Generalized Teleinstrumentation

telescience

NCMIR
NATIONAL CENTER for MICROSCOPY and IMAGING RESEARCH
at San Diego, an NIH supported research center

What is Generalized Teleinstrumentation?

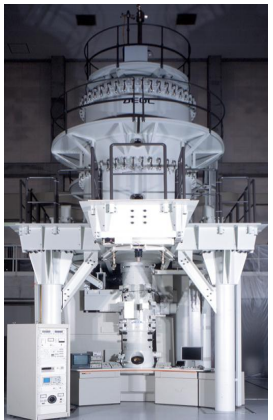
•The Teleinstrumentation system is a secure system allowing users to remotely control instruments, acquire image data at various resolutions, and collaborate with other scientists around the world.

•The new Generalized Teleinstrument System is based on a Service Oriented Architecture because it incorporates WebService standards and Grid standards to provide the functionality of controlling an instrument in a collaborative environment and to handle the large amounts of data coming from the instrument.

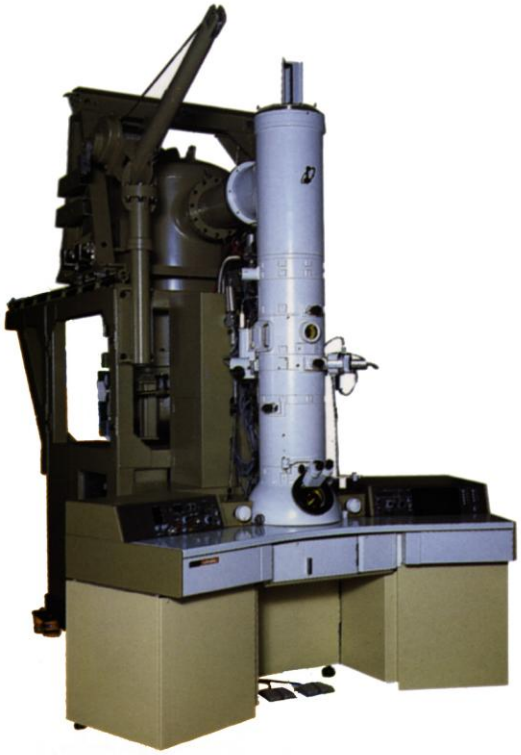
•By using standard Grid and Webservice protocols, our software allows interoperability with what the Telescience Project (https://telescience.ucsd.edu) has already developed.

•The goal is to allow scientists to acquire meaningful datasets remotely while having the entire data product tracked by the telemicroscopy system.



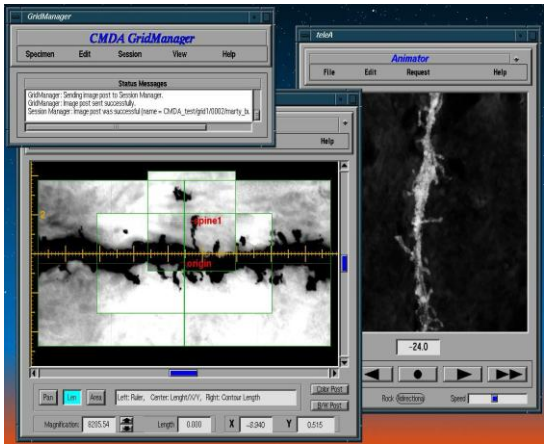



Telemicroscopy Began as a Pioneering Effort to Provide Remote Access to Scientific Resources

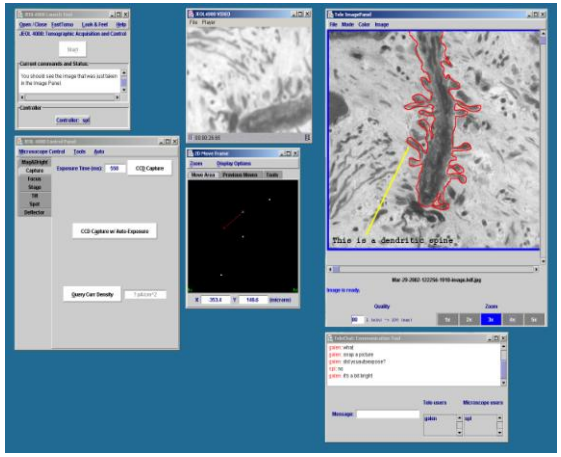


-Began by remotely controlling the JEOL4000 Electron Microscope located in NCMIR/UCSD.

-Able to modify microscope parameters, acquire 2K x2K images, provide a collaborative environment for scientists.



