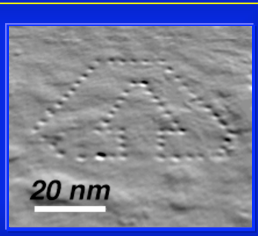
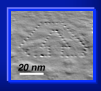
Evolving the Telepresence Collaboratory



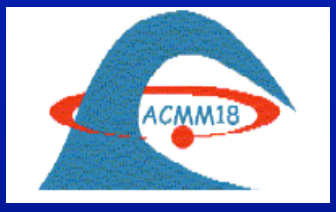
Nestor J. Zaluzec
zaluzec@microscopy.com

Office of Science - BES Program
US Department of Energy

Electron Microscopy Center
Argonne National Laboratory



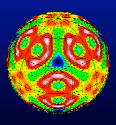
Thanks to



Telepresence Collaboratories are about the future...

U.S. DoE Nanoscale Science Research Centers (NSRCs)

- *NSRCs*
  - *Research facilities for synthesis, processing, and fabrication of nanoscale materials*
  - *Co-located with existing user facilities (synchrotron radiation light sources, neutron scattering facilities, EM Centers, & other specialized facilities) to provide characterization and analysis capabilities*
  - *Operated as user facilities; available to all researchers; access determined by peer review of proposals*
  - *Provide specialized equipment and support staff not readily available to the research community*
  - *Conceived with broad input from university and industry user communities to define equipment scope*



NanoScience Research Centers

Phased Construction: 2001-> 2005
Begin Operation: 2006->2008

Computationally Mediated Experimental Science Facilities

- Expt. Data Generator/ On-Line Collaboratories
- Regional User Facilities to Build & Characterize at the Nano Scale
- In-house R&D in NanoScience Specialized to Local Expertise

Modeling/Theory Institutes at Each NSRC

- Simulation Data Generator
- Synergistic Understanding of Structure/Properties Relationships , Design of New Materials
- Strongly Coupled to the Local R&D and Local/Remote Computational Resources

Nanoscience Education of Next Generation of Scientists

- On-Line Collaboratory Functions
- Investment / Coordination with Local University Programs

NSRC's Expt./Collaboration Data Projections

Users: ~ 100 -200/Year/Center
~ 500 - 1000 External Reseachers
~ 30 - 50 FTE's Internal Researchers

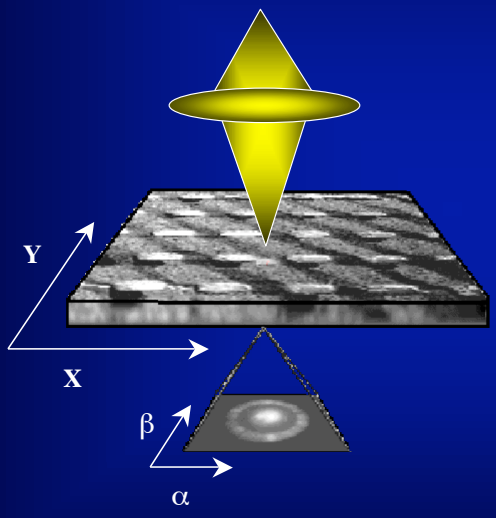
Characterization Data: ~ 0.4 - 8 Tb / User
Fabrication/Collaboration: VTC's / AG Nodes / DCS / Streaming Data

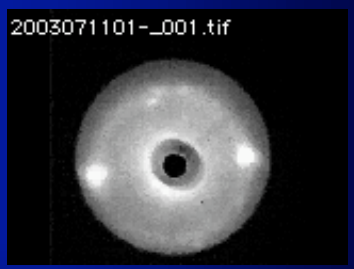
	Values(Tbits) /Yr/Usr	Year 2005	2006	2007	2008
# Users		100	300	500	1000
Data/User Low End	0.4	40	120	200	400
Data/User High End	8	800	2400	4000	8000
AGNode @ 2hrs	0.15	15	45	75	150
DCS/VTC @ 2hrs	0.01	1	3	5	10
Streaming Data @ 16hrs	0.05	5	15	25	50
Network Data (Min -Tbits)		56	168	280	610
Network Data (Max-Tbits)		816	2448	4080	8210
Simulations/Modeling	?	?	?	?	?

But we don't generate that amount of Data!

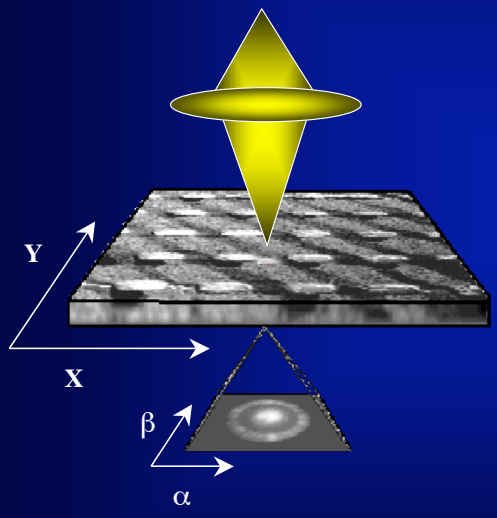
Everyone may not do this now… but a growing number of you will start

Position Resolved Diffraction





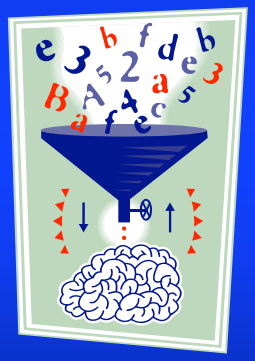
Position Resolved Diffraction



XY \ αβ	256^2	512^2	1024^2
64^2	262M	1G	4.2G
128^2	1G	4.2G	16.7G
256^2	4.2G	16.7G	67G
512^2	16.7G	67G	275G
1024^2	67G	275G	1T

Where does TP Collaboration Fit?

- *Innovation and the big questions*
  - *opportunities for the future*
  - *multidisciplinary opportunities*
  - *changing the "rules of the game"*
- *Status*
  - *implementation and deployment*
  - *early adopters*
  - *SOTA experiments*
- *Future*
  - *community engagement*
  - *Roadmaps*
  - *community input and assessment*



TP Collaboratory Potentials

- *New problem solving capabilities*
  - *rapid assembly of virtual teams*
  - *access to remote facilities and experiments*
  - *interfaces to distributed data archives/experiment repositories*
- National and international cyberinfrastructure leverage
  - *corporate and government commitments*
  - *billions of dollars in leverage*
    - *commoditization of infrastructure*
- Distributed facility and collaboration access
  - *Equipment sites (ES) and distributed collaborators*
  - *cooperating institutions and policies*
- Strong security features
  - *secure experiment control and data sharing policies*
- Resource discovery and monitoring services
  - *available resource identification and continuous status monitoring*

