

TelePresence Collaboration:

***Evolving a New Paradigm
for Conducting Research***

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



INCOMING SUBSPACE SIGNAL

You would have a Star Trekkian Life Style

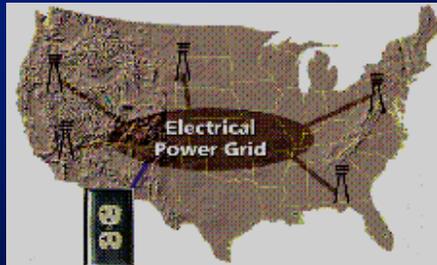
- You Would Live Where You Want to
- You and Your Colleagues Would Meet in Interesting Places
- You Would Leave Your Things Where You Need or Use Them
- You Would Need to “Arrange” to Meet People in Certain Places at Certain Times
- You Would Need Mechanisms to “Locate” People and Things
- Security Might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



Your Electrical Power Available Here



Your Information Power Available Here

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

TELEPRESENCE COLLABORATORIES: THE NEXT GENERATION OF EDUCATIONAL AND RESEARCH RESOURCES

Walter J. Zakarias

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 aided by the exponential growth of the Internet and its use for the secure operation of communication. Remote-based. Remote control has been implemented by a number of protocols mainly to facilitate local operators and remote operators of a variety of instruments including the full range of electron microscopes as well as their auxiliary equipment. There are now an entire range of commercial and research products which enable access of resources via the Internet. Each of these falls in appropriate scale in the great 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 problem, requirements, relative importance and the cost. Only in terms of \$/hour and bandwidth of the network solution can be defined. Furthermore, the very nature of the nature of collaboration can be defined and each of its various components considered. Equally important are the associated issues involving avoid and how resources are they: resources, data, safety, people.

For distributed collaboration to be successful in a microscopical analysis application, all of the aspects of the microscopical environment must be replicated. To achieve the goal of microscopical collaboration a number of globally relevant issues, in the sense that they apply to all scientific investigations, must be addressed. These include: Hardware, Electronic, Software, Standards, Protocols, Shared, Telepresence/Video, Security/Access Control, Discovery Mechanisms, Transport Protocols, Resource Management and Open World User Interfaces. The effective implement is a collaborative each of these factors must be understood and an environment created which allows both local and remote operators to operate in a seamless manner, one in which the visual and audio queues are real time, not in which the collaboration is not limited by the physical distance between the participants.

How Big is The Data

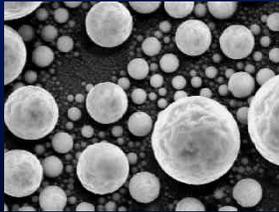
8 bits = 1 byte = 1 character

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)



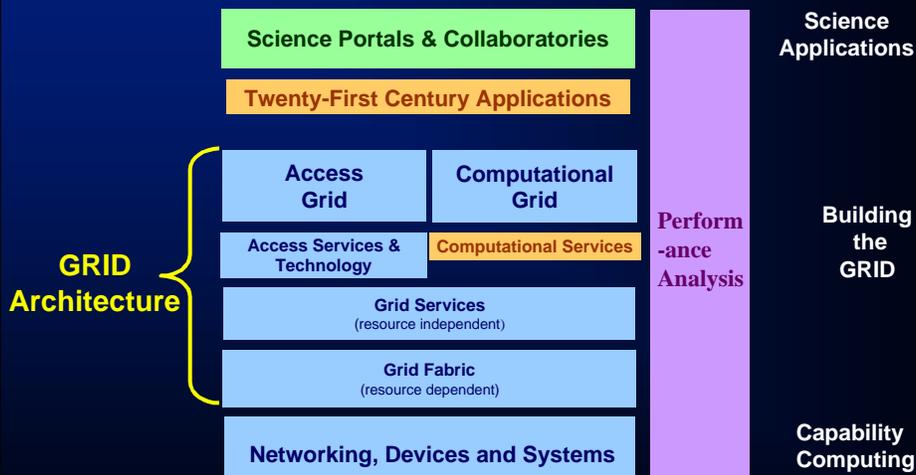
Journal Issue ~ 500 Mbytes

56 Kbit/sec -> 24 hours

1 Mbit/sec -> 90 Minutes

1 Tbit/sec -> 4 msec

Layered Approach to the Information Access



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



Instrumentation



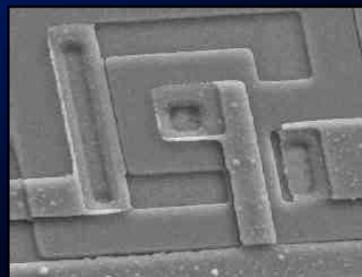
Data



Collaborators

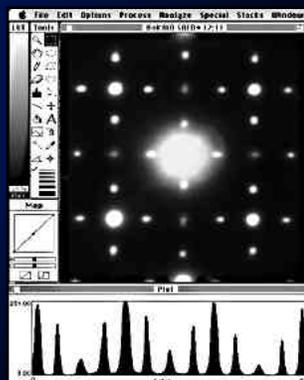
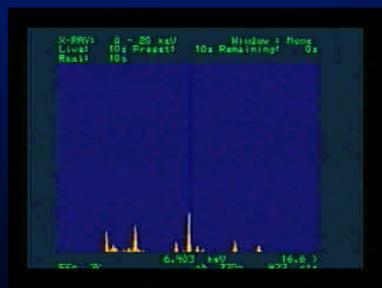
Working with Instruments the Experimentalist Needs:

