



CENIC | California's Research & Education Network

Louis Fox & CENIC Staff | April 1, 2021



Welcome
Kim Lewis, Legislative Advocate

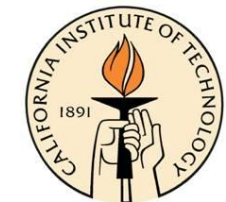


The CENIC Research and Education Network, CalREN
Louis Fox, President & CEO

CENIC is a 501(c)(3) with the mission to advance education and research statewide by providing the world-class network essential for innovation, collaboration, and economic growth.

Charter Associates:

- California K-12 System
- California Community Colleges
- California State University System
- Stanford, Caltech, USC
- University of California System
- California Public Libraries
- Naval Postgraduate School





8,000+ miles of optical fiber

Members in all 58 counties connect via fiber-optic cable or leased circuits from telecom carriers

Over 12,000 sites connect to CENIC

A non-profit chartered & governed by its members

Collaborates with over **750 private sector partners** and contributes approximately **> \$100,000,000** to the CA economy

24-plus years of connecting California



KISTI
KREONET
Korea
CSTNET
China
GLORIAD
Hong Kong

GEMNet2
Japan
TransPAC/
Pacific Wave
100Gbps
Japan

UH
Oahu
AARNet
Australia
IGN-X
Japan
NII/SINET
Japan
TransPAC
Japan
CERNET
China

CANARIE
Canada
100 Gbps
PNWGP

ESnet
DREN

Internet2

NORDUnet
Nordic Countries

JANET
United Kingdom
SURFnet
Netherlands
GEANT
Europe
ESnet
CERN

FRGP

Internet2

UltraLight
(CalFed)

ABQG

DREN

NREN
(NASA Ames)

ESnet

Nodes in California:
Palo Cedro, Chico, Corning, Sacramento, Colusa, Merced, Fresno, Emeryville, Sunnyvale, Bakersfield, Riverside, Palm Desert, Yuma, San Francisco, Palo Alto, Soledad, Los Angeles, Tustin, San Diego, Tijuana, San Luis Obispo

- CalREN Nodes**
- Optical add/drop
 - Optical add/drop & DC
 - Optical add/drop, DC, & HPR

TWAREN
TANET
Taiwan
Qatar
Foundation
Qatar
NUS-GigaPoP
Singapore

UH
Oahu
UH
Hawaii



- Partner Exchange Links
- Participant Links
- Prospective Links
- AP-REX Links
- Pacific Wave Backbone
- Pacific Wave POP
- AP-REX POP
- Pacific Research Platform (PRP)
- PRP Science DMZ Fabric
- Software Defined Network
- Commercial Peering Points (Amazon, Google, & Microsoft)

- WESTERN REGIONAL NETWORKS**
States served by WRN members:
- ABQG: New Mexico GigaPoP
 - CENIC: California
 - FRGP: Colorado & Wyoming
 - PNWGP: Washington, Montana, Alaska, Oregon & Idaho
 - UH: Hawaii

With support from the National Science Foundation



Non-Profit Research and Education Networks: Critical Infrastructure Powering Our Nation's Most Important Work

The logo for CENIC, featuring the word "CENIC" in a bold, dark blue sans-serif font. The letter "N" is stylized with colorful, abstract lines in shades of green, yellow, and blue passing through it.

CENIC connects California to the world — advancing education and research statewide by providing a world-class network essential for innovation, collaboration, and economic growth.

HIGHER-ED



INDIGENOUS COMMUNITIES

RESEARCH CENTERS



GOVERNMENT

K-12



HEALTHCARE

LIBRARIES



PUBLIC SAFETY

COMMUNITY NON-PROFITS



CULTURAL INSTITUTIONS



How is CENIC responsive to its user community of 12,000 member institutions and 20+ million Californians?

Raul Rincon, Vice President of Operations & HR
Stanley Han, Manager of Network Operations

CENIC Benefits to California Institutions


CENIC's California Research and Education Network (CalREN) is a multi-tiered, high-performance network serving the majority of research and education institutions in the state.

Each year, 20 million Californians use CalREN at 12,000 member institutions.

