Pacific Research Platform: One Year On

Project #ACI-1541349: Larry Smarr, PI, Calit2, University of California, San Diego

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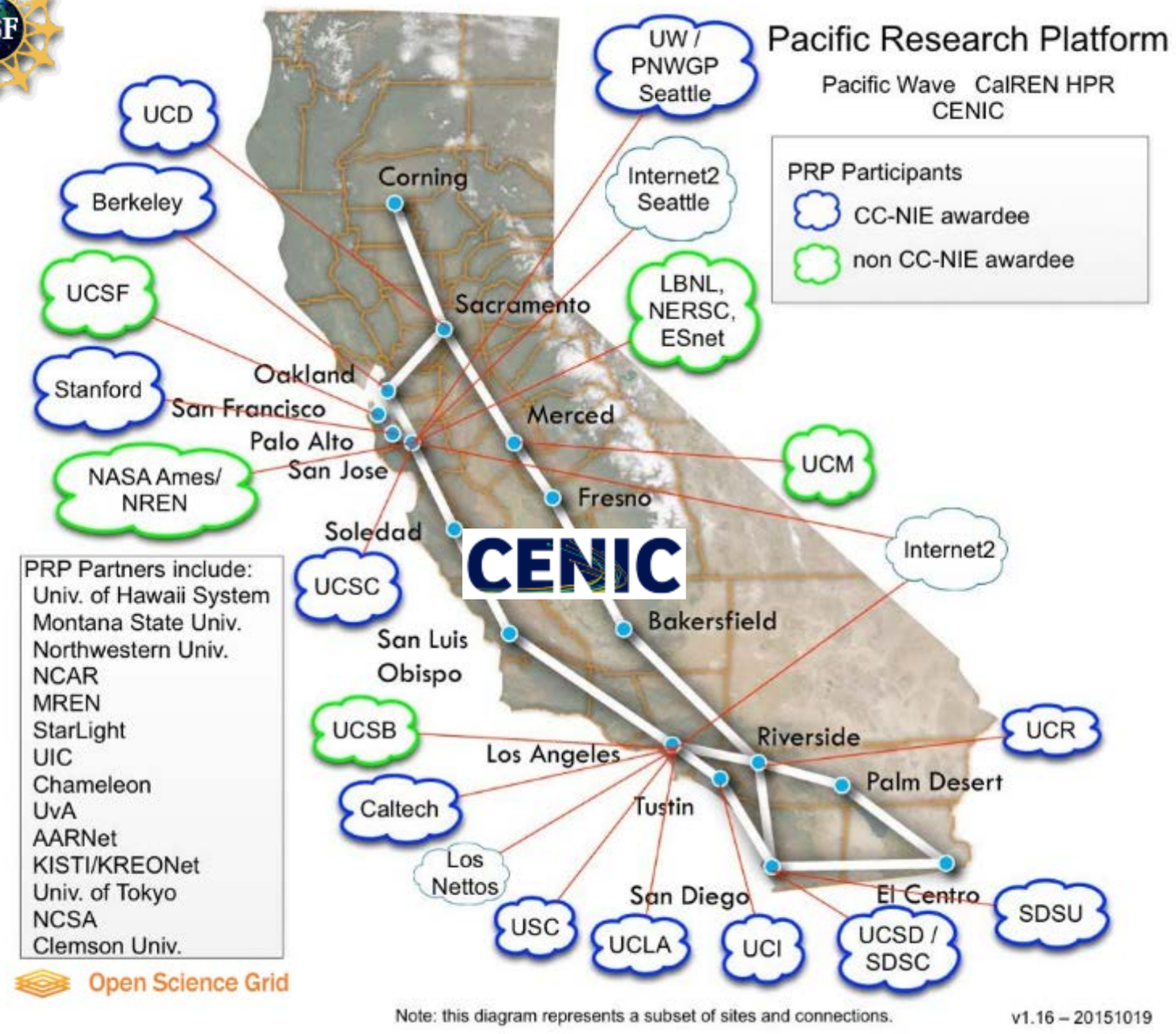
John Graham, UC San Diego, Qualcomm Institute,

Phil Papadopoulos and Dmitry Mishin, San Diego Supercomputer Center,

Louis Fox and John Hess of CENIC, and others

September 29, 2016

One Year In: The Pacific Research Platform is Now a Working End-to-End Science-Driven DMZ-Connector



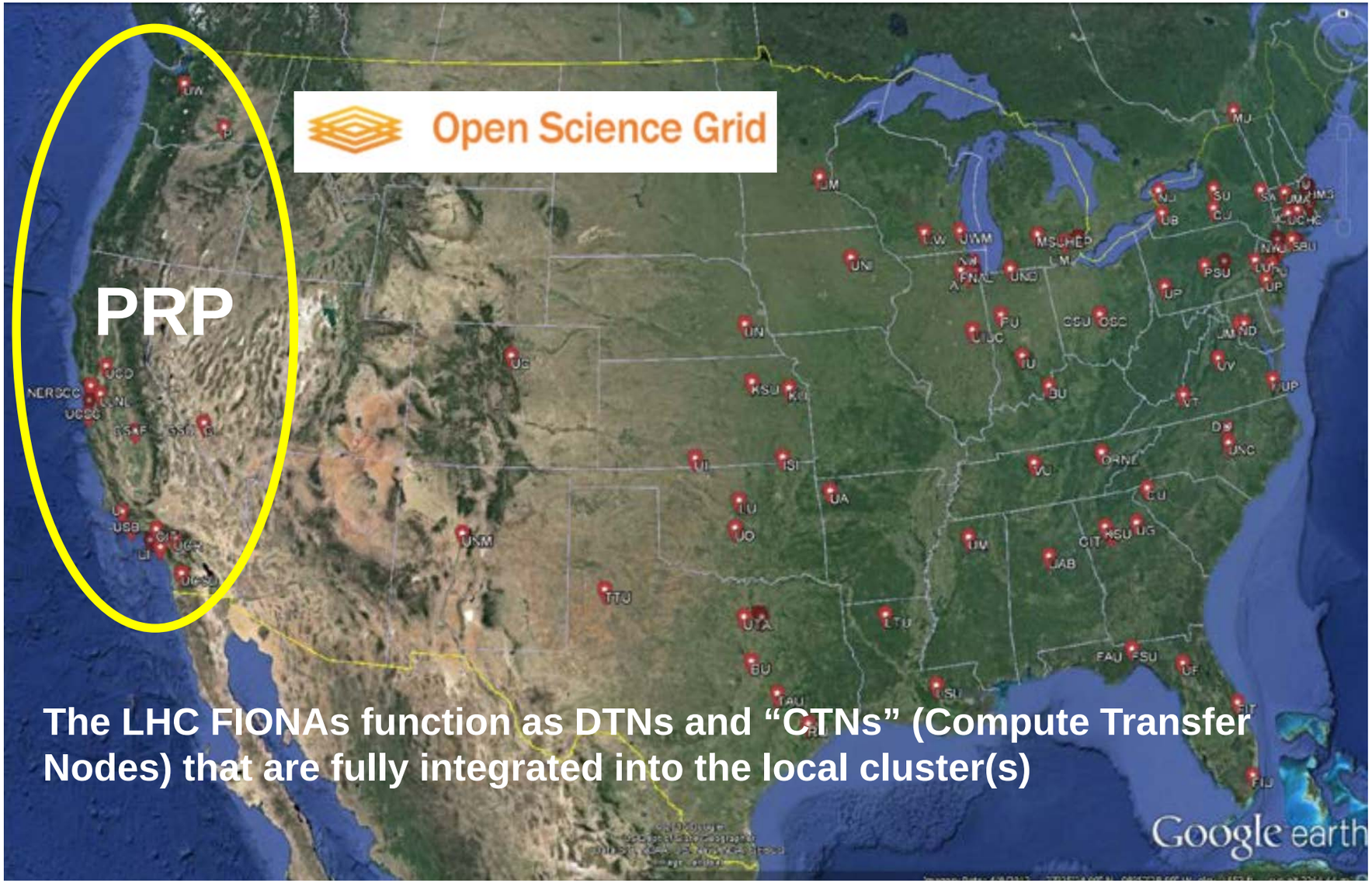
NSF CC*DNI Grant
$5M 10/2015-10/2020

PI: Larry Smarr, UC San Diego Calit2
Co-Pis:

- **Camille Crittenden, UC Berkeley CITRIS**
- **Tom DeFanti, UC San Diego Calit2**
- **Philip Papadopoulos, UC San Diego SDSC**
- **Frank Wuerthwein, UC San Diego Physics SDSC**

Source:
John Hess, CENIC

The Demand Now: OSG Federates Clusters in 40/50 States: Creating a Scientific Compute and Storage "Cloud"



Source: Miron Livny, Frank Wuerthwein, OSG

The Demand Now: Climate Data

UCSD/SIO Campus Climate Researchers Need to Download Results from NCAR Remote Supercomputer Simulations to Make Regional Climate Change Forecasts

Dan Cayan

USGS Water Resources Discipline

Scripps Institution of Oceanography, UC San Diego

much support from Mary Tyree, Mike Dettinger, Guido Franco and other colleagues

NCAR now at to 10Gbps Link Over Westnet from Wyoming and Boulder to CENIC/PRP

Sponsors:

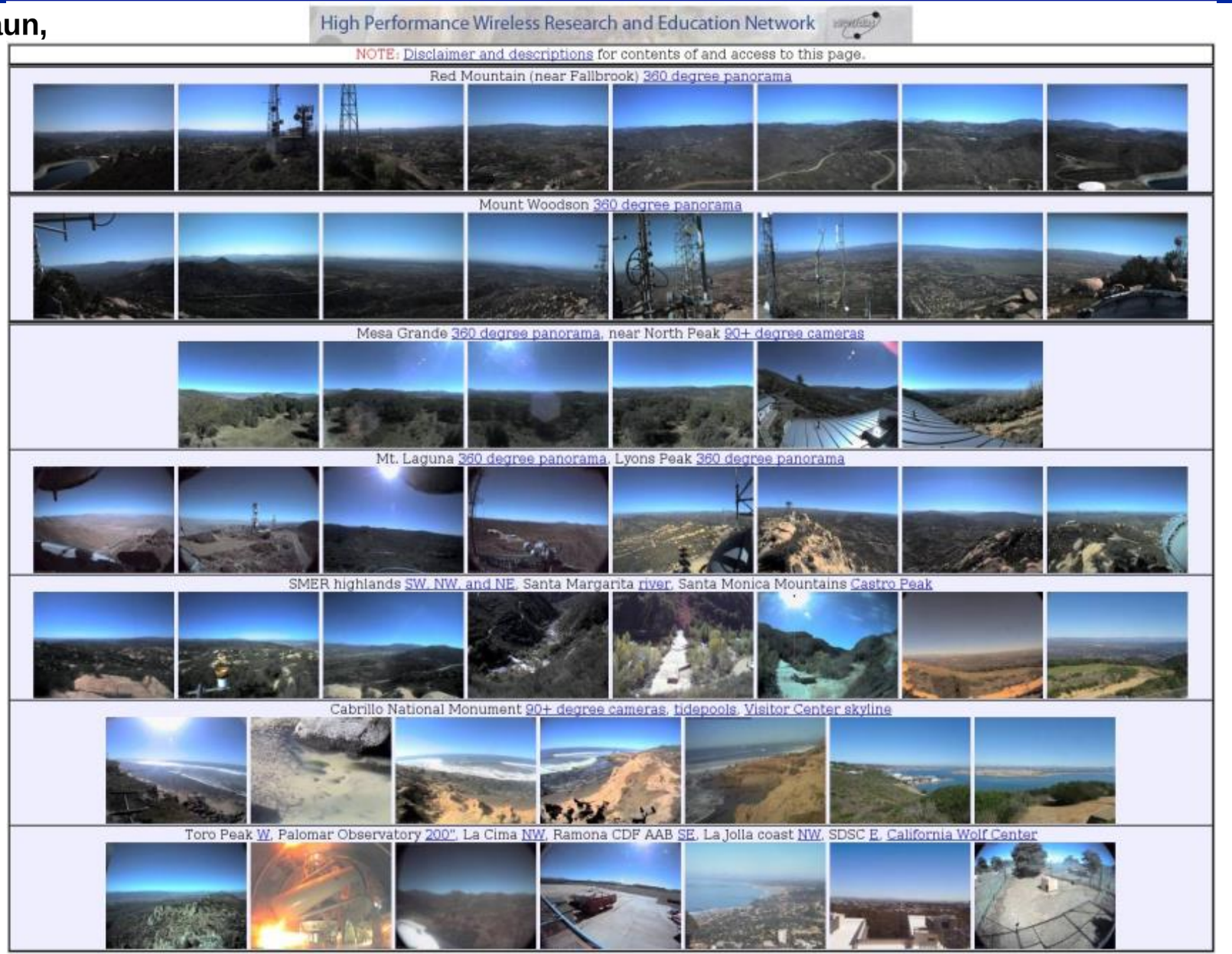
California Energy Commission

NOAA RISA program

California DWR, DOE, NSF

Demand Now: Real-Time Network Cameras on Mountains for Environmental Observations and Fires

