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The Corporation for Education Network Initiatives in California

2005-06 Annual Report

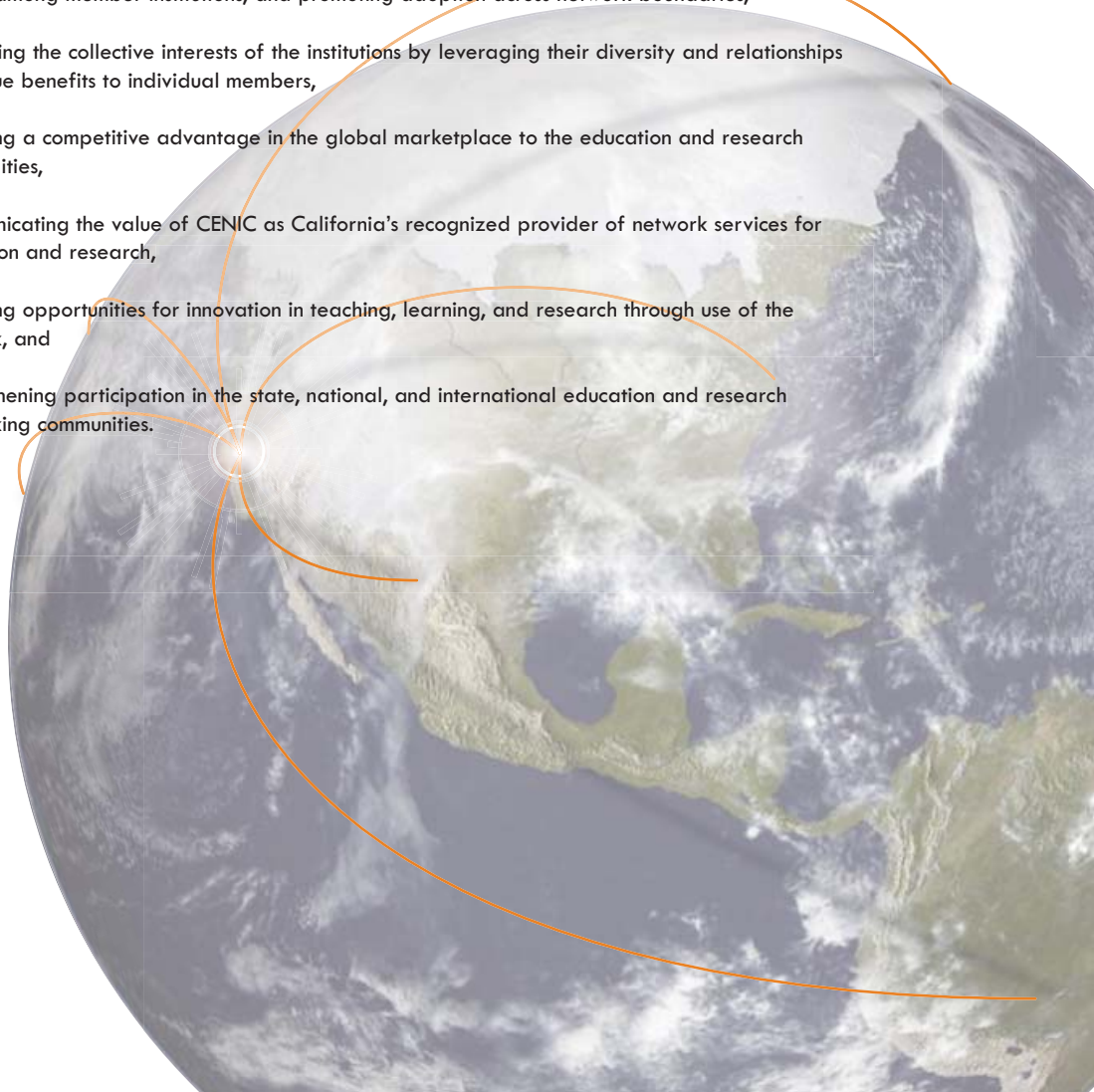
California's higher education and research communities leverage their networking resources under CENIC, the Corporation for Education Network Initiatives in California, in order to obtain cost-effective, high-bandwidth networking to support their missions and answer the needs of their faculty, staff, and students.

CENIC designs, implements, and operates CalREN, the California Research and Education Network. CalREN is a high-bandwidth, high-capacity Internet network specially designed to meet the unique requirements of these communities, and to which the vast majority of the state's K-20 educational institutions are connected. In order to facilitate collaboration in education and research, CENIC also provides connectivity to CalREN for non-California institutions and industry research organizations with which CENIC's Associate researchers and educators are engaged.

CENIC is governed by its member institutions. Representatives from these institutions also donate expertise through their participation in various committees designed to ensure that CENIC is managed effectively and efficiently, and to support the continued evolution of the network as technology advances.

CENIC is committed to the following goals:

- 1 Continuously improving a robust, cost-effective, state-of-the-art communications network, accessible to participating education and research institutions,
- 2 Working with member institutions to define a value chain of services, and developing innovative ways to deliver scalable solutions to members,
- 3 Leading efforts of participating institutions to provide end-to-end service quality and interoperability among member institutions, and promoting adoption across network boundaries,
- 4 Advancing the collective interests of the institutions by leveraging their diversity and relationships to accrue benefits to individual members,
- 5 Providing a competitive advantage in the global marketplace to the education and research communities,
- 6 Communicating the value of CENIC as California's recognized provider of network services for education and research,
- 7 Providing opportunities for innovation in teaching, learning, and research through use of the network, and
- 8 Strengthening participation in the state, national, and international education and research networking communities.



1997 CENIC founded.

1998 CalREN begins serving the network needs of California's research universities.

1999 CENIC begins to offer settlement-free commodity peering over CalREN.

2000 CalREN expands to serve the K-12 community.

2001 University and Community College System of Nevada (UCCSN) connects to CalREN from Las Vegas to Anaheim and from Reno to Sacramento.

2003 CalREN becomes the single network serving California's entire education community when California's community colleges and California State University campuses migrate to CalREN. NOC Advisory Committee recommends that CENIC insource its NOC services.

2004 CENIC's Network Operations Center begins formal operation in January.

CENIC moves to Cypress, CA location in February.

2005 CalREN connectivity continues beyond California with University of Arizona and Arizona State University. NASA Ames Research Center joins CalREN.

CalREN achieves world's first international Gigabit connection over dark fiber with CUDI Mexican research network and Central/South American redCLARA in July.

2006 CalREN deploys a fully diverse Gigabit network through the Coachella Valley.

CalREN joins Global Lambda International Facility (GLIF) community with OC-192 link to Pacific Northwest Gigapop and CA*net 4.

2007 Upgrades to DC network to begin.

2008 Upgrades to HPR network to begin.

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Letter from the President



Jim Dolgonas
President
and
Chief Executive Officer
CENIC

The 2005-06 fiscal year at CENIC has been one of continued network expansion, in bandwidth and connections both within California and beyond, and I'm delighted to share with you some of this past year's accomplishments.

In 2005, CENIC provided UC's newest campus in Merced with fiber paths to our CalREN-DC network, and this year we delivered a second, Gigabit Ethernet, connection from the Merced campus to the CalREN-HPR network hub sites in Sacramento and Riverside. The Naval Postgraduate School in Monterey became the newest CalREN Associate and was connected at Gigabit speeds to the HPR network.

CENIC installed dual, diverse Gigabit connections from the CalREN backbone to six CSU campuses, and six other CSU campuses received dual connectivity. CENIC also completed the migration of California's community colleges to CalREN Video Services. Data services for four community college campuses were upgraded to DS3 speeds, and Palomar College received Gigabit connectivity. CENIC also created a new fiber loop to the greater Coachella Valley area from Riverside, south through Palm Desert and into Imperial County, and returning to San Diego.