By using CalREN broadband, CENIC member institutions enjoy supremely reliable, efficient, and cost-effective access as well as these benefits:

- Unlimited broadband use
- Access to a state-of-the-art network
- Entry into a participatory, membership organization
- Network design expertise
- Cloud connectivity and content services
- 24/7 Network Operation Center
- Scaling services to the need
- Federal and state subsidy assistance
- Lower costs on circuits & equipment
- A global community of tens of thousands of Research & Education institutions

Network Operations Center (NOC)



One of the most valuable benefits to CENIC members is the 24/7/365 Network Operations Center (NOC), which maintains our technical environment for millions of organizations and individuals across California, handling network monitoring, management, and control.

CENIC NOC Statistics 2020

Supported 900+ Devices

- *Optical Networking Systems*
- *Switches*
- *Routers*

Supported 749 Telco Circuits

216,275 Alarms Assessed

25,827 Tickets Created

1,631 Maintenances Performed



CENIC and leading edge networking: How do we support education, research, and clinical care?

Robert Kwon, Director of Engineering

Leading Edge Networking: How are we different?

CENIC is different from traditional ISPs

- Custom network tailored to the unique needs of Research and Education
- Aggressive and proactive upgrades to avoid impacts to user experience
- Governed by our members (i.e. Collaborative environment with our participants to ensure that their voices are heard)
- Connections to national and international research institutions through Internet2 and Pacific Wave
- Security services such as DDoS Mitigation and joint approach to impact mitigation
- Lower cost on circuits and equipment

Next-Generation Infrastructure is a significant modernization effort across all of CENIC's networks

- 50 CENIC datacenters all across California
- Leading edge technologies such as coherent optical, segment routing, and 400 Gigabit per second

What's coming next?

- Layer 2&3 Virtual Private Network services enhancing privacy and flexibility in extending member's network through CENIC
- Services such as Rapid Private Interconnect, Epic (an electronic medical record platform), Cloud and Exchange connections
- Spectrum service and 400 Gigabit per second circuits across CENIC's network

Leading Edge Networking

Enabling multidisciplinary, multinational research.


California's research universities are global leaders in science and innovation, which creates an advantage for the entire state. The following slides are examples of recent projects supported by CENIC.

The Pacific Research Platform (PRP)



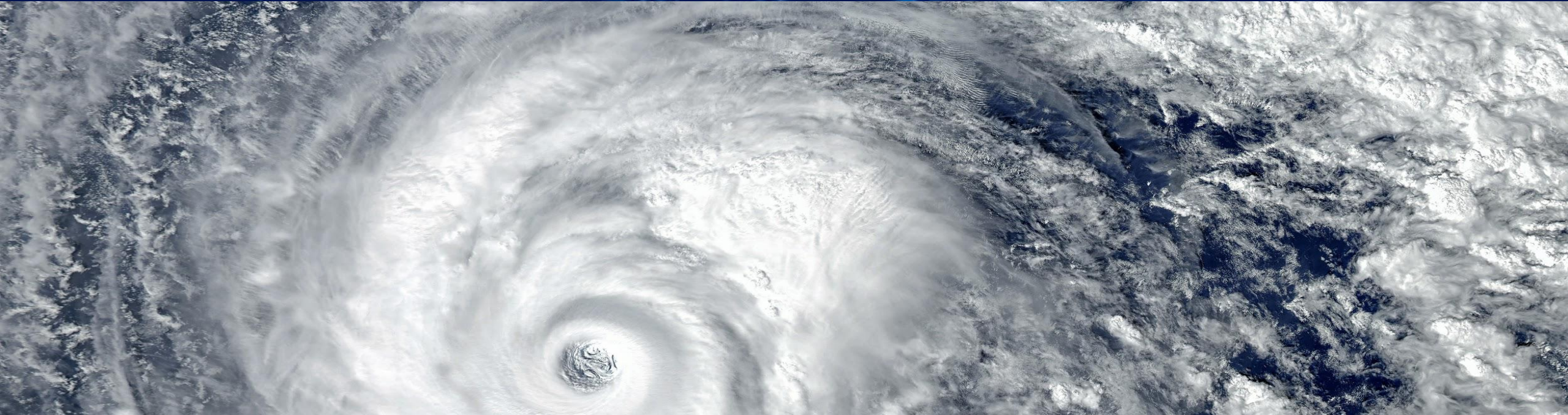
The PRP is a partnership of more than 50 institutions globally, led by researchers at UC San Diego and UC Berkeley and includes the National Science Foundation, Department of Energy, and all of California's major research universities. The PRP builds on the optical backbone of Pacific Wave, a joint project of CENIC and the Pacific Northwest GigaPOP (PNWGP) to create a seamless research platform that encourages collaboration on a broad range of data-intensive fields and projects.

