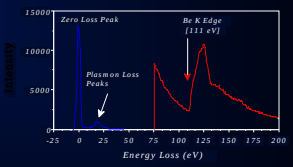
AEM
Analytical Electron Microscopy



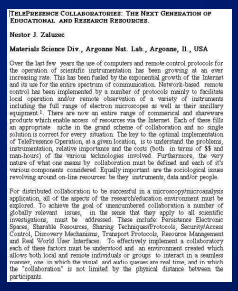






Morphology, Crystallography, Elemental , Chemical , Electronic Structure



TELEPRESENCE COLLABORATORIES: THE NEXT GENERATION OF EDUCATIONAL AND RESEARCH RESOURCES.

Nestor J. Zaluzec

Materials Science Div., Argonne Nat. Lab., Argonne, IL, USA

Over the last few years the use of computers and remote control protocols for the operation of scientific instrumentation has been growing at an ever increasing rate. This has been fueled by the exponential growth of the Internet and its use for the entire spectrum of communication. Network-based remote control has been implemented by a number of protocols mainly to facilitate local operation and/or remote observation of a variety of instruments including the full range of electron microscopes as well as their ancillary equipment.[1] There are now an entire range of commercial and shareware products which enable access of resources via the Internet. Each of these fills an appropriate niche in the grand scheme of collaboration and no single solution is correct for every situation. The key to the optimal implementation of TelePresence Operation, at a given location, is to understand the problems, instrumentation, relative importance and the costs (both in terms of $$ and man-hours) of the various technologies involved. Furthermore, the very nature of what one means by collaboration must be defined and each of it's various components considered. Equally important are the sociological issues revolving around on-line resources: be they instruments, data and/or people.

For distributed collaboration to be successful in a microscopy/microanalysis application, all of the aspects of the research/education environment must be explored. To achieve the goal of unencumbered collaboration a number of globally relevant issues, in the sense that they apply to all scientific investigations, must be addressed. These include: Persistance, Electronic Spaces, Sharable Resources, Sharing Techniques/Protocols, Security/Access Control, Discovery Mechanisms, Transport Protocols, Resource Management and Real World User Interfaces. To effectively implement a collaboratory each of these factors must be understood and an environment created which allows both local and remote individuals or groups to interact in a seamless manner, one in which the visual and audio queues are real time, and in which the "collaboration" is not limited by the physical distance between the participants.

How Big is The Data

8 bits = 1 byte = 1 character

1 page ~50 - 250 kbytes

1 byte ~ 1 pixel (256)
1 Image ~ 300 kbytes (640x480)
1 HR Image 2 M bytes (1k x 1k x 16 bits)

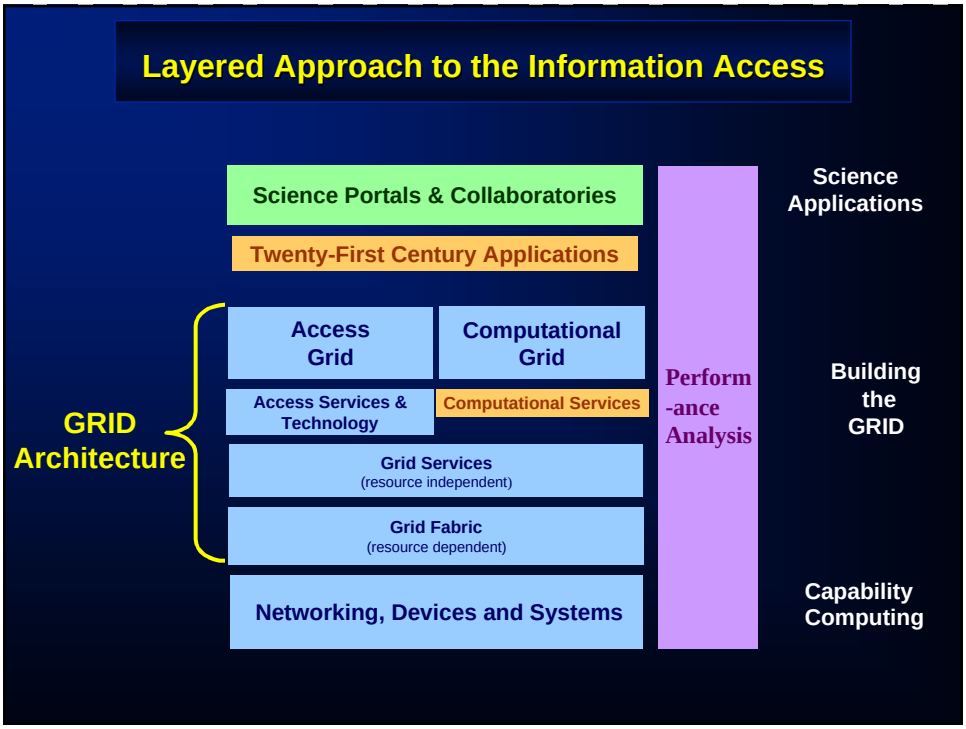
Journal Issue ~ 500 Mbytes

56 Kbit/sec -> 24 hours

1 Mbit/sec -> 90 Minutes

1 Tbit/sec -> 4 msec

Layered Approach to the Information Access



A Collaboratory

.. is a center without walls in which users can perform their research without regard to geographical location- interacting with colleagues, accessing instrumentation, sharing data and computational resources and access information in digital libraries".

William Wulf - 1989

A Collaboratory

... is not

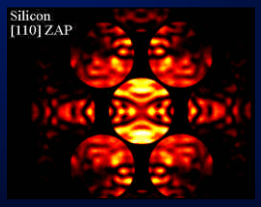
a replacement for a real laboratory or a direct competitor for real laboratories.

... it is

an extension of the real laboratory to open new opportunities of the resources a real lab but at an affordable "cost" to the collaborators

Key to All Scientific Experiments is the Interaction of Investigators with:

Instrumentation



Data

Collaborators

Many Tools of Collaboration

- Traditional
  - Site Visit
  - Telephone
  - Fax
  - Snail Mail

Many Tools of Collaboration

- Low Bandwidth Internet
  - Email
  - FTP
  - Telnet
  - WWW (static)

Many Tools of Collaboration

- Medium Bandwidth Internet
  - Streaming audio/video
  - Screen/CPU sharing
  - Asynchronous video conferencing

Many Tools of Collaboration

- High Bandwidth Internet
  - Synchronous video conferencing
  - Interactive Data Manipulation
  - Interactive Visualization
  - Interactive Instrumentation

Many Faces/Needs of Collaboration

- Resource Discovery
- Planning and Organization
- Experiment Design
- Software Development
- Computation and Simulation
- Lab Experiments
- Analysis and Discovery
- Consultation and Mentoring
- Authoring
- Dissemination of Results

Types of Collaboratories

- *Loosely Coupled*
  - *Microscopy Listserver*
- *Moderately Coupled*
  - *SPARC - Space Physics and Astronomy Research Collaboratory*
- *Tightly Coupled*
  - *TelePresence Microscopy Sites*

Collaboration / Productivity

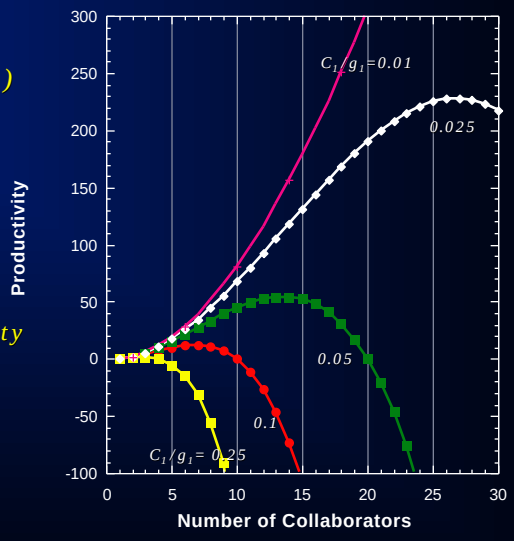
$$P(n) = g_1\, n(n-1) - c_1 n^2(n-1)$$

P = productivity

c_1 = cost of connectivity

g_1 = gain in group productivity

n = number of collaborators

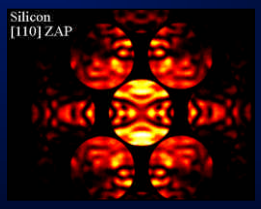


Functional Requirements for Collaboration

- Persistence
- Sharable Entities
- Sharing Techniques, Methods, Protocols
- Session/Access Control
- Discovery Mechanisms
- Transport Mechanisms
- Resource Management
- Real World Interfaces

Key to All Scientific Experiments is the Interaction of Investigators with:

Instrumentation

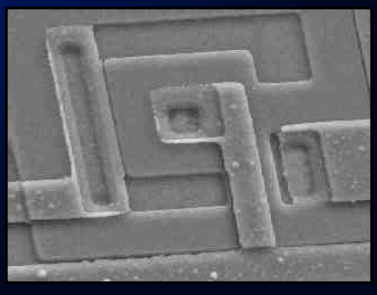


Data

Collaborators

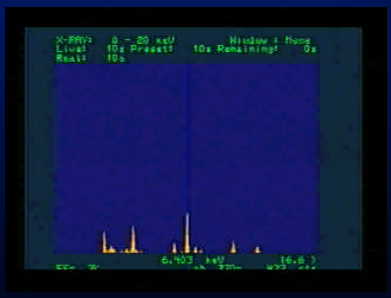
Working with Instruments the Experimentalist Needs:

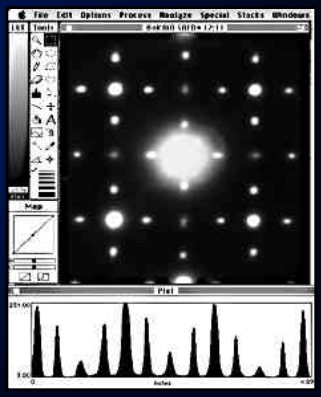
- **Monitor the Progress of the Experiment**
  - **Dials, Knobs, Gauges, Conditions, Images, Spectra.....**
- **Real-Time Control of the Experiment**
  - **Ability to Interact with the Instrumentation**



Working with Data

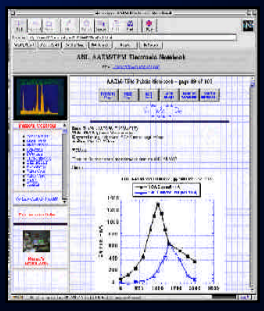
- Real-Time Access to Current Results
- Analysis Tools
- High Performance Data Engines