TelePresence is About Community Building

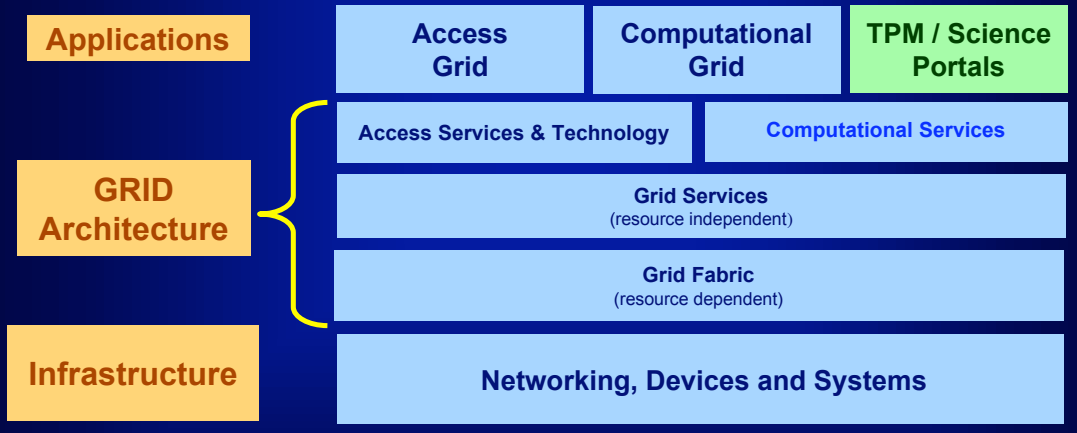
- ***Socialization and community***
  - ***multidisciplinary groups***
    - ***Physics, Chemistry, Biology, , Materials, Engineering,,…***
  - ***geographic distribution***
- ***Enablers***
  - ***distributed, unique experimental facilities***
  - ***multimodal collaboration systems***
  - ***distributed, large-scale data archives***
  - ***leading edge computing systems***

- ***Opportunities and challenges***
  - ***creating 21st century infrastructure***
  - ***nurturing a sustainable, multidisciplinary community***

Working Together: Infrastructure

- Telepresence
  - teleobservation
    - remote observation of experiments
  - teleoperation
    - remote control of resources
- Collaboration support
  - collaborative tools to support distributed R&D teams
    - community codes to provide software tools for research
    - collaborative frameworks
    - frameworks for simulation
- Repositories of resources
  - experimental data, numeric simulation results
  - digital content (e.g., movies, video)
  - software tools

Layered Approach to Computational Mediated Science



The Grid

Infrastructure & Computing

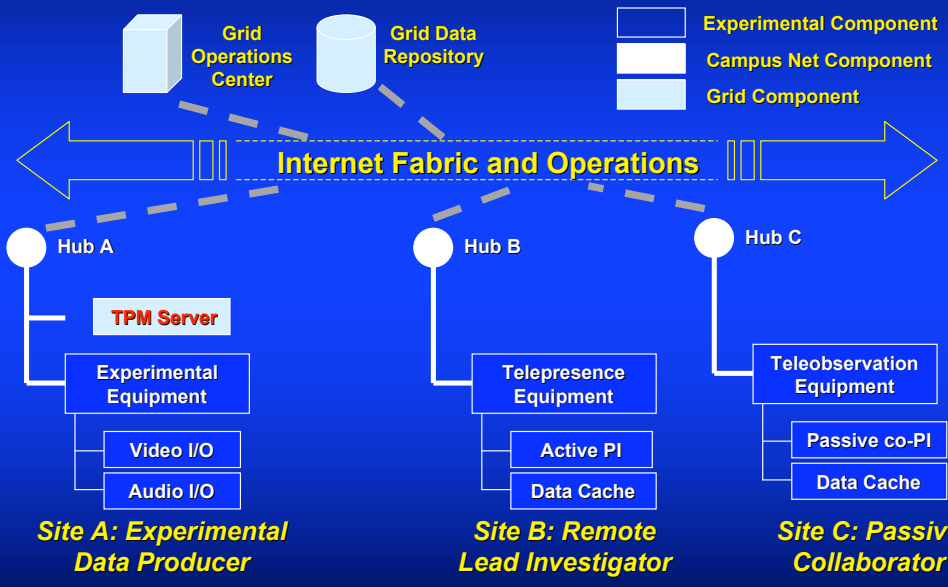
What can it do?

Exploit underutilized resources

- *–Virtual Organizations*
  - *•Data Grids*
  - *•Collaboratories*
- *–Resource Balancing*
- *–Parallel CPU resources*
- *–Reliability*
- *–Strong Security (if needed)*

More Info… http://www.globus.org

The Grid *in Collaboratories*



Site A: Experimental Data Producer

Site B: Remote Lead Investigator

Site C: Passive Collaborator

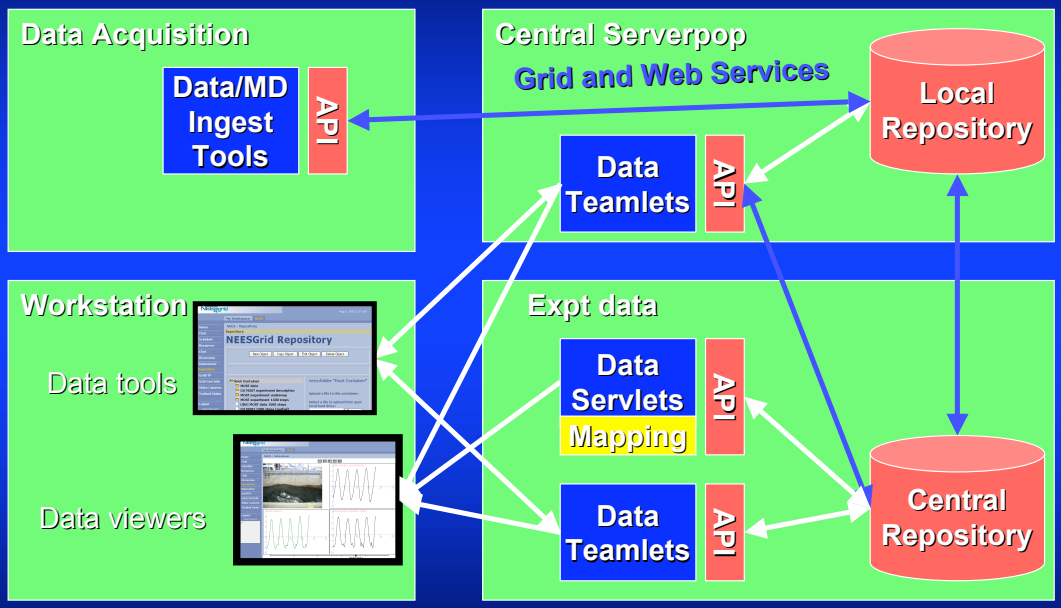
TP Architecture Approach

- *Common infrastructure that can used across wide range of applications*
  - *Balance generic mechanisms, extensibility for future growth, efficiency for application specific tasks*
- *Validate against user requirements*
  - *Input from user requirements analysis*
  - *Build on proven technology base*

TPC Grid Data – Current Elements

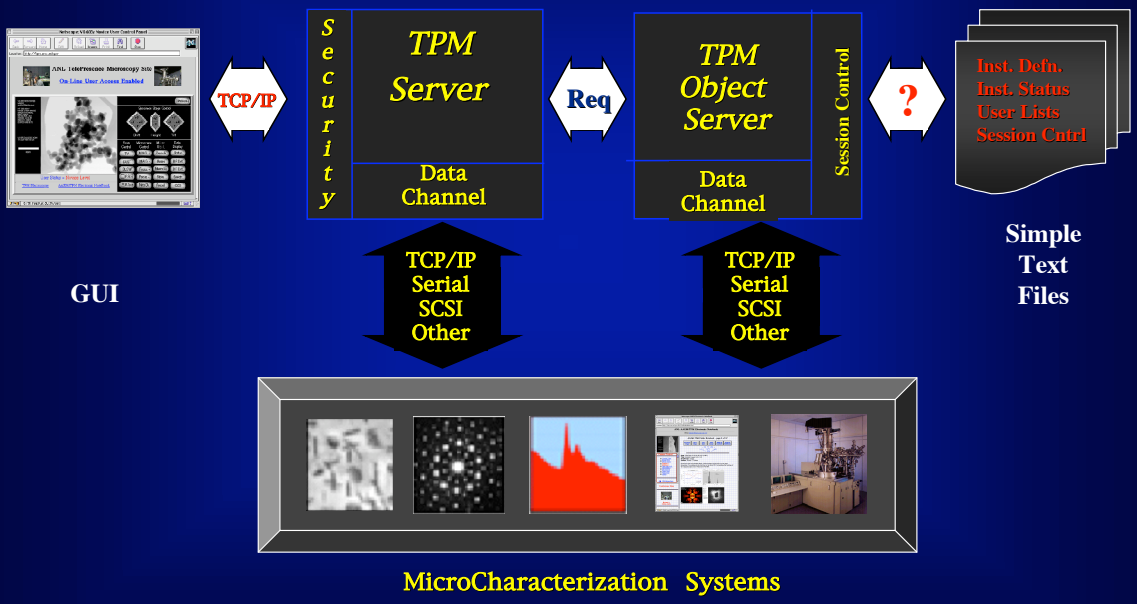
- *Local Repository*
- *Central Repository*
- *APIs – Run locally on the Grid's OGSA Web Services*
  - *File Management Services*
  - *Meta Data Services*
  - *Data Mapping Services*
- *Data Viewers*
  - *Streaming (numeric, X/Y graph)*
  - *Stored (X/Y graph, 2-D structure, video)*

