“The Pacific Research Platform The First Six Years”

PRP Capstone Symposium

Virtual Meeting

June 22, 2021

Dr. Larry Smarr

Founding Director Emeritus, California Institute for Telecommunications and Information Technology;

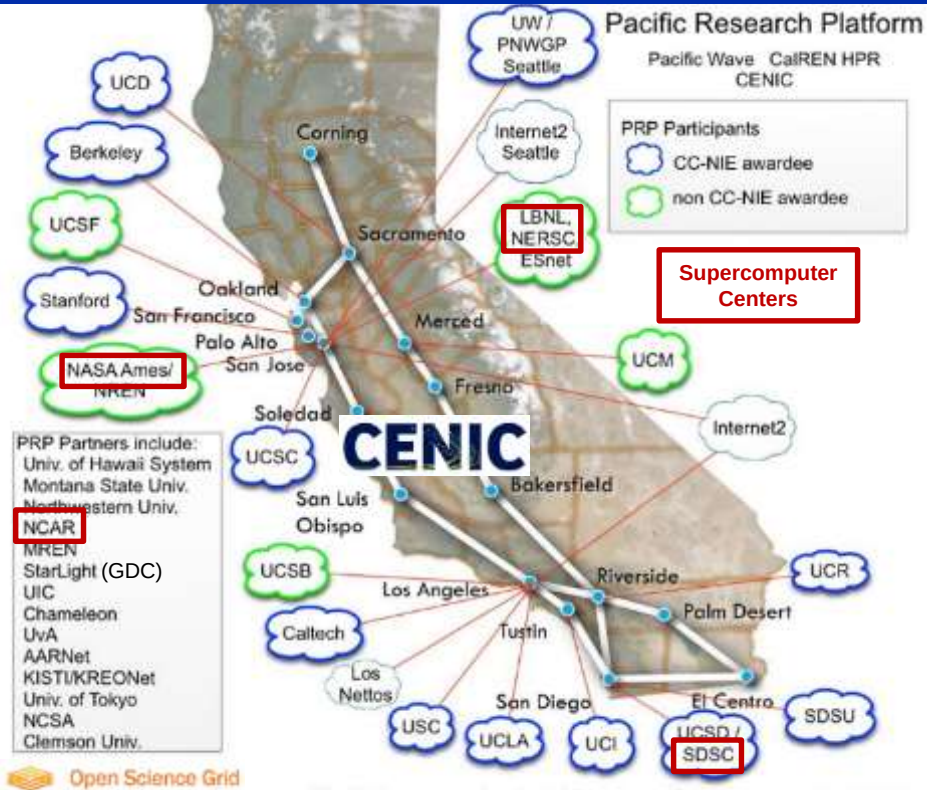
Distinguished Professor Emeritus, Dept. of Computer Science and Engineering

Jacobs School of Engineering, UCSD

http://lsmarr.calit2.net

PACIFIC RESEARCH PLATFORM

2015 Vision: The Pacific Research Platform Will Connect Science DMZs Creating a Regional End-to-End Science-Driven Community Cyberinfrastructure



NSF CC*DNI Grant
$6.3M 10/2015-10/2020
In Year 5 Now

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

- **Camille Crittenden, UC Berkeley CITRIS,**
- **Philip Papadopoulos, UCI**
- **Tom DeFanti, UC San Diego Calit2/QI,**
- **Frank Wuerthwein, UCSD Physics and SDSC**



ESnet: Given Fast Networks, Need DMZs and Fast/Tuned DTNs

PRP PACIFIC RESEARCH PLATFORM

Source: John Hess, CENIC

Terminating the Fiber Optics - Data Transfer Nodes (DTNs): Flash I/O Network Appliances (FIONAs)

UCSD-Designed FIONAs Solved the Disk-to-Disk Data Transfer Problem *at Near Full Speed* on Best-Effort 10G, 40G and 100G Networks