Telemicroscopy (GridManager), circa 1992



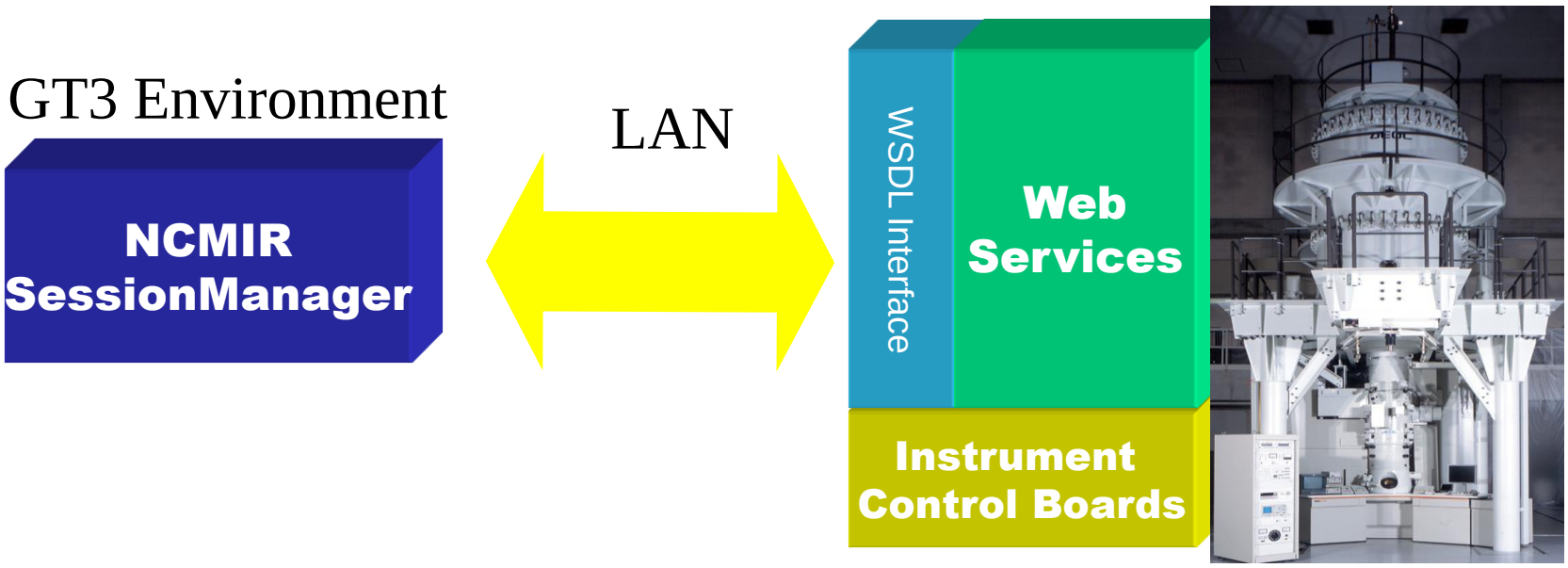
Telemicroscopy (VidCon2), circa 1999-2003

Exposing Instruments as Web Services

• Currently Working with various Instrument Manufactures (such as JEOL, Gatan, Tietz, Nikon,Zeiss) to develop a Web Service Layer on top of instrument drivers and current instrument software. We have signed confidentiality agreements with all companies.

•Instrument Webservices are C,C++ or .NET webservices on top of instrument control and camera drivers. The robustness and flexibility of Webservices allows us to easily integrate several instrument control boards and software.

•Eventually they are linked to the Session Manager GridService that acts as the central service for clients to communicate with the instrument.



TeleScience SessionManager Components

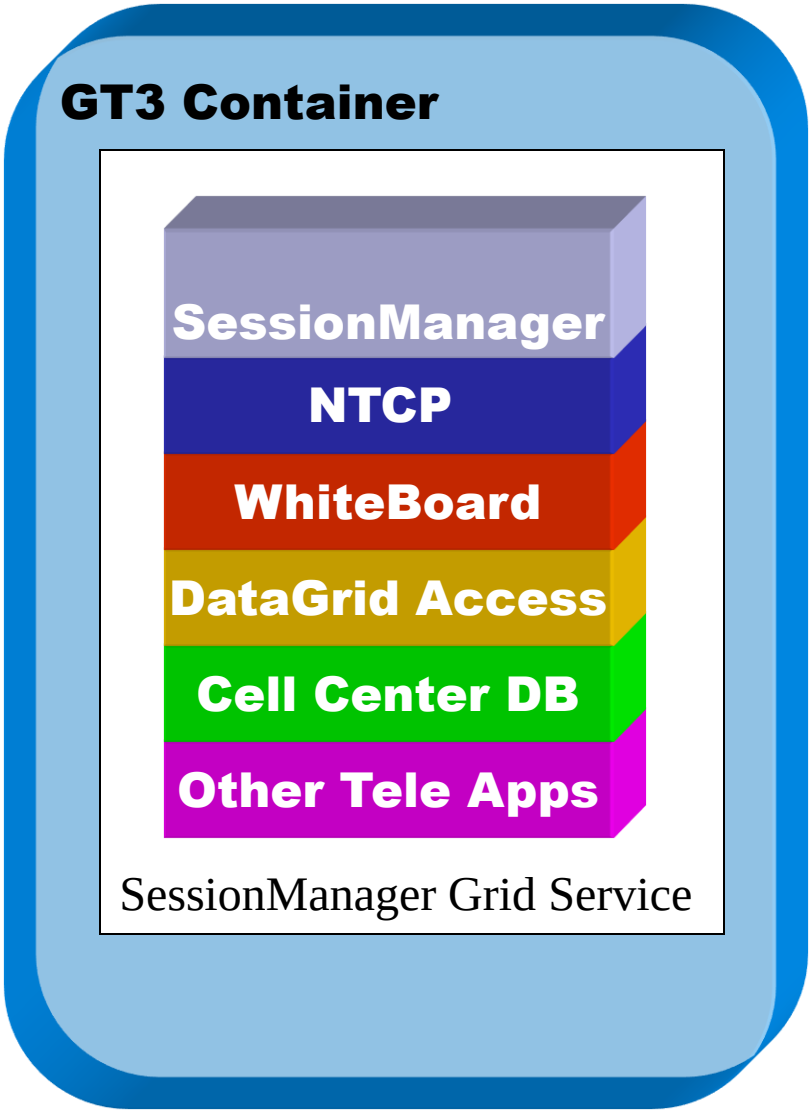
The SessionManager gridservice is composed of different operation providers:

