20 YEARS OF CONNECTING CALIFORNIA

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SPRING 2017


CENIC connects California to the world,
advancing education and research statewide by
providing a world-class network essential
for innovation, collaboration, and economic growth.

"We knew we didn't want California to be an island. We wanted to be excellent. We wanted to be ahead of the curve."

Stuart Lynn, CENIC CEO Emeritus

"Stuart [Lynn} had the foresight to realize California would benefit from having its own network."

Jim Dolgonas, CENIC CEO Emeritus

The Founding

The Art of Networking

Built for Research, Driven by Science

"Networking is a scaled business and the larger the network, the better and more efficient it becomes."

Bill Clebsch, Associate Vice President, Stanford University

"We wanted a place in which we could work on new technologies and advance technology in the future"

Russ Hobby, former CIO, UC Davis

“In California, CENIC is the one vehicle that’s neutral. It has the opportunity to deliver significant public benefit without losing sight of its original purpose.”

Tom West, CENIC CEO Emeritus

“I think CENIC has extraordinarily good leadership. I’ve never seen such a sequence of solid leaders.”

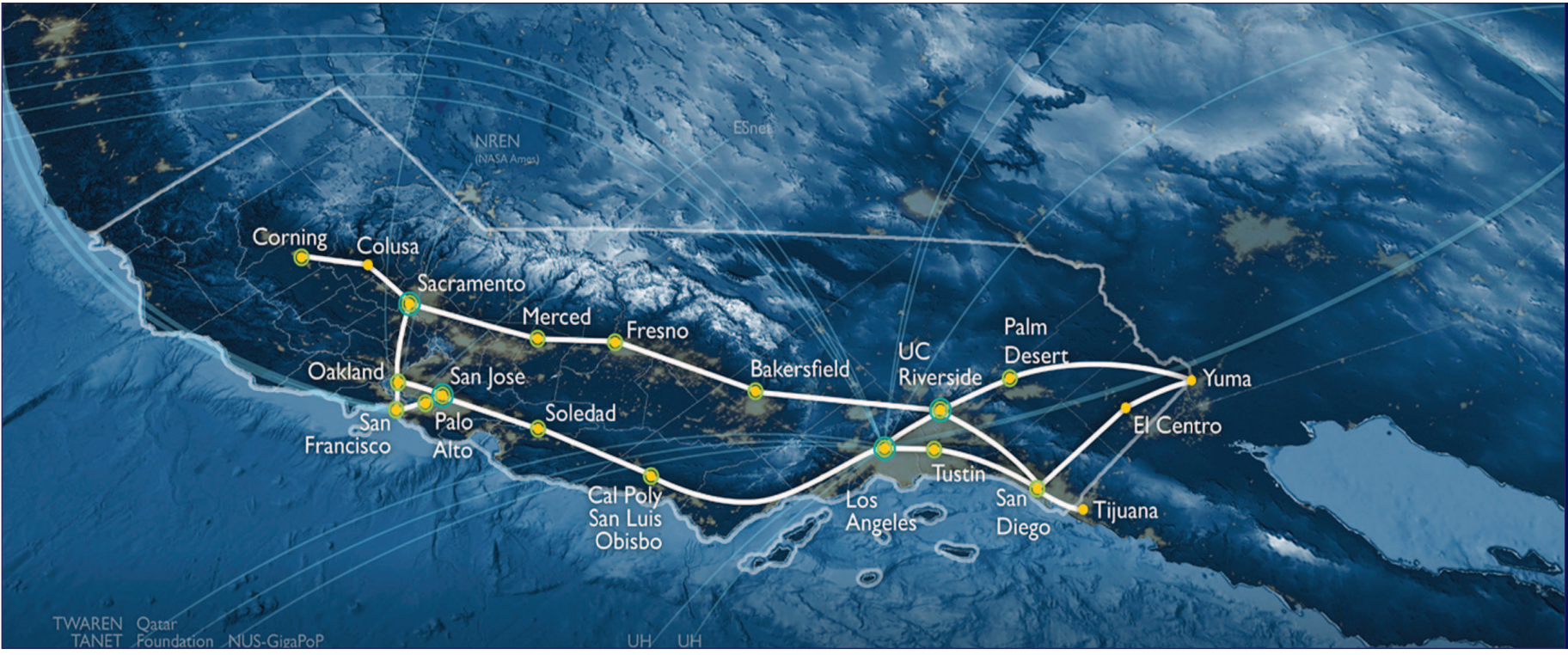
Ron Johnson, Vice President, CIO Emeritus, & Professor, University of Washington

Expanding Access

Right Leaders, Right Time

“CENIC’s future is both one of deepening our commitment to the things we have done historically and looking at new activities that bring value to California.”

Louis Fox, CENIC President & CEO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(NASA Ames)
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There were networks in California before CENIC was founded; the idea of a network wasn't new. What was new in 1997, however, was the size, the scope, and the collaboration necessary to achieve what became CENIC.

As the state that was arguably home to the people who created the Internet in the first place, California had many scientists, faculty, and computer engineers building connections with their colleagues and peers at neighboring institutions. Fueled by grants from the National Science Foundation (NSF), these early networks were focused in tight geographic regions.

In the Bay Area, BARRNet—the Bay Area Regional Research Network—connected four University of California campuses (Berkeley, Davis, Santa Cruz, and San Francisco), Stanford University, Lawrence Livermore National Laboratory, and the NASA Ames Research Center. CERFNet originated at the San Diego Supercomputer Center, and provided additional connectivity to UCLA, Caltech, and the University of California, Irvine. And in the Los Angeles region, Los Nettos connected the California Institute of Technology (Caltech), the University of Southern California and its Information Sciences Institute, and the University of California, Los Angeles (UCLA). Each of these networks was a powerful player in its region, in large part because of the prominence of the institutions.

