



**Corporation for Education Network Initiatives in California**

**Leading the Way to Tomorrow's Internet**

**ANNUAL REPORT FISCAL YEAR 2003-2004**



# LETTER FROM THE PRESIDENT

## DEAR FRIENDS AND COLLEAGUES:

Our vision is that every educator and researcher in California has access to advanced communications infrastructure enabling the best teaching, learning and research experiences in the nation. Our 2003–04 year was a big step in achieving that vision.

The second generation of CalREN, CENIC's network for education and research, reached into each one of California's 58 counties. The optical backbone was provisioned allowing multiple 10-Gb/s connections—essentially establishing a statewide local area network for education and research. There is no other research and education network in this nation that can make those claims.

These far-reaching steps enabled incredible accomplishments in our user community. Today, all of the California Community Colleges and the California State University Colleges have much better access to each other, to new Internet-based videoconferencing services and to the greater Internet. K–12 schools are making great strides in building local infrastructure to take advantage of this new capability—73 percent of California schools were connected to CalREN. And research institutions like the University of California are able to provide the best connectivity for their students and faculty—for experiments, research and learning experiences.

In addition, a new international capability called Pacific Wave was founded by CENIC and our colleagues in the NorthWest to expand the availability of interconnections for California and the rest of the Pacific Rim.

I invite you to read about the successes CENIC enjoyed from July 2003 to June 2004.

Sincerely,

Jim Dolgonas  
President and COO, CENIC



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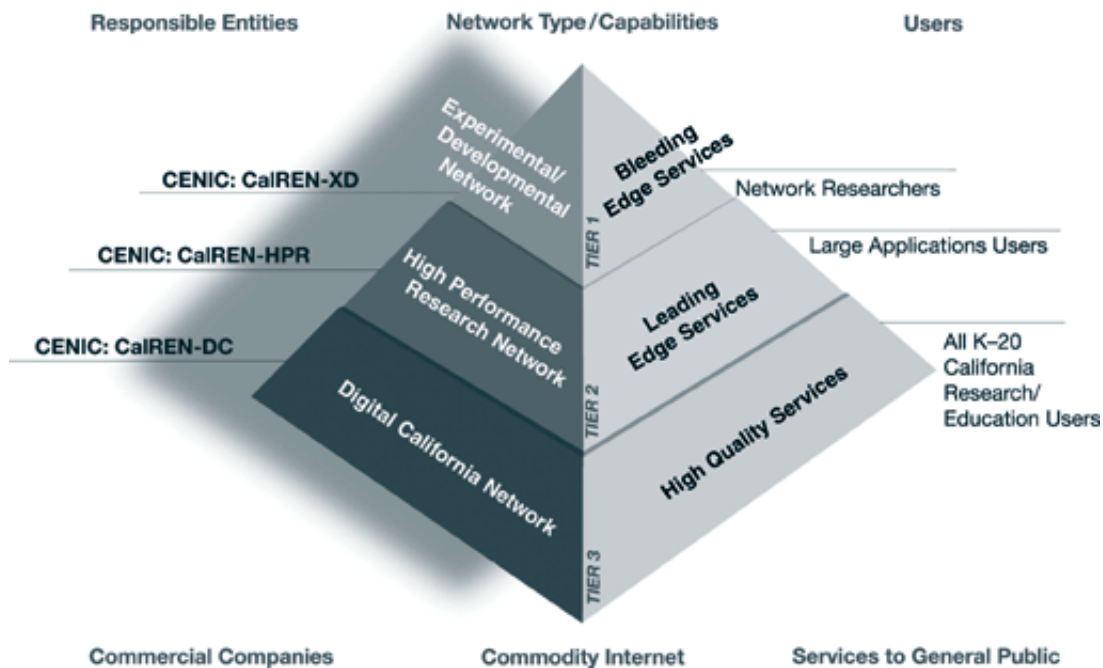


# INTRODUCTION TO CENIC

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 AND EVOLUTION For California Research and Education Community