•Maintains a secure session between all clients using Globus Security

•NTCP(NeesGrid Teleoperations Control Protocol) dispatches requests to the instrument plugin modules for execution.

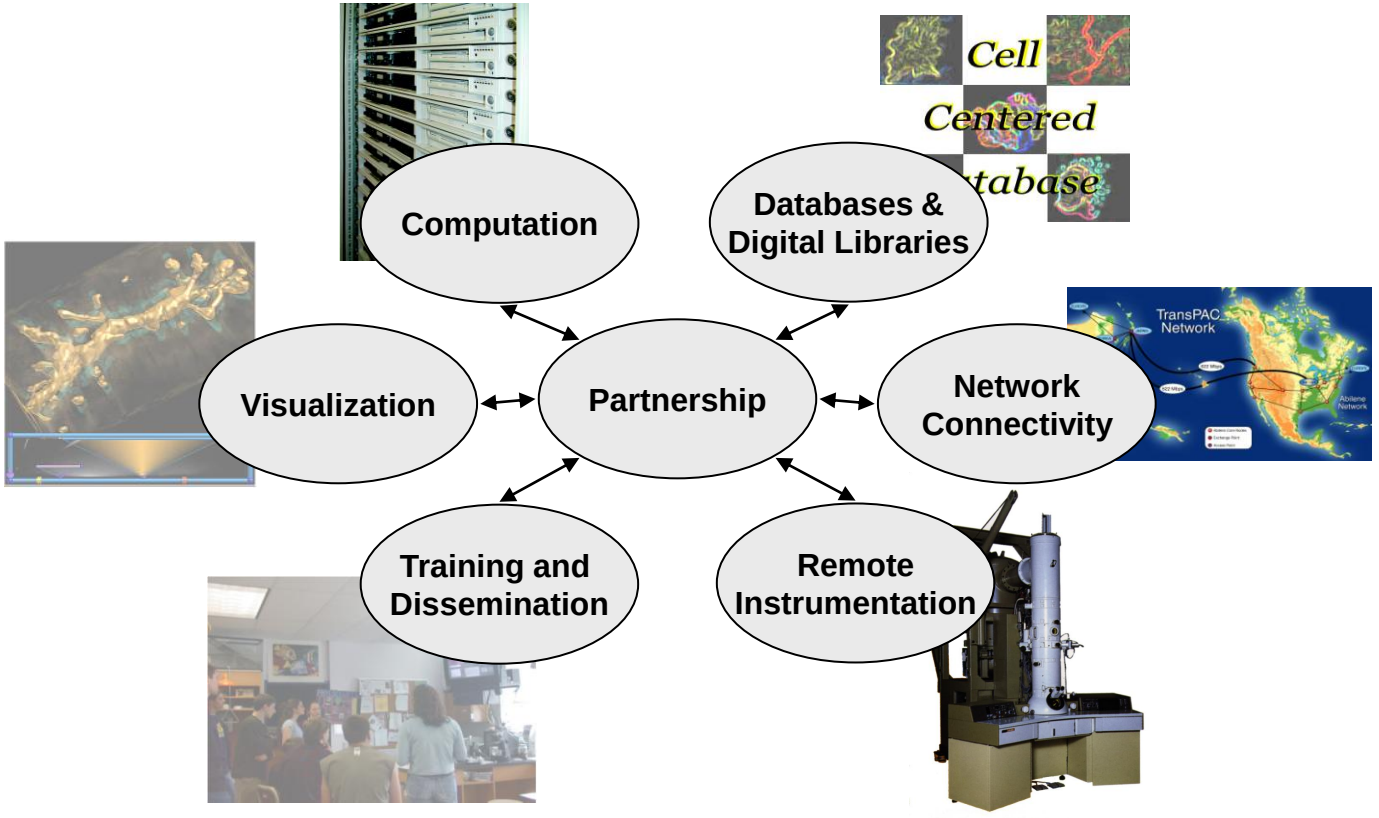
•The Whiteboard provides collaborative features for clients to share information about the data that is being acquired from the instrument. Features include text based communication, sharing image overlays.

•The SessionManager also allows access to the information in the Cell Centered Database and accessing other Telescience Applications for processing data.