WIFIRE



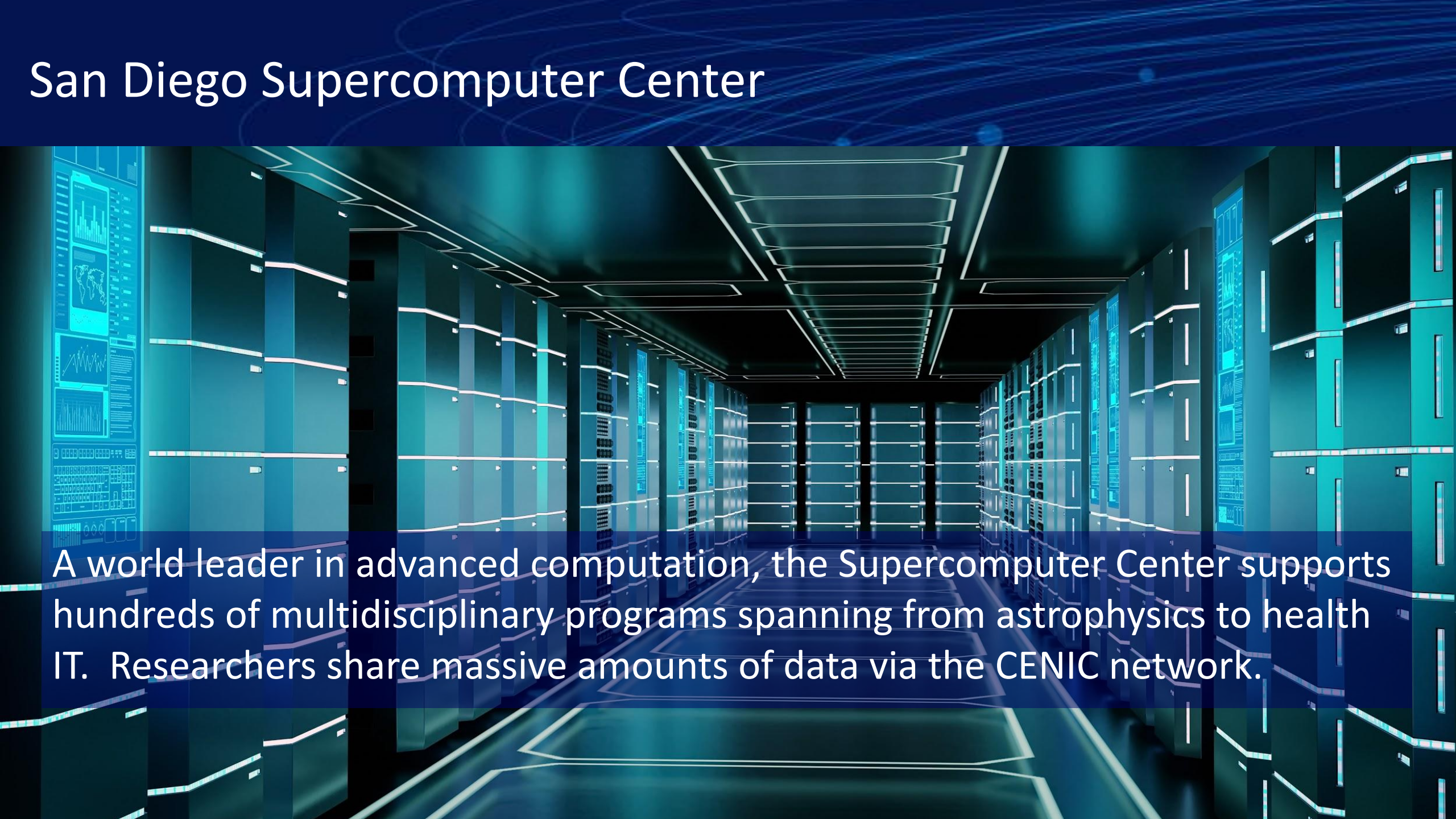
To meet growing needs in hazards monitoring and response, the WIFIRE Lab provides situational awareness for first responders. Hundreds of cameras and meteorological stations stream data to San Diego Supercomputer, where it is compiled and analyzed to provide predictive models that are shared in real time via a communications network with emergency personnel in the field. This allows informed response and deployment strategies such as evacuations, firebreaks, retardants, resource use, and more.

