

Global Possibilities: CENIC's CalREN Enables Worldwide Collaboration

In today's high-tech, high-bandwidth world, collaboration knows few boundaries, and partners in research and education often span the globe. CENIC considers enabling researchers and educators in California to connect meaningfully with their peers around the nation and the world to be a central part of its mission and vision. To this end, CENIC has taken the initiative in operating, participating in, and supporting a wide range of ventures designed to extend worldwide both the benefits of advanced-services networking and the vision of the California research and education community.

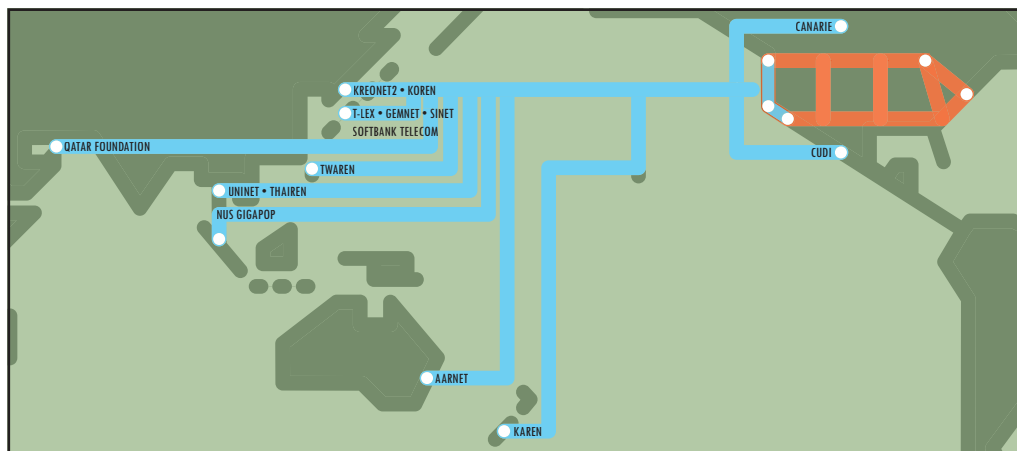
One of these ventures is Pacific Wave (www.pacificwave.net), a state-of-the-art international peering exchange facility designed to connect CalREN participants to research and education networks throughout the Pacific Rim and beyond. A joint project between CENIC and the Pacific Northwest Gigapop (PNWGP), in collaboration with the University of Washington, Pacific Wave enables US or international networks to connect to CalREN and to one another at any of three locations along the US Pacific coast.

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

CENIC also furthers collaboration in the Americas via a relationship with CUDI (Corporación Universitaria para el Desarrollo de Internet, www.cudi.edu.mx). CUDI is a Mexican nonprofit corporation composed of members from the public and private sectors. 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. CENIC's relationship with CUDI enables a wide variety of educational and research uses, as described below.

In 2000, a high-speed link between CalREN and the CUDI network was established and, with funding from the National Science Foundation, upgraded in capacity. CENIC currently supports 1 Gb/s connectivity to CUDI.

CENIC also has 10 Gb/s connections to the National LambdaRail and Internet2 backbones through which exchange participants and CENIC members can obtain connectivity to Europe, the Middle East, and beyond.



California & Beyond

Science, Education, and Culture Go Global with High-Bandwidth Networking

- **Grid computing:** By linking disparate components together over a high-bandwidth backbone, computers that span the globe can be created, with the ability to allocate compute time, storage, and other resources dynamically.

- **Collaboratories:** Many of the world's most powerful scientific instruments are inaccessible or unique. Telescopes reside on mountaintops in Chile or Hawaii, colliders in Europe and the United States, and deep-ocean instrumentation all over the world. With the ability to access and configure, and control these instruments in real time, researchers half a planet away can work together to create a single, global experiment that can adapt to its own data collection.

- **Remote Learning:** High-definition videoconferencing of the type made possible by global advanced networks when added to international student exchange programs, can enable transformative experiences for students and faculty that would not otherwise have been possible.