We welcomed the University of Arizona and Arizona State University. The Nevada System of Higher Education also received Gigabit connectivity to both the CalREN-DC and the CalREN-HPR networks, a boost from their previous connection speed.

The Gigabit connection between CalREN and CUDI/CLARA was broken out into two separate Gigabit connections for each network. An OC-192 circuit supporting connections to the Global Lambda Integrated Facility at Gigabit speeds between CalREN and the Pacific Northwest Gigapop was also installed this year as a cooperative effort involving CANARIE and the Canadian optical R&E network CA*net 4.

CENIC's Network Operations Center has also moved forward on its Disaster Recovery Plan. Crucial tools have been identified to be replicated at the recovery facility at UC Irvine, and our engineers are engaged in training on how to achieve an incident-free failover. The NOC continues to provide Layer 1 support for National LambdaRail as well as support for their national Phase II deployment. And thanks to the survey sent out to customers who have contacted the NOC for assistance, we're able to report a customer satisfaction level of 97%.

A new scheduling software package powered by the Polycom Conference Suite was put into place to enable campus videoconference administrators to schedule and manage their own videoconferences with even greater convenience and flexibility.

CENIC has also been delighted to contribute networking support to some of the most significant international conferences of the past year, including SC|05, iGrid 2005, and the US-India Summit on Education, Research, and Technology. At our own conference, "Your Connection to The World," held in Oakland this past March, attendees enjoyed presentations by some of the best and brightest of California and beyond, including our Innovations in Networking Award winners, which you'll learn about in this report.

CENIC's core engineering team developed a design proposal for the next-generation CalREN-DC network and presented it to the CalREN-DC Technical Advisory Council (TAC) in March to overwhelming approval. A design subcommittee of the CalREN-HPR TAC also developed design recommendations for the next-generation CalREN-HPR. With the approval of the design, the upgrade to the DC network will begin in 2007. It is expected that the HPR network will be upgraded in 2008.

In summary, it's been a busy year. Our network has improved for our Associates, our services have expanded, and the reach of CalREN and California's research and education communities has extended beyond both the borders of our state and our nation. New Associates have joined, and existing ones have experienced significant improvements in their connectivity. None of this would have been possible without the tireless effort and dedication of our Associates, our industry partners, especially Cisco and AT&T, the members of our Advisory Councils and ad hoc groups and committees, and of course our staff. We look forward to building on these great accomplishments next year, and working with you to achieve them!



“CENIC has been able to
negotiate
substantial discounts

on network components such as fiber-optic cable
for its California Research & Education Network (CalREN) ... ”

*California State Auditor Report: California K-12 High-Speed Network
January 2006*

board & committees

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Director of Technology Planning and
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Office of the Vice-Provost, Information
and Educational Technology
University of California, Davis

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John Haskins, Chair 2006
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Network Manager
Santa Cruz County Office of Education

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Deputy Chief Information Officer
University of Southern California
Patrick Perry

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Associate Director, Infrastructure
Services
UC Berkeley

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Vice Provost, Educational Partnerships
and Learning Technologies,
University of Washington
Catherine McKenzie

California Community Colleges

Chancellor's Office	East Los Angeles	Mendocino	San Diego Miramar
Alameda	El Camino	Merced	San Francisco City
Allan Hancock	Evergreen Valley	Merritt	San Joaquin Delta
American River	Feather River	MiraCosta	San Jose City
Antelope Valley	Folsom Lake	Mission	San Mateo
Bakersfield	Foothill	Modesto Junior	Santa Ana City
Barstow	Fresno City	Monterey Peninsula	Santa Barbara City
Butte	Fullerton	Moorpark	Santa Monica
Cabrillo	Gavilan	Mt. San Antonio	Santa Rosa
Cañada	Glendale	Mt. San Jacinto	Santiago Canyon
Canyons	Golden West	Napa Valley	Sequoias
Cerritos	Grossmont	Ohlone	Shasta
Cerro Coso	Hartnell	Orange Coast	Sierra
Chabot	Imperial Valley	Oxnard	Siskiyou
Chaffey	Irvine Valley	Palomar	Skyline
Citrus	Lake Tahoe	Palo Verde	Solano
Coastline	Laney	Pasadena City	Southwestern
Columbia	Las Positas	Porterville	Taft
Compton	Lassen	Redwoods	Ventura
Contra Costa	Long Beach City	Reedley	Victor Valley
Copper Mountain	Los Angeles City	Rio Hondo	Vista
Cosumnes River	Los Angeles Harbor	Riverside	West Hills
Crafton Hills	Los Angeles Mission	Sacramento City	West Los Angeles
Cuesta	Los Angeles Pierce	Saddleback	West Valley
Cuyamaca	Los Angeles Southwest	San Bernardino Valley	Yuba
Cypress	Los Angeles Trade Tech	San Diego Centers for Education and Technology	
De Anza	Los Angeles Valley	San Diego City	
Desert	Los Medanos	San Diego Mesa	
Diablo Valley	Marin		

University of California

Office of the President	UC Riverside
UC Berkeley	UC San Diego
UC Davis	UC San Francisco
UC Irvine	UC Santa Barbara
UC Los Angeles	UC Santa Cruz
UC Merced	

California State University

Office of the Chancellor	CSU Channel Islands	CSU Los Angeles	Humboldt State University
California Maritime Academy	CSU Chico	CSU Monterey Bay	San Diego State University
California State Polytechnic University San Luis Obispo	CSU Dominguez Hills	CSU Northridge	San Francisco State University
California State Polytechnic University Pomona	CSU East Bay	CSU Sacramento	San Jose State University
CSU Bakersfield	CSU Fresno	CSU San Bernardino	Sonoma State University
	CSU Fullerton	CSU San Marcos	
	CSU Long Beach	CSU Stanislaus	

California Private Universities

California Institute of Technology
Jet Propulsion Laboratory

Stanford University
Stanford Linear Accelerator Center
Stanford Medical Center

University of Southern California
Health Sciences Campus
Information Sciences Institute
University Park Campus