Two FIONA DTNs at UC Santa Cruz: 40G & 100G
Up to 192 TB Rotating Storage





Add Up to 8 Nvidia GPUs Per 2U FIONA
To Add Machine Learning Capability

PRP PACIFIC RESEARCH PLATFORM

NSF

FIONAs Designed by UCSD's Phil Papadopoulos, John Graham, Joe Keefe, and Tom DeFanti

SDSC

2018/2019: Installing Community Shared FIONA CPU/GPU/Storage Systems on Campuses and Working With Campus CIOs on DMZs



UC Santa Cruz



UC Irvine



UC Santa Barbara



Stanford



UC Merced

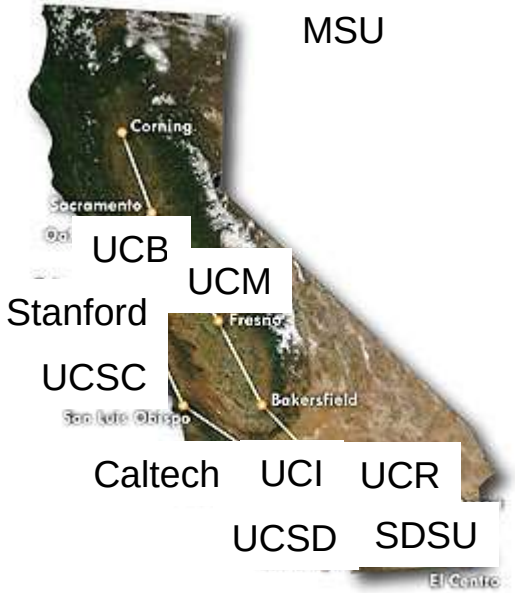
Ann Kovalchick
Panel 2



UC Riverside

PRP
PACIFIC RESEARCH PLATFORM

2017-2020: CHASE-CI Grant Adds a Machine Learning Layer Built on Top of the Pacific Research Platform



CI-New: Cognitive Hardware and Software Ecosystem Community Infrastructure (CHASE-CI)

For the Period September 1, 2017 – August 31, 2020

SUBMITTED – January 18, 2017

PI: Larry Smarr, Professor of Computer Science and Engineering, Director Calit2, UCSD
Co-PI: Tajana Rosing, Professor of Computer Science and Engineering, UCSD
Co-PI: Ken Kreutz-Delgado, Professor of Electrical and Computer Engineering, UCSD
Co-PI: Ilkay Altintas, Chief Data Science Officer, San Diego Supercomputer Center, UCSD
Co-PI: Tom DeFanti, Research Scientist, Calit2, UCSD

NSF Grant for 256 High Speed "Cloud" GPUs
For 32 ML Faculty & Their Students at 10 Campuses
To Train AI Algorithms on Big Data