Source: Hans Werner Braun, Frank Vernon, HPWREN

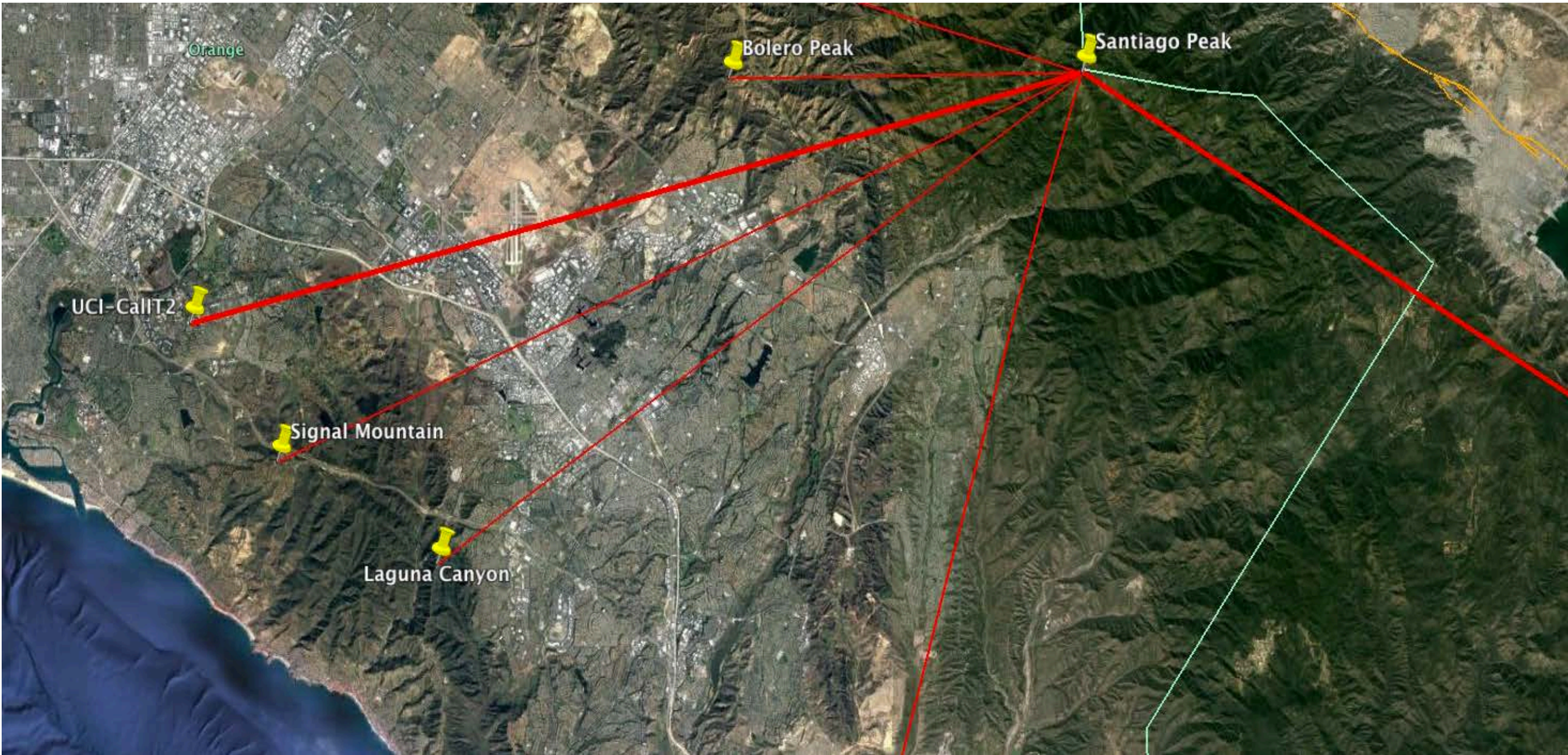


Why? 14 May 2014:
9 Simultaneous Active Fires in San Diego County

San Diego County Red Mountain Fire Cameras

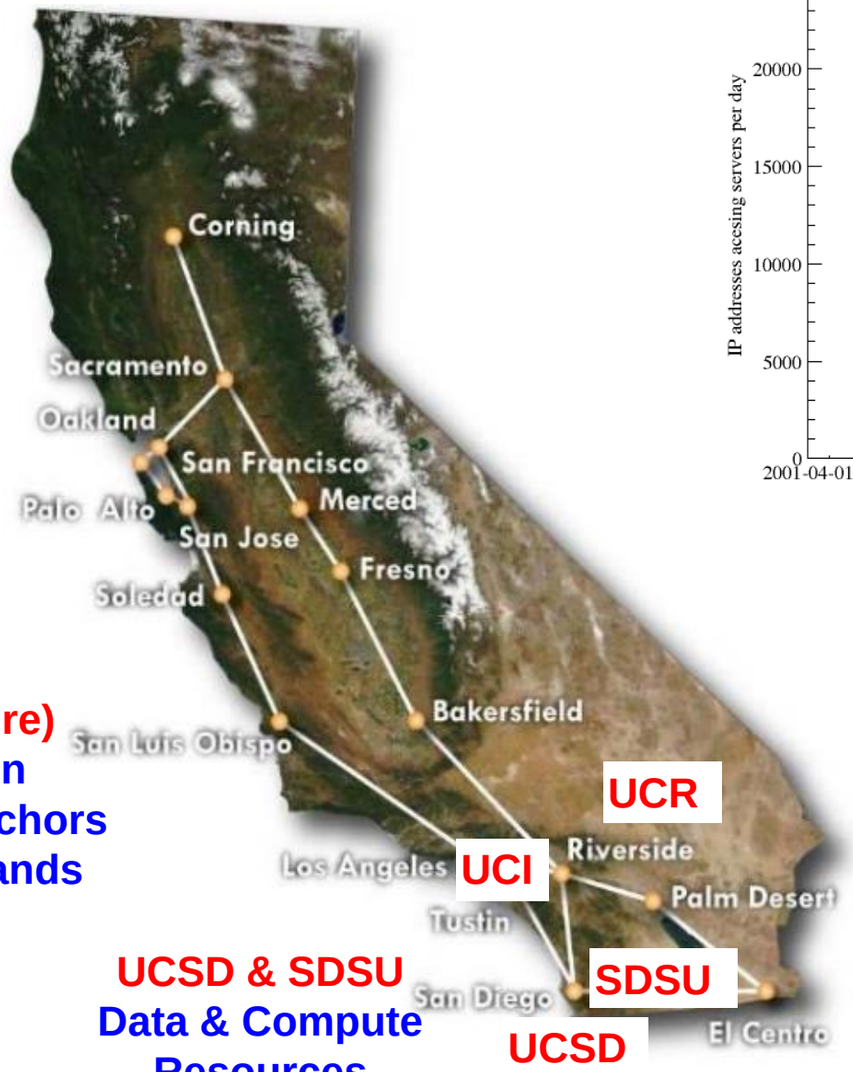
- **Southeast (left) “Highway” Fire**
- **Southwest (center rear) “Poinsettia” Fire**
- **West (right) “Tomahawk” Fire**

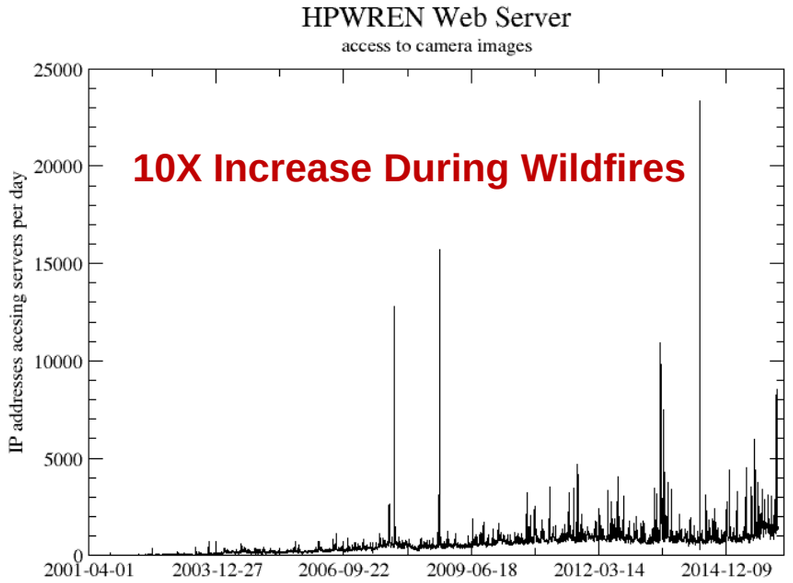
Demand Now Growing: Extending HPWREN's Wireless Reach



HPWREN Users and Public Safety Clients Gain Redundancy and Resilience from PRP Upgrade

- **PRP CENIC 10G Link UCSD to SDSU**
  - DTN FIONAs Endpoints
  - Data Redundancy
  - Disaster Recovery
  - High Availability
  - Network Redundancy





Data From Hans-Werner Braun

UCI & UCR (Future)
Data Replication
and PRP FIONA Anchors
as HPWREN Expands
Northward

UCR

UCI

UCSD & SDSU
Data & Compute
Resources

SDSU

UCSD

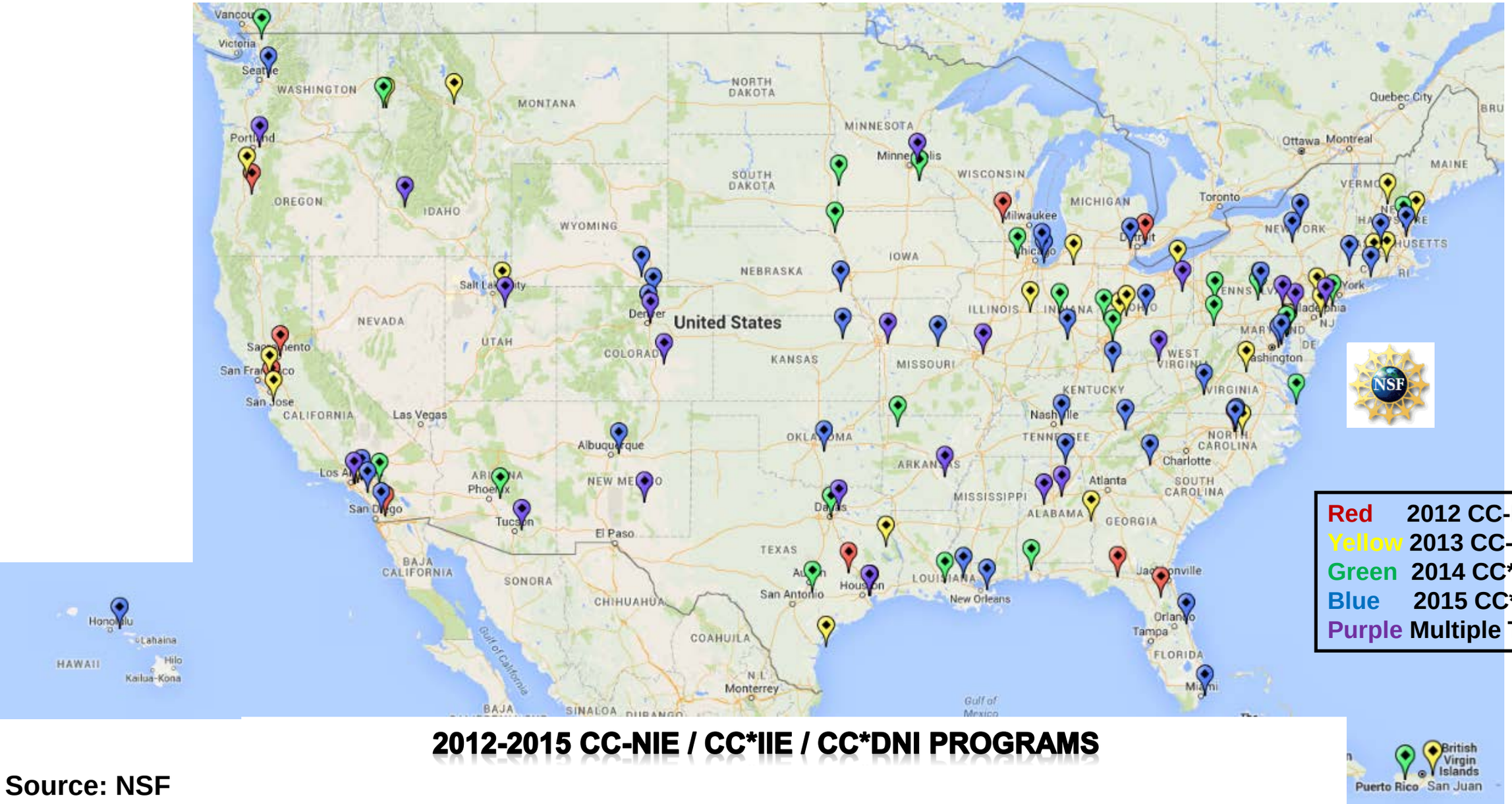
San Diego Countywide
Sensors and Camera
Resources

