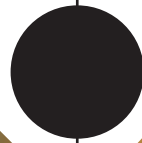




Leading the Way to Tomorrow's Internet



Corporation
for Education
Network Initiatives
in California

Annual Report
2004-2005



Letter from the President

Dear Friends and Colleagues:

Our vision is that every educator and researcher in California has access to an advanced communications infrastructure enabling the best teaching, learning and research experiences in the nation. Our 2004-2005 year was a big step in achieving that vision.

The year brought increased high-speed networking to all segments of education. At the research institution level, the UCSD campus was provided with a 10 Gb/s connection to the CalREN backbone. The NASA Ames Research Center and the UCR Heckman Center in Palm Desert were connected to the CalREN backbone at 1 Gb/s, and projects to bring two fiber paths to UC Merced were completed. The CalState system benefited from the initial implementation of higher speed and diverse connections to the CalREN backbone with the implementation of 1 Gb circuits from the CalREN backbone to CSU Northridge, the first of 11 initial CSU campuses slated for such enhancement to their already existing connections. In addition, CSU San Bernardino's Palm Desert campus was connected at 1 Gb/s. The majority of California Community College campuses received upgrades in their connections to CalREN from T1 speeds (1.544 Mb/s) to DS/3 (45Mb/s).

2004-2005 was a year of stability for the K-12 segment in terms of network. The activity during the year was focused on integrating the K-12 video conferencing and the CalREN Video Services environments.

CENIC also substantially increased the number of commodity network peers, reducing the cost of sending traffic to non-educational sites. And CENIC implemented connections to a number of international networks to facilitate collaborations among researchers and educations in California and those in other nations.

These far-reaching steps enabled incredible accomplishments in our user community. I invite you to read about the successes CENIC enjoyed from July 2004 to June 2005.

Sincerely,

Jim Dolgonas
President and COO, CENIC

“Our vision is that every educator and researcher in California has access to an advanced communications infrastructure ...”

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Introduction to CENIC

The Corporation for Education Network Initiatives in California—known as CENIC—is a not-for-profit corporation serving the California Institute of Technology, California State University, Stanford University, University of California, University of Southern California, California Community Colleges, and the statewide K–12 school system. CENIC’s mission is to facilitate and coordinate the development, deployment, and operation of a set of robust multitiered advanced network services for this research and education community.

Network Development & Evolution

for the California Research and Education Community

CalREN-XD

Experimental/Developmental Network

Bleeding-edge Services for Network Researchers

Tier 1

CalREN-HPR

High-Performance Research Network

Leading-edge Services for Large Application Users

Tier 2

CalREN-DC

Digital California Network

All K-20 California Research and Education Users

Tier 3

CENIC represents the common interests of its associates, who are drawn from California’s higher education academic and research communities, and is highly accountable to the institutions it serves in order to fulfill the trust that has been placed with it.

CENIC's Mission & Goals

The mission of the Corporation for Education Network Initiatives in California (CENIC) is to develop, deploy, and operate leading edge network-based services and to facilitate and coordinate their use for the research and education community to advance learning and innovation.

CENIC is committed to the following goals:

- 1 Operate a robust, cost effective, state-of-the-art communications network for participating education and research institutions;
- 2 Promote high quality end-to-end network services and interoperability among participating institutions;
- 3 Advance the collective and individual interests of participating CENIC institutions by leveraging their diversity and relationships to create benefits to individual members;
- 4 Provide a competitive advantage in the global marketplace to the CENIC Associates' education and research communities;
- 5 Become California's recognized provider of network services for education and research; and,
- 6 Stimulate innovation in teaching, learning, and research through use of the network.



The CENIC Organization

In 1998, CENIC's California Research and Education Network (CalREN) began serving the network needs of California's research universities. In 2000, CENIC expanded CalREN's network services to the state's K-12 community. By 2003-04, CalREN was the single network serving the entire education community in California—including K-12, the California Community Colleges, the California State University system, the University of California system, California Institute of Technology, the University of Southern California, and Stanford University. Today, CENIC is a major player in both the national and international networking arenas and manages the largest and most robust statewide optical network for education in the nation.

Since its inception, CENIC's primary focus has been on serving the networking needs of the education community by offering robust high-quality and high-capacity networking services at economical costs. To support its mission, CENIC relies on associate-based advisory committees, the outsourcing of specialized services outside its area of core competence, and lean staffing.