"I thought we should talk to each other," said Russ Hobby, from the University of California, Davis. "So I formed the California Internet Federation to get people together to consider how all of these networks needed to connect."

Although the federation members met quarterly for close to five years, sharing solutions to issues such as routing concerns, while NSFNet was in place there was never a move to fully integrate the networks statewide. Outside of the federation, the California State University system had CSUNet, an expansive network that effectively connected its campuses across the state.

That landscape in 1995 changed with the NSF's decision to decommission its backbone service and transition to a different architecture, one dependent on commercial services for connectivity.

"It was in the mid-1990s that I realized that the national backbone network could be provided by the commercial Internet," said Steve Wolff, NSF program director from 1986 through 1995. "So I took the money that would have been spent on the national backbone and divided it between the regional networks, helping them buy into commercial networks."

"There were a number of us from universities who said 'Hey, there's still a need for this kind of thing,'" said Hobby. "The NSF was thinking that the commercial sector would just take on the national network and run it from there. We realized that the commercial sector was really concerned with expanding what was, while we wanted a place in which we could work on new technologies and advance technology in the future."

"The commercial network wasn't as well developed as I believed it was," said Wolff. "That is why Internet2 came along as a private entity to serve the universities."

Tom West was CIO of the California State University system at the time. "A number of universities decided we couldn't rely on the private sector to bring us the speed we needed for our research and educational purposes."

Representatives of universities and research institutions from across the country gathered over the next several months to plan alternatives to NSF's backbone. Among those meetings was the Monterey Futures Network meeting, which was followed several months later by a meeting at Cheyenne Mountain, in which the unique needs of research and education institutions were discussed.

By 1996, the early leaders of what would become Internet2 scheduled a meeting for higher education institutions at Chicago's O'Hare airport.

"We met in the basement of O'Hare," said former Berkeley CIO Jack McCredie. "As I recall the individuals who were there included our networking guy David Wasley."

"Yes, I was there," said Wasley. "We wanted to discuss whether we needed a network outside of the commercial network, and we all agreed that a platform of some sort would be useful."

"This was the famous meeting that involved the formation of Internet2," said former UC CIO Stuart Lynn. "All of the California institutions sat at the end of the table to show that we were a band of brothers, in this thing together."

"Yep. We all sat together," said Hobby. "We sat together so we could get going faster. We knew we had work to do."

"We were a block," said Tom West. "We reflected a unified front, and that was instrumental."

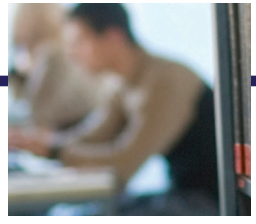
"We made clear to the national effort that, although we were strongly supportive of it, California needed to be reckoned with as an entity," said Lynn.

Those involved recall a sense of urgency following that meeting, and the need to quickly get California institutions working together to prepare for the development of what would be Internet2. A few, however, were skeptical that the effort could overcome the parochial pride that had built up in those small, yet important, networks scattered throughout the state.

"The real genius in all of this was Stuart Lynn"

Cliff Frost, formerly at UC Berkeley

"At some point in the meeting, Stuart said 'Hey, you guys, we should do the same thing in California that is being proposed nationally—a network that's inclusive of all of us, that we can connect to this national network when it gets built,'" said Sherilyn Evans who, at the time, worked in the UC Office of the



President. “We all said, ‘Great idea, Stuart,’ and left the meeting thinking ‘You’ll never get the CSU and UC systems to agree with each other and create a partnership with the three independents.’ We all thought Stuart was a guy whose reach exceeded his grasp, but we all went back to get it done.”

“I was told by my old friends in the East that there’s no way you’ll get the California universities and systems to work together,” said Stuart Lynn, who was leading networking efforts from the UC Office of the President. “I told them they were probably right, but that I was going to give it a whirl because it’s the right thing to do.”

“I never really understood Stuart’s job in the Office of the President. Sure, he would coordinate activities, but he didn’t have any budget or real oversight,” said McCredie. “But at that Chicago meeting, we all pledged that California would be really involved and that the UC system would take a significant role with Internet2. And Stuart emerged as the leader in trying to bring the UC system together with some of the privates and the CSU system to get this done.”

“Stuart Lynn was the instigator in forming CENIC,” said CSU’s Tom West. “He was the guy who drove the bus of this thing. He said ‘We’re not going to have all this disparate stuff going on in the future, so we need to bring all the institutions together.’”

Wasley agreed. “Stuart had this vision that the future of networking in California wasn’t just for the UC schools. He believed that all the universities in California should collaborate. It wouldn’t have happened if Stuart hadn’t worked that way.”

“The real genius in all of this was Stuart Lynn,” said Cliff Frost, former Berkeley Director of Network Services. “The UC system almost never cooperated on anything, particularly in the 1990s. The fact that Stuart was able to get the UCs, the privates, and the CSUs in a room, and get them to cooperate, was remarkable.”

"Of course the stimulus, and the reason the timing was right, was the NSF's request for proposals," said Lynn. "They were funding $365,000 grants to help institutions connect to the internet. But to trigger the grant dollars, the institutions had to match the money. I used that as an opportunity to engage my colleagues, and traveled around to the institutions. I dealt first with the UC campuses, which are not famous for working together. I got Dick Atkinson, the UC President at the time, to get involved. I told him that the Office of the President needed to do the right thing, and he came up with the matching funds. This was a very persuasive tool that I could bring to the campuses, helping my counterparts as well as the chancellors at UC get behind the effort.

