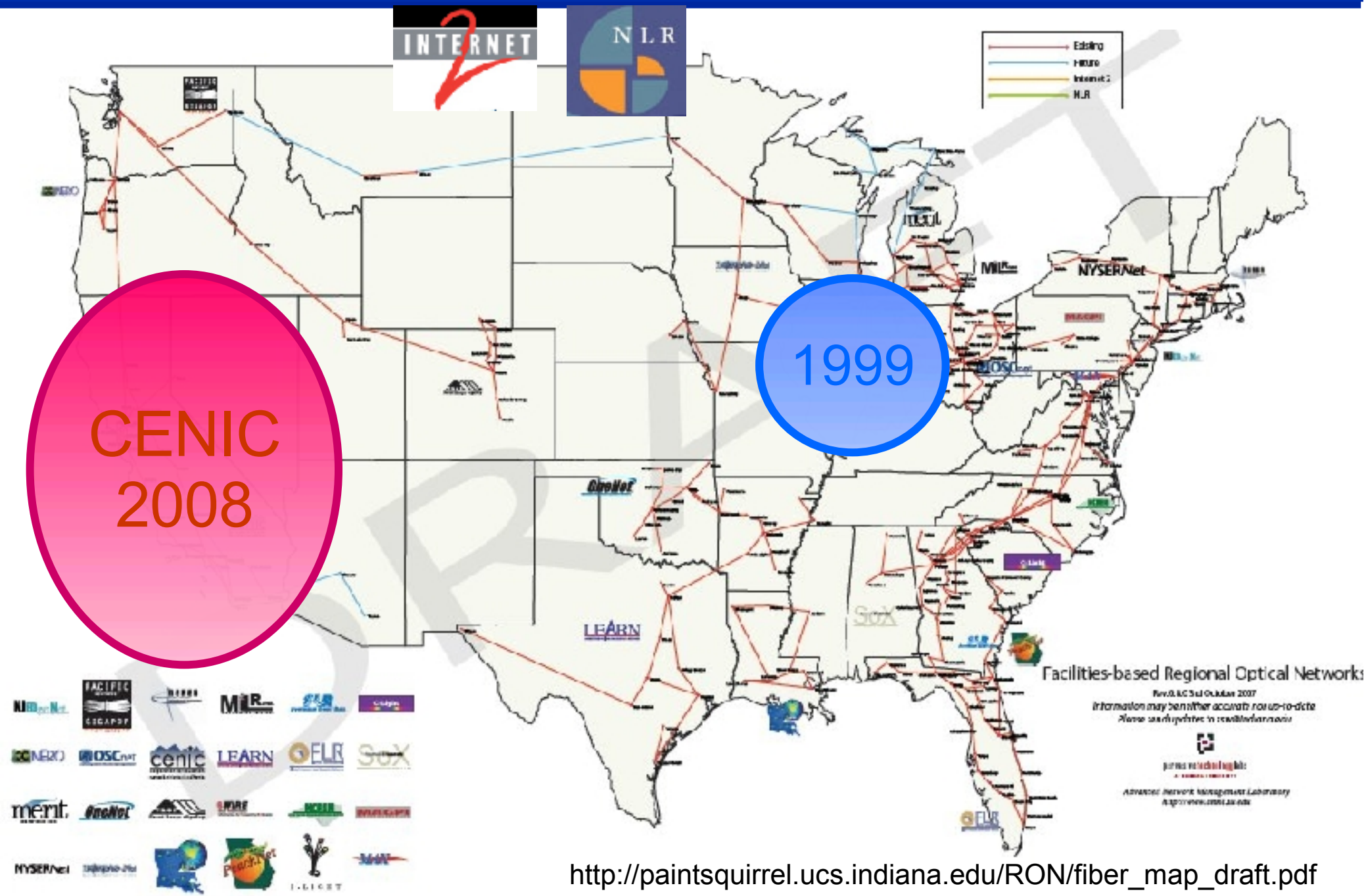
Using Photonics to Prototype the Research Campus Infrastructure of the Future: The UCSD Quartzite Project