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



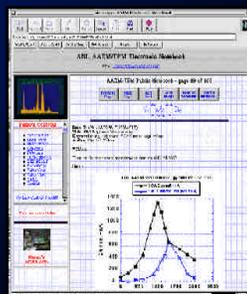
Working with Data

- 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**



The Collaboratory

Goals

- To Integrate these three key elements (**Instruments, Data, and Investigators**) into a collaboratorative framework by creating an Interactive Multi-Disciplinary Persistent Electronic Space focussed around Areas of Scientific Excellence/Expertise
 - **Physical Sciences:** Physics , Materials , Mechanical, Electrical & BioEngineering,.....
 - **Life Sciences:** Biological Sciences, Pathology, Medicine ,
- Establish the **Enabling Factors** which govern operation & control of scientific instruments over Networks using the Current and Next Generation Internet as the transport backbone, while using the Collaboratory as focus/tool of the interaction.
- Incorporate Collaboratory into the **Research Environment** as well as in **Distance Learning**

The TelePresence Collaboratory

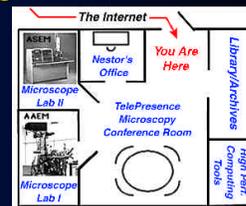
- **Create a Persistent Virtual Location around Centers of Scientific Interest**
- **Integrate Operation & Control of Scientific Experiments**

Allow **Remote Users** to have either **passive** or **active** participation to experimentation with access to both **Expertise and Instrumentation**

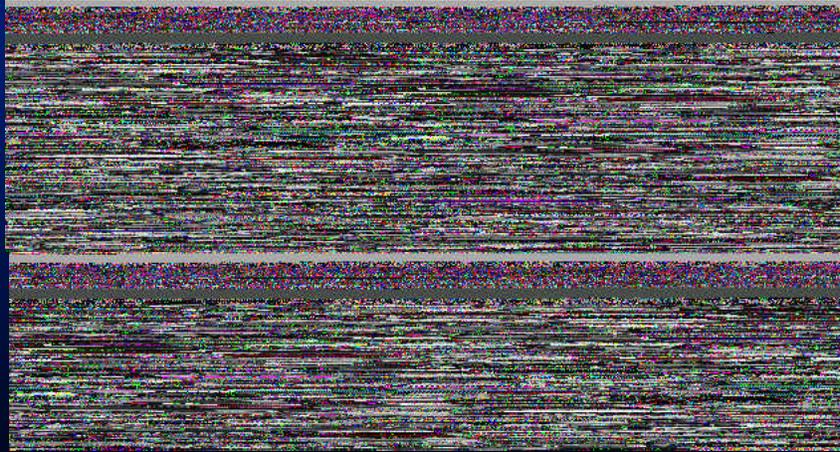
via a platform independant GUI

 - Experimental Windows, Electronic Notebooks
 - Meeting Rooms/Offices/ TeleConference Links
 - Libraries/Data Archives
 - Access to High Performance Data Engines for data processing
- **Provide Opportunities for Distance Learning and Remote Collaboration at all levels**
 - Research and Industrial Collaborations
 - Middle / High / and Univeristy Levels
- **Provides a set of requirements which taxes the limits of the Internet**

Imaging, Spectroscopy, Real-Time Control, Conferencing,



TelePresence Collaboration Enables Access to Resources via the Internet



TelePresence Collaboration

The Challenge

Controls

Instrumentation, Data, Standards,
Legacy Platforms, Human Factors, Time, Budget



Input

Users
Enablers



New Paradigm
for Interactive
R&D and
Education

Output



Networks, Servers,
Browsers, Tools

Mechanisms

TelePresence Microscopy Collaboratory

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***

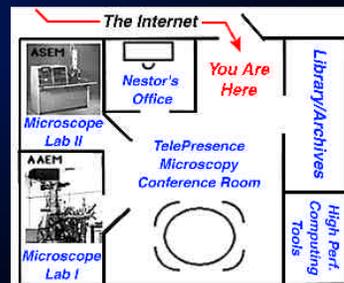
Persistent Electronic Space

WWW Site is an Ideal Proto-type Model of a Persistent Electronic Space

- **Observational Modes**
- **Capabilities for both Dynamic and Static Data**
- **Can Host both Private and Public Areas**
- **Completely Digital Media**
- **A/V Compliant**
- **Enables Data Sharing with minimal work**
- **Extensible to Application Sharing**

Characteristics of a Persistent Electronic "Lab"

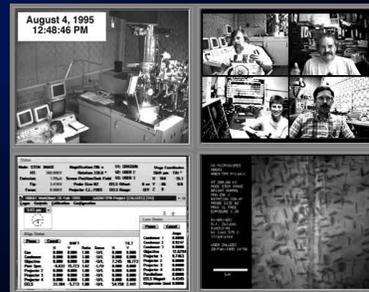
- **Always There**
- **Collaboratory Interaction Zone**
 - Offices, Work Areas, Labs, Mailboxes
- **Access Control**
 - **Active**
 - Public/Private/Restricted
 - Real Time Interactions
 - Editable
 - **Passive**
 - Public/Private/Restricted
 - Viewable not Editable
- **Scalability**



Sharable Entities

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



Security

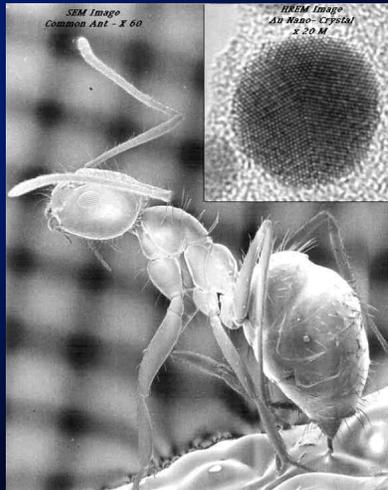
- We are putting valuable and complicated facilities or data online to the whole world
- The data generated using these facilities may be proprietary
- If security "gets in the way" it will not be used.
- If security is too weak, valuable assets are at risk.