PACIFIC RESEARCH PLATFORM

SDSC UC San Diego

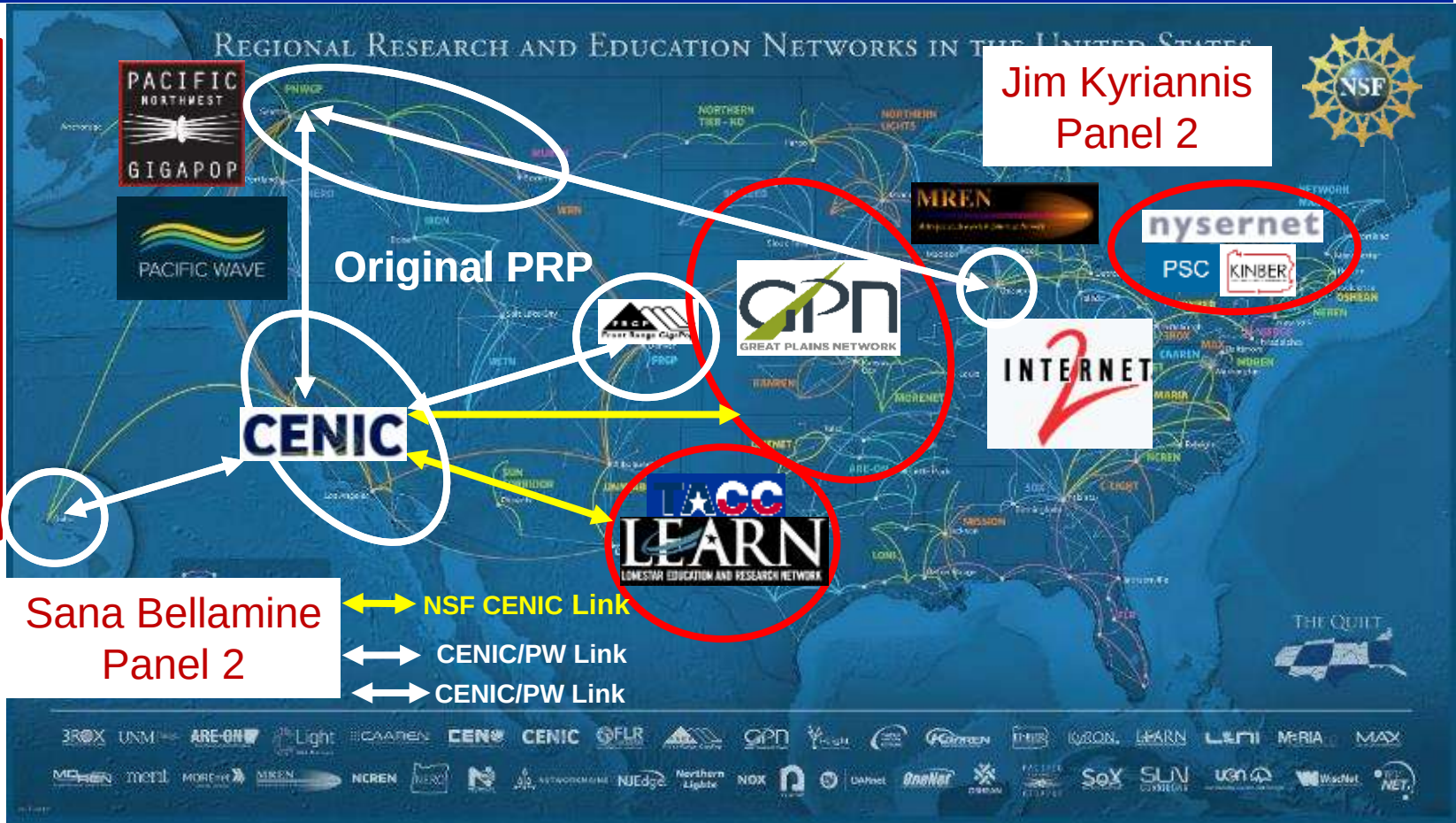
2018-2021: Toward the National Research Platform (NRP) - Using CENIC & Internet2 to Connect Quilt Regional R&E Networks