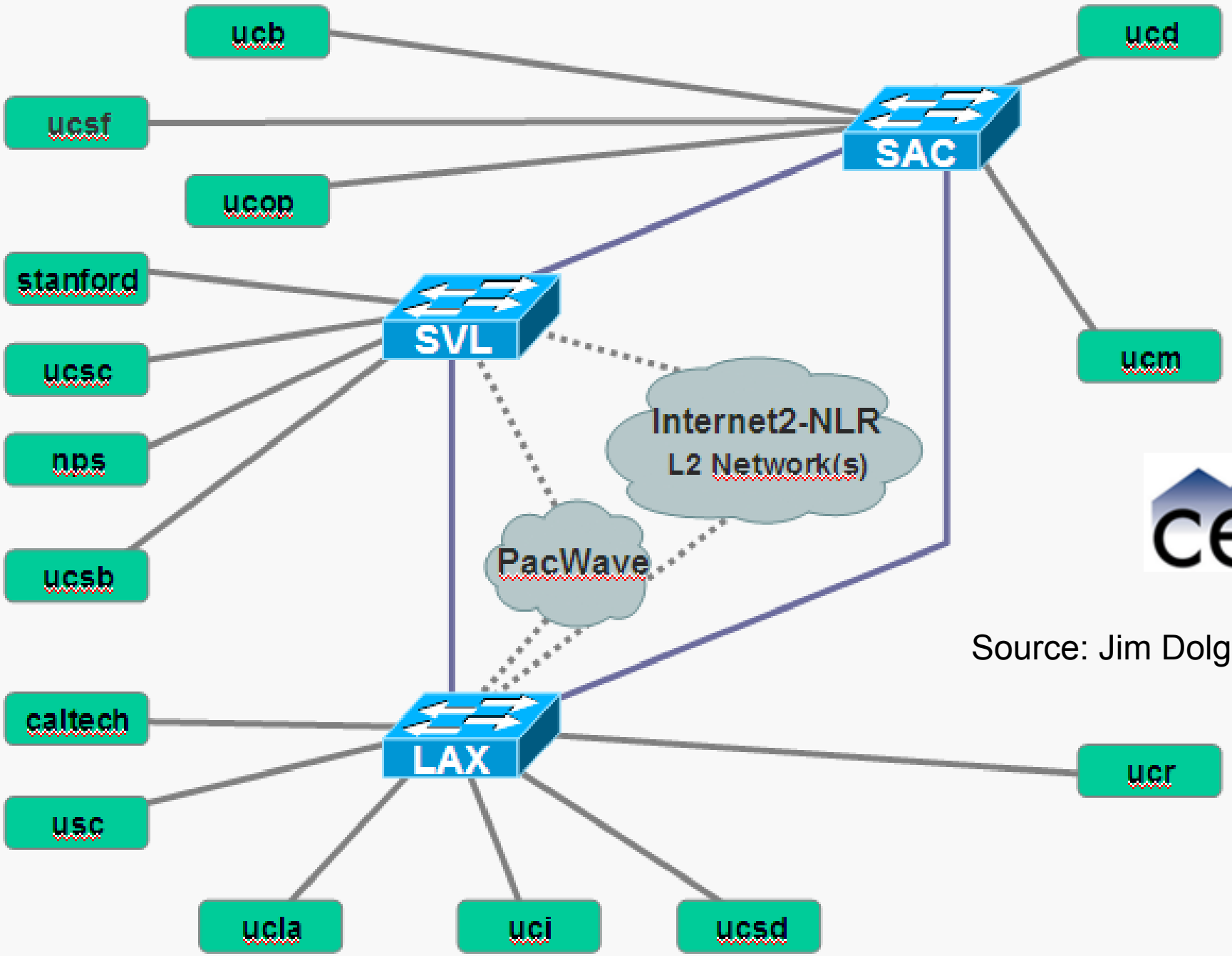
Philip Papadopoulos
Larry Smarr
Joseph Ford
Shaya Fainman
Brian Dunne
University of California, San Diego

Interconnecting Regional Optical Networks Is Driving Campus Optical Infrastructure Deployment



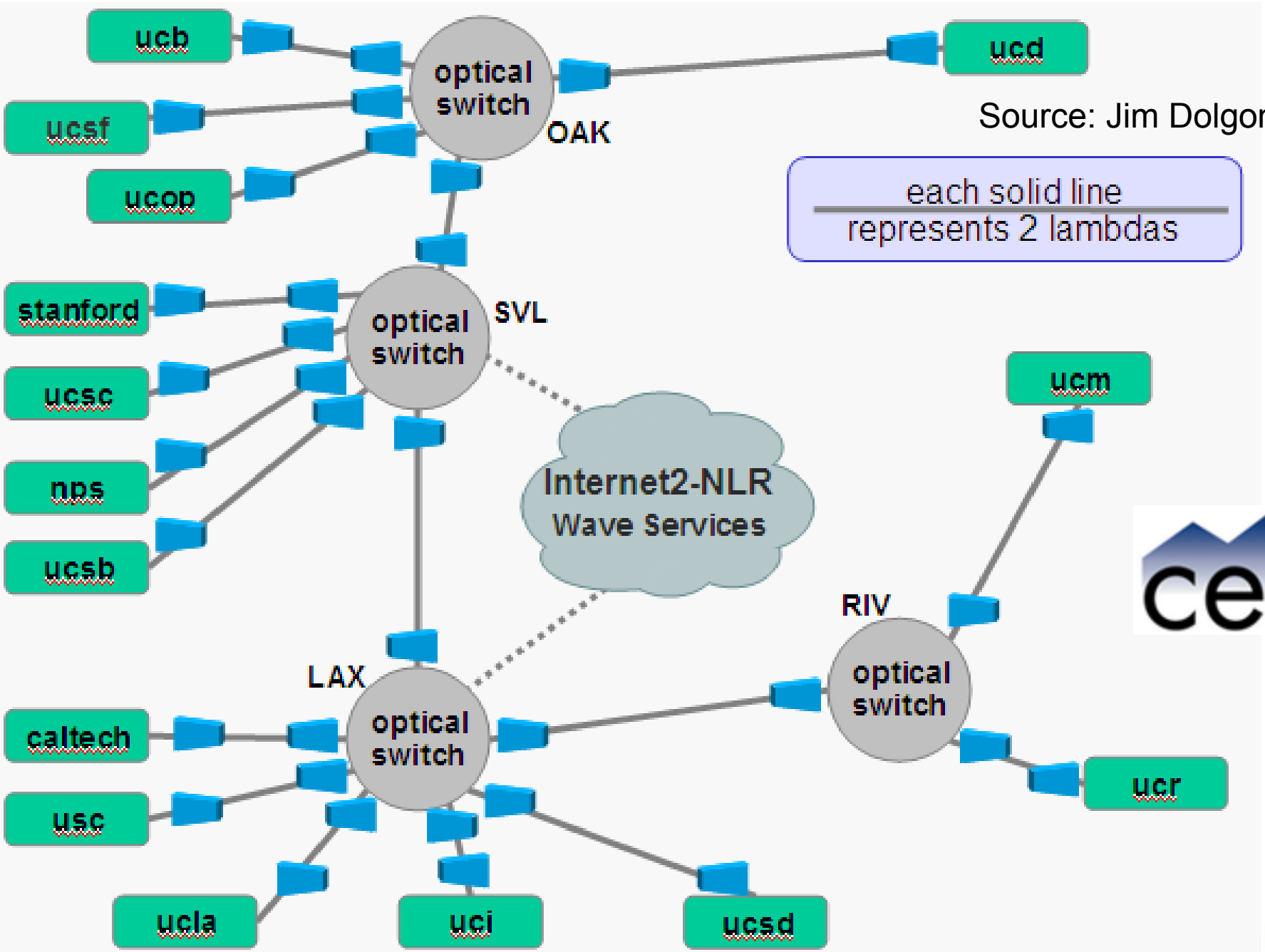
http://paintsquirrel.ucs.indiana.edu/RON/fiber_map_draft.pdf