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# CENIC ASSOCIATES

## CENIC CHARTER ASSOCIATES

### California Community Colleges

Chancellor's Office

Alameda

Allan Hancock

American River

Antelope Valley

Bakersfield

Barstow

Butte

Cabrillo

Cañada

Canyons

Cerritos

Cerro Coso

Chabot

Chaffey

Citrus

Coastline

Columbia

Compton

Contra Costa

Copper Mountain

Cosumnes River

Crafton Hills

Cuesta

Cuyamaca

Cypress

De Anza

Desert

Diablo Valley

East Los Angeles

El Camino

Evergreen Valley

Feather River

Folsom Lake

Foothill

Fresno City

Fullerton

Gavilan

Glendale

Golden West

Grossmont

Hartnell

Imperial Valley

Irvine Valley

Lake Tahoe

Laney

Las Positas

Lassen

Lemoore

Long Beach City

Los Angeles City

Los Angeles Harbor

Los Angeles Mission

Los Angeles Pierce

Los Angeles Southwest

Los Angeles Trade Tech

Los Angeles Valley

Los Medanos

Marin

Mendocino

Merced

Merritt

MiraCosta

Mission

Modesto Junior

Monterey Peninsula

Moorpark

Mt. San Antonio

Mt. San Jacinto

Napa Valley

Ohlone

Orange Coast

Oxnard

Palomar

Palo Verde

Pasadena City

Porterville

Redwoods

Reedley

Rio Hondo

Riverside

Sacramento City

Saddleback

San Bernardino Valley

San Diego City

San Diego Mesa

San Diego Miramar

San Francisco City

San Joaquin Delta

San Jose City

San Mateo

Santa Ana

Santa Barbara City

Santa Monica

Santa Rosa

Santiago Canyon

Sequoias

Shasta

Sierra

Siskiyou

Skyline

Solano

Southwestern

Taft

Ventura

Victor Valley

Vista

West Hills

West Los Angeles

West Valley

Yuba

### California Institute of Technology

Jet Propulsion Laboratory

### California State University System

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 Fresno

CSU Fullerton

CSU East Bay

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

### Stanford University

Stanford Linear

Accelerator Center

Stanford Medical Center

### University of California System

Office of the President

UC Berkeley

UC Davis

UC Irvine

UC Los Angeles

UC Merced

UC Riverside

UC San Diego

UC San Francisco

UC Santa Barbara

UC Santa Cruz

### 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

## CALREN ASSOCIATES

University and

Community College

System of Nevada

# CENIC'S MISSION AND VISION

## MISSION

**C**ENIC's mission is to develop, deploy and operate a set of seamless and robust statewide communications services capable of supporting advanced research and education applications in order to further California's leadership in education and research.

CENIC is committed to the following goals:

1. Overseeing the deployment of a robust, cost effective, state-of-the-art statewide communications infrastructure and supporting resources accessible to all institutions of education in California;
2. Facilitating high-quality operational support for that infrastructure;
3. Coordinating the development of common protocol standards and practices among participating institutions to ensure end-to-end quality of service and interoperability;
4. Ensuring that the advanced communications infrastructure can be utilized fully and effectively by the institutions it serves;
5. Enabling the study of a variety of cost-recovery models for the delivery of advanced communications services and their potential impact on the institutions they serve;
6. Catalyzing partnerships with government agencies and the private sector to facilitate availability of precompetitive communications services and equipment in support of advanced information technology applications;
7. Representing the common interests of the institutions it serves in leveraging relationships with vendors and in working with statewide and national governmental bodies; and
8. Advancing the national network communications infrastructure through active participation in Internet2, National LambdaRail and other initiatives.

## VISION

**C**ENIC's vision is that every educator and researcher in California has access to advanced communications infrastructure enabling the best teaching, learning and research experiences in the nation.

CENIC's top priority is to enable California's diverse research and education community by offering access to the most economical and advanced communications infrastructure available for research and learning. Empowering California's research scientists and engineers, educators and students with access—anytime, anywhere—to world-class information technology resources requires CENIC's steadfast commitment to innovation. To that end, CENIC stimulates innovation as a(n):

- ◆ Global thought leader in the application of advanced networking technologies;
- ◆ National asset with expertise in the operation of both an advanced services network and an experimental network infrastructure for higher education institutions;
- ◆ Early adopter of the power of an advanced services network for delivering rich education tools and resources to K–12 institutions;
- ◆ Model for leveraging investments and controlling costs while increasing capacity;
- ◆ Catalyst for innovations in multidisciplinary academic research teams;
- ◆ Facilitator between content providers and content consumers;
- ◆ Leader in global digital media collaborations;
- ◆ International model for funding and operating a cohesive consortium;
- ◆ Provider of cost-effective, high-quality services; and
- ◆ Independent organization.

# 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, 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 system operated the 4CNet network—which served its campuses and the California Community Colleges—and CENIC contracted with 4CNet for Network Operation Center (NOC) services. Upon integration of 4CNet into the CalREN network, CENIC adopted a new model for providing NOC services to the multitiered CalREN backbone. When, in 2003-04, a NOC advisory committee recommended that CENIC insource its NOC services, CENIC hired network engineers. CENIC relies on its board and advisory councils with assistance from corporate partners, such as Cisco Systems and SBC, to guide the management of CalREN. With the creation of separate High-Performance Research (HPR) and Digital California (DC) Networks (see page 7), 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.

## 2003-04 CENIC 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*

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Patrick Perry  
*Vice Chancellor, California Community Colleges*

Steve Relyea  
*Vice Chancellor, Business Affairs, University of California, San Diego*

Larry Smarr  
*Director, California Institute for Telecommunications and Information Technology*

## 2003-04 Business and Technical Advisory Councils

### Business Advisory Council

Jerry Keith, Chair  
*Director of Communications, University of California, Riverside*

### DC Technical Advisory Council

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*Executive Director, Collaborative Technology Initiatives, California State University, Monterey Bay*

Mick Holsclaw, Vice Chair  
*Associate Vice Chancellor for Information Technology, Los Rios Community College District*

### HPR Technical Advisory Council

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

Mike Scott, Vice Chair  
*Network and Academic Computing Service, University of California, Irvine*

# THE CALREN NETWORK

## BACKGROUND

**C**alifornia 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 infrastructure consists of 1,500 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 primarily of owned fiber, which allows multiple yet independent networks to exist over a common physical infrastructure. A small amount of fiber is leased. 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-

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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.

## HIGHLIGHTS

**T**he net results of the second-generation CalREN are far-reaching and impressive.

- ◆ CENIC operates a statewide, fiber-based telecommunications network tailored to the needs of California's educational community.
- ◆ CalREN is built on 10-gigabit ethernet, the state-of-the-art networking standard. This permits research and education collaborations among CENIC institutions on an unprecedented scale—in effect, establishment of a statewide local area network.
- ◆ CENIC's vision for integrating the backbone, middle-mile and first-mile network among K–20 institutions and their local communities serves as a national model, positioning CENIC as a policy leader.
- ◆ The CalREN model promotes economies of scale to educational institutions for ISP services, its Network Operations Center and video support.

## 4CNet Integration

During most of the 1990s, the California State University (CSU) system operated a network to serve its campuses. In the last half of the decade, CSU also provided network services to the state's community colleges.