Until 2003-04, the California State University (CalState) system operated the 4CNet network—which served its campuses and the California Community Colleges (CCCs)—and CENIC contracted with 4CNet for Network Operation Center (NOC) services. In 2003-04, the CalState system and the CCCs began to use CENIC's CalREN network instead of 4CNet. Upon integration of 4CNet into the CalREN network, CENIC adopted a new model for providing NOC services to the multitiered CalREN backbone. In 2003-04, a NOC advisory committee which included representatives from all CENIC education segments recommended that CENIC insource its NOC services (CENIC began offering NOC support in June of 2003, and the CENIC NOC began formal operation in January of 2004). CENIC relies on its board and advisory councils, with assistance from corporate partners, such as Cisco Systems and AT&T, to guide the management of CalREN. With the creation of separate High-Performance Research (HPR) and Digital California (DC) Networks, the former Technical Advisory Council (TAC) became HPR TAC and a new DC TAC was formed.

Until 2004, CENIC subleased space from the CSU system in facilities shared with the 4CNet staff. Based on the need to house the new NOC, CENIC entered into a five year sublease in Cypress, California, about two miles from its previous location in Los Alamitos, and moved to its present location in February of 2004.

2004-05 Board Members

John Silvester, Chairman
Vice-Provost for Scholarly Technology
University of Southern California

David Ernst, Vice-Chairman
Chief Information Officer and Assistant Vice Chancellor
California State University

Jim Davis, Secretary¹
Associate Vice Chancellor
University of California, Los Angeles

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Associate Vice President, Information Technology
California State University, Hayward

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Sonoma State University

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President, CENIC

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Director, Information Technology Services
California Institute of Technology

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University of California, San Diego

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California Institute for Telecommunications
and Information Technology

2004-05 Advisory Councils

Business Advisory Council

Jerry Keith, Chair^{2,4}
Director of Communications,
University of California, Riverside

DC Technical Advisory Council

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Associate Vice Chancellor for Information Technology
Los Rios Community College District

Johanna Madjedi, Vice Chair
Director, Communication & Computing Services
California Polytechnic State University

HPR Technical Advisory Council

Michael Van Norman, Chair
Manager, Technology and Development
University of California, Los Angeles

Mike Scott, Vice Chair (2004) Chair (2005)
Network and Academic Computing Service
University of California, Irvine

John Haskins, Vice Chair (2005)
Network Analyst, Office of Information Technology
University of California, Santa Barbara

1 - Audit Committee Chair, 2 - Audit Committee Member, 3 - Finance Committee Chair, 4 - Finance Committee Member

CENIC Associates

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 Universities

Office of the Chancellor
California Maritime Academy
California Polytechnic State University
San Luis Obispo
California State Polytechnic University
Pomona
CSU Bakersfield
CSU Channel Islands
CSU Chico

CSU Dominguez Hills
CSU East Bay
CSU Fresno
CSU Fullerton
CSU Long Beach
CSU Los Angeles
CSU Monterey Bay
CSU Northridge
CSU Sacramento

CSU San Bernardino
CSU San Marcos
CSU Stanislaus
Humboldt State University
San Diego State University
San Francisco State University
San Jose State University
Sonoma State University

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

CENIC Partners

California K–12 System
Encompassing 58 counties and 985 districts

CaIREN Associates

The Nevada System of Higher Education
NASA Ames Research Center

The CalREN Network

Background

California Research and Education Network (CalREN) is CENIC's answer to broadband connectivity for California's educational community—from K–12 through higher education. The first generation of CalREN operated in the San Francisco and Los Angeles areas over two carrier-provided SONET rings connected by high-speed north/south links. The network was connected in the north and south to the Internet2 Abilene backbone, a national broadband network for the educational community.

Planning for the second generation of CalREN began in 2000. In January 2003, CENIC began deployment of the nation's first multitiered, statewide optical network infrastructure. The CalREN backbone infrastructure consists of 2400 miles of fiber and long-haul optical equipment to support multiple Gigabit Ethernet connections at speeds ranging from one Gigabit per second (Gb/s) to 10 Gb/s.

The CalREN backbone consists of owned fiber, which allows multiple independent networks to exist over a common physical infrastructure. Simply put, CalREN has multiple separate networks operating on the backbone, which are integrated at the physical and operations level, thus enabling high-quality production services, high-performance applications, and network research.