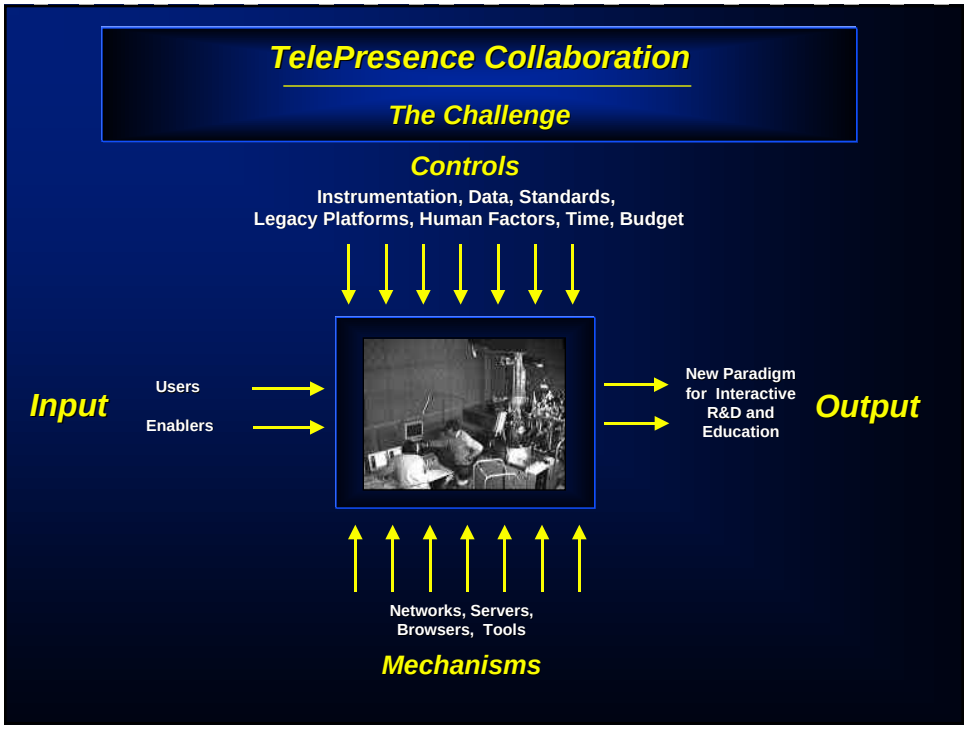
Working with Collaborators , Investigators Need to:

- **Discuss the Experimental Progress**
- **View Data While It is Being Acquired**
- **Sketch Out Trends**
- **Access Supporting Documentation**



TelePresence Collaboration

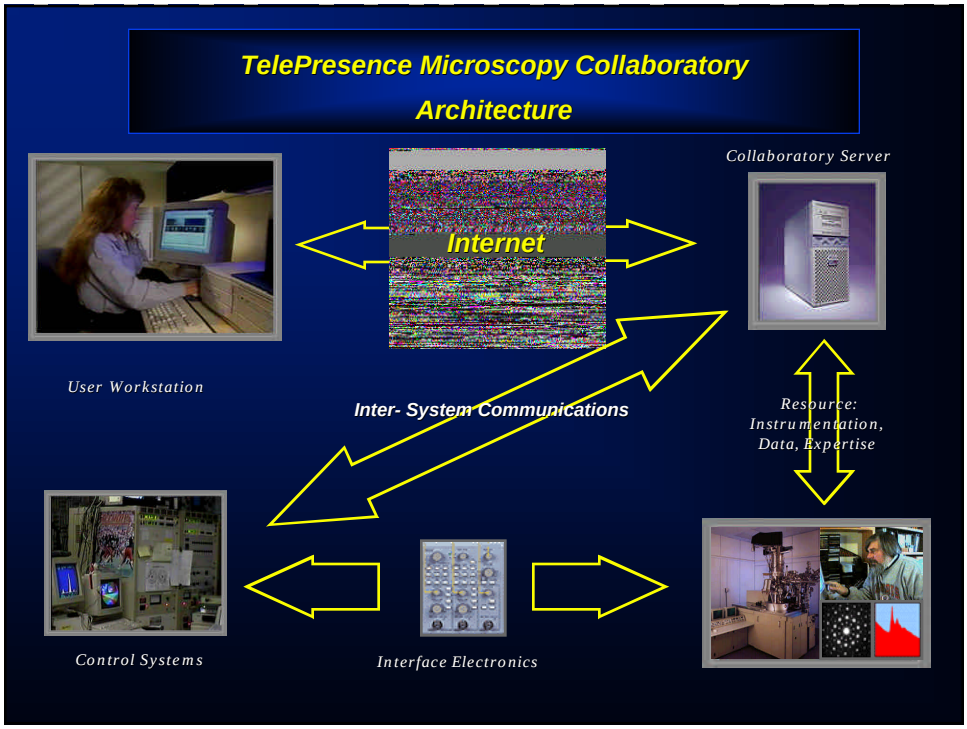
The Challenge



TelePresence Collaboration

Benefits

- Access to Unique Research Tools
  - On-Line Shared Resources and Expertise
  - Permanent and Natural GUI Interface to Instruments and Data
  - Service & Diagnosis of Instrumental Problems
- Persistent Electronic Laboratories
  - Setup and Continue Experiments within a Collaboratory
  - Maintain Contact with Colleagues Regardless of Location
- Education, Teaching, Training to/from Remote Sites
  - Interfaces for Novice, Operator & Expert Users
    - Government / Industry/ University/ K-12

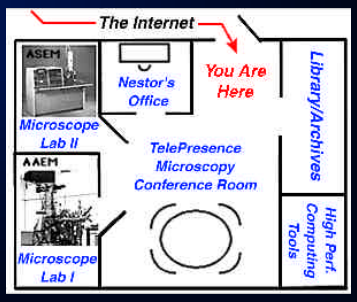


Functional Requirements for Collaboration

- Persistence
- Sharable Entities
- Sharing Techniques, Methods, Protocols
- Session/Access Control
- Discovery Mechanisms
- Transport Mechanisms
- Resource Management
- Real World Interfaces

Characteristics of a Persistent Electronic "Lab"

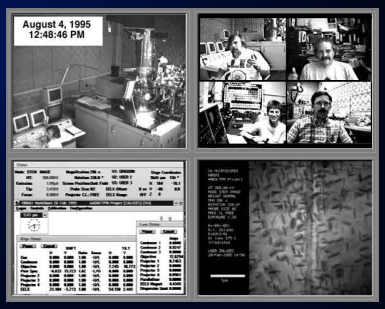
- **Always There**
- **Collaboratory Interaction Zone**
  - Offices, Work Areas, Labs, Mailboxes
- **Access Control**
  - **Active**
    - Public/Private/Restricted
    - Real Time Interactions
    - Editable
  - **Passive**
    - Public/Private/Restricted
    - Viewable not Editable
- **Scalability**



Sharable Enties

Items in the Collaboratory which may be "Sharable"

- **People / Expertise**
  - On-Line Expertise & Knowledge -> Non-Linear Interaction
- **Data**
  - Text/Graphics Documents
  - Images, Spectra
- **Instrumentation**
- **Application Programs**
- **Sessions**



Sharing Techniques

- Laboratory/Office Environment (A/V)
  - Video Conferencing
  - Lab “Space”
  - Floor Control
- Fixed Data (FTP, Email)
  - Items which do not change with Time
    - Archived Text, Graphics....
    - Archived Data Sets
- Time Sensitive Data (A/V, Streaming Data)
  - Real Time Images / Spectra
  - Real Time Analyses
  - Real Time Documents

Session Control / Discovery

- Session Control (Security)
  - How big is the Collaboratory / User Base
  - Access Levels (Administrative)
  - Must not get in the way of doing work.
    - Access Control Lists (ACL)- passwords
    - User Certificates - Encrypted Keys
- Discovery
  - Searchable for the Various Sharable Entities
  - State Sensitive
    - Changes with the availability of the Entity
    - Changes with access control levels
  - Directory Services

Security is vital on the Web

- We are putting valuable and complicated facilities online to the whole world
- The data generated using these facilities may be proprietary

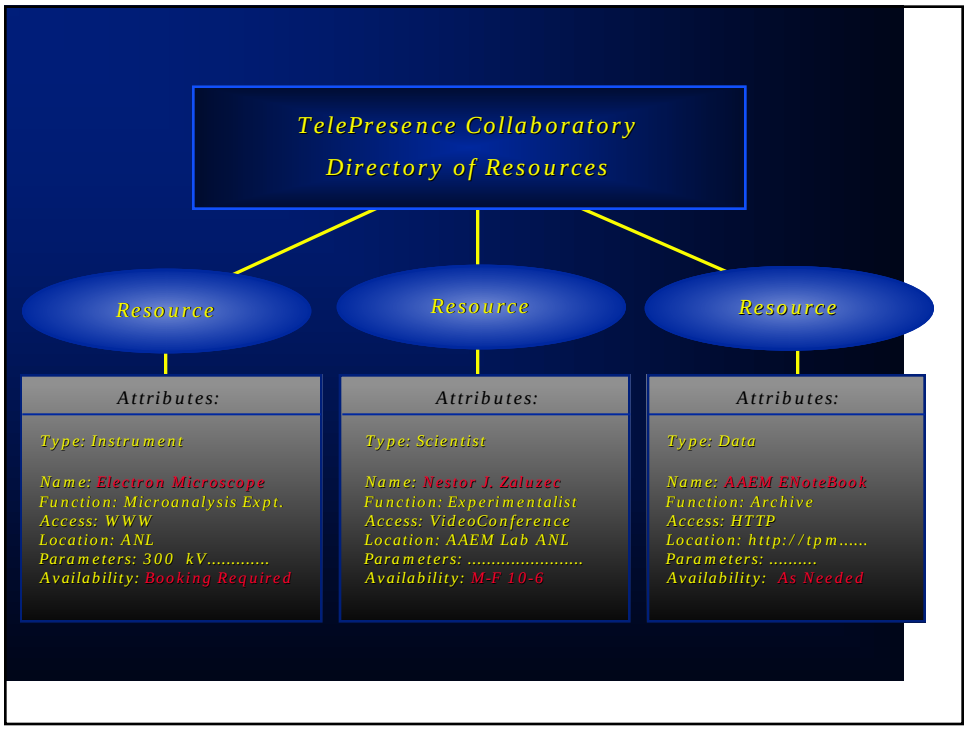
If security "gets in the way" it will not be used.

If security is too weak, valuable assets are at risk.