SDSC

Initially Proposed PRP Multi-Campus Science Driver Teams

- **Biomedical**
  - Cancer Genomics Hub/Browser
  - Microbiome and Integrative ‘Omics
  - Integrative Structural Biology
  - High-Resolution Microscopy
- **Earth Sciences**
  - Data Analysis and Simulation for Earthquakes and Natural Disasters
  - Climate Modeling: NCAR/UCAR
  - California/Nevada Regional Climate Data Analysis
  - CO2 Subsurface Modeling
- **Particle Physics**
- **Astronomy and Astrophysics**
  - Telescope Surveys
  - Galaxy Evolution
  - Gravitational Wave Astronomy
- **Scalable Visualization, Virtual Reality, and Ultra-Resolution Video**

NSF Funded Over 100 Campuses to Build Local Big Data Freeways Based on Community Input and on ESnet's Science DMZ Concept



2012-2015 CC-NIE / CC*IIE / CC*DNI PROGRAMS

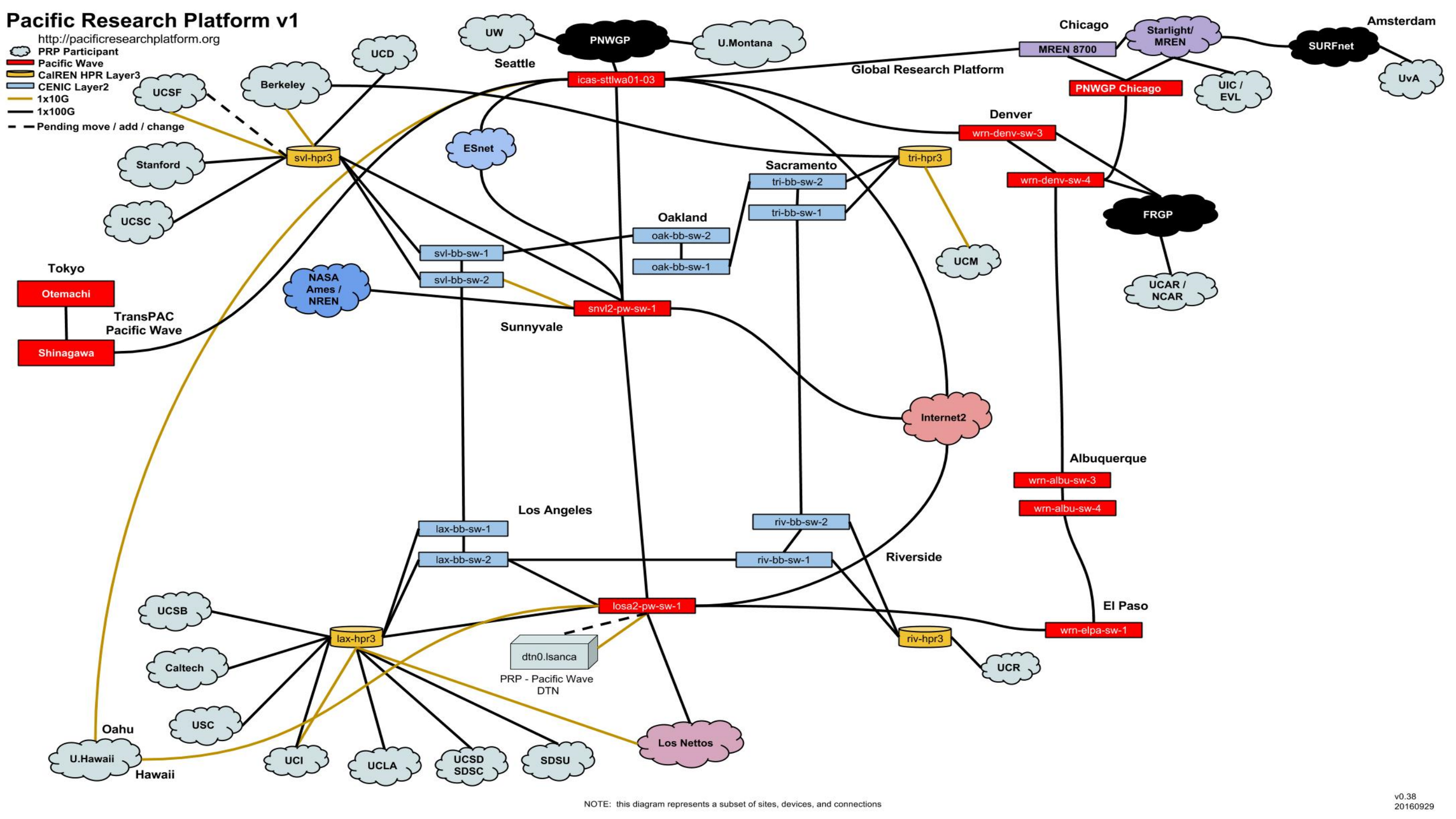
Source: NSF

DOE ESnet's Science DMZ: A Scalable Network Design Model for Optimizing Science Data Transfers

- **A Science DMZ integrates 4 key concepts into a unified whole:**
  - **A network architecture designed for high-performance applications, with the science network distinct from the general-purpose network**
  - **The use of dedicated systems for data transfer**
  - **Performance measurement and network testing systems that are regularly used to characterize and troubleshoot the network**
  - **Security policies and enforcement mechanisms that are tailored for high performance science environments**

Science DMZ Coined 2010

http://fasterdata.es.net/science-dmz/


Pacific Research Platform v1
http://pacificresearchplatform.org
PRP Participant
Pacific Wave
CalREN HPR Layer3
CENIC Layer2
1x10G
1x100G
Pending move / add / change
UW
PNWGP
U.Montana
Seattle
UCD
Berkeley
UCSF
Stanford
UCSC
svl-hpr3
ESnet
Chicago
Starlight/ MREN
MREN 8700
Amsterdam
SURFnet
UvA
Global Research Platform
icas-sttlwa01-03
PNWGP Chicago
UIC / EVL
Denver
wrn-denv-sw-3
wrn-denv-sw-4
FRGP
UCAR / NCAR
tri-hpr3
Sacramento
tri-bb-sw-2
tri-bb-sw-1
UCM
Oakland
oak-bb-sw-2
oak-bb-sw-1
svl-bb-sw-1
svl-bb-sw-2
Tokyo
Otemachi
Shinagawa
TransPAC
Pacific Wave
NASA Ames / NREN
snvl2-pw-sw-1
Sunnyvale
Internet2
Albuquerque
wrn-albu-sw-3
wrn-albu-sw-4
Los Angeles
lax-bb-sw-1
lax-bb-sw-2
riv-bb-sw-2
riv-bb-sw-1
Riverside
losa2-pw-sw-1
El Paso
wrn-elpa-sw-1
riv-hpr3
UCR
UCSB
lax-hpr3
Caltech
USC
dtn0.lsanca
PRP - Pacific Wave DTN
Oahu
U.Hawaii
Hawaii
UCI
UCLA
UCSD SDSC
SDSU
Los Nettos
NOTE: this diagram represents a subset of sites, devices, and connections
v0.38
20160929

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The Campus FIONAs – Flash I/O Network Appliance: Linux PCs Optimized for DMZs over Distance