The new optical backbone infrastructure became operational in late 2003. By early 2004, CENIC had extended its second-generation network to its research university members: Caltech, Stanford, the University of California and University of Southern California—all of which are connected to the CalREN backbone by fiber with end-to-end capacity ranging from 1–10 Gb/s. In 2004-05, CENIC extended the network into UC Merced, the Palm Springs area, and to NASA's Ames Research Center.

CaIREN-Digital California Network

The CaIREN Digital California network (CaIREN-DC) provides high-quality network services for K–20 students, teachers, and administrators, and the faculty, researchers, and staff of colleges and universities. The CaIREN backbone was extended between 2001 and early 2003 into each of California's 58 counties to facilitate connectivity among K–12 schools. CaIREN-DC serves more than 8,000,000 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-DC facilitates resource sharing and collaboration between K–12 and higher education for educational purposes and videoconferencing. The backbone supports specialized quality of service (QoS) to facilitate high-quality videoconferencing. The DC network also provides connectivity to the commodity Internet.

The California Community College system uses the network for communications among its campuses and off-campus centers. CSU uses CaIREN-DC for linking campus administrators to a central administrative computing facility in Salt Lake City.

In 2005 CaIREN-DC was extended by means of a fiber construction project from Riverside, through California's Coachella Valley, to San Diego. This project provides Gigabit Ethernet connectivity to sites throughout that region.

High school and colleges in California are using IP-based videoconferencing to connect students with experts in digital animation from major studios such as Pixar, Disney, Dreamworks, Warner Brothers, and Sony, thanks to CENIC and a program known as ACME (www.acmeanimation.org). Students learn digital animation skills and important lessons about working in the animation industry through their discussions with professional animators.

In fall of 2004, the program expanded its reach thanks to CENIC's CaIREN Video Services project, which enables schools to use IP-based videoconferencing over CaIREN.

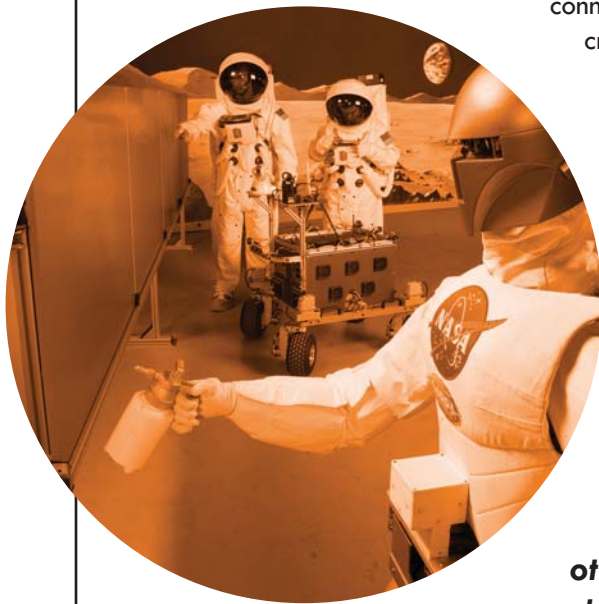


CalREN-High-Performance Research Network

CalREN High-Performance Research network (CalREN-HPR) provides leading-edge services for large-application users at CENIC associate sites. This 10 Gigabit 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. CalREN-HPR is connected to Abilene, Internet2's national backbone, and provides the means for all educational institutions in California to access Abilene. The CalREN-HPR backbone provides the advanced networking features, such as jumbo frames IPv6, necessary to support current and emerging leading-edge applications.

A wide range of large-scale, multidisciplinary projects are conducted by researchers at CENIC member institutions over CalREN-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.

In 2005, the CalREN fiber backbone was extended to Tijuana to provide access to the Corporación Universitaria para el Desarrollo de Internet (CUDI), the Mexican research and education network, and to the Cooperación Latino-Americana de Redes Avanzadas (CLARA), the Latin American Cooperation of Advanced Networks. 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; Santiago, Chile; São Paulo, Brazil; and Miami, coming full circle in San Diego via National LambdaRail.



Thanks to the advances from the NASA Ames Research Center, space exploration has become a reality and promises not only research but also concrete economic and technological benefits. The world has opened up to the possibilities of information technology, biotechnology, and nanotechnology, and thanks to CENIC's CalREN-HPR network, the Ames Research Center is now better able to collaborate with other researchers all over the world. In April 2005, CENIC completed a fiber optic connection between Ames, located in Mountain View, and its Sunnyvale hub site.