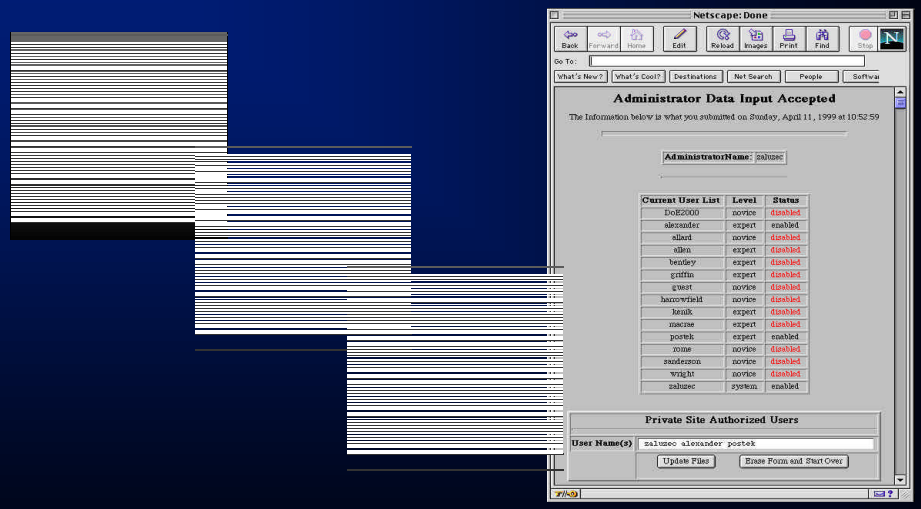
Security

- Secure a Web-based prototype
  - Client and server certificates — authentication
  - SSL encryption
  - Host data protection via directory access
- Use the Entrust security context to
  - Encrypt communication channels
  - Create secure control applications
  - Create certificate issuing programs
- Create a security services engine

Current TelePresence Operations Architecture
WWW Model Provides Seemless Integration



Access Control / Security



Transport Mechanisms

Infrastructure Requirements

- Hardware
  - Transport Medium (i.e. the lines)
  - Network Protocols
    - LAN, WAN.....(Speed, Speed and More Speed)
    - Quality of Service
- Software
  - Data Protocols
    - Real TimeStreaming Protocols
      - Server Type
      - Data Type (Lossy/Lossless)
      - Client Hardware/Software
    - Fixed Data Set Protocols
      - Time Sensitive /Insensitive
      - Size
      - Format
  - Commerical vs Custom vs Shareware

Resource Management

- Availablity of the Resource (People/Instruments)
  - On-Line/Off-Line
- Access Control
  - Safety
  - Expertise
  - Proprietary data
- Floor Control
  - Who is in Control
  - How is control passed to others

Real World Interfaces

- Hardware Interfaces
  - Adaptable to different sharable entities
  - Platform independent communications protocols
  - Client/server visualization hardware
- Software Interfaces
  - Security Aware
  - User & Network Friendly
  - Adaptable
  - Scalable
- Computational Interfaces
  - Data object definitions
  - Data passing
  - Legacy Systems

Know your Collaboration Demographics

	Edu	Com	Gov	Org	Individuals
Organization	51%	24%	19%	3%	3%

	USA	Rest of the World
Location	67%	33%

Platform:	**World Wide**	**USA Only**	**Operating Systems**
PC Based	293 (47%)	206 (41%)	Win 95 (~98%),Win NT(<1%), Win 3.1(<1%)OS/2 (< 1%)
Mac Based	279 (45%)	251 (49%)	Mac OS V 7.5xx (100%)
Unix Based			
SUN	36 (~6%)	32 (~6%)	Solaris Note: 2 sites account for 20 systems!
SGI	10 (~2%)	9 (~2%)	SGI
IBM RS	6(~1%)	6(~1%)	not specified
DEC	2 (<1%)	2 (<1%)	not specified
HP	1(<<1%)	1(<<1%)	not specified
NEXT	1(<<1%)	1(<<1%)	Next
Total CPU's	**628**	**508**	

Collaboration Demographics

Organization	**Edu**	**Com**	**Gov**	**Org**	**Individuals**
	51%	24%	19%	3%	3%

	USA	**Rest of the World**	**Totals**
Location	67%	33%	100%
CPU's	508 (81%)	120 (19%)	628 (100%)

	Modem	**ISDN**	**>T1**	**SiteWide (Speed Unknown)**
Internet Connection	13(13%)	7(7%)	28(28%)	51(52%)

	Yes	**No or Unknown**
Firewall On-Site	26%	74%

	CuSee Me	**Intel ProShare**	**PicTel**	**Vic/Vat**	**All Others**
Video Conferencing	17	3	3	2	3

	NetScape	**MicroSoft IE**	**All Others**
Browser	87%	12%	3%

(some sites run multiple types of browsers hence totals exceed 100%)

TelePresence Microscopy Collaboratory

Key Issues

- *Security*
- *Enabling Functions*
- *Collaboration Functions*
- *Persistence Functions*
- *Instrument Interactions*

TelePresence Microscopy Collaboratory
Key Issues

- ***Security***
  - Instrument
  - Data
- ***Enabling Functions***
  - Client Access Tools
  - Network Connectivity
  - Quality of Service

TelePresence Microscopy Collaboratory
Key Issues

Collaboration Functions

Virtual Workspace
- – Real Time Data
- – Asynchronous Data
- – Observation Areas
- – Private Meeting Rooms

Digital Media Sharing
Tele/Video Conferencing
Data Sharing
Library/References/Archives
Application Sharing
- –Data Analysis Tools

Persistence Functions

Data Archiving
Session Archiving
Electronic Notebooks
Data Mining

Device Interactions

Instrument Interface
Legacy Systems
Perphiperal Systems

Collaboration Functions

Virtual Workspace
- Real Time Data
- Asynchronous Data
- Observation Areas
- Private Meeting Rooms

Digital Media Sharing

Tele/Video Conferencing

Data Sharing

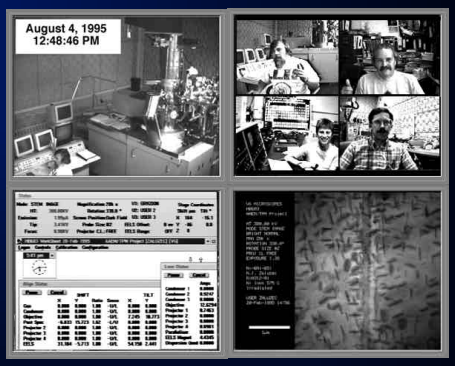
Library/References/Archives

Application Sharing
- Data Analysis Tools

TelePresence Microscopy

Provides Access to:

- *Instrument Room*
- *Tele-Conferencing*
- *Instrument Status*
- *Experimental Data*
- *On-Line Control*



Video Conferencing Tools

- Establish a Suite of Video Conferencing Tools which are compatible with the hardware and Software in the Collaboratory
- Determine the Applicability to Needs of the Site
- Determine their Limitations:
  - Accessibility
  - Ease of Use
  - Bandwidth
  - Platform Dependencies
  - Functionality
- Evaluate and Develop a Scheme for Harmonization
- Integration into the Inter-operability Framework

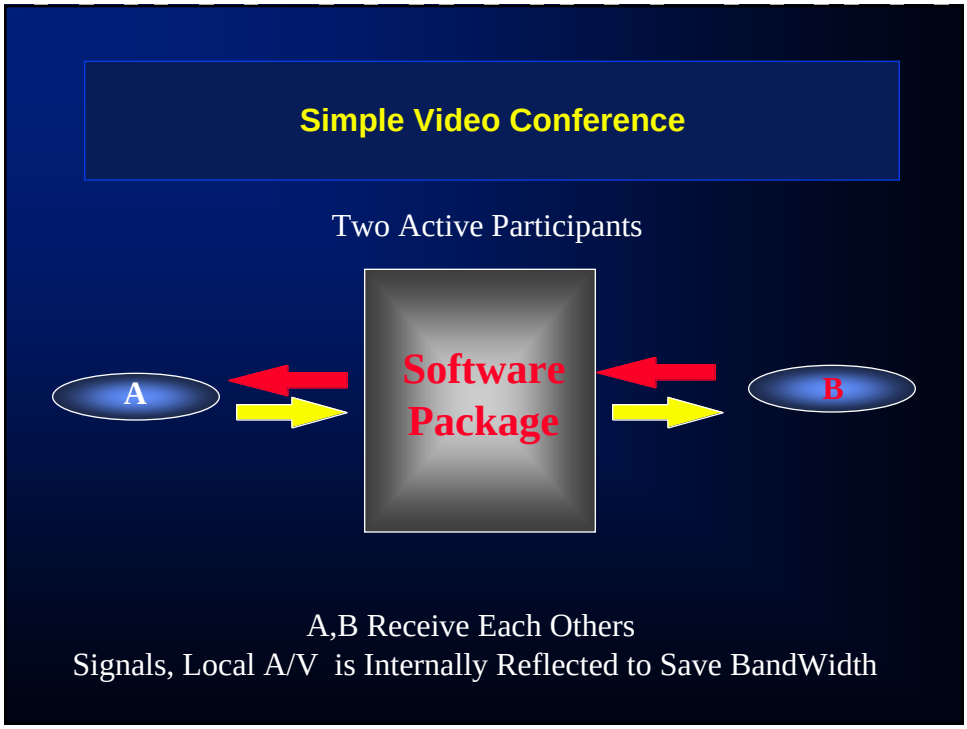
Video Conferencing

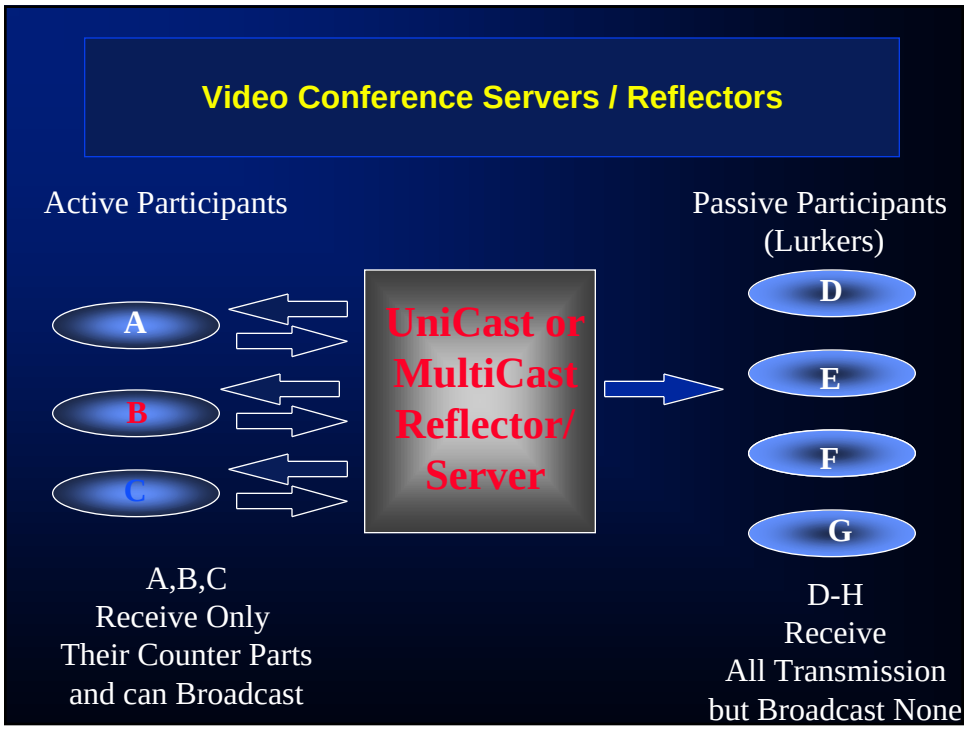
Requirements:

- Support concurrent multi-site video receive and site broadcast capability
- Support concurrent multi-site audio receive and site broadcast capability
- Support multiparticipant real time applications
- Compatibility with majority of Site client hardware
- Compatible with session creation & scheduling by Site servers but not necessarily by Site clients
- Lossy video acceptable (min. image size 160x120).
- Lossless audio mandatory (at most times).
- Moderate cost for clients (Free to < $150)
- Extensible to possible RTP services for remote data acquisition & control.
- Compatible with eventual implementation of multicast broadcast
- Compatible with Web-based infrastructure for launching.

