VANDERBILT UNIVERSITY School of Medicine

OME at Vanderbilt

Michael J. McCaughey, PhD

Dept. of Molecular Physiology and Biophysics

Topics

- Research at Vanderbilt
- Cell Imaging Shared Resource
- Imaging and OME
- Future Plans
- Potential Contributions

Vanderbilt Research

- 15th in NIH funding; fastest growth rate
- 8 of top 10 NIH funded programs
- 24th in Federal research funding
- $444 million research project awards
- Research programs partner with 832 bed teaching/research hospital complex
- Expanding Bioinformatics/Imaging research

CELL IMAGING SHARED RESOURCE

CISR - A shared optical imaging resource, available for all researchers with appointments at Vanderbilt University.

Center funded and internally directed

A Variety of High Performance Tools

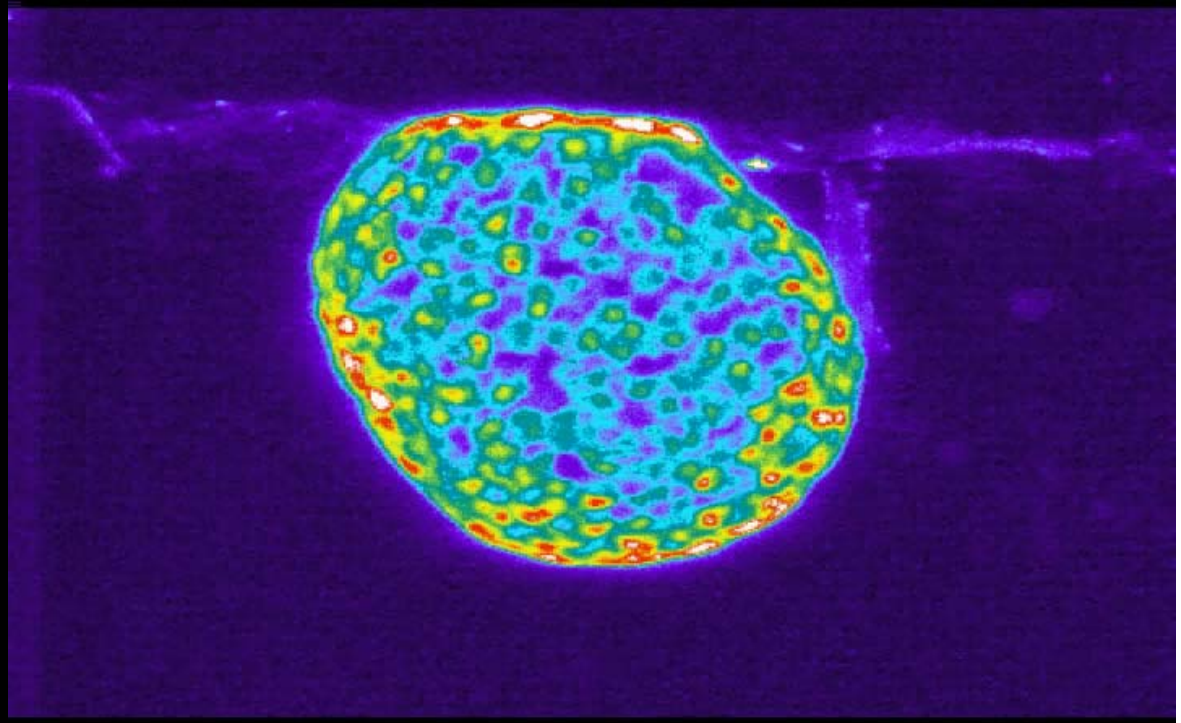
- Confocal Microscopes
  4 LSM 510/LSM510 Meta
- Wide-field Microscopes
  Zeiss, Nikon, Olympus, Leica
- Two-Photon Microscopes
  Zeiss LSM410, Nikon
- Electron Microscopy
  Phillips CM12 & CM-20, Hitachi X-650
- “Real-Time” Confocal
  LSM 510 Live