"Towards The NRP"
3-Year Grant Funded by NSF
$2.5M
October 2018

PI Smarr
Co-PIs Altintas Papadopoulos Wuerthwein Rosing DeFanti

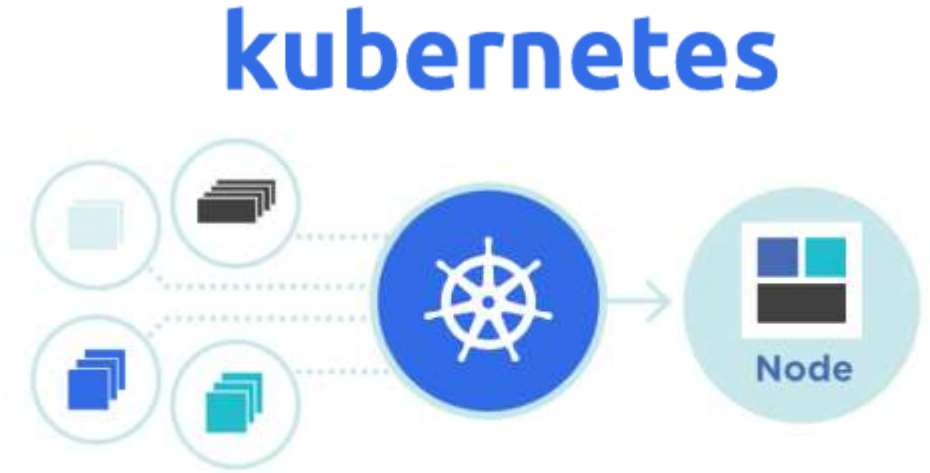
SDSC

PRP
PACIFIC RESEARCH PLATFORM



2018/2019: PRP Game Changer!
Using Kubernetes to Orchestrate Containers Across the PRP

User Applications



Containers

PRP PACIFIC RESEARCH PLATFORM

Clouds

PRP PACIFIC RESEARCH PLATFORM

CLOUD NATIVE COMPUTING FOUNDATION

PRP's *Nautilus Hypercluster* Adopted Kubernetes to Orchestrate Software Containers and Rook, Which Runs Inside of Kubernetes, to Manage Distributed Storage



Battle-tested, production storage

Rook is based on an embedded version of Ceph, which has 10+ years of production deployments and runs some of the worlds largest clusters.

Cloud-native environment integration

Rook runs as a cloud-native service for optimal integration with applications in need of block, object, or file storage.

"Kubernetes with Rook/Ceph Allows Us to Manage Petabytes of Distributed Storage and GPUs for Data Science,
While We Measure and Monitor Network Use."
--John Graham, Calit2/QI UC San Diego

PRP PACIFIC RESEARCH PLATFORM

Nautilus

it²

PRP's Nautilus is a Multi-Institution Hypercluster Connected by Optical Networks

Nautilus

180 FIONAs on 25 Partner Campuses
Networked Together at 10-100Gbps

Installed CPUs	Installed GPUs	Rotating Storage
7478	516	4000 TB

PRP PACIFIC RESEARCH PLATFORM

CENIC

THE QUILT

INTERNET2

PRP Principles:
Technology Evolution and Community Building

- **Innovation**
  - Identify technologies nearing tipping points & evolve them into PRP stable services
  - Early access to new hardware is critical (FPGA/GPU/TPU/DPU…)
  - Aggressively adopt automation software systems
- **Adoption**
  - Early engagement with opensource software projects (Rook / Admiralty …)
  - Share experience with the community (Workshops, Portal docs, Matrix chat, and weekly PRP call)
- **Scaling**
  - Reduce complexity for initial onboarding of hardware, projects and users
  - Build more turnkey solutions supporting both research and instructional computing needs
- **Sustaining**
  - Actively seek new collaborations
  - Grow the Nautilus user support service Social Network in the Matrix chat federation
  - Promote the Pot-Luck-Supercomputing paradigm

