

InterAct

A Networking Applications Magazine

Volume 4 • Fall 2003

Can California support a ubiquitous gigabit statewide network by 2010?

Thirteen California visionaries think so. Learn how they're doing it—and how, in the process, they're paving the way for the rest of us.



2003 On the Road to a Gigabit Awards Issue

Table of Contents

InterAct: A Networking Applications Magazine • Volume 4 • Fall 2003



p. 2

Letter from the Gigabit or Bust Initiative Team 1

First Place Winners

The Ultrawideband Cowboy Lassos Affordable Wireless Broadband Access 2

The Road to a Gigabit Leads to Canyon Hills 4

Imperial County's Fiber-Optic Education Network for the New Millennium 6

From Obstacles to Fundamental Fabric 9

Beyond the Textbook 11

El Monte Union High School District Partners with SBC to Deliver a Gigabit to Every High School 13

Honorable Mention Winners

Light Bridge 15

Virtual Education 16

Dark Fiber Proves Education Has the Right Tool for the Right Job 17

City College of San Francisco's Network 18

Remote Media Immersion 19

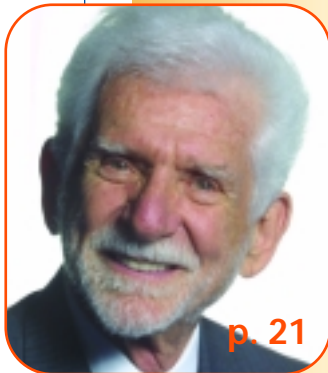
Bringing the California State Parks System to Kids throughout the State 20

Personal Broadband Where You Want It, When You Want It 21

Other CENIC Programs 28



p. 14



p. 21

On the cover As part of a project from Honorable Mention Education Award winner Orange County Department of Education, a Crystal Cove State Park ranger talks with students from the ocean's bottom.



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

InterAct is published annually by the Corporation for Education Network Initiatives in California (CENIC). CENIC is a not-for-profit corporation serving the California Institute of Technology, California State University, Stanford University, the University of California, the 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. For additional information about CENIC, visit www.cenic.org or send e-mail to info@cenic.org.

Every month, CENIC generates a wide variety of documents designed to spread the word about the latest developments in advanced network services technology. To subscribe, visit www.cenic.org/Pubs.html.

To receive future issues of *InterAct* and similar hard-copy publications, contact editor@cenic.org and request to be added to CENIC's hard-copy mailing list.

DEAR FRIENDS AND COLLEAGUES

This issue of *InterAct* features the winners of CENIC's On the Road to a Gigabit Awards—a program honoring California visionaries who apply network technology in innovative ways to encourage the development and implementation of a ubiquitous gigabit statewide network by 2010. Showcasing the pioneering ideas of today's visionaries and the promise of tomorrow's Internet, the program highlights the technologies paving the road to a gigabit world. The awards were sponsored in part by Cal-(IT)².

In 2003, CENIC launched its Gigabit or Bust™ initiative, with initial funding provided by the California Technology, Trade, and Commerce Agency. Through the initiative, CENIC has accepted the challenge of establishing an action plan to bring one gigabit to every home, business, and school in California by 2010.

As a part of the One Gigabit or Bust initiative, CENIC engaged Gartner Consulting to determine the economic potential of an acceleration of next-generation broadband deployment in California. Gartner's report, entitled One Gigabit or Bust Initiative™—A Broadband Vision for California, concludes that “a \$376-billion upside in gross state product by 2010 is made possible with the implementation of a focused One Gigabit or Bust broadband initiative. Moreover, 2 million new jobs could be created.”

The One Gigabit or Bust initiative builds on CENIC's successes in the state. In the late 1990s, CENIC developed and deployed CalREN (California Research and Education Network), an advanced services network for California's research and higher education communities.

CENIC's next initiative was the Digital California Project (DCP), funded by the state of California. The DCP's goal is to connect all 58 counties in California to CENIC's CalREN. As of July 31, 2003, 56 of those counties has been connected, serving 75 percent of the state's K-12 campuses.

This year, to provide its constituents with the most robust set of capabilities available anywhere for research and education, CENIC entered into a 20-year lease for a statewide fiber-optic infrastructure providing a first-of-a-kind optical network.

Join us on the road to a gigabit.

Tom West, President and CEO, CENIC

Larry Smarr, Director, Cal-(IT)², and Harry E. Gruber Professor, UCSD

Susan Estrada, Director, One Gigabit or Bust Initiative

The Ultrawideband Cowboy Lassos Affordable Wireless Broadband Access

First Place: Innovation

THE INNOVATION AWARD RECOGNIZES INNOVATIVE contributions to high-performance networking that best exemplify the creative spirit and the bottoms-up philosophy that created the Internet.

Called the “Ultrawideband Cowboy” by *Wired* magazine, Dewayne Hendricks and his company, Dandin Group, are lassoing wireless technology to bring affordable broadband to underserved areas. As part of a National Science Foundation-funded effort called Advanced Networking with Minority-Serving Institutions, Hendricks implemented Motorola’s wireless Canopy hardware on three Indian reservations.

Hendricks and a team of Native Americans from tribal schools at participating reservations deployed Motorola’s Canopy fixed-wireless broadband solution as part of a project whose goals were to provide an advanced networking infrastructure in areas previously impossible to serve due to remoteness and high costs. Residents of both Turtle Mountain and Fort Berthold reservations in North Dakota and Fort Peck reservation in Montana now have a full-service Internet protocol (IP) infrastructure that can be used for Internet access, as well as video and IP telephony. At Fort Berthold, the Canopy solution set a distance record for wireless products of this class—traversing 27 miles while delivering 20 megabits of bandwidth.

The Canopy units in the three tribal communities were used for creating 20-megabit backbones in these rural, remote, and geographically challenging territories to bring broadband capacity

to communities that lacked a consistent telecommunications infrastructure or had been previously underserved. The Canopy wireless system was the right solution for these communities: its flexibility allowed various configurations to build out reservationwide local area networks where none previously existed.

The East Bay Municipal Utility District in northern California jumped on the bandwagon recently to work with Dandin Group to implement broadband wireless technology as a replacement part of the district’s legacy microwave network. The district was facing a cost of \$2 million to upgrade and repair the microwave network and decided to investigate alternatives. The replacement Canopy technology cost \$50,000—thereby providing tremendous cost savings while giving the reliability that a major public utility needs.

These projects serve as models for advanced network services delivery to other reservations and underserved areas. Fixed broadband wireless technology such as the Canopy system’s is flexible, affordable, and a perfect solution for rural communities, communities on the wrong side of the digital divide, and local government networks. Dandin Group’s efforts illustrate effective utilization of broadband wireless systems. As wireless technology continues to evolve, more bandwidth can and will be



John Mitchell of Dandin and Les Laky of Fiber Internet Center in Palo Alto install a cross-bay link.

delivered to end users via approaches like these.

Embracing the slogan “Wire free! Internet bound!” Dandin Group is dedicated to the belief that wideband wireless technology is the best prospect for connecting the world. Hendricks says: “While wired approaches to delivering gigabit bandwidth are certainly worth pursuing, wireless alternatives also need to be pursued and developed. Wireless bandwidth delivery could very well be the only viable alternative for underserved areas in the years to come. As such, it is important to acknowledge

this significant achievement in the use of current wireless technology to provide advanced network services to a number of underserved areas at significantly lower price points.”

In addition to its On the Road to a Gigabit award, Dandin Group also won the Wireless Communications Association’s industry award, the Wemmie, in the category Underserved Community, U.S. Rural Market. Wemmies are awarded to carriers and vendors that use advanced wireless technology to deliver broadband service in innovative ways demonstrating either outstanding technological advances or exemplary service.

First-place Innovation Award winner was Dandin Group. For more information on Dandin Group, visit <http://www.dandin.com>. ●

Motorola’s Canopy units provide high-capacity solutions. While current Canopy products can provide 35-mile line-of-sight backbones at 20-megabit broadband capacity, plans are imminent to bring the next generation of broadband Canopy units to market at 50-megabit capacity. Isolated communities will not only have access to the Internet but also can use this infrastructure to bring all of the contemporary applications and solutions available to urban areas—such as

e-government management, distance learning, tele-medicine, and e-commerce—directly to their communities.

The Canopy solution is affordable. Paired links cost about \$3,000—a fraction of the cost of installing wire-line legacy systems. With additional production, newer product lines, and higher-capacity units coming to market, the costs of a basic broadband-capable system will be further reduced.

Canopy units do not have to use proprietary spectrum. The units have been tested and deployed in the unlicensed portions of the radio spectrum, and therefore do not require costly private licensing approval and deeply bureaucratic regulatory approvals to deploy the broadband network system.

Canopy units are easy to install. Nontechnical workers under appropriate supervision can install the units—depending on the structures they are being attached to—in about an hour—even by one person and with minimal technical expertise. Moreover, the units are small and can be mounted on a variety of structures or supports, thereby minimizing their impact to deployment in a community.

For more information about Canopy technology, see <http://motorola.canopywireless.com/>.



A Canopy unit is being installed by an East Bay Municipal Utility District employee at the Comanche Dam site near Valley Springs, California.

The Road to a Gigabit Leads to Canyon Hills

A Pardee Master-Planned Community

First Place: Community

THE COMMUNITY AWARD HONORS INNOVATIVE USES OF high-performance networking to overcome economic-and/or location-based network disadvantages.

In Lake Elsinore, California, the road to a gigabit leads to Canyon Hills, a master-planned community by Pardee Homes. Situated in the rolling hills between Interstates 15 and 215, south of Canyon Lake and east of the City of Lake Elsinore, Canyon Hills comprises approximately 2,000 acres, nearly half of which will be preserved as natural open space, including existing hills and slopes, Cottonwood Creek, and San Jacinto River.

Perhaps more impressive than the community's picturesque surroundings is its state-of-the-art, fiber-to-the-home, Gigabit Ethernet network.

Pardee's Telecommunications Vision for Canyon Hills

Pardee's technology vision for Canyon Hills is an environment that supports access to advanced telecommunications services, including access to education and training through electronically connected schools, enhanced telecommuting with real work-at-home capabilities, videoconferencing, telemedicine, interactive e-commerce with graphics, and interactive entertainment.

The vision includes implementing a smart community network that uses the power of technology and high-speed Internet access to provide residents with enhanced telecommunications services and strategic relationships with telecommunications partners that can

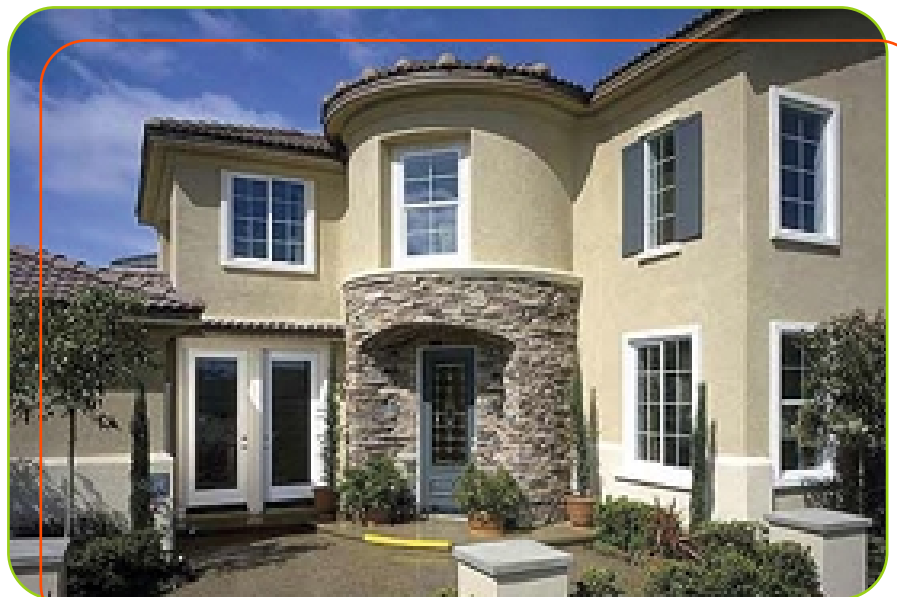
implement and manage leading-edge technology and services.