- **Strategic Relationships:** In a world where innovation knows no borders, enabling nations to make the most of their own unique resources by partnering beyond their borders is a crucial benefit of international advanced networking. With cooperative agreements in place, advanced networks make it possible for a nation's research community to ensure that nation's economic health.

- **Disaster Recovery and Homeland Security:** Natural disasters rarely respect international boundaries, and man-made ones often require international cooperation. High-bandwidth networking between researchers worldwide can enable the data-sharing and response necessary to ensure safety and security when lives are in the balance.

- **Network Architecture:** If any of these visions are to be realized, it will require a great deal of collaborative research into such computational structures and the networks and software that must be created to support them.

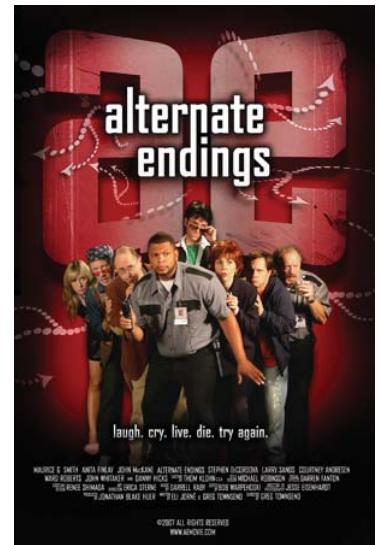
Turning Dreams into Reality: Digital Cinema and Advanced Networks



The international nonprofit CineGrid promotes research, development, and deployment of ultra-high-performance digital media – sound and picture – over advanced networks, using grid computing technologies for networked collaboration. CineGrid has organized a number of experimental projects designed both to showcase what advanced networks can support in the world of digital media, and to test those same networks, pushing them as far as they can go in the pursuit of the most immersive possible experience. Eighteen advanced networks including CENIC's CalREN participate in CineGrid, enabling their members to collaborate with colleagues on cutting-edge digital cinema on multiple continents.

The means by which data is shared among participants in CineGrid is the CineGrid Exchange, a distributed digital media repository designed to support CineGrid member-driven testbeds for digital media asset management, distribution, and preservation applications. The Exchange consists of digital media of varying resolution, subject matter, and format made accessible to CineGrid members via secure high-speed networks. Exchange assets are stored at multiple sites linked by secure photonic networks at the California Institute for Telecommunications and Information Technology (Calit2) at UC San Diego, Keio University, and the University of Amsterdam and SARA (Amsterdam Lighthouse).

Storehousing and accessing large amounts of highly specialized data isn't just about the bandwidth, though. Management software specific to the needs of digital cinema must also be developed, and CineGrid features specialized grid management software, optimized for cinematic data and metadata. Between storage, access, processing, and management, CineGrid demonstrates the ways that advanced networks enable planet-wide collaboration on projects considered unthinkable only a few short years ago.



Studying the Last Great Planetary Frontier from a Global Perspective

The oceans are often considered the last great frontiers for exploration on the planet, and the mighty influence they wield over life on Earth makes their study of critical importance to humanity. However, their sheer size, changeability, and inaccessibility to researchers beyond a certain point make them a challenging arena for discovery without high-performance networking. Such networking can enable access to and real-time control over remote observing equipment in hostile environments, storage and access to the enormous amounts of data generated by them, and collaborations between equally widely distributed researchers.

The Ocean Observatories Initiative (OOI) aims to do all of this, laying the foundation for future ocean science observations and enabling powerful new research capabilities by transitioning the oceanographic community from expedition-based data gathering to persistent, controllable observations using a suite of interconnected sensors to collect ocean and seafloor data at high sampling rates over years to decades. Researchers all over the world will make simultaneous, interdisciplinary measurements to investigate a spectrum of phenomena including episodic, short-lived events and more subtle, longer-term changes and emergent phenomena in ocean systems.