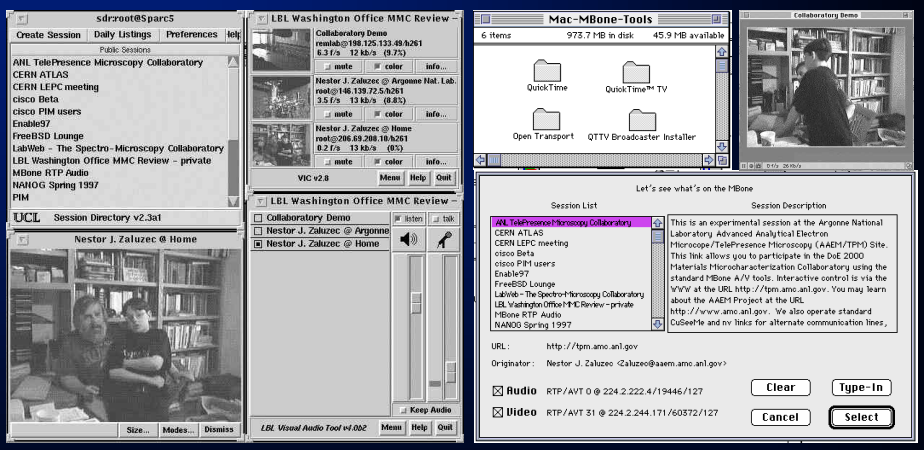
Optional:

- White board capabilities
- Compatibility with electronic notebooks


Simple Video Conference
Two Active Participants
A
Software Package
B
A,B Receive Each Others
Signals, Local A/V is Internally Reflected to Save BandWidth

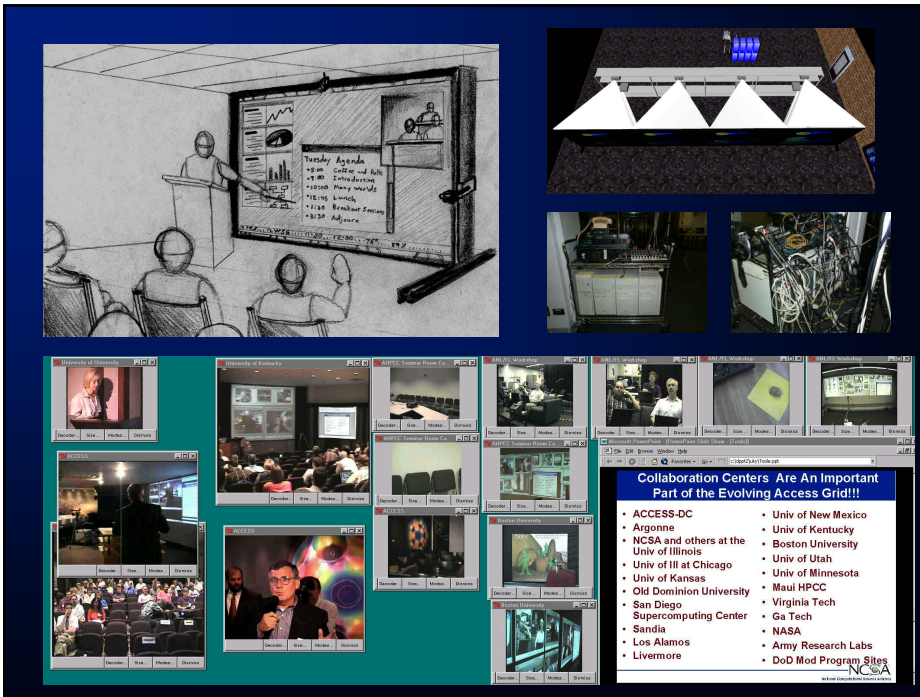

Video Conference Servers / Reflectors
Active Participants
Passive Participants
(Lurkers)
A
B
C
UniCast or MultiCast Reflector/ Server
D
E
F
G
A,B,C
Receive Only
Their Counter Parts
and can Broadcast
D-H
Receive
All Transmission
but Broadcast None

Unix Tools: MBone



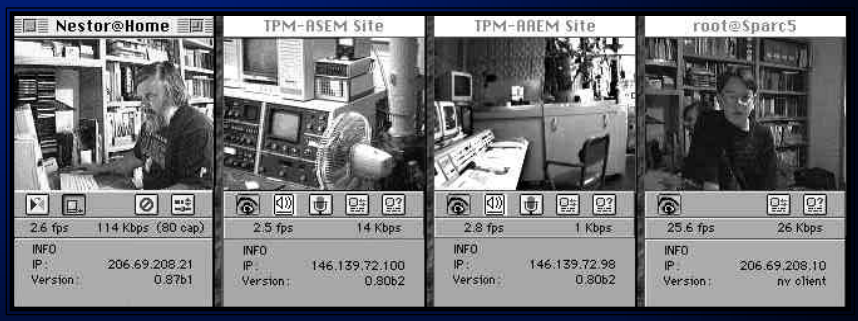
Unix Platform Mac/PC

Very Good Quality, but must have a MultiCast Feed and Router



Cu-SeeMe

http://cu-seeme.cornell.edu/~WCW



Unicast Broadcast, Shareware & Commerical Versions
Can run on multiple platforms, no special routing needed
Has it's problems, but it works. Relflector usually a Unix Box.
Unix System can communicate with CuSeeMe Reflectors
There are other systems out also, but not platform independent

Network Based Video Conferencing is Routine but Imperfect

Persistent Electronic Space Tools

- **Data Archiving**
- **Session Archiving**
- **Data Mining**
  - ➪**Electronic Notebooks**

Persistent Electronic Space Tools

An Electronic Notebook is a repository for objects that document scientific research.

Input Data

Query Data

Retrieve Data

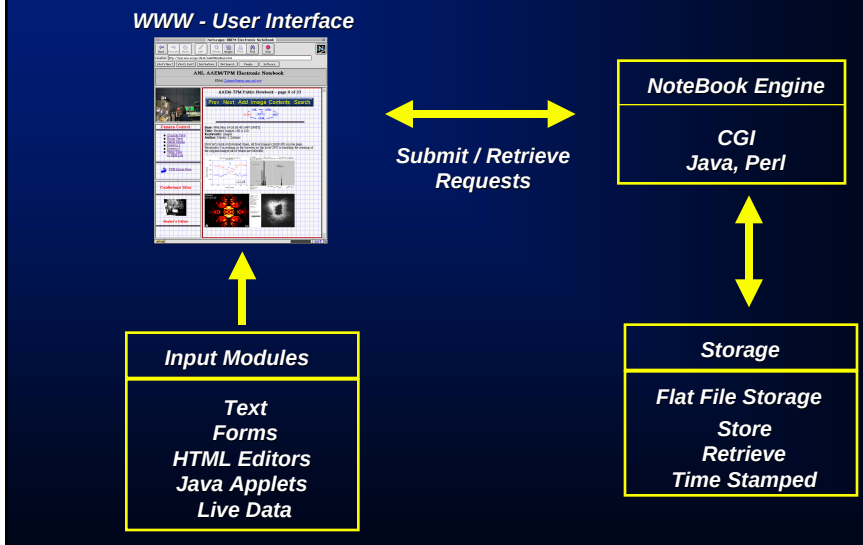
Basic objects are: text, numerical data, images , drawings

Persistent Electronic Space Tools

Why an Electronic Notebook?

- Virtual Laboratories encourage shared remote access to expensive, one-of-a-kind / state-of-the-art resources.
- Remote control of scientific instruments logically requires on-line documentation of capabilities and data.
- Collaboration of distributed researchers is enhanced by a common record keeping device.

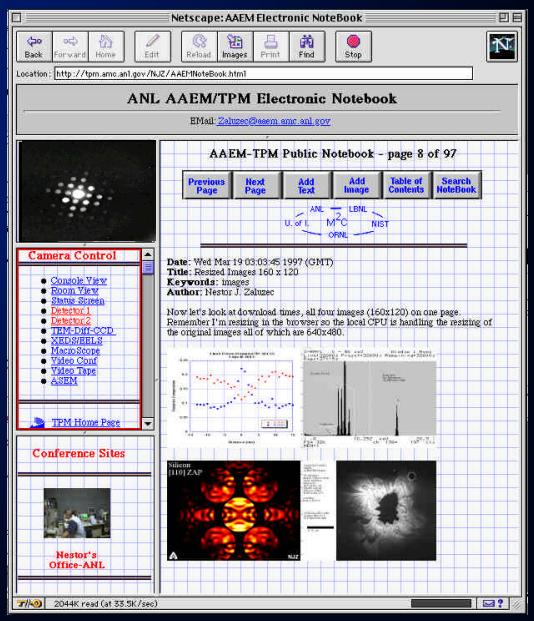
Notebook Architecture



TelePresence Microscopy

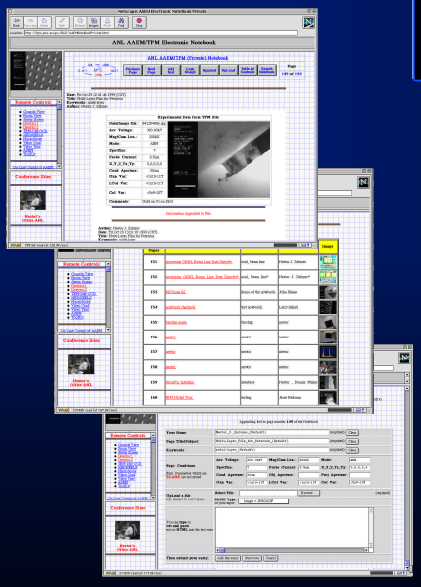
Electronic NoteBooks

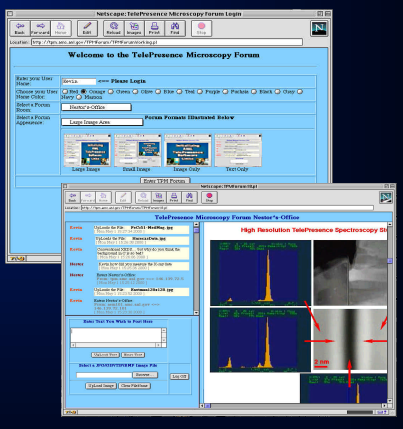
On-Line Data Sharing and Collaboration



Expanded Collaboration Tools

Electronic NoteBooks , Forums, ...