Pardee incorporated several design elements in the contracts with its builders, including in-home wiring and a backbone conduit system within the community interconnecting homes, schools, and businesses. Service providers include the local telephone company, ILEC; the cable television provider, CATV; and its Internet partner, FiberRide, which is deploying a state-of-the-art, fiber-to-the-home, gigabit Ethernet network. The

network will provide more than 10 times the capability of either digital subscriber line (DSL) or cable modem technologies.

The value of fiber to the community and to the home is significant. Home owners will be able to increase their access to bandwidth in real time. This access will meet the needs of both modest users (e-mail and websurfing) and the most-dynamic home office users.

Pardee is implementing an intranet to help tie the community together with easy access to useful information. Residents want the ability to communicate with others who share their interests and concerns. The interactive nature of the intranet transforms consumers into active producers in the creation of information. The intranet encourages and supports conversations. Residents raise



Laurel Ridge is the first neighborhood of the Canyon Hills community.



Lake Elsinore is one of California's fastest-growing cities.

their own issues, find out about local yard sales for the weekend, review local movie listings, and read local restaurant reviews written by patrons who have eaten there. The residents will have access to live, online communications, including town meetings, community bulletin boards, and expert advice.

Pardee's Telecommunications Partners

Stephen Mayo, president of Intelconnect, Inc., was selected by Pardee Homes to create and implement the technology plan for Canyon Hills. Intelconnect, designs and implements next-generation telecommunications solutions for single-family, multifamily, and mixed-use developments; communities; small, medium-size, and large business campuses; and business parks. Mayo works with developers to provide advanced Internet and data services, a community intranet, video services, bundled telephone services, smart home wiring, community conduit/fiber infrastructure design, and strategic alliances with service providers.

Service Providers

Intelconnect chose FiberRide to provide an Ethernet, fiber-to-the-home network within the community for Internet/intranet services. Homes are provided a 100 Mbps connection on a gigabit Ethernet backbone. Each home has a smart home wiring package, including a local area network, a CATV amplifier, and telephone jacks throughout.

Other Telecom Providers

AT&T provides cable television services. Verizon is the local telephone company. This combination of service providers brings sufficient capacity for a diverse array of communications, entertainment, and Internet services for the residents of Canyon Hills such as:

- *Flexible voice communication.* This includes competitive packages for local, long-distance, and telephony options such as call waiting and voice mail.

- *Digital entertainment.* Including a comprehensive array of cable, movies on demand, music channels, and interactive games. Kids will be able to engage in popular multiuser games with friends, while parents will be able to order from movies on demand with advanced pause, replay, and commentary features.
- *Community intranet.* A community intranet will facilitate connections among residents as well as among community resources. Community

Your exploration of the Lake Elsinore Valley begins with your discovery of the city of Lake Elsinore, a picturesque community wrapped around a 3,300-acre recreational lake with the dramatic Ortega Mountains and Cleveland National Forest rising up on the west side to provide a naturally scenic backdrop for one of California's fastest-growing cities, strategically located along the busy I-15 corridor in Riverside County and easily accessible to the business centers of Los Angeles, Orange County, and San Diego County.

A valleywide population of more than 125,000, lower land and housing costs, the availability of prime lots for commercial and light industrial development, and a young, highly skilled workforce, combined with pro-development government, make Lake Elsinore Valley an exciting find.

Adapted from Lake Elsinore Valley Chamber of Commerce, <http://www.levcc.org>

- *High-speed Internet access.* This is always-on Internet access, with flexible plans for a range of Internet access speeds and residential gateways for high-speed Internet delivery throughout the home. Such broadband availability allows for telecommuting, home-based e-business applications, and videoconferencing with neighbors and local schools.
- *Electronic services.* This includes smart home options for security, home management, and other e-commerce services. With these services, residents can check on the status of their home from work and abroad—such as remote control of energy—as well as arrange for local services to the home—such as security services.

groups will have a forum to communicate with volunteers and publicize their activities. Residents will be able to access local event, weather, and traffic information.

Leading the Way

Canyon Hills makes an excellent model for a true fiber-to-the-home network for a large community in which the developer deployed the network. It is not passive optical networking. Single-mode fiber connects each home, school, and business directly to the property central office node. As if this weren't impressive enough, the current cost of the 100 MB Internet service is \$25 per month without a contract.

continued on page 22

Imperial County's Fiber-Optic Education Network for the New Millennium

First Place: Gigabit or Bust

THE GIGABIT OR BUST AWARD HONORS THE HIGH-performance networking application/technology that best exemplifies what life would be like in a gigabit-connected world.

To facilitate learning in Imperial County, the Imperial County Office of Education (ICOE) began exploring videoconferencing in 1995 as a tool to increase opportunities for students, teachers, and administrators. We discovered, as had many before us, that videoconferencing was costly, complicated, and anything but user-friendly. Therefore, we decided to sit back and allow the new developments in Internet protocol (IP) video to mature. In 1999, we were

Partnerships: We think we need them, but do we?

ICOE had a vision and desire. With our grant award, we even had a sudden infusion of money. Yet without strategic partnerships, we would not have had the success we enjoy. Our community partnerships were nurtured from the beginning. Some of our existing partnerships were expanded and new partnerships were formed to facilitate collaboration in innovative and exciting ways.

Enlisting the support of the 17 independent school districts in the county was crucial. Getting schools to understand the potential and to a certain degree, to take a leap of faith as we moved into new areas required tremendous communication and sensitivity.

A significant partnership was formed with our locally owned public utility company, the Imperial Irrigation District (IID). The IID granted us access to dark fiber cable from its network infrastructure and allowed us the privilege of using its utility poles to install cable from site to site. That pole contact agreement is a critical element in our plan, as it allows us to build our network as needed without the complications of right-of-way issues.

It was also important for us to include city and county governments, as well as

other public agencies as we worked toward our vision of a high-tech community. Many of the relationships created with those agencies and schools have resulted in significant returns.

The most significant result of the collaboration was the formation of a county-wide joint powers authority for telecommunications: the Imperial Valley Telecommunications Authority (IVTA).



California state parks from across the state are joined in a videoconference bridge at the Imperial County Office of Education.

The IVTA was created in response to the need for clear agreements between and support from public agencies as we built our private fiber-optic network. The group serves as the oversight board for the network, with the Imperial County Office of Education as network administrator.

Having a strong consortium of agencies has allowed us to leverage previously disparate resources, such as cable franchise agreements and our own agreement. It has also served as a vehicle for leveraging resources from communication carriers laying fiber in the ground or erecting communication towers. A new countywide ordinance requires these carriers to negotiate public benefits for the IVTA in order to be issued permits.

Getting schools to understand the potential and, to a certain degree, to take a leap of faith as we moved into new areas was something that required tremendous communication and sensitivity.

awarded a Technology Innovation Challenge Grant from the U.S. Department of Education that created the Borderlink Project and provided the initial momentum for our efforts in videoconferencing. Through Borderlink, we were able to seed what would grow into the enterprise IP videoconferencing system we have today.

This has resulted in a variety of resources' being brought to the table for shared benefit, such as supplying spools of fiber cable, installing dark fiber in the ground for our use, and providing tower space for wireless applications.

Last, we've found vendor partnerships to be instrumental. While most partnerships with vendors equate to sales and projected revenues, we've selected vendors that understand our vision and that are genuinely interested in playing a significant role.

Connectivity: Building a single network for data and video

The two primary reasons we chose to implement IP-based videoconferencing are cost and the ability to utilize the existing network infrastructure in our schools.

In order to utilize the system the way we envisioned, we needed to offer schools a way to use it as a daily tool in the classroom. This required the ability to place and use videoconferencing equipment in all schools and any classroom. IP video



Students interact through videoconferencing with a Holocaust survivor from the Simon Wiesenthal Museum of Tolerance.

was the only way to meet that requirement. Having separate video-conferencing lines, such as Integrated Service Digital Network (ISDN), in every classroom was cost prohibitive. Additionally, build-

ing a separate video local access network was not an option, because many of our schools were having a difficult time maintaining one network.

As if this were not enough, the issue of recurring costs each time a unit was to be used in a classroom was a significant reason to look toward an IP implementation. We required the ability for teachers and students to utilize the technology whenever and as often as needed. Having schools incur line charges each and every time they used the system would present a major barrier to the adoption of videoconferencing into classroom instruction. With IP videoconferencing, the issue was eliminated for all usage on our network. Any of our 59 schools can use the system between sites without any recurring charges.

Our schools can also connect at any time with other videoconferencing sites across the globe. If schools need to connect with sites that are not on our network—such as the San Diego Zoo's Camden Children's Garden—they can be connected with units via ISDN.

Project EdNET is—

- A comprehensive joint-use approach with all 16 school districts, city agencies (for example, libraries and law enforcement), county agencies (for example, Social Services and the Health Department), community colleges, and San Diego State University-IVC
- An innovative partnership with the IID, the publicly owned utility company
- A major innovative project focused on decreasing the digital divide in a traditionally underserved area of the state identified as a federal Enterprise Community, and more recently, a Champion Community
- A project that will interface with and leverage other statewide initiatives such as the Digital California Project, CalREN, and 4Cnet
- A project that will be a replicable model for the state in terms of innovative use of technology and collaboration among multiple public agencies
- A project that will empower the region to deliver Advanced Placement courses with teacher training and support, increased University of California eligibility for students, standards-based teacher training via technology, and professional development via video teleconferencing

Schools simply go to our gateway device over IP, which connects them to other units using ISDN. For this, we incur line charges. However, we're finding an increasing number of sites that are connecting to high-speed Internet connections and that are becoming capable of IP videoconferencing. Efforts such as the Digital California Project have begun to eliminate this issue for interaction across California schools and educational agencies.

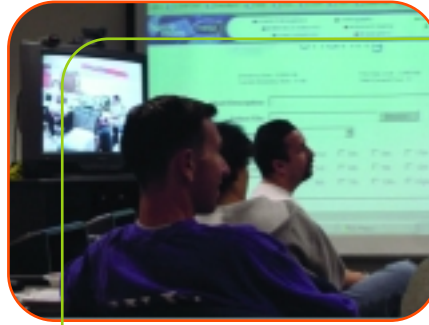
Network security issues became a major obstacle for us in the implementation of IP videoconferencing. We found few solutions for getting across security measures (known as firewall and NAT transversal). This posed a huge challenge for us. After a tremendous amount of research and testing, we decided on a solution from Ridgeway Systems and continue to work in partnership with the company on our implementation.