Capacity, Utilization

- Facility Access: 24 hours/day, 7 days/week
- Current Confocal Use: ≈ 700 hours / month
- Current Widefield Use: ≈ 300 hours / month
- PI's (research groups): ≈ 250, mostly VUMC
- Individuals utilizing confocal services in the past 6 months > 400

LSM 5 LIVE

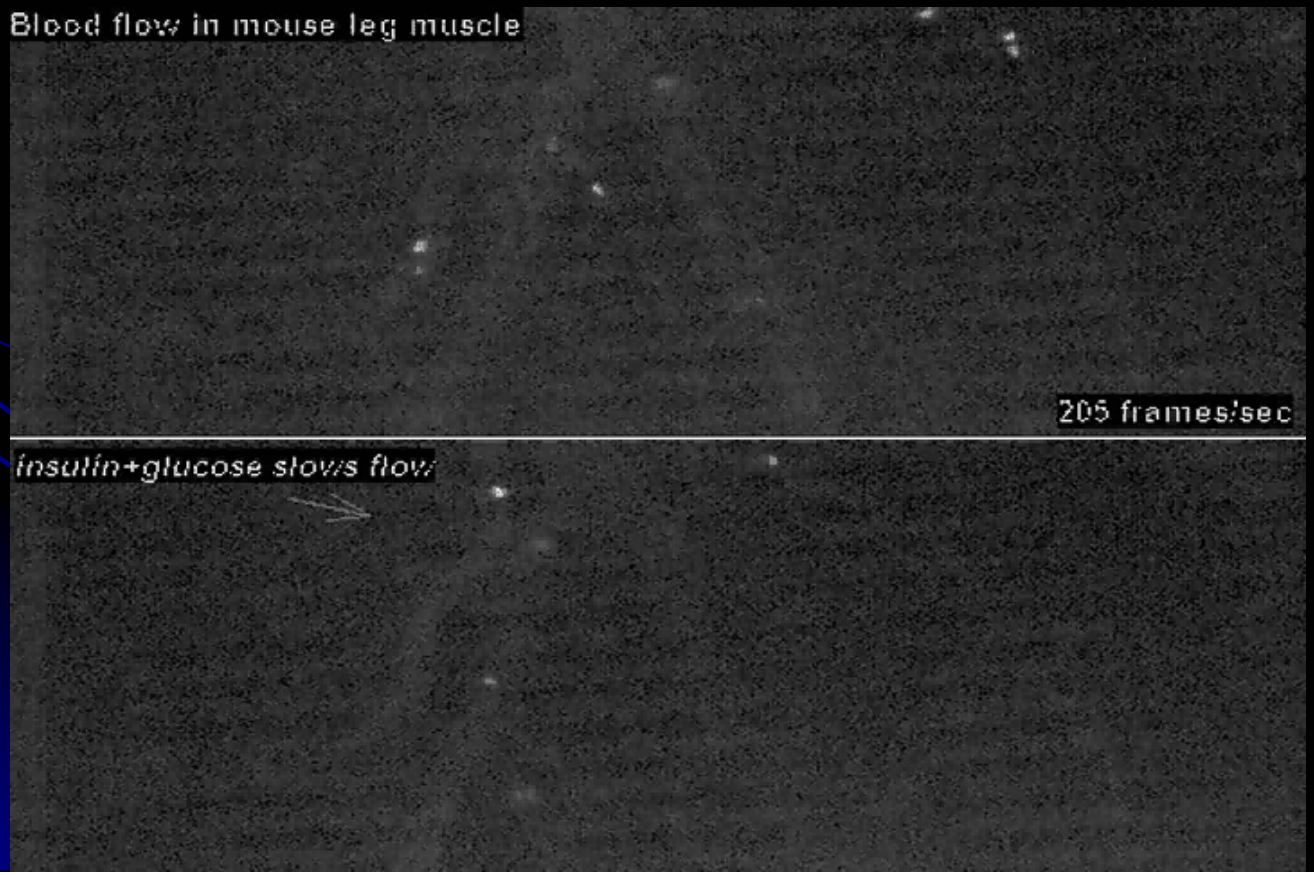
"Real-time" extended focus projections (3D) of pancreatic islet loaded with fluo-4. Calcium waves propagate across the islet following addition of 10 mM glucose; the oscillations in individual cells are relatively in phase. The advantage of imaging with the LSM 5 Live is that the calcium wave propagation across the islet can be temporally resolved.