CENIC Switched Ethernet Network
HPRng-L2 Design

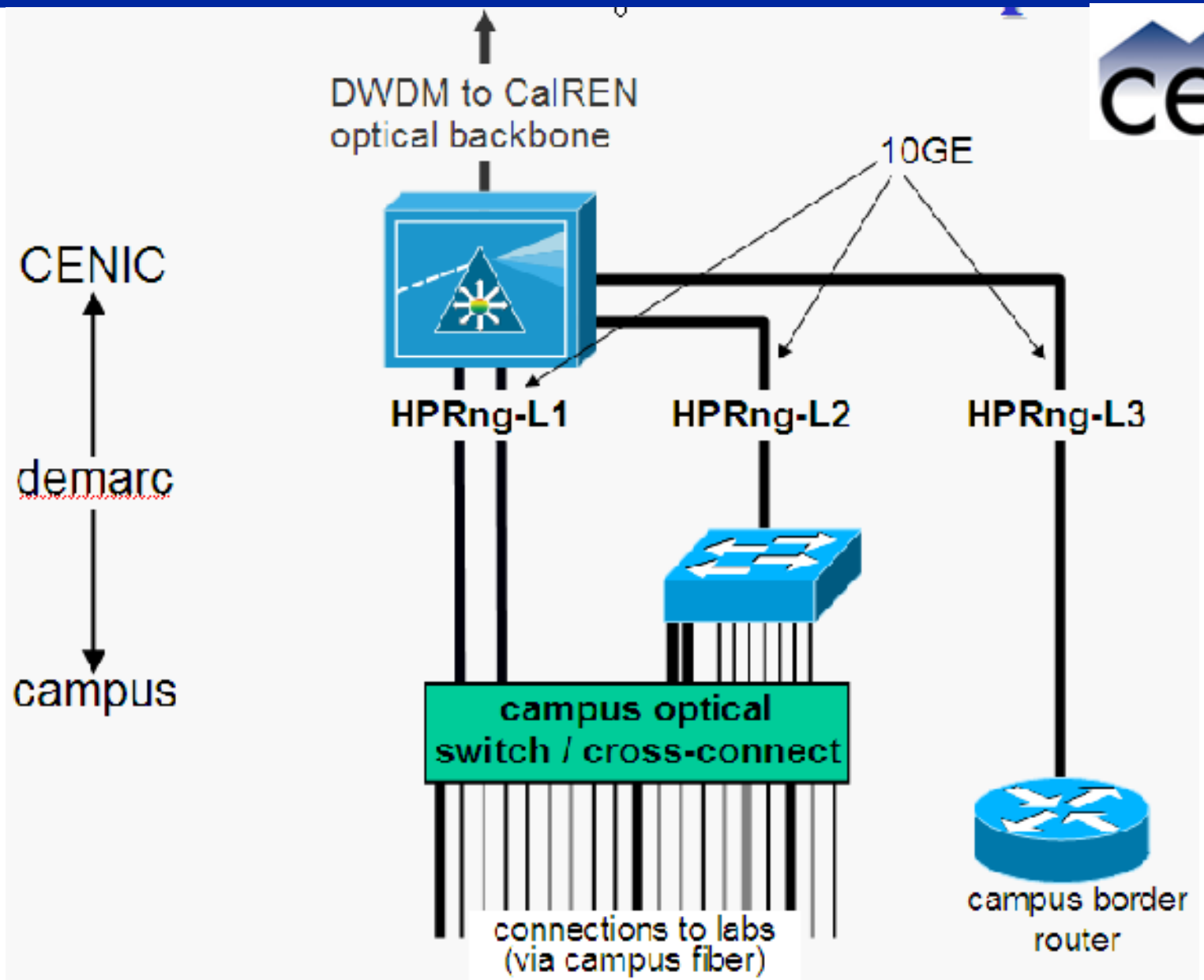


Source: Jim Dolgonas, CENIC

CENIC Switched Optical Network
HPRng-L1 design

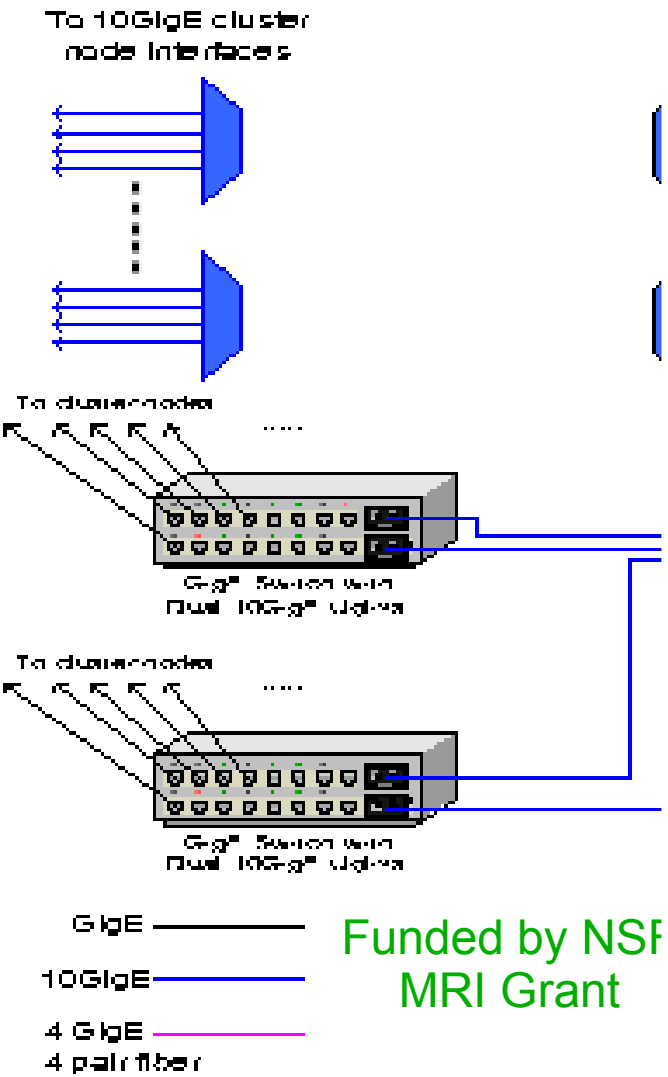


Campus Preparations Needed to Accept CENIC CalREN Handoff to Campus



Source: Jim Dolgonas, CENIC

Current UCSD Experimental Optical Core: Ready to Couple to CENIC L1, L2, L3 Services

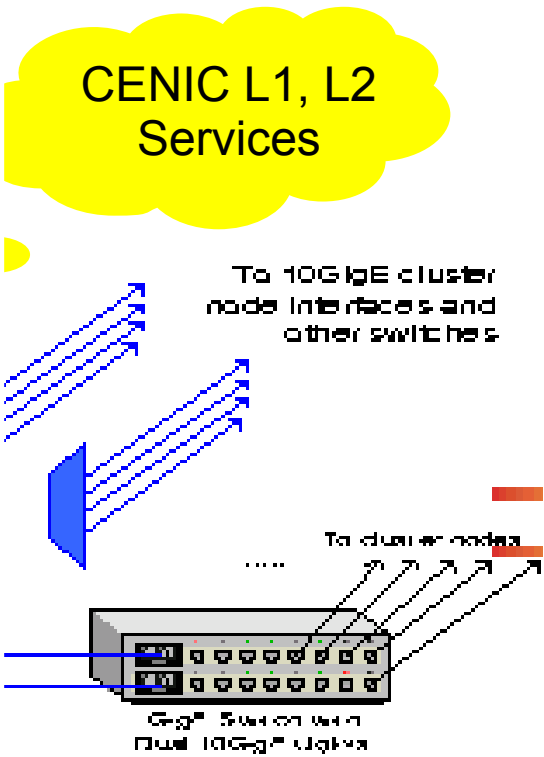


Goals by 2008:

- >= 50 endpoints at 10 GigE
- >= 32 Packet switched
- >= 32 Switched wavelengths
- >= 300 Connected endpoints

Approximately 0.5 TBit/s Arrive at the "Optical" Center of Campus
Switching will be a Hybrid Combination of:
Packet, Lambda, Circuit --
OOO and Packet Switches
Already in Place

Funded by NSF MRI Grant



OptIPuter Border Router

Source: Phil Papadopoulos, SDSC/Calit2
(Quartzite PI, OptIPuter co-PI)