TelePresence Microscopy

Microscopy is one of the few methodologies applied to nearly every field of science and technology in use today.

A microscope can be as simple as a hand held optical device or as complex as a multi-million dollar research tool.

Using these instruments, both scientists and students can explore the synergistic relationships of structure and properties of a wide variety materials in both the Physical and the Life Sciences.



Microscopy & Microanalysis

Experimental methodologies which employ electron-optical instrumentation to spatially characterize matter on scales which range from tenths of a millimeter to tenths of a nanometer. The principle modalities employed are:

Imaging

Transmission Electron Microscopy
Scanning Transmission Electron Microscopy
Scanning Electron Microscopy



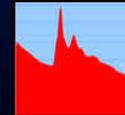
Diffraction

Convergent Beam Electron Diffraction
Selected Area Electron Diffraction
Reflection High Energy Electron Diffraction



Spectroscopy

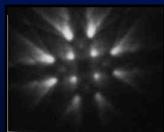
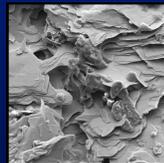
X-ray Energy Dispersive
Electron Energy Loss
Auger Electron



MicroCharacterization via Electron Microscopy

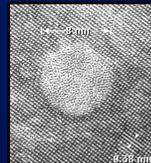
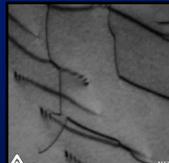
SEM

Scanning Electron Microscopy



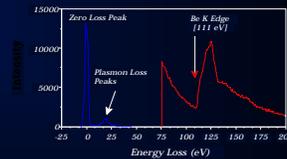
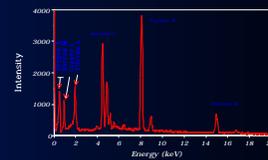
TEM - STEM - HREM

Transmission - Scanning Transmission -
High Resolution Electron Microscopy



AEM

Analytical Electron
Microscopy



Morphology, Crystallography, Elemental, Chemical, Electronic Structure

ANL - Advanced Analytical Electron Microscope

- **Cold Field Emission Electron Source**
 - V_0 : 50 - 300 kV
- **Ultrahigh vacuum (UHV) environment**
 - $\sim 1 \times 10^{-11}$ torr - Gun, $< 2 \times 10^{-10}$ torr - Column
 - $< 5 \times 10^{-10}$ torr - Specimen Preparation Chamber
- **Electron Optics capable of :**
 - STEM / SEM:
 - TEM:
 - CBED/SAED:
 - Other Modes: TSEM, TSED, RHEED
- **Side Entry Goniometer Stages**
 - RT Double Tilt Beryllium:
 - LN2 Cooled Double Tilt Be Stage:
 - Single Tilt Heating Stage:
- **Analytical SubSystems on the E/O Column**
 - XEDS, EELS, AES
- **Specimen Preparation Chamber**
 - High Pressure/Temperature Gas Reaction Cell
 - Thin Film Evaporation Chamber
 - Mini-SIMS system - Gallium LMIS, Quad Mass Analyzer
 - RV LEED & Vacuum Transfer Vessel
 - ANL MultiPort Station for development work.
- **Computer Control**
- **Special Objective Lens Port Configuration**
 - 7 Experimental Ports on Objective Lens for Analytical Equipment
 - 3 Additional Ports for Electrical Feedthrus etc...



TelePresence Microscopy

Require Access to:

- Instrument Room
- Instrument Status
- Experimental Data
- Video Conferencing
- Electronic Notebooks
- On-Line Control