Expanding the Functionality of Collaboration Tools

Current TelePresence Operations Architecture
WWW Model Provides Seemless Integration

TelePresence is Beyond Desktop Teleconferencing

- Physical Groupwork spaces
  - lighting, audio, video, screens
- Virtual collaborative spaces
  - strong metaphors for resource organization
  - interaction scope management
- Agenda driven scenarios and work sessions
  - lectures, brainstorming, demos, meetings, planning
- Integration with GRID services
  - resource management, security, services, brokering
- Debut at Chautauqua ‘99 in August and Sept.
  - Boston U, U Kentucky, and UNM
  - ACCESS, Argonne, NCSA, EVL, Utah (supporting sites)

Deployment Issues

- Integrating emerging tools into on-going science programs
- Who supports the tools?
  - Installation
  - Training
  - Infrastructure
- Commercialization
- Interoperability and Standards

Device Interactions
User/Instrument Interfaces

Instrument Interactions

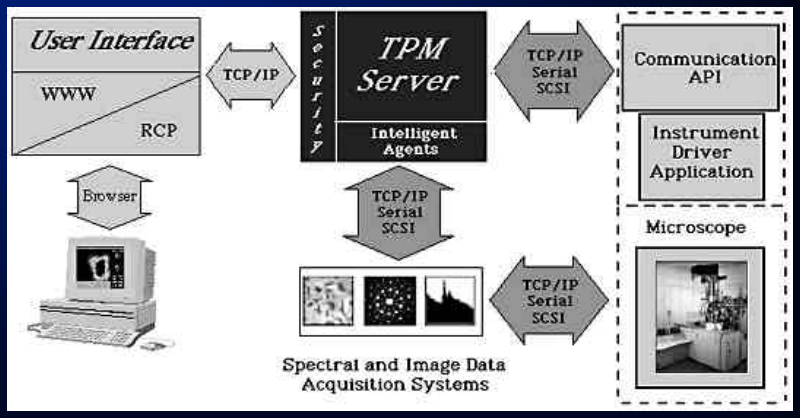
Legacy Systems

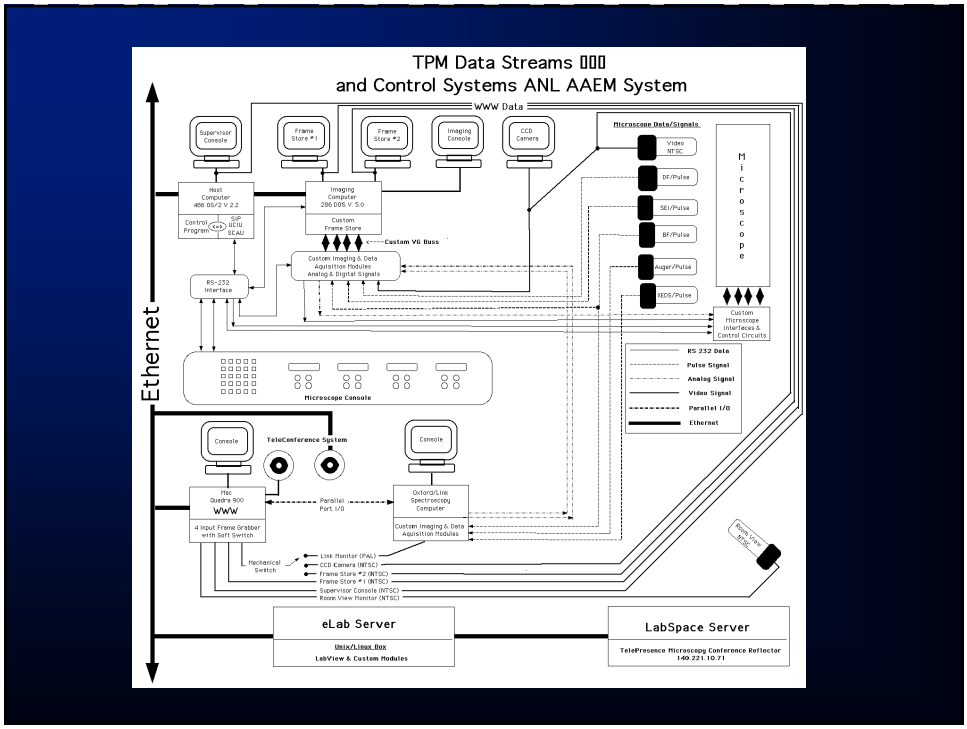
Perphiperal Systems

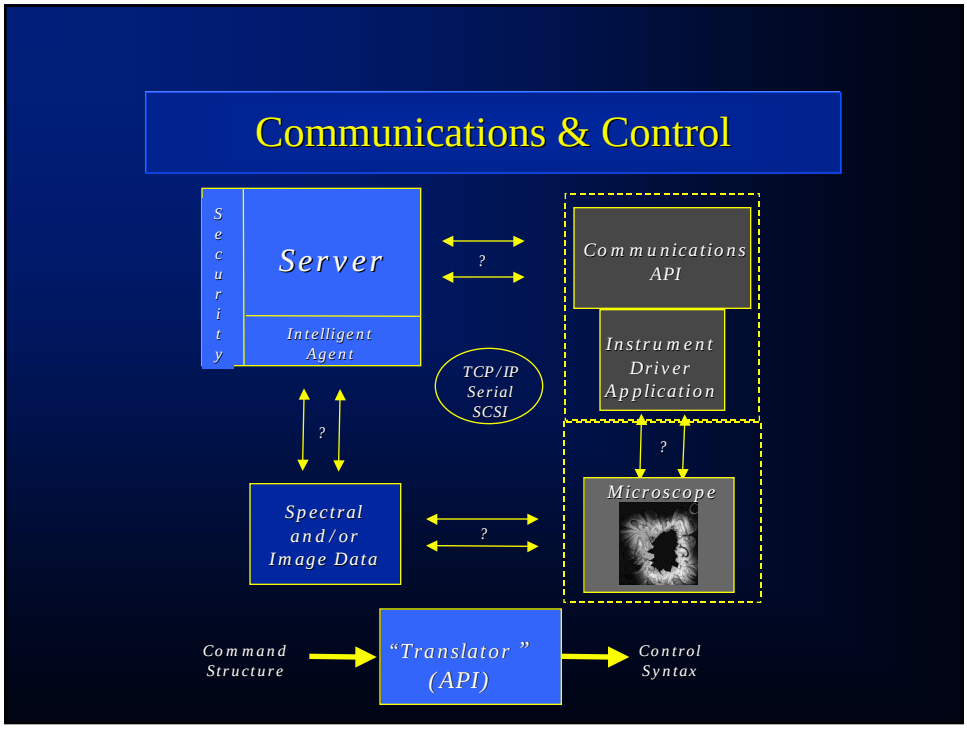
Functionality

- Platform Independent
- Intuitive GUI
- Responsive to the User
- Adaptable to Wide Range of Instruments
- Provides What the User Needs to Do the Experiment

Communications Architecture

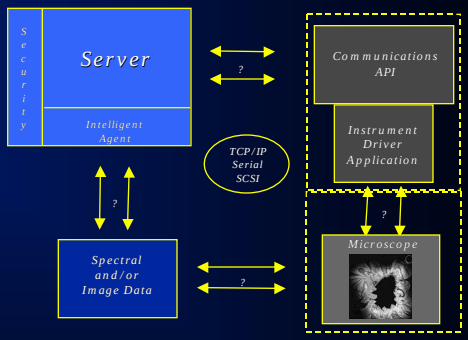



TPM Data Streams
and Control Systems ANL AAEM System
Ethernet
www Data
Supervisor Console
Frame Store #1
Frame Store #2
Imaging Console
CCD Camera
Microscope Data/Signals
Video NTSC
DF/Pulse
SEI/Pulse
BF/Pulse
Auger/Pulse
EDS/Pulse
Microscope
Host Computer 486 DS/2 V 2.2
Control Program
SIP UCID SCAU
Imaging Computer 286 DOS V. 5.0
Custom Frame Store
Custom VG Buss
Custom Imaging & Data Aquisition Modules Analog & Digital Signals
RS-232 Interface
Custom Microscope Interfaces & Control Circuits
Microscope Console
RS 232 Data
Pulse Signal
Analog Signal
Video Signal
Parallel I/O
Ethernet
Console
TeleConference System
Console
Mac Quadra 900 WWW
4 Input Frame Grabber with Soft Switch
Parallel Port I/O
Oxford/Link Spectroscopy Computer
Custom Imaging & Data Aquisition Modules
Mechanical Switch
Link Monitor (PAL)
CCD Camera (NTSC)
Frame Store #2 (NTSC)
Frame Store #1 (NTSC)
Supervisor Console (NTSC)
Room View Monitor (NTSC)
Room View Video
eLab Server
Unix/Linux Box
LabView & Custom Modules
LabSpace Server
TelePresence Microscopy Conference Reflector
140.221.10.71


Communications & Control
Security
Server
Intelligent Agent
?
TCP/IP
Serial
SCSI
Communications API
Instrument Driver Application
?
?
Microscope
Spectral and/or Image Data
?
Command Structure
"Translator" (API)
Control Syntax

Design Criteria

- Client Platform
  - •CPU Speed, DeskTop Area
- Connectivity of User
  - •ISDN, T1, T3.....
- Variable User Level
  - •Novice, Expert, System
- Instrument Safety
  - •Don't allow some operations
- Instrument Data Format
  - •Square/Rectangular Pixels, Spectral Data, ...
- API / Instrument Communication Speed



Operations: Novice Level - Basic

- Translate/Tilt
- Focus Image
- Adjust Probe
- Magnify Image
- Change Mode: TEM, STEM, SEM, DIFF, AEM,.....
- Change Acquisition Rates (TV, Fast, Slow, Line, Static, Raster)
- Change Resolutions (1Kx1K, 640x480,320x240....)
- Change Detectors (BF, DF, CCD, XEDS, EELS....)
- Read/Write Instrument Parameters
- Recall/Store Data (Images, Spectra, Text)

Operations: Expert Level - Advanced

- Full Instrument Alignments
- Full Electron-Optical Adjustments
- Expert Modes
  - HREM
  - HADF/STEM
  - Holography
  - Spectral Imaging
  - Energy Filtered Imaging/Diffraction
  - Others....

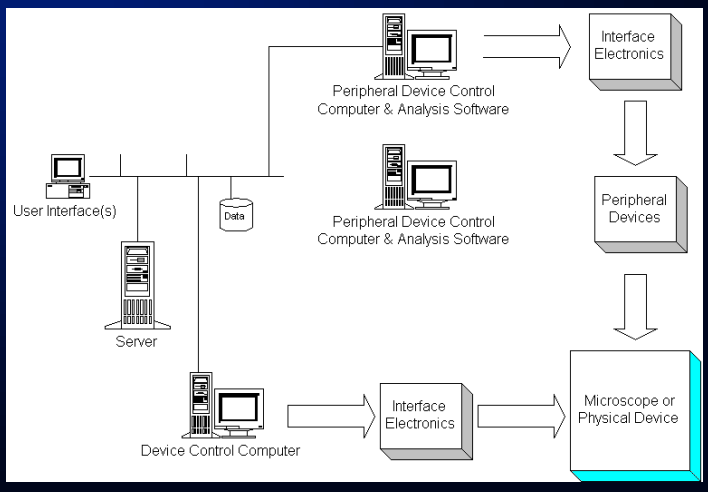
Operations: System Level

- HighVoltage/Gun Operations
- Specimen/Stage Exchange
- Calibrations
- StartUp/Shutdown
- Vaccum Related Operations