SDSC

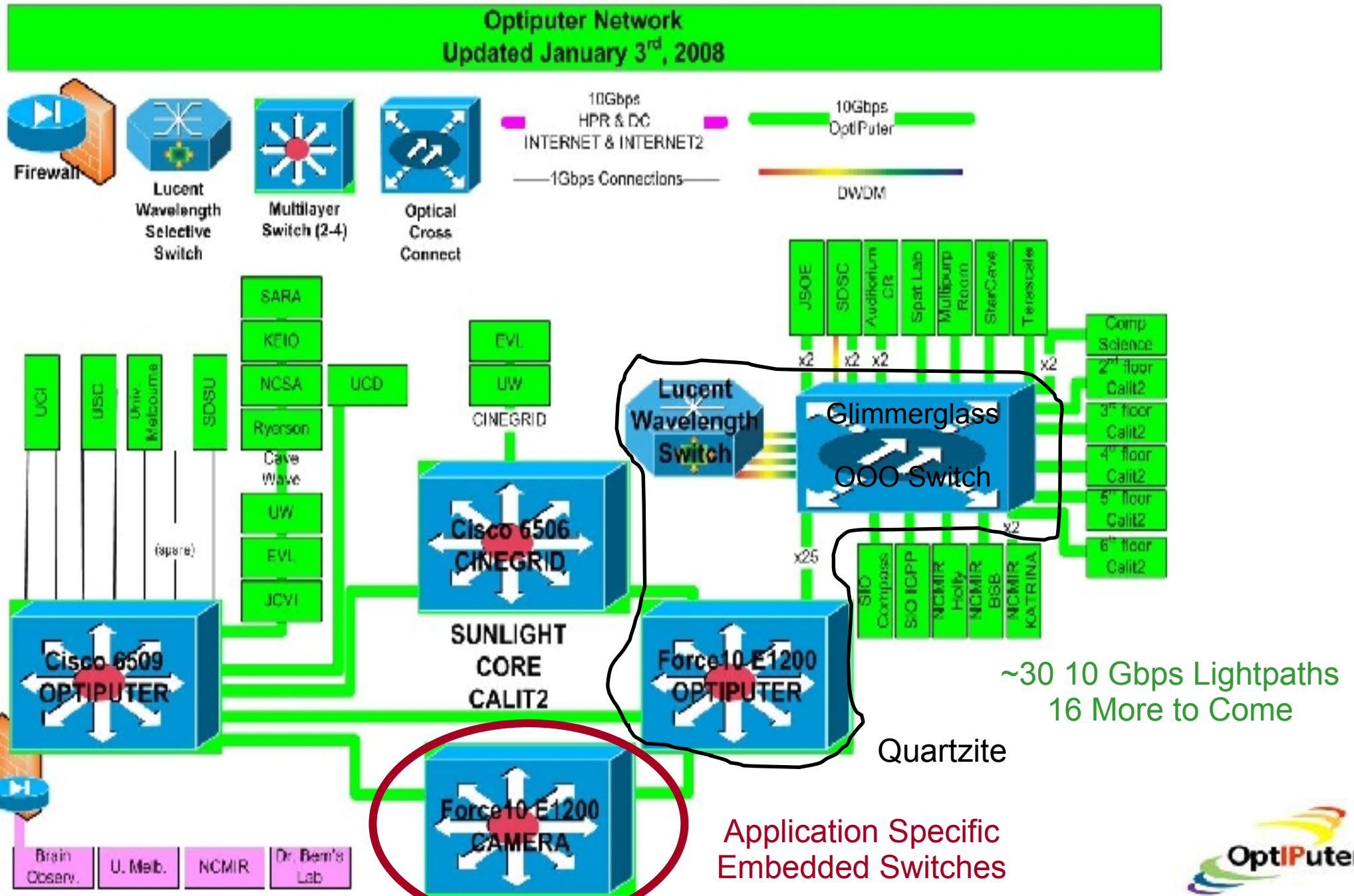
OptIPuter

Calit2 Sunlight
Optical Exchange Contains Quartzite



10:45 am
Feb. 21, 2008

Block Layout of Quartzite/OptIPuter Network



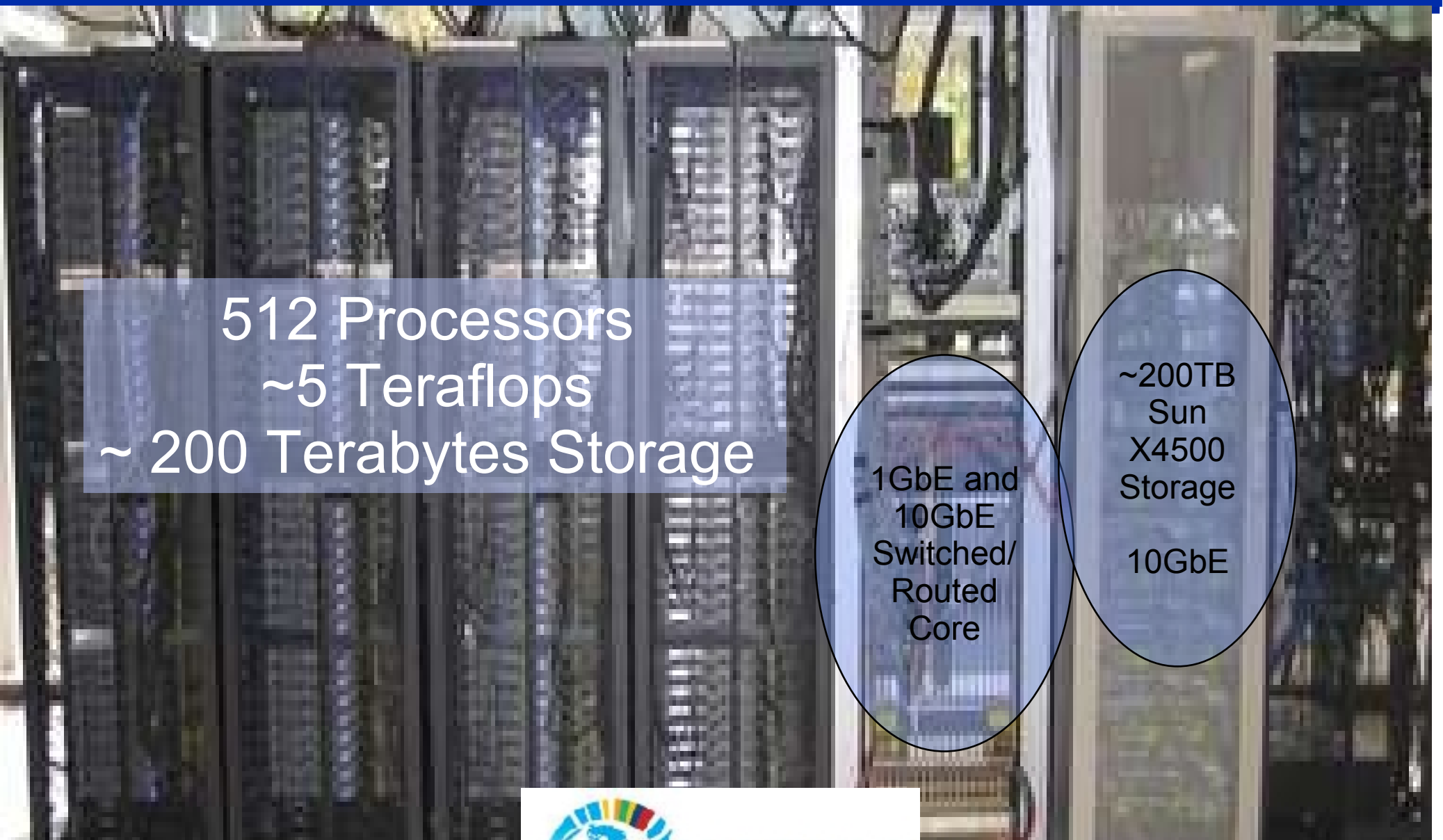
~30 10 Gbps Lightpaths
16 More to Come

Quartzite

Application Specific Embedded Switches

OptIPuter

Calit2 Microbial Metagenomics Cluster Production System



SDSC

ROCKS

camera
Marine Microbial Ecology

J. Craig Venter INSTITUTE

OptIPuter

Straightforward Use Case
Quartzite Connected Computational Science

- Needed to Run a Large Number of Pre-computed BLAST Sequence Alignments for JCVI Fragment Recruitment Viewer (FRV)
- CAMERA Development and Batch Clusters Oversubscribed
- Had Spare Capacity in SDSC Cluster Connected to Quartzite

- Reconfigure Private Side of Network to "Attach" Nodes in SDSC Rockstar Cluster to CAMERA Ikelite Cluster for Batch Processing
  - Direct Network Connection to CAMERA X4500 Thumper Storage
  - No Changes to Application Software or Paths
  - Rockstar Nodes Reconfigured to Support FRV Needs
- Rockstar (SDSC) Nodes Integrated as Part of Ikelite (Calit2) Batch System
  - ~2000 CPU-Days Dedicated Computing over Previous 14 Days
  - O(2TB) of Output
  - Running Right Now

Source:Phil Papadopoulos, SDSC/Calit2
(Quartzite PI, OptIPuter co-PI)

Green Modular Datacenters Optically Connected
UCSD Installing Two Sun Microsystems Boxes



Sun Black Box Container



7 Racks plus Network



Takes up 2 Parking Spaces



Data Power Cooling

UCSD Structural Engineering Dept.