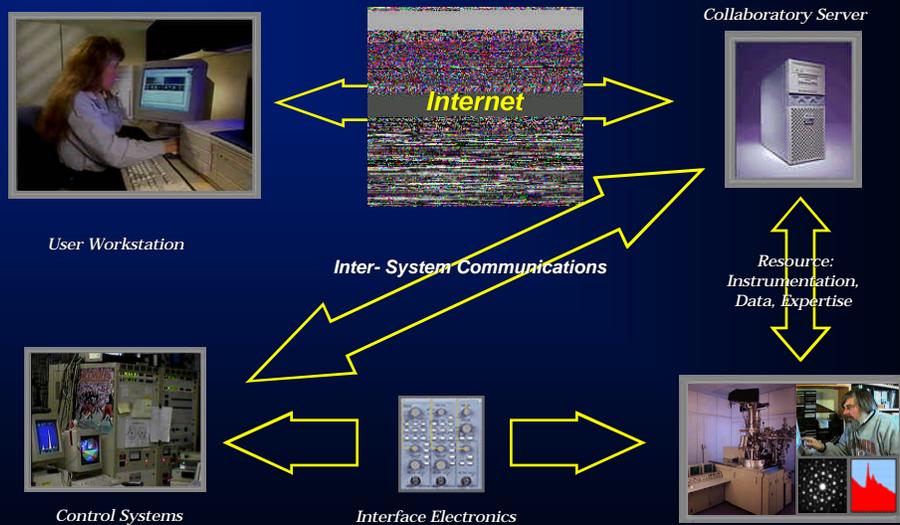
August 4, 1995
12:48:46 PM

| Stage | Current | Setpoint | Unit | Range | Min | Max |
|----------|---------|----------|------|--------|--------|----------|
| Gun | 0.0000 | 0.0000 | kV | 0.0000 | 0.0000 | 300.0000 |
| Column | 0.0000 | 0.0000 | mm | 0.0000 | 0.0000 | 0.0000 |
| Specimen | 0.0000 | 0.0000 | mm | 0.0000 | 0.0000 | 0.0000 |
| Port 1 | 0.0000 | 0.0000 | mm | 0.0000 | 0.0000 | 0.0000 |
| Port 2 | 0.0000 | 0.0000 | mm | 0.0000 | 0.0000 | 0.0000 |
| Port 3 | 0.0000 | 0.0000 | mm | 0.0000 | 0.0000 | 0.0000 |
| Port 4 | 0.0000 | 0.0000 | mm | 0.0000 | 0.0000 | 0.0000 |
| Port 5 | 0.0000 | 0.0000 | mm | 0.0000 | 0.0000 | 0.0000 |
| Port 6 | 0.0000 | 0.0000 | mm | 0.0000 | 0.0000 | 0.0000 |
| Port 7 | 0.0000 | 0.0000 | mm | 0.0000 | 0.0000 | 0.0000 |

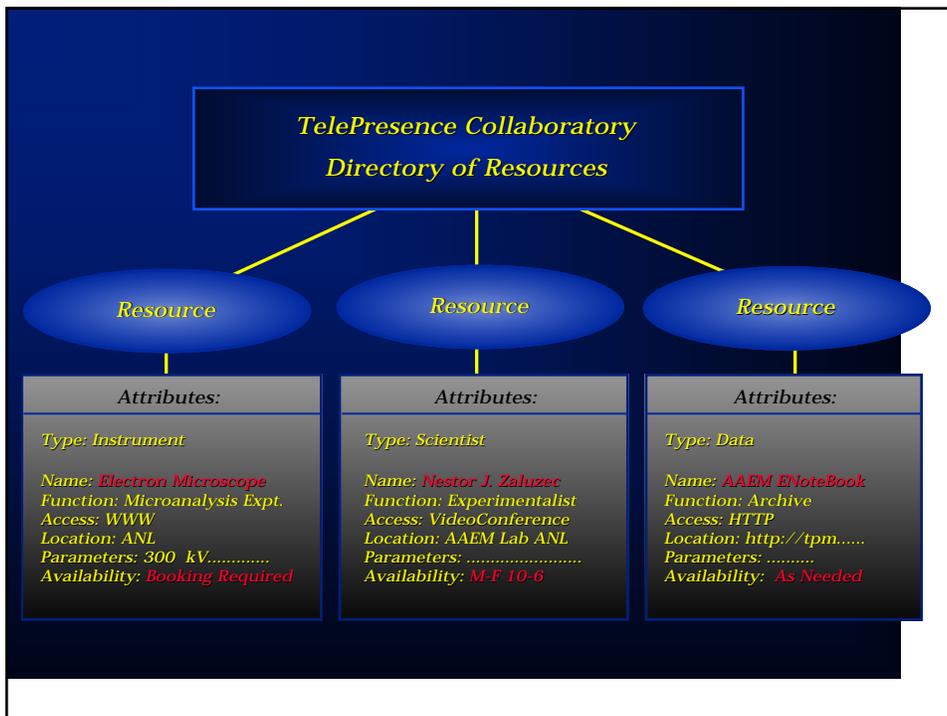
Functionality

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

TelePresence Microscopy Collaboratory Architecture



Current TelePresence Operations Architecture
WWW Model Provides Seamless Integration



ANL - WWW
TPM Server

Provides
Platform
Independent
Access

The screenshot shows a Netscape browser window titled "Netscape: ANL TPM Site Frames Version". The address bar contains "http://tpm.anl.gov/TPM4/Video.html". The page content includes a header for "AAEM TelePresence Microscopy Site Materials MicroCharacterization Collaboratory" with a visitor count of 30749 since August 1, 1996. A central video window shows a person in a lab. To the right, there is a "Collaborator" list, "General Information" with links to switch to Collaboratory Mode, and "User Functions" including a "Full Screen Display Mode" and "On-Line Microscope Controls". A "Login" button is visible under "Authorized UserID and Password Required". A navigation menu at the bottom left lists various views like "Operator's Console", "AAEM Room View", "MacroScope", "Video Cont. Screen", "Video Taped Session", "ASEM Room", "Status Screen", "Detector No. 1", "Detector No. 2", "TEM - Diff - CCD Detector", "WDS, FEELS Spectrometers", and "MJZ Software Toolkit".