Through a unifying cyberinfrastructure, researchers will have the ability to respond to events detected by the network and, from their desktop computer, adapt the sampling strategies of equipment and sensors deployed on the infrastructure. Distributed research groups can form virtual collaborations to collectively analyze and respond to ocean events.

Enhancing International Student Exchanges with High-Definition Video



Monash University in Australia and the UC San Diego division of Calit2 have added high-definition videoconferencing to their respective student-exchange programs, enabling transformative experiences for students and faculty that would not otherwise have been possible – and earning the institutions the CENIC 2010 Innovations in Networking Award for high-performance applications.

HD video allows mentors at UCSD to attend final student seminars that are presented both to audiences at Monash and their mentors at UCSD concurrently. Thus, they receive feedback from

both Monash and UCSD mentors, significantly enhancing the outcomes of their internship. Likewise, Monash students at UCSD present final seminars back to their mentors in Australia while presenting to a local audience at UCSD. The first groups of students to benefit from this use of HD videoconferencing were UCSD students spending summer 2009 at Monash as part of the NSF- and Calit2-funded Pacific Rim Experiences for Undergraduates (PRIME) program. A similar program then sent four Monash students to UCSD the following winter under the Monash Undergraduate Research Projects Abroad (MURPA) program. Monash's program goes a step further by adding an advanced seminar scheme, in which students attend seminars by world leading experts before they depart Australia. The seminar scheme is novel, because it makes it feasible to attract some of the world's best researchers "virtually" to Monash.



Monash's Chancellor, Dr Alan Finkel, wrote recently of his experience attending one of these seminars, "I've participated in numerous video conferences to date but nothing like this. The quality was so high that the experience was almost as if we were all in the same room."

The Software Infrastructure that Makes Global Advanced Networking Possible

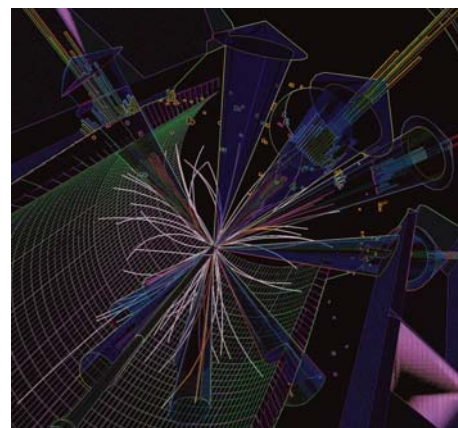


In 2001, the High-Energy/Nuclear Physics (HENP) Internet2 working group was formed which comprised Shawn McKee of the University of Michigan and fellow physicists Harvey Newman of Caltech and Rob Gardner of the University of Chicago, to investigate next-generation networking and how it might aid physics experiments on the scale of the Large Hadron Collider or LHC, located at the European Centre for Nuclear Research (CERN) in Geneva, Switzerland.

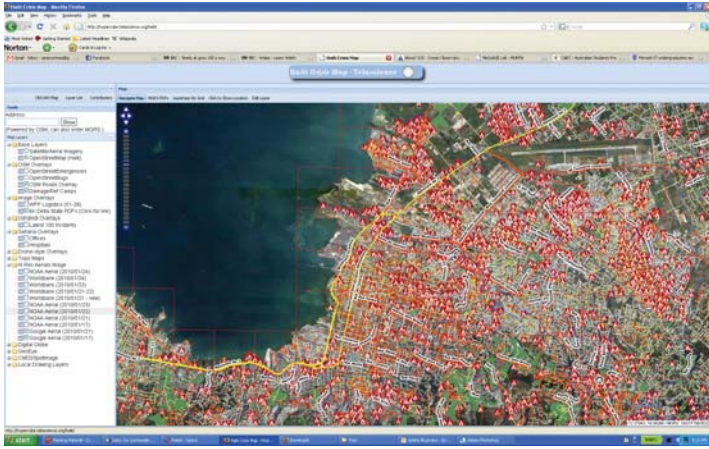
From this group emerged the UltraLight project, a collaboration led by experimental physicists and network engineers motivated to develop the

information technology that would let scientists across the globe analyze the petabytes of data that the LHC and its ensuing international collaborative experiments would generate.