California K-12 System

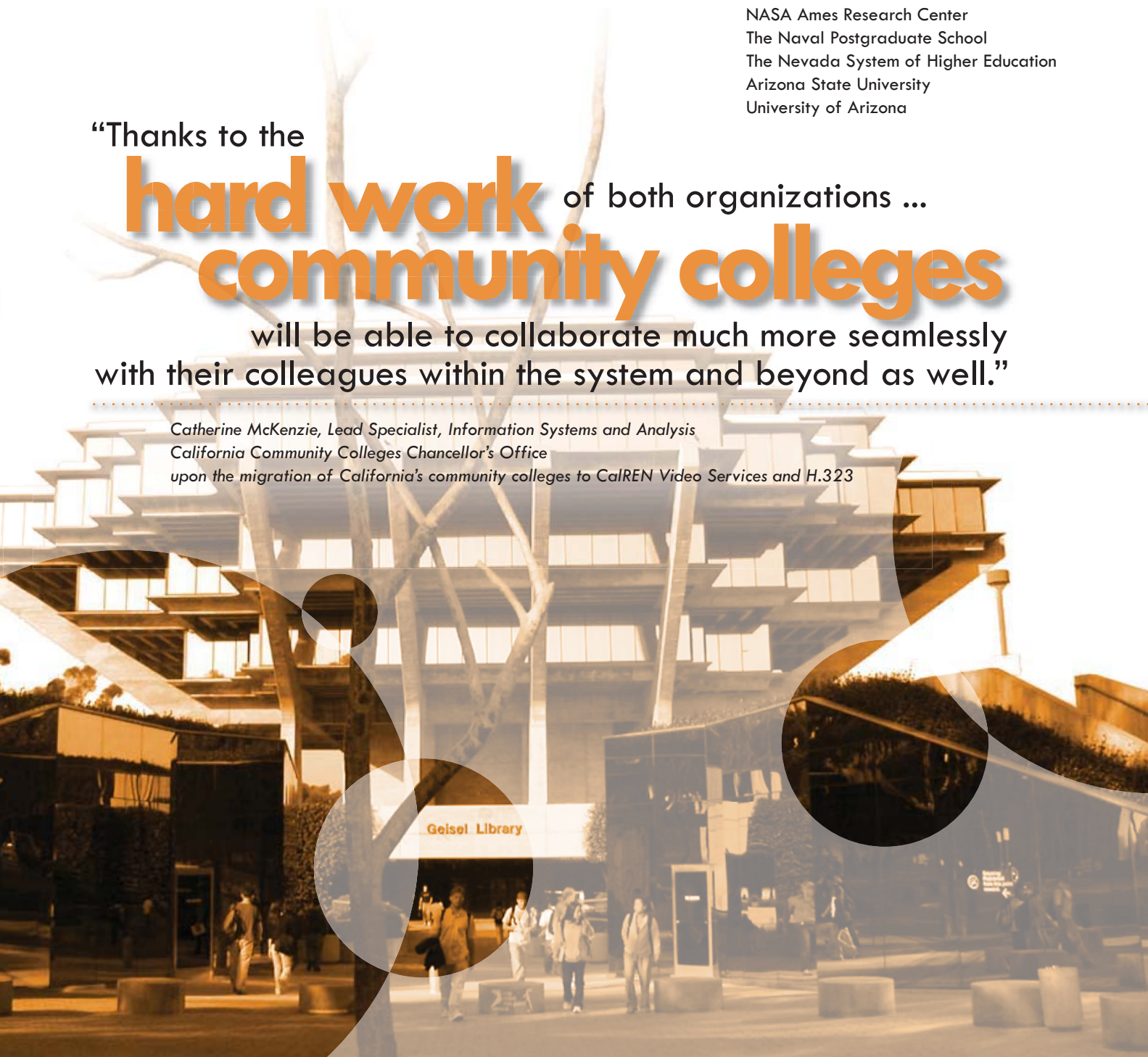
Serving 74 node sites and over 8,000 schools
Encompassing 58 counties and 985 districts

CalREN Associates

NASA Ames Research Center
The Naval Postgraduate School
The Nevada System of Higher Education
Arizona State University
University of Arizona

“Thanks to the
hard work of both organizations ...
community colleges
will be able to collaborate much more seamlessly
with their colleagues within the system and beyond as well.”

*Catherine McKenzie, Lead Specialist, Information Systems and Analysis
California Community Colleges Chancellor's Office
upon the migration of California's community colleges to CalREN Video Services and H.323*



CalREN consists of

2500 miles of CENIC-owned and managed fiber, plus:

- 472 routers,
- 81 switches,
- 51 optical components, and
- 275 managed telco circuits.



the CalREN network

CalREN consists of a CENIC-operated fiber-optic backbone to which CENIC connects schools and other institutions in all 58 of California's counties via leased circuits obtained from telecom carriers or by CENIC-owned fiber-optic cable. In the map to the left, the orange circles indicate CalREN network connection points or circuit aggregation facilities.

Three separate networks operate simultaneously over the CalREN optical backbone:

CaIREN-DC

Digital California — provides high-quality network services for K-20 students, teachers, and administrators, and the faculty, staff, and researchers of colleges and universities. CaIREN-DC serves more than 8 million students, faculty, and staff at approximately 140 higher education institutions and 8,000 elementary and high schools. The CaIREN-DC backbone operates at 2.5 Gb/s.

CaIREN-HPR

High-Performance Research — provides leading-edge services for large-application users at Associate sites. The 10 Gb/s CaIREN-HPR backbone connects the major research institutions and national laboratories in California, and certain select institutions outside of California with whom our Charter Associates are engaged. It is connected to Abilene, the Internet2 backbone, and to the National LambdaRail (NLR) packet-based network, PacketNet.

CaIREN-XD

Experimental/Developmental — designed to support bleeding-edge services for network researchers. It provides California's network researchers and others whose research requires access to the cutting edge of optical network infrastructure with access to the lowest layers of optical networks on which to perform their research. It connects to NLR's WaveNet (lambda-based) and FrameNet (Ethernet-based) networks as well.

Network Development & Evolution for the California Research and Education Community

CaIREN-XD

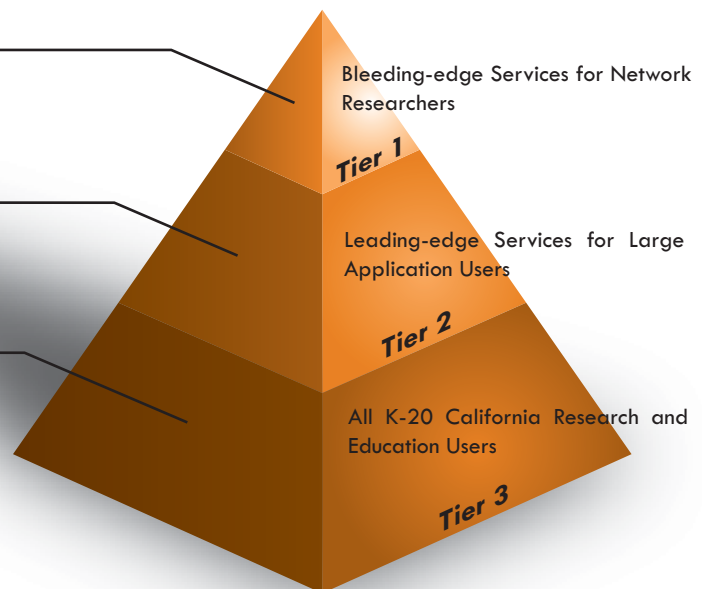
Experimental/Developmental Network

CaIREN-HPR

High-Performance Research Network

CaIREN-DC

Digital California Network



Thanks to CalREN's state-of-the-art fiber-optic backbone, all three of these networks can operate independently, with different services and performance objectives. For example, researchers can perform network experiments on the XD network without interfering with the normal, daily operation of the other tiers for the benefit of the K-20 education community.

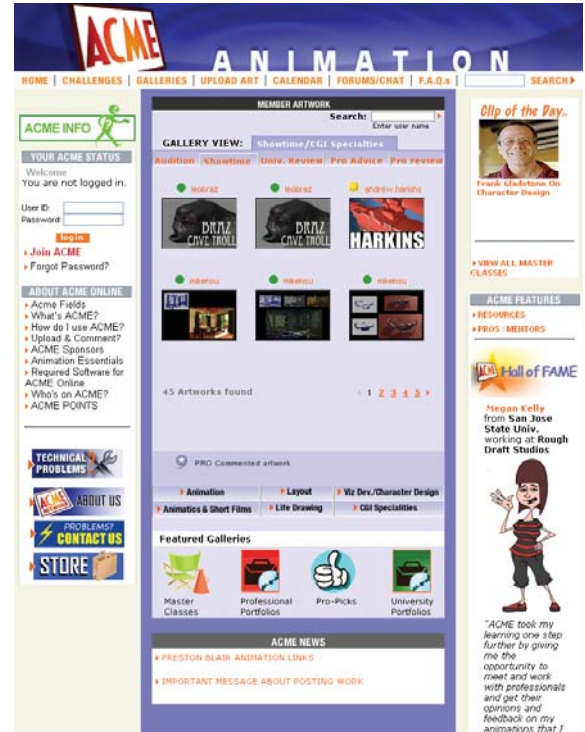
the CaREN network

CaREN-DC

The CaREN-Digital California network is the “bread and butter” network for California’s K-20 educational community, providing high-bandwidth connectivity and high-quality network services to the students, faculty, and staff of California’s schools, colleges, and universities. CaREN-DC provides connectivity to the commodity or commercial Internet for CENIC member institutions and facilitates collaboration and resource sharing between K-12 and higher education. Thanks to its support of specialized Quality of Service (QoS), it also facilitates high-quality videoconferencing via CaREN Video Services.