Current Data Elements

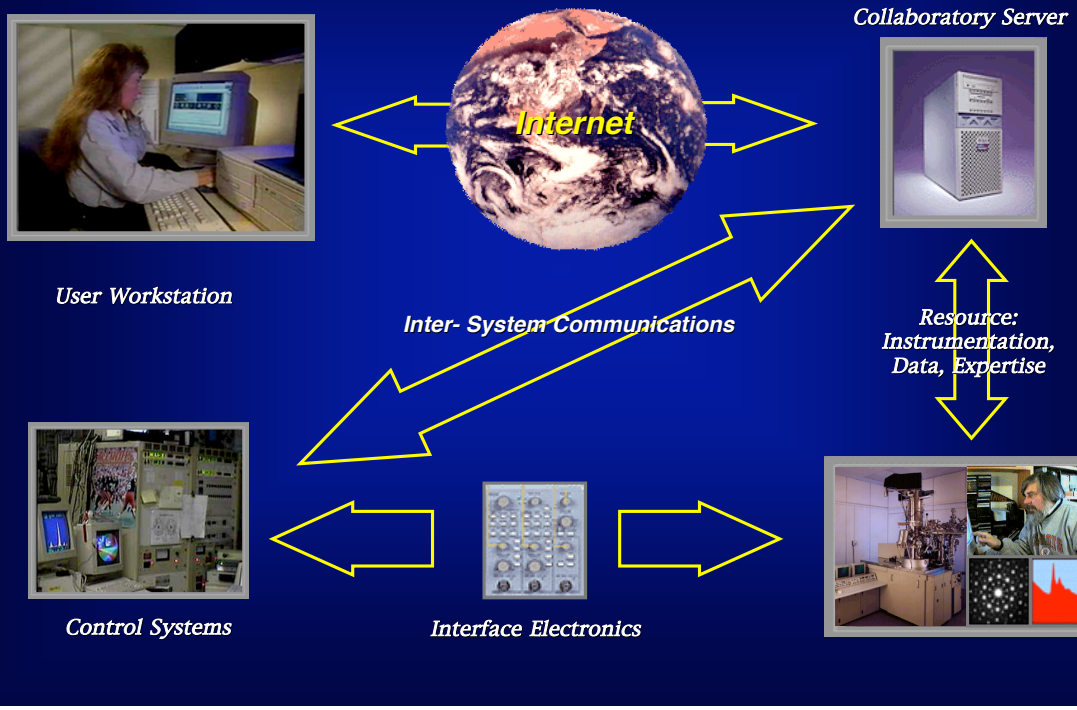


TelePresence Collaboration Enables Access to Resources via the Internet

TelePresence Operations Architecture

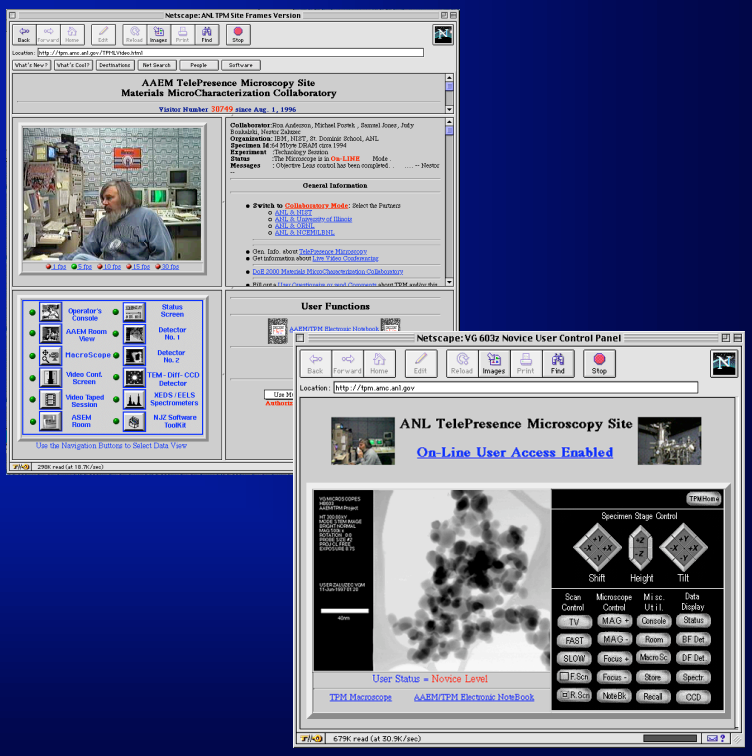


Computationally Mediated Collaboration: TelePresence Miroscopy Collaboratories



ANL - WWW TPM Server

Provides Platform Independent Access



TelePresence Does Not Apply to Microscopy / Microanalysis

National Science Foundation - NEES Grid Collaboratory

Oregon State
Oct. 2002

Univ. of Nevada - Reno
Sept. 2002

Rensselaer Polytehnic Inst.
Mar. 2003

NEESgrid TelePresence System

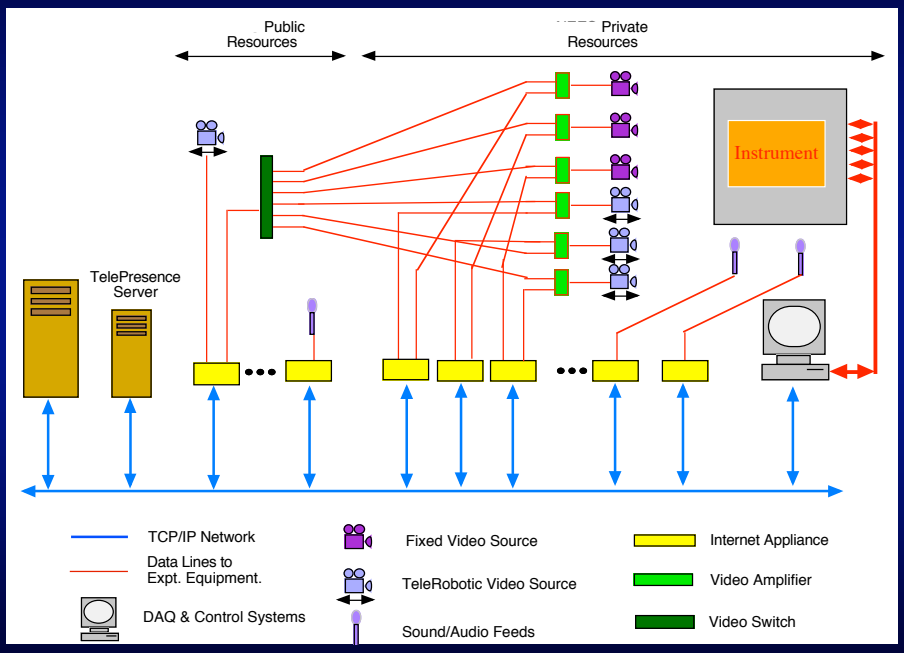
Univ. of Colorado
May 2003

Univ. of Texas
June. 2003

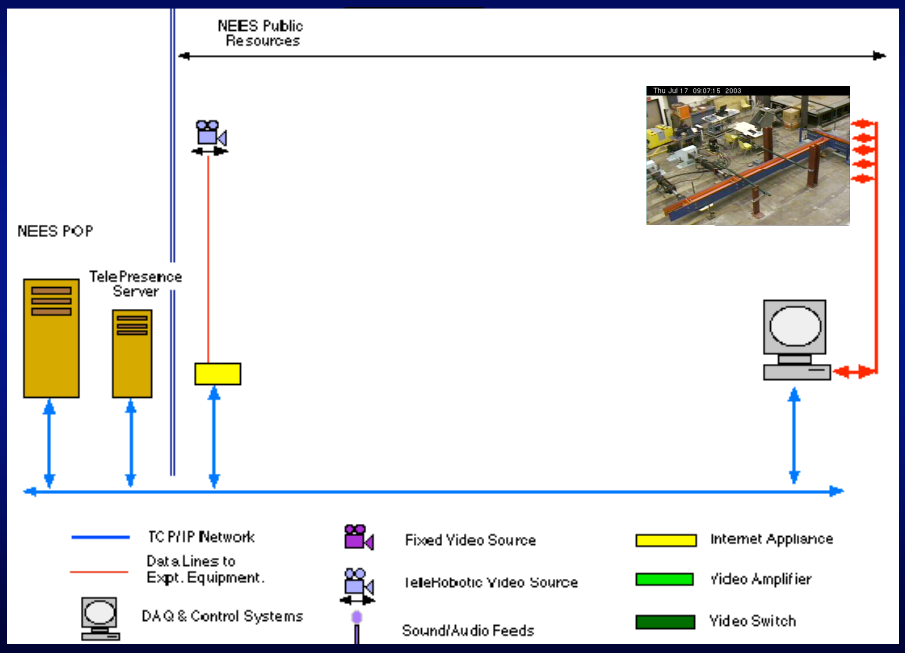
Univ. of Illinois
May 2003

Nestor J. Zaluzec *SI -Team: Materials Science Division , ANL*
Daniel Kuchma *Expt-Team: Civil Engineering Department, UIUC*

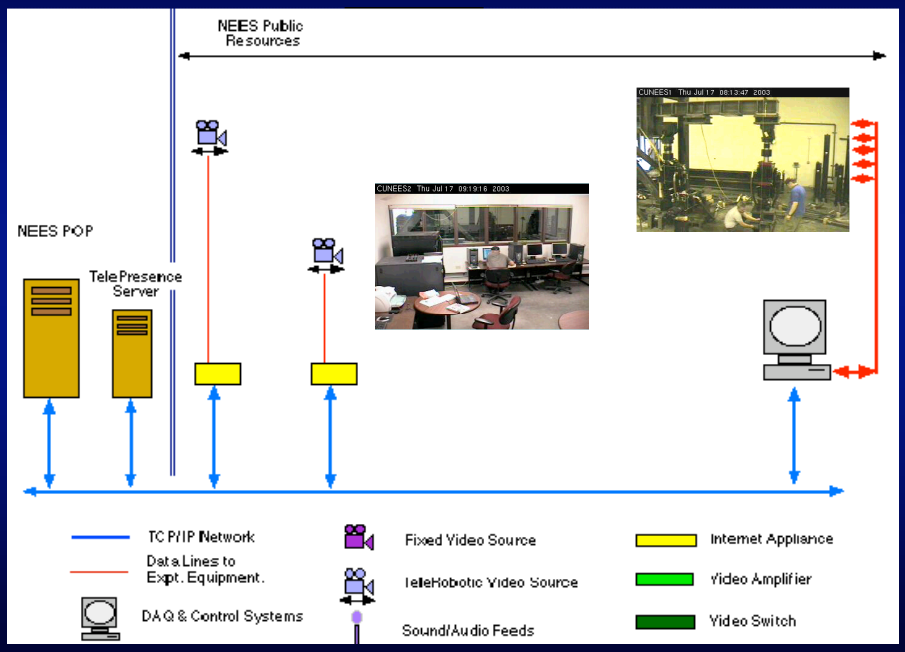
TelePresence System - Basic Hardware Components