In 2003, as CalREN transitioned to an ethernet, fiber-owned infrastructure, planning began to migrate the CSU and California Community Colleges (CCC) into the CalREN network—creating one integrated K–20 network for the state. Integration of the sites served by 4CNet into CalREN was largely completed by June 30, 2004, resulting in significant cost savings for 4CNet members, and a minimum fourfold increase in backbone capacity.



The CSU campuses, the CCC and K–12 schools are linked to the backbone by leased circuits ranging from 1.5 Mb/s to 622 Mb/s, although two CSU campuses have 1 Gb/s connections. In 2003, 97 percent of CSU sites were connected, most at speeds ranging from 45 Mb/s to 1 Gb/s; 75 percent of California's 107 community colleges were connected by the end of June 2004 at speeds of 1.5 Mb/s or 45 Mb/s and 100 percent of the connections to K–12 sites were connected to the new network at 45 Mb/s or 155 Mb/s. In addition, as part of migrating the community colleges to CalREN, those colleges that had been limited to 1.5 Mb/s were upgraded to 45 Mb/s. Two CSU campuses were provided with fiber connectivity to the backbone and 30 percent of the CalREN video services (CVS) sites completed their migration to video-over-IP (VOIP).

### **CalREN-Digital California Network**

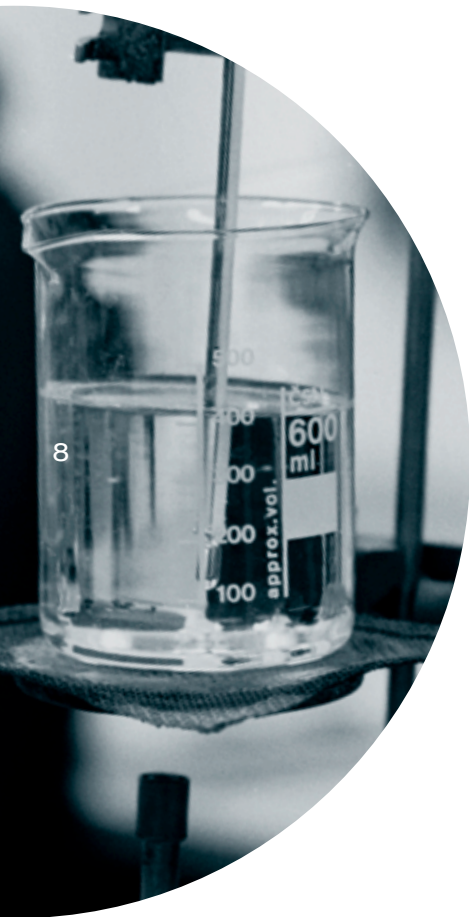
The CalREN Digital California (CalREN-DC) network, provides high-quality network services for K–20 students, faculty, researchers and staff. Through the Digital California Project, the CalREN backbone was extended to each of California's 58 counties to facilitate connectivity among K–12 schools. It serves more than 8,000,000 students, faculty and staff at approximately 140 higher education institutions and 8,000 elementary and high schools.

The CalREN-DC backbone operates at 2.5 Gb/s. CalREN-DC facilitates resource sharing and collaboration between K–12 and higher education for educational purposes and videoconferencing. The backbone supports specialized middleware called quality of service (QoS) to facilitate high-quality videoconferencing. The DC network also provided connectivity to the commodity Internet.

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

Meet & Confer is CCC's free Web- and phone-based collaboration service designed to meet the needs of CCC faculty, staff, administrators and students. Meet & Confer, operated over the DC network, offers a number of uses, including but not limited to training, grant collaborations, meetings and other remote collaborative events, which support the business of education beyond the brick and mortar classroom. Its feature set includes advanced polling, as well as live application sharing and enabling. Participants may share documents from their desktops, show PowerPoint slides, share Web pages, chat with other participants and have remote control over the event. The CCC Meet & Confer project is located at Palomar College in San Marcos and was initially funded by a grant from the California Community Colleges Chancellor's Office. It is American Disability Act and Section 508 compliant.





Over the past decade, biology has been transformed into an information science requiring extensive computational efforts and high data aggregation and throughput, as well as mathematical and analytic tools. CalREN-HPR provides the cyber-infrastructure to facilitate biologists' understanding of the principles underlying the immense complexity of biological systems with sufficient precision to gain predictive understanding of the behavior of biological networks. That predictive understanding is a central scientific goal of the Institute for Quantitative Biomedical Research (QB3), one of four UC Institutes for Science and Innovation. Ultimately, the research enabled by QB3—a collaboration between UC Berkeley, UC San Francisco and UC Santa Cruz—will lead to design interventions that can modify the behavior of biological networks.

## **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 more than 50 research institutions and national laboratories in California, including the San Diego Supercomputer Center 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 10-gigabit backbone operates IPv6 and employs the advanced networking features 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, 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.

## **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 thousands 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. CalREN's XD network enables the research community to perform research that may disrupt or even permanently disable the existing network.

In addition to network research, 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 University of California, San Diego and the University of Illinois at Chicago with participation from San Diego State University; the University of Southern California's Information Sciences Institute; the University of California, Irvine; Northwestern University; as well as the San Diego Super-computer 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.

### **Network Operations Center**

The three tiers of CalREN are operated and monitored 24/7 by a network operations team of CENIC engineers. The Network Operations Center (NOC) is responsible for such activities as circuit installations and moves; operating 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 repair; and developing and maintaining network maps and reports. As of November 2003, the CENIC NOC also provided layer 1 (fiber and optronics) support for National LambdaRail.