"Of course, I didn't have that tool for the private universities, but I was very proud of the people at those campuses. Stanford, Caltech, and USC got it right away. They came on board, and realized that the whole was larger than the sum of the parts—that we would get a bigger opportunity with NSF if we got together for our proposal."

"Stuart, in his very diplomatic role, met with the CIOs of Caltech, Stanford, USC, and all the UC campuses," recalled Wasley. "Out of those meetings came a somewhat tenuous but very important decision that we should submit a proposal for one of the NSF's high-speed networking matching grants, using the grant to help build a California network."

"I talked to the NSF and I asked how they would feel about a group proposal. They were very encouraging. They thought it was a good thing to do so, we started working to get the institutions to agree," said Lynn. "Money is a remarkable stimulus, but I think the biggest stimuli were the people involved across the campuses. I'm sure, like me, they had doubts that we could pull it off."

"I remember walking around to faculty members at Caltech and asking what type of work they were doing that would qualify as meritorious," said Caltech's John Dundas. "It wasn't easy putting it together, getting faculty to write pieces, and getting approvals from administrators and our VPs."

Sitting down for meetings, pounding the pavement, and driving the highways paid off for California when a coordinated NSF grant application was finally submitted. The coalition, however, lacked one very important constituency.

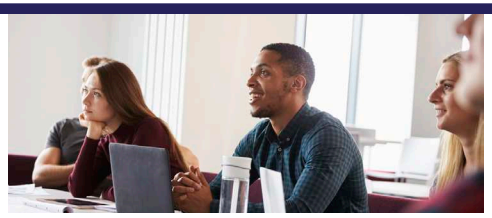
"One of my great disappointments was that the California State Universities could not be part of that proposal," said Lynn. "I want to make it clear that in the early planning, as we came together at meetings, Tom West, Dave Reese, and others in Cal State were a very important part of the discussions. But when it came to proposal time, the NSF was clear that this was for research institutions only. We couldn't find a way to include CSU into the proposal."

"Susan Estrada, who had been executive director of CERFNet, and I wrote the proposal," said Russ Hobby. "We thought it would go out through the UC President's Office, but instead it was submitted from the consortium."

"The CSU was left out in the first round, and since I was working there at the time, we weren't too happy about that," said Dave Reese.

"We had a little brouhaha about that internally," said Tom West. "Stuart convinced us that we had to put our Research 1 institutions forward first and that we could later go for a second round for the CSU, which we did."

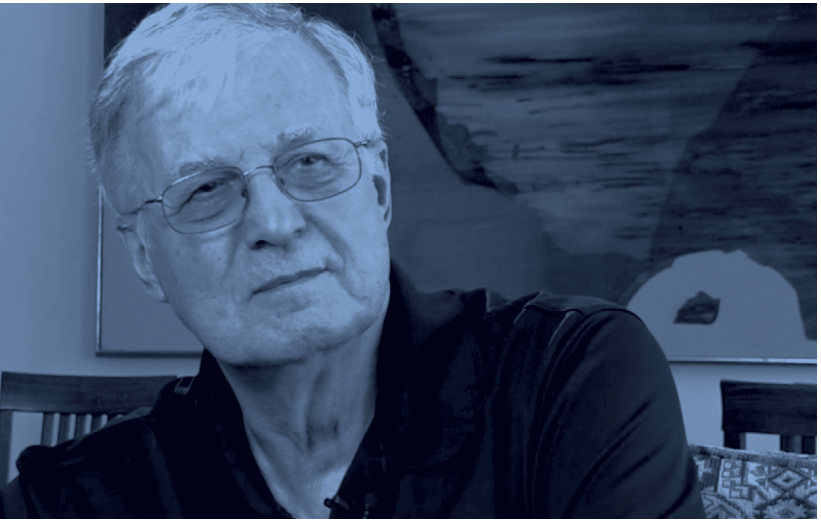
"Looking back, it was the right idea," said Reese. "The following year, the NSF released another solicitation that included the comprehensive universities, so CSU was included then."



CENIC | M. Stuart Lynn, founding CEO of CENIC, 1996–1999

Following a career in academia, business, and consulting, Stuart Lynn was recruited back to the University of California Office of the President (UCOP) in 1996 to serve as Chief Information Officer. “I thought I would retire,” he said. “Some of my old friends at Berkeley learned I was in the neighborhood and they persuaded me to come into that position as CIO, so I went out of retirement.”

“Before I got there, there had been various initiatives trying to get the campuses of the University of California (UC) and also the privates—Stanford, Caltech, and USC—to collaborate on a California network,” recalled Lynn. “Those earlier networks failed, primarily because of the insularity of our systems. It just wasn’t the right time.”



“We made clear to the national effort that… California needed to be reckoned with as an entity.”

Stuart Lynn,
CENIC CEO Emeritus

What made the difference this time was an opportunity issued by the National Science Foundation (NSF): $365,000 grants to help institutions connect to the Internet. To trigger the grant dollars, however, institutions needed to match the money.

“I used that (NSF grant) as an opportunity to engage my colleagues, dealing first with the UC campuses, who are not famous for wanting to do things together,” said Lynn. “I convinced UC President Dick Atkinson to come up with the matching funds for the UC campuses, which was a very persuasive tool to get the chancellors behind a collaborative grant submission. Of course, I didn’t have that tool for the private universities, but they realized right away that we would get a bigger opportunity with the NSF if we got together for our proposal.”