Working with the IID, we continue to build out our countywide fiber-optic network. We currently utilize gigabit Ethernet on the wide area network, which allows our schools to use videoconferencing with little regard to bandwidth. However, we have many schools and other agencies using the system that are currently connected to the data network at T-1 speeds. We plan activities with the understanding we will consume a minimum of one-third of their total bandwidth through videoconferencing. Depending on the activity, this has had minimal to moderate impact on school connectivity. We plan to have all schools connected to the private network over the next two years.

Equipment: Videoconferencing for every room

Our goal was not to create videoconferencing rooms or to force a technology without a purpose, but rather, to make every room capable of videoconferencing and to develop meaningful uses. In order to reach this goal, our equipment needed to meet several criteria:

1. Affordable hardware
2. User-friendliness at all levels



We're currently training site leaders through a new program designed to build capacity at sites. The program will provide technical support through student tech teams, training support for teachers and administrators, and application development through collaboration between schools.

3. Variety of configurations
4. Capability for utilizing a variety of connectivity speeds

Asking schools to purchase a \$9,000 unit for each classroom was not feasible. We had a requirement to place in classrooms affordable units that would integrate seamlessly with the higher-end units on the network. For us, that narrowed our choice to a single vendor: Polycom. Polycom's \$500 ViaVideo unit was a perfect match for our needs. More important, Polycom had various levels of products to meet our criteria. For all equipment (desktop or room systems) we've standardized on a minimum of 384 K conferences but can increase to 2 Mbps if needed. We've integrated data collaboration and several distance-learning tools to complete the package.

During the past two years, we've developed a close partnership with Polycom that has resulted in significant benefits for us as we've moved forward. With nearly 200 end points (active videoconferencing units) currently on our network, we need to ensure seamless integration of various systems and we require advanced management features to keep costs down as much as possible. Polycom has provided an end-to-end solution meeting these needs.

Application: Putting it all together

Implementing any new system of this magnitude requires a tremendous amount of support. We're currently

training site leaders through a new program designed to build capacity at sites. The program will provide technical support through student tech teams, training support for teachers and administrators, and application development through collaboration between schools.

While numerous videoconferencing activities are currently being supported in the areas of tutoring, coaching, professional development and general meetings, we began offering several videoconferencing courses for high school students during spring 2003. Some of these courses are community college courses offered as concurrent enrollment, thereby giving our students a head start on college.

In addition to support and training, putting it all together takes commitment and a shared vision among all stakeholders. We've been fortunate to have these from the beginning, and we look to the future with much anticipation.

First-place Gigabit or Bust Award winner was Imperial County Office of Education. The project team included John D. Anderson, county superintendent, ICOE; Todd Finnell, director of learning technologies, ICOE; Jurg Heuberger, planning director, County of Imperial; and Steve Hogan, director of public works, City of El Centro. For more information on Project EdNET, visit <http://www.icen.org>. For more information on the Borderlink Project, see <http://www.borderlink.org>.

Article contributed by Todd Finnell. ●

From Obstacles to Fundamental Fabric Making the Network Work

First Place: Biggest, Fastest in the West

THE BIGGEST, FASTEST IN THE WEST AWARD HONORS the fastest and most-scalable high-performance networking application/technology.

Today network scientists at California Institute of Technology (Caltech), the European Organization for Nuclear Research (CERN), the Stanford Linear Accelerator Center (SLAC), and Los Alamos National Laboratory (LANL) are driven by high-energy and nuclear physicists (HENPs) who are using multihundred-gigabits-per-second transAtlantic links to transfer terabytes per day between SLAC in California and European computer centers in Lyon, France; in Padova, Italy; and near Oxford, England. The data rates are required by the HENP community and are doubling annually. As a result of those needs, a high-performance trans-Atlantic network testbed was developed to illustrate that it is possible today, with commercial off-the-shelf components, to achieve high bandwidth connections.

An important part of the test bed is delivering the message that the Internet's transmission control protocol (TCP) and the Internet itself have not run out of steam. The Internet continues to scale. We do not have to await difficult-to-deploy modifications to be made to backbone router congestion strategies in order to provide high bandwidth connections. New techniques, developed in this test bed, will work well on a shared-gigabit network—one envisioned by the One Gigabit or Bust initiative.

At the same time, project participants are leading the way in demonstrating and understanding how to achieve these

high throughputs. TCP is a well-understood, mature technology with many good features, including the fact that it's reliable and friendly on shared networks. TCP can scale from modem speeds to multigigabit-per-second regions. New TCP stacks (software) need to be deployed only at the sender location, which means modifications to backbone routers are not required and jumbo frames are not needed. The network becomes a catalyst/enabler, not a bottleneck.

Worldwide collaborations of people working with large amounts of data become increasingly possible. Les Cottrell of SLAC says: "Today moving data like this takes a combination of wizards with experience in networking,

operating systems, and more. One result of our work will be to identify the critical components and configuration settings to provide recipes and simplify use for later users. Another result is to provide feedback for vendors about how individual components work, how they work together, where the bottlenecks are, and what needs attention."

"Today moving data like this takes a combination of wizards with experience in networking, operating systems, and more. One result of our work will be to identify the critical components and configuration settings to provide recipes and simplify use for later users."

—Les Cottrell, SLAC



At the CENIC 2003 awards luncheon. From left to right: Sylvain Ravot, Caltech; Suresh Singh, Caltech; Les Cottrell, Stanford Linear Accelerator Center; Wu-chun Feng, Los Alamos National Laboratory.

Breaking the Internet2 Land Speed Record

Scientists at California Institute of Technology (Caltech), the European Organization for Nuclear Research (CERN), the Stanford Linear Accelerator Center (SLAC), and Los Alamos National Laboratory set up a high-performance transAtlantic network test bed with a 10 Gbits/s link between Sunnyvale, California, and Chicago and utilized the 2.5 Gbit/s DataTAG link between Chicago and Geneva, Switzerland. At each site, high-performance commercial PCs running the standard Linux operating system were connected by using commercial Sysconnect 1 gigabit Ethernet (GE) and Intel 10 GE network interface cards (NICs). Memory-to-memory data transfers have been performed via the standard TCP stack (New Reno) and a TCP stack (FAST TCP) developed at Caltech. The team transmitted over a terabyte of data in just less than an hour from Sunnyvale

near SLAC in California to CERN in Geneva with a single TCP stream between 2 PCs with 10GE NICs by using jumbo frames and the standard (New Reno) TCP. This corresponds to a sustained TCP rate of 2.38 Gbps across 10,037 kilometers for more than one hour. Utilizing 10 hosts connected via 1GE NICs, the FAST TCP stack and standard 1,500 byte maximum transmission units (MTUs), the team was able to transfer 21 terabytes in 6 hours with 10 flows at an aggregate throughput of 8.6 Gbps. This beats the Gbps limit for a single TCP stream across the Atlantic.

The test bed components:

CPU: Pentium 4 (Xeon) with 2.4 GHz CPU. For GE, used Sysconnect NIC. For 10 GE, used Intel NIC, Linux 2.4.19 or 20

Routers: Cisco GSR 12406 with OC192/POS & 1 and 10 GE server interfaces (loaned, list > \$1M), Cisco 760x, Juniper T640 (Chicago)

Level 3 OC192/POS fibers (loaned SNV-CHI, monthly lease cost: about \$220K)

With the start of the next generation of HENP experiments at the Large Hadron Collider at CERN in Geneva, the transAtlantic requirements are expected to drive multi-ten-gigabit-per-second connections soon. SLAC's BaBar experiment already has almost a petabyte of stored data, with exabytes (10^{18}) collected and stored over one decade. If the network continues to improve in performance by a factor of 2 per year, as it has for the past 10–20 years, then we can expect universities, research establishments, and businesses with 155-Mbit/s or 622-Mbit/s connections today to have 100 times this performance by 2010.

Other data-intensive sciences with similar growing needs include global climate prediction, astrophysics, human genomics, fusion, and seismology. In the future, we can see these connectivity speeds' also being valuable for the telemedicine, aerospace, oil, and media distribution industries. For example, utilizing this type of connection, two full-length DVD movies could be transferred in one minute or a full-length CD can be transferred in 2.3 seconds. Downloading movies would become as easy as downloading music.

What are the next steps? The 2.5-Gbit/s limit needs to be broken. Faster CPUs, with 60 percent more MHz/Mbits/s over TCP for disk-to-disk throughput, are needed, as is a better understanding of

continued on page 23



Beyond the Textbook

Elementary Students Grapple with Complex Social Issues

First Place: Education

THE EDUCATION AWARD HONORS INNOVATIVE USES of high-performance networking in K–12 and higher education.

The University of California, Santa Barbara (UCSB) Center for Teaching for Social Justice (CTSJ) has been pioneering innovative uses of interactive video over the Internet to provide enriched experiences for K–12 students as well as active learning opportunities for these students to work with their peers. The CTSJ arranged for Santa Barbara area elementary students to serve as docents of a virtual tour of artifacts from the *Henrietta Marie*, a slave ship that sank off the Florida coast nearly 300 years ago. This remarkable exhibit was on loan to the Karpeles Library in Santa Barbara. The Santa Barbara student docents conducted a virtual tour of the exhibit for fourth-, fifth-, and sixth-grade peers in Sacramento's Elk Grove School District who viewed the tour at CSU Sacramento. Thanks to the benefits of high-speed Internet connections made possible by CENIC's Digital California Project (DCP), Elk Grove students were able to interact via the network virtually face-to-face with the Santa Barbara elementary students. A month later, the Sacramento area students asked for an opportunity to share their expertise on life in the migrant camps. They used a variation of the docent model by arranging an oral history interview with a CSU faculty member, Maria Mejorado, and two undergraduates whose families were migrant farm workers and who, themselves had grown up in migrant camps. The interview enabled Santa Barbara

students to explore issues unavailable in their local community, thereby creating a second unique opportunity for learning for both sets of students. Crucial to the success of these efforts were the teachers' preparation of the docents and the classes, and the support of the CTSJ staff.

These activities spurred new collaborations within the University of California—between a UC and a CSU campus—and with schools in various parts of the state. Organizers had to find creative ways of overcoming technological limitations. This was critical for making the virtual interactive events possible, particularly since all schools throughout the state may not have the hardware, software or connection speeds required to support this kind of interaction. For example, because the Elk Grove school district was not yet connected to the DCP, CSU Sacramento allowed the students to use its facilities. For similar reasons, the Santa Barbara area students used facilities at the UC Santa Barbara campus. The UC Office of the President (UCOP) also played a role by creating a technological bridge between UCSB and CSU Sacramento so that the virtual events were made possible.

During their work, students and teachers moved beyond the textbook, beyond



A virtual tour of the Henrietta Marie.

the classroom, and beyond the standards. Not only did they show that elementary students are able to grapple with complex social issues, but they also

During their work, students and teachers moved beyond the textbook, beyond the classroom, and beyond the standards. Not only did they show that elementary students are able to grapple with complex social issues, but they also showed how K–12 can take advantage of university resources and subject matter experts.

showed how K–12 can take advantage of university resources and subject matter experts. New possibilities for learning and communicating were created for everyone involved.