## **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

Initial OptIPuter deployment consisted of six dedicated gigabit ethernet waves. The project is based on the philosophy that bandwidth is getting faster, cheaper than storage, and that storage is getting cheaper, faster than computing. The project has two application drivers—bioscience and geoscience—in which scientists are generating multigigabytes of 3-D data objects residing on distributed archives that can be correlated, analyzed and visualized in an interactive and near real-time environment.

The OptIPuter represents a revolution in architecture, creating virtual parallel computers where individual processors, memory and peripherals are widely distributed but connected through standard IP delivered over multiple dedicated waves. In this model, a world of supernetworks is created by replacing computers with optical networks.

may grow to 10 Gb/s and the 10 Gb/s HPR backbone and the XD segments will be supported over 40 Gb/s technologies.

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 H.323 environment—the latest standard for videoconferencing equipment. CSU was joined by the CCC system and the University of California system in planning an H.323 infrastructure to support videoconferencing across all three tiers of the network. The K-12 community—through the Digital California Project—also expressed interest in using H.323 services across CalREN. A consultant was hired by CSU to facilitate discussion and assist with specific tasks associated with implementation of H.323. A multisegmental steering committee was formed that issued an RFP, reviewed proposals and awarded a contract for equipment, software and services.

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. An implementation plan was developed that included technical requirements and end-user needs. Oversight, user and technical committees were formed to perform the work. By the end of June 2004, all CSU sites and 21 percent of the community college sites were migrated to the CVS H.323. Moreover, K-12 began to use the services.

The CVS project will be implementing a new scheduling capability during fiscal year 2004-05. An advisory committee has been created to recommend whether to buy this capability commercially or develop it internally. The committee will recommend a specific product if that path is chosen. A recommendation from this group is expected around the beginning of 2005.

### Pacific Wave-Los Angeles

Pacific Wave-Los Angeles (Pacific Wave-LA), formerly known as The Los Angeles Landing, has a new high-performance exchange point to facilitate peering among U.S. and international research and education networks. The exchange point, established across three locations in downtown Los Angeles, is the preferred means for peer networks connecting to the Internet2 Abilene network in Los Angeles and for direct peering between international and U.S. research and education networks. Pacific Wave-LA will operate under the umbrella of Pacific Wave.

### Internet Service Provider Services

CENIC has connections to three Internet service providers (ISPs). The ISP contracts are negotiated through a national consortium of educational institutions, known as Quilt.

- ◆ CENIC upgraded the existing ISP connections with Qwest from 622 Mb/s to gigabit ethernet and added a new provider, Cogent, with a gigabit ethernet connection. This brings the total ISP capacity to 6 Gb/s across three providers: Qwest, Level(3) and Cogent.
- ◆ On July 1, 2003, CENIC lowered the cost of ISP services from \$200 per megabit per month to \$126 per megabit per month.
- ◆ CENIC increased peers to 1.5 Gb/s of commodity traffic through the use of no-cost peering arrangements—a cost savings of approximately \$148,000 per month.

### Fiber Acquisition

CENIC has considerable expertise in the area of fiber acquisition and construction. CENIC associates have leveraged this expertise to obtain additional fiber assets for their campuses.

### OUTREACH

**C**ENIC Today, a free monthly electronic newsletter was published. *InterAct Magazine*, an advanced networking applications magazine, saw its third year of publication. And the annual CENIC conference was held in the spring, drawing more than 200 participants, including nationally prominent keynote speakers.

# THE DIGITAL CALIFORNIA PROJECT

## BACKGROUND

The Digital California Project (DCP) was established in the summer of 2000 to facilitate the expansion of California's higher education, high-speed, advanced-services network (CalREN) to the K–12 education community. One of the project's objectives was to provide equal access to high-speed networks and network-based resources to all K–12 schools in California—a state with enormous geographic, social and economic diversity. Through the DCP, K–12 schools not only received high-quality access to online state resources but, through CENIC's participation in Internet2, they obtained access to online resources from institutions outside California, as well.

CENIC's funding for the DCP was provided via a contractual relationship with the University of California. CENIC established a Program Steering Committee, with representation from 16 state K–20 education organizations, to provide advice and feedback.

The DCP had a solid record of achievement in 2003–04 despite the fiscal constraints caused by a state budget crisis: in 2000–01, the DCP was funded at a level of \$32 million; by its fourth year of operation in 2003–04, the budget had fallen to \$13.3 million. The governor's proposed budget for 2004–05 restored an earlier \$21 million funding level and shifted funding from State General funds to Proposition 98 funds and shifted responsibility for its management from the University of California to a lead county office of education. In July 2004, the name of the network was changed to K–12 High Speed Network.

## HIGHLIGHTS

In early 2004, CENIC reached a major milestone in the DCP program by connecting the sole unconnected county, Del Norte, to the CalREN backbone. During 2003–04, all education segments in California began transition to the new higher-capacity, higher-capability CalREN advanced-services network. By June 30, 2004, CENIC had migrated all 58 DCP/K–12 county node sites to the new CalREN network.

