“The CENIC-AI Resource”

SoCal Higher Ed CIOs Meeting

September 16, 2024

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, UC San Diego

Website: https://lsmarr.net/

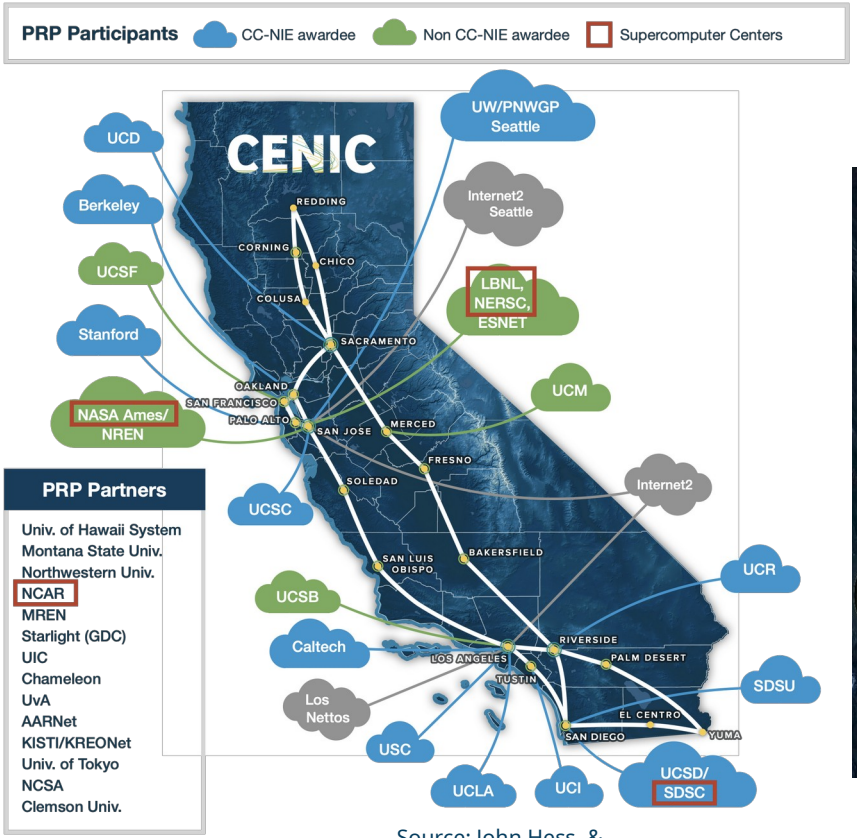
NRP NATIONAL RESEARCH PLATFORM

CENIC AIR

CENIC ARTIFICIAL INTELLIGENCE RESOURCES

NRP Nautilus

2015 Vision: The Pacific Research Platform Will Build on CENIC to Connect Science DMZs Creating a Regional Community Cyberinfrastructure



Source: John Hess, & Hunter Hadaway, CENIC

NSF CC*DNI Grant
$6.3M 10/2015-10/2020
Extended – Ended Year 7 in Oct 2022



NRP NATIONAL RESEARCH PLATFORM

CENICAIR
CENIC ARTIFICIAL INTELLIGENCE RESOURCES

NRP Nautilus

Data Transfer Nodes (DTNs) Terminate CENIC's Fiber Optics on Campuses: Flash I/O Network Appliances (FIONAs)

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



Add Up to 8 Nvidia GPUs Per 2U FIONA
To Add Machine Learning Capability
Up to 240TB Storage