The Telescience Core Methodology

Integrate resources, technologies and applications using standardized Grid middleware technologies and advanced networking to provide an end-to-end solution for challenges like multi-scale biomedical imaging.

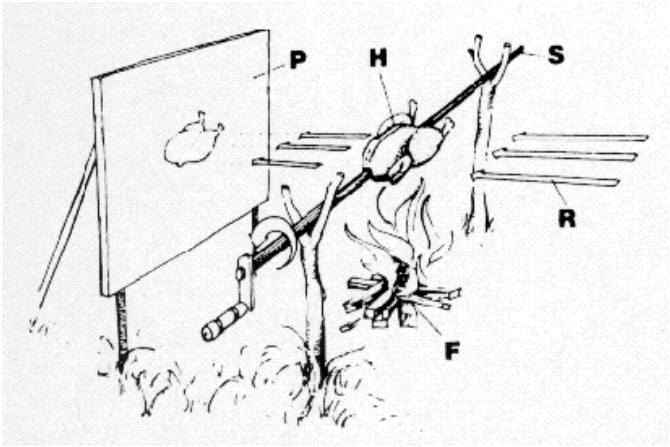


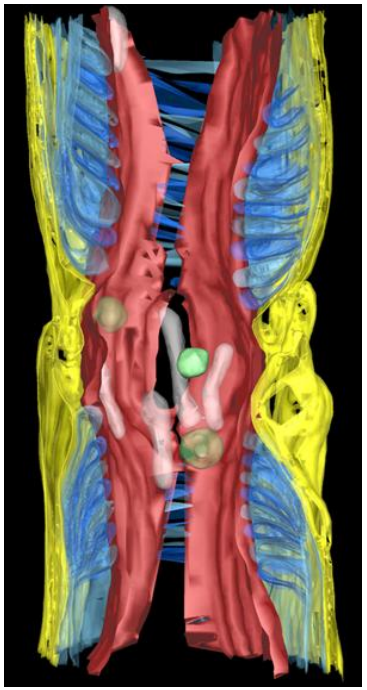
Electron Microscopic Tomography is a Testbed Driver for Telescience

Derive 3D information about a sample from a series of 2D projections.

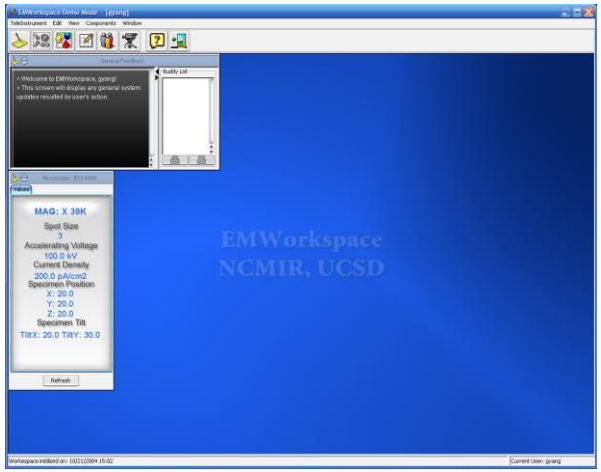
Perfect application for driving the integration of technologies:

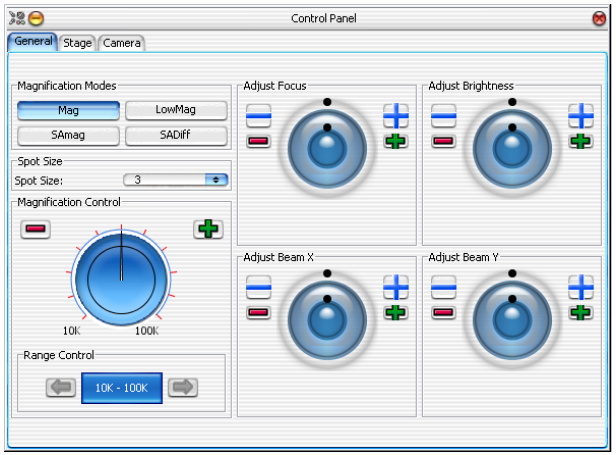
- **Computation and data intensive**
- **Requires increased access to unique, expensive instrumentation**
- **Requires advanced visualization tools for segmentation and analysis of the data**
- **Detailed process well suited for collaboration**
- **Demand from neuroscience community for accelerated population of databases of biological structure**