During 2003–04 the connectivity of districts and schools to CalREN was as follows:

- ◆ 73 percent of California's schools—serving more than 4 million students and 82 percent of the county district offices—were connected to CalREN at speeds of 1.5 Mb/s or higher. This enabled them to take advantage of network-based instruction, professional development tools and collaborative resources and technologies.
- ◆ Recognizing that 1.5 Mb/s will not be sufficient to support a growing demand for network-delivered interactive and multimedia learning resources, many California schools have acquired higher-capacity connectivity. The DCP last-mile database indicates that approximately 900 schools and 140 district offices connected to CalREN have network connectivity at 45 Mb/s or higher. This represents a 62 percent increase in the number of highly connected schools and a 361 percent increase in the number of highly connected districts over the past three years. This pattern reflects a natural progression of network build-out from the county offices to the district offices, and from the district offices to the schools.
- ◆ During the summer of 2003, CENIC released findings from a study of networking infrastructure needs and alternatives in Del Norte and Humboldt counties. Review of these two rural northwest California counties provided examples of the digital divide at work: 63 percent of district offices and 49 percent of schools with connectivity speeds of less than 1.5 Mb/s were located in these rural areas of northern California. CENIC-sponsored network assessments, stakeholder planning and broadband implementation in these counties were positioned to serve as a model for similar areas.
- ◆ Although geography was important, the lack of 1.5 Mb/s connectivity does not appear to be related to socioeconomic status. Ten percent of schools with 25 percent or fewer students participating in free and reduced lunch programs had less than 1.5 Mb/s connectivity; whereas 9 percent of schools with 76 percent or more students participating in

Performance  
Reliability Security  
**Powered by  
K-12 Education,  
DCP Delivers**  
Cost

free and reduced lunch programs had less than 1.5 Mb/s connectivity. On the other hand, schools with high percentages of English-language learners (ELL) were more likely to be among those who lack 1.5 Mb/s connectivity. Only 9 percent of schools with 25 percent or fewer students who were ELL had less than 1.5 Mb/s connectivity; whereas 20 percent of schools with 76 percent or more students who were ELL had less than 1.5 Mb/s connectivity.

In addition to developing the architecture of the network, installing the network infrastructure and managing its operation, CENIC facilitated access to and sharing of existing electronic resources and encouraged the development of new electronic resources for teaching and learning. In doing so, CENIC played a pivotal role in helping statewide bodies and organizations to ensure that California's K–12 education meets the demands of the 21st century. Those affected included the California Department of Education, the Office of the Secretary of Education, the State Board of Education, the Commission on Teacher Credentialing, California's colleges and universities, and K–12 county and district offices, among others.

### In early 2004, CENIC reached a major milestone in the DCP program by connecting the sole unconnected county, Del Norte county, to the CalREN backbone.

During the past fiscal year, a great deal of effort was spent identifying the appropriate method for making network-based educational resources more intuitive. A series of meetings with individuals from various state agencies that regulate K–12, as well as other major stakeholder organizations, was convened by DCP staff to develop an initial consensus regarding the types of resources that should be promoted for use in schools and the criteria for ensuring the quality of such resources. The first result of this major undertaking was reflected in the Digital California Online Resources Web site, which became operational in October 2003 and ensured that the resources promoted by DCP would be in alignment with California's policy direction.

## IN PARTNERSHIP

In addition to collaborations with a wide range of state and local constituencies, the DCP participated in select national initiatives. Light Bridge is a U.S. Department of Education project, which employs the CalREN–DC network to pilot revolutionary practices in preparing pre-service teachers to be sophisticated users of technology in the classroom.

The goals of Light Bridge are to:

- ◆ Strengthen teacher education programs through the development of multimedia content offered via broadband networks;
- ◆ Establish a student/teacher supervision system that assures high-quality support and assistance at a distance; and
- ◆ Disseminate teacher education video content and online resources.

To date, Light Bridge has created 25 teacher preparation lessons, including 85 video segments. Lessons are available in QuickTime and include text- and Web-linked resources. Light Bridge's lesson authoring system (VOILA) has been used to create and upload lessons entirely online. The system enhances the scalability of Light Bridge and expands the availability of high-bandwidth content.

Videoconferencing-over-IP is Light Bridge's latest area of resource development. The ability to provide assessment and support to pre-service teachers situated at a distance from university campuses has proven to be an important adjunct to campus-based systems.

Light Bridge was awarded an honorable mention in the Partnership category of CENIC's On the Road to a Gigabit Awards program. The Partnership Award honors the best use of high-performance networking developed by a private/public partnership. More information about Light Bridge and the 2003 On the Road to a Gigabit Awards can be found at [www.cenic.org/gb/awards/2003/winners.htm](http://www.cenic.org/gb/awards/2003/winners.htm); more information about Light Bridge can be found at [www.sonoma.edu/lightbridge](http://www.sonoma.edu/lightbridge).

## THE FISCAL BALANCING ACT

State funding for DCP is supplemented each year by the federal E-rate program and by the California Public Utilities Commission's California Teleconnect Fund (CTF). In 2003–04, CENIC/DCP staff continued organization of an E-rate consortium to secure federal E-rate discounts on circuits funded by DCP in each county. The E-rate consortium and other DCP staff efforts to obtain funding from the CTF generated revenue available for grants to solve the first-mile challenge of connecting to CalREN-DC.

The federal E-rate program is a key part of the infrastructure build-out in California. In total, California's public K–12 schools receive approximately \$250 million per year in E-rate discounts to connect schools to the Internet and reduce telecommunications costs.

The CTF has been a boon to school districts and county offices of education that are connected to DCP, and has enabled DCP to survive—despite recent state budget cuts—by providing funding for circuits that CENIC leases on DCP's behalf.

During April of 2002, CENIC awarded a total of \$1.4 million to 28 K–12 school districts through a competitive first-mile grant program. The awards were used to establish or extend school connections to the CalREN-DC network and to the commodity Internet at speeds of 1.5 Mb/s or greater. More than 200,000 students at nearly 200 sites benefited. In July 2003, first mile grants totaling \$650,000 were awarded to 24 entities, representing 34 school sites. The grants enabled the sites to acquire the networking equipment and circuits required to join the CalREN-DC network. Unfortunately, given the budget reductions of 2004, CENIC was unable to provide first mile grants to connect schools to the network as it has done in previous years.