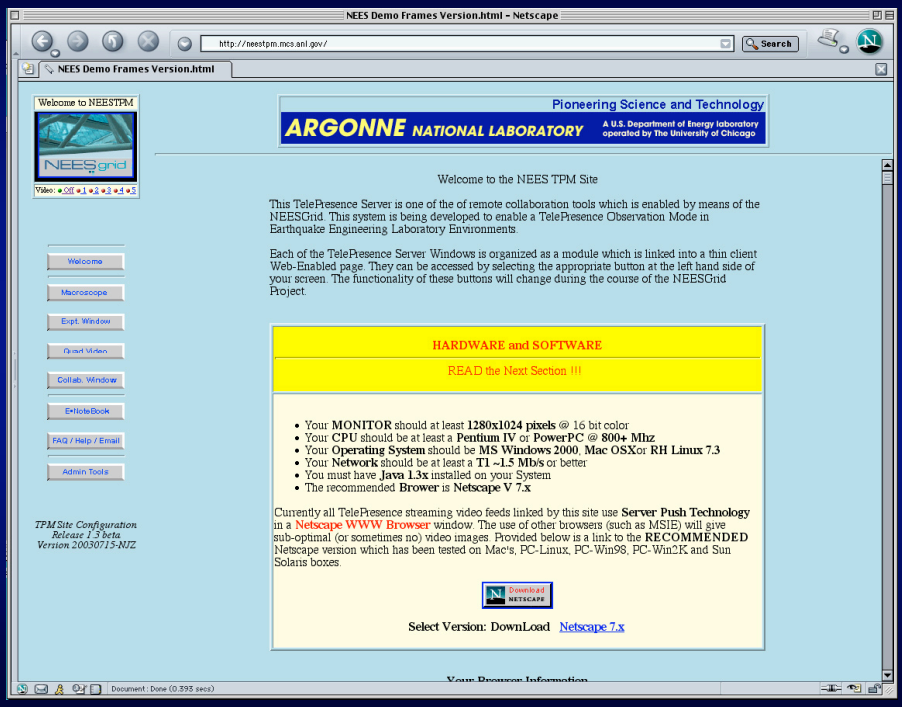


TelePresence System - UIUC



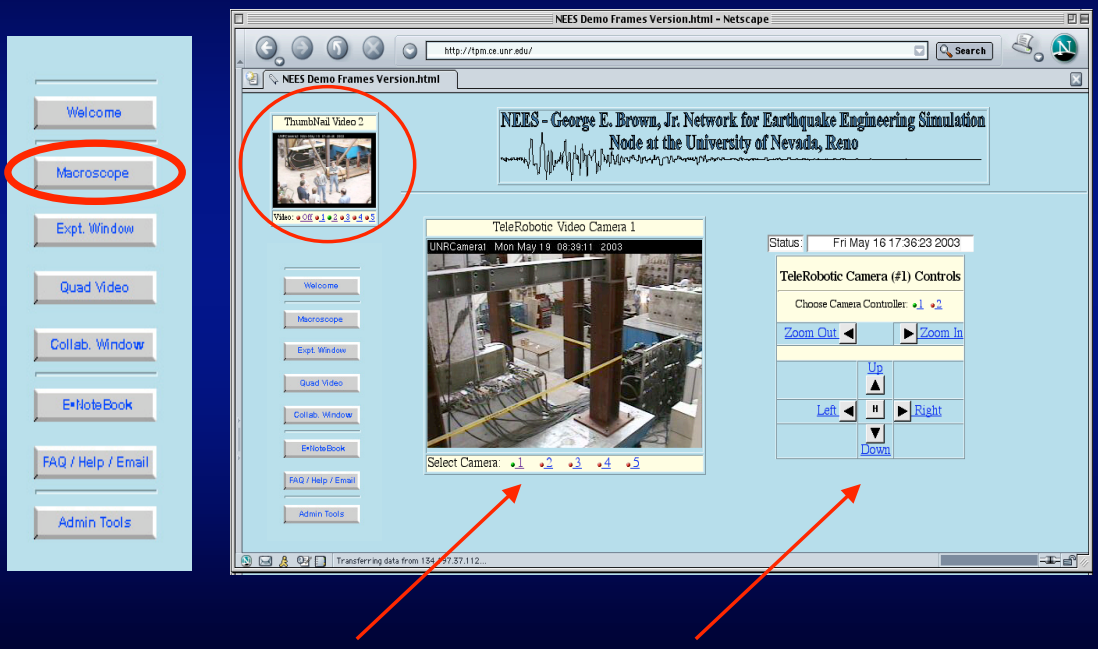
TelePresence System - Univ. of Colorado



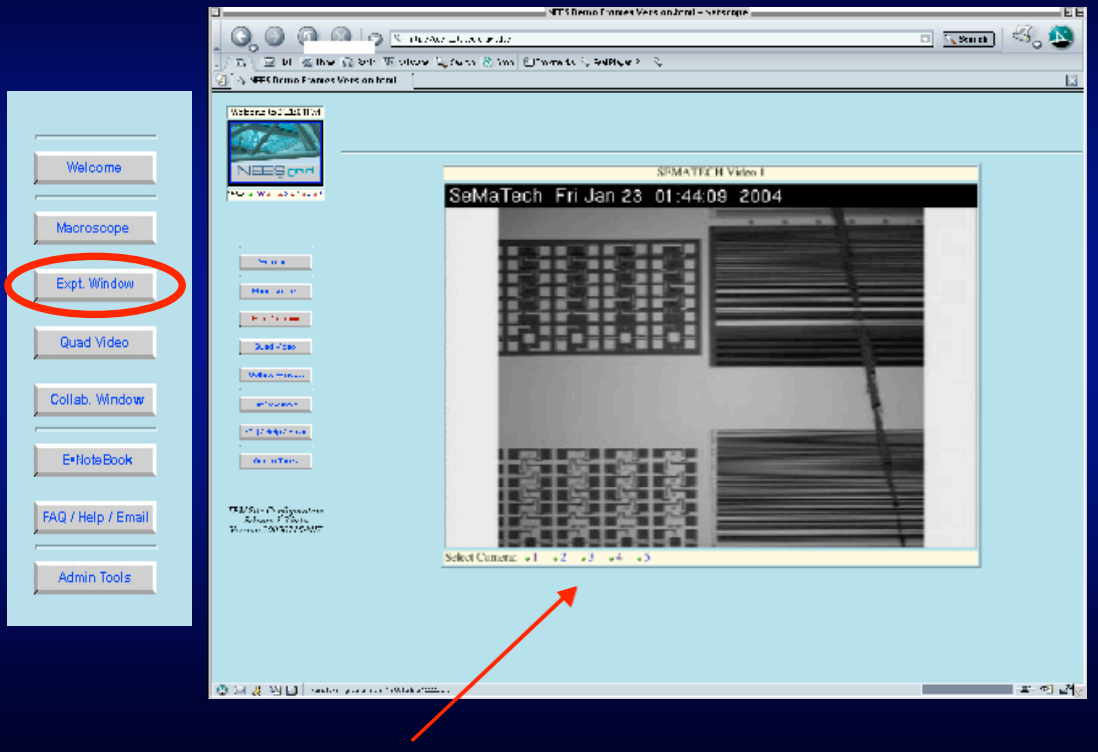


- General Information
- TeleRobotic Camera Controls
- Larger Windows
- Multiple Windows
- Multiple Sites
- Electronic Notebook
- FAQ/Help
- Administrative Functions