A working group formed of members of the HPR Technical Advisory Committee has been working with CENIC to develop the design for the next generation of the HPR network.

CalREN-Experimental/Developmental Network

CalREN Experimental/Developmental network (CalREN-XD) 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 NASA's Jet Propulsion Lab (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. CalREN-XD is a dedicated, experimental, wide-area infrastructure, and its use will not compromise the reliability of CalREN's other two tiers presently in production mode.

The CalREN-XD network is critical. Fundamental changes in the way networks operate cannot be developed and tested on production networks supporting millions of users, such as the existing CalREN-HPR and CalREN-DC. New networking applications, services, and optical technologies must be developed in an environment that does not adversely impact current 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 CalREN-XD network enables the research community to perform research that may disrupt or even permanently disable the existing network.

In addition to network research, CalREN-XD supports important national research collaborations such as the OptIPuter, funded by the National Science Foundation. The OptIPuter is a five-year research program led by the California Institute for Telecommunications and Information Technology (Calit2), a partnership between the University of California at San Diego and the University of California at Irvine. The University of Illinois at Chicago is a crucial participant as well, with further participation from many other universities and research institutions, including Northwestern University, San Diego State University, Texas A&M, the University of Southern California's Information Sciences Institute, and the University of Illinois at Urbana-Champaign, as well as the San Diego Supercomputer Center and other TeraGrid sites around the nation. The CalREN-XD network provides intersite connectivity as one part of this powerful distributed infrastructure to support data-intensive scientific research and collaboration.



The CalREN Network Operations Center

The three tiers of CalREN are monitored and managed 24/7/365 by a team of CENIC network engineers. The Network Operations Center (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 National LambdaRail.

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 has agreed to serve as an alternate facility site. Critical tools to be housed at UCI have been identified, and necessary equipment has been configured and deployed.

California & Beyond: Network Expansion

University of Arizona Project

In May 2005, CENIC initiated a project to connect the University of Arizona and Arizona State University (ASU) to the CalREN-HPR network over CENIC-managed connections. By the end of 2005, both campuses will connect to CalREN via a fiber route from the Phoenix hub site, through Yuma, and then on to CENIC's hub in San Diego.

CSU Campus Access Infrastructure Project

The Campus Access Infrastructure Project is a CSU system-wide program that will greatly improve CSU campus and other CSU site connectivity to the CalREN backbone. The end result will be redundant, diverse paths from each campus to the backbone to improve robustness and performance. Circuit orders were placed in April 2005 for the first cohort of eleven campuses slated for a carrier-provided Gigabit Ethernet connection while dark fiber connections are scheduled to begin delivery in 2006. In July 2005, CSU Northridge became the first CSU campus to have been provided with dual, diverse connections to CalREN.

"Middle mile" fiber has been purchased for the initial CAI dark fiber connections, and detailed last-mile design work is underway.

Coachella Valley Fiber Project

In September 2004, the H. N. and Frances Berger Foundation made a \$3.4million grant to CENIC for the initial phase of the Coachella Valley Fiber Project. Representing a new dark-fiber build-out to the greater Coachella Valley area from Riverside and south from Palm Desert into Imperial County, the Coachella Valley Fiber Project establishes new backbone hub sites at UC Riverside and at the Palm Desert Educational Complex. In March 2005, CENIC lit the first Gigabit Ethernet connection establishing connectivity between the CENIC backbone and the Palm Desert campus of CSU San Bernardino. Less than a week later, another GigE connection was turned on for the dedication of the Heckmann Center for Entrepreneurial Management of UC Riverside, also in Palm Desert.

CUDI/CLARA Project

The aim of the CUDI/CLARA Project is to increase bandwidth to CUDI, Mexico's research and education network, from a DS/3 (44.7 Mb/s) to 1 Gb/s, as well as providing a separate 1 Gb/s path from CLARA, Latin/South America's research and educational network, to San Diego for connection to CalREN. The aim of this project was to create a 1 Gb/s ring connecting San Diego and Miami with Central and South America. This project is funded by the NSF. This connectivity was established in July, 2005.