FIONAs Are Rack Mounted

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

NSF

QUALCOMM INSTITUTE

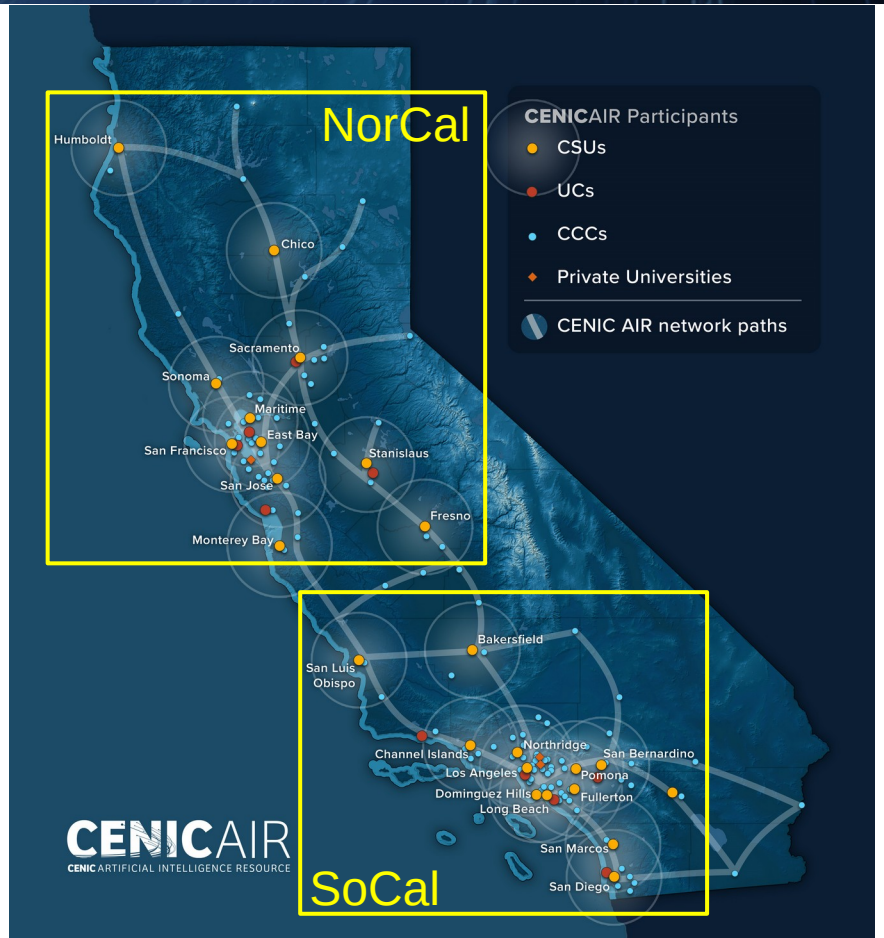
SDSC

NRP NATIONAL RESEARCH PLATFORM

CENIC AIR
CENIC ARTIFICIAL INTELLIGENCE RESOURCES

NRP Nautilus

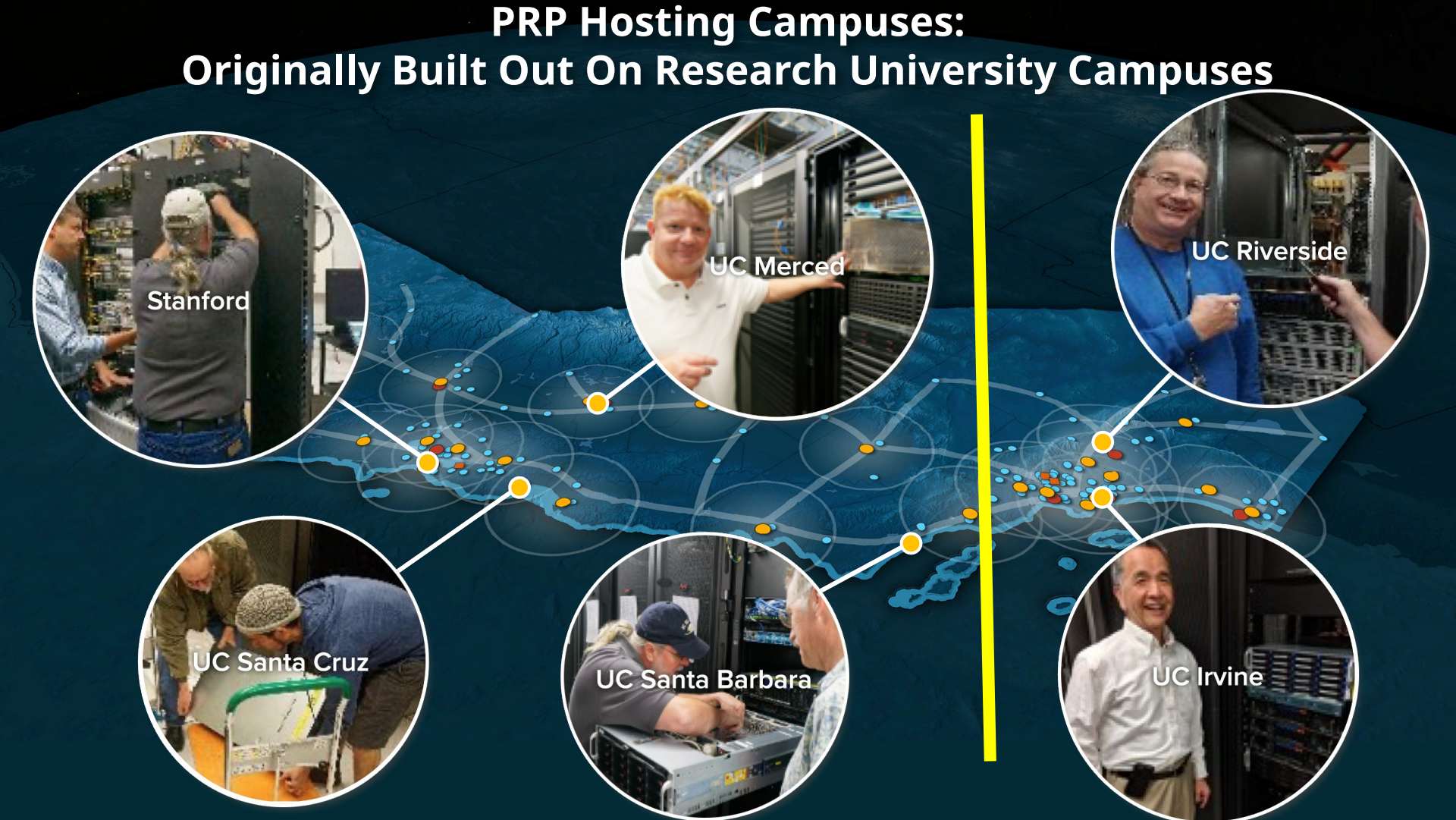
California's Research & Education Campuses are Regionally Organized