TeleRobotic Cameras

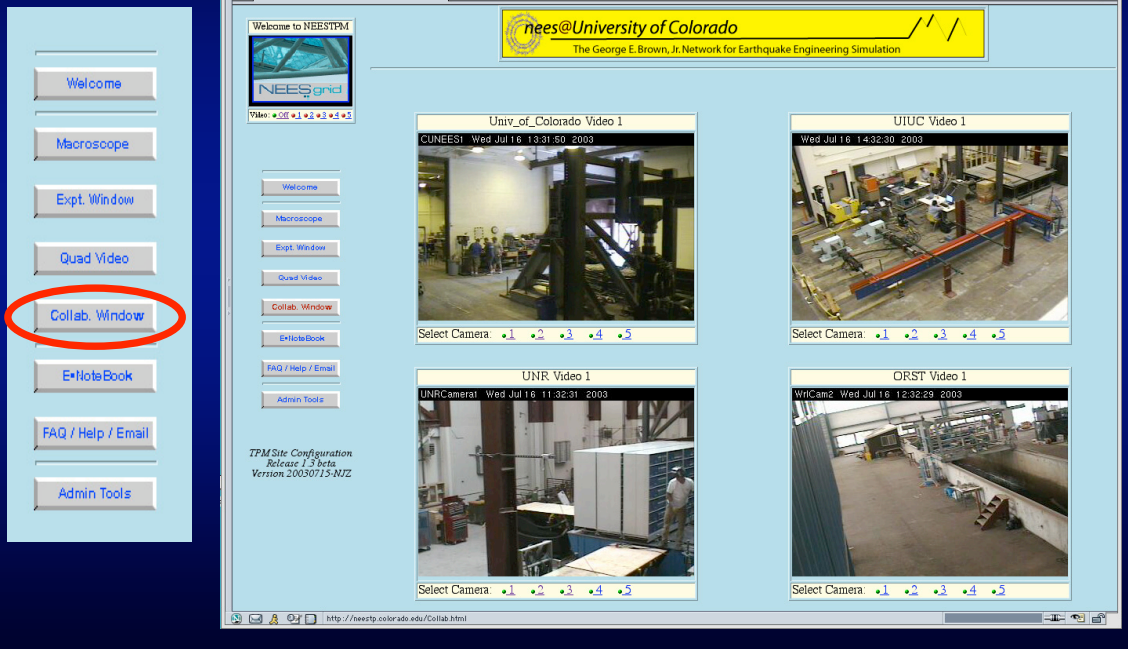


Experimental Window

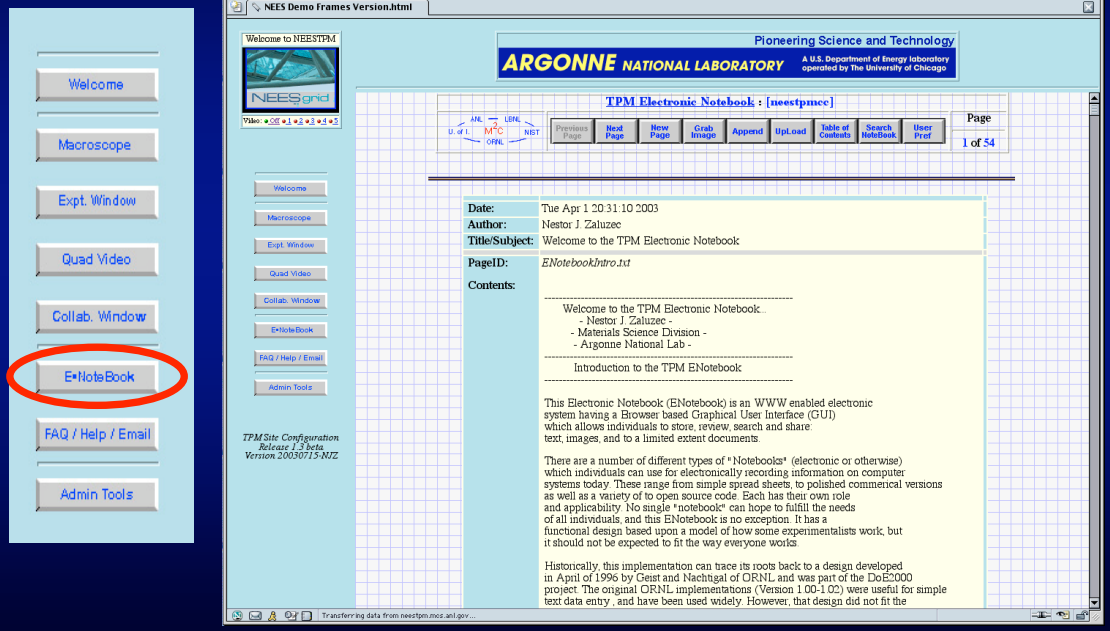


Quad Window