FIONAs Are
Science DMZ Data Transfer Nodes (DTNs) &
Optical Network Termination Devices

Phil Papadopoulos & Tom DeFanti
Joe Keefe & John Graham

Typical FIONA Rack-Mount Build:

Cost	**$8,000**	**$20,000**
Intel Xeon Haswell	**E5-1650 v3 6-Core**	**2x E5-2697 v3 14-Core**
RAM	**128 GB**	**256 GB**
SSD Flash	**SATA 3.8 TB**	**SATA 3.8 TB**
Network Interface	**10/40G**	**2x40G or 100G**
GPU	**none**	**NVIDIA Tesla K80**
RAID Drives 0 to 200TB (add ~$100/TB); $$ NVMe for 100G		

QUALCOMM INSTITUTE

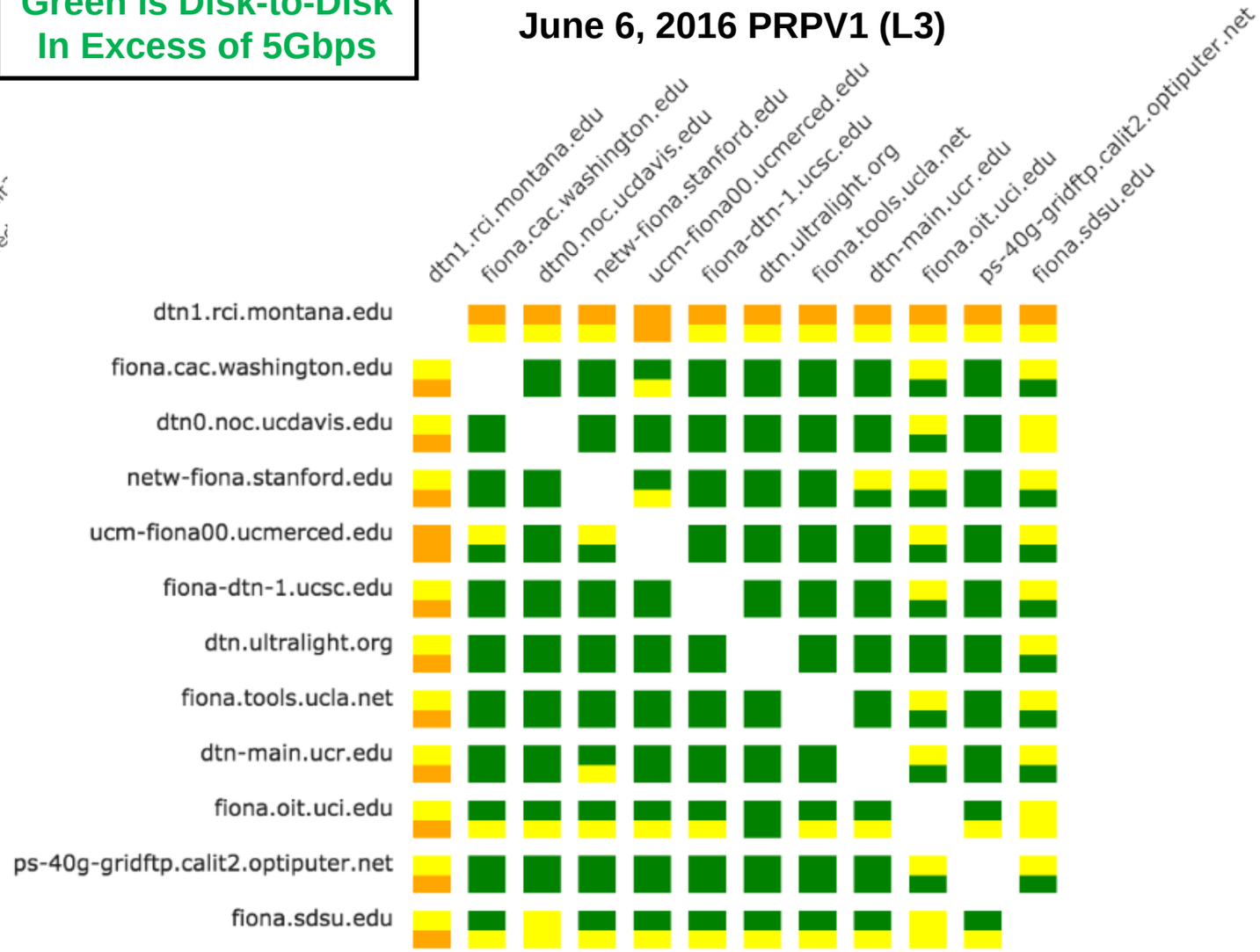
SDSC

PRP MaDDash: Point-to-Point Bandwidth Map
GridFTP File Transfers-Note Huge Improvement in Five Months

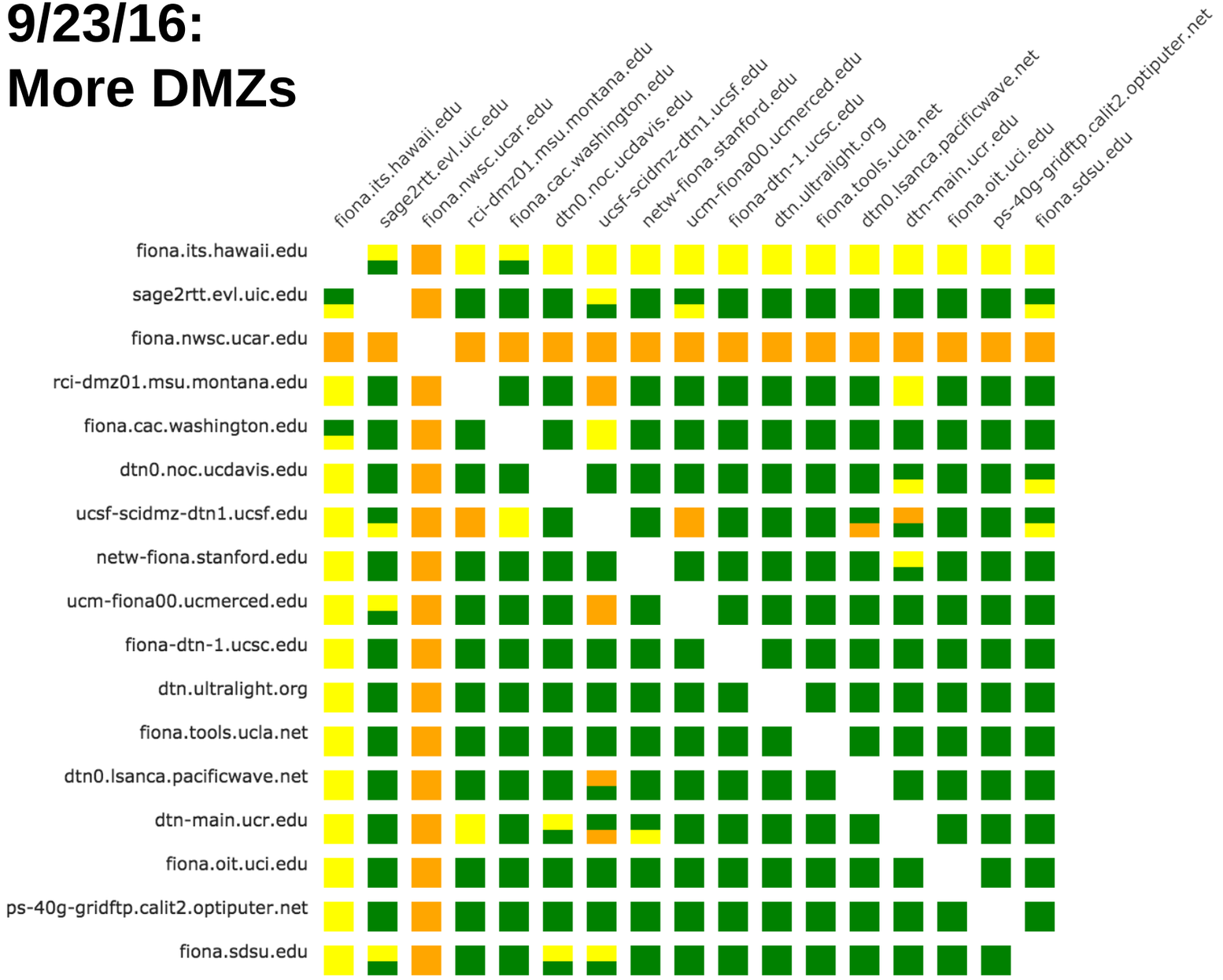
Green is Disk-to-Disk In Excess of 5Gbps

January 29, 2016 PRPV1 (L3)

June 6, 2016 PRPV1 (L3)



9/23/16: More DMZs



$295 1Gb/s FIONette DTN: ~$1,000 with 2TB Flash (Takes 6 hours to fill at ~1Gb/s)

ZOTAC ZBOX M-series MI523 Nano – Core i3 6100U 2.3 GHz – 0 GB – 0 GB

ZOTAC

Mfg. Part: ZBOX-MI523NANO-U | CDW
Part: 4283836 | UNSPSC: 43211520

Really works, thanks to ESnet's TCP DTN tuning and tweaking!