Access Control / Security

The screenshot shows a Netscape browser window titled "Netscape: Done" displaying an "Administrator Data Input Accepted" message. The message states: "The information below is what you submitted on Monday, April 11, 1999 at 10:52:59". Below the message is a form with the following data:

AdministratorName: palmeo

| Current User List | Level | Status |
|-------------------|--------|----------|
| root | root | disabled |
| alexander | expert | enabled |
| aliant | novice | disabled |
| adwa | expert | disabled |
| benley | expert | disabled |
| griffin | expert | disabled |
| guest | novice | disabled |
| harcovf@ml | novice | disabled |
| jenik | expert | disabled |
| macroe | expert | disabled |
| postek | expert | enabled |
| rome | novice | disabled |
| subdram | novice | disabled |
| wright | novice | disabled |
| zahroc | system | enabled |

Private Site Authorized Users

User Name(s): palmeo alexander postek

Buttons: Update Files, Erase Form and Print Over

**On-Line
Instrument
Control**

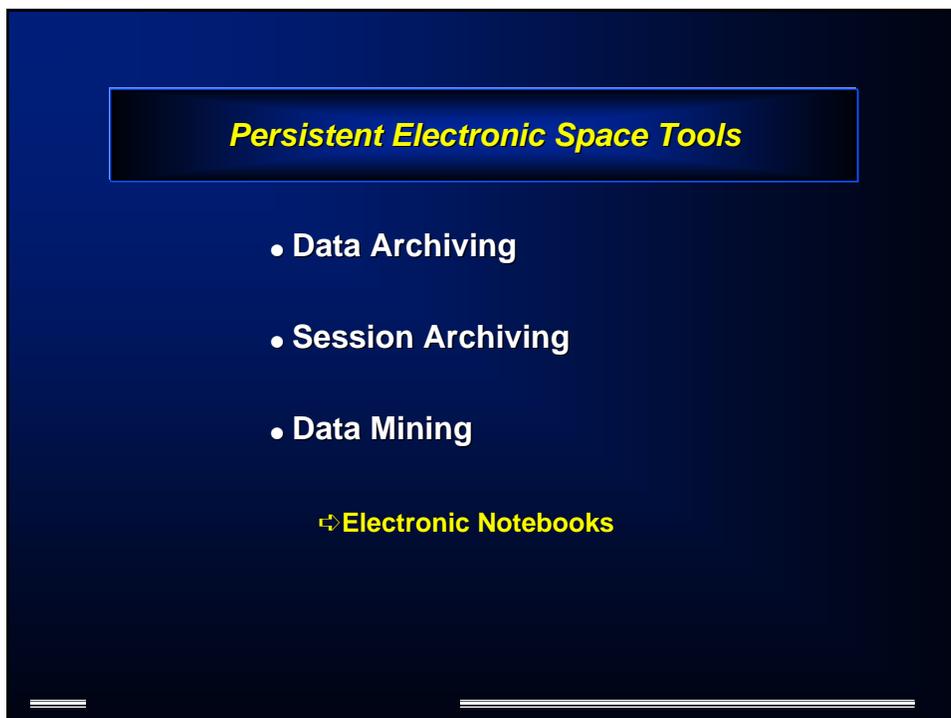
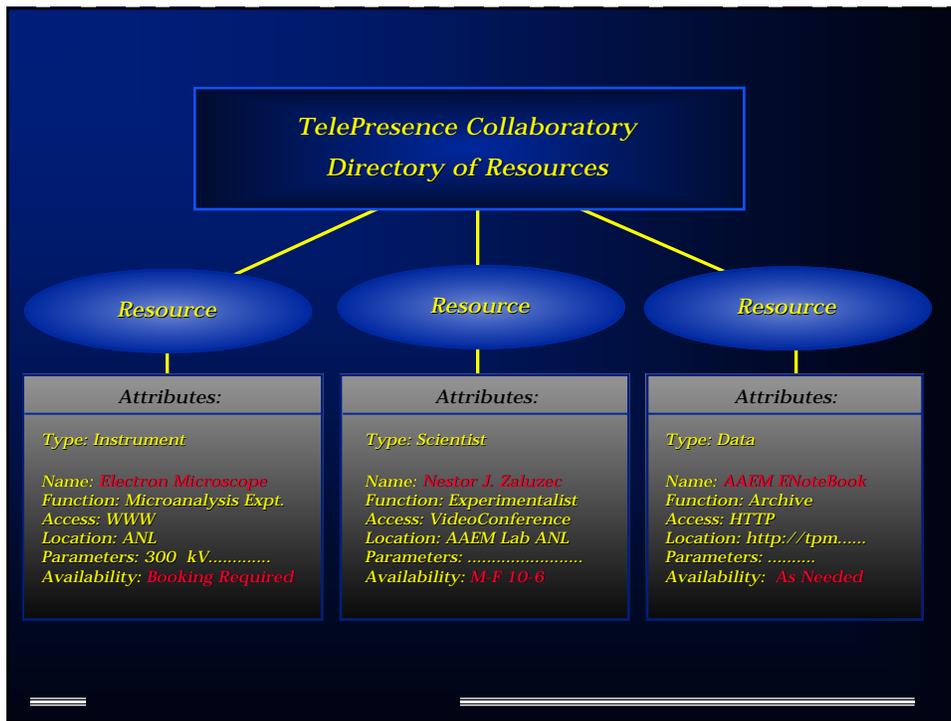
**Platform
Independent
WWW
Interface**

The screenshot shows a Netscape browser window titled "Netscape: VG 603z Novice User Control Panel". The address bar shows "http://tpm.amc.anl.gov". The main content area features the "ANL TelePresence Microscopy Site" header with "On-Line User Access Enabled". A central panel displays a grayscale micrograph of a specimen. To the right of the image is a "Specimen Stage Control" section with directional arrows for "Shift", "Height", and "Tilt". Below this is a control panel with buttons for "Scan Control" (TV), "Microscope Control" (MAG +, FAST, SLOW, F.Scan), "Misc. Util." (Console, Room, Macro Sc, Store, Recall), and "Data Display" (Status, BF Det., DF Det., Spectr., CCD). A "User Status = Novice Level" indicator is visible. The status bar at the bottom indicates a download speed of "679K read (at 30.9K/sec)".