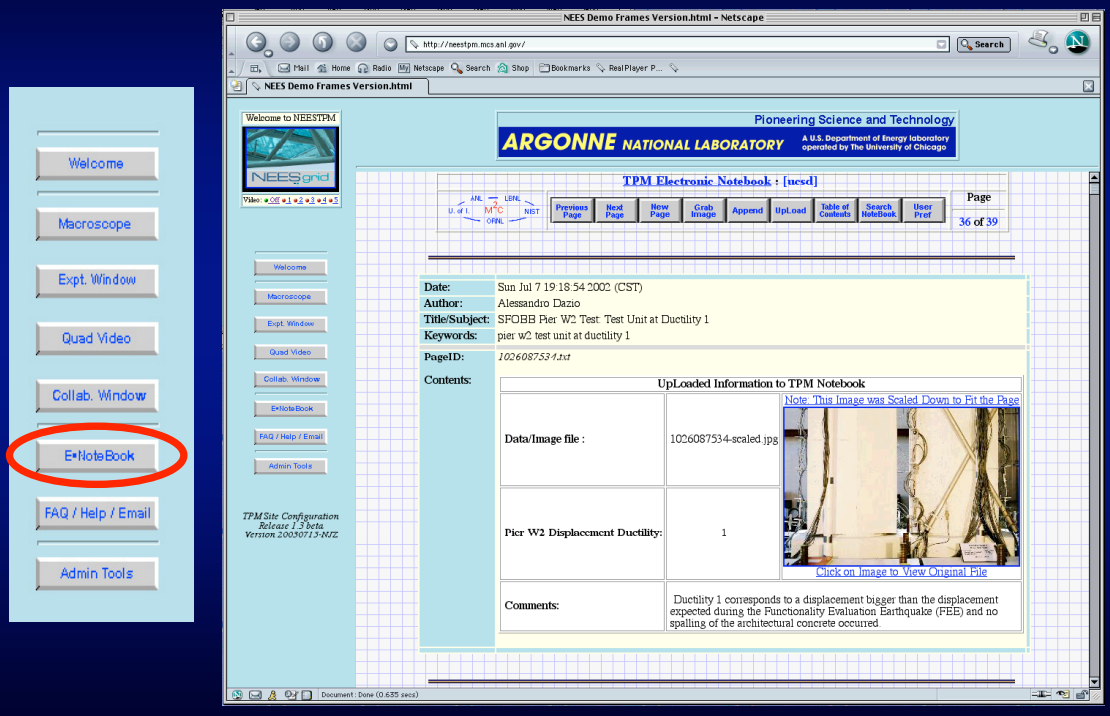
Multi-Site Collaboration Window



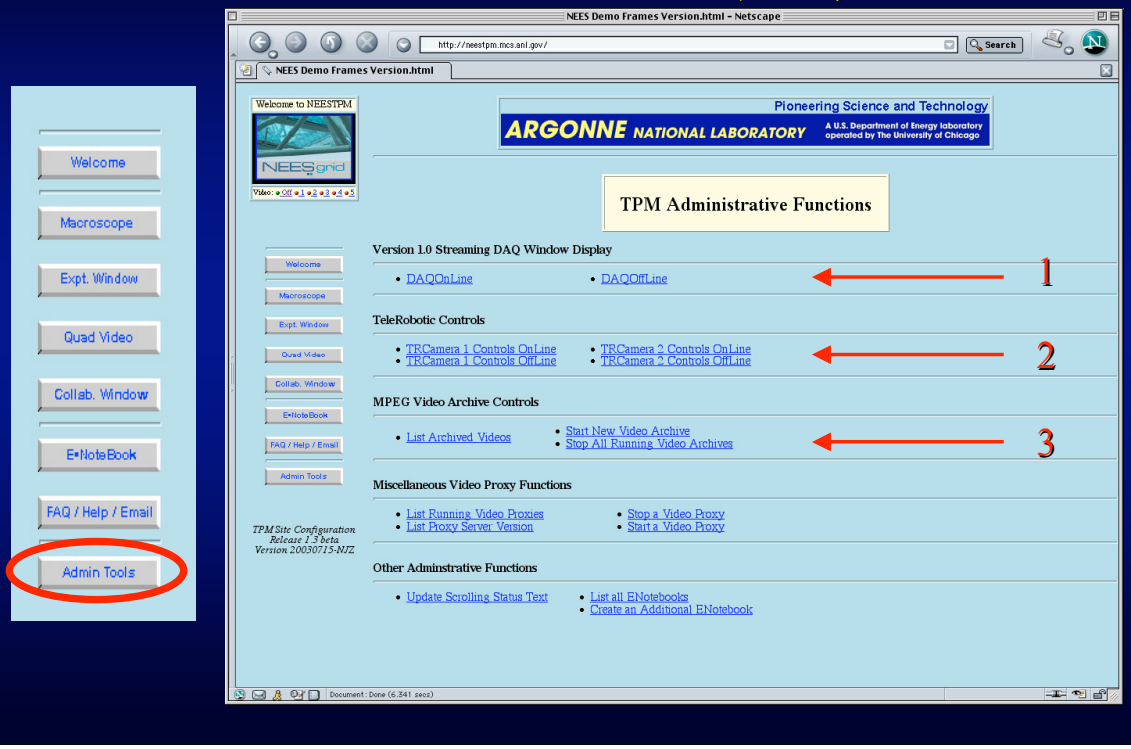
ENotebook