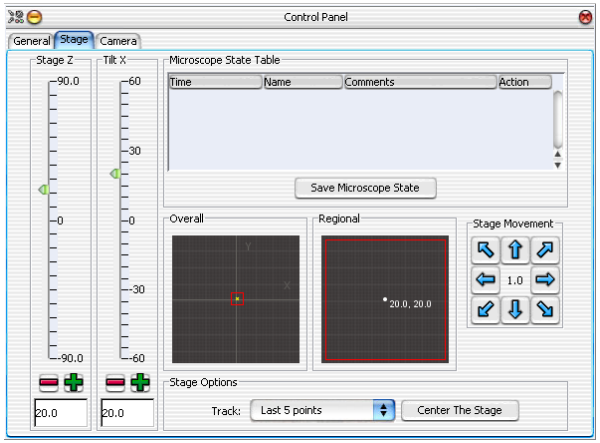


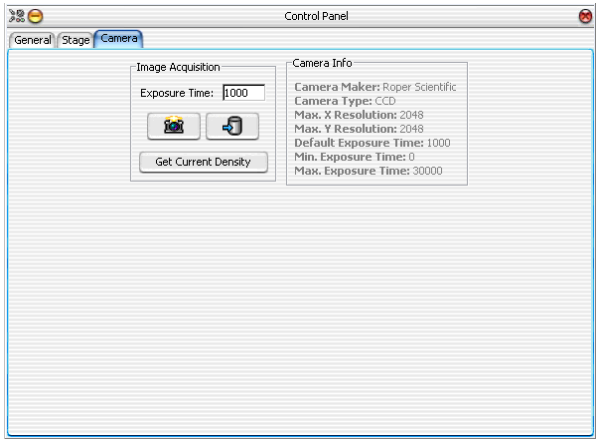


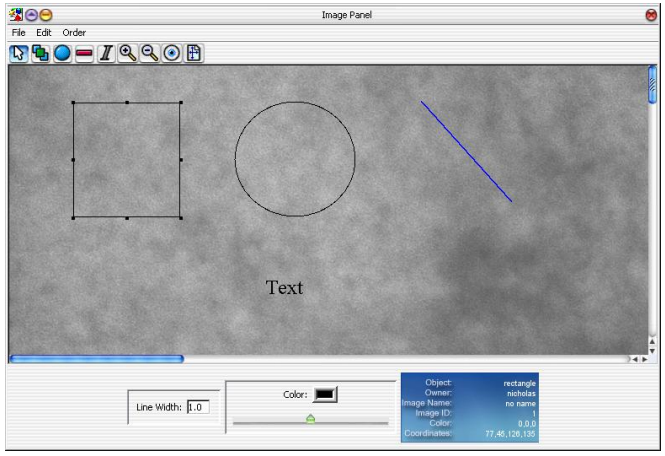
EM Workspace

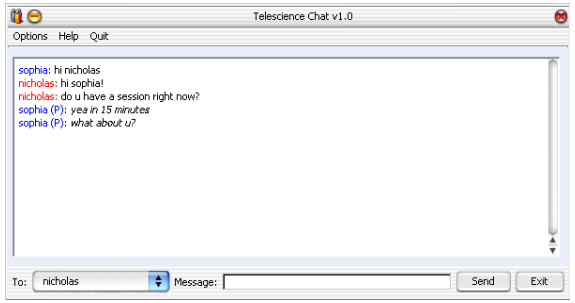


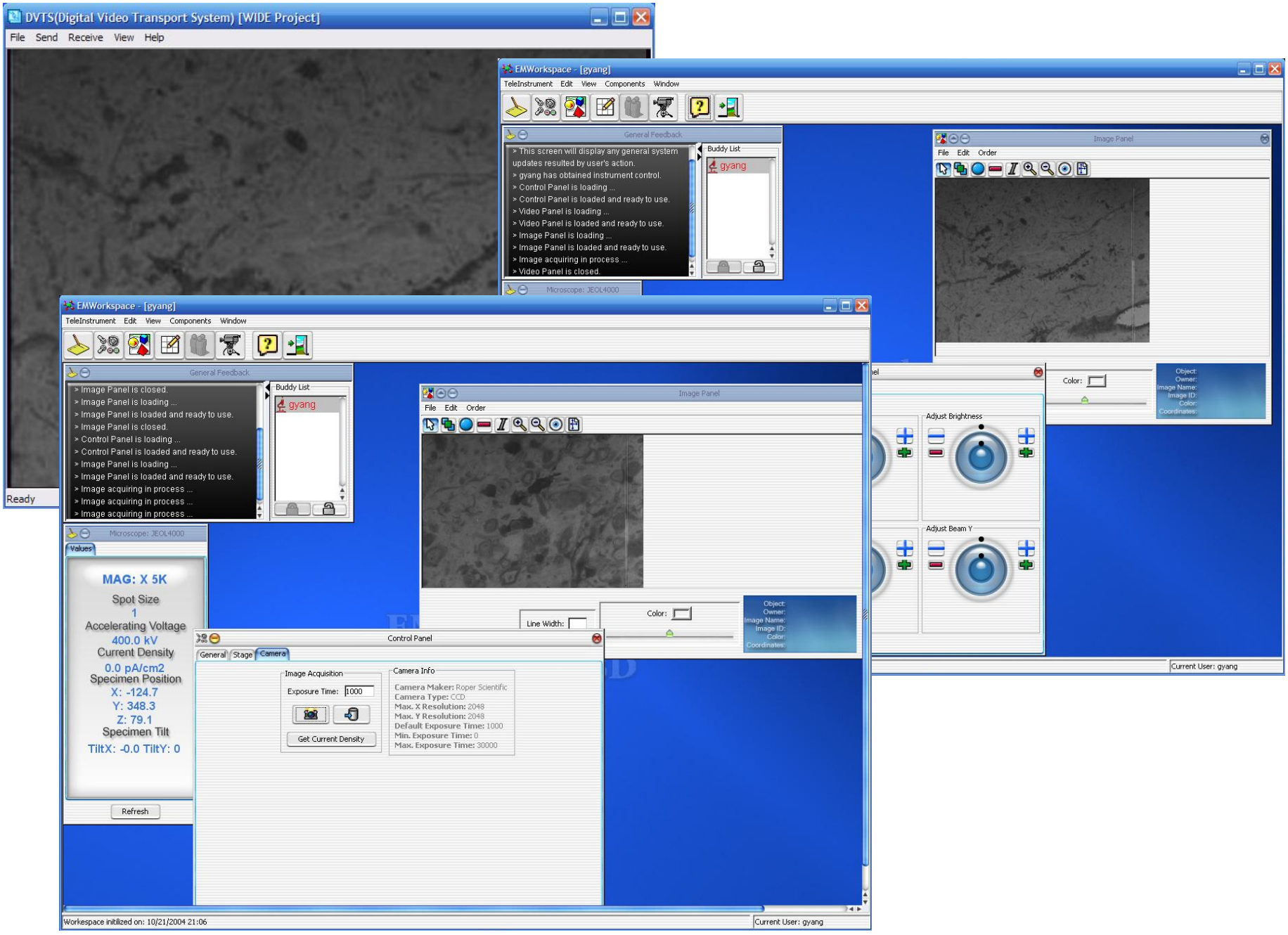











DVTS(Digital Video Transport System) [WIDE Project]
File Send Receive View Help
Ready
EMWorkspace - [gyang]
TeleInstrument Edit View Components Window
General Feedback
> This screen will display any general system updates resulted by user's action.
> gyang has obtained instrument control.
> Control Panel is loading ...
> Control Panel is loaded and ready to use.
> Video Panel is loading ...
> Video Panel is loaded and ready to use.
> Image Panel is loading ...
> Image Panel is loaded and ready to use.
> Image acquiring in process ...
> Video Panel is closed.
Buddy List
gyang
Microscope: JEOL4000
Image Panel
File Edit Order
Color:
Object:
Owner:
Image Name:
Image ID:
Color:
Coordinates:
Adjust Brightness
Adjust Beam Y
Current User: gyang
EMWorkspace - [gyang]
TeleInstrument Edit View Components Window
General Feedback
> Image Panel is closed.
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> Control Panel is loaded and ready to use.
> Image Panel is loading ...
> Image Panel is loaded and ready to use.
> Image acquiring in process ...
> Image acquiring in process ...
> Image acquiring in process ...
Buddy List
gyang
Microscope: JEOL4000
Values
MAG: X 5K
Spot Size
1
Accelerating Voltage
400.0 kV
Current Density