CENIC's research and educational network, CalREN, was an essential tool for providing a real and authentic context for presenting information to others, for learning to communicate with those outside one's context, and for seeing a need for learning about the lived experiences of others. The network cyberinfrastructure was integrated into a larger educational process that spanned an extended period of time.

The Santa Barbara/Elk Grove collaboration demonstrated the need for varied disciplinary knowledge—for example, the knowledge held by students, teachers, university faculty, and technology

CENIC's research and educational network, CalREN, was an essential tool for providing a real and authentic context for presenting information to others, for learning to communicate with those outside one's context, and for seeing a need for learning about the lived experiences of others.

support staff at UC, CSU, and UCOP. The result provides a model for issues on both sides of the technological interface and for how such information can enlighten subsequent projects. The CTSJ is expanding to a new set of projects this year and a summer institute—providing the knowledge to build people networks that take advantage of the virtual or digital networks.

In the CTSJ's Summer Institute 2003, teachers from California and the rest of the nation worked with the following teacher leaders on their projects.

- *Perspectives on the Arts*: Phil Levien, San Marcos High School
- *Perspectives on History*: Gail Desler,

Elk Grove Unified School District

- *Perspectives on Science in Community*: Ralph Cordove, Goleta Union School District
- *When Justice Failed and History Happened Here*: Gail Desler and Harriet Rose, Elk Grove Unified School District; Lauri Dahlin, Santa Barbara School Districts; and their fifth-grade students

Prof. Judith Green and her associates at the UCSB CTSJ and resource teacher Gail Desler of the Elk Grove Unified School District are early adopters of video technology with K-12 students.

Green said: "Our approach is grounded in the work teachers and students are doing in classrooms every day. The focus of our collaborative work is on local stories and global connections—a way of engaging students in learning and communicating about complex historical issues."

Green and Desler are studying new ways to use technologies involving teachers and university collaborators across the state. Seeking creative ways to solve logistical, technical, and pedagogical issues, they're sponsoring activities that assist teachers wishing to conduct or participate in interactive distance video and oral history projects that meet state standards across many disciplines.

The focus of our collaborative work is on local stories and global connections—a way of engaging students in learning and communicating about complex historical issues.

First-place Education Award winner was University of California, Santa Barbara, Center for Teaching for Social Justice. Participants from UCSB CTSJ were Dr. Judith Green; Carol Dixon and Hsiu-Zu Ho, codirectors; Elizabeth Grace, technology coordinator; Ralph Cordova, research coordinator; and Heather Tomlinson, evaluation coordinator.

Teachers from Washington School, Santa Barbara, were Gail Desler, Elk Grove Unified School District; and Jean Rogers-O'Reilly.

Participants from the Gevirtz Graduate School of Education were Bill Doering, director of the Information Technology group; and Kambiz Ebrahim, multimedia research center

Participants from CSU-Sacramento, were Marcy Hernandez, Nena Maravilla, and Maria Mejorado.

For information on UCSB CTSJ, visit <http://www.education.ucsb.edu/socialjustice/>.



Show off your innovative use of network technology!
 Register now for CENIC's 2004 Awards.
 See the back cover of this issue for details.

On the road to a Gigabit

El Monte Union High School District Partners with SBC to Deliver a Gigabit to Every High School

First Place: Partnership

THE PARTNERSHIP AWARD HONORS THE BEST USE OF high-performance networking developed by a private/public partnership.



The El Monte Union High School District, working with SBC/Pacific Bell and its networking equipment vendors, has given the capability for gigabit bandwidth on demand to all of the district's high schools via SBC's GigaMAN service. The economically disadvantaged district used a creative design that placed layer-3-capable gigabit cards in existing routers, upgraded current voice-switching equipment, and took advantage of fiber infrastructure improvements to save \$1 million over alternative proposals. Integrated into the design are links between schools and links to the district office for usability in case of partial network failure.

This innovative solution gives each school access to scalable, high-performance networking applications such as voice-over IP, large-bandwidth Internet access, and streaming video on a platform that allows for future-proofing.

In the old network, all six high schools were served from the district office. Each school had three T-1 lines: two for data and one for voice. The voice and data circuits were separate. Online testing and Internet access demands strained the available bandwidth. The district knew that its demands would continue to grow from ever-increasing district data and Internet access requirements to new video requirements. And it knew it wanted a more flexible network, one that could combine both voice and data.

What made El Monte choose GigaMAN? For one thing, the district gets more bang for the buck. The old network was half the price, but 1/20 the bandwidth. El Monte will also realize future cost savings in equipment

upgrades. This solution bought the district ample bandwidth for a converged network plus plenty of bandwidth for future applications. Finally, this solution was both E-Rate and California Teleconnect Fund eligible.

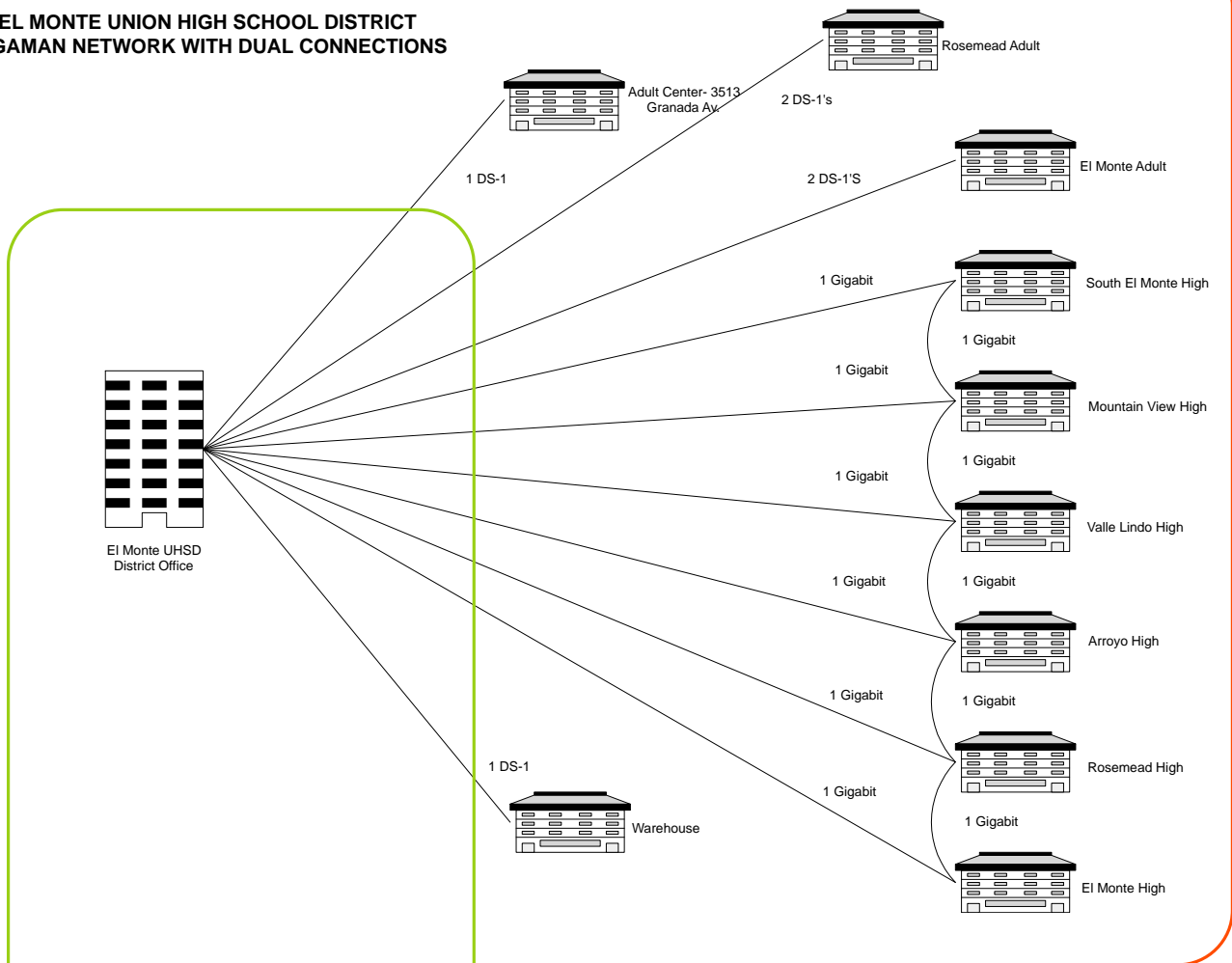
The fact that the El Monte Union High School District is a pioneer in gigabit networking is more remarkable because it is not a large, well-funded school district. It has shown that with initiative and creativity, it could participate in the

The "island" of El Monte, a 4-by-7-mile tract of rich, low-lying land east of Los Angeles between the San Gabriel and Rio Hondo rivers, has always offered respite and replenishment to native dwellers and travelers. Located approximately 12 miles east of downtown Los Angeles, El Monte is the hub of the San Gabriel Valley, where two major freeways—Interstates 605 and 10—intersect.

El Monte is ethnically a diverse community, with year 2000 demographics reflecting an increase in the Asian population up to an all-time high of 18 percent, the Hispanic population remaining steady at 75 percent, and the Caucasian population decreasing to 7 percent.

Source: <http://www.ci.el-monte.ca.us/>

**EL MONTE UNION HIGH SCHOOL DISTRICT
GIGAMAN NETWORK WITH DUAL CONNECTIONS**



El Monte Union High School district qualifies for the maximum 90 percent E-rate discount, a program that provides discounts to assist schools and libraries in the United States in obtaining affordable telecommunications and Internet access. E-Rate discounts range from 20 to 90 percent and are based on income level.

fully connected future world. The district hopes that its example may spur others to use creativity, public/private partnerships, and innovative solutions to reach the goal of a one-gigabit statewide network by 2010.

El Monte didn't let the high cost of completely new high-performance networking gear stop it from having a district-wide ubiquitous gigabit network. Technology officials worked with its vendor partners like SBC/Pacific Bell to take

full advantage of government grants, such as E-Rate and the California Teleconnect Fund, of creative uses of existing technology, and of carrier infrastructure improvements to create a scalable, high performance network that serves each one of its schools.

First-place Partnership Award winner was El Monte Union High School Gigabit Network. The partners were El Monte Union High School District and SBC/Pacific Bell. Participants were Garrett McKay (gmckay@emuhsd.k12.ca.us), El Monte Union High School District, and Ken Mills (km2127@sbc.com), SBC/Pacific Bell.

Light Bridge

Supporting Teacher Education through 21st-Century Technology

Honorable Mention: Partnership

THE PARTNERSHIP AWARD HONORS THE BEST USE OF high-performance networking developed by a private/public partnership.

Light Bridge demonstrates that technology can create powerful learning communities that enable teacher educators and schools to provide unprecedented levels of support for future teachers.

The goals of Light Bridge are to:

- Strengthen teacher education programs through the development of rich video content offered via the next generation of the Internet.
- Establish a student teacher support and supervision system that ensures high-quality support and assistance at a distance.
- Disseminate teacher education video content, online resources, and the student teacher support and supervision system.

The first result is a set of Web-based video lessons with exceptional usability. The lessons were originally produced at one campus and have since grown to include a national group of authors. The resources are free and available for use

by all interested faculty and preservice teachers.