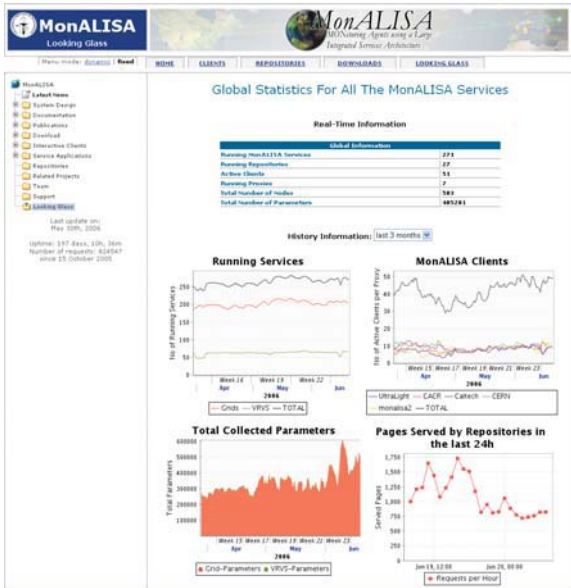
California’s Community College system uses CaREN-DC for communications among its campuses and off-campus centers. The California State University system uses it to link their campus administrators to a central administrative computing facility in Salt Lake City, UT. And every week, well over 130 videoconferences are scheduled and conducted over CaREN-DC among CaREN Charter Associate sites.

In 2006, CENIC awarded its Innovations in Networking Award for Educational Applications to Acme Animation during its annual conference, “Your Connection to the World.” An excellent example of innovative use of the network to promote student achievement, this program connects students in California high schools and colleges with animation industry professionals from Pixar, Disney, Dreamworks, Warner Brothers, and Sony. Students learn digital animation skills and important lessons about working in the animation industry through their discussions with professional animators. In the fall of 2004, this program expanded its reach thanks to CENIC’s CaREN Video Services, which enables schools to use high-quality, IP-based videoconferencing over the CaREN-DC network.



CaREN-HPR

A wide range of large-scale, multidisciplinary projects are conducted by researchers at CENIC member institutions over CaREN-HPR: quantitative biomedical research, design of smart buildings for energy efficiency and seismic safety, and surgery via real-time streaming video, as well as national and international data-intensive grid experiments in high-energy and nuclear physics. Real-time collaboration, remote sensing, large-scale data aggregation, and distributed computing are enabled by networking capabilities across these applications.



The CaREN-HPR 10 Gb/s backbone connects the major research institutions and national laboratories in California, including the San Diego Supercomputer Center, the Jet Propulsion Laboratory, and the University of California Institutes for Science and Innovation: the California Institute for Quantitative Biomedical Research (QB3), the California Institute for Telecommunications and Information Technology (Calit2), the California Nanosystems Institute (CNSI), and the Center for Information Technology Research in the Interest of Society (CITRIS). CaREN-HPR also provides the means for all educational institutions in California to access National LambdaRail and Internet2.

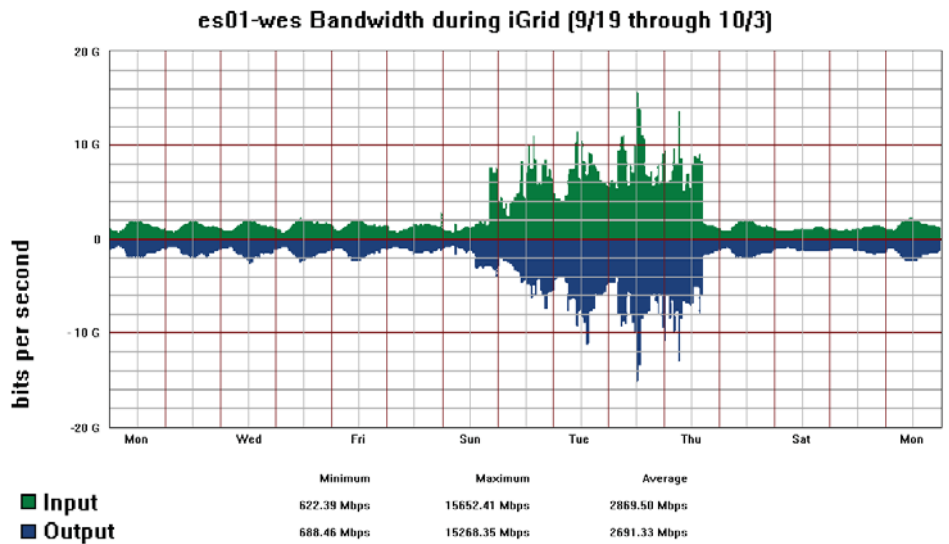
At CENIC’s 2006 annual conference, a team of researchers from Caltech and Universitatea Politehnica of Bucharest were awarded the Innovations in Networking Award for High-Performance Applications for MonALISA (Monitoring Agents in a Large, Integrated Services Architecture), a system which provides a distributed-service architecture to monitor, manage, and optimize the performance of grids, networks, and running applications in real time and an excellent example of the sort of application that CENIC Associates use CaREN-HPR to develop. Among the distributed computing systems currently managed by MonALISA is the Ultralight grid, an optical testbed for high-energy physicists worldwide.

CaIREN-XD

The CaIREN-XD network is critical to future advances in networking and science. Fundamental changes in the way networks operate cannot be developed and tested on production networks supporting millions of users, such as CaIREN-HPR and CaIREN-DC. New networking applications, services, and optical technologies must be developed in an environment that does not adversely impact current production users. In addition, network researchers must collaborate, test, and further understand how these new communications systems will operate in a real-world production setting. The CaIREN-XD network enables the research community to perform research that could disrupt the existing production networks without interfering with other users on the CaIREN backbone.

To that end, the CaIREN-XD network is designed to support bleeding-edge services for network researchers at sites like the San Diego Supercomputer Center, the University of California Institutes for Science and Innovation, the Center for Advanced Computing Research and the Jet Propulsion Laboratory (both at Caltech), the University of Southern California and its Information Sciences Institute, Stanford University and the Stanford Linear Accelerator Center, national laboratories, and other major research entities which collaborate with researchers in California. It provides California's computer scientists, network engineers, and optics researchers with access to the lowest layers of optical networks on which to perform research. CaIREN-XD is a dedicated, experimental, wide-area infrastructure, and its use does not compromise the reliability of CaIREN's other two tiers presently in production mode.

In addition to network research, CaIREN-XD supports important national research collaborations and events such as iGrid 2005, the latest in a series of community-driven biennial international grid events to accelerate the use of multi-10Gb networks. At the latest iGrid event in September 2005 on the UC San Diego campus, over four dozen scientific applications – many linking different countries and continents – showcased the uses to which researchers and educators could put high-performance optical networks. Both CENIC and National LambdaRail contributed a total of 50 Gigabits of bandwidth to make these applications possible. As the graph above shows, the bandwidth consumed by the event was considerable and yet did not impact the performance of the other two tiers for CaIREN Associates.