PACIFIC RESEARCH PLATFORM

John Graham
Panel 2

PRP is Science-Driven:
Connecting Multi-Campus Application Teams and Devices



Frank Wuerthwein
Panel 1

Particle Physics

CMS



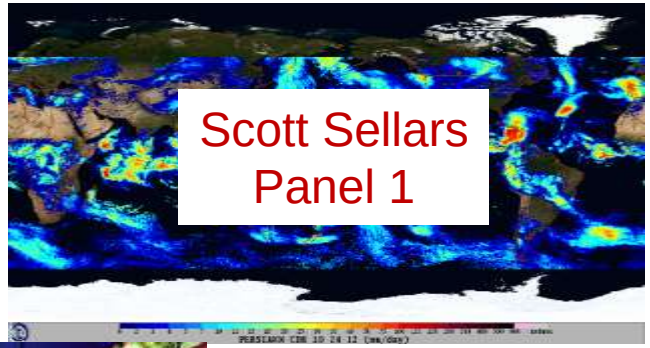
Alex Feltus
Panel 1

Biomedical 'omics

NSF



Telescope Surveys

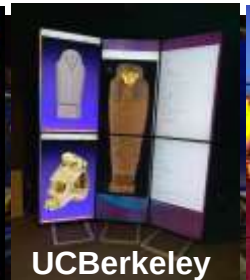


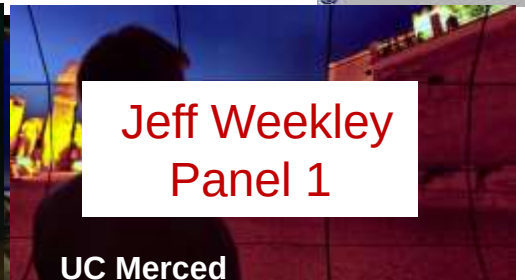
Scott Sellars
Panel 1

Earth Sciences

Visualization, Virtual Reality, Collaboration







Jeff Weekley
Panel 1

PRP
PACIFIC RESEARCH PLATFORM

Supporting and Expanding Emerging High-Priority PRP Applications

- Climate Change-Induced Natural Hazards Prediction and Mitigation
  - Wildfires

Ilkay Altintas
Panel 1



- Data Analysis from Large-Scale Scientific Instruments
  - CASPER

Dan Wertheimer
Panel 1



- Community Biological Database Generation
  - Better Forcefields for COVID-19 Simulations



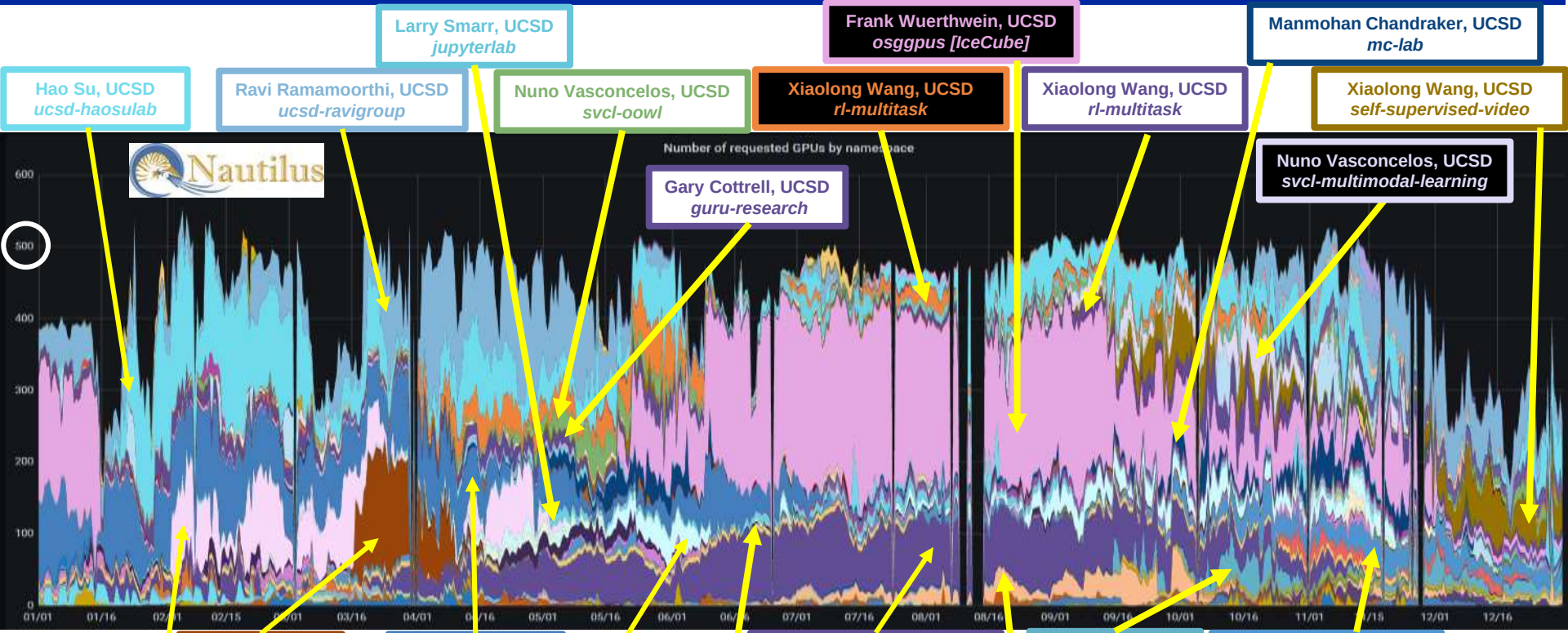
- Understanding the Brain
  - NSF's NeuroNex