Resources include:

Lesson introduction. This page contains a brief video introduction in which an expert overview is given on the topic and the critical elements to be portrayed in the subsequent video demonstrations and support materials. All videos play in QuickTime format, and a download link to this cross-platform freeware is available at the lessons page. In addition, the videos are in Fast Start format, allowing viewers to begin play while download occurs. Viewers with QuickTime Pro can save videos to their hard drive by selecting the pull-down menu at the lower right corner of the video player and choosing Save as QuickTime Movie.

Video demonstrations. Each of the video demonstrations is approximately 3 minutes in length and shows a teacher demonstrating a critical element of the respective topic, skill, or teaching method. A pull-down menu allows viewers to choose the videos to be played, and the controller bar at the base of the video player gives the options to pause, forward, or reverse the video. As videos play, they're accompanied by a transcript on the right side of the screen, with the option of selecting a printer-friendly version. If this proves to be distracting, the viewer can select

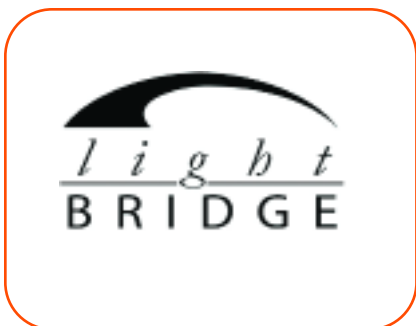
Hide Text from the player window.

Support materials. This page provides a menu of materials that accompany the video demonstrations and lead to further understanding of the topic presented. Support materials typically include sample activities and assignments; assessment examples, additional text descriptions of critical elements within a topic, presentation resources, off-site links to related Web resources, and appropriate professional standards.

During the transition to a national scope of authoring and implementation of the videos in teacher education, it was discovered that a true benefit to education would be to use a Web-based authoring tool that allowed other professionals to publish video-based lessons to the web for their own professional use as well as for access by others. This allows the scope of the project to grow beyond its original time line and resource development goals—indefinitely. However, most of the proprietary software that could be used for such a purpose proved to be too costly or impractical for use by a global audience. Through consultation with the Center for Distributed Learning (CDL), it was decided that creating an authoring tool specifically for the purpose of publishing project lessons would be an innovative and worthwhile endeavor. Light Bridge and the CDL collaborated for approximately 12 months to create the authoring tool that was implemented in late 2002.

The first step in the authoring tool process occurs when a faculty member has applicable materials in electronic

continued on page 23



Virtual Education

Around the World and under the Sea

Honorable Mention: Education

THE EDUCATION AWARD HONORS INNOVATIVE USES OF high-performance networking in K-12 and higher education.

Instead of reading about space history in textbooks, students from Brea Junior High School toured the Smithsonian National Air and Space Museum guided by LeRoy London, director of educational outreach. They peered into an Apollo space capsule, viewed the Kitty Hawk, compared it with the Spirit of St. Louis, talked together, and asked Mr.

Students travel virtually under the sea and converse with divers at the ocean bottom in Crystal Cove State Park. They study oceanography at Dana Point's Ocean Institute and join classmates as they conduct science experiments on the Sea Explorer 5 miles out at sea.

London questions about what they were seeing. For 100 students, it required 2,250 miles of travel to Washington, D.C. For 400 others, including parents, it required a trip to the school auditorium. Through the magic of videoconferencing, everyone experienced a firsthand look and interactive conversation with experts at the museum.

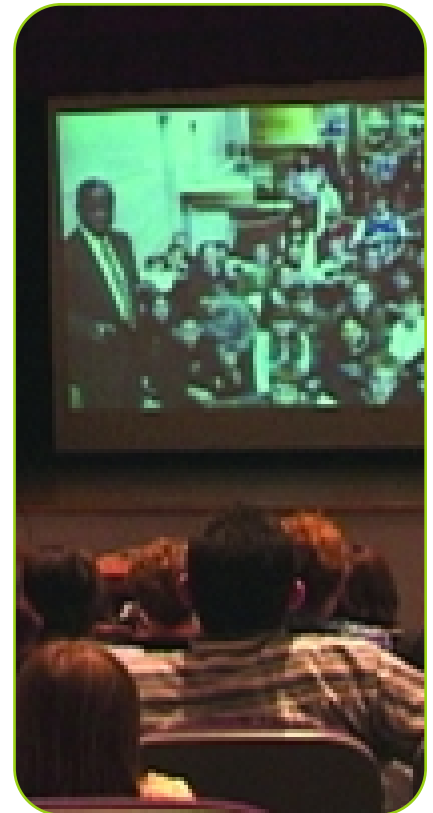
Videoconferencing has opened the world to students, educators, and parents in the public schools in Orange County, California. Sixteen sites, strategically located to give access across the county, are in place. That number will grow to 22 by fall 2003, and more are planned for 2004.

The primary uses currently are for virtual field trips for students and for

professional development for educators. Students travel virtually under the sea and converse with divers at the ocean bottom in Crystal Cove State Park. They study oceanography at Dana Point's Ocean Institute and join classmates as they conduct science experiments on the Sea Explorer 5 miles out at sea. Through videoconferencing, students are now able to visit portions of California state parks that are closed to the public. In the Saddleback Valley Unified School District, high school students have their artwork critiqued and discuss their ideas with an internationally known artist. This fall, Orange County students will add engagement in collaborative learning projects across the nation and around the globe.

Educators in Orange County enjoy direct access to nationally renowned researchers and practitioners and to their colleagues both in the county and beyond. Prior to videoconferencing, educators might hear a speaker at a conference or glean ideas from colleagues at an occasional meeting. Now they interact with leaders such as Rick

Educators in Orange County enjoy direct access to nationally renowned researchers and practitioners and to their colleagues both in the county and beyond.



Brea students and parents tour the Smithsonian National Air and Space Museum.

DuFour and Douglas Reeves several times during the year, and they connect with each other for in-depth conversations from convenient sites around the county. The dialogue is interactive, and questions reflect the successes and challenges of implementing new strategies. "This is much more of a coaching model than listening and taking notes at a conference. Consequently, the results in the classroom are more substantial. As educators, we need to be able to ask questions and refine practice with the guidance of those who have success with concepts or strategies that may be

continued on page 24

Dark Fiber Proves Education Has the Right Tool for the Right Job

Honorable Mention: Biggest, Fastest in the West

THE BIGGEST, FASTEST IN THE WEST AWARD HONORS the fastest and most-scalable high-performance networking application/technology.

Several years ago, the University of Southern California (USC) became an early implementer of a dark-fiber infrastructure in the metropolitan Los Angeles area that spans buildings at One Wilshire in downtown Los Angeles, USC's University Park Campus (UPC), USC's Health Science Campus (HSC), USC's Information Sciences Institute (ISI), and USC's Institute for Creative Technologies (ICT) in Marina del Rey.

This successful academic implementation of dark fiber over a variety of wavelengths imparts a vision for next-generation education models, and early use of these technologies has provided proof of concept. User-owned and -managed dark fiber, combined with various technologies at its end points, illustrates that dark-fiber infrastructure could be the next big thing in network infrastructure for universities.

The dark fiber was originally implemented via multiple-gigabit and Sonet wavelengths using coarse wavelength division multiplexing gear. At the end of these wavelengths, Foundry Networks hardware was implemented with multiple gigabit paths and asynchronous transfer mode (ATM) over an OC-12 wavelength (622 Mbps). Various projects were run over this infrastructure, including USC campus HSC to the ISI network, plus connections to various Internet service providers (ISPs) on the Los Angeles Access Point (LAAP)

Internet exchange point. The enabling of the LAAP over this infrastructure afforded ISPs and research groups the ability to communicate directly by using gigabit ports on each end. Additionally, various research projects obtained layer 2 virtual local access networks or ATM-provisioned circuits.

In the past year, a 10-gigabit path was added between the Foundry Networks equipment. Currently there is a 10-gigabit path between UPC on the USC campus in downtown Los Angeles and ISI. This infrastructure was used to facilitate demonstration of 10-gigabit connections at the Internet2 members meeting in October 2002. It also facilitates many gigabit peerings between these campuses/sites. Current experiments are under way with the next-generation Internet protocol, IPv6, as well as with other advanced applications.

This implementation provides the basic infrastructure for USC and other Los Nettos members. Los Nettos is a consortium of the key computer science research centers in the Los Angeles area. Los Nettos consists of five major organizations interconnected with high-

speed lines. Hub sites have redundant connections. The members are ISI, USC, California Institute of Technology (Caltech), the Jet Propulsion Laboratory (JPL), and TRW.

USC's 10-gigabit and more capabilities provide the gigabit platform for desktop initiatives at USC and its partners. The capabilities also provide the necessary bandwidth for Grid and other high-performance computing applications at USC, Caltech, JPL, and ISI. The capabilities provided by dark-fiber implementation should take USC and its partners far into the future—proving it is the right tool for the right job.

Honorable Mention Biggest, Fastest in the West Award winner was *University of Southern California.* ●

This successful academic implementation of dark fiber over a variety of wavelengths imparts a vision for next-generation education models, and early use of these technologies has provided proof of concept. User-owned and -managed dark fiber, combined with various technologies at its end points, illustrates that dark-fiber infrastructure could be the next big thing in network infrastructure for universities.

City College of San Francisco's Network

A Gigabit-Connected World with Cost Savings for Curriculum and Collaboration

Honorable Mention: Gigabit or Bust (tie)

THE GIGABIT OR BUST AWARD HONORS THE HIGH-performance networking application/technology that best exemplifies what life would be like in a gigabit-connected world.

City College of San Francisco is planning to implement a dark-fiber-based metropolitan area network (MAN) by using coarse wave division multiplexing (CWDM) technology to connect 13 educational sites within the city of San Francisco. The City College MAN provides the infrastructure to support a fully converged network that enhances curriculum initiatives, provides connectivity for collaboration efforts with other institutions, and meets internal communication needs. While increasing connectivity and providing new paths for

communication, implementation of the MAN reduces monthly operating expenses while at the same time providing a very scalable network that can easily accommodate changes in traffic volumes and technology improvements.

Nine of the sites are City College campuses; the others are the San Francisco Unified School District (K-12), San Francisco State University, UC San Francisco Mission Bay, and a CENIC point of presence (POP). The network has

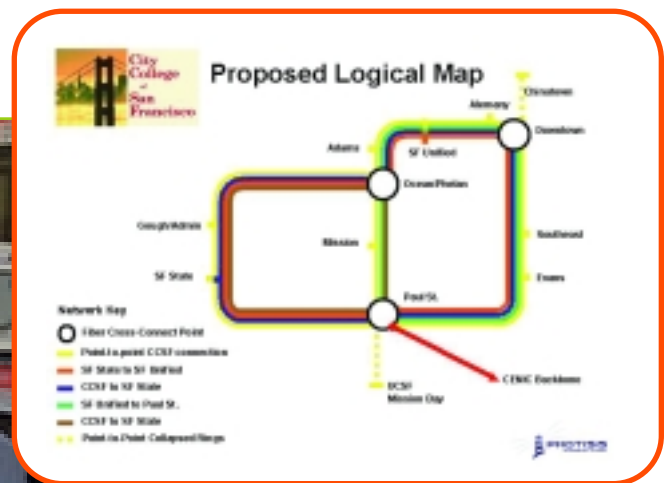
been funded by a 2001 bond initiative and is scheduled for completion in early 2004. The proposed fiber lease terms are 20 years, which will ensure the network will be a valuable resource for education in San Francisco well into the future.