National Oceanic and Atmospheric Administration - NOAA

A satellite image of a hurricane, showing a clear eye and spiral cloud bands over a dark ocean surface.

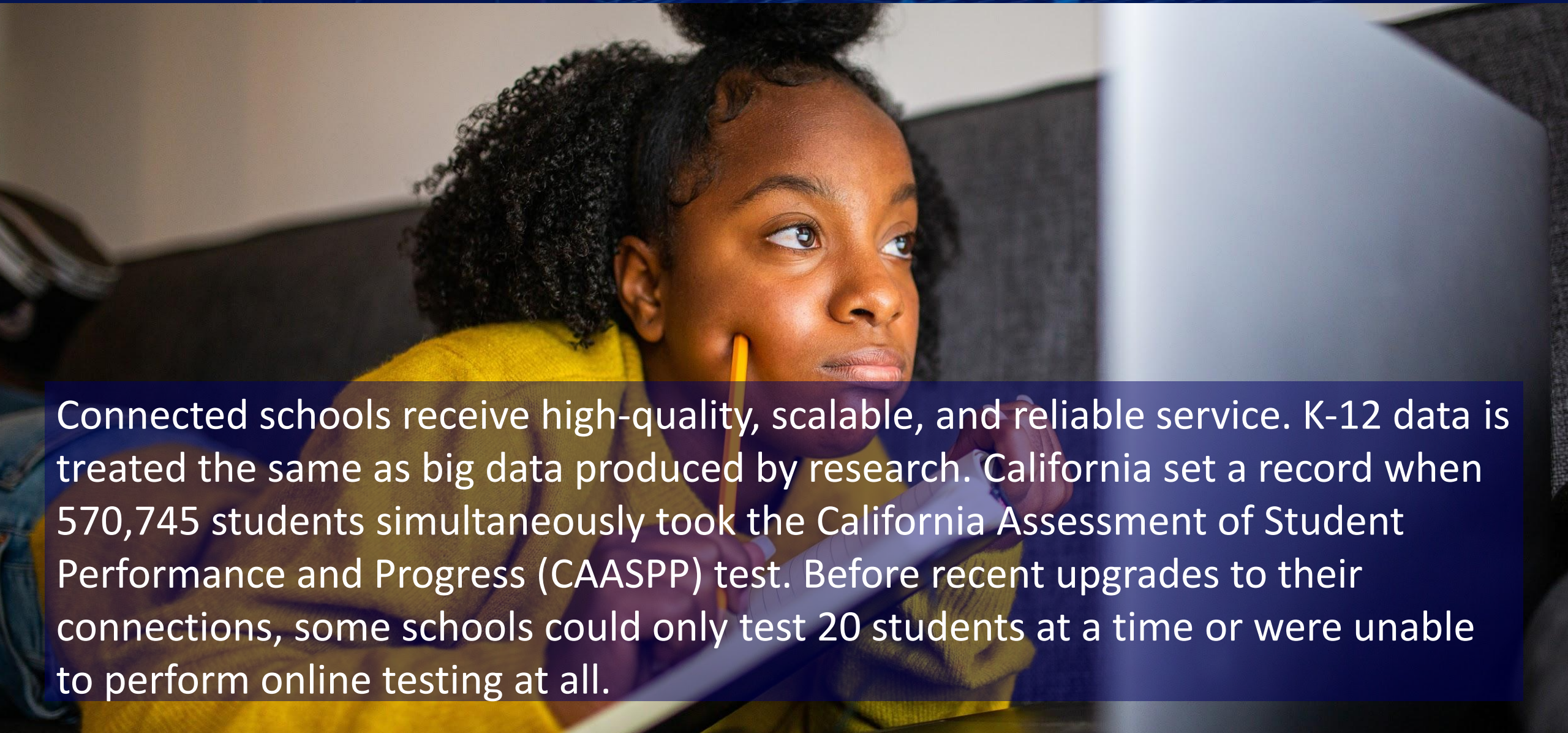
NOAA's work on climate change, weather, oceans, and coasts is transferred and shared among its own sites and California's research universities. CENIC's networks provide connectivity for NOAA to move and share data amongst research sites, and employ climate instruments in California, the Nation and across the globe.