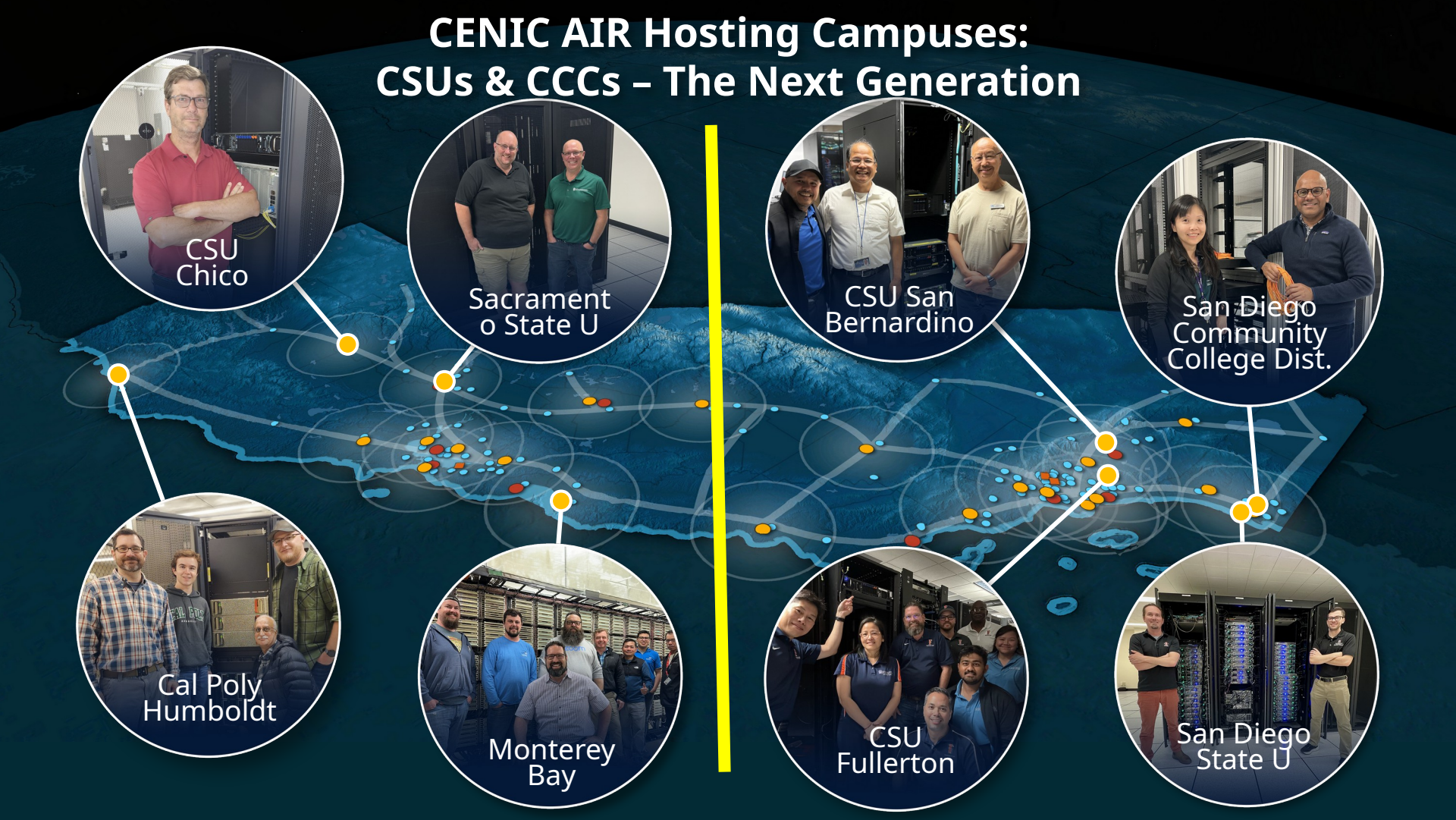
NRP NATIONAL RESEARCH PLATFORM

NRP Nautilus

PRP Hosting Campuses:
Originally Built Out On Research University Campuses



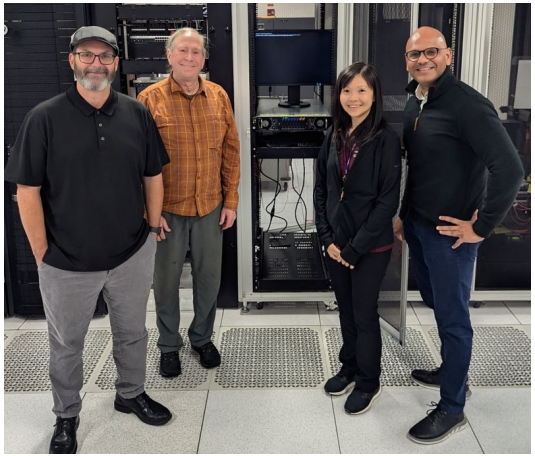
CENIC AIR Hosting Campuses:
CSUs & CCCs – The Next Generation



SDCCD Is the 1st California Community College to Host CENIC AIR Computational Resources



Peter Maharaj, Rose Parnsoonthorn,
In the SDCCD Machine Room





**First Nautilus FIONA Installed
In a CCC Machine Room
August 30, 2024**

NRP NATIONAL RESEARCH PLATFORM

CENIC AIR
CENIC ARTIFICIAL INTELLIGENCE RESOURCES

NRP Nautilus

2023 - The National Research Platform Emerges From the Pacific Research Platform

NRP NATIONAL RESEARCH PLATFORM

NEWS GRANTS TECHNOLOGY COMMUNITY JOIN / CONTACT



Professor Frank Würthwein

- Director - SDSC
- Distributed High-Throughput Computing Lead - SDSC

Designed for Growth and Inclusion

The National Research Platform (NRP) is a partnership of more than 50 institutions, led by researchers and cyberinfrastructure professionals at UC San Diego, supported in part by awards from the National Science Foundation.

https://nationalresearchplatform.org/

Nautilus is NRP's Multi-Institution Hypercluster Which Creates a Community Owned and Operated "AI Resource"

May 9, 2024

Nautilus NSF

~200 FIONAs on 27 Partner Campuses
Networked Together at 10-100Gbps

Installed GPUs	Installed CPU Cores	Rotating Storage
1210	23855	7000 TB

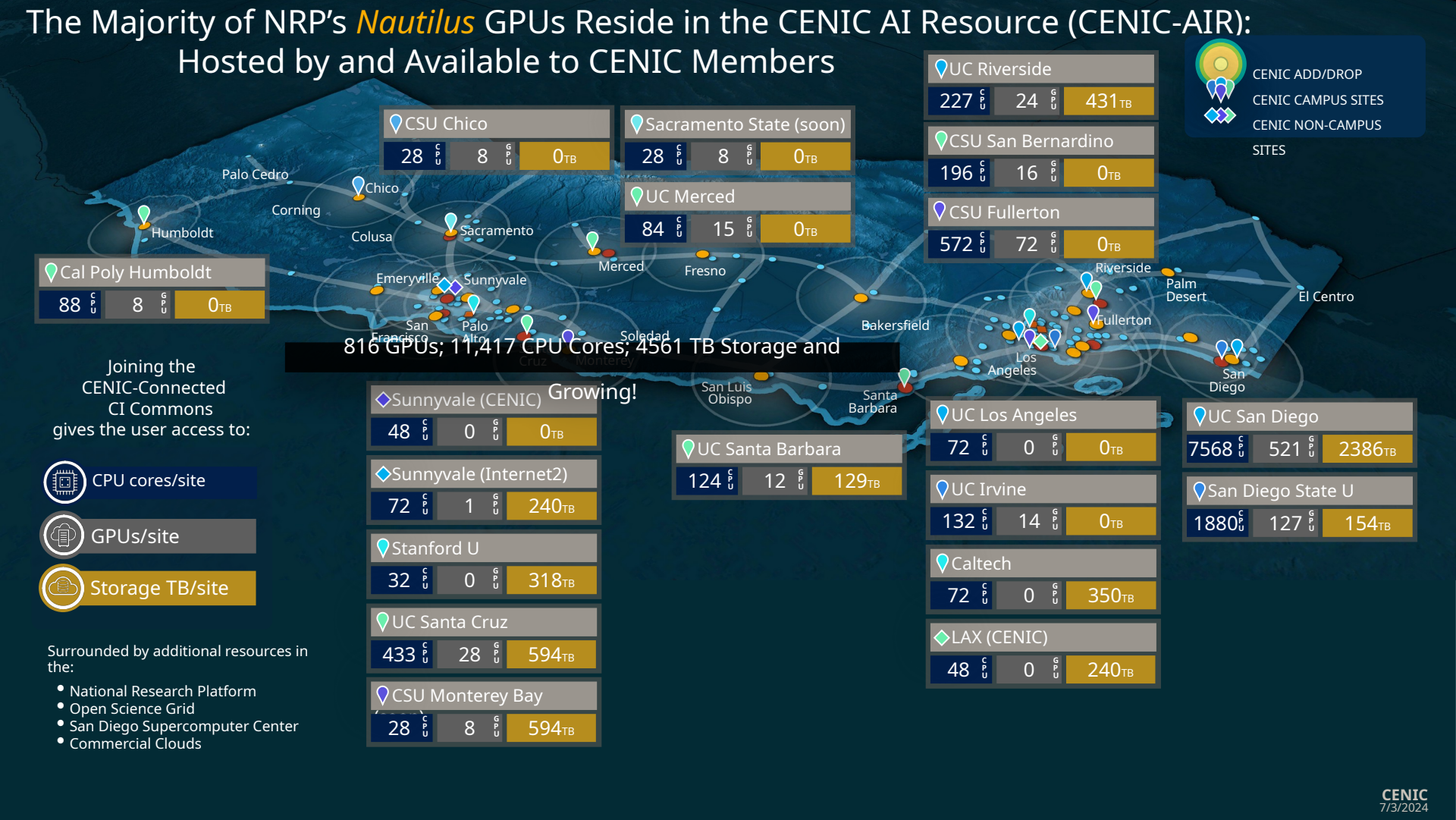
CENIC THE QUILT INTERNET2

NRP NATIONAL RESEARCH PLATFORM

CENICAIR
CENIC ARTIFICIAL INTELLIGENCE RESOURCES

NRP Nautilus

The Majority of NRP's *Nautilus* GPUs Reside in the CENIC AI Resource (CENIC-AIR): Hosted by and Available to CENIC Members