Lynn talked with the NSF and was told that a group proposal would be well received, although there was considerable doubt at the national level that it was possible to get California institutions to work together on a shared network.

"I think I was being something of a catalyst in bringing people together," said Lynn. "I had worked with some of the private institutions, had some influence with the UC campuses, and had some very important engagement from Tom West and Dave Reese at the Cal State system in planning for the proposal."

"One of my great disappointments was that the California State University (CSU) system could not be part of that proposal because the NSF made it clear that this grant was for research institutions only. I was very pleased that Tom and Dave and others from CSU continued to participate because I thought that was important."

Lynn and the planning group developed a memorandum of understanding among the institutions noting that UCOP would be the lead institution on the proposal, but that there would be an organizational structure reflecting each institution's interest. In early 1997, the consortium learned they would receive a grant award.

"We had to work fast to put a not-for-profit organization together that was independent of our institutions," said Lynn. "Lawyers with the University of California were concerned about this independent company taking money that was granted in the name of UC, but that wasn't UC's alone."

Naming the organization was the first challenge. Early discussions focused on naming the statewide network CamReal, after El Camino Real, the "King's Highway" that connects the 21 missions in California. "I had some suggestions that were bad ones," said Lynn. "Dave Wasley was the man who came up with CENIC. And there was some debate about exactly what it stood for, but David got the acronym right—the Corporation for Educational Networking in California."

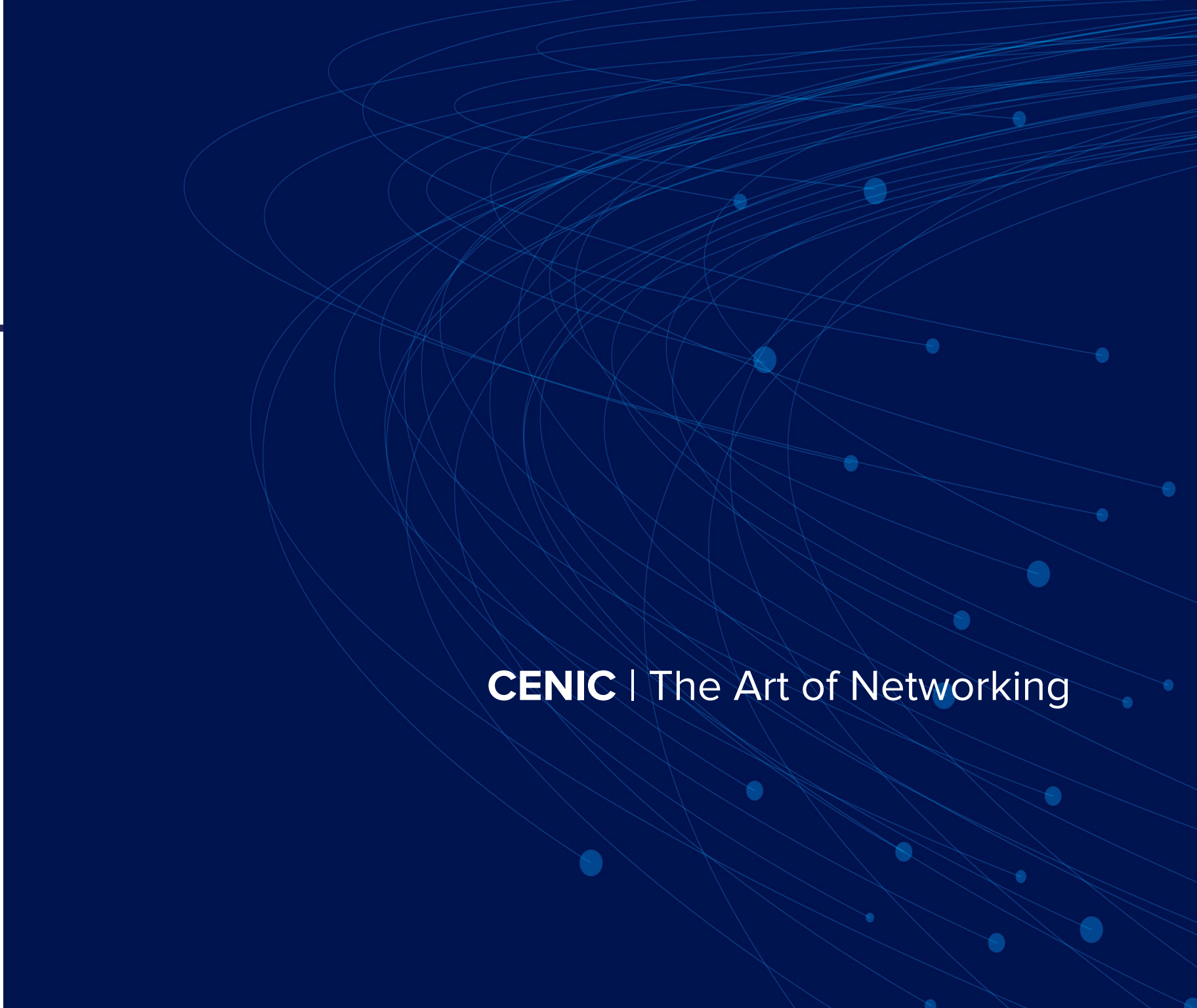
Stuart Lynn is also credited with building the governance model that engaged all members equally in meaningful decisions, while assuring UC lawyers that its institutional accountability was retained. "I remember spending a lot of time with the UCSF lawyers putting the 501(c)(3) together to establish CENIC," recalled Lynn. "I came up with a sort of Solomonic way of setting up the board so UC couldn't dominate, but would have some ability to ensure its interests, and that satisfied the lawyers. That was a challenge putting that together, but we succeeded."