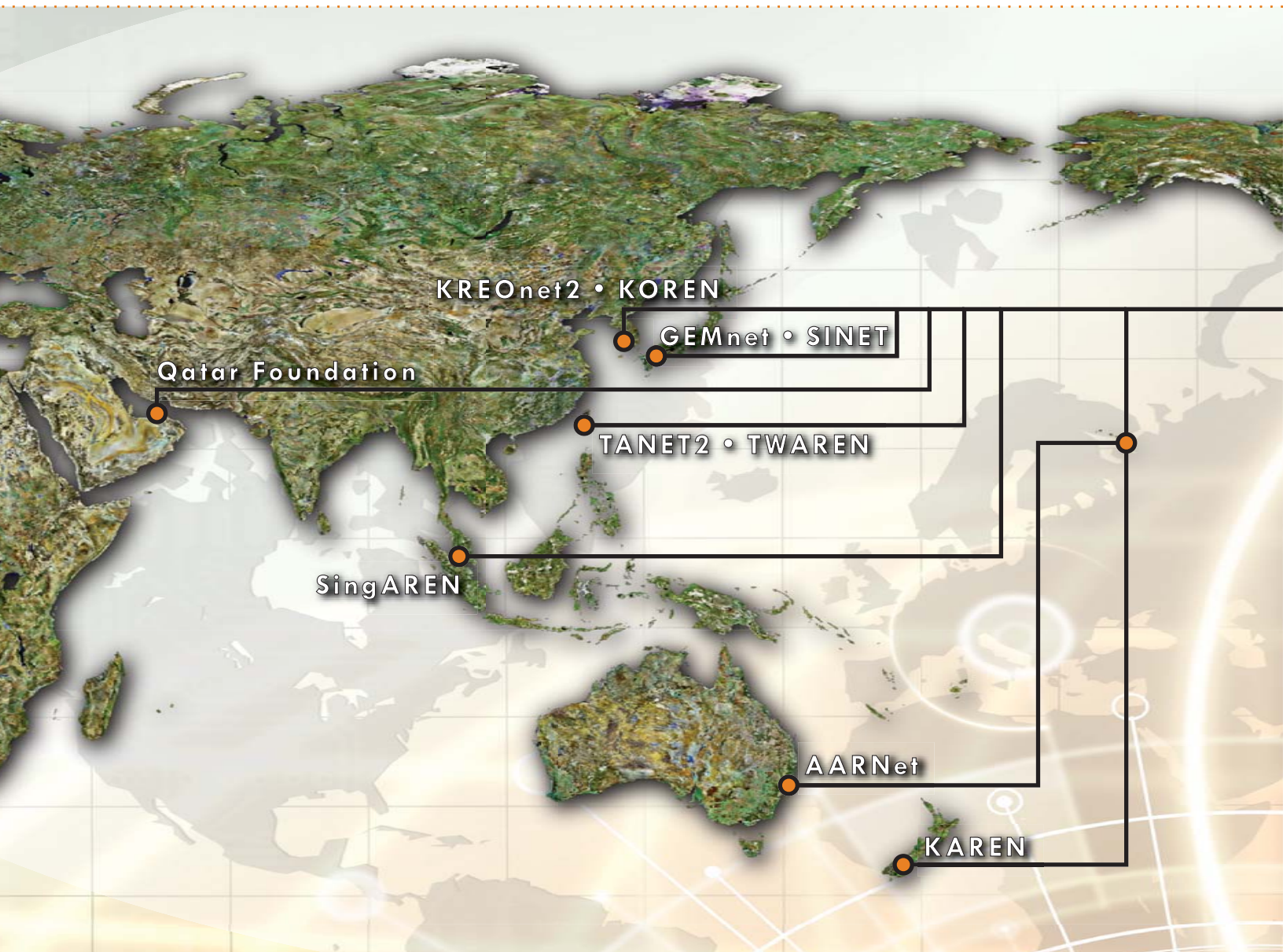


The CENIC Network Operations Center

The three tiers of CaIREN are monitored and managed 24/7/365 by the CENIC Network Operations Center, staffed by a team of highly skilled network engineers. The NOC is responsible for such activities as circuit installations and moves; monitoring and managing the optical (Layer 1), Ethernet (Layer 2), and routing (Layer 3) levels of the network; responding to network abuse complaints; network monitoring, maintenance, and diagnostics; equipment replacement; and developing and maintaining network maps and reports. Since November 2003, the CENIC NOC has also provided Layer 1 (fiber and optronics) support for the nationwide National LambdaRail network.

In order to ensure that CENIC is able to provide ongoing NOC services in the event that the primary NOC site in Cypress is unusable, CENIC developed a Disaster Recovery Plan in early 2005. UC Irvine serves as an alternate facility site. Critical tools are housed at UCI, and necessary equipment has been configured and deployed.

beyond california: world



CENIC has taken the initiative in operating, participating in, and supporting a wide range of ventures designed to extend world-wide both the benefits of advanced-services networking and the vision of the California research and education community. One of these ventures is Pacific Wave, a joint project between CENIC and the Pacific Northwest Gigapop in collaboration with the University of Southern California and the University of Washington. A state-of-the-art international peering facility, Pacific Wave connects CalREN participants to research and education networks through the Pacific Rim and beyond, including Australia, Canada, Japan, Korea, Malaysia, New Zealand, Qatar, Taiwan, and Singapore. Participant networks include:

Asia-Pacific:

TransPAC2

Australia:

AARNet

Canada:

CA*net 4

Japan:

GEMnet

SINET

T-LEX

Korea:

KREONet2/KOREN

Malaysia:

MIMOS Berhad

New Zealand:

KAREN/REANNZ

Qatar:

Qatar Foundation

Taiwan:

TANET2

TWAREN

Singapore:

NUS-Gigapop

SingAREN

United States:

Abilene/Internet2

The Boeing Company

CENIC

Comcast

DREN

ESnet

Los Nettos

Microsoft Corporation

NREN

Pacific Northwest Gigapop

Pointshare

Ultralight

Global connectivity



CalREN also furthers collaboration in the Americas via a 1 Gigabit connection to CUDI (Corporación Universitaria para el Desarrollo de Internet), a nonprofit corporation that funds the Mexican advanced, high-speed network. Via a 1 Gigabit link, CalREN is also connected to redCLARA, a collaboration of various national high-bandwidth networks throughout Central and South America that serves to interconnect researchers there to one another and the world.

CalREN is also directly connected via a 1 Gigabit link to CA*net 4, the Canadian research and education network, and via its connections to Abilene and National Lambda-Rail, also enables collaboration with Europe and the Western Hemisphere.

CENIC also offers commodity peering with the following corporations and others:

- | | | |
|---------------------|-----------------------|------------------------|
| China Telecom | SingTel | Sony Online |
| Time Warner Telecom | Comcast | Entertainment |
| Earthlink | Microsoft Corporation | Nokia |
| Japan Telecom | BBC Internet Services | Google |
| Korea Telecom | Yahoo! | Charter Communications |
| Telecom Malaysia | Akamai Technologies | Cox Communications |

CENIC actively pursues

peering relationships

with other network providers,

both research network peers for the CalREN-HPR network and commodity network peers for the CalREN-DC network.



**the
future
of
CaIREN**

network expansion

CSU Campus Access Infrastructure Initiative

The Campus Access Infrastructure Initiative is a CSU system-wide program to improve the connectivity of CSU campuses and other CSU sites to the CalREN backbone. The end result will be diverse paths from each campus to the backbone to improve robustness and performance. This year, CENIC installed dual, diverse Gigabit connectivity from the CalREN backbone to CSU's Northridge, Chico, San Jose, San Francisco, Fullerton, and Dominguez Hills campuses. CENIC also provided dual connectivity (with one Gigabit connection) to Fresno, Stanislaus, Sonoma, Humboldt, Bakersfield, and the California Maritime Academy. Testing, construction, site visits, and planning are underway for the remaining CSU campuses, as well as the Moss Landing Marine Laboratories and the Stockton Multi-Campus Regional Center.

CA Community Colleges Circuit Upgrades

Data services for Las Positas, Columbia, and Mission Colleges have all been upgraded to DS3 connectivity. Palomar College became the fourth community college campus to receive Gigabit connectivity, which will serve both the campus and the California Community Colleges Satellite Network (CCCSAT) in providing instructional and educational materials to the entire community college system.

CENIC also completed the migration of California's community colleges to CalREN Video Services. With this migration, all campuses are using the H.323 IP-based video protocol.

CENIC continues to work with the Community Colleges Chancellor's Office to monitor bandwidth utilization and propose cost-effective solutions that will provide increased bandwidth to districts with high utilization rates.