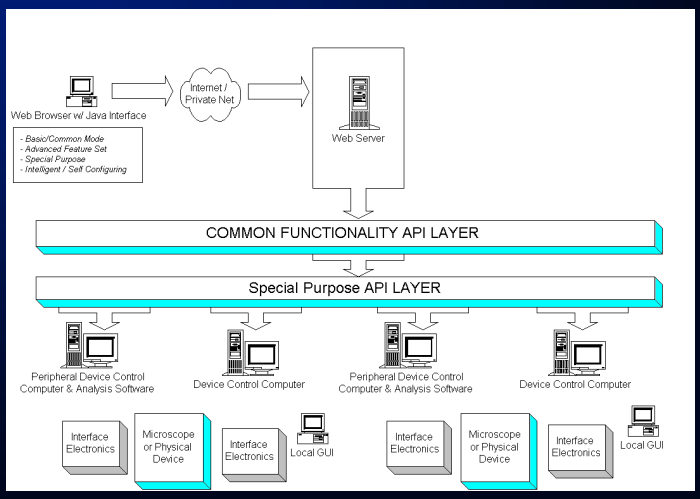
Novice Level Interface

Platform Independent Control

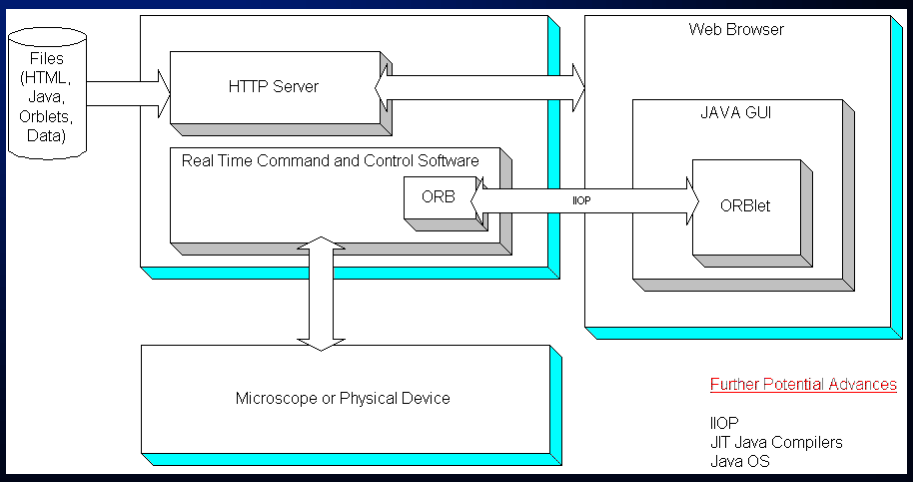
Current Architecture



Next Generation: Hardware Architecture



Next Generation: Software Architecture



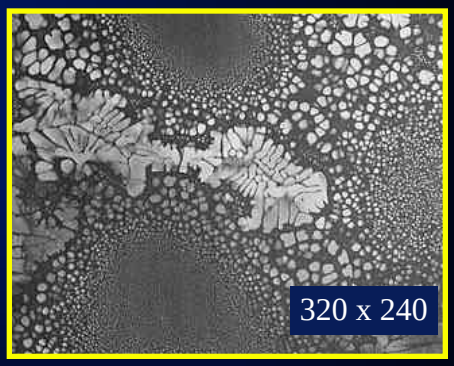
Instrument Data Object Definitions

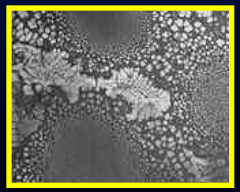
Property	Action	Results
focus	can do	value
magnification	set	min
translation	get	max
tilt		structure
aperture		is stable
beam position		table of N
diffraction		is valid
filament		description
probe		default value
image, shutter		
vacuum		

Video over the Net
Bandwidth Issues

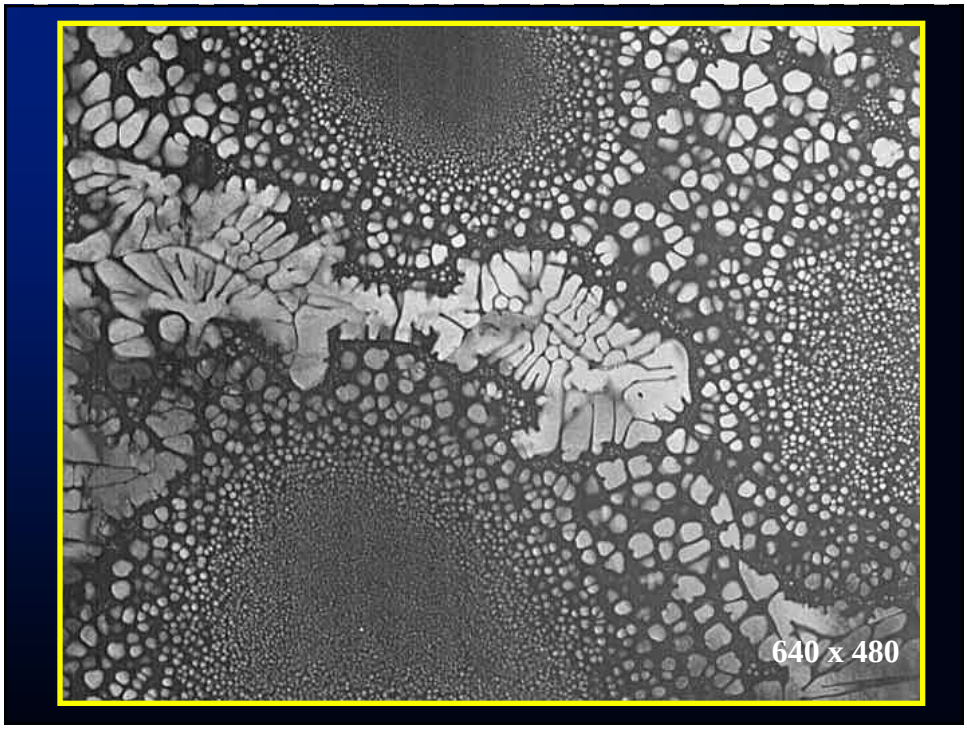
Nominal Image Sizes for an 8 bit (256) level

640 x 480 ~ 300Kb
320 x 240 ~ 75Kb
160 x 120 ~ 19Kb





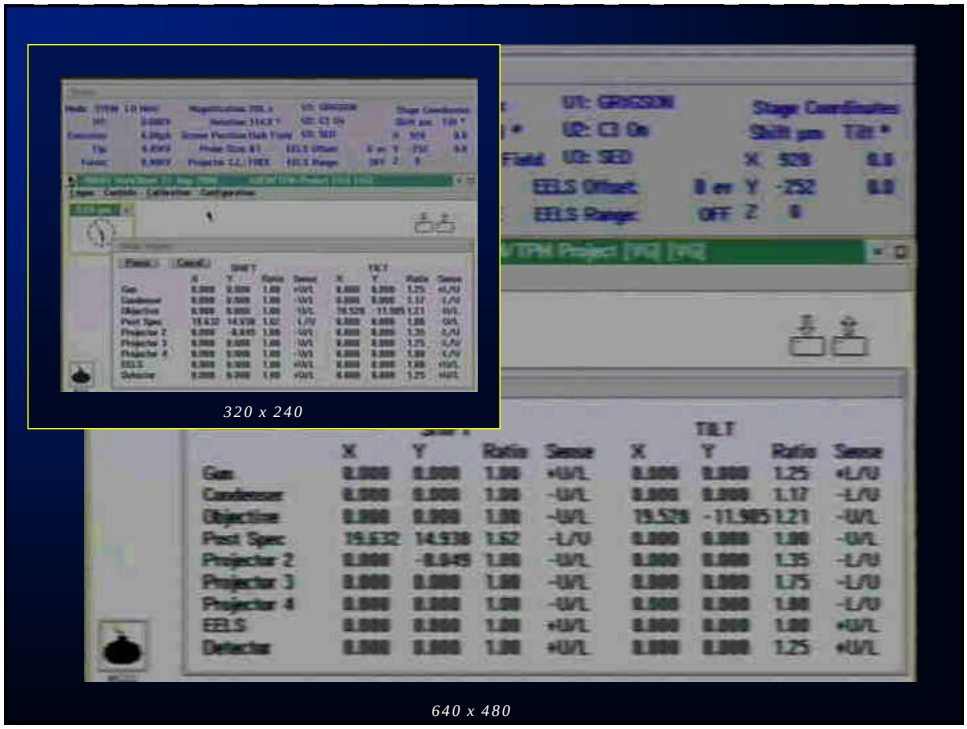
160x120

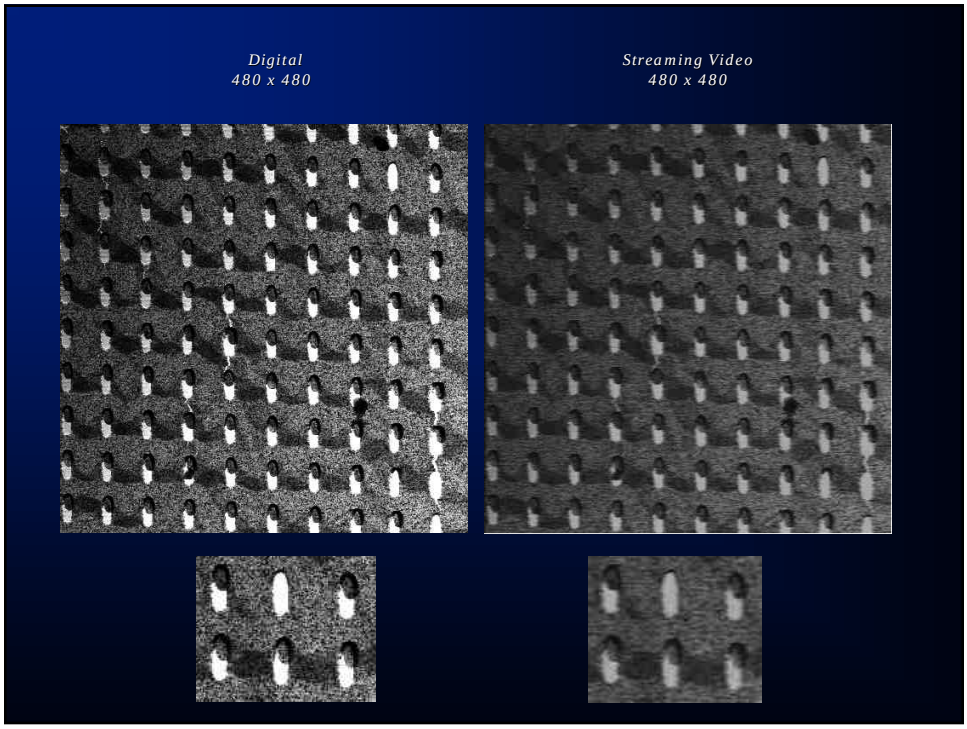


Video over the Net
Bandwidth Issues

Average Kbytes per JPEG Image

JPEG Quality 100 = best	Resolution		
	160 x 120	320 x 240	640 x 480
1	2.2	6.0	17.9
10	2.6	6.8	20.0
20	3.1	7.6	22.4
30	3.6	8.5	24.7
40	4.1	9.3	27.1
50	4.6	10.2	29.4
60	5.0	11.0	31.8
70	5.5	11.9	34.1
80	6.0	20.7	53.0
90	8.8	28.0	78.7
100	22.3	74.9	229.2


320 x 240
640 x 480


Digital
480 x 480
Streaming Video
480 x 480

Video over the Net
Bandwidth Issues

Maximum Aggregate Frames per Second - 160 X 120

JPEG Quality 100=best	Bandwidth - Kbps							
	14.4 Modem	28.8 Modem	56 1-ISDN	112 2-ISDN	1540 T-1	10,000 Ethernet	45,000 DS3	100,000 Fast E
1	0.61	1.22	2.98	6.0	82	531	2391	5313
10	0.52	1.03	2.51	5.0	69	449	2018	4485
20	0.44	0.88	2.14	4.3	59	382	1721	3824
30	0.38	0.77	1.87	3.7	51	333	1500	3332
40	0.34	0.68	1.65	3.3	45	295	1329	2953
50	0.31	0.61	1.48	3.0	41	265	1193	2651
60	0.28	0.55	1.35	2.7	37	240	1082	2405
70	0.25	0.51	1.23	2.5	34	220	990	2201
80	0.23	0.47	1.14	2.3	31	202	913	2028
90	0.16	0.32	0.78	1.6	22	140	629	1397
100	0.06	0.13	0.31	0.6	9	56	251	557