Imaging condition: 20x/0.75 planapo, 8 z-sections at 2µm intervals, complete z-series 3/sec at 24 fps, 1.5% 488 laser was sufficient and did not appear to cause photodamage during imaging of >12,000 frames

LSM 5 Live Studies

Time-lapse sequence of blood cells flowing in small vessels in the thigh muscle of a live mouse. Fluorescent “spots” are individual red blood cells labeled with sulforhodamine B. Because the vessels were not labeled the image contrast was purposely reduced in the movies to visualize the faint outline of the vessels. The top half of the movie shows cells moving fast in the vessels prior to infusion of insulin + glucose which rapidly slowed the flow rate, caused by vasodilation (shown in the bottom half of the movie).



CISR Data Problem

Where do I store my images?

- Images are stored on scope PC
- Users are responsible for managing their own images
- “You leave it, you lose it” deletion policy
- Lost data = wasted effort

A better alternative…

OME and CISR

…is, of course, OME.

For CISR, OME solves the problem of:

- Image management
- Image retention
- Data storage
- Maintenance

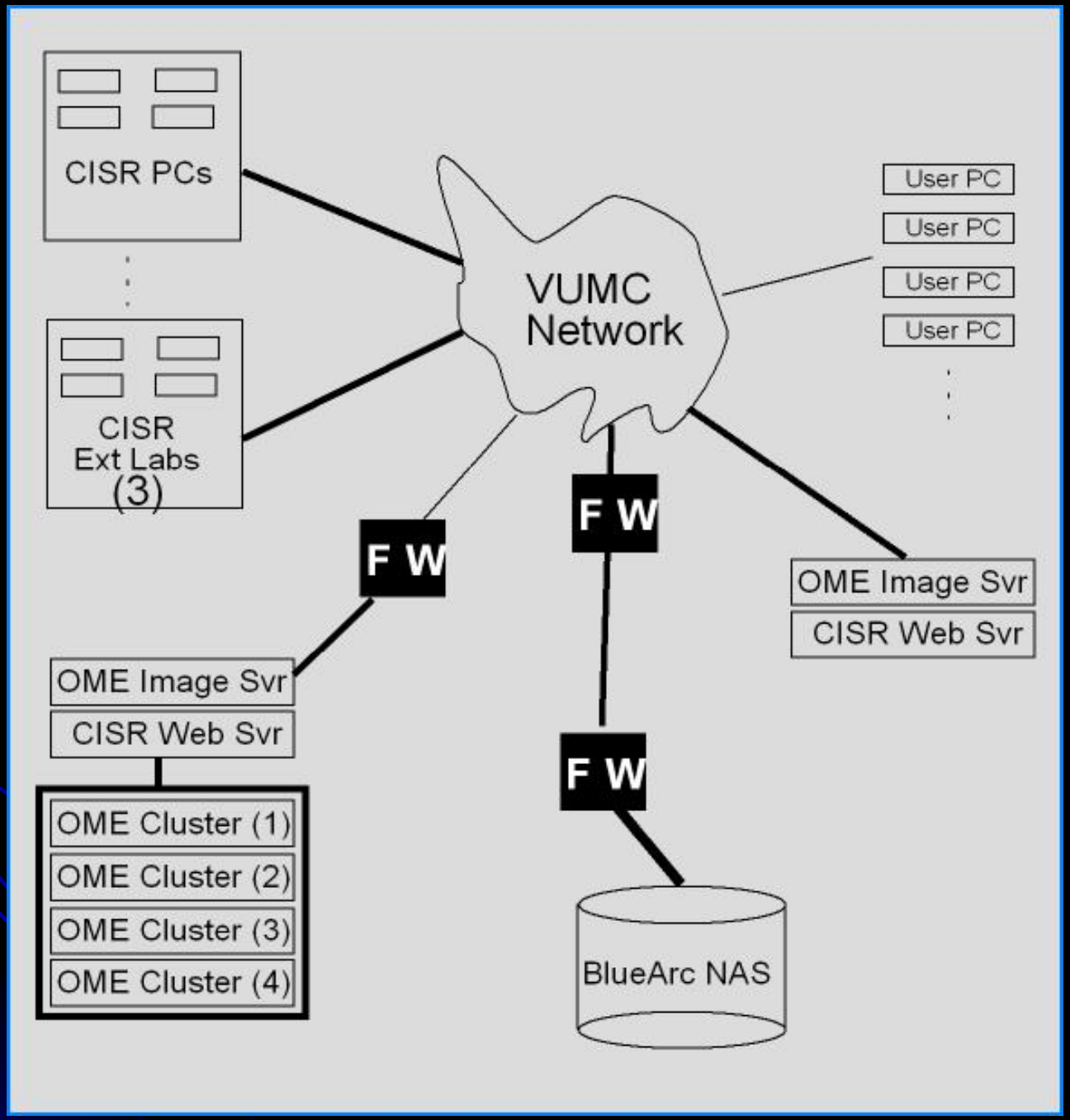
Implementation Design

We need an image capture and curation system that is fast, robust and easy to use.

GOALS:

- Capture images to DB in real time
- Five 9's or better uptime
- Minimum additional user training
- Low management overhead
- Low cost

Network Layout



OME SERVERS

- Web server (dual 2.6GHz Opteron 252)
  Scheduling, authorization
- OME server (dual 2.6GHz Opteron 252)
  OME, security