The network has been designed to accommodate converged voice, data, and video traffic and will be used by approximately 100,000 City College students, 2,000 faculty members, and 1,000 classified staff for three primary applications. First, it will be used for Internet access for the nine City College campuses. City College's average daily peak utilization is approximately 20 Mbps and is steadily increasing. This network project will provide the

continued on page 24



The City College of San Francisco's network engineering team: left to right, Tim Ryan, network manager, and Glen Van Lehn, senior network engineer.



Remote Media Immersion

Using the Network to Transmit a Complete Audio and Video Environment

Honorable Mention: Gigabit or Bust (tie)

THE GIGABIT OR BUST AWARD HONORS THE HIGH-performance networking application/technology that best exemplifies what life would be like in a gigabit-connected world.

Imagine you're in a remote location—a concert hall, a meeting room, a lab, a classroom, a museum, a football stadium, or a friend's home—without needing to travel there physically. You perceive the audio and visual three-dimensional ambience around you, move around in it, and interact, communicate, and collaborate with the environment and the other people there. This is the essence of immersive technology: the creation of a complete audio and visual environment that places people in a virtual space where they can communicate naturally even though they're in different physical locations. At the Integrated Media Systems Center (IMSC) at the University of Southern California, we pursue research, engineering, education, and industrial collaborations to develop the technologies of immersive and other integrated media systems (IMS). We've developed an immersive, on-demand Internet application called Remote Media Immersion (RMI) as an initial realization of immersive technology.

The image shown at the right is an example of RMI for capturing, transmitting, and reproducing a concert by a symphony orchestra. An array of microphones is placed in a concert hall, and the audio signals they measure are transmitted using high-speed, wide area networks such as CalREN, Internet2, or a local area network. Simultaneously, very high-resolution video (high-definition video or better) is captured by one

or more cameras and also transmitted through the high-speed network. Both audio and video may also be recorded locally or at sites located anywhere on the network for off-line playback. Following this acquisition and data stor-

age, the processed audio is reproduced (rendered) in an immersive environment that accurately preserves the audio frequencies and their correct spatial relationships to the listener, thereby completely reproducing the ambience of the original concert venue. Combining synchronized high-definition video with the immersive sound completes the experience. The reproduction site can be as small as a living room or as large as an auditorium.

Creating a convincing sense of immersive presence requires the delivery of extremely high-fidelity picture and sound that approaches the limits of human perception. RMI incorporates several technical innovations to achieve that.

1. Acquiring, transmitting and displaying video at data rates of 45 Mbps or more to provide high-definition or better quality.
2. Acquiring and transmitting 16 or more channels of audio information, each at 1 Mbps, and processing and rendering 12 or more channels to provide true immersive audio that accurately reproduces the audio sensations with

continued on page 26

Immersive audio and video is transmitted from a server through a shared high-speed network to a client location. There the audience is immersed in an audio environment that accurately reproduces the frequency content and spatial relationships of the concert. Combining the immersive audio with high-definition video completes the system.



Bringing the California State Parks System to Kids throughout the State

Honorable Mention: Community

THE COMMUNITY AWARD HONORS INNOVATIVE USES OF high-performance networking to overcome economic and/or location-based network disadvantages.

“Civics never meant anything to me until I went through this program.” “Science used to be boring, but now I want to come to science class.” “Those kids really are just like us, even though their neighborhood is so different.” Such are the reactions of students who’ve participated in the California State Parks Distance Learning program. The reaction of school administrators and teachers is no less enthusiastic. Echoing the sentiments of most school representatives in the program, Lagunitas Elementary School principal/superintendent Mary Butler said, “It has given new life to our science program.”

California State Parks initiated the Distance Learning program in response to increasingly high numbers of California students living in urban areas

strives not only to close the distance between today’s urban youth and their natural and cultural heritage but also to close the technological divide that separates their schools from the world beyond their walls.

This program is a partnership that includes several county offices of education and several school districts. It uses CENIC’s CalREN-DC to deliver academic-content-standards-based programs to schools throughout California. Live video streaming and videoconferencing are combined with a multitude of high-quality, archived digital resources to provide presentations that highlight the natural and cultural resources of the California State Parks system. Without the CalREN-DC, these programs would be impossible to deliver and many of these students would be unaware of the parks’ value.

The program is led by Donna Pozzi, chief of the park’s Interpretation and Education Division, and Alan Friedman, chief information officer of the parks. Joe von Herrmann, park interpreter, coordinates the project statewide. The programs are developed and implemented by teams consisting of teachers and park employees located around the state.

The three components of the Distance Learning program are Video Streaming, Building Bridges, and Parks On-Line

The Distance Learning program strives not only to close the distance between today’s urban youth and their natural and cultural heritage but also to close the technological divide that separates their schools from the world beyond their walls.

in which distance or economic and social barriers prevent them from experiencing the values of California’s state parks. The Distance Learning program



Ranger Kevin Williams narrates a live video feed.

Resources for Teachers and Students programs.

The Video Streaming component sends a live, ranger-narrated, video feed from Año Nuevo State Reserve (home of northern elephant seals) into classrooms. One camera (SealCam) is located in the midst of a breeding colony of elephant seals on Año Nuevo Island. Another camera is located in the park’s visitor center, where a ranger presents a 15-minute program. The signal from the island gets mixed into a presentation that superimposes the ranger on the seal video, much like a TV weather person in front of a weather map.

continued on page 27

Personal Broadband Where You Want It, When You Want It

Honorable Mention: Innovation

THE INNOVATION AWARD RECOGNIZES INNOVATIVE contributions to high-performance networking that best exemplify the creative spirit and the bottoms-up philosophy that created the Internet.

The team at ArrayComm is capitalizing on its fundamental advances and years of field experience in adaptive radio technology to create a unique combination of broadband communication and mobility. This addresses a now well-understood evolution pattern of Internet user demand: once people get a glimpse of the benefits the Internet can bring to their lives—whether it's for entertainment, information access, creativity, communication, or just getting their work done—they want more. Once they experience a broadband connection either at home or at the office, they don't want to use anything slower. (They also don't want to have to pay a lot for the privilege.) And once they taste the appetizer of untethered freedom that WiFi and increasing laptop adoption are bringing to local area networks, they see the value of using broadband Internet everywhere they go. ArrayComm calls this concept of ubiquitous high-speed Internet access *personal broadband*, and the company is leading the charge to make it a reality.

Several technologies have promised to address this need for an always-on, anywhere Internet connection but with very limited success because of high costs and low real-world data rates. ArrayComm's iBurst Personal Broadband System uses patented smart antenna advances and a fresh protocol design to break through the cost barriers other technologies have faced and to deliver the first truly viable mobile broadband wireless solution.



Kyocera, ArrayComm's manufacturing partner, is installing iBurst equipment for commercial operation in Sydney later this year.

The iBurst Personal Broadband System

ArrayComm's iBurst system offers subscribers a whole new experience based on the combination of two different service categories they already know and depend on: the high-speed and low flat-

rate price of a wired broadband Internet connection but with the untethered personal freedom of cellular voice communication. Subscribers to iBurst can enjoy average data rates in excess of 1 Mbps while fully mobile throughout any covered area. While the immediate applications of this technology are clear—extending broadband access to homes and small businesses outside the coverage area of wired alternatives and allowing mobile users to take their broadband connection with them to do the things they're already doing over the Internet but wherever they choose—personal broadband will also facilitate new classes of mobile information services. Downloading music while on the move, publishing high-resolution digital photos instantly, sharing video postcards, playing richly interactive games, distributing real-time enterprise knowledge to a mobile workforce—in a world of personal broadband, any device you can take with you can have a high-speed connection to the network, enabling a grand, new experiment in novel modes of work and play.

The iBurst system comprises base stations and user terminals in desktop modem or PCMCIA-card form that communicate using ArrayComm's industry-leading IntelliCell antenna array processing technology and a new airlink protocol designed from the ground up to make maximum use of the range, capacity, and spectral efficiency gains IntelliCell can provide. An iBurst cell has approximately the same coverage as a conventional cellular base station but more than 40 times the capacity. By actively managing the interference in an iBurst cell and focusing radio energy only on its intended recipients, ArrayComm's IntelliCell technology enables the system to reuse the same radio resource multiple times within the

same sector—a result no other smart antenna technology has yet achieved. In addition, IntelliCell technology is currently used in more than 170,000 base stations in operation, so the foundations of the iBurst technology have been well tested in the battle of real commercial network deployments.

The iBurst system works as a seamless extension of the wired broadband access network in use today. The system leverages all existing Internet protocol (IP) infrastructure and is compatible with all IP-based provisioning systems, applications, services, and content. For service providers in multiple industry categories, the system's high capacity and transparent operation offer a much-needed enabler for offering broadband services with attractive economics in deployment and operation. For subscribers, it represents freedom and connectivity like they've never experienced.

Coming Soon to Spectrum Near You

The unusually high capacity and low cost of the iBurst system are attracting attention from service providers in

The iBurst system works as a seamless extension of the wired broadband access network in use today. The system leverages all existing IP infrastructure and is compatible with all IP-based provisioning systems, applications, services, and content.

several different segments of the communications industry. As the lead example, ArrayComm's partnership with a coalition led by Personal Broadband Australia is facilitating what is now the world's largest mobile broadband wireless access system deployment, covering more than 1.5 million people in Sydney with iBurst connectivity. Stay tuned for more to come.

Honorable Mention Innovation Award winner was ArrayComm. For information about ArrayComm, visit <http://www.arraycomm.com>. ●

The Road to a Gigabit Leads to Canyon Hills

continued from page 5

Developer Profile

Pardee Homes—with operations in the counties of Los Angeles, Ventura, San Diego, and Las Vegas—is one of the

Canyon Hills is soon to become perhaps the most exemplary of all of Pardee's master-planned communities.

largest fully integrated home builders in the United States. Pardee Homes purchases raw land, obtains entitlements, installs the infrastructure, builds out virtually all of the residences, and builds the industrial and commercial components within the property.

Pardee's land base is one of a kind, with 20 master-planned communities that accommodate 45,000 home sites and 750 acres of commercial and industrial property. These communities—including schools, parks, houses of worship, open space, and related amenities—will ultimately be the home of 120,000 people and will have a market value of more than \$10 billion.

Canyon Hills is soon to become perhaps the most exemplary of all of Pardee's master-planned communities. In addition to a bold technology vision, the master plan calls for a balanced mix of housing types—both single-family detached homes and multifamily homes—as well as community shopping facilities, elementary schools, middle schools, two neighborhood parks of 5 acres each, and a community park of nearly 30 acres.

Inteleconnect

Inteleconnect designs integrated turn-key telecommunications solutions for campuses, mixed-use developments, communities, telephone and cable television companies, and small, medium-size, and large businesses, and it designs telephone-provider neutral building and interbuilding infrastructure (duct and manhole system, copper/fiber plant, and central office space/CEVs) to handle advanced Internet and data networks, CATV and digital television, and telephone services.