**On-Line
Instrument
Control**

**Platform
Independent
WWW
Interface**

The screenshot shows a Netscape browser window titled "Netscape: TelePresence Spectroscopy Remote XEDS/EELS Control". The address bar shows "http://tpm.amc.anl.gov". The main content area features the "AAEM/TPM Project" header with "TelePresence Spectroscopy Mode" and "Remote User Controls Disabled". The interface is split into two main sections: "AAEM BF/DF Image" on the left, showing a grayscale micrograph, and "X-ray / Electron Spectrometer" on the right, showing a spectral plot with a prominent peak. Below these sections are control panels for "Microscope Controls" (MAG +, MAG -, Focus +, Focus -) and "Spectrometer Controls" (Start, Clear, Stop, Over Lay). A "Return to Standard TPM Operating Mode" link is at the bottom, with options for "20\" Screen Low Res", "17\" Screen Low Res", and "14\" Screen Low Res". The status bar at the bottom indicates a download speed of "34639K read (at 38.2K/sec)".



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

WWW - User Interface



Input Modules

Text
Forms
HTML Editors
Java Applets
Live Data

Submit / Retrieve Requests

NoteBook Engine

CGI
Java, Perl

Storage

Flat File Storage
Store
Retrieve
Time Stamped

TelePresence Microscopy

Electronic NoteBooks

On-Line
Data Sharing
and
Collaboration

Netscape: AAEM Electronic Notebook

Location: <http://tpm.ansc.anl.gov/NAE/NoteBook.html>

ANL AAEM/TPM Electronic Notebook
EMail: Zabney@ansc.anl.gov

AAEM-TPM Public Notebook - page 8 of 97

Navigation: [Previous Page](#) [Next Page](#) [Add Text](#) [Add Image](#) [Table of Contents](#) [Search Notebook](#)

U.S.F.L. LINL MTC NST
OPNL

Date: Wed Mar 19 03:03:45 1997 (GMT)
Title: Resolved Images 140 x 120
Keywords: images
Author: Hestir J. Zabney

Now let's look at downloaded images, all four images (160x120) on one page. Remember I'm assuming, as the browser on the local CPU is handling the viewing of the original images all of which are 640x480.

Camera Control

- Console View
- Room View
- Status Screen
- Detect W.L.
- Detect W.C.
- TEM Diff. CCD
- Micrographs
- Microscope
- Video Cont.
- Video Image
- ASSEM

Conference Sites

Nestor's Office-ANL

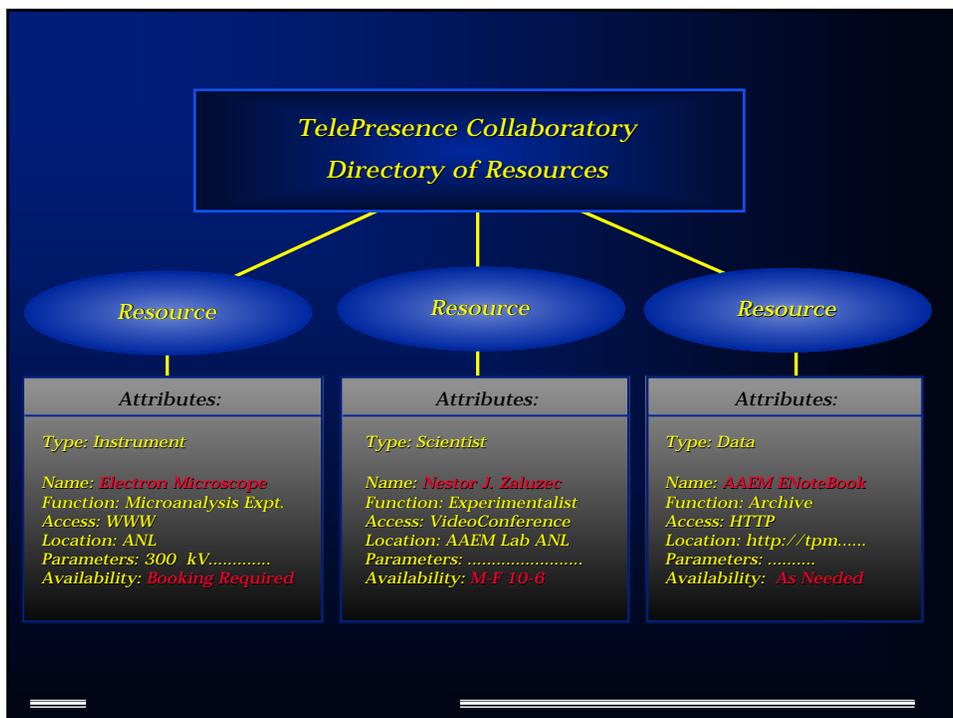
Expanded Collaboration Tools

Electronic NoteBooks , Forums, ...