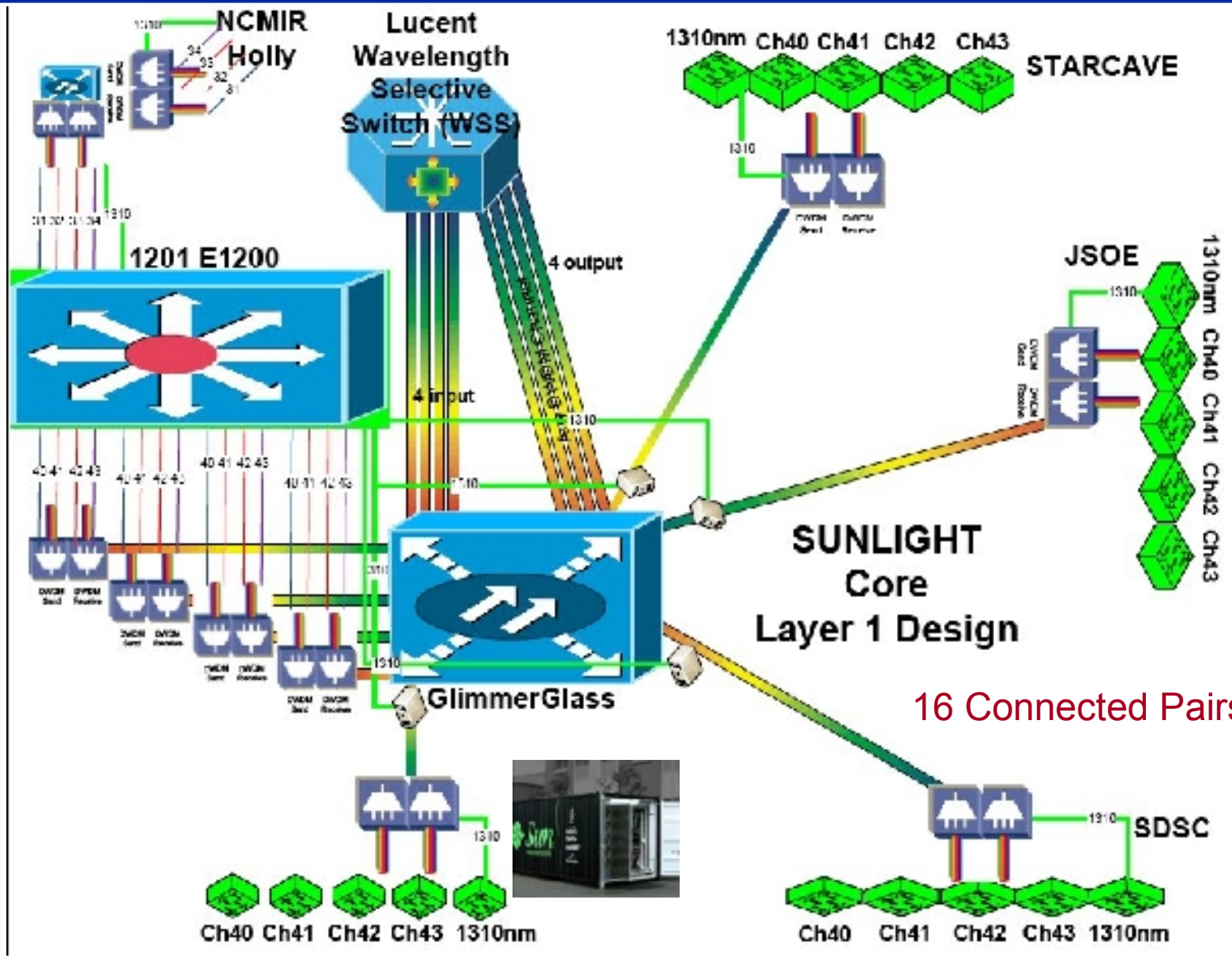
Conducted Tests May 2007

UCSD Jacobs School of Engineering

it²

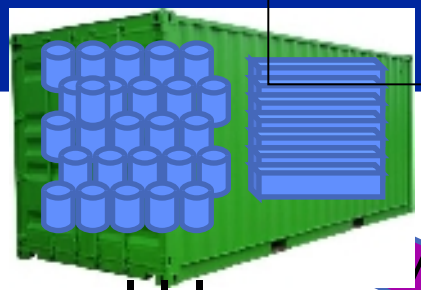
OptIPuter

Initial Deployment of UCSD DWDM Reconfigurable Lambda Mesh

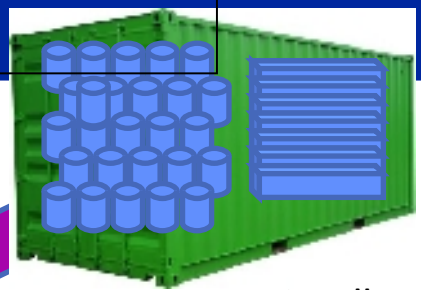


Source:Phil Papadopoulos, SDSC/Calit2
(Quartzite PI, OptIPuter co-PI)

Quartzite – Influencing Next-Generation UCSD Network



Active Data Replication



N x 10 Gbit

N x 10 Gbit

Eco-Friendly
Storage and Compute

"Network in a box"
- > 200 Connections
- DWDM or Gray Optics

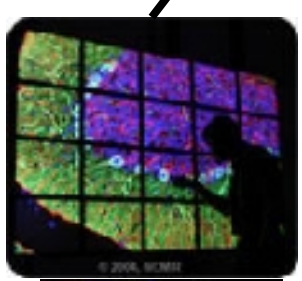


10 Gigabit
L2/L3 Switch

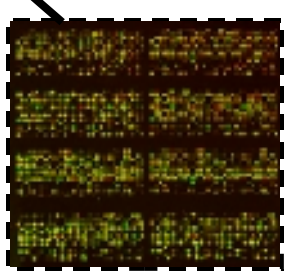
Wide-Area 10G
- Cenic/HPR
- NLR Cavewave
- Cinegrid
- …