	CPU	GPU	TB
Cal Poly Humboldt	88	8	0
CSU Chico	28	8	0
Sacramento State (soon)	28	8	0
UC Merced	84	15	0
Sunnyvale (CENIC)	48	0	0
Sunnyvale (Internet2)	72	1	240
Stanford U	32	0	318
UC Santa Cruz	433	28	594
CSU Monterey Bay	28	8	594
UC Santa Barbara	124	12	129
UC Riverside	227	24	431
CSU San Bernardino	196	16	0
CSU Fullerton	572	72	0
UC Los Angeles	72	0	0
UC Irvine	132	14	0
Caltech	72	0	350
LAX (CENIC)	48	0	240
UC San Diego	7568	521	2386
San Diego State U	1880	127	154

SoCal Campuses Host 90% of the GPUs & CPUs and 75% of the Storage for CENIC-AIR



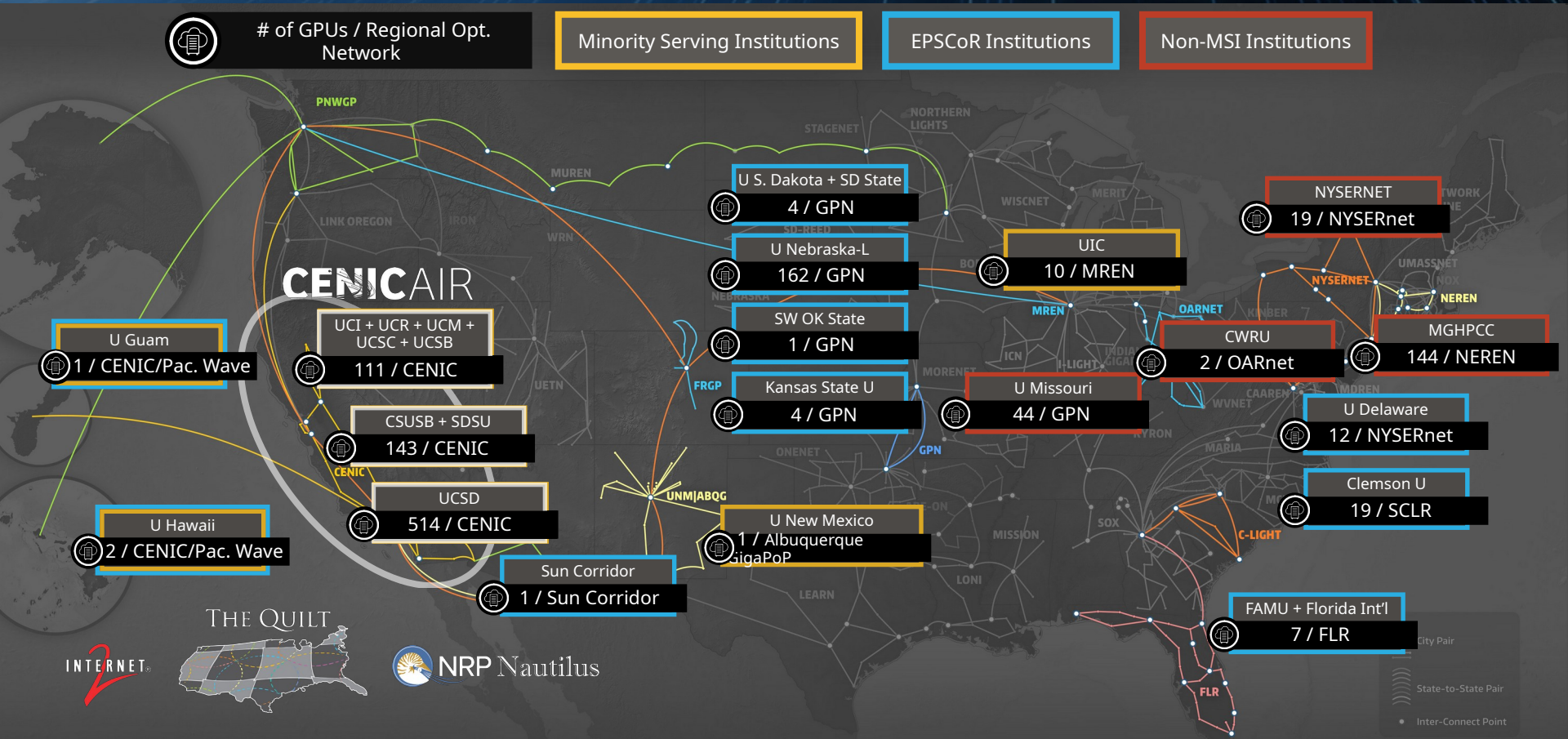
774 GPUs; 10,767 CPU Cores;
3561 TB Storage
and Growing!

NRP NATIONAL RESEARCH PLATFORM

CENIC AIR
CENIC ARTIFICIAL INTELLIGENCE RESOURCES

NRP Nautilus

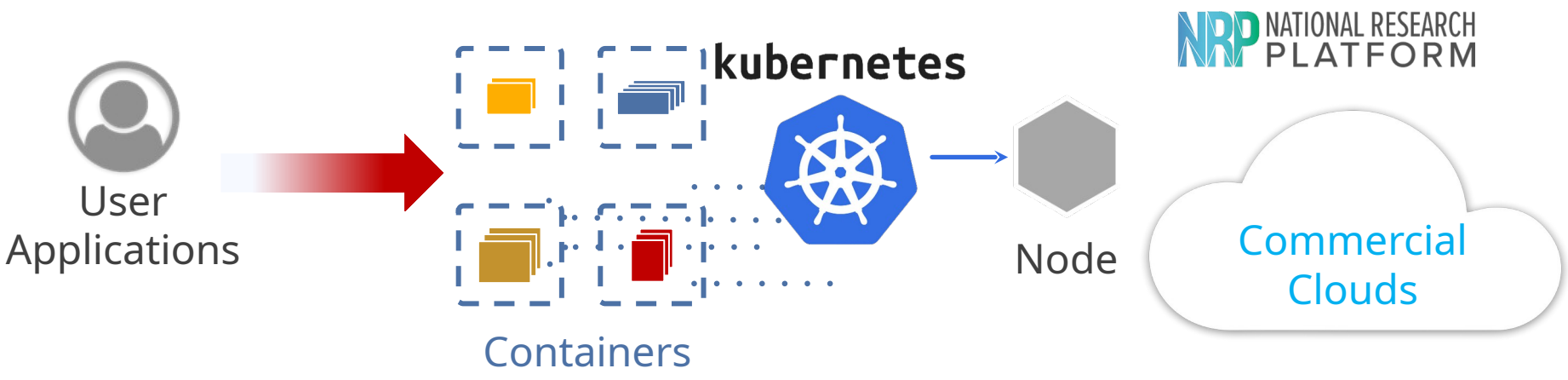
The Users of the CENIC-AIR Can Burst into NRP's Nautilus Hypercluster Outside of California