The collage shows three main components:

- ANL AAEMTPM Electronic Notebook:** A web-based interface for managing experimental data and notes, featuring a sidebar with navigation options and a main content area with a grid and image viewer.
- TelePresence Microscopy Forum Login:** A web page for logging into a forum, with fields for Username and Password, and a 'Remember Me' checkbox.
- High Resolution TEM Image:** A scientific image showing a crystal lattice structure with a corresponding energy-dispersive X-ray (EDS) spectrum overlaid on the right side.

Expanding the Functionality of Collaboration Tools



TelePresence Microscopy

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 an **eLab**
- Maintain Contact with Colleagues Regardless of Location

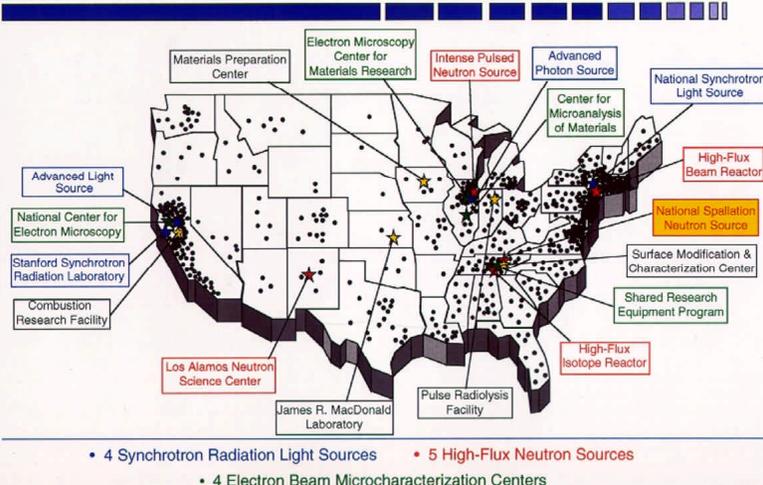


– R&D, Education, Teaching, Training to/from Remote Sites



Office of Basic Energy Sciences

18 Scientific User Facilities (☆) and 1,400 Research Projects at 200 Institutions (●)



Materials MicroCharacterization Collaboratory



The Collaboratory Concept



A “... ‘center without walls,’ in which the nation’s researchers can perform their research without regard to geographical location

- interacting with colleagues,
- accessing instrumentation,
- sharing data and computational resources, [and]
- accessing information in digital libraries.” *Bill Wulf (1989)*

Adding value to Scientific User Facilities through

- accessibility, utilization, and integration of unique facilities;
- enhanced ability to assemble multidisciplinary teams
- new science by supporting collaboration and sharing across a gamut of tasks

TelePresence Collaboratory Deployment is Growing



TelePresence Collaboration



MultiSite Collaboration

The screenshot displays a multi-site collaboration interface. On the left, three video feeds are visible: the top one is labeled 'Zaluzec@ANLTPM' and shows a man with a beard; the middle one is labeled 'NIST - S4500' and shows a man in a white shirt; the bottom one is labeled 'M. Bennett' and shows a woman. Each video feed includes a status bar with frame rate or data rate information (12.3 fps, 46 Kbps, and 0.0 fps respectively). On the right, a large window titled 'Netscape: TelePresence Spectroscopy Remote XEDS/XES Control' is open. The browser address bar shows 'http://tpm.ans.anl.gov/TPM.pl'. The main content area of the browser window is titled 'AAEM/TPM Project' and 'TelePresence Spectroscopy Mode at Argonne National Laboratory'. It features two main panels: 'AAEM BF/DF Image' with a microscope image and 'X-ray / Electron Spectrometer' with a spectral plot. Below these panels are control buttons for 'Microscope Controls' and 'Spectrometer Controls'. At the bottom of the browser window, it indicates 'User Status = Novice Level' and 'Return to Standard TPM Operating Mode' with three radio button options: '30" Screen Low Res', '17" Screen Low Res', and '17" Screen Low Res'.

Remote Collaboration Example ANL - NIST - TI



Complete copies
available on
VideoTape or CD
Contact:
postek@nist.gov
zaluzec@anl.gov

Educational Outreach / Distance Learning

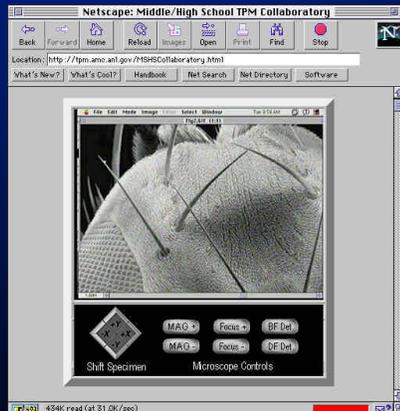
- Electronic collaboratories are a natural and accessible educational resource
- Web-based, schools should not require specialized software / hardware
- Teaching should be interactive
- Learn to “collaborate” remotely

Middle/High School Collaboratories



TelePresence Microscopy

Middle/High School Collaboratories



Netscape Client on Mac's & PC's in Classroom provides simple and inexpensive interface where students and remote instructors can interact with Microscopes.