Southern California Backbone Redesign Project

Related to the Coachella Valley Fiber Project, the Southern California Backbone Redesign Project involves changes to the CalREN backbone path in southern California. This project moved the Central Valley fiber termination from Los Angeles to the new CalREN hub site at UC Riverside and redirected the diverse path between Los Angeles and San Diego, reducing a single point of network failure in downtown Los Angeles through which pass two CENIC backbone paths. In addition, by establishing a new aggregation point in Riverside, the project reduces circuit costs for Associates in that part of the state.

The NASA Ames Project

As noted previously, CENIC completed a fiber optic connection between Ames, located in Mountain View, and its Sunnyvale hub site in April of 2005. The NASA Research Park, adjacent to Ames, will also benefit. Current tenants of the Research Park include UC Santa Cruz, San Jose State University, Carnegie Mellon, and Lockheed Martin.

The National LambdaRail Phase II Project

Under contract to National LambdaRail, Inc., CENIC provides Layer 1 services. The NLR PII Project involves deployment of the next phase of the National LambdaRail footprint from Florida to California. As the Layer 1 NOC for National LambdaRail, CENIC provides support for the deployment and ongoing operation of NLR.

Future Directions: Network Upgrades

It is expected that the user bandwidth needs of each network tier—DC, HPR, and XD—will increase over time and drive upgrades to the CalREN networks. The 2.5 Gb/s DC backbone will likely grow to 10 Gb/s, and the 10 Gb/s HPR backbone and the XD segments will be supported over 40 Gb/s technologies. In addition, CENIC is exploring the introduction of optical switching as a service in the coming year, which would allow the provision of wavelengths-on-demand to research institutions and facilitate both short- and long-term connections to projects such as NLR, Pacific Wave, and Internet2.

CENIC utilizes a variety of tools to monitor and manage the network. As CalREN users request additional monitoring services and as improved tools become available, the NOC will incorporate those items into its complement of management software.



CalREN Video Services—CVS

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 latest standard for videoconferencing equipment. CSU was joined by the CCC and UC systems as well as the K-12 segment through the Digital California Project in planning an H.323 infrastructure to support videoconferencing across all three systems. The K-12 community—through the Digital California Project—also expressed interest in using H.323 services across CalREN.

In April 2003, CSU formally requested that CENIC take responsibility for the H.323 project. CENIC began implementation of CalREN Video Services (CVS), including the migration of former H.320 sites at CSU and CCC to H.323. By the end of June 2004, all CSU sites and 21 percent of the community college sites were migrated to the CVS H.323, and K-12 began to use the services. In mid-2005, the UC system began working with CENIC on plans for UC's transition to CVS.



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.

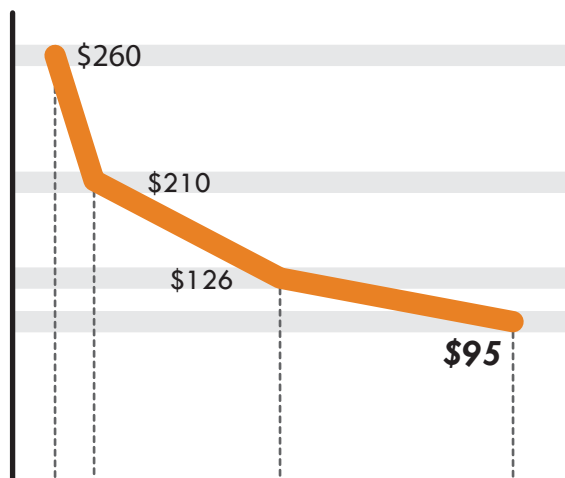
The CVS project also began testing scheduling software to allow videoconference administrators at each CVS site to schedule conferences themselves. The CVS Oversight Committee recommended Polycom's PCS software for this purpose, and a test server was installed in June 2005. CENIC began recruiting volunteers to serve as test sites for the software during this time.

ISP & Peering Services

CENIC operates multiple connections to the commodity Internet, spread across four geographic locations and three Internet service providers (ISPs). The ISP contracts are negotiated through the Quilt, a national consortium of educational institutions, which provides pricing substantially lower than otherwise available.

In May 2002, pricing was at \$260 per Megabit per month, and in July 2002, it fell to \$210. July 2003 saw it fall to \$126, and then to \$95 in July of 2004.

CENIC operates peering connections to a variety of commodity ISPs and content providers to reduce ISP costs and improve network performance. Aggregate peering traffic increased in 2005 to 1.9 Gbps, providing a cost savings to CENIC associates of approximately \$3.4million/year.