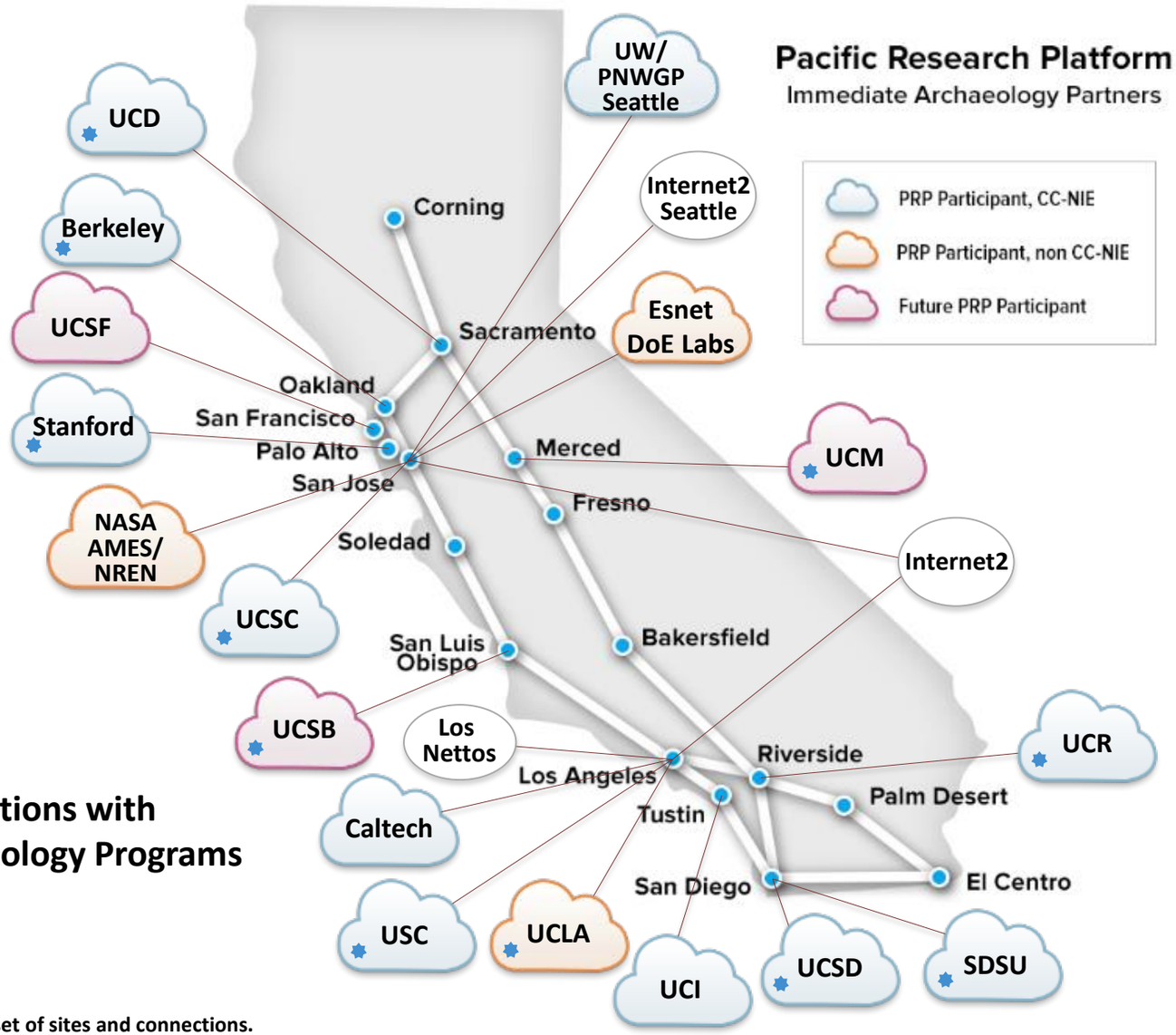
What have the PRPv1 and FIONAs Done in Year 1?

- **Connected >16 DMZs at 10G and 40G, demonstrating disk-to-disk GridFTP at ~7.5G and 12.5G respectively, and 900Mb at 1G (Caltech's FDT is faster)**
- **Thus showing *BEST EFFORT* TCP works amazingly well over regional and national distance by putting the appropriate FIONA right at the border router (international distance to UvA, NSCC, AARnet, KISTI, others, next).**
- **Engaged a lot of network engineers and scientists and techs, got them working together; engaged their CIOs too**
- **Provided a means to isolate disk-to-disk performance issues with daily monitoring and detailed tracking**
- **Motivated several campus adoption models for science use (extend DMZ, provide DMZ computer rooms, go into the cloud or to SC centers?)**
- **Offered security strategies in the absence of campus firewalls, especially for instruments; motivated a lot of discussion!**

PRP is NOT Just for Big Data Science and Engineering: Linking Cultural Heritage and Archaeology Datasets

Building on CENIC's Expansion To Libraries, Museums, and Cultural Sites

> **"In an ideal world –**
> **Extremely high bandwidth to move large cultural heritage datasets around the PRP cloud for processing & viewing in CAVEs around PRP with Unlimited Storage for permanent archiving."**
> **-Tom Levy, UCSD**



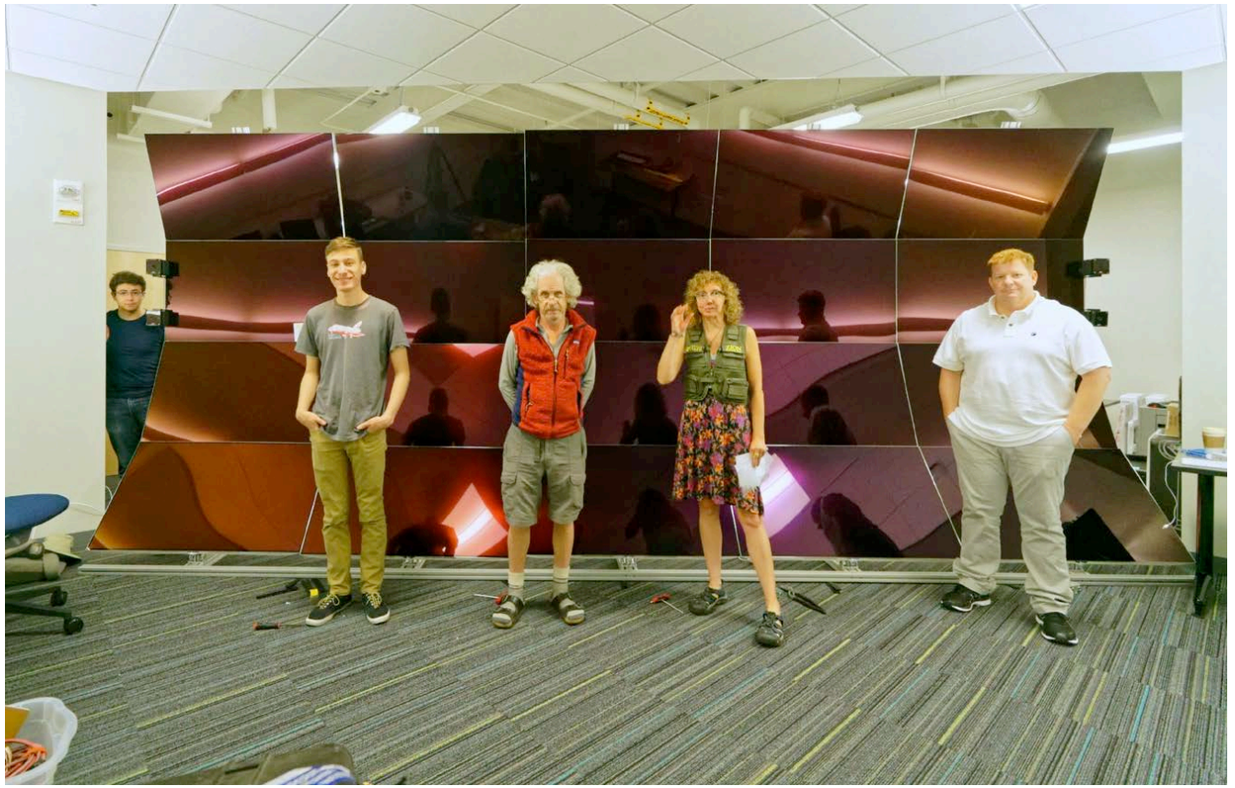
* Institutions with Active Archaeology Programs

Note: This diagram represents a subset of sites and connections.