- Servers have redundant failover
- Currently running OME-perl
- GB fiber connection to VUMC network

Analysis Clusters

Local 8 processor Intel 2.4GHz Xeon

- MATLAB
- ROCKS cluster (CentOS)
- Tightly coupled with OME server

Integration with ACCRE

- 360 dual-processor X86 (2.0 GHz Xeon and Opteron) nodes
- 336 dual 2.2 GHz IBM PowerPC 970 (G5) J20 blades.

BlueArc

BlueArc Titan SiliconServers

- 20Gbps throughput
- Cache scales to 14GB
- 4 million files/directory
- Maximum Capacity: 256TB
  - Fiber Channel (10K)
  - SATA (7.2K)

Central Scrutinizer

- A package of PHP, perl and Java scripts that manage user interaction with CISR and OME.
- Schedule management/Calendar
- Training
- Personnel
- Billing
- Data/Image Management

How It Works

- User schedules scope time on Web site
  - Scripts check for training, authorization, first time user, updates calendars
- Scripts perform “nagware” functions
- User logs on at scheduled time
  - Custom WinXP pGina logon script mounts drive on BlueArc
  - Scripts update calendar, billing

How It Works (con't)

- User captures images directly to storage
- User logoff
  - Scripts auto-annotate images, import to OME
  - Unmount share
  - Scripts update billing, calendars
  - Optional notification of staff, next user
  - Optional hardware monitor
  - Optional service message

Back at the Lab…

- User logs on to OME web server
  - LDAP/AD authentication
  - CIFS mount user share from BlueArc
- User accesses new images (web or Shoola)
  Performs usual OME tasks
- Analysis can be directed to local cluster or ACCRE