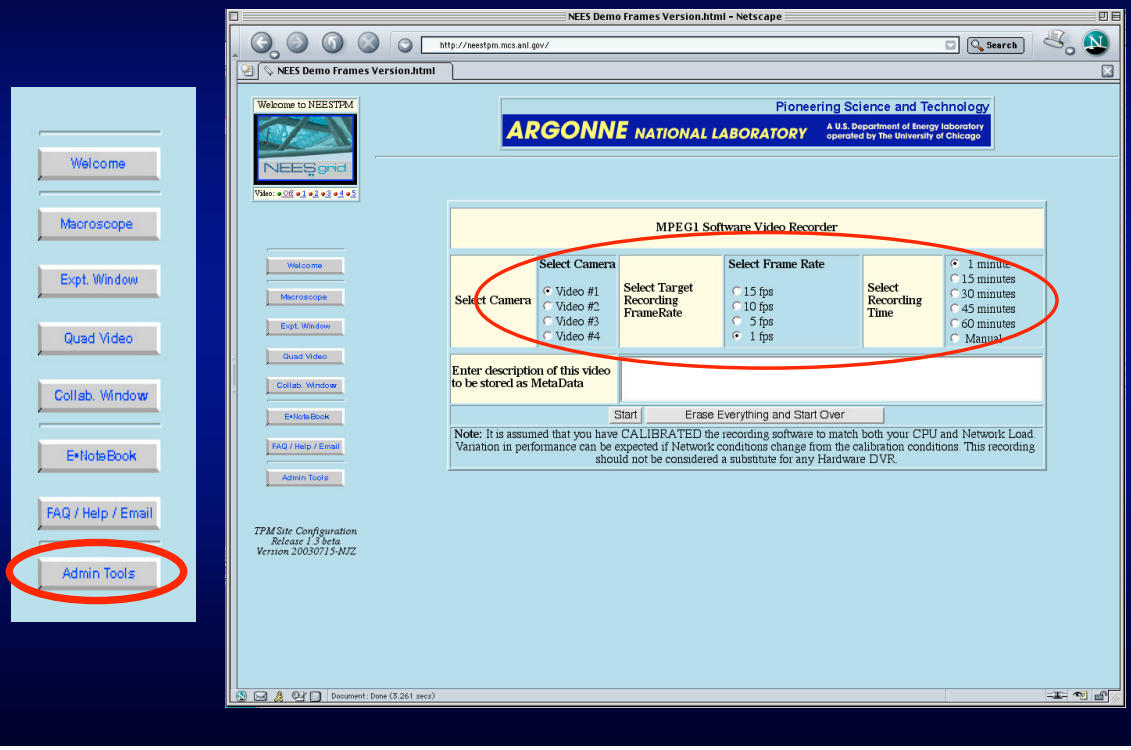
ENotebook

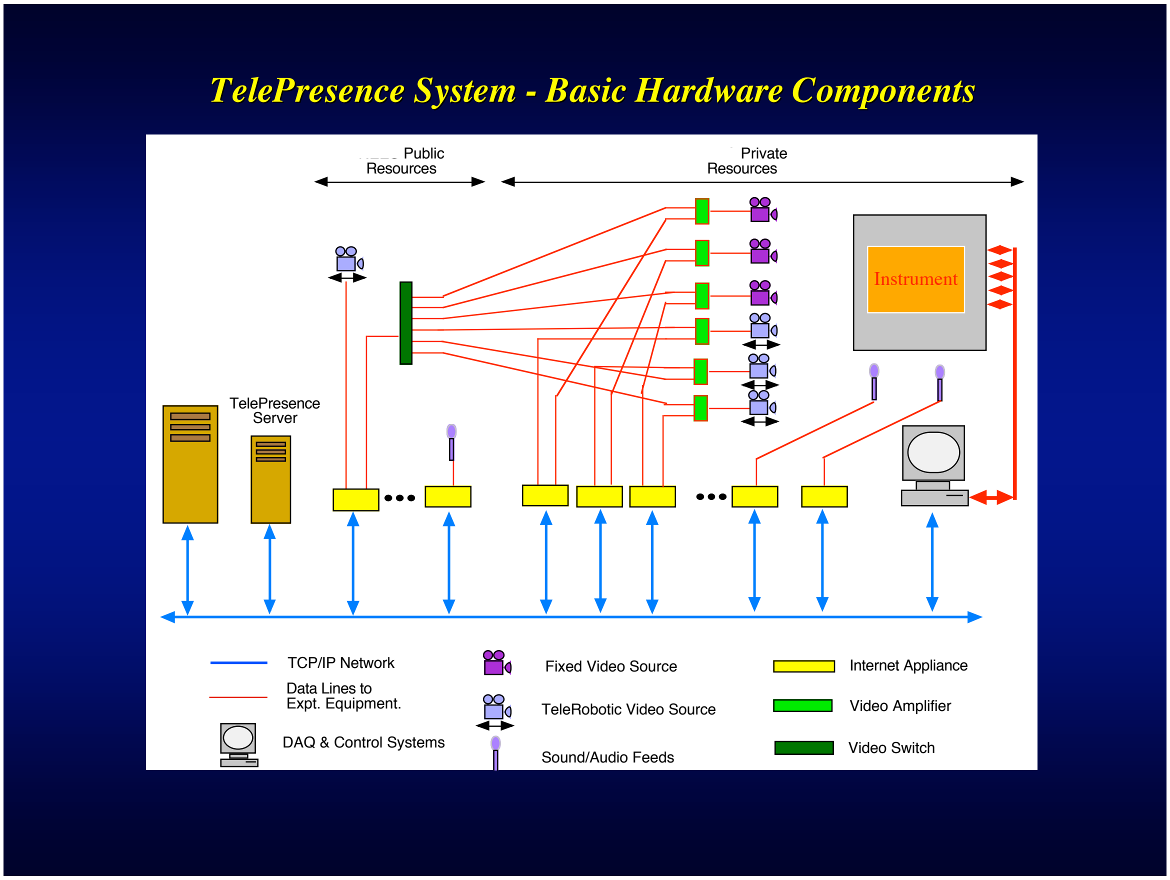


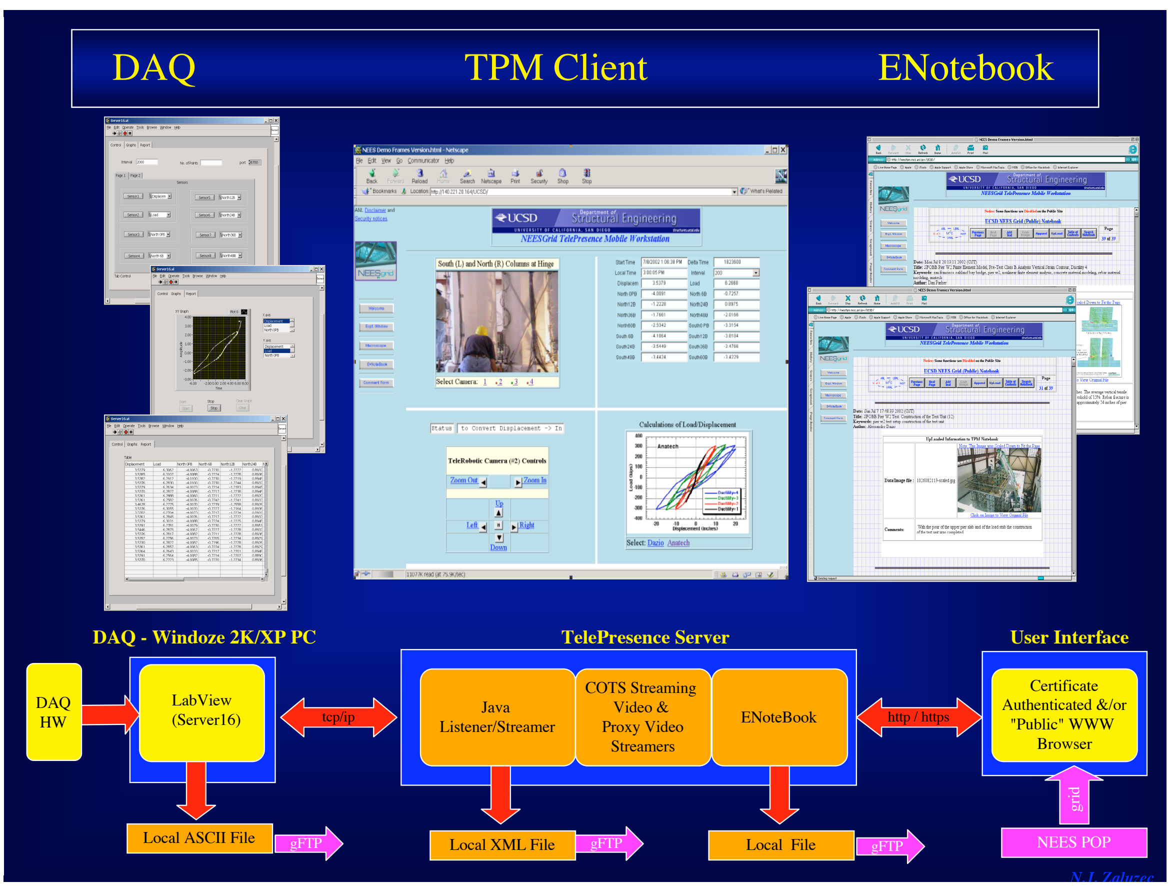
Administrative (Local)