Average Kbytes per JPEG Image

JPEG Quality 100 = best	Resolution		
	160 x 120	320 x 240	640 x 480
1	2.2	6.0	17.9
10	2.6	6.8	20.0
20	3.1	7.6	22.4
30	3.6	8.5	24.7
40	4.1	9.3	27.1
50	4.6	10.2	29.4
60	5.0	11.0	31.8
70	5.5	11.9	34.1
80	6.0	20.7	53.0
90	8.8	28.0	78.7
100	22.3	74.9	229.2

Maximum Aggregate Frames per Second - 320 X 240

JPEG Quality 100=best	Bandwidth - Kbps							
	14.4 Modem	28.8 Modem	56 1-ISDN	112 2-ISDN	1540 T-1	10,000 Ethernet	45,000 DS3	100,000 Fast E
1	0.23	0.47	1.14	2.3	31	204	917	2037
10	0.21	0.42	1.01	2.0	28	181	814	1809
20	0.19	0.37	0.90	1.8	25	161	724	1610
30	0.17	0.33	0.81	1.6	22	145	652	1450
40	0.15	0.30	0.74	1.5	20	132	593	1318
50	0.14	0.28	0.68	1.4	19	121	544	1209
60	0.13	0.26	0.63	1.3	17	112	502	1117
70	0.12	0.24	0.58	1.2	16	104	467	1037
80	0.07	0.14	0.34	0.7	9	60	270	600
90	0.05	0.10	0.25	0.5	7	44	200	444
100	0.02	0.04	0.09	0.2	3	17	75	167

Maximum Aggregate Frames per Second - 640 X 480

JPEG Quality 100=best	Bandwidth - Kbps							
	14.4 Modem	28.8 Modem	56 1-ISDN	112 2-ISDN	1540 T-1	10,000 Ethernet	45,000 DS3	100,000 Fast E
1	0.08	0.16	0.39	0.8	11	69	312	693
10	0.07	0.14	0.35	0.7	10	62	279	620
20	0.06	0.13	0.31	0.6	9	56	250	555
30	0.06	0.12	0.28	0.6	8	50	226	502
40	0.05	0.11	0.26	0.5	7	46	207	459
50	0.05	0.10	0.24	0.5	7	42	190	423
60	0.05	0.09	0.22	0.4	6	39	176	391
70	0.04	0.08	0.20	0.4	6	36	164	365
80	0.03	0.05	0.13	0.3	4	24	106	235
90	0.02	0.04	0.09	0.2	2	16	71	159
100	0.01	0.01	0.03	0.1	1	5	25	55

Sun Video Maximum Framerate

JPEG Quality 100 = best	Resolution		
	160 x 120	320 x 240	640 x 480
1	12	29	1.4
10	12	29	1.4
20	12		
30	12		
40	12		
50	12		
60	12		
70	11		
80	11		
90	10		
100	6		

Parallax Maximum Framerate

JPEG Quality 100 = best	Resolution		
	160 x 120	320 x 240	640 x 480
1	30	30	30
10	30	30	30
20	30	30	30
30	30	30	30
40	30	30	30
50	30	30	30
60	30	30	30
70	30	30	30
80	30	30	30
90	30	30	25
100	30	30	20

Video over the Net
Bandwidth Issues

Maximum Aggregate Frames per Second - 320 X 240

JPEG Quality 100=best	Bandwidth - Kbps							
	14.4 Modem	28.8 Modem	56 1-ISDN	112 2-ISDN	1540 T-1	10,000 Ethernet	45,000 DS3	100,000 Fast E
1	0.23	0.47	1.14	2.3	31	204	917	2037
10	0.21	0.42	1.01	2.0	28	181	814	1809
20	0.19	0.37	0.90	1.8	25	161	724	1610
30	0.17	0.33	0.81	1.6	22	145	652	1450
40	0.15	0.30	0.74	1.5	20	132	593	1318
50	0.14	0.28	0.68	1.4	19	121	544	1209
60	0.13	0.26	0.63	1.3	17	112	502	1117
70	0.12	0.24	0.58	1.2	16	104	467	1037
80	0.07	0.14	0.34	0.7	9	60	270	600
90	0.05	0.10	0.25	0.5	7	44	200	444
100	0.02	0.04	0.09	0.2	3	17	75	167

Video over the Net
Bandwidth Issues

Maximum Aggregate Frames per Second - 640 X 480

JPEG Quality 100=best	Bandwidth - Kbps							
	14.4 Modem	28.8 Modem	56 1-ISDN	112 2-ISDN	1540 T-1	10,000 Ethernet	45,000 DS3	100,000 Fast E
1	0.08	0.16	0.39	0.8	11	69	312	693
10	0.07	0.14	0.35	0.7	10	62	279	620
20	0.06	0.13	0.31	0.6	9	56	250	555
30	0.06	0.12	0.28	0.6	8	50	226	502
40	0.05	0.11	0.26	0.5	7	46	207	459
50	0.05	0.10	0.24	0.5	7	42	190	423
60	0.05	0.09	0.22	0.4	6	39	176	391
70	0.04	0.08	0.20	0.4	6	36	164	365
80	0.03	0.05	0.13	0.3	4	24	106	235
90	0.02	0.04	0.09	0.2	2	16	71	159
100	0.01	0.01	0.03	0.1	1	5	25	55

Hardware/Software

What is out there?

What do you need?

Basic System Requirements

- Platform/CPU
  - Choose your flavor (Mac, WinTel, Unix ...)
    - But Not less than 150 Mhz
  - Video Input Device (signal from the instrument)
  - Video Input Card
- Lots of RAM 64 Mb or better
- Lots of VRAM 4-8 Mb
- Reasonable HD ~ 2 Gb
- WWW Server Software
  - Apache, NCSA, Netscape, MacHttpd, ...
  - Video Server Software

Macintosh Hardware

Many Macintoshes have built-in video capture capabilities. If your Mac has the letters "AV" in the model name, or a round port in the back with a yellow ring inside, then your system is capable of capturing video. If not, you'll need to add a video capture card. Just make sure your system can handle it (you need at least a 100-MHz PowerMac with 32MB RAM running System 7.5 or higher). More horsepower yields better results, so an upgrade will improve the quality of your video.

http://support.info.apple.com/aboutapple/prodlst3.html

Apple Card M2894LL/D Apple Video System ($125)

http://support.info.apple.com/aboutapple/prodlst2.html

M3447LL/A Power Macintosh AV card ($275)

http://www.radius.com/Products/VideoVisionML.html"

Radius VideoVision ML ($2,499)

Macintosh Software

http://reddwarf.wmw.utwente.nl/pub/www/persons/vertegaal/software/aboutframeserver.html

FrameServer

FrameServer will provide your WWW home pages with the option for outside webbers to look into your office. FrameServer can be used with any CGI-compliant WWW server (such as WebStar or WebCenter) running on any Macintosh computer equipped with a QuickTime-compatible camera.

http://www.mmcorp.com/~binky/webcamtoo/index.html

WebCamToo/WebCamTurbo

WebCamToo (WCT) is a fully functioning webserver, handling requests for documents, be they HTML files or image files or whatever. WCT also acts as a live video server. WCT was designed to be extremely easy to use, requiring no technical knowledge.

Windows Hardware

A high-end video capture card costs a couple of hundred dollars and requires a relatively powerful PC--at minimum, a 100-MHz Pentium with 32MB RAM running Windows 95. If you're trying to stream video live, you'll want at least a 200-MHz Pentium II with 32MB RAM. PC video capture cards worth considering include:

http://www.winnov.com/productsf.htm Winnov Videum AV ($199)

http://www-nt-ok.creaf.com/video/vb-mmat/ Video Blaster Multimedia Album Toolkit ($179)

http://www.atitech.ca/products/aiwpro/ ATI All in Wonder 4MB Video Capture/TV Tuner ($275)

http://www.alaris.com/ Alaris QuickVideo Pro ($629)

http://www.core-dynamics.com/fx.html DynaFx TV Card and Authoring System

Windows 95/NT Software

http://www.jcs-canada.com/emulive.html

EMULive 2.0

EMULive is a simple but powerful image processing application that delivers fluid live web video (or individual frames) that can be viewed from within standard web browsers without the need for plug-ins. EMULive runs in Windows95 or WindowsNT, and works with all 100% compatible video for windows capture devices. Image transport is handled via a local (or remote) file copy or via standard FTP. This application is shareware - $19.95.

http://www.gcomm.com/webcast/home.html

Webcast

WebCast takes the input from any Video for Windows compatible camera and broadcasts live video and audio. This video broadcast can then be received by anyone on the Internet using only the Netscape Web Browser. Commerical Program

Sun Hardware

Very High End and Very Expensive Cards compared to the Windows and Mac Platforms.

http://www.sun.com

Good and Stable but not ultimate high end.

Sun Video Card ($1500)

http://www.parallax.com

Great Performance but very expensive

Parallax Video Card ($8000)

Serving Video

Client pull

This method is the most used by simple sites to show single snapshots of whatever the Camera points to. It is the most easy method to set up, and the one that works perfectly for dial-up style Internet connections. It also won't take much bandwith from your connection.

Server push

This is the most resource-consuming method, and thus, and becoming more and more implemented. It is also the most live method, as it can allow the users to view real-time video streams coming directly from your Video Source.