Stuart's colleagues attribute much of that success to his quietly persuasive personality as well as his far-reaching vision for the potential of an organization like CENIC."We knew we didn't want California to be an island. We wanted to be part of something that was happening worldwide, and we knew that wasn't going to happen with the commodity Internet," said Lynn. "The commodity internet has to satisfy many individual interests, so it averages out. We didn't want to be average. We wanted to be excellent. We wanted to be ahead of the curve."

CENIC | M. Stuart Lynn, founding CEO of CENIC, 1996–1999

"If you had told me in 1996 that what we were starting would become what I see today, I would have said, 'well, that's a little far-fetched.' But it was always our goal to break down the barriers of distance and time to facilitate really effective research and educational collaboration across the state of California, with the rest of the nation, and around the world, too, by building the right kind of linkages into national and international networks. We always had that goal in mind."

CENIC CharterMembers March 2017


CENIC | The Art of Networking

The early network engineers who fueled CENIC's start began their careers before networking was a career. All of them, in fact, completed their undergraduate degrees with no access to email, and no instant access to global knowledge.

"In 1978, I was the electronic engineer for the science department, and my job was to build and fix stuff," said Jim Warner of UC Santa Cruz. "We made things. Computers were just sort of an annoying, small part of our job. We'd help people solder things together so they could print things. We got into the networking business because skills like soldering and putting things together were necessary to put a LAN together."

John Dundas began his career at the Jet Propulsion Lab in Pasadena. "Landing on the moon was a big reason for me to get involved with the JPL in 1977. I worked on the Voyager spacecrafts when they were launched, and ended up working with the deep space network, which are those tracking stations that track and move all the data for all the unmanned probes."

Rich Fagen is another who moved from the JPL to Caltech in the mid-1980s. "One of my first jobs was to write a manual on how to use email," he said. "And then I convinced the people doing the Caltech directory to add email addresses, and they asked me 'Why would you do that?'"

With its corporate structure in place by 1998, CENIC moved quickly to activate, build, and then expand a statewide network connecting the UC system, the private universities, and, finally, the expansive CSU system.

"Peering is complicated and has to be good for both parties. In hindsight, we made some incredibly shrewd moves"

Bill Clebsch, Associate Vice President, Stanford University

Before CENIC provided the first statewide network—the California Research and Education Network, or CalREN—getting data from UC campuses in the southern part of the state to the Bay Area was difficult.

"We were on CERFNet and Berkeley was on BARRNet and UCLA was on Los Nettos," recalled Mike Scott, from UC Irvine. "UC Berkeley might have excellent connectivity to BARRNet, but UC Irvine couldn't connect easily, so it was hard to connect with our colleagues in Northern California."

"What we had at that point in time were two OC-48 rings: one in the Bay Area that connected the institutions there, and one that connected the institutions in LA to San Diego, and they were interconnected by an OC-12 connection," recalled Tom West. "Then CSUNet supplied the redundancy, and that was another way of drawing everybody in."

"In the first iteration of the network, we bought leased services from PACBell," said John Dundas. "We did SONET rings throughout the state, and we just stuck routers on these things and created a network that way."

In its early years, CENIC built its network with volunteers who worked for member organizations and were assigned to various tasks with the growing network.

With Stuart Lynn's retirement, there was an opening for a Chair of CENIC's Board, so USC's John Silvester stepped up. "I became the chair and served from 2000 to 2006."

"The member institutions had a much more hands-on role in the operations of the network in the Tom West days," said UCSC's Jim Warner. "For a long time, Tom was proud of the fact that CENIC only had two employees and the rest of the work was accomplished by talent from the campuses."

UCLA's Jim Davis arrived in California from Ohio State in 2000. "CENIC was similar in nature to what I was used to from OSU," said Davis, who served as CENIC Board Chair from 2006–2009. "What was impressive was how well-run and how together the group was. I had just come off a networking group that was shut down, and here was a group that was very well-run and a very well-supported organization."

Davis wasn't the only transplant to California from the Midwest at that time. Larry Smarr, former director for the National Center for Supercomputing Applications in Illinois, had arrived at UC San Diego to found and direct the California Institute for Telecommunications and Information Technology.

"In my last years of work in Illinois, I had advocated that the future was based on fiber optics, and had convinced the Governor at the time to invest," said Smarr. "So I get to California and find they're leasing SONET. One of the first things I do on the board is say, 'Why don't you guys have your own fiber optic plan for your network?'"

Smarr found a willing colleague in CENIC Board Chair John Silvester. "I gave a speech to a national group saying we needed to get into fiber optics because the commercial services weren't providing that level of service," said Silvester. "We wanted to build our own network with CENIC. We wanted to own it and control our own destiny, since companies are profit-oriented and not focused on what's in the

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Tom West, CENIC CEO Emeritus

best interest of research and education. So we thought that if we bought our own fiber, we could get into providing those services to our campuses before the commercial sector would be willing to."

"We wanted to be ahead of the curve," recalled Stuart Lynn, "and that's why we knew we were going to need our own dark fiber, as soon as we could find a way to make that happen. It didn't happen on my watch. It happened under Tom's watch."