San Diego Supercomputer Center

A perspective view of a server room with rows of server racks and glowing blue digital data overlays. The scene is illuminated with a cool blue and teal color palette, featuring glowing lines and data visualizations on the server panels and ceiling. The racks extend into the distance, creating a sense of depth and scale.

A world leader in advanced computation, the Supercomputer Center supports hundreds of multidisciplinary programs spanning from astrophysics to health IT. Researchers share massive amounts of data via the CENIC network.

K-12 Online Learning & Testing



Connected schools receive high-quality, scalable, and reliable service. K-12 data is treated the same as big data produced by research. California set a record when 570,745 students simultaneously took the California Assessment of Student Performance and Progress (CAASPP) test. Before recent upgrades to their connections, some schools could only test 20 students at a time or were unable to perform online testing at all.

Dynamic and flexible architecture of CENIC Network

COVID changes in usage

- Zoom and Virtual Private Network traffic increased to 1 Pb per week, post stay at home order
- Residential ISP traffic increased by 323% for a total of 7.6 Pb per week, post stay at home order

CENIC constantly working behind the scenes to ensure the best network for our members

- Implementing new technologies beginning with Research Institutions for CENIC to build a stable support model. These technologies eventually get implemented to the wider audience - today, we have 100Gb connected libraries, K-12s, CSUs, UCs, and Independents
- Continuously adding direct connections to popular services such as Amazon, Google, Microsoft, Zoom, Facebook, and Netflix among many others
- Listening to our community and working with our partners to have direct connections to education related services such as Blackboard and Desire2Learn
- Staying ahead of network capacity needs to ensure no customer impact during dynamic changes in usage



Broadband Access and Equity: What Next Steps Can We Take Together?

Louis Fox, President & CEO

CENIC Broadband Access and Equity

- Core Program Initiatives: Schools and Libraries
- To and Through Community Anchor Institutions
- Municipal Projects for High Poverty Communities
- Tribal Nations and CENIC
- CalREN Augmentations (prospective)
- University Medical Centers & Partner Health Care Organizations
- Broadband Public Policy

Core Program Initiatives: K-12 Schools

Broadband Infrastructure Improvement Grants (BIIG)

\$76.7M invested over the past six years for improvements to individual schools with poor connectivity. To date, 431 schools have been served.

Broadband Infrastructure Grants (BIG)

\$7.5M for last mile connections to individual schools without fiber connections. Finalizing awards.

Core Program Initiatives: Libraries

Gigabit Libraries Initiative

- Since inception, 829 libraries are connected to CalREN, either directly or indirectly through library aggregation points.
- Another 67 library sites are actively in the process of being connected.
- Up to 62 new library sites were included in this year's Library RFP.

Exploring “To and Through” Community Anchor Institutions: Projects to Connect Students at Home

A photograph of two young women with long dark hair, smiling and looking at a laptop screen. They are in a home setting with a light blue wall, a lamp, and a plant in the background. The woman on the left is wearing glasses and a light blue shirt, while the woman on the right is wearing a red sweater. A semi-transparent purple box is overlaid on the bottom half of the image, containing white text.