At present, it appears federal E-rate funding will continue to be available in 2004–05. However, the appropriation in the state budget for CTF is insufficient to continue the critical discounts on telecommunications for schools, libraries, qualified health clinics and community technology programs.

The 2003–04 fiscal climate brought both good news and bad news. DCP staff worked with other organizations to support

Senate Bill 720 (SB 720)—a bill that authorized \$3 million for nonprofit educational entities, such as school districts, to receive 90 percent of the one-time costs of obtaining advanced telecommunications services. SB 720 was enacted into law and in December 2003 the California Public Utilities Commission reported that revenues were available to implement the bill.

**In April 2002, CENIC awarded a total of \$1.4 million to 28 K–12 school districts through a competitive first-mile grant program. The awards were used to establish or extend school connections to the CalREN-DC network and to the commodity Internet at speeds of 1.5 Mb/s or greater.**

## OUTREACH

CENIC published a monthly electronic newsletter, DCP Today, to foster appreciation of and build support for the DCP project. Content ranged from relevant national news articles to network updates and information on newly emerging applications and e-learning activities. There were more than 500 subscribers receiving DCP Today.

# ONE GIGABIT OR BUST™ INITIATIVE

## BACKGROUND

**C**ENIC was created for and has become a successful driver of advanced wide-area communications infrastructure for the entire education community in California. Many institutions are feeling the pressure to deliver anytime, anywhere education and next-generation ubiquitous broadband is essential in achieving that goal. By taking a leadership role in ensuring that the education community is well-served with advanced broadband infrastructure throughout California, the One Gigabit or Bust Initiative is a small investment toward a potentially huge return on the nature and delivery of education statewide.

CENIC's One Gigabit or Bust Initiative addresses the critical technical, policy, financial and organizational challenges facing delivery of one-gigabit broadband to every education institution, business and home in the state by 2010. The goal of one gigabit represents more than a thousand-fold increase from today's commercial DSL and cable modem networks.

**Ubiquitous broadband on the order of one gigabit within the decade is definitely within reach.** Today, laptops come equipped with built-in gigabit ethernet. Just a few years ago, DSL and cable modem capabilities did not exist. The major technical barrier to achieving gigabit bandwidth is the first-mile challenge—actually is more like thirty feet from the curb to the home or business.

As part of the initiative, in 2002 CENIC retained the services of international, technology-focused research firm, Gartner Consulting, to determine the economic potential of accelerating next-generation broadband deployment in California. The subsequent report, *One Gigabit or Bust Initiative—A Broadband Vision for California*, concluded that “a \$376B upside in gross state product by 2010 is made possible with the implementation of a focused one-gigabit initiative. Moreover, two million new jobs could be created.” The One Gigabit or Bust Initiative was launched in June 2003 with the release of the Gartner report, which is available at [www.cenic.org/gb/pubs/gartner/index.htm](http://www.cenic.org/gb/pubs/gartner/index.htm).

In response to the Gartner report, CENIC created the One Gigabit or Bust Roundtable with the goal of identifying the

opportunities and obstacles surrounding implementation of robust, end-to-end broadband capabilities to all residents and businesses in California. It was officially launched in November 2003 and since has attracted higher education institutions, science and engineering research organizations, healthcare industries, entertainment and media sectors, state agencies and local governments, community-based organizations, and small, medium and large corporations.

The actual work of the Roundtable—identifying the challenges to achieving one-gigabit access throughout California by 2010 and establishing an action plan to achieve it—was done in task forces. Task forces were formed to address the state's broadband networking needs for critical components of economic development in California, such as e-learning, e-health services, e-commerce, e-entertainment, and so forth. Task force themes included broadband technologies, communications and outreach, entertainment, fiber mapping, ICT standards, intellectual property, Latino education, municipality best practices, museum education, policy, rural issues, university applications and wireless.

The majority of the work is handled via mailing lists. Face-to-face meetings occur three times a year.

One of the most significant challenges facing the initiative is the first-mile problem of providing connections from users' homes, schools and offices to nearby network hubs. Cable and copper offer immediate options; the Gigabit or Bust Initiative is examining other technologies, as well. In addition to the technical and fiscal hurdles affecting first-mile deployment, the Gartner study emphasized the importance of the regulatory and policy environment at various public jurisdictions and the conflicting patterns of stakeholder interests.





## HIGHLIGHTS

### One Gigabit or Bust Initiative Roundtables and Workshops

On October 16, 2003, CENIC's One Gigabit or Bust Initiative Latino Education Issues Task Force and the Hispanic Association of Universities and Colleges held a workshop to address the best means to bring ubiquitous Internet access to underserved Latino communities. A white paper, *Fostering a Collaborative Vision of a One-Gigabit Ubiquitous Network for California's Latino Community*, was published in January 2004. Copies of the white paper are available at [www.cenic.org/gb/pubs/latinowp.pdf](http://www.cenic.org/gb/pubs/latinowp.pdf).

The One Gigabit or Bust Roundtable was officially launched in November 2003 at a two-day event in Sacramento. Participants included representatives from private enterprise, health services, entertainment, local and state government, regulatory bodies, community-based organizations, and education, among others.

A second Roundtable was held in Marina del Rey in May 2004 in conjunction with the annual CENIC conference, themed "On the Road to a Gigabit." Participants were introduced to a host of technical and policy issues related to broadband deployment.

A third Roundtable was scheduled for the summer of 2004 in Oakland.

Planning commenced for an invitation-only event, "Voice-over-IP, Universal Service and Next-Generation Broadband: A Solutions Summit." Under present economic models, funding for Universal Service programs will likely be halved. As such, the structure for funding needs to be examined. The workshop was held in June 2004 and brought



together thought leaders to develop recommendations with a view towards a future of ubiquitous next-generation broadband deployment statewide.