Peak 1100 PRP CPU-Cores

PRP
PACIFIC RESEARCH PLATFORM

Top 20 GPU Users Out of 400 Nautilus Namespace Applications: Together They Consumed Nearly 500 GPUs in 2020



PRP
PACIFIC RESEARCH PLATFORM

Community Building
Through Large-Scale Workshops



Ana Hunsinger
Futures

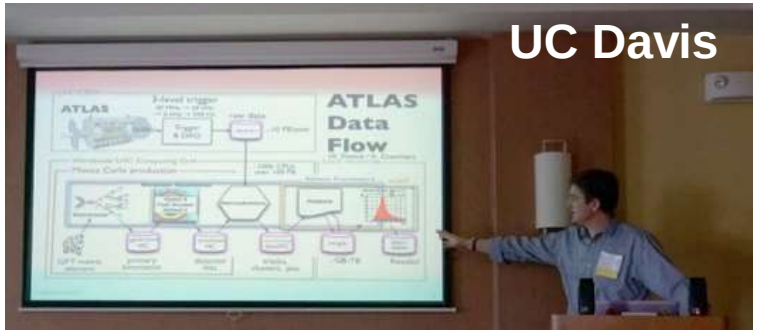




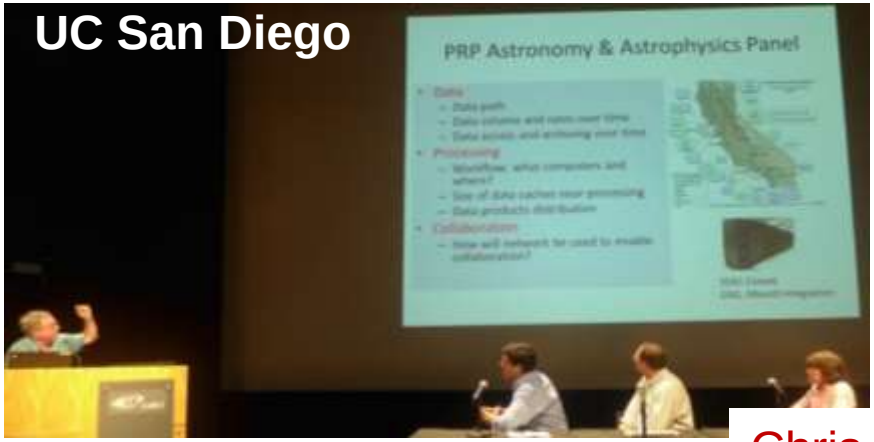


PRP
PACIFIC RESEARCH PLATFORM