CENIC provides expertise, policy guidance, convening and connecting, and project analysis *(focusing on the technical, economic, and social facets)*

Offering CalREN backhaul services

Numerous LTE projects at various stages across California

Exploring Municipal Projects for High Poverty Communities

San Diego Promise Zone (wireless)

With UCSD using a new building adjacent to the Promise Zone

City of San Rafael Canal Zone Project

10 city block WiFi mesh in the most economically distressed area, with many multi-generational, multi-family dwellings

Prospective Pacific Wave offering to Municipalities (backhaul and peering)

Tribal Nations and CENIC

Tribal Digital Village – CENIC / Pacific Wave

Successful project connecting 20 tribes in Southern California

Current Projects with:

Bear River Tribe | Wiyot Tribe | Round Valley Tribe

Prospective CalREN Augmentations for Unserved and Underserved CENIC Communities: Digital 299

Digital 299

- Humboldt State University (HSU) and CENIC exploring opportunities for community anchor institutions along the path
- Lead private sector partners are Transpacific Networks (TPN), Google, and Facebook
- TPN et al also building "Project Echo" (to Singapore, with branching units to Guam and Indonesia, and phase two to Hawaii and Japan) and a data center in Arcata
- Memorandum in process for fiber IRUs (for CENIC, and for Internet2/Pacific Wave/Asia Pacific R&E network partners)
- Prospective Rural Internet Exchange with CENIC and HSU for Northwest California



-  Pacific Wave & CIIX + Cloud
(CENIC International Internet Exchange)
-AWS, NetFlix, Google, Yahoo...
-  HSUIIX Fabric
-  CENIC Backbone
-  Optical add/drop
-  Optical add/drop, & DC
-  Optical add/drop, DC, & HPR



- Partner Exchange Links
- Participant Links
- Prospective Links
- AP-REX Links
- Pacific Wave Backbone

- Pacific Wave POP
- AP-REX POP
- Pacific Research Platform (PRP)
- PRP Science DMZ Fabric
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With support from the National Science Foundation



January 2021

Prospective CalREN Augmentations for Unserved and Underserved CENIC Communities: Coachella Valley

College of the Desert, CSU San Bernardino, Berger Foundation, Pacific Lightwave, CTC Technology, and community leaders

- CENIC has fiber and colocation in the Coachella Valley through support from the Berger Foundation
- Potential Rural Internet Exchange Opportunity with additional fiber South toward the Salton Sea
- Opportunities with Arcadian Infracom (Interstate 40 Dallas to LA) w/lateral from Needles to Blythe and Indio
- Exploring intersections with CAFII and RDOF (and new programs from the 117th Congress)
- Exploring opportunities with Imperial County Office of Education

CENIC Fiber in the Coachella Valley



University Medical Centers & Partner Health Care Organizations

Telehealth Partner Network

Montage Health and Community Hospitals of the Monterey Peninsula

Epic Systems (Electronic Health Record)

CENIC Electronic Health Platform (*peering, caching, and exchange services*)

Broadband Public Policy

CENIC briefing papers for the California State Legislature and publications on broadband, wireless, Rural Internet Exchanges, and related topics

Engagement with numerous partner organizations on issues related to community anchor institutions (and their constituents) in state and federal public policy and programs:

CPUC, CETF, Office of Emergency Services, Schools, Hospitals, Library Broadband Coalitions (SHLB), The Quilt, Benton Foundation, and others

The background is a dark blue gradient with a complex pattern of thin, white, curved lines that create a sense of motion and depth. Scattered throughout the scene are numerous small, semi-transparent white dots of varying sizes, some of which appear to be connected by the lines, suggesting a network or a data visualization. The overall aesthetic is clean, modern, and technical.

Thank You

For more information,
please contact: klewis@cenic.org

Resources

Learn More about CENIC On our website: cenic.org

Read more stories about CalREN and how CENIC members use the network on our blog: cenic.org/blog

Glossary of Broadband Terms:

<https://docs.google.com/document/d/1MydomzKUdpaRIhOmfUePs2iy4I0UZVxVdNEVbbS11ac/edit?usp=sharing>

Blog Posts & Presentations

- [CENIC PERSPECTIVES: Wireless Internet Technologies for Access, Equity, and Continuity](#)
- [Broadband for Every California Household: One Gigabit or Bust!](#)
- [Understanding Network Impacts of Increased Online Learning](#)

Social Channels:

- LinkedIn: <http://www.linkedin.com/company/cenic>
- Twitter: <http://www.twitter.com/CENICnews>
- YouTube: <https://www.youtube.com/channel/UCusC8odlj2ukhXYIfaAGobQ>

The background is a dark blue gradient. It features a complex, abstract pattern of thin, light blue lines that swirl and intersect, creating a sense of motion and connectivity. Scattered throughout this network are small, semi-transparent blue dots of varying sizes, some appearing as nodes in the network. The overall aesthetic is modern and technological.