The Corporation for Education Network Initiatives in California (CENIC) provides Video-over-IP services over CalREN. Its charge is to support the current technological environment for existing rooms and technology involved in videoconferencing while integrating Video-over-IP into the environment.

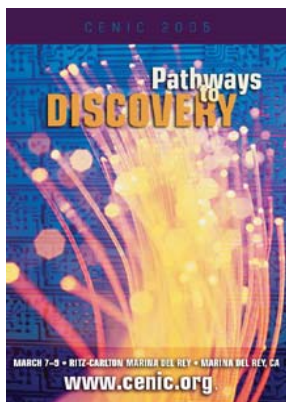
Community Outreach

Conferences & Meetings

CENIC's ninth annual conference, "Pathways to Discovery," was held in Marina del Rey March 7-9, 2005. The first keynote speaker was Susan Kennedy of the California Public Utilities Commission, who spoke on the topic of Broadband Deployment in California. The second keynote speaker was kc claffy of Cooperative Association for Internet Data Analysis (CAIDA), who spoke on the topic of the Top Problems of the Internet and What Can Be Done to Help.

The CENIC 2005 conference enjoyed a full Gigabit connection to the CalREN backbone, accomplished via a free-space optical link from the conference hotel in Marina del Rey to the USC Information Sciences Institute and CENIC's backbone.

In addition, CENIC held its final One Gigabit or Bust™ Roundtable Meeting in February 2005.



CENIC's Website Redesign

In September 2004, CENIC's website was reorganized and streamlined to improve the user experience.

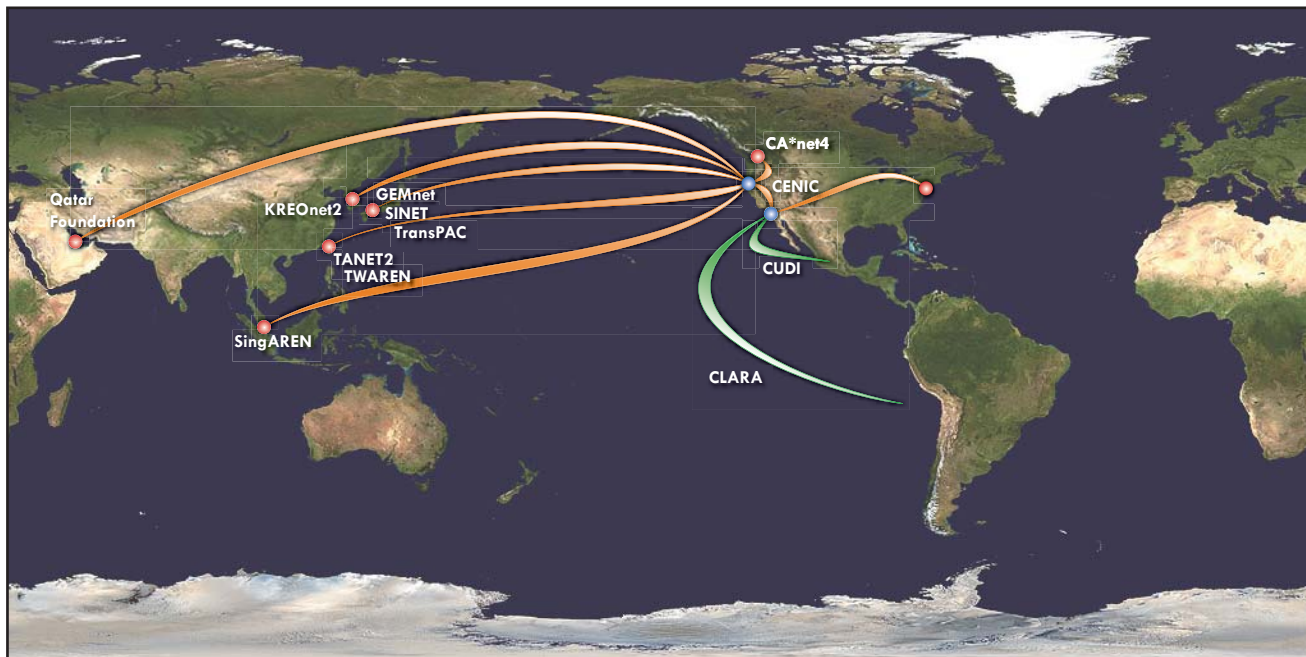


Publications

CENIC Today, a free monthly electronic newsletter sent out at the end of every month, was produced. InterAct Magazine, an advanced networking applications magazine, saw its third year of publication.