### On the Road to a Gigabit Awards Program

CENIC's On the Road to a Gigabit Awards program honored California visionaries who have demonstrated innovative ways to encourage development of a ubiquitous broadband network by 2010. The first round of awards was presented in May 2003, in conjunction with CENIC's annual conference in Santa Barbara; 2004 winners were recognized at CENIC's March 2004 conference in Marina del Rey. Award categories are as follows:

**The Biggest, Fastest in the West Award** honors the fastest, most scalable high-performance networking application or technology.

**The Community Award** honors innovative uses of high-performance networking to overcome social disadvantages (e.g., economic- and/or location-based).

**The Education Award** honors innovative uses of high-performance networking in K-12 and higher education.

**The Gigabit or Bust Award** honors the high-performance networking application or technology that best exemplifies what life would be like in a gigabit-connected world.

**The Innovation Award** recognizes innovative contributions to high-performance networking that best exemplify the creative spirit and bottoms-up philosophy that created the Internet.

**The Partnership Award** honors the best use of high-performance networking developed by a private-public partnership.

A list of 2004 winners can be found at [www.cenic.org/gb/awards/2004/winners.htm](http://www.cenic.org/gb/awards/2004/winners.htm). Winners will also be featured in a future issue of *InterAct Magazine*.

A list of 2003 winners and descriptions of their projects can be found at [www.cenic.org/CENIC2003/NGIAwards/NGIWinners.htm](http://www.cenic.org/CENIC2003/NGIAwards/NGIWinners.htm). A special edition of *InterAct Magazine*, devoted to the 13 first-place and honorable-mention winners, was published in fall 2003, and can be found at [www.cenic.org/pubs/interact/interactvol4.pdf](http://www.cenic.org/pubs/interact/interactvol4.pdf).

### Self-Assessment Guide

From December 2003 through June 2004, CENIC staff and a team of volunteer consultants created the *On the Road to a Gigabit, Are We There Yet? A Self-Assessment Guide for Communities* workbook and complementary Web site.

The guide was designed to provide a benchmark of a community's readiness to participate in the economic, social, political and personal changes that ubiquitous, mobile, gigabit broadband entails. It offers a clear snapshot of where communities fall along a continuum of readiness—ranging from Stage One, in which communities possess a minimum of the necessary technology and applications to Stage Four, in which communities possess very advanced technologies and ubiquitous applications. The assessment tool offers actions that a community's government,

**O**ne gigabit is not a technology or a transmission speed, nor is it merely high bandwidth. Rather, one gigabit is about transforming the personal, professional and civic lives of California residents—offering every individual the means to be an information producer, as well as an information consumer.

businesses, schools, community groups and individual citizens can take to prepare for and benefit from those changes.

The guide asks respondents to assess community readiness for broadband in terms of wired network infrastructure, wireless network infrastructure, network applications and services, and policy leadership. Technical guidelines are available for large and urban governments, small urban and rural governments, hospitals and clinics, K–12 schools, higher education, libraries, small businesses, large businesses and community-based organizations.

The official debut of *On the Road to a Gigabit Broadband, Are We There Yet?—A Self-Assessment Guide for Communities* was part of the summer 2004 Roundtable meeting in Oakland.



### OUTREACH

**G**iven the scope of the Initiative and broadband's economic potential for improving communities throughout California, an effort was made to reach out to organizations that provide leadership to cities and counties. Relationships were formed with key organizations, including the California Association for Local Economic Development, the California League of Cities and the California State Association of Counties.

Presentations on the One Gigabit or Bust Initiative were made at their respective annual meetings, as well as other state and national technology conferences.

To facilitate a dialogue on this topic, CENIC launched First Mile, a twice-monthly e-publication targeting the interests of research, education, commerce, state and local government and the public in addressing the issues surrounding the implementation of robust end-to-end broadband capabilities to every education institution, business and home in California. Archived copies are available at [www.cenic.org/gb/pubs/firstmile/index.htm](http://www.cenic.org/gb/pubs/firstmile/index.htm).

CENIC published a bimonthly, e-newsletter, Gigabit Today, which included announcements of initiative activities and targeted information about the technical, policy, financial and organization challenges facing the delivery of one gigabit. Archived copies are available at [www.cenic.org/gb/pubs/gbtoday/index.htm](http://www.cenic.org/gb/pubs/gbtoday/index.htm).

# CENIC RELATIONSHIPS

**C**ENIC'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.

## NEW STRATEGIC RELATIONSHIPS

**T**he two newest initiatives for CENIC are Pacific Wave and National LambdaRail.

### Pacific Wave

CENIC and the Pacific Northwest GigaPOP (PNWGP) agreed to cooperate in a joint project to create, deploy and operate an advanced, extensible peering facility along the entire Pacific coast of the United States. The University of Southern California is an important participant in making this initiative possible.

This novel project, known as Pacific Wave, creates a new peering paradigm by removing the geographical barriers of traditional peering facilities. Pacific Wave will enable any U.S. or international network to connect at any one location along the U.S. Pacific Coast facility, as well as offer the option to peer with any other Pacific Wave participant—regardless of physical location. It is hoped that 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.

The Pacific Wave international peering exchange facility will initially offer connection points in Los Angeles and Seattle—points proximal to submarine cable landing sites along the coast. A 10-gigabit ethernet service will connect the two Pacific Wave nodes. Plans for the Layer 2, ethernet-based exchange facility include support for jumbo frames and all IP traffic types (IPv4, IPv6 and multicast). Deployment of the Pacific Wave 10-gigabit ethernet facility from Los Angeles to Seattle is expected by the summer of 2004. The program will be jointly managed by

CENIC/USC and PNWGP. For more information, visit [www.pacificwave.net](http://www.pacificwave.net).