Connecting Coachella Valley to the World

In September 2004, the H. N. and Frances C. Berger Foundation made a \$3.4 million grant to CENIC for the initial phase of this project, representing a new dark-fiber build-out to the greater Coachella Valley area from Riverside and south from Palm Desert into Imperial County. This year, the second phase of this project was completed, and the CalREN backbone now extends from Palm Desert through Yuma, AZ and El Centro, CA, returning to San Diego. CalREN now features a fully diverse Gigabit network from Riverside to San Diego to provide services to the fast-growing Coachella Valley region.

Connections to Central and South America

In July of 2005, CENIC and Mexico's Corporación Universitaria para el Desarrollo de Internet (CUDI) created the world's first international Gigabit connection over dark fiber when CalREN and the CUDI network established connectivity between San Diego and Tijuana. This extension was made possible by funding from the NSF via a sub-grant from Florida International University to facilitate Western Hemisphere Research and Education Networks/Links Interconnecting Latin America (WHREN/LILA). The aim of WHREN/LILA is to create a 1 Gb/s ring between San Diego; Tijuana, Mexico; Santiago, Chile; São Paulo, Brazil; and Miami, coming full circle in San Diego via National LambdaRail.

A high-speed connection to CUDI was created in 2000 and upgraded to a Gigabit connection in July 2005. This connection was shared between CUDI and the South and Central American research and education networks redCLARA until December 2005, when each network received a separate 1 Gigabit connection to CalREN.

network expansion

Enabling Canada-California Innovation

The first summit of the Canada-California Strategic Innovation Partnership was held at UCLA in January 2006. During this event, attendees stated that connecting California to CANARIE's CA*net 4, the state-of-the-art Canadian research and education network and one of the most advanced such networks in the world, was a high priority and would serve as an enabling platform for collaborations between California and Canada. In June 2006, a 1 Gb/s link between CA*net 4 and CalREN was announced to attendees of the second summit in Vancouver as a demonstration of the capabilities of a new OC-192 connection between the two networks at the Pacific Northwest Gigapop in Seattle.

This circuit supports connections to the Global Lambda Integrated Facility (GLIF), an international virtual organization that promotes the paradigm of lambda networking. The GLIF participants are National Research and Education Networks (NRENs), consortia and institutions working with lambdas. GLIF participants jointly make lambdas available as an integrated global facility for use by scientists and projects involved in data-intensive scientific research. To learn more, visit <http://www.glif.is/>.

The National LambdaRail Phase II Project

On February 20, 2006, National LambdaRail announced the completion of their Phase II project – the deployment of a nationwide advanced optical, Ethernet, and IP networking infrastructure on more than 10,000 miles of fiber-optic cable across the United States. CENIC provides Layer 1 NOC services to NLR and in this capacity, CENIC supported NLR during Phase II, which doubled the footprint of this national research and education network.

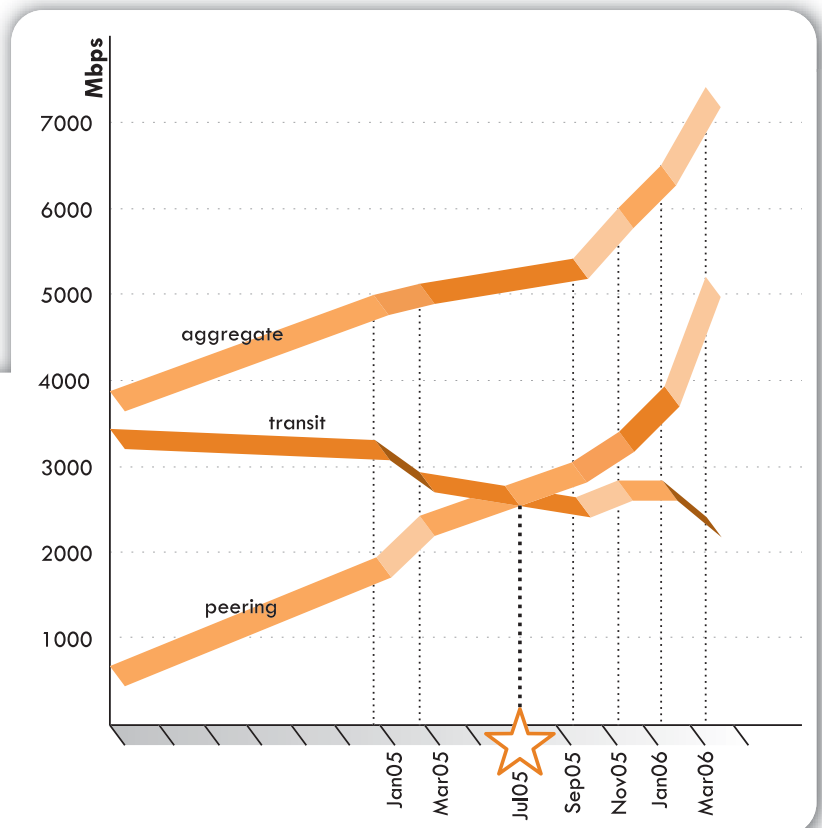
Underlying the recently completed national network is a fiber-optic infrastructure similar to that deployed in the CalREN backbone. This owned architecture can provide various types of networking including wavelengths, switched Layer 2 services, or routed IP services with both flexibility and long-term cost predictability and control. As an NLR participant – and original member – CENIC provides its Associates with access to the capabilities of NLR, with a primary interconnect in Los Angeles, and optical wavelength (lambda), Ethernet, and IP services. CENIC also shares collocation space with NLR in Sunnyvale, CA and provides the NLR backbone between Los Angeles and Sunnyvale as well.

DC & HPR Network Upgrades

CENIC's core engineering team developed a design proposal for the next-generation CalREN-DC network and presented this design to the DC Technical Advisory Committee in March 2006, to overwhelming approval. A design subcommittee of the HPR TAC also developed design recommendations for the next-generation CalREN-HPR. With the approval of both designs, the upgrade to the DC network is scheduled to begin in 2007, with the HPR network upgrade slated to begin in 2008.

Peering vs. Transit Cost Savings

CENIC has worked aggressively over the last two years to increase the amount of commodity peering, whose effective cost is less than \$10 per Mb/s/month, and to reduce the amount of higher cost commodity transit traffic. As shown, in the beginning of the 2005-06 fiscal year, CENIC reached a major milestone in sending more commodity traffic via fixed cost, relatively inexpensive commodity peering than via comparatively expensive usage-sensitive commodity transit. This has helped reduce or maintain commodity costs for CENIC Associates, as volumes of commodity traffic have increased.



CalREN video services

In 2002, CENIC and the CSU system formed a joint steering committee to address the issues of implementing Video-over-IP on the CalREN-DC network. The goal was to establish standards and specifications for converting existing videoconferencing systems to a new IP-based H.323 environment – the current standard for videoconferencing equipment. CSU was joined by the CCC and UC systems in planning an H.323 infrastructure to support videoconferencing across all three systems.

By the spring of 2006, all CSU and CCC sites had migrated to H.323 and the use of CVS infrastructure. During this time, CENIC also developed interoperability between CVS and the Internet2 Commons, allowing CVS sites to join the I2 Commons and participate in IP-based videoconferencing with Internet2 members without the burden of maintaining separate H.323 equipment configurations. The UC system currently employs H.323 for videoconferencing and will transition to CVS in the coming year.

In March 2004, the CalREN Video Services Oversight Committee was formed in order to provide governance and decision-making. An End-User Subcommittee was formed in April of the same year to advise the Oversight Committee on issues of importance to the videoconference administrators who would be interacting with CVS on a routine basis. Representatives from all four segments — CCC, CSU, UC, and K-12 — participate.