PRP Links
Creates Distributed Virtual Reality

PRP

WAVE@UC San Diego

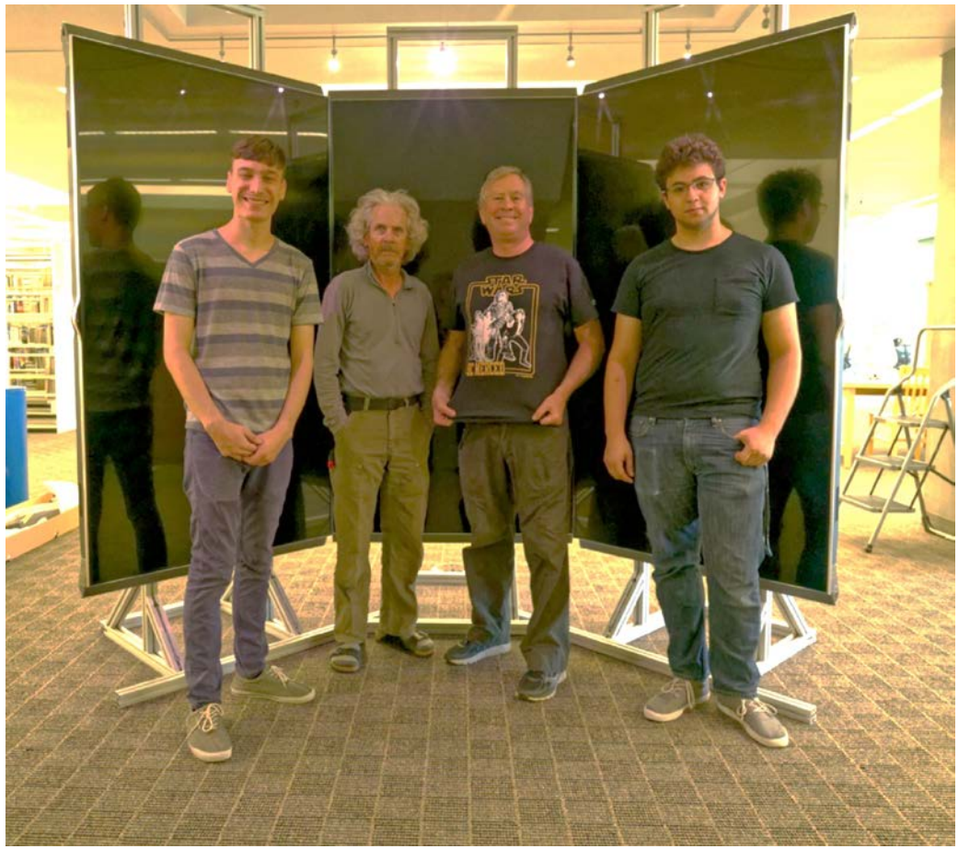


MerWAVE @UC Merced

Linking Libraries at UCB, UCLA, UCM and UCSD with the PRP and FIONA CAVE Kiosks

48 Megapixel CAVE Kiosk for UCSD Library

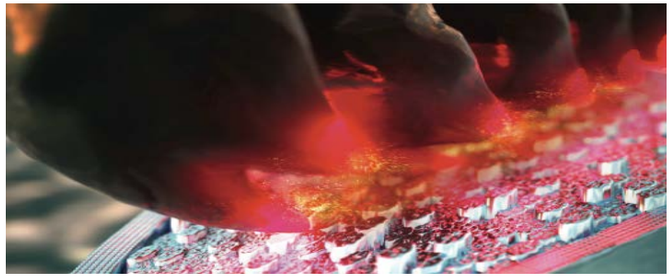
UCSD Library Review, June



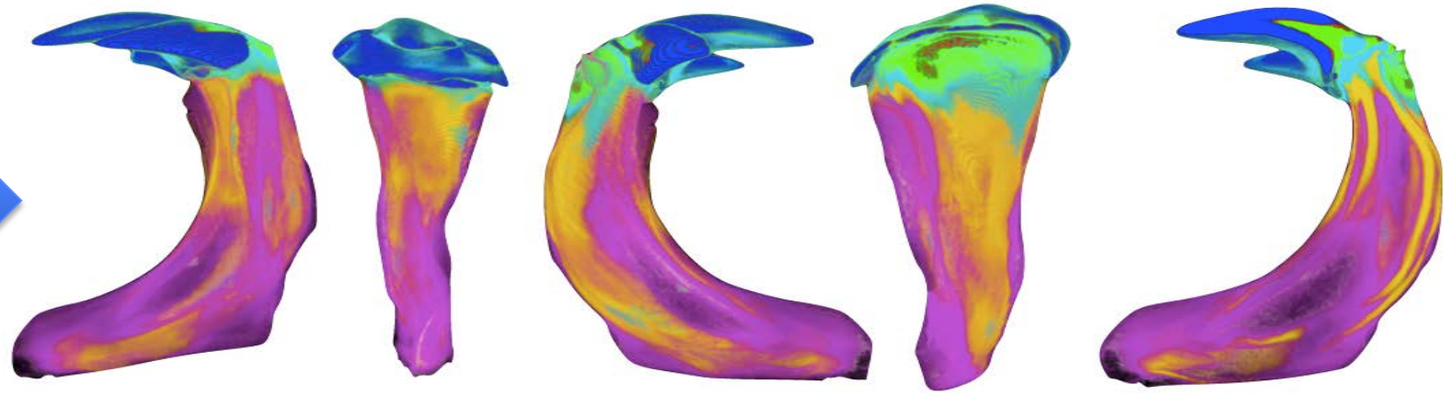
24 Megapixel UCM Library Installation, July

3D Reconstructions from NCMIR X-ray Microscopic Computed Tomography Facilitates Development of Bioinspired "Tough" Materials

UCR researchers are modeling the teeth (radula) of marine snail, *Cryptochiton Stelleri*, to engineer new biomimetic abrasion resistant composites

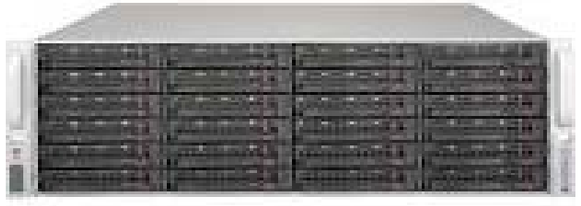


NCMIR X-ray Microscope (XRM) Zeiss Versa 510



MicroCT reconstructions of Chiton radula. Chiton radula have evolved to incorporate an iron oxide mineral, *magnetite*, making them extremely hard and magnetic. Images courtesy of Steven Herrera, Ph.D., Kisailus Biomemetics and Nanostructured Materials Laboratory, UC Riverside

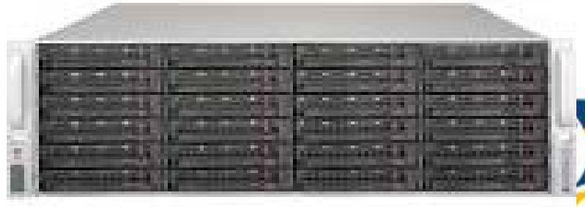
UCSD/NCMIR
Fiona/Data Transfer Node (DTN)