Inteleconnect Pres. Stephen Mayo has spent 27 years in telecommunications at a diverse mix of companies. In 1998 Mayo created Inteleconnect, Inc., to focus on technology solutions for residential communities, businesses, and commercial developments. Mayo has signed a number of strategic alliances to bring full-spectrum technology expertises together to define and implement next-generation telecommunications services.

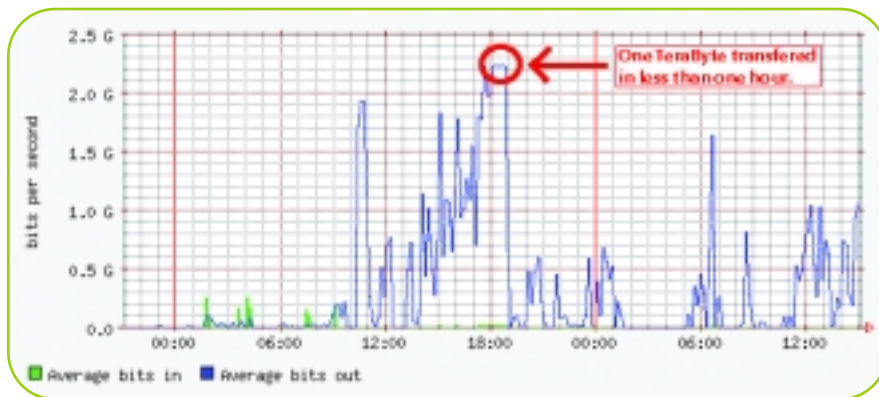


Plan Two in Laurel Ridge features advanced energy and technology features.

First-place Community Award winner was Inteleconnect, Inc. Participants included Stephen Mayo, president of Inteleconnect and James Stringer, Canyon Hills project director of Pardee Homes. For more information on Pardee Homes, visit <http://www.pardeehomes.com>. For more information on Inteleconnect, visit <http://www.inteleconnect.com>. ●

From Obstacles to Fundamental Fabric

continued from page 10



This graph illustrates the sustained TCP rate of 2.38 Gbps across 10,037 kilometers (6,223 miles) for more than one hour.

how to use multiprocessors. People will need to understand how to make 10-gigabit Ethernet network interface cards work with 1,500 B MTUs. Only then will this type of performance move from hero demonstrations to commonplace occurrence.

It's expected that the performance this test bed achieved will be commonplace and even mundane by the end of the decade. Current test bed work is critical for setting expectations for applications and users, planning, and understanding how to achieve high-performance con-

nections and making it easy to do so.

The network, once viewed as an obstacle for virtual collaborations and distributed computing in grids, can now start to be viewed as a catalyst instead. Grid nodes distributed around the world will simply become depots for dropping off information for computation or storage, and the network will become the fundamental fabric for tomorrow's computational grids and virtual supercomputers.

First-place Biggest, Fastest in the West Award winners were (collaborators and sponsors) Caltech: Harvey Newman, Steven Low, Sylvain Ravot, Cheng Jin, Xiaoling Wei, Suresh Singh, Julian Bunn; SLAC: Les Cottrell, Gary Buhrmaster, Fabrizio Coccetti; LANL: Wu-chen Feng, Eric Weigle, Gus Hurwitz, Adam Englehart; CERN: Olivier Martin and Paolo Moroni; ANL: Linda Winkler; DataTAG, StarLight, TeraGrid, SURFnet, NetherLight, Deutsche Telecom, Information Society Technologies; Cisco, Level(3), Intel, DoE, European Commission, National Science Foundation. ●

Light Bridge

continued from page 15

format. The faculty member accesses the Light Bridge site and goes to Submit a Lesson. At this point, the faculty member can read an overview of the process and decide on stage of readiness. When he or she is ready, it's time to follow a series of six screens with prompts that elicit the necessary information for both the database and the respective lesson interface. The final screen requests the files for the identified materials and prompts the user to upload by clicking the Submit button. Now or at any other point during the lesson submission the lesson author can preview the lesson in the Web environment.

Once a lesson has been submitted, the author receives verification and notice that a further e-mail from Light Bridge is forthcoming. Similar to the process of MERLOT, the lesson is placed into a

general submissions section until further review. In addition, authors can request that their lesson be peer-reviewed. If the peer review proves positive, the lesson is moved to the peer-reviewed features section and notice is given to the author. This denotes the quality of the work to his or her professional community—for instance, it terms of tenure and review—as well as the greater education community. Lessons that do not pass the peer-review process would be classified as either acceptable with changes (feedback given) or unacceptable or inappropriate (will not be posted, and ineligible for resubmission).

Honorable Mention Partnership Award winner was Light Bridge, Sonoma State University. Participants included James Fouché, director; Brett Christie, codirector; and Janet Hardcastle, administrative specialist.

For information about Light Bridge, visit <http://www.sonoma.edu/lightbridge>.

Light Bridge is a PT3 catalyst grant. ●

During the transition to a national scope of authoring and implementation of the videos in teacher education, it was discovered that a true benefit would be to use a Web-based authoring tool that allowed other professionals to publish video-based lessons to the Web for their own professional use as well as for access by others.

Virtual Education

continued from page 16



From the ocean's bottom, a Crystal Cove State Park ranger talks with students.

new to us," says Sandra Lapham, who administers instructional technology at the Orange County Department of Education.

For students and teachers alike, video-conference technology gives consistent access to current information. Orange County Superintendent of Schools William M. Habermehl says: "The

California economy requires a highly literate workforce that is skilled in mathematics and science. Schools are preparing students for a world in which knowledge, especially in science, is growing at an incredible rate. Access to knowledge has to include resources that are not dependent upon current economies. We are putting systems in place that provide information and resources independent of the state's budget situation at any given time. Wise investment in online technologies, including videoconferencing, will help ensure that all of our students have sufficient access to resources to help them meet any educational objective."

Videoconferencing instantaneously connects students and teachers with people, places, and information. Plans are in place to build relationships this fall with students in China and Mexico. Students will also participate in project-based learning as local classrooms collaborate with others in northern California and Indiana on environmental issues.

California is committed to educating more than 6 million children—and leaving none of them behind. Videoconferencing and related technologies hold the promise of significantly leveling the playing field for children and teachers. Opportunities that have been traditionally available to a few are now accessible

Wise investment in online technologies, including videoconferencing, will help ensure that all of our students have sufficient access to resources to help them meet any educational objective.

to many through virtual education. For the first time, we have an opportunity to literally transcend time and space for every education stakeholder.

Honorable Mention Education Award winner was Orange County Department of Education. For information about Orange County Department of Education, see <http://www.ocde.k12.ca.us>. ●

City College of San Francisco's Network

continued from page 18

infrastructure to easily increase bandwidth as required to support demand.

Second, the network will be used to carry voice-over Internet protocol (VoIP) telephone traffic among faculty and staff throughout the City College campuses. A VoIP telephone system vendor was selected and will complete the system installation and conversion by the end of 2003.

Third, the MAN will be used to supply video services to City College campuses in order to enhance the learning experience for 100,000 students. Multiple formats will be implemented, including delivery of the existing community cable

channel, EAtv-27, into each classroom.

A video-on-demand system will also be implemented in accordance with the

This implementation provides for other school districts an example of how a network can be funded, designed, implemented, and maintained.

video-over-IP standards being developed by CENIC—allowing customized programming into the classroom while

eliminating the coordination efforts required with the existing portable VCR systems. The intention is to use this network and its increased Internet bandwidth to support City College's growing online course offering that reaches out to students beyond the conventional campus infrastructure to include individuals who may be homebound or otherwise unable to move about on a daily basis.

Connectivity to other educational sites is included in order to support existing and future academic initiatives. Within the San Francisco Unified School District, a framework is being created that will be utilized for the delivery of Advanced Placement courses to all high school students. Within San Francisco State University, the framework is avail-

able to support a joint-use facility, which is also being funded by the 2001 bond initiative. And within UCSF–Mission Bay, communications services are being implemented for utilization by the joint Bio-Link academic initiative.

This implementation provides for other school districts an example of how a network can be funded, designed, implemented, and maintained. One example of an implementation technique that could be emulated by other schools is City College’s evaluation of the distance from its facilities to various fiber providers and its determination of the best approach, which is to implement the network in segments by utilizing fiber from the vendor that can most cost-effectively reach a given campus. The resulting network will consist of multiple fiber providers, each with designated handoff points and separate long-term lease agreements.

Potential fiber vendors and associated distances have been identified. The vendors include Level 3, MFN, RCN, and Qwest. The distances from the nearest fiber provider to City’s campuses range

from 50 feet to 4,000 feet. Under this scenario, the total construction distance involved is approximately 11,000 feet, compared with distances of 20,000 to 50,000 feet if a single provider were used. To reduce leasing costs, City will take advantage of existing fiber pricing agreements that have been negotiated by CENIC with Level 3 and MFN. To reduce construction costs, some campuses will be served by aerial fiber as

The intention is to use this network and its increased Internet bandwidth to support City’s growing online course offering that reaches out to students beyond conventional campus infrastructure to include individuals who may be home-bound or otherwise unable to move about on a daily basis.

opposed to in-ground fiber (where it is permitted by city building codes). City College is also working with the city and county of San Francisco to evaluate existing ducts they have in place that may be beneficial to its MAN project.

Overall, significant portions of the network being implemented by City College could be used to extend the network to other educational institutions as well as to private homes throughout the city. To allow for this and also to achieve maximum design flexibility, a CWDM-based design is being implemented by using Finisar hardware that will allow individual wavelengths to traverse the network without affecting existing services.

Tim Ryan, network manager at City College of San Francisco, said: “The City College metro area network project consists of a technically innovative and long-term approach to an issue faced by all colleges within the state. It combines technical advancements developed within the metro-Ethernet marketplace and also the cooperative philosophy present within higher education environments. In addition to this, it applies unique construction techniques and city-based strategies developed within CANARIE (Canada) and other municipal organizations.”

The metro area network has significant advantages and benefits over the existing leased-line service at City College:

1. It improves network access and services for a very large student body of approximately 100,000 students.
2. It integrates with other educational institutions in San Francisco ranging from the San Francisco Unified School District to UCSF Mission Bay, which is one of the most-advanced research facilities in the United States.
3. It achieves a significant cost savings for City College as opposed to monthly leased services. During the proposed 20-year lease period, an approximate savings of \$1 million is expected.



4. The proposed dark-fiber design creates the framework for simplified future expansion.
5. It allows for reduction of City College's monthly expenses by building into one of northern California POPs, thereby eliminating a last-mile telecommunication expense.
6. The design allows implementation and support by the existing City College Network Engineering staff, a key consideration due to existing state budget problems and the associated hiring freeze.
7. It provides a live hands-on learning environment for use by faculty and students in the Computer Network and Information Technology Department.
8. It provides a platform for new curriculum initiatives incorporating video technologies.
9. It allows City College of San Francisco to acquire control over the cost of the communication services needed to operate its distributed campus environment. This is particularly important because of the evolving and unpredictable telecommunication business environment.

Honorable Mention Gigabit or Bust Award winner (in a tie) was City College metro area network of San Francisco as led by Tim A. Ryan, network manager, City College of San Francisco.