In 2005, at the request of the CVS Oversight Committee, CENIC installed the Polycom Conference Suite (PCS), a software package that would allow campus videoconference administrators to schedule and manage their own videoconferences. Comprehensive planning, testing, and implementation activities culminated in the unveiling of the CVS Scheduling Desk, powered by PCS, in June 2006. Campus videoconference administrators are now empowered to schedule and manage their own videoconferences, providing even greater convenience and flexibility.

For more information about CalREN Video Services, visit cvs.cenic.org.

The New CVS Scheduling Desk

Powered by the Polycom Conference Suite, the CVS Scheduling Desk gives campus videoconference administrators the ability to schedule their own videoconferences directly. Videoconference administrators can now login to a scheduling server and select videoconference facilities from a list, create recurring conferences, and manage existing conferences, including changing conference dates, times, and participant sites.

While videoconference administrators are currently able to request videoconferences through the legacy system, CENIC strongly encourages everyone to visit cvs.cenic.org to learn more about how they can benefit from the advantages offered by the new CVS Scheduling Desk.



CENIC 2006: your

At CENIC's annual conference, held from March 13-15, 2006 in Oakland, CA, attendees enjoyed presentations and demonstrations by dozens of members of the CalREN community and their collaborators from all over the globe. The three-day event was held at the Marriott Oakland City Center Hotel in downtown Oakland and featured presenters showcasing the uses of CalREN in all disciplines from hard science to the arts, as well as network researchers, and CENIC officers discussing CalREN, its present and its future.

On the second day of the conference, CENIC presented its annual Innovations in Networking Awards to recognize exemplary innovations that leverage the network and have the potential to improve the way instruction and research is conducted, even when the impact of the innovation may not be felt immediately. This year's award winners were:

Outstanding Individual Contribution: David Wasley

David was instrumental in initiating the discussions which led to the formation of CENIC and served as CENIC's first Director of Projects. This required not only the technical expertise necessary to meld differing types of networks into one cohesive architecture, but the organizational skills to finalize by-laws and help form the first CENIC board and committees.

Educational Applications: Acme Animation

Acme Animation is an educational project using IP-based videoconferencing to connect students in California schools with experts in digital animation from major studios such as Pixar, Disney, Dreamworks, Warner Brothers, and Sony. Students learn digital animation skills and important lessons about working in the animation industry through their discussions with professional animators.

Learn more at www.acmeanimation.org.

High-Performance Applications: MonALISA

MonALISA (Monitoring Agents using a Large Integrated Services Architecture), developed over the last four years by Caltech and its partners at CERN and the Universitatea Politehnica Bucharest, is a globally scalable framework of services to monitor and help manage and optimize the operational performance of computing grids, networks, and running applications in real-time. This framework is ideal for creating and dynamically managing dispersed collaborative environments over Internet networks.

Learn more at monalisa.caltech.edu.

Gigabit/Broadband Applications: Loma Linda Connected Community Program

Through this project, Loma Linda has become one of only 40 cities nationwide that provide fiber-to-the-home and business directly to residents and to include such specifications in their building law. Residents now enjoy connectivity of the sort that only universities and top business parks claim elsewhere in the US.

Learn more at www.llccp.net.

Experimental/Developmental Applications: iGrid 2005

Larry Smarr, Director of the California Institute for Telecommunications and Information Technology (Calit2), and iGrid's co-chairs, Maxine Brown of the University of Illinois at Chicago (UIC) and Tom DeFanti of UIC and Calit2 accepted this award for iGrid 2005. More than four dozen pioneering applications from 20 countries showcased at the September event in San Diego, many of them linking different countries on different continents.

Learn more at www.igrid2005.org.

connection to the world



"Your Connection to the World" was sponsored by Cisco Systems, Level 3 Communications, AT&T, Ciena Corporation, Juniper Networks, and Movaz Networks. CENIC would like to acknowledge their assistance in making "Your Connection to the World" possible.

CENIC's next annual conference, CENIC '07: Making Waves, will take place March 12-14, 2007 in the sunny and beautiful city of La Jolla, CA. For more information including online registration, sponsorship opportunities, our conference program, and hotel and travel information, visit cenic07.cenic.org.



• "These projects are all
stunning examples
of the ways in which
high-bandwidth networking
can benefit not only research and education
but the community at large."

Jim Dolgonas, President & CEO, CENIC

CENIC relationships

Pacific Wave

Pacific Wave is a state-of-the-art international peering exchange facility designed to serve research and education networks throughout the Pacific Rim and the world. A joint project between CENIC and the Pacific Northwest Gigapop in collaboration with the University of Southern California and the University of Washington, Pacific Wave creates a new peering paradigm by removing the geographical barriers of traditional peering facilities. It enables any US or international network to connect at any of three major metropolitan areas along the US Pacific coast, as well as offers the option to peer with any other Pacific Wave participant, regardless of physical location.

By presenting a seamless, unified, international peering exchange facility at strategic Pacific coast locations, the Pacific Wave peering facility is a magnet for research and education partners throughout Canada, Mexico, South America, and the Pacific Rim.

Originally established in Los Angeles and Seattle, Pacific Wave was extended in 2005 to Sunnyvale. Major national and international research and education networks, including Abilene, ESNnet, TransPAC2, GEMnet, and CA*net 4 interconnect using the Pacific Wave infrastructure.

The distributed design of Pacific Wave allows participants to engage in bilateral peering regardless of which node they are physically connected to. This design offers significant flexibility and opportunities for networks utilizing any of a dozen trans-Pacific cables for their circuits as well as for building redundancy and robustness into peering relationships that would otherwise be cost-prohibitive and complex to engineer. Current participants represent networks and agencies from Australia, Canada, Japan, Korea, Malaysia, New Zealand, Qatar, Singapore, Taiwan, and the United States.

For more information, visit www.pacificwave.net.

National LambdaRail

Incorporated in May 2003, National LambdaRail (NLR) is a major initiative of US research universities and private sector technology companies to provide a national scale infrastructure for research and experimentation in networking technologies and applications.

NLR advances the research, clinical, and educational goals of its members and other institutions by establishing and maintaining a unique nationwide network infrastructure that is owned and controlled by the US research community. Ownership of the underlying optical infrastructure ensures the research community unprecedented control and flexibility in meeting the requirements of the most advanced network applications and providing the resources demanded by cutting-edge network research. NLR also supports experimental and production networks, fosters networking research, promotes next-generation applications, and facilitates interconnectivity among high-performance research and education networks.

By combining a national optical networking laboratory with the top networking and application researchers in the country, NLR will keep the United States at the forefront of 21st century technology. The establishment of NLR has enabled the advancement of network research and scientific applications, ensuring that the best researchers maintain leadership positions in emerging national and international scientific collaborations, and creating new networking services and capabilities that will help invigorate the information technology and telecommunications industries.

Recognizing that California is home to many of the nation's computational scientists and network researchers, CENIC drove the founding and implementation of NLR and provides Layer 1 services to NLR, Inc. under contract. The NLR Phase II Project involved completion of the next phase of the National LambdaRail footprint from Florida to California during the recent fiscal year. As the Layer 1 NOC for National LambdaRail, CENIC provided operational support during this deployment.

Pacific Wave also uses the National LambdaRail infrastructure in a joint project to create, deploy, and operate an advanced, extensible peering facility along the entire Pacific Coast of the US.

In addition to CENIC, NLR members include Case Western Reserve University, Cisco Systems, the Committee on Institutional Cooperation, Cornell University/Northeast LambdaRail, Duke University (representing a coalition of North Carolina universities), Florida LambdaRail, Front Range GigaPop/University Corporation for Atmospheric Research, Lonestar Education and Research Network, Louisiana Board of Regents, Mid-Atlantic Terascale Partnership/the Virginia Tech Foundation, NASA, Oak Ridge National Laboratory, Oklahoma State Board of Regents, Pacific Northwest Gigapop, Pittsburgh Supercomputer Center/University of Pittsburgh, Southeastern Universities Research Association, Southern Light Rail, and the University of New Mexico.