0.0 pA/cm2
Specimen Position
X: -124.7
Y: 348.3
Z: 79.1
Specimen Tilt
TiltX: -0.0 TiltY: 0
Refresh
Image Panel
File Edit Order
Line Width:
Color:
Object:
Owner:
Image Name:
Image ID:
Color:
Coordinates:
Control Panel
General Stage Camera
Image Acquisition
Exposure Time: 1000
Get Current Density
Camera Info
Camera Maker: Roper Scientific
Camera Type: CCD
Max. X Resolution: 2048
Max. Y Resolution: 2048
Default Exposure Time: 1000
Min. Exposure Time: 0
Max. Exposure Time: 30000
Workspace initilized on: 10/21/2004 21:06
Current User: gyang

TeleInstrument Software

- Globus 3 Toolkit (Middleware Technology)

  -SessionManager (one Grid service per instrument)

- Java Client (EM Workspace)

  - Java Media FrameWork, Java Swing, Java Advanced Imaging, globus libs

  -Collaboration components such as text based chatting and drawing overlays on 2D high resolution images.

- Storage Resource Broker v.2.2 and v.3.0

  -Data Grid used for storing data coming from the instrument

- C/C++/.NET webservices (Server-side)

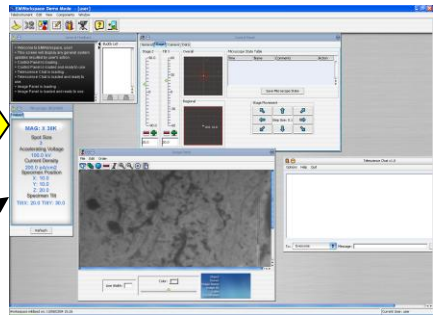
  -Services used for backend control of the instrument.

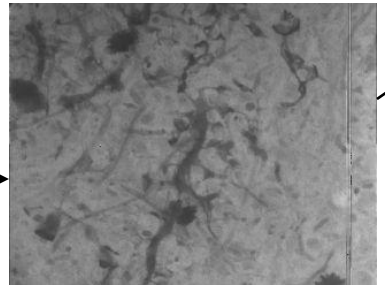
Current Workflow Scenario

Instrument

GT3 GridService

Java Client





Single image:

2K x 2K x 2 bytes = 8MB

4K x 4K x 2 bytes = 32MB

1. User will log into a current session and will acquire control. User will manipulate microscope parameters (Magnification, Brightness, Focus, X and Y stage moves etc.)