The following are gratefully acknowledged for their participation in this article: Chancellor Philip R. Day Jr., City College technical visionary; Ali Nooriala, CEO and principal architect; James Jones, vice president of consulting services, Photis Consulting; John Wilson, president and CEO, eXchange Colocation; and the network engineering departments at San Francisco State University, the University of California at San Francisco, and the San Francisco Unified School District. ●

Remote Media Immersion

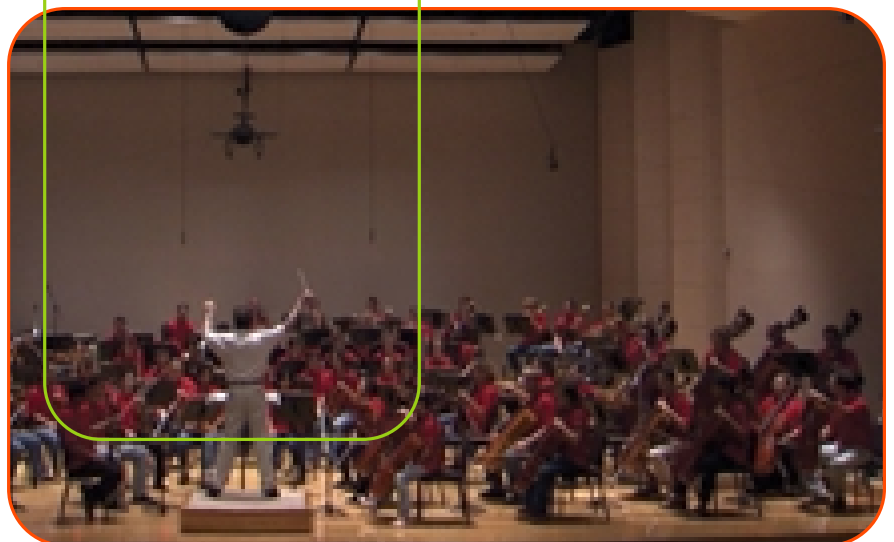
continued from page 19

3. Processing of information from a limited number of microphones (as few as two) using virtual microphone techniques to provide a full, immersive audio experience.
4. Devising architectures for real-time storage and playback of these multiple independent streams of video and audio data from heterogeneous, scalable, distributed servers.

The long-term goal of RMI and its underlying technology is the creation of seamless immersive distributed environments for any type of multiuser human interaction, including entertainment, education, gaming, simulation, teleconferencing, social gatherings, and performance events such as music, theater, or sports.

5. Development of protocols for synchronized, efficient real-time transmission of multiple video and audio streams from multiple distributed servers over local area and wide area shared networks. We impose rigid bounds on time delays among the streams, latency, and quality of service. The strict quality requirements are necessary to avoid glitches, hiccups, artifacts, and loss of immersive realism.
6. The robust integration of all of these technical areas. In addition to protocols that overcome network losses, RMI includes retransmission and other protocols at the application and perceptual layers to overcome losses in the transmission process and provide a seamless experience for users.

RMI is unique and successful because we completely control the end-to-end process by capturing the content, interfacing to the network, transmitting it without perceptual loss of information or quality, and rendering it at multiple geographically distant locations. It transforms the Internet from a low-fidelity medium for browsing



information to a high-fidelity medium delivering a rich experience beyond any home medium in existence today. It is one of the few Internet applications that goes beyond the network connections and raw bandwidth requirements of an application.

The long-term goal of RMI and its underlying technology is the creation of seamless immersive distributed environments for any type of multiuser human interaction, including entertainment, education, gaming, simulation, teleconferencing, social gatherings, and performance events such as music, theater, or sports. These applications require the development and extension of nationwide and statewide high-speed networks to provide the audio and video quality and realism for immersive interaction. Reducing delay is particularly important for interactive applications of RMI among many participants. The deployment of high-speed networks will help reduce the overall delay in transmission by simplifying the video compression and other signal processing required. Future RMI technology may include even more-realistic video: larger screens, panoramic or hemispherical displays, 3-D stereo video, and increased resolution.

Honorable Mention Gigabit or Bust Award winner (in a tie) was University of Southern California Integrated Media Systems Centers. Participants included Alexander A. Sawchuk, Roger Zimmermann, Cyrus Shahabi, Ulrich Neumann, Chris Kyriakakis, Tomlinson Holman, and Christos Papadopoulos. For information on University of Southern California Integrated Media Systems Centers, visit <http://imsc.usc.edu/rmi/>.

This research has been funded by the Integrated Media Systems Center, a National Science Foundation Engineering Research Center, under Cooperative Agreement No. EEC-9529152 and Grant No. EIA-0116573. Any opinions, findings, conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect those of the National Science Foundation. ●

Bringing the California State Parks System to Kids throughout the State

continued from page 20



This integrated program using multiple technological approaches truly brings the state parks to the classroom.

The Building Bridges component creates a partnership between two classrooms and parks from different areas of the state. Using digital photos, digital video, presentation software, and other tools, students prepare reports about “their park.” The two classrooms

The Distance Learning program enables economically disadvantaged children to experience parks hundreds of miles from their homes in areas rarely visited by their families. The inspiring backdrops of the state parks buttress their lessons in the fields of history, visual and performing arts, science, math, and English.

then communicate via a videoconference using the CalREN-DC. During the video conference, the students present their report to their sister school and teach each other about “their park” and themselves.

The PORTS component consists of a series of programs developed locally and then made available to schools throughout the state via the CalREN-DC. Each component of PORTS is a unit of study that includes several in-class lesson plans, online material, and videoconferences with parks. Currently, schools in San Diego, Orange, Sacramento, and Marin counties are participating in development of this program.

The California State Parks Distance Learning program furthers the mission of the state parks and improves the education of California schoolchildren by using the power of the CalREN-DC. It enables students in urban areas and other locales to experience the grandness of their state parks while addressing academic content standards. Often, these students, due to their physical and cultural environments, are unaware of the values, and importance of the California State Parks System. The Distance Learning program enables economically disadvantaged children to experience parks hundreds of miles from their homes in areas rarely visited by their families. The inspiring backdrops of the state parks buttress their lessons in the fields of history, visual and performing arts, science, math, and English. This integrated program using multiple technological approaches truly brings the state parks to the classroom.

Honorable Mention Community Award winner was California State Parks. Participants included Alan Friedman, Joe von Herrmann, and Donna Pozzi. Grateful acknowledgement to contributing author, Joe von Herrmann. ●

Other CENIC Programs

CENIC IS ABOUT MORE THAN JUST PRODUCING A GREAT network applications magazine. Read about how some of our other projects are helping CENIC lead the way to tomorrow's Internet. For more information about CENIC, see <http://www.cenic.org>.

CalREN

CENIC's California Research and Education Network (CalREN) establishes a multitiered optical network-services fabric to serve all research and education in California.

Following are CalREN's three levels:

CalREN-XD. CENIC's experimental and developmental network supports 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 at Caltech and its Jet Propulsion Lab, the University of Southern California and its Information Sciences Institute, Stanford University and the Stanford Linear Accelerator Center, national laboratories and other major network research entities that collaborate with researchers in California.

CalREN-HPR. CENIC's high-performance research network provides leading-edge services for large-application users and CENIC associates sites. CalREN-HPR is an integral component of Internet2.

CalREN-DC. CENIC's Digital California network provides high-quality services for K-20 students, faculty, researchers and staff. The Digital California Project: K-12 Statewide Network being implemented by CENIC extends the existing backbone to each of the 58 California counties to facilitate connectivity by California's K-12 schools.

In addition to providing the entire California research and education com-

munity with the most cost-effective advanced services network available, the multitiered CalREN infrastructure supplies the high-level network services needed to successfully conduct high-performance research activities. It also provides network researchers in California with the infrastructure needed to conduct critical investigations into optical networking technology.

Digital California Project (DCP)

The DCP is a state-funded effort to build the necessary network infrastructure required to enable California's schools to take advantage of tomorrow's advances in network technology. In essence, we are developing an advanced-services network to serve the K-20 education and research community.

The overarching goal of the DCP is to enrich learning for all K-12 students in California, with a three-tiered focus on:

- Identifying and making accessible a rich array of education resources to enhance the teaching and learning process for K-12 educators and students.
- Strengthening the existing program and service relationships between universities, community colleges and K-12 schools in the areas of teacher preparation, professional development, curriculum development, student outreach, and information resource sharing.
- Developing a comprehensive and integrated, high-speed statewide network infrastructure that will expand K-12 schools' connectivity to each other, to higher education institu-

tions, and to other organizations across the globe.

In order to attain this goal, the DCP is concentrating its efforts on accomplishing the following objectives:

- Facilitating access to rich content resources for teaching and learning in K-12.
- Creating an environment that facilitates collaboration between California's K-12 and higher education communities.
- Operating a robust statewide advanced services network for California's K-20 community.

One Gigabit or Bust Initiative

CENIC's One Gigabit or Bust Roundtable addresses critical technical, policy, financial and organization challenges facing the delivery of one gigabit broadband to all Californians by 2010. The Roundtable brings together the interests of research, education, commerce, state and local government and the general public to address the issues surrounding the implementation of robust end-to-end broadband capabilities to every education institution, business and home in California.

Joining the One Gigabit or Bust Roundtable enables institutions to:

- Meet and collaborate with other interested industry and academia members on critical problems in using or creating a gigabit network.
- Learn about the One Gigabit or Bust Initiative and what it means to their business.
- Tackle problems including development and research on policy, technology, implementation, and economic issues.

The Roundtable has two one-day meetings per year and assists members in forming task forces to address specific topics of interest. ●



Corporation for Education Network Initiatives in California

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CENIC Partners

California K-12 System
 encompassing 58 counties and 985 districts

CaIREN Associates

University and Community College System of Nevada

CENIC 2004

On the road to a Gigabit

CALL FOR ENTRIES



CENIC invites industry, academia, government, and community organizations to apply for the 2004 On the Road to a Gigabit Awards. Cosponsored by CENIC and Cal(IT)², the awards honor the pioneering ideas of California's visionaries and the promise of tomorrow's Internet by highlighting technologies paving the road to a ubiquitous gigabit statewide network by 2010.

Categories

- **Biggest, Fastest in the West** The fastest and most-scalable high-performance networking application/technology
- **Community** Innovative uses of high-performance networking to overcome economic- or location-based network disadvantages.
- **Education** Innovative uses of high-performance networking in K-12 and higher education
- **Gigabit or Bust** The high-performance networking application/technology that best exemplifies what life would be like in a gigabit-connected world
- **Innovation** Innovative contributions to high-performance networking that best exemplify the creative spirit and the bottoms-up philosophy that created the Internet
- **Partnership** The best use of high-performance networking developed by a private/public partnership

Criteria

- The extent to which the application/technology meets the stated goals of the award category
- The extent to which the application/technology promotes the development and implementation of a ubiquitous gigabit statewide network by 2010
- The impact and benefits of the application/technology

Judges are leaders in industry, government, and academia.

Awards will be announced at CENIC's annual conference in March 2004.

To enter the awards program, see <http://www.cenic.org/CENIC2004/awards/awards.htm>.

Completed entry forms must be submitted by December 5, 2003.

CENIC gratefully acknowledges Mike Bailey for creation of the 3-D California image above. Does everyone still have their 3-D glasses? Go get 'em!



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