Users Can Execute Their Containerized Applications in the NRP or in Commercial Clouds

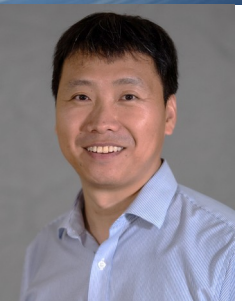
Nautilus Containerized Applications Are “Cloud Ready”

Nautilus



NRP NATIONAL RESEARCH PLATFORM

CSUN Prof. Bingbing Li
Machine Learning Research Projects Utilizing Nautilus



CSUN Prof.
Bingbing Li

CSUN | ARCS Arizona Research Center for STEAHM

- **Energy Disaggregation for Manufacturing Plant**
  - Faculty Lead: Dr. Bingbing Li (CSUN), Dr. Richard Donovan (UCI)
  - **DNNs: Long Short-Term Memory (LSTM) RNN, PyTorch**
- **Graph Representation Learning for Material Prediction and Recommendation in CAD Automation**
  - Faculty Lead: Dr. Bingbing Li (CSUN)
  - Collaborator: Dr. Daniele Grandi @ Autodesk and Dr. Thomas Lu @JPL
  - **DNNs: UV-Net Graph Neural Networks (GNN), PyTorch**
- **Knowledge Graph Construction Through the Potential of Large Language Models within Manufacturing**
  - Faculty Lead: Dr. Bingbing Li (CSUN)
  - Collaborator: Dr. Jerry Fuh & Senthil Kumar @ National University of Singapore
  - **DNNs: LLMs (ChatGPT & LLaMa), Tensorflow**
- **Multi-Domain AI for Future Manufacturing**
  - Faculty Lead: Dr. Bingbing Li (CSUN)
  - Collaborator: Dr. Edward Chow & Dr. Thomas Lu @JPL
  - **DNNs: LLMs (ChatGPT & LLaMa), Tensorflow**
- **Medical Image Restoration through Optical & CT Scanning**
  - Faculty Lead: Dr. Xiyi Hang & Dr. Bingbing Li (CSUN)
  - Collaborator: Dr. Ye Pu and Prof. Demetri Psaltis @ Swiss Federal Institute of Technology Lausanne
  - **DNNs: Large-Kernel CNN, Tensorflow**

TensorFlow

PyTorch

LLM
LARGE LANGUAGE MODEL

ChatGPT

Meta

SDSU Is the Lead Campus for the New CENIC-Connected Technology Infrastructure for Data Exploration (TIDE) NSF Grant

- **A CSU Resource for Research & Education:**
  - **NSF CC* Regional Computing Award for ~$1M**
    - **$800 for a New Computational Core**
    - **$200 for Students to Help Onboard and Support Users**
  - **Federated with NRP Nautilus**
  - **First New NSF Resource in CENIC-AIR**

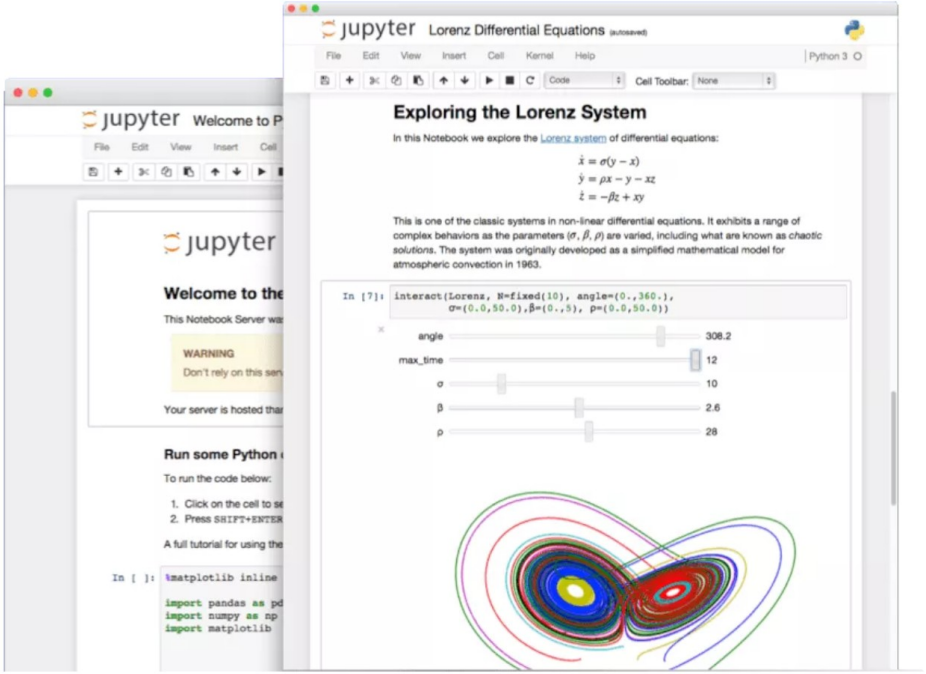


616 CPU Cores | 73 GPUs | 14.592 TB RAM

CENIC 2024 Innovations in Networking Award

Source: Jerry Sheehan, TIDE PI

Jupyter Notebooks
Have Become The Popular Method of Sharing Computational Documents



Jupyter Notebook: The Classic Notebook Interface

The Jupyter Notebook is the original web application for creating and sharing computational documents. It offers a simple, streamlined, document-centric experience.