What happened was the burst of the dot-com bubble between 1999 and 2001, which provided an opportunity to purchase long-term access to extensive dark fiber networks, and thus to create fiber optic connectivity for the institutions connected by CENIC.

"The dot-com bust helped us, because it meant that people with fiber and equipment were hungry to give us deals," recalled Tom West. "Had it not occurred, I think we wouldn't have been as fortunate."

"This is not something other institutions were doing, but in Canada they were," said CENIC's Sherilyn Evans. "Ron Johnson (at the University of Washington) knew that and shared it with Tom, and they agreed that with all the excess fiber it was a good time to buy. With Tom taking the lead, they started identifying where fiber was available."

Many also cite the relationship with Cisco as an early success factor. "The relationship between Cisco and California was important too. The technology was critical, and Tom West played that so brilliantly," recalled Washington's Ron Johnson. "He's a gifted manipulator when it comes down to it. He's so self-effacing and plays the populist, but he's very gifted at making things happen."

As CENIC moved toward having greater control and ownership of its network, the time came to select a network operations center (NOC) for the system.

"Somewhere along the way we had to make a decision about the network control center, and there were different places that could do it," recalled Berkeley's Jack McCredie.

"We got a call from Tom West to come review NOC proposals," said Mike Scott of UC Irvine. "When we looked at the CSU facilities, they were doing distance video learning, with 200 sites. They knew what they were doing and had been doing it for years. They were so far ahead of UC it was amazing."

The network itself was built with remarkable speed, considering the significant complexity of the pieces and the many parts of its consortium. Participants overcame the bureaucracy that normally inhibits quick action within systems of public higher education, as well as the usual conservatism of private institutions.

"What really cemented the win in California is that by building an independent network, we weren't subjected to the political issues that happen on campuses," said Silvester. "And the real win was that, through our peering relations, we got into the game of providing commodity traffic in addition to the research traffic. By making that work across institutions, we were providing huge amounts of traffic. That means we've saved millions of dollars by pushing it out through peering traffic instead of through commercial networks."

Network peering relations are based on human relationships, and CENIC has been fortunate that its engineers and member institutions have strong relationships regionally, nationally, and internationally. In other countries, research and education communities frequently establish peering relationships in order to enhance and enable research and

educational opportunities among members. CENIC itself was established with that goal in mind, enabling a natural progression to robust peering relationships.

These relationships have shifted a significant portion of network traffic to peering, away from commercial transit networks that meter and charge fees based on usage.

In 2003, nearly 93 percent of CENIC's traffic with the outside world used these fee-based transit connections. Thanks to a targeted and sustained effort by CENIC engineers, by 2012 that balance had shifted dramatically. Not including the CENIC traffic that routes through CalREN or through other research networks like ESNet and Internet2, approximately 75 percent of CENIC's traffic now travels through peering connections, with just 15 percent going over fee-based transit connections.

CENIC now engages in commodity network peering with 88 providers, a result of more than a decade of negotiations by CENIC on behalf of its member institutions.

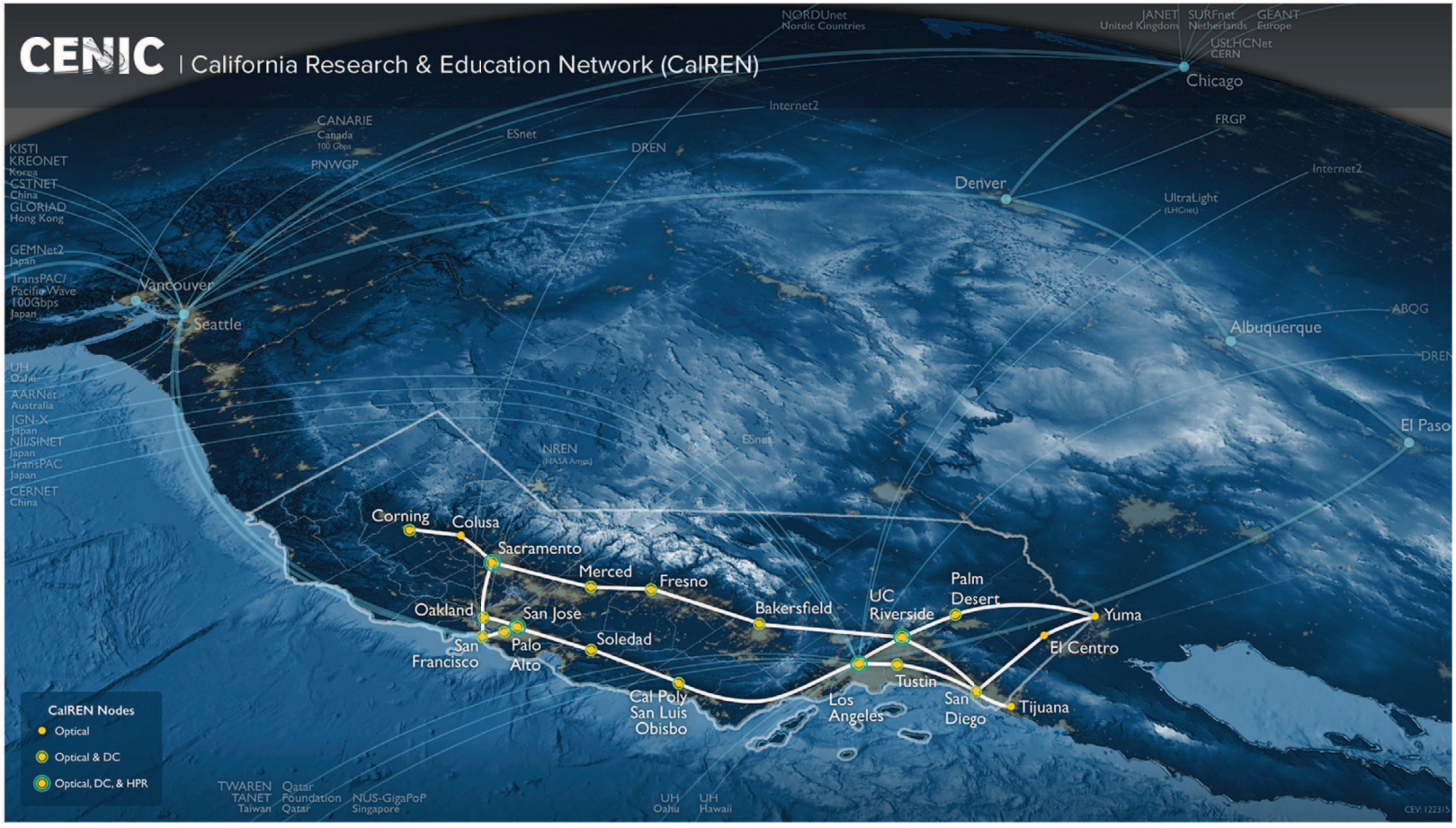
"In hindsight, we made some incredibly shrewd moves," said Stanford's Bill Clebsch. "We were very early in the peering game, and just agreed to exchange traffic with other networks. Peering is complicated and has to be good for both parties, but a lot of this was a handshake between technical people, and boy, that allowed us to save a lot of time and money. It turned out to be just brilliant."