CENIC Global Partnerships

CENIC's mission and vision require that CENIC maintain relationships outside of California. These relationships span both the United States and the globe, enabling CENIC's customers to collaborate in research and educational projects in all disciplines worldwide. To that end, CENIC supports and participates in a wide range of projects designed to extend and expand advanced-services networking through the nation and the world.



The result of a collaboration between CENIC, Pacific Northwest Gigapop, and USC, Pacific Wave facilitates global high-bandwidth research collaboration. Its members include:

Canada: CA*net4

The Pacific Rim: Japan - GEMnet, TransPAC, SINET
Korea - KREOnet2
Singapore - SingAREN
Taiwan - TANET2, TWAREN

The Middle East: The Qatar Foundation

CENIC's CUDI/CLARA project also provides for high-bandwidth collaboration between researchers in Mexico and South America.

CENIC's CalREN network also connects to the Internet2's Abilene backbone, and via Abilene, to New York and then on to Europe. Thus worldwide high-bandwidth network-based collaboration is possible for any researcher or educator in California.

In today's high-tech, high-bandwidth world, collaboration knows few boundaries, and partners in research often span the globe. To that end, CENIC considers enabling such collaboration between researchers and educators in California and around the world to be a central part of its mission and vision.

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 locations 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 will be 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, ESNet, TransPAC2, GEMnet, and CA*net4, interconnect using the Pacific Wave infrastructure.

The distributed design of Pacific Wave allows participants to engage in bilateral peerings 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 Japan, Korea, Australia, Canada, Taiwan, Singapore, Malaysia, Qatar, and the United States.

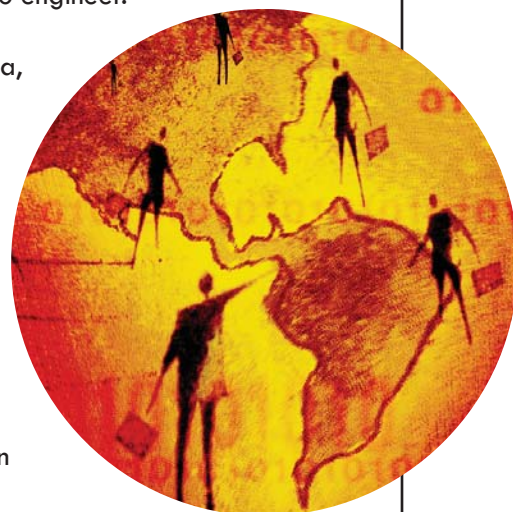
For more information, visit www.pacificwave.net.

National LambdaRail

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

NLR aims to catalyze innovative research and development into next generation network technologies, protocols, services and applications.

National LambdaRail is advancing the research, clinical, and educational goals of members and other institutions by establishing and maintaining a unique nationwide network infrastructure that is owned and controlled by the U.S. 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 aims to support experimental and production networks, foster networking research, promote next-generation applications, and facilitate 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 will enable the advancement of network research and scientific applications, ensure that the best researchers maintain leadership positions in emerging national and international scientific collaborations, and create new networking services and capabilities that will help invigorate the information technology and telecommunications industry.

Recognizing that California is home to many of the nation's computational scientists and network researchers, CENIC drove the founding and implementation of NLR—a key component to the advancement their scientific endeavors.

Under contract to National LambdaRail, Inc, CENIC provides Layer 1 services. The NLR PII Project involves deployment of the next phase of the National LambdaRail footprint from Florida to California. As the Layer 1 NOC for National LambdaRail, CENIC will provide 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 U.S.

In addition to CENIC, NLR members include Case Western Reserve University, Cisco Systems, Committee on Institutional Cooperation, Cornell University, Duke University, Florida LambdaRail, Georgia Institute of Technology, Internet2, Lonestar Education and Research Network, Louisiana Board of Regents, Mid-Atlantic Terascale Partnership, Oak Ridge National Laboratory, Oklahoma State Board of Regents, the Pacific Northwest GigaPOP, the Pittsburgh Supercomputing Center, SURA, UCAR/FRGP and University of New Mexico

In June 2005 the National LambdaRail and Internet2 boards signed letters of intent to combine the two organizations, which promises greater access to experimental networking facilities and cutting-edge Internet applications and services, enabling rapid development and adoption of advanced networking capabilities.