On-Demand Physical
Connections









Microarray

Your
Lab
Here

camera

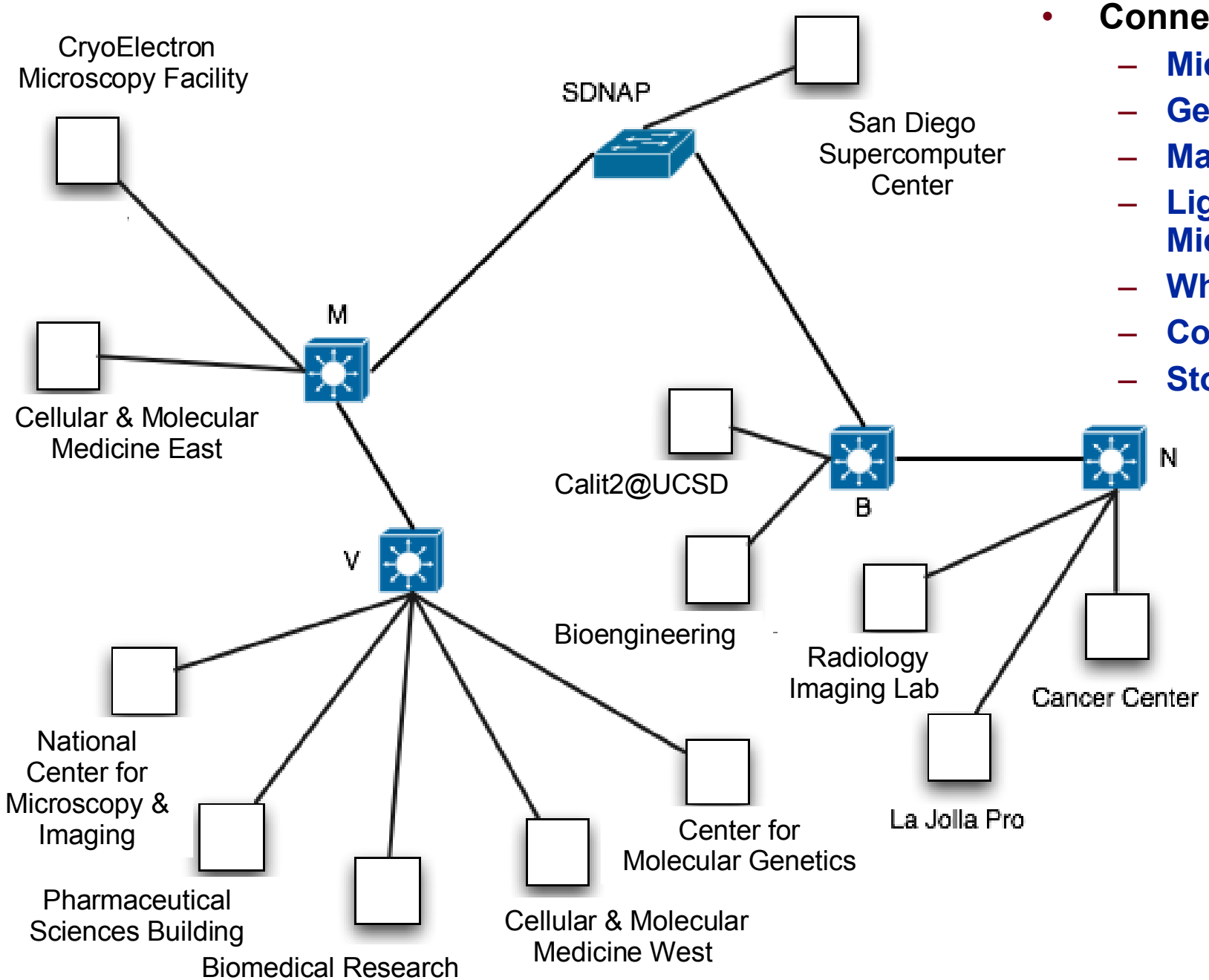
NCMIR

NBCR

Source:Phil Papadopoulos, SDSC/Calit2

OptIPuter

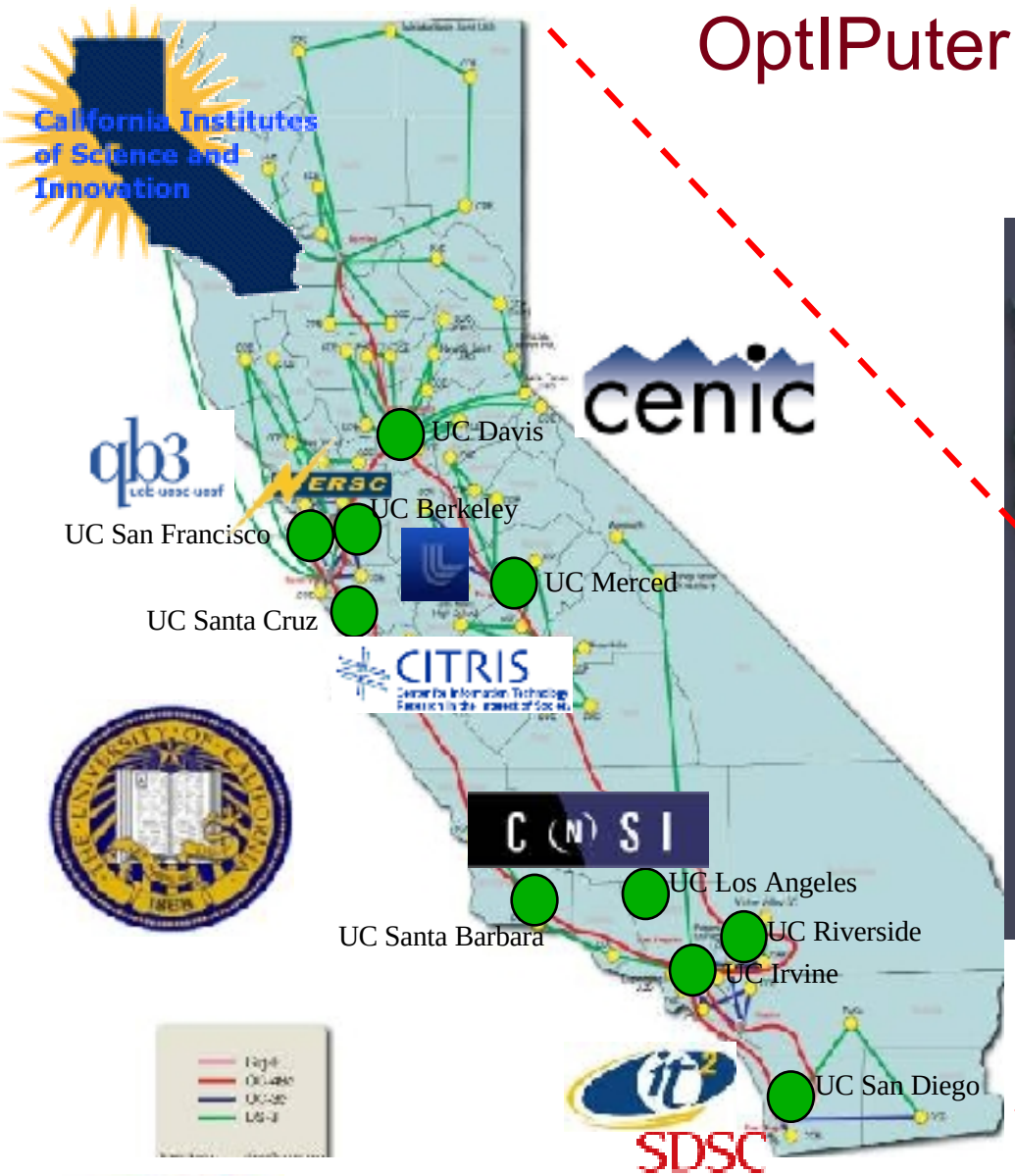
UCSD Planned Optical Networked Biomedical Researchers and Instruments



- **Connects at 10 Gbps :**
  - **Microarrays**
  - **Genome Sequencers**
  - **Mass Spectrometry**
  - **Light and Electron Microscopes**
  - **Whole Body Imagers**
  - **Computing**
  - **Storage**

OptIPuter

Creating a UC Cyberinfrastructure of Campus OptIPuter "On-Ramps" to NLR, I2, and TeraGrid Resources



OptIPuter + CalREN-XD + TeraGrid = "OptiGrid"



Creating a Critical Mass of End Users on a Secure LambdaGrid

Source: Fran Berman, SDSC , Larry Smarr, Calit2

Summary

- Quartzite Deployment is Nearly Complete
- More Than ½ Terabit/s (Unidirectional) Aggregate Bandwidth
- Twenty 10Gbit DWDM-Connected Pairs (40 Optics) (400 Gbit/S)
- 4x4x8lambda WSS
- Has Already Influenced CAMERA Project Design
- Has Already Influenced Next-Generation Campus Research Cyber-infrastructure
- Room for Expansion Within the Core