CAMERAS				
Hardware	Manufacturer	Platform	Cost (US $)	Type
Aver PC-Cam	AverMedia	PC	$105	VCD
Axis Camera	Axis	PC/Mac	$1,200	Net
CCD-Z5 ZCam	Sony	PC	$149.99	VCD
EggCam	Panasonic	PC	$220	VCD
iCam	Perceptual Robotics	PC	$7,000	VCD
iFire	AIMS Lab	PC	$???	VCD
QuickCam Home	Logitech	PC/Mac	$110	PnP
QuickCam Pro	Logitech	PC/Mac	$130	PnP
QuickCam VC	Logitech	PC/Mac	$100	PnP
PCA635VC	Philips	PC	$170	PnP
PCA645VC	Philips	PC	$180	PnP
SecureCam Pro	StarDot Tech.	Win	$649	Phone
SiteZap	Rearden	Mac	$1,995	N/A
WebCam III	Creative Labs	PC	$89.90	PnP
WinCam.Live	Stardot Technologies	PC	$400	PnP

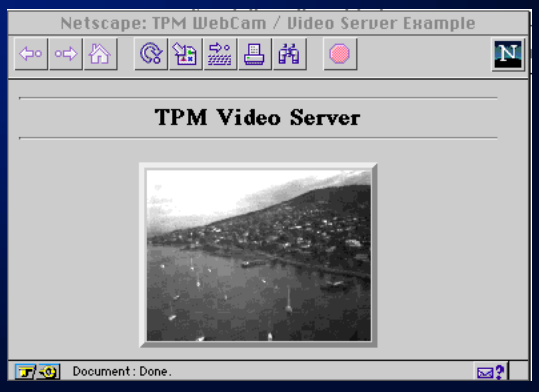
Unix Software

- **camserv** - Streaming webcam software for free UNIX
- **cqcam** - Connectix Color QuickCam driver for Linux
- **MCS-WebCam** - MCS-WebCam is an easy to use live video/audio server for and the Silicon Graphics platforms.
- **Syscam Pro for Linux/NT** - SysCam Pro is a complete web controlled camera system.
- **UGrab** - The UNIX Webcam Tool -
- **Video For Linux** - Video4linux is a project to provide a common API to video sources, tuning sources, teletex and other TV related VBI data.
- **Webcam for Sun** - Webcam for sun is an application which uses the server push mechanism to send live video from Sun workstation to Web clients aware of the server push mechanism
- **GTS** for Sun - Commerical Products using the server push mechanism

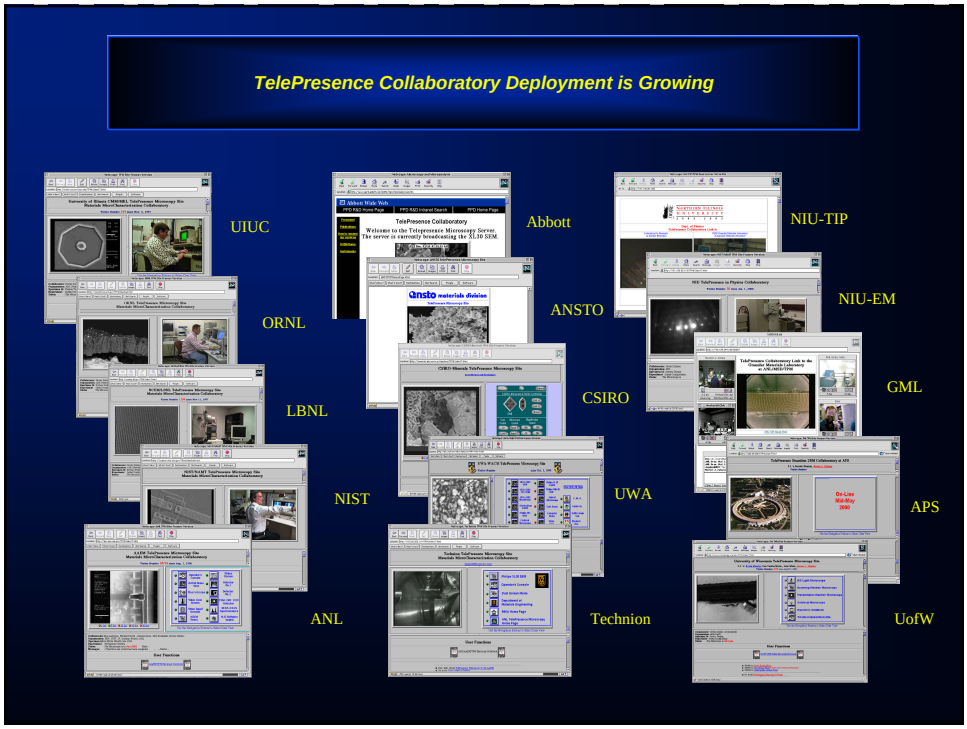
A Simple Video Server WWW Site

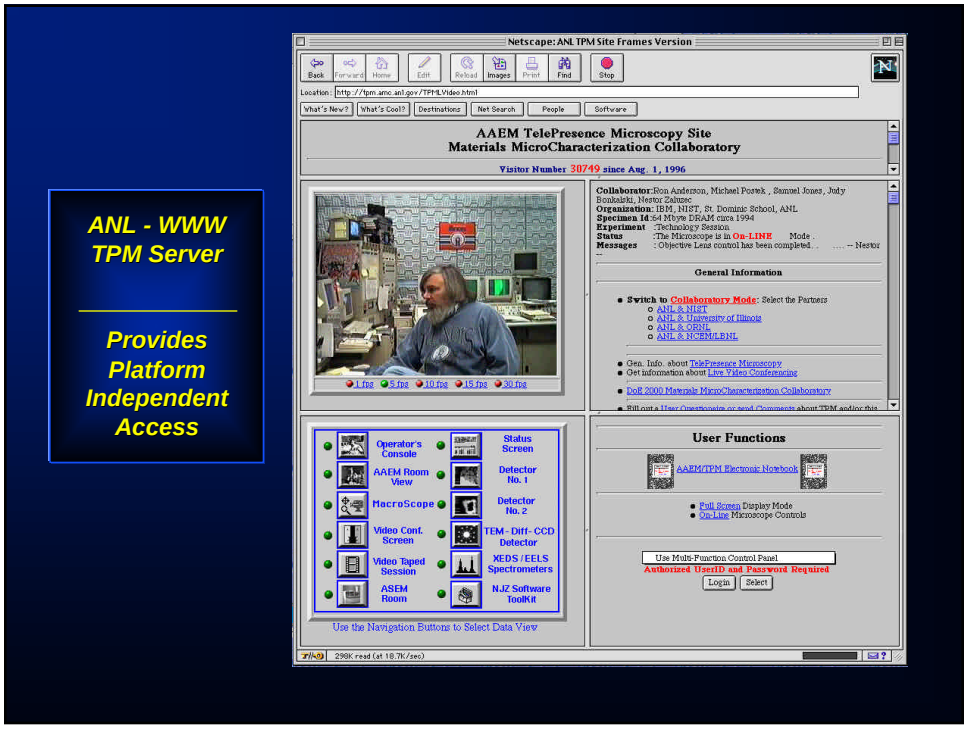
```
<html><body>
<TITLE>  TPM WebCam / Video Server Example  </TITLE>
<BODY><center><h2><hr>TPM Video Server</center>
<hr></h2><center>
<table border=4>
<tr><td>
<IMG SRC="http://www.somesite.com/?width=160;height=120;method=push;">
</td></tr> </table>
</body></html>
```

Example of WebCam Output



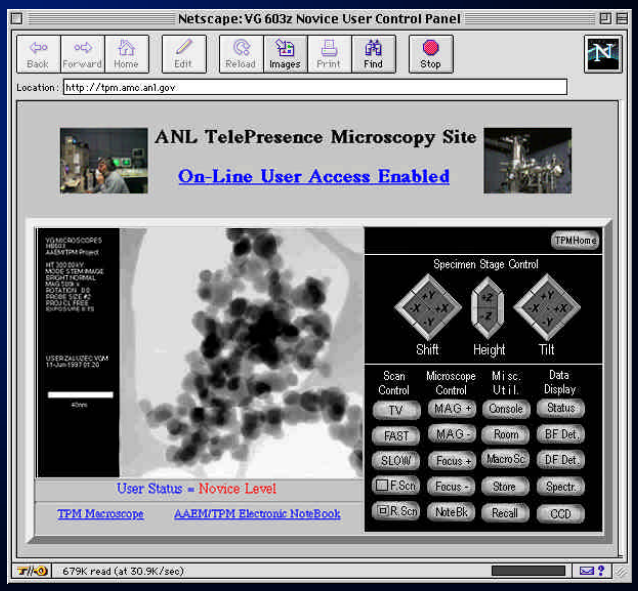
View out of Wrest Point Hotel
ACEM-15 Conference
Sat Jan 31, 1998


TelePresence Collaboratory Deployment is Growing
UIUC
Abbott
NIU-TIP
ORNL
ANSTO
NIU-EM
LBNL
CSIRO
GML
NIST
UWA
APS
ANL
Technion
UofW


ANL - WWW TPM Server
Provides Platform Independent Access
Netscape: ANL TPM Site Frames Version
AAEM TelePresence Microscopy Site
Materials MicroCharacterization Collaboratory
Visitor Number 30749 since Aug. 1, 1996
General Information
User Functions
Use the Navigation Buttons to Select Data View

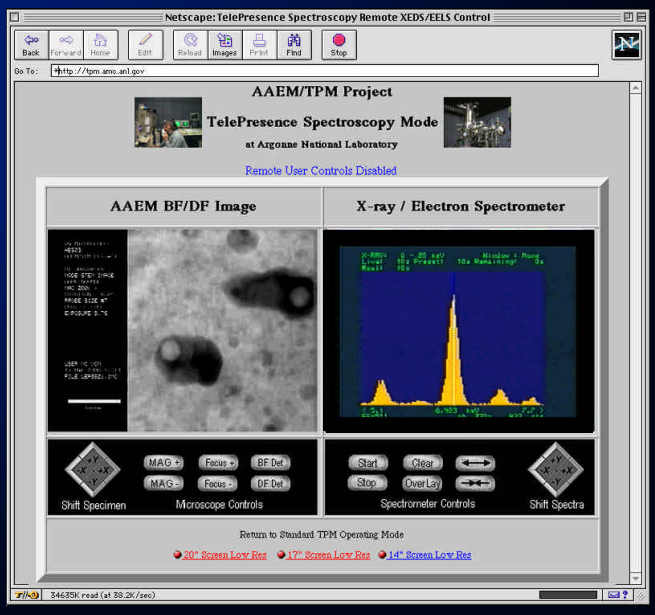
On-Line Instrument Control

Platform Independent WWW Interface



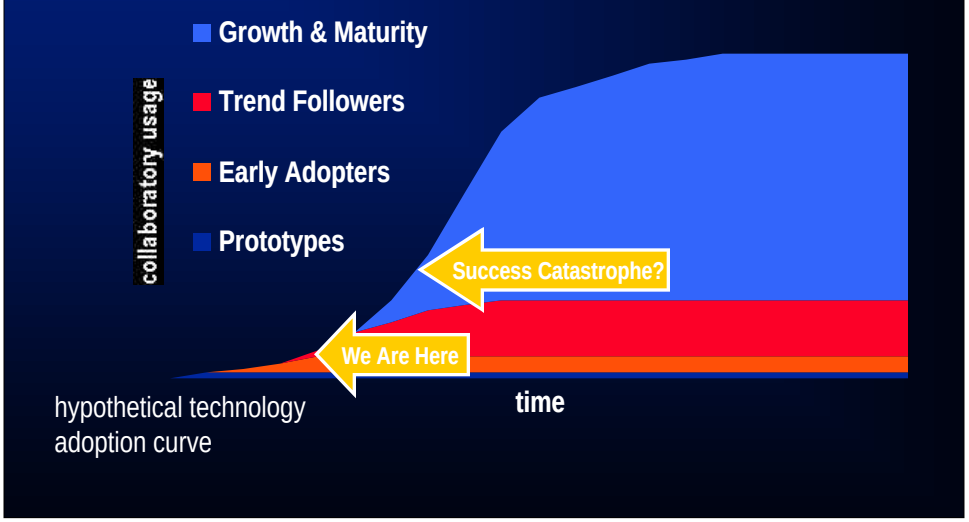
On-Line Instrument Control

Platform Independent WWW Interface



Scaling to the DOE Enterprise

Network Usage Tracks Collaboratory Use



But there is still one thing that can't be easily done using TelePresence

Observations

- Wulf model of a collaboratory is not a realistic/viable entity for the DoE Labs.
- Collaboratories will not spontaneously create themselves
- Collaboratories will not evolve without Experimentalist/Progammer's and the Computer Scientists working together to create the next generation.
- Working Collaboratories must have working tools sets not prototypes which are being debugged.