For more information, visit www.nlr.net.

CENIC's mission and vision require that CENIC maintain relationships outside of California. To that end, CENIC supports and participates in a wide range of projects that extend and expand advanced-services networking throughout the nation and the world.

Ongoing Relationships

Corporación Universitaria para el Desarrollo de Internet

The Corporación Universitaria para el Desarrollo de Internet (CUDI) is 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.

In May 1999, CENIC and CUDI signed a Memorandum of Understanding (MOU) to promote their respective and shared goals and objectives by providing for appropriate collaborations and interconnections among their institutions. A high-speed communications link between CENIC and CUDI was established in 2000, and as noted earlier, CENIC increased CUDI/CLARA bandwidth from a DS/3 to 1 GigE with funding from the NSF. For more information, visit www.cudi.edu.mx.

University Corporation for Advanced Internet Development and 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.

The Measurement Infrastructure Project will create a measurement fabric associated with Gigapops in Quilt and make it possible to debug problems at the Gigapop level using interactive tests and common tools. For more information, visit www.internet2.edu, www.thequilt.net, and www.ucaid.edu.

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.

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 CENIC network 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.

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.

Pacific Internet2

The Pacific Internet2 (PI2) is a coalition that seeks to leverage the resources of several western states by linking their statewide networks with each other and with the national Internet2 backbone. Participating states include Alaska, California, Hawaii, Nevada, Oregon, and Washington. A working coalition was formed and the PI2 Open Access Web site was created.

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.



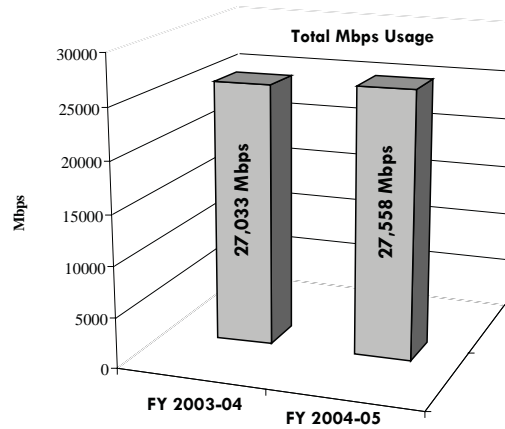
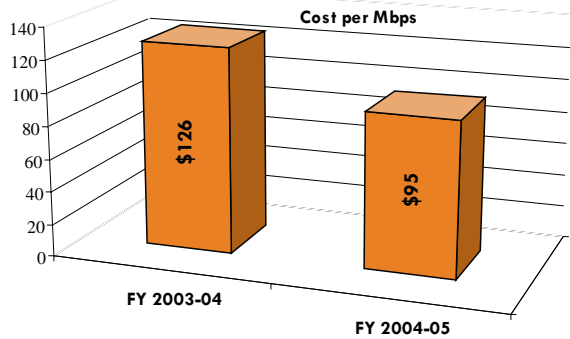
Financial Summary

	FY 2003-04 (in thousands)	FY 2004-05 (in thousands)
CalREN Core Network Fees	\$17,730	\$17,552

Total revenues for backbone services remained constant.

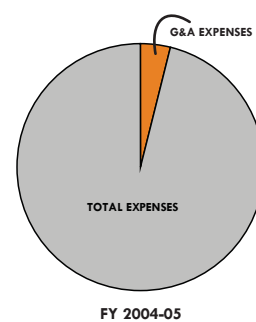
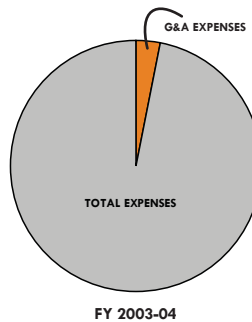
	FY 2003-04	FY 2004-05
Cost per Mbps (for access to non-educational sites)	\$126.00	\$95.00
Total Mbps Usage	27,033	27,558

Fees for transit to non-educational sites dropped by 25%.
Usage remained constant.



	FY 2003-04 (in thousands)	FY 2004-05 (in thousands)
G&A Expense	\$1,488	\$1,701
Total Expenses	\$46,868	\$43,457
Percentage of Total Expenses	3.2%	3.9%

Administrative costs remained low.







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