..And at the Office

- Scripts manage new users

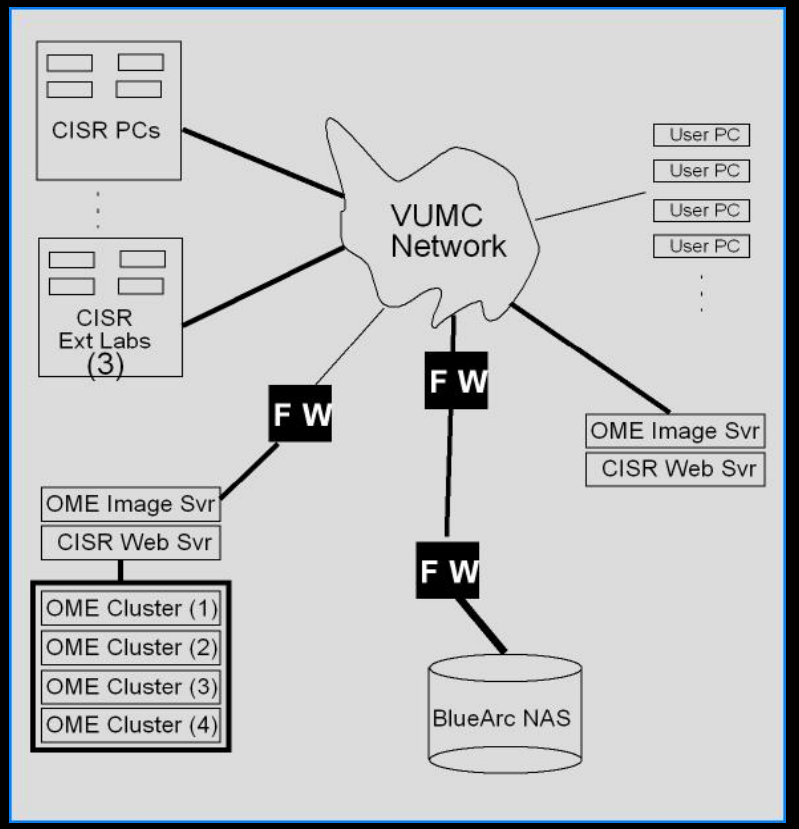
  Set access to microscopes,BlueArc share,
  OME, Web, local cluster and ACCRE

- PI billed for scope time, BlueArc space, cluster/ACCRE usage

- Scripts manage calendar and other maintenance functions

Potential Problems

- Speed, reliability (Firewalls, routers)
- Failover
- Backups
- Storage management
- User Management
- Security
  - Authentication
  - Authorization
  - HIPAA?



Possible Solutions

- Integrate AD/LDAP services with OME DB
- ACLs
- Local spool disk (5 LIVE)
- Avoid SMB?
- Private network
- Throw money

Contributions

VU would like to participate in and contribute to the future development of OME

- LDAP/AD module for OME-perl & OMERO
- User management tool
- MetaMorph file utility
- Billing/backend
- Distributed File Sharing

User Management

Webapp for adding and managing users

- Uses existing Apache web
- PHP and PostgresSQL based
- Can integrate with LDAP/AD
- Customizable with Plug-ins

Authentication

Modify OME-perl to use LDAP (or AD) authentication instead of local DB

- Complete, awaiting testing and generalization
- Integrate with OMERO
- Integrate with management tool
- Installable module

MetaMorph

MetaMorph intends to open their file format structure to developers

- MM v7.0 has a modular file engine.
- MM is converting from COM to DLL
- Available “end of May”
- Will allow native read/write to OME
- VU intends to integrate MM with OME
- Networkable electronic license

Backend

Any interest in a modular
“Central Scrutinizer”?

- Could be rolled as a package (web, calendar, user management, billing)
- Tight integration with OMERO possible?
- Depends on local lab structure and management style

Distributed File Sharing

- REDDnet – distributed data storage "depots" across US, Europe, Asia
- Fast (buffering) or slow storage
- exNodes portable file descriptor
- L-Store – VFS; Uses IBP common storage
- Metadata in XML format
- Distributed Hash Table
- Scales to Petabytes

L-Store

Details of file location hidden from user

Provides distributed access to metadata

Provides redundancy, security