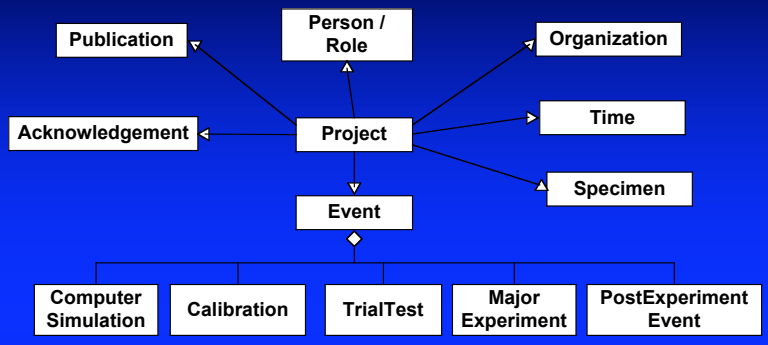
Digital VCR




TelePresence System - Basic Hardware Components
Public Resources
Private Resources
Instrument
TelePresence Server
TCP/IP Network
Data Lines to Expt. Equipment.
DAQ & Control Systems
Fixed Video Source
TeleRobotic Video Source
Sound/Audio Feeds
Internet Appliance
Video Amplifier
Video Switch


DAQ
TPM Client
ENotebook
DAQ - Windoze 2K/XP PC
TelePresence Server
User Interface
DAQ HW
LabView (Server16)
tcp/ip
Java Listener/Streamer
COTS Streaming Video & Proxy Video Streamers
ENoteBook
http / https
Certificate Authenticated &/or "Public" WWW Browser
grid
Local ASCII File
gFTP
Local XML File
gFTP
Local File
gFTP
NEES POP
N.J. Zaluzec

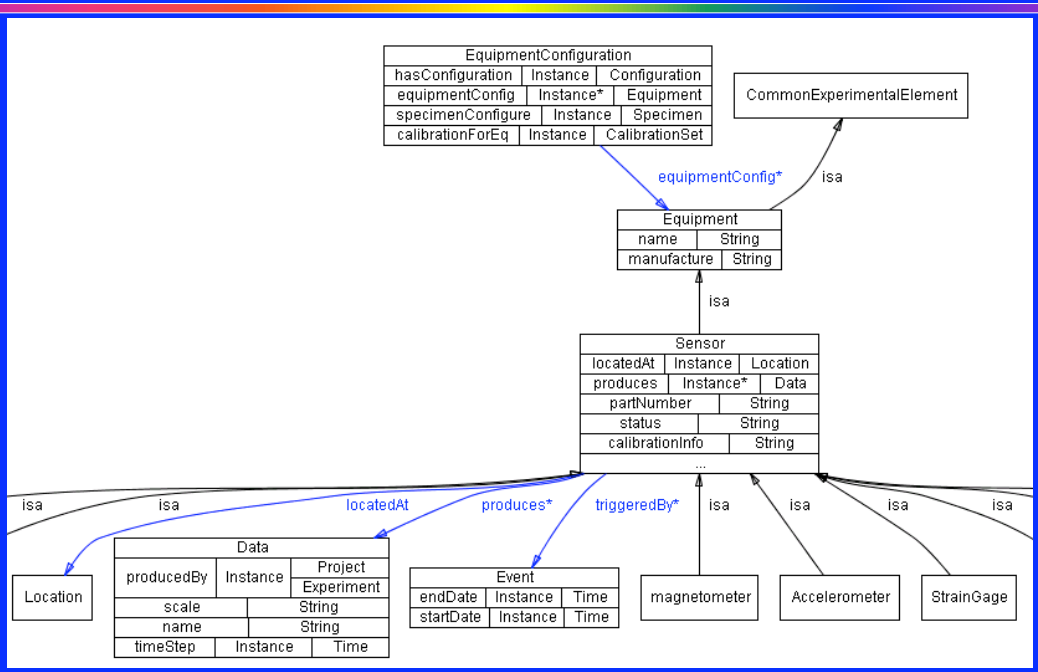
Project Model



Key Additions:

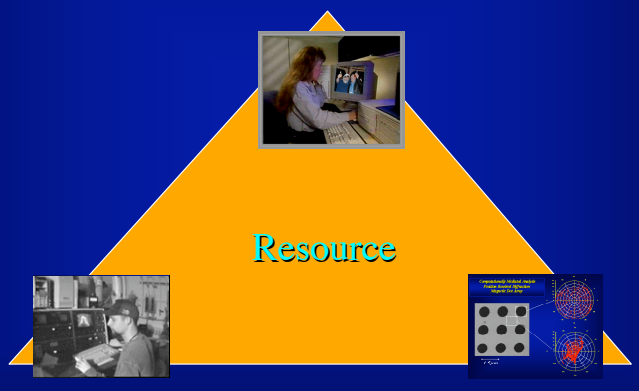
- Project has many events, which categorized in five types
- All the events have trials and versions
- Project deals with certain specimen; but specimen modeling varies widely: domain dependent, project dependent, experiment dependent

Sensor Model (generated by Ontoviz)



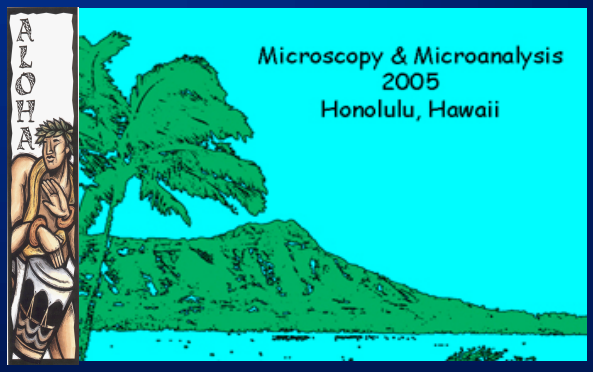
Middle/High School Collaboratories

Evolution of TelePresence



Microscopy & Microanalysis 2005

Joint - MSA, MSA, AMMS, MNZ, CAPSEM, IMS



- Pre-Meeting Congress
- Sunday Short Courses
- Presidental Happenings
- Symposia
  - Tutorials
  - FIG's
  - Biological Sciences
  - Physical Sciences
  - Adv. Inst. & Tech
  - Contributed
- Posters