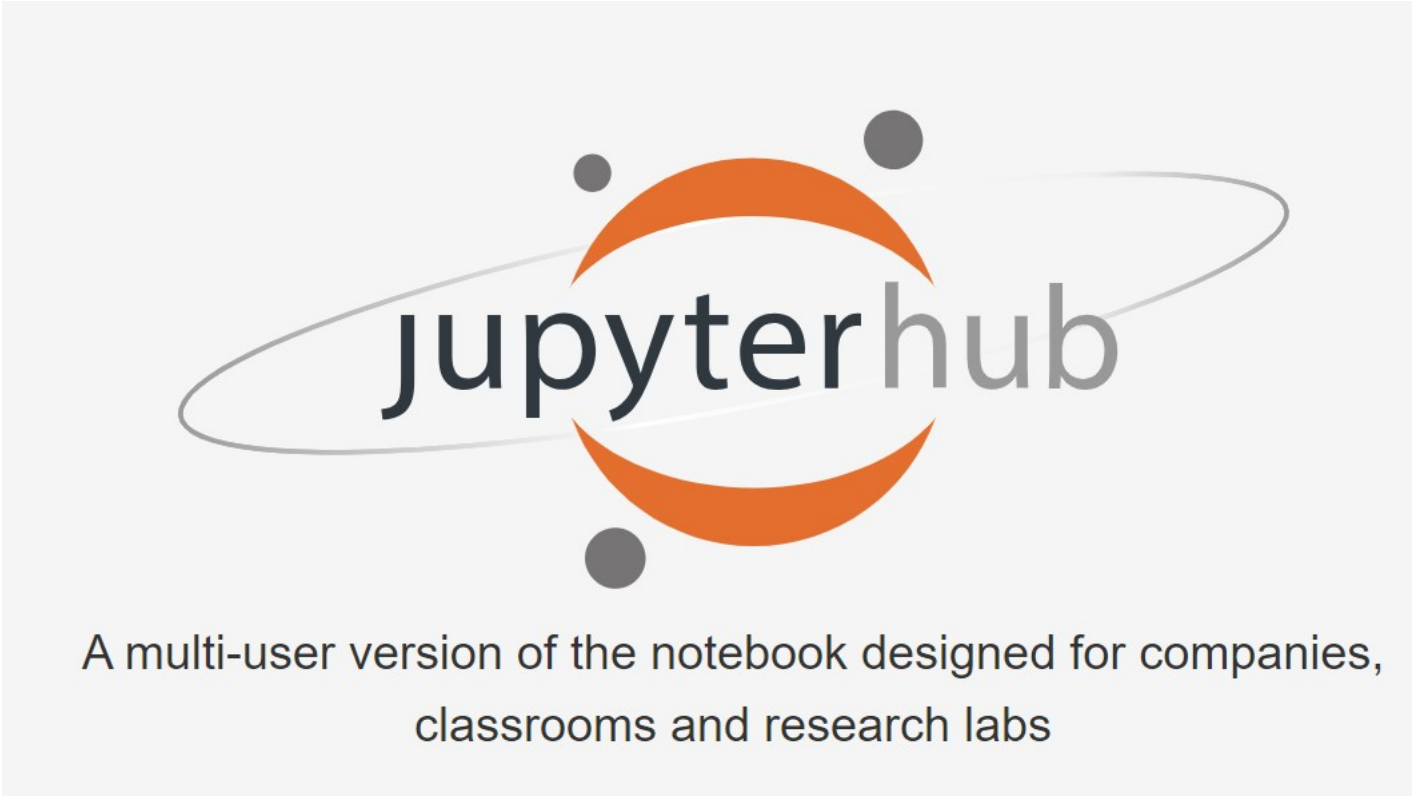
Try it in your browser | Install the Notebook

NRP NATIONAL RESEARCH PLATFORM

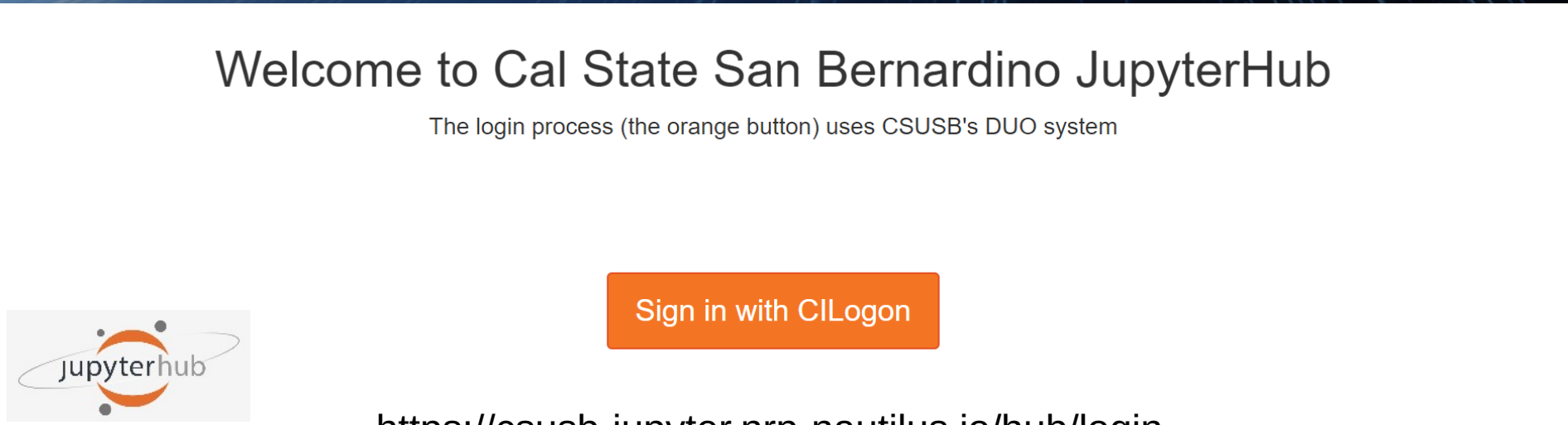
CENIC AIR
CENIC ARTIFICIAL INTELLIGENCE RESOURCES

NRP Nautilus

jupyterhub is the Multi-User Version of the Jupyter Notebook



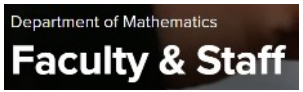
A Key Reason CSUSB Has The Largest CSU Nautilus Usage: They Installed and Publicized the JupyterHub “Easy Button”



https://csusb-jupyter.nrp-nautilus.io/hub/login

Over 450 Total Users
Tripled in the Last Six Months!