UltraLight — an Innovations in Networking award winner for 2008 — relied in part on one of the 2006 award winners, MonALISA. MonALISA, developed over the last six years by Caltech and its partners at CERN and the Universitatea Politehnica Bucharest, is a globally scalable framework of services to monitor and help manage and optimize the operational performance of computing grids, networks, and running applications in real time. This framework is ideal for creating and dynamically managing dispersed collaborative environments over Internet networks. Both UltraLight and MonALISA stand as high-performance international collaborations guaranteed to enable further such achievements in the years to come, all made possible by advanced networks.



Eye on the World: Enabling Timely Response and Analysis in Times of Crisis

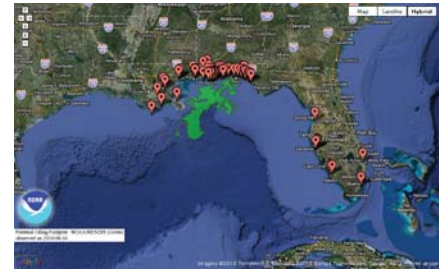


California's research and education community has become a vital part of emergency response in the Golden State during wildfires, earthquakes, and other crises, but the value brought by that community in times of trouble extends globally. Aiding the thousands of disaster responders during the 2010 earthquake in Haiti was San Diego State University's Visualization Center, led by co-directors Eric Frost and John Graham and known informally as the VizLab.

SDSU has a partnership with the US Navy, creating a collaboration whereby the VizLab is the chief resource for processing geo-based image data for the Navy. Such data can help emergency teams sharpen their response, thus enabling them to save more lives more effectively and efficiently. At the Haiti Crisis Map website (shown at left), such

information is available around the world and collected from global participants. Like the Naval Postgraduate School, the VizLab also functioned as a valuable resource during Hurricane Katrina and the Boxing Day Tsunami as well, but the earthquake in Haiti marks the first time that the technology was able to aid responders as the event itself unfolded.

With the explosion of the Deepwater Horizon oil rig resulting in a massive environmental disaster in the Gulf of Mexico, the VizLab is once again in the eye of the storm coordinating an innovative citizen response effort that leverages GPS-enabled smartphones. The resulting storehouse of image and other data (shown at right) will be open to public access online — and of course, thanks to the high-bandwidth connections enjoyed between CENIC Associates and the researchers with whom they collaborate, the data will be even more amenable to sharing, processing, and analysis worldwide.



Forging Innovation-Based Relationships Across National Borders



With over 100 Nobel laureates calling California home, and with Canada ranking first among the G-7 nations in terms of research publications, a partnership between the two would be sure to benefit them and the world — and that partnership already exists. Called the Canada-California Strategic Innovation Partnership (CCSIP) it seeks to catalyze collaborative research, development, and delivery between California and Canada by bringing together the best minds and innovation resources from California and Canada, stimulating new models for collaboration, and providing leadership on the sustainability challenges facing our planet today.

In 2010, CCSIP announced the selection of 15 bilateral projects emerging from its first call for proposals. The initiatives are supported by over \$1 million in new research funding, and combine expertise, research resources and investment from both constituencies. They aim to develop novel models of R&D collaboration that address global challenges such as climate change, infectious diseases such as H1N1 influenza, and the demand for sustainable energy.

Bringing together a total of 23 Canadian universities and eight campuses of the University of California (linked via Canadian participation in Pacific Wave) and more than 49 companies, government labs, and agencies on both sides of the border, the selected initiatives feature the organization of nine collaborative events such as workshops and symposia and the development of six Canada-California R&D business plans over the next year. These multidisciplinary projects engage a total of more than 150 scientific and industry leaders, including multinational corporations, small-to-medium-sized companies, hospitals, and medical centers. Key areas of R&D focus include infectious diseases, global health, carbon capture and sequestration, biofuels, next-generation digital media, and green information and communications technology (ICT).