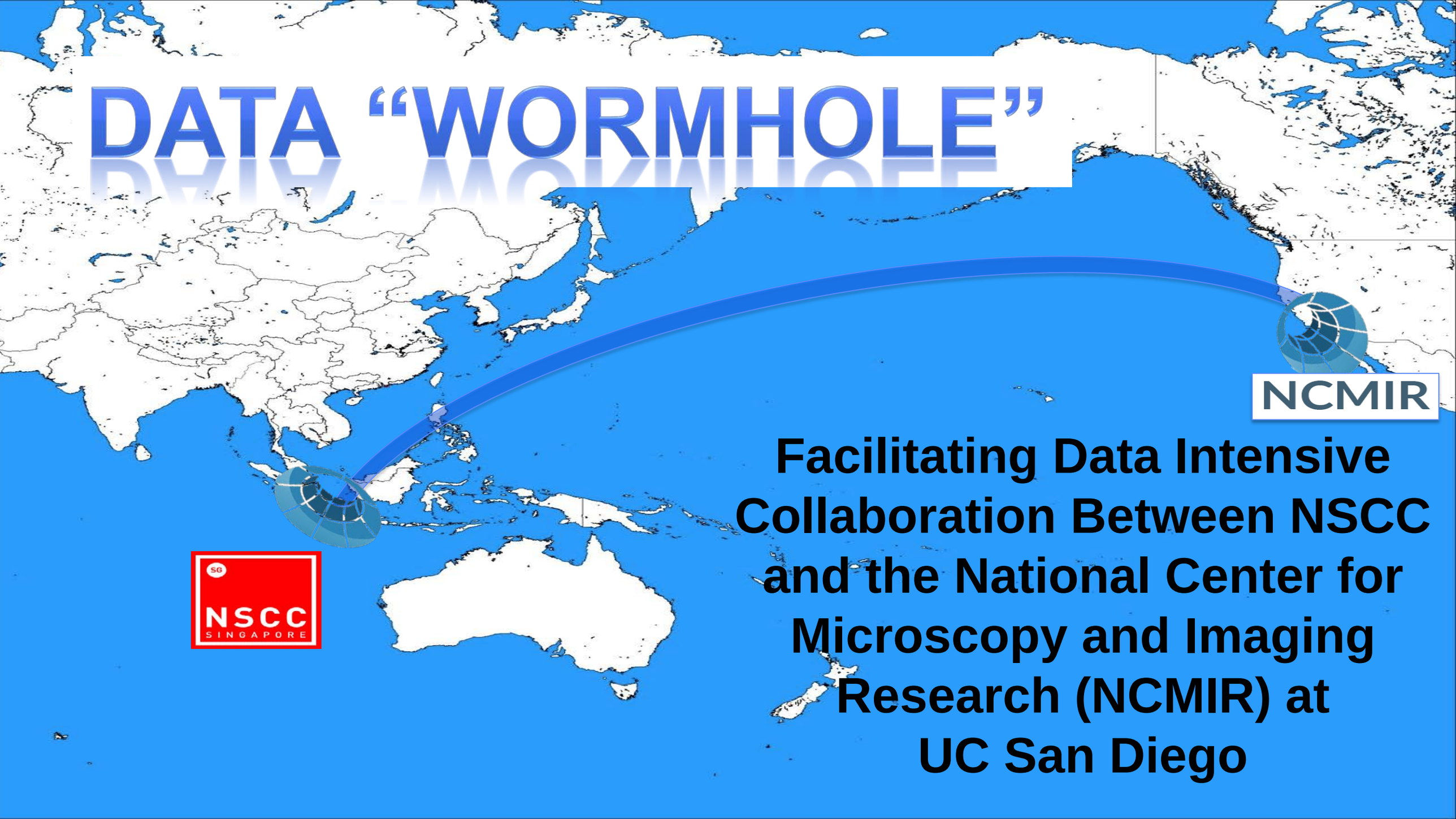
PRP Facilitated Collaborative Data Transfer 10Gbps

XRM Data Sets are 100+ GBs

UC Riverside
Fiona/Data Transfer Node (DTN)

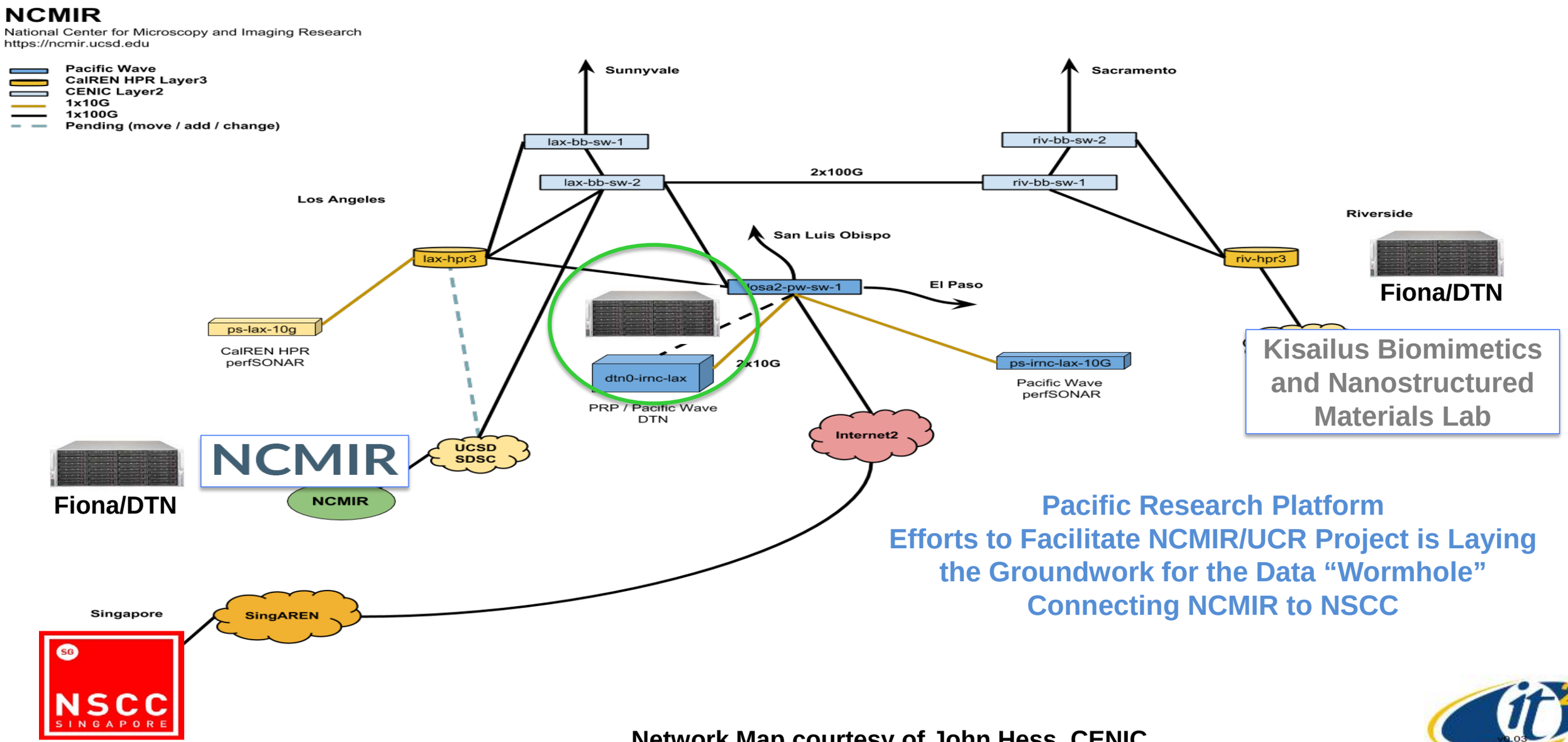


DATA "WORMHOLE"



Facilitating Data Intensive Collaboration Between NSCC and the National Center for Microscopy and Imaging Research (NCMIR) at UC San Diego

FIONAs in the Middle and Ends of the Wormhole



Pacific Research Platform
Efforts to Facilitate NCMIR/UCR Project is Laying the Groundwork for the Data "Wormhole" Connecting NCMIR to NSCC

Network Map courtesy of John Hess, CENIC
NOTE: this diagram represents a subset of sites, devices, and connections

v0.03
20160721

Next: National Research Platform and Global Research Platform Building on CENIC/Pacific Wave Connections and GLIF

Current International GRP Partners

PRP Support:

- US National Science Foundation (NSF) awards CNS 0821155 and CNS-1338192, CNS-1456638, ACI-1540112, and ACI-1541349
- University of California Office of the President CIO
- UCSD Chancellor's Integrated Digital Infrastructure Program
- UCSD Next Generation Networking initiative
- Calit2 and Calit2 Qualcomm Institute
- CENIC, PacificWave and StarLight
- DOE ESnet