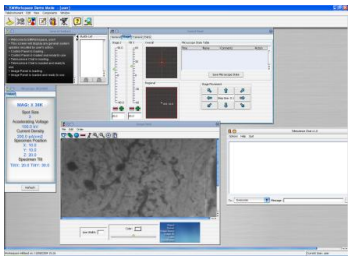
2. Once the user has discovered a potential area, they can acquire a high resolution with one of the instrument cameras. Each image is deposited into the data grid as well.

3. If the data is acceptable to the user, they can then go ahead and deposit it into the Database along with information from the instrument.

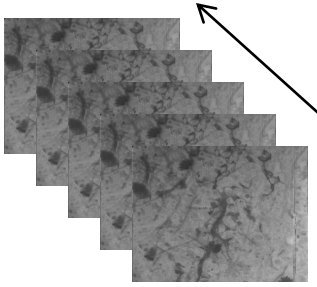
Future Workflow Scenarios

Instrument

Java Client

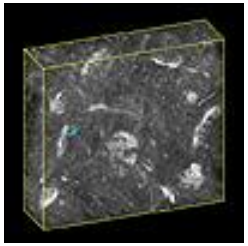


NCMIR SessionManager



Acquired at various tilts

Computational Resource



3D volume data set

-1k x 1k x 2 bytes x (60 images) = 120MB

-2k x 2k x 2 bytes x (60 images) = 480MB

-4k x 4k x 2 bytes x (60 images) = 1.9 GB

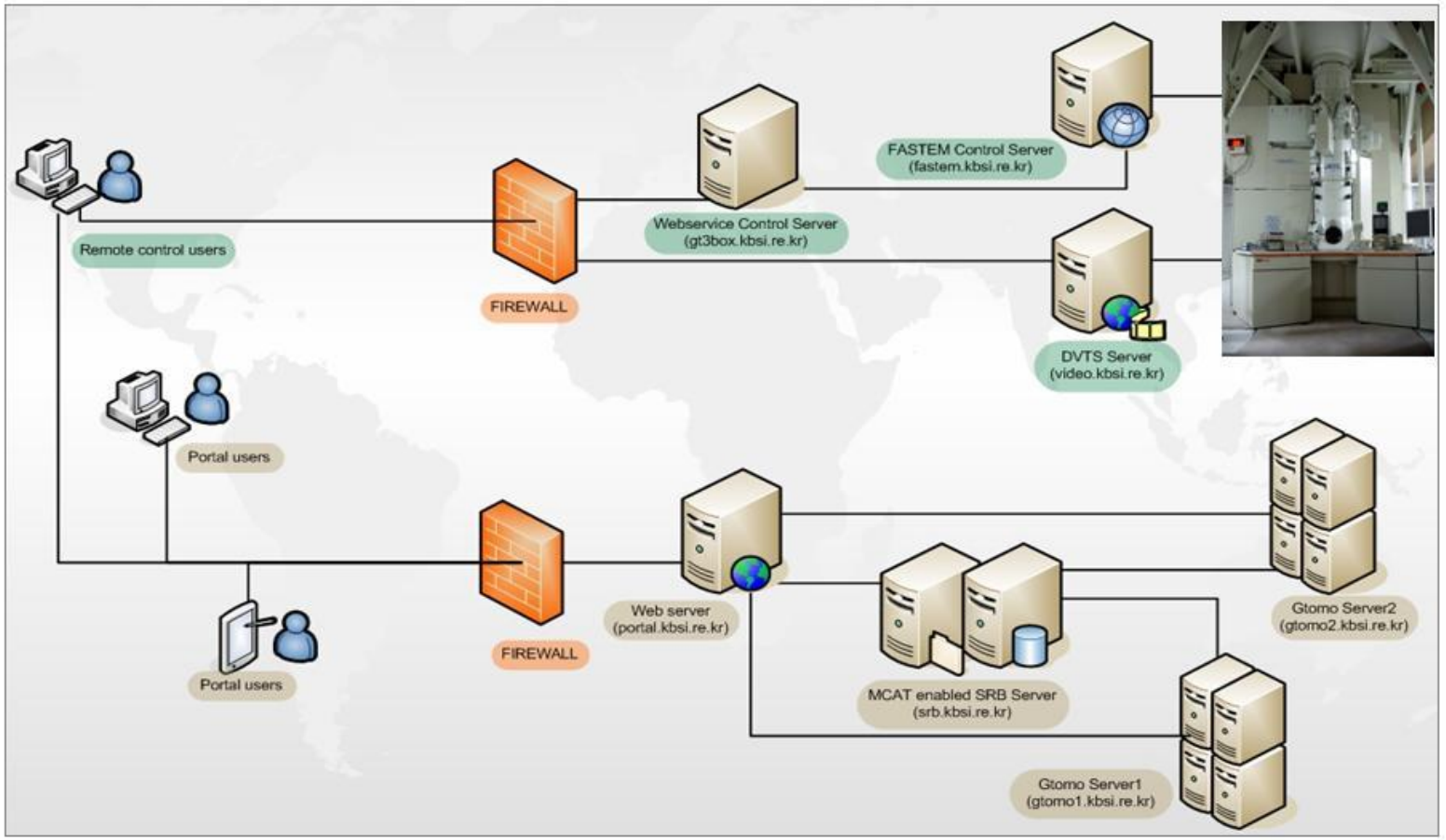
4. User is interested in acquiring a 3D dataset but needs to ensure that he/she has found a useful area. Can acquire a series of images so that a simple back projection algorithm can reconstruct the dataset.