Appendices & Expanded Information

CENIC Benefits to California Institutions

- **All-you-can-eat broadband use.** CENIC does not charge Associates on per-bit terms and CENIC Associates have access to the entire portfolio of networks that CENIC manages, including access to CENIC member institutions, access to Internet2, access to other research and education peer networks, access to the Internet, and point-to-point services available at Layer 1 (wave), Layer 2 (VLAN), and Layer 3 (MPLS).
- **Access to a state-of-the-art network.** Associate Members have access to CalREN, CENIC's ultra-high-speed backbone network. Because CENIC owns its own fiber and optical infrastructure, additional capacity can be provisioned in a very short timeframe, allowing almost unlimited growth to meet the needs of the most demanding research applications.
- **Entry into a participatory, membership organization.** Associate Members are offered collaboration resources, access to the Technical Advisory Councils where members have a voice in how the network operates and evolves, training sessions such as for IPV6 and perfSONAR, and an annual conference where users can share knowledge.

CENIC Benefits to California Institutions

- **Network design expertise.** CENIC engineers design, configure, and deploy all layers of the network infrastructure, and implement agreed-upon connectivity solutions.
- **Discounts on equipment.** CENIC's extensive relationships with dozens of commercial services and equipment providers as well as vast buying power provides members with circuits and other telecommunications equipment at the best possible price.
- **Cloud connectivity and content services.** Use of CalREN's settlement-free peering services (to nearly 100 peers) provides high-speed access to many data-intensive sites frequented by researchers, students, and educators, such as Amazon, Google, and Microsoft.
- **24/7 Network Operation Center.** CENIC's NOC monitors CalREN and connections into CalREN around the clock. Members can contact the NOC at any time, and CENIC's team of experienced, highly trained network engineers will respond.

CENIC Benefits to California Institutions

- **Scaling services to the need.** CENIC consults with each member and assists staff in choosing the right level of service that both meets present needs and enables cost-efficient scalability in the future.
- **Federal and state subsidy assistance.** CENIC obtains state and federal subsidies on behalf of its members, including federal E-rate subsidies ranging from 20% to 90%, on both one-time and recurring costs for Internet access and upgrades for libraries and K–12 schools. CENIC also applies for the California Teleconnect Fund discount for monthly recurring costs, which is 50% after applicable E-rate discounts.
- **A community of thousands of research and education institutions.** By connecting to CalREN, members can connect directly to other education institutions around the globe.

Sustaining the level of technical excellence

CENIC Network Engineers

- Rigorous Interviewing Process
- In-Depth On-boarding
 - Phased approach
 - Catered to candidate
- Continuing Technical Education
 - Development plan meetings
- Building a Culture of Collaboration & Continuous Development

CENIC Internship Program

- **3 Month Internship program** that includes: daily responsibilities, technical presentations, and shadowing sessions.
- **Permanent Hires**
 - Core Engineering
 - Internet Services
 - Project Management
 - Systems Administration
 - Software Engineering

Core Program Initiatives: K12 Schools

- **Broadband Infrastructure Improvement Grants (BIIG)**
 - \$76M invested over the past five years for improvements in individual schools with poor connectivity
- **Broadband Infrastructure Grants (BIG)**
 - \$7.5M for last mile connections to individual schools with the least connectivity
 - Innovative solutions with partners – private and public sectors
 - RFP with a total of 134 combinations of schools and aggregation points were bid, for 68 schools across 19 counties (culled from a much longer list of schools/aggregation sites)
 - Under review, then awards, contracting, E-rate process this fiscal year, deployment starting in July 2021