Slide Adapted from
Prof. Youngsu Kim



NRP NATIONAL RESEARCH PLATFORM

CSUSB WE DEFINE THE Future

NRP Nautilus

UCSD's Information Technology Services Has Adapted NRP FIONA8s To Support Students in Data Science (DS) & Machine Learning (ML) Courses



SDSC Racked FIONAs:

- 132 32-bit GPUs
- 1024 CPU-cores
- 10/100G Networking
- Not Federated With NRP



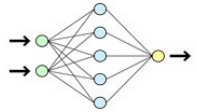
Software Used By Stud

PyTorch

TensorFlow

Caffe

jupyter



ANACONDA

NumPy

NVIDIA CUDA

kubernetes

docker

- **Student-Focused Platform For:**
  - Undergraduate & Graduate Coursework
  - For-Credit Independent Study
  - Thesis/Dissertation Research
  - Capstones & Projects
- **Research-Driven Architecture**
- **Managed by UCSD IT Services**
- **Used in Over 60 Courses by More Than 6000 Students**

Source: Adam Tilghman, UCSD ITS

NRP NATIONAL RESEARCH PLATFORM

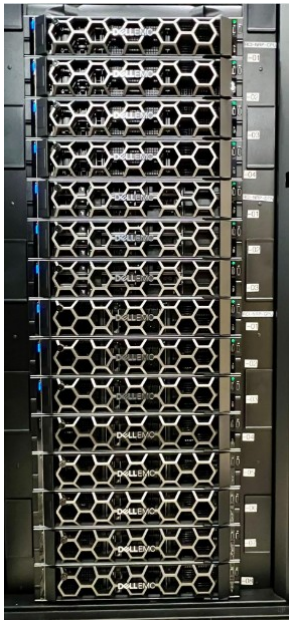
CENIC AIR
CENIC ARTIFICIAL INTELLIGENCE RESOURCES

IT SERVICES
UC San Diego

NRP Nautilus

SDSU's VERNE Expands UCSD's Instructional Model by Federating with NRP: Visionary, Education, Research, Network, Ecosystem

SDSU Information Technology Division



CENIC

NVIDIA. docker kubernetes jupyter PyTorch TensorFlow MATLAB RStudio

- **Dell PowerEdge Cluster for Instructional Use:**
  - 15 Nodes with:
    - 32 A100 GPUs (can bemanaged as 232 independent GPU
    - 768 CPU cores
    - 240 TB Persistent Storage
  - A Learning Resource that Surges for Research and Instruction
  - System Administration as a Service from the NRP
- **Growth in Both SDSU Courses and Students Using VERNE**
  - Spring Quarter 2024
    - 14 Courses
    - 300 Students

Slide courtesy of Jerry Sheehan and Mike Farley

NRP NATIONAL RESEARCH PLATFORM

CENIC AIR CENIC ARTIFICIAL INTELLIGENCE RESOURCES

NRP Nautilus

UCSD, SDSU, SDSC & NRP Are Working Together With SDCCD & SDCOE to Create a Common San Diego Instructional JupyterHub



VERNE

SDSU

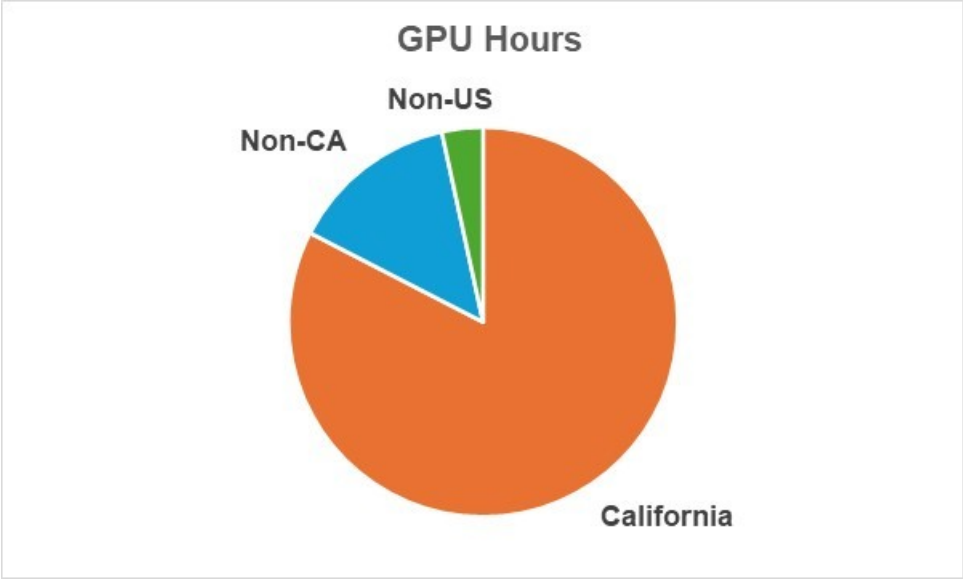
Launch JupyterHub

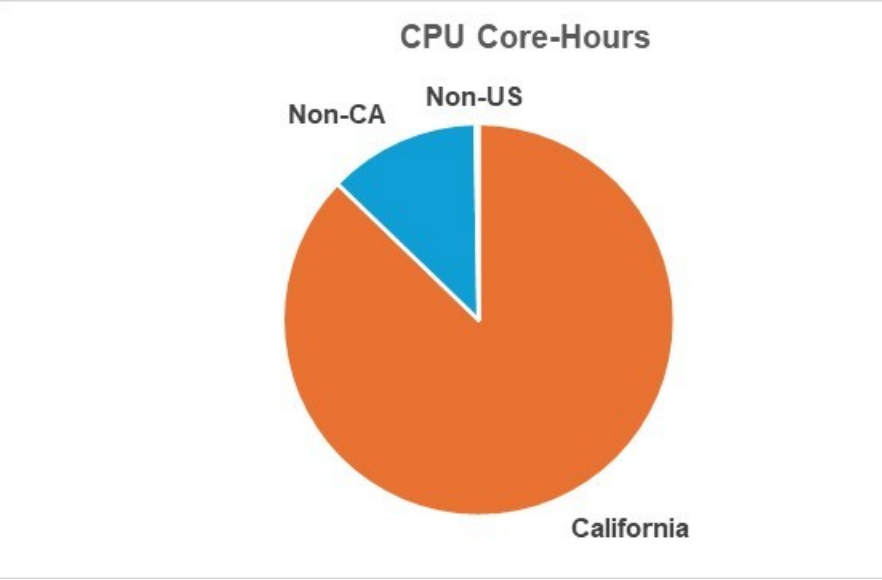


DSMLP

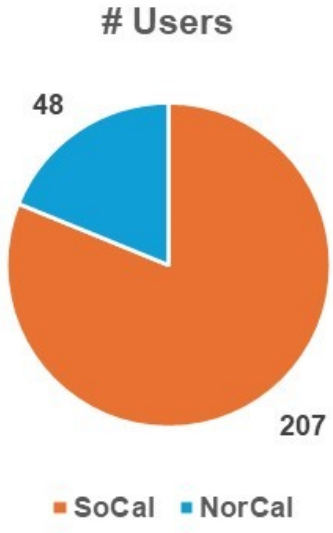
UC San Diego

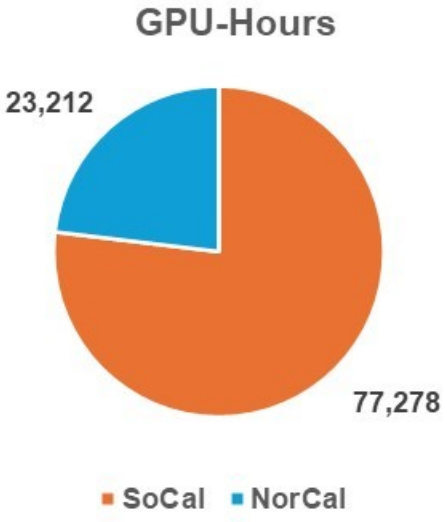
California Campuses Dominated the Use of the 107 NRP Namespaces With Active jupyterhubs Embedded in the Last 9 Months