For more information, visit www.nlr.net.

UCAID • Internet2

The University Corporation for Advanced Internet Development (UCAID) is a consortium of more than 200 universities and other institutions founded to develop the next-generation Internet, or Internet2. CENIC charter members are among the founding institutions of UCAID and the Internet2 consortium. CENIC representatives have been actively involved in all facets of Internet2 since its inception, including governance, infrastructure development, applications, and middleware. In Southern California, CENIC provides its associates with a 10 Gb/s Ethernet connection to Abilene, the national Internet2 backbone. It is the first such connection in the nation. By taking advantage of Pacific Wave, CENIC also provides a redundant 10 Gb/s connection to Abilene in Seattle.

CENIC joined its sister regional and statewide network aggregators known as Gigabit points-of-presence (Gigapops) to form the Quilt project under UCAID. Among other things, the Quilt fosters innovative projects that enhance working relationships among the Gigapops.

The Quilt's purposes and objectives are:

- To provide advanced network services to the broadest possible research and educational community;
- To promote end-to-end continuity, consistency, reliability, interoperability, efficiency, and cost-effectiveness in the development and delivery of advanced network services; and
- To represent common interests to backbone network service providers, industry, government, standard-setting organizations, and other organizations involved in or influencing the development and delivery of advanced network services.

One of the Quilt's first efforts is the Commodity Internet Services (CIS) Project. The CIS's primary objective is to aggregate the buying power of Quilt participants to obtain the best value and lowest pricing for commodity Internet services.

Another initiative, the Regional Fiber Project, is designed to provide a forum for communication between different regional implementations of fiber infrastructure and to enable sharing of information on technologies and business practices in use and under experimentation nationally and beyond.

For more information, visit www.internet2.edu, www.ucaid.edu, and www.thequilt.net.

Corporación Universitaria para el Desarrollo de Internet (CUDI)

The Corporación Universitaria para el Desarrollo de Internet (CUDI) was founded in 1999 as a Mexican nonprofit corporation composed of members from the public and private sectors. Its purpose is to promote and coordinate the development of high-capacity telecommunications and computing networks to assist the development of scientific and educational activities in Mexico. CUDI funds an advanced, high-speed network in Mexico and has agreements with a number of carriers that provide high-performance applications to higher education and research institutions.

For more information, visit www.cudi.edu.mx.

Cooperación Latino Americana de Redes Avanzadas (CLARA)

The initial idea for the creation of CLARA arose during the June 2002 meeting in Toledo, Spain of the CAESAR (Connecting All European and South American Researchers) project, a European Commission funded feasibility study to evaluate the possibility of a direct interconnection between the pan-European research network GÉANT and similar activities in Latin America. In June 2003, the statutes of the CLARA organization were signed. It is based in Montevideo, Uruguay. Ultimately, the redCLARA network will connect more than 700 universities and research centers of Latin America.

For more information, visit www.redclara.net.

CENIC relationships

The Nevada System of Higher Education

The Nevada System of Higher Education (NSHE) represents three research institutions and six community colleges. The NSHE operates NevadaNet, which serves higher education plus K–12 schools in 17 counties. NSHE is a CalREN Associate with links between Las Vegas and Los Angeles in the south and Reno and Sacramento in the north.

For more information, visit system.nevada.edu.

CANARIE

CANARIE, Inc. – Canada's advanced Internet development organization – is a nonprofit corporation supported by its members, project partners, and the Canadian government. CANARIE's mission is to accelerate Canada's advanced Internet development and use by facilitating the widespread adoption of faster, more efficient networks and by enabling the next generation of advanced products, applications, and services to run on them. Headquartered in Ottawa, Ontario, CANARIE employs 22 full-time staff dedicated to the research and implementation of advanced networks and applications that will stimulate economic growth and increase Canada's international competitiveness.

CANARIE has already succeeded in enhancing Canadian R&D Internet speeds by a factor of almost one million since its inception in 1993. The organization has also funded numerous advanced Internet applications projects, providing some 500 companies with the opportunity to achieve business success through innovation. CANARIE also intends to act as a catalyst and partner with governments, industry, and the research community to increase overall IT awareness, ensure continuing promotion of Canadian technological excellence, and ultimately foster long-term productivity and improvement of living standards.

For more information, visit www.canarie.ca.

EDUCAUSE

EDUCAUSE is the nation's leading professional organization for information technology in higher education. CENIC is a member of the EDUCAUSE Net@EDU program, which formed the Broadband Pricing Group (BPG) with CENIC as an active participant.

The goals of the BPG are to provide all research and education institutions with cost-efficient bandwidth and to facilitate the deployment of a seamless and robust nationwide network. Some of the ideas and strategies of CENIC's Optical Network Infrastructure Initiative originated with the BPG in the form of white papers and recommendations submitted to UCAID and EDUCAUSE.

For more information, visit www.educause.edu.

Association of Pacific Rim Universities

The Association of Pacific Rim Universities (APRU) was founded with the goal of helping these geographically linked institutions become more effective contributors to the development of an increasingly integrated Pacific Rim community, a goal analogous to and supportive of the efforts of the Asia Pacific Economic Cooperation. By increasing mutual understanding among the chief executives of these leading universities, APRU aims to stimulate cooperation throughout the fields of teaching and research on issues of importance to the Pacific Rim community.

For more information, visit www.apru.org.

Internet Educational Equal Access Foundation

The Internet Educational Equal Access Foundation (IEEAF) is a public-private partnership whose goal is to obtain donations of unused communications and networking assets and international bandwidth to enable global collaboration in research and education. CENIC's participation resulted from an MOU between CENIC and Geographic Network Affiliates, Inc. in February 2000.

The IEEAF is a broker among educational entities, corporations, governments, and regional and national network organizations. It identifies and accepts donated assets and matches them to educational needs. The partnership's vision is to accelerate the global growth of Internet2 in order to achieve universal educational access, and to help solve the digital divide on a global scale through the use of submarine and terrestrial dark fiber, carrier hotels, licenses to rights-of-way, and other assets.

For more information, visit www.ieeaf.org.

financial summary

CalREN Core Network Fees

Total revenues for backbone services remained stable.

FY 2004-05
(in thousands)
\$17,552

FY 2005-06
(in thousands)
\$17,160

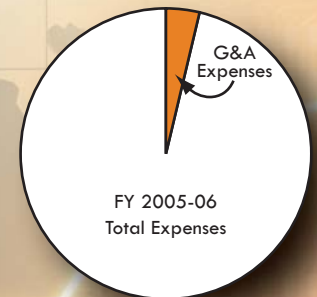
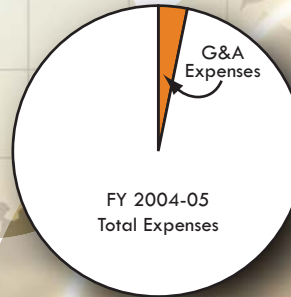
G&A vs. Total Expenses

G&A Expenses
Total Expenses
Percentage of Total Expenses

FY 2004-05
(in thousands)
\$1,701
\$43,457
3.9%

FY 2005-06
(in thousands)
\$1,928
\$42,464
4.5%

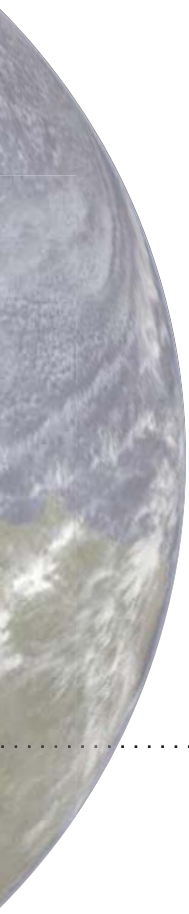
Administrative costs remained low.



Contact CENIC at (714) 220-3400 or info@cenic.org to learn how your institution can

connect to CalREN.





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