The CENIC members who are actively engaged in national networking organizations also experience the impact of its reputation. UC Irvine's Mike Scott has been involved with the national higher education networking organization Educause, and notes that any mention of his relationship with CENIC is greeted with nods of recognition and approval.

Today, UC Santa Cruz colleagues Jim Warner and Doug Hartline see CENIC's continued connections with top engineering talent and with member organizations as the key to future success.

"There is no easy path to remaining a technical leader," said Warner. "What seems important to me, though, is that we're working together to help institutions meet their functional needs and to provide services they need and want."

"CENIC's success is based on what's best for us and for the state to be competitive," said Hartline. "We're doing something that's larger and better because we're doing it together, and that's the perspective that must prevail for this success to continue."



CENIC

January | 2016

CENIC | Tom West, CEO of CENIC, 1999–2004

Tom West came to California in 1981, and ultimately served as Chief Information Officer for the California State University (CSU) system. He was there in 1996 when he received a call from Stuart Lynn at the University of California Office of the President. As he recalled, it was just as the National Science Foundation had decided to quit funding the NSFNet and to launch its high-performance computing initiative.

"In California, up to that point in time, UC had a network, CSU had a network, and, as part of the NSFNet, there was a network in Southern California and in the Bay Area," said West. "That's when Stuart called and said we needed to try to go after some of this high-performance computing grant money the NSF was going to award."

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Tom West,
CENIC CEO Emeritus

West and his colleague Dave Reese were deeply involved in the earliest discussions, even though the CSU system was not included in the original grant application.

"CSU was not part of that original grant, and we had a little brouhaha about that internally," recalled West. "But Stuart convinced us to put our Research 1 institutions forward first, and then we could be part of the next round of funding for the rest. And that's what we did."

West was actively engaged with the CENIC board of directors from the start. When Lynn retired from his UC role in 1999, the board decided to hire its first chief executive for CENIC.

"They were having a hard time finding good candidates and someone asked me to be a candidate to head CENIC," recalled West. "I said I would be drafted, but not a candidate, so they recruited me."

As the first CENIC employee, West quickly dove into the business of building out the statewide network.

"Not long after I started, we made the decision to build our backbone with fiber, if we could," said West. "Companies like Level 3 and equipment providers like Ciena and Cisco had inventory they had to move, and we got very deep discounts. Those early relationships worked for everyone involved. I do believe our early engagement with all of them enabled them to be successful with other organizations similar to ours across the country."

With the core network infrastructure in place, West and CENIC's at-large board member, Ron Johnson—CIO for the University of Washington and director of the Pacific Northwest Gigapop—began working to extend CENIC's reach.

"One day Ron commented that we needed to connect Seattle to San Diego. He told me he was working with people in Alaska and those doing research activities in the Arctic, and that we had all this work that could connect to this big supercomputing center in San Diego," recalled West. "Ron Johnson is a very rare person. He's quite bright. I'm just a workhorse. I synthesize and integrate ideas while people like Ron Johnson generate a lot of ideas."

"Eventually we came up with the name Pacific LightRail for the project of connecting the network from Alaska to San Diego. And we said we needed to have redundancy, so let's go over to Denver, then down to Albuquerque, and back to San Diego, creating a redundant route. And that's how we began building a network across the country. Today, when you talk about Pacific Wave and its reach, well, the genesis of Pacific Wave was that notion of a Pacific LightRail."

As the effort to expand the network took on a life of its own, West felt it was time to add someone with operations expertise to CENIC.

"The board agreed to hire a COO and we asked Jim Dolgonas," said West. "I thought he would say no, but he said yes and I thought that was great."

Although West was in charge when California invested in bringing K-12 into the CENIC network, he is quick to point to Dolgonas' role in making that happen.