### National LambdaRail

Incorporated in May 2003, National LambdaRail, Inc. (NLR) is a consortium of key U.S. public and private research entities, including several major research universities and technology companies, that have come together to create a national optical research network capable of meeting the most advanced research requirements for science, engineering and medicine over the next five to ten years. NLR aims to reenergize innovative research and development into next-generation network technologies, protocols, services and applications.

NLR's mission is to provide an enabling network infrastructure for new forms and methods of research in science, engineering, health care and education, as well as for research and development of new Internet technologies, protocols, applications and services. NLR will offer the nation's research community its first

**Pacific Wave will enable any U.S. or international network to connect at any one location along the U.S. Pacific Coast facility, as well as offer the option to peer with any other Pacific Wave participant—regardless of physical location.**

experience of direct control over a nationwide optical fiber infrastructure, enabling a wide range of facilities, capabilities and services in support of both application- and networking-level experiments. It will support a diverse community of computational scientists, distributed systems researchers and networking researchers in their quest to solve the complex challenges of network architecture, end-to-end performance and scaling.

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.

NLR will facilitate two broad areas of research activity: high-performance computational science and engineering research,



and high-performance networking research. NLR's principle objectives are to bridge the gap between leading-edge optical network research and state-of-the-art applications research, and to push beyond the technical and performance limitations of today's Internet backbones. Accordingly, it will have the capacity to support both experimental and production networks at the same time, similar to CalREN.

Most of the important computational science research efforts of this century are multidisciplinary—involving multiple length and time scales in the simulations as well as multiple science and engineering disciplines. Expertise in the various subdisciplines is scattered around the world. NLR will be capable of facilitating real-time interactions of these disparate researchers' work.

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.

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. For more information, visit [www.nlr.net](http://www.nlr.net).

## ONGOING RELATIONSHIPS

### **Corporación Universitaria para el Desarrollo de Internet**

The Corporación Universitaria para el Desarrollo de Internet (CUDI) is a Mexican nonprofit corporation comprising members from the public and private sectors. Its purpose is to promote and coordinate the development of high-capacity telecommunication

and computing networks that will 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.

### **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. In Northern California, CENIC provides its associates with a 622 Mb/s connection.

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

Quilt's purposes and objectives are to:

- ◆ Provide advanced network services to the broadest possible research and educational community;
- ◆ Promote end-to-end continuity, consistency, reliability, interoperability, efficiency and cost-effectiveness in the development and delivery of advanced network services; and
- ◆ 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 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](http://www.internet2.edu) and [www.ucaid.edu](http://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
- ◆ 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](http://www.educause.edu).

## **University and Community College System of Nevada**

The University and Community College System of Nevada (UCCSN) represents three research institutions and six community colleges. UCCSN operates NevadaNet, which serves higher education plus K-12 schools in 17 counties. UCCSN 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 [www.nevada.edu/](http://www.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
- ◆ 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.

## **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. For more information, visit [www.washington.edu/networking/pacifici2/](http://www.washington.edu/networking/pacifici2/).

## **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](http://www.apru.org).



# FINANCIAL SUMMARY

Fees for operation of the core CalREN network grew between 2002–03 and 2003–04, but represent a smaller share of total CENIC revenue as revenues associated with connection between the CalREN backbone and campuses and colleges grew with the integration of 4CNet into CalREN.

## CalREN Core Network Fees Versus Total Revenues

	Fiscal Year 2002–03	Fiscal Year 2003–04
Percentage of Core Network Fees to Total Revenues	40	27

General administrative (G&A) costs continue to represent a small share of CENIC's total expenses.

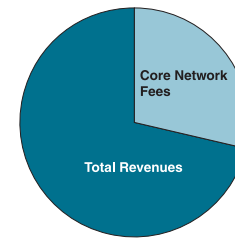
## G&A Versus Total Expenses

	Fiscal Year 2002–03	Fiscal Year 2003–04
G&A Expense	1,336,862	1,487,851
Total Expenses	51,416,048	46,868,432
Percentage of Total Expenses	2.6	3.2

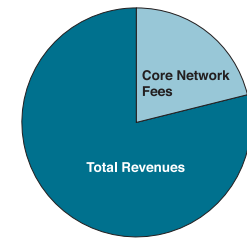
Total access to the commercial Internet increased by approximately 42 percent. Costs decreased significantly, from \$200 per Mbps to \$126 per Mbps, as CENIC was able to leverage purchasing power of all California institutions.

## Internet Service Provider (ISP) Rate per Mbps Versus Total Usage

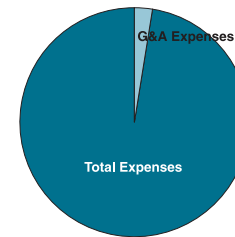
	Fiscal Year 2002–03	Fiscal Year 2003–04
ISP Cost per Mbps	200	126
ISP Total Mbps Usage	19,094	27,033



FISCAL YEAR 2002–03



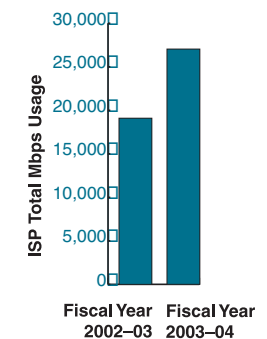
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5757 Plaza Drive, Suite 205, Cypress, CA 90630  
714 220 3400 • [www.cenic.org](http://www.cenic.org) • [info@cenic.org](mailto:info@cenic.org)