5. A quick low resolution volume is produced for the user to decide if a high resolution acquisition would be useful.

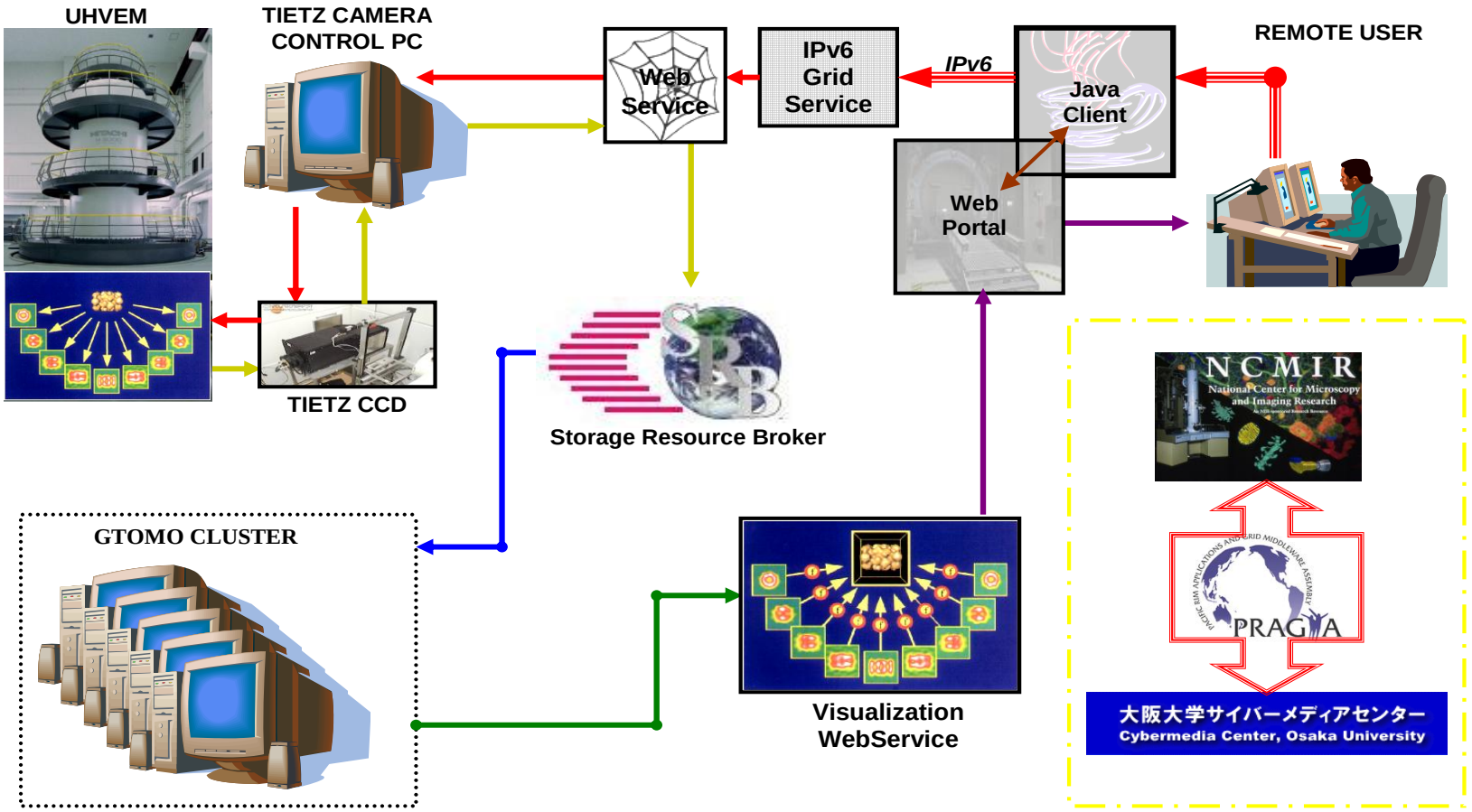
Deployed Telescience/Telemicroscopy system on the KBSI/KISTI Grid Environment

UHV-TEM Telescience

- Computational Setup for Tomography
- Telemicroscopy Upgrade with NCMIR/UCSD



Deploying Telescience on the world's most powerful electron microscope



Built on GT3 and ready for GT4

- **Currently the Telemicroscopy system is built using OGSI API interfaces.**
- **The WS-Resource Framework & WS-Notification for GT4 are an evolution of OGSI**
- **GT4 OGSA Services can be defined and implemented as Web services**
- **The Teleinstrument system can take advantage of GT4 Web services standards as well**