Core Program Initiatives: Libraries

■ Gigabit Libraries Initiative

- For CENIC, starting our 10th year since the launch of the initiative in February of 2012
- Of the 1,117 eligible libraries, 829 are connected to CalREN, either directly or indirectly through connection to library aggregation points
- An additional 67 library sites are actively working with CENIC to get connected (i.e., circuits on order, but not yet in production)
- An additional 62 library sites were included as new sites in this year's Library RFP. If all 62 move forward and are connected (ideally between July 1, 2021 and June 30, 2022), there will be 958 libraries connected to CalREN

Exploring “To and Through” Community Anchor Institutions: Projects to Connect Students at Home

- CENIC: Provide expertise, policy guidance, convening and connecting , and project analysis (focusing on technical, economic, and social facets)
- CalREN backhaul services
- Current projects in various stages:
 - Val Verde School District: Fixed Wireless Mesh (GeoLinks)
 - Fontana School District: LTE Network (Zayo)
 - Berkeley School District (Sonic)
 - College of the Desert Palms Springs Campus (Study by CTC Technology)
 - Existing Projects by County Offices of Education:
 - Kings County Office of Education (LTE)
 - Imperial County Office of Education(fiber and wireless) through the Imperial Valley Telecommunications Authority

Exploring Municipal Projects for High Poverty Communities

- **San Diego Promise Zone (wireless)**
 - With UCSD (Professor Ramesh Rao & Nishal Mohan, Entrepreneur in Residence)
 - Using new UCSD building adjacent to the Promise Zone
- **City of San Rafael Canal Zone Project**
 - City and Library of San Rafael, County of Marin, AT&T
 - 10 city block Wi-Fi mesh in the most economically distressed area, with many multi-generational, multi-family dwellings
- **Prospective Pacific Wave offering to Municipalities (backhaul and peering)**
 - Inquiries by a few cities, no real activity to date

Tribal Nations and CENIC

- Tribal Digital Village – CENIC / Pacific Wave
 - Successful project connecting 20 tribes in Southern California
- Bear River Tribe
 - AT&T is a partner
- Wiyot Tribe
 - Working with the Wiyot Tribe and Information Technology Disaster Resource Center (ITDRC)
- Round Valley Tribe
 - Various partners and prospective partners to the Round Valley Tribe, including Hunter Communications (CASF proposal), Frontier (RDOF) and synergies with schools and library projects

Prospective CalREN Augmentations for Unserved and Underserved CENIC Communities: Digital 299

■ Digital 299

- Humboldt State University (HSU) and CENIC exploring opportunities for community anchor institutions along the path
- Lead private sector partners are Transpacific Networks (TPN), Google, and Facebook
- TPN et al also building "Project Echo" (to Singapore, with branching units to Guam and Indonesia, and phase two to Hawaii and Japan) and a data center in Arcata
- Memorandum in process for fiber IRUs (for CENIC, and for Internet2/Pacific Wave/Asia Pacific R&E network partners)
- Prospective Rural Internet Exchange with CENIC and HSU for NW California

University Medical Centers & Partner Health Care Organizations

- "Telehealth Partner Network"
 - Pilot with UC Davis Health, Center for Health and Technology
 - Support for 30+ specialty areas and 200 prospective partner hospitals and clinics
- Montage Health and Community Hospitals of the Monterey Peninsula
 - Long-term CENIC Associate -- active, innovative community members
- Epic Systems (Electronic Health Record)
 - New peering and exchange with CENIC in California Internet hubs; CENIC-Epic MSA in review; technical teams active
- CENIC Electronic Health Platform (peering, caching, and exchange services) in development concurrent with MPLS capacity in the Network (early FY21-22)

Broadband Public Policy

- Briefing papers for the California Legislature and others
- Support for and participation in various telehealth forums with CETF, Partners in Care Foundation, and the California Primary Care Association
 - With CETF organized two large conferences: “Delivering on the Promise of Telehealth to Improve Health Status in California”
- CENIC Publications on broadband, wireless, Rural Internet Exchanges, and related topics
- Engagement with numerous partner organizations on issues related to community anchor institutions (and their constituents) in state and federal public policy and programs:
 - CPUC; CETF; Office of Emergency Services; Schools, Hospitals, Library Broadband Coalitions (SHLB); The Quilt; Benton Foundation, and others