Increasing Participation Through PRP Science Engagement Workshops







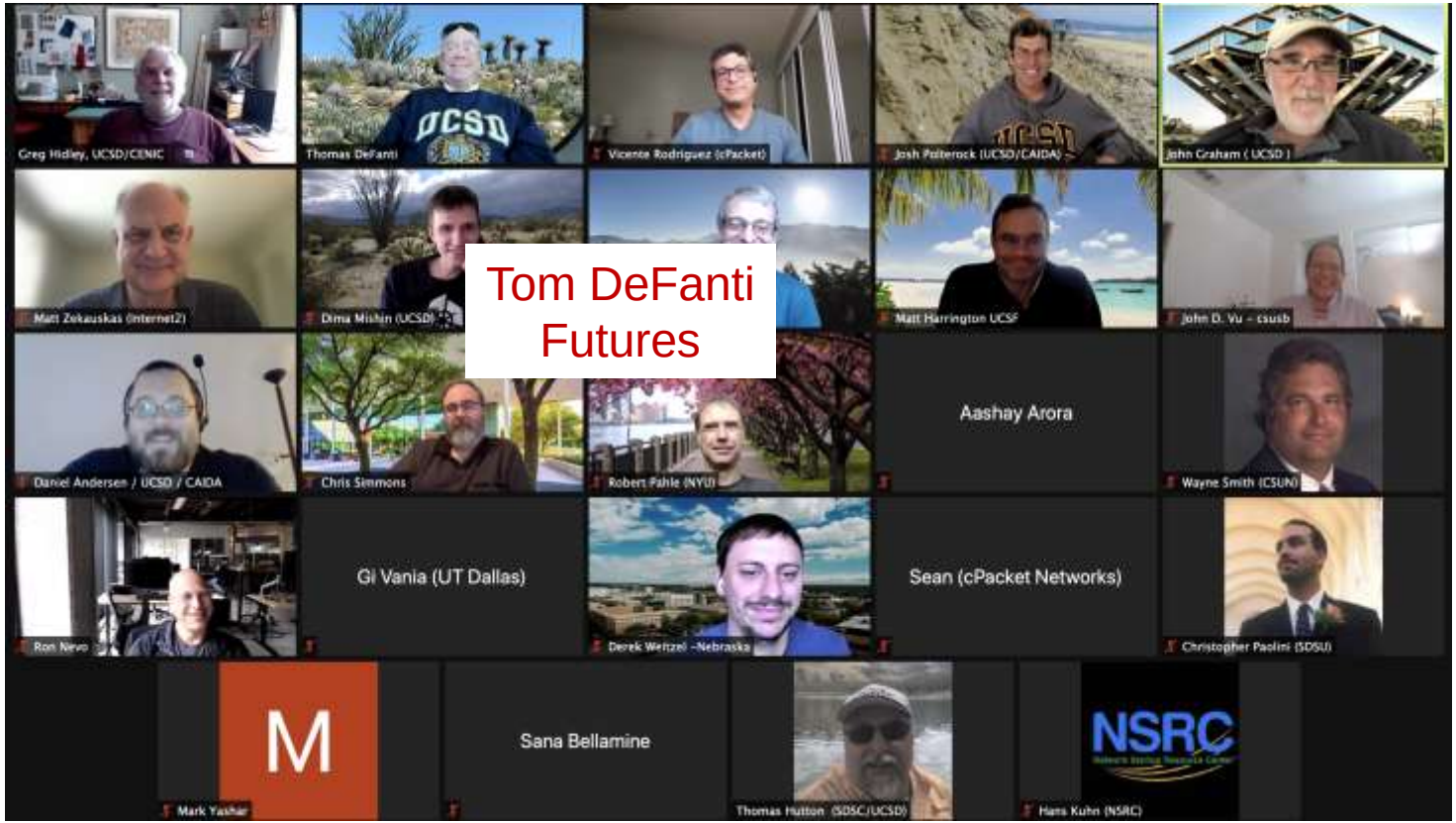


Chris Hoffman
Futures

Source: Camille Crittenden, UC Berkeley

PRP
PACIFIC RESEARCH PLATFORM

PRP Weekly Engineering Zoom Meeting



PACIFIC RESEARCH PLATFORM

Community Building Though Inclusion and Diversity: Workshops With Minority Serving Universities

2NRP Montana State University

Richard Alo
Panel 2







PRP
PACIFIC RESEARCH PLATFORM