Live Video Conferencing using "CuSeeMe" provides low cost interactions between Instructor and Students

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)



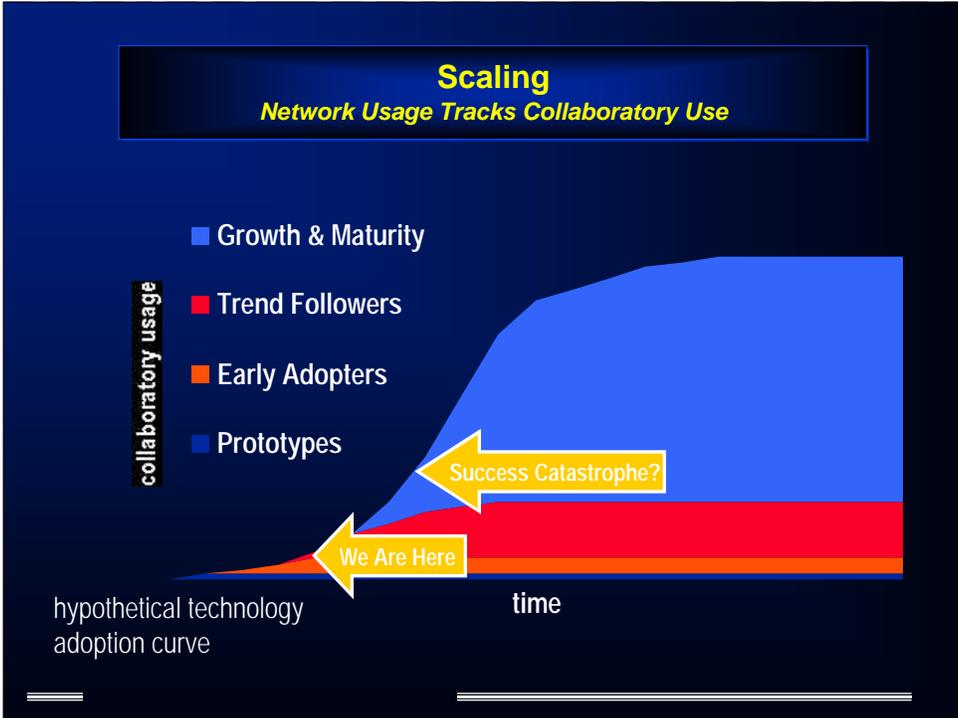
Collaboration Centers Are An Important Part of the Evolving Access Grid!!!

- ACCESS-DC
- Argonne
- NCSA and others at the Univ of Illinois
- Univ of Ill at Chicago
- Univ of Kansas
- Old Dominion University
- San Diego Supercomputing Center
- Sandia
- Los Alamos
- Livermore
- Univ of New Mexico
- Univ of Kentucky
- Boston University
- Univ of Utah
- Univ of Minnesota
- Maui HPC
- Virginia Tech
- Ga Tech
- NASA
- Army Research Labs
- DoD Mod Program Sites

InterOperability of TPM with Other Internet Tools

Access Grid

Metro



TelePresence Microscopy

Vision

The key to the understanding the TelePresence Microscopy Collaboratory and it's role is to remember that ultimately, it is *not simply the presence of, or access to instrumentation* that produces new ideas, better students or new science.

TelePresence Microscopy

Vision

Instead, advances results from the *work of individuals who learn from their interactions with others*. These individuals continue to interact, to formulate ideas , develop new instruments/technology or execute “experiments” to solve vexing problems, expand their knowledge and understanding , and this carried out using the tools which we have placed at their disposal.

TelePresence Microscopy

Vision

In the TPM, a *Functional Collaboratory* is the “tool” which we are developing and/or extending. The concept of an *Interactive Persistent Electronic Space* is a major component of a collaboratory that enables scientists to work together.

Demonstration Connection to ANL TPM Site

Accessing the TPM Collaboratory from your DeskTop Computer

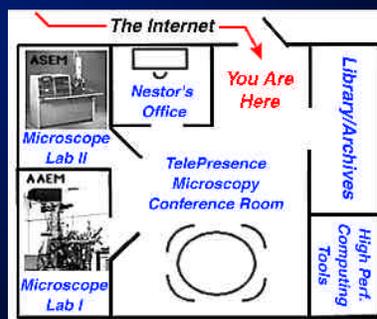
- **Install a copy of NetScape Version 2.0 or better on your Computer**
 - The TPM Server software is computer platform independent you may use any **Macintosh, Intel/PC, or Unix** computer. The faster your CPU the better the performance, a high resolution 17" (800 x 600 pixel) monitor is recommended but not required.
 - Microsoft *Internet Explorer (IE)* software is *not compatible* with the TPM server
- **Using your WWW Browser login to the TPM Public Site**
 - <http://tpm.amc.anl.gov>
 - Use the fastest connection to the Internet you can obtain
 - Fast Modems are usable but not recommended
 - ISDN is acceptable, T1 connections are fine
- **To Operate the Microscope over the Internet**
 - You must login to the TPM Private Site.
 - This requires authorization and is password protected.
 - Video Conferencing software is recommended but not necessary a Telephone may substitute
 - Contact Colin Macrae to discuss your experiment and/or needs

ANL TelePresence Microscopy Collaboratory

<http://tpm.amc.anl.gov>

Zaluzec @ AAEM. AMC.ANL.GOV

TelePresence Microscopy Collaboratory



<http://tpm.amc.anl.gov>

Connection to Nestor's Office