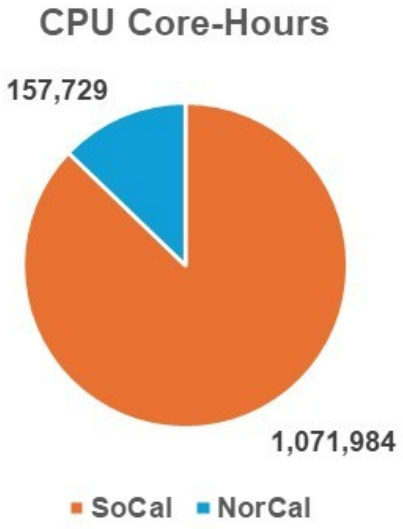




SoCal Campuses Dominate NorCal Usage in these NRP Namespace jupyterhubs







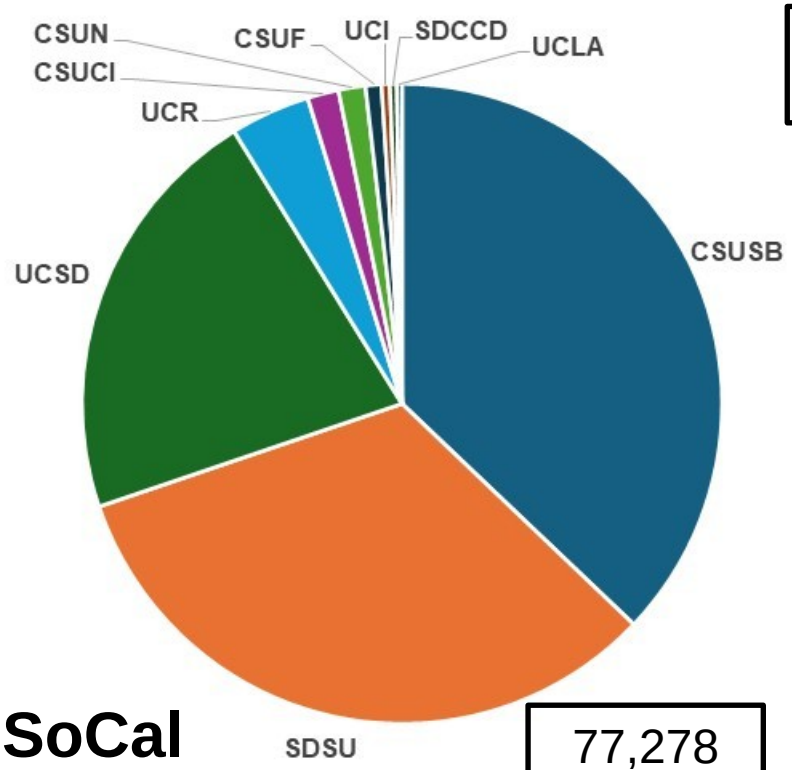
Last 9 Months:
12/1/2023 to
8/31/2024

NRP NATIONAL RESEARCH PLATFORM

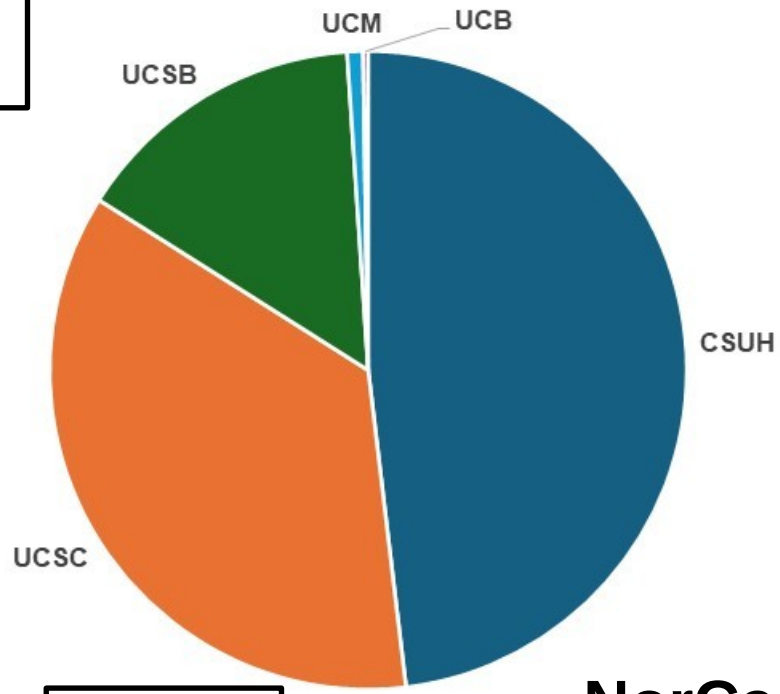
CENIC AIR
CENIC ARTIFICIAL INTELLIGENCE RESOURCES

NRP Nautilus

SoCal Used 3x the jupyterhub GPU-Hours as NorCal-Leading Campuses Were CSUs



Last 9 Months: 12/1/2023 to 8/31/2024



SoCal

77,278 GPU-Hrs

3X

23,212 GPU-Hrs

NorCal

NATIONAL RESEARCH PLATFORM

CENIC AIR
CENIC ARTIFICIAL INTELLIGENCE RESOURCES

NRP Nautilus

Use the NRP Web Site to Get Started and Find Expert *Community* Support

nationalresearchplatform.org

NRP NATIONAL RESEARCH PLATFORM

NEWS GRANTS TECHNOLOGY COMMUNITY JOIN / CONTACT

Contact Us

Join the NRP mailing list

Get Quick Access

Matrix Chat Has Over 1000 Members

Nautilus Documentation

Getting Started with Nautilus

Matrix Chat

Join in Using the CENIC-AIR

NRP NATIONAL RESEARCH PLATFORM

CENIC AIR
CENIC ARTIFICIAL INTELLIGENCE RESOURCES

NRP Nautilus