"Jim was instrumental in getting K–12 on the network. But we had to be clever as the daylights to sell our higher ed members on taking the risk," said West. "We had to guarantee that the core mission of CENIC was going to stay intact. And that's the beauty of networking. When you have a fiber base, you can do that. You can have a digital California network that serves K–12. You can have a high-performance network that serves research and education. And you can do experimental things for people on the leading edge of activities, and protect their work by giving them circuits or lambdas that are independent of everyone else's. We just had to remind people that you can do a multiplicity of things on a network like ours, and have separation where you want it."

While West is recognized as an idea guy who took risks on behalf of research, he now sees the future of CENIC as residing in its ability to expand access as a public service to all of California.

"In California, CENIC is the one vehicle that's neutral. It's a not-for-profit, and it's not a major provider that has to come up with a return on investment," said West. "It has the opportunity to deliver significant public benefit without losing sight of its original purpose. The challenge now for the CEO and for the board is to not lose sight of the core mission and, at the same time, continue to move to serve not only the R&E community, but larger needs in the state of California. It's a natural extension."


CENIC | Built for Research, Driven by Science

The idea for CENIC grew from the needs of research faculty at California's top universities. It logically follows, then, that the research community has shaped CENIC's approach to networking from its earliest days. And the work of scientists, faculty, and computer engineers is not limited by geography, a fact that has provided a guiding premise of CENIC—that leading-edge research requires a dedicated high-end network.

"John Silvester, the Chair of the Board (1999–2006), helped make the case for the work that goes on across borders, because he himself was a faculty member and researcher," said former CEO Jim Dolgonas. "He was able to point out that a lot of research takes place not within an institution, not within a state, but within a nation and across nations. It was something we could bring to researchers at research universities for pretty much no cost. It was a benefit not just to Stanford or the University of California in general, but to individual faculty members in this or that discipline."

As the network was expanding into its current three-tier structure, the high speeds and sophistication required by leading researchers provided their own challenges.

"One of the challenges has been balancing requests from individual researchers against institutional objectives," said Dolgonas. "A university CIO may say, 'Well, faculty member so-and-so has asked CENIC for special help and this isn't really a priority of ours, so I'm not sure we should do it.' Actually, those were the activities I wanted to support. While they may not have been core to the institutional mission, they help individual faculty members, [and] thus help California retain its national position in the research hierarchy."

This research and scientific leadership is driven by faculty at California's elite universities who are in pursuit of new knowledge.

"I remember working with Harvey Newman, a high-energy physicist at Caltech who has set land speed records for pushing data over networks," recalled John Dundas. "He wants to know how much data can be pushed through the networks for work with things like the large hadron collider at CERN."

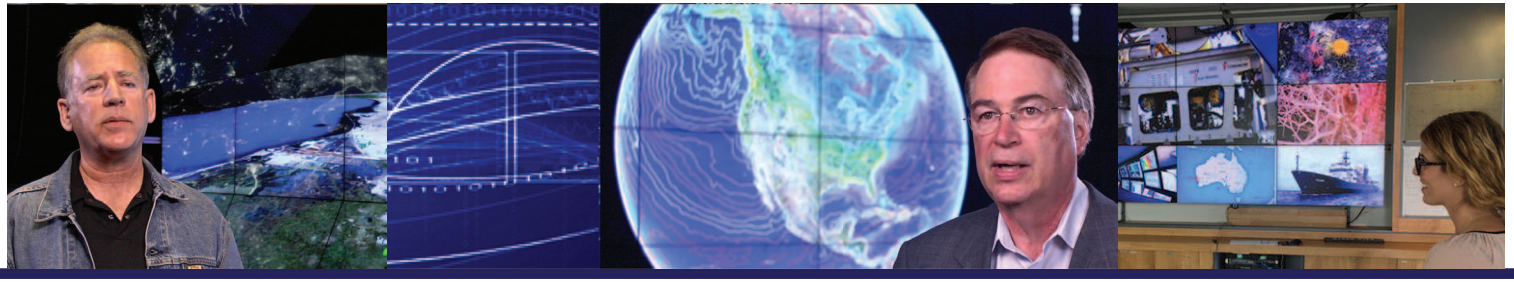
"What Harvey Newman does, he probably couldn't have done without CENIC's help," said Caltech's Rich Fagen. "He continues to hold the record. CENIC helps him a lot. He's very happy with them. If we didn't have CENIC, I don't know how he would accomplish it."

In addition to individual faculty needs are the requirements of federally-funded research grants seeking collaborative outcomes on national and international levels.

"There's a research project called the BIRN—the Biomedical Informatics Research Network," said UC Irvine's Mike Scott. "To join it you have to have gigabit connectivity servers so that large data sets can be transferred from point A to point B. It's an NIH initiative, and we're able to be part of it because of CENIC."

"In terms of the economic impact, I think it starts with the research activities," said former CEO Tom West. "There's a significant amount of collaborative research among universities within California and with institutions elsewhere that is made possible because of networking. CENIC's network is a critical dimension of that, because we've had it for almost 20 years. It continues to grow in terms of capacity. The results of that research then have a payoff in terms of practical uses that add to the general economy."

For research-intensive universities, the collaborative nature of science was already well understood, but the impact of increasing access beyond their peer groups was an unexpected benefit.



"The community at Stanford needed this. Our researchers needed better ways to reach collaborators at other institutions," said Jay Kohn, a founding CENIC Board member and Director of Networking at Stanford. "It was my role to ensure they could research with their peers as well as their Stanford colleagues. That resulted in new developments for Stanford. Connecting with community colleges, with K–12, and with Mexico—those were good things for California. And becoming the connecting point for Asia—bringing that in was good as well."

By the end of its first decade of operation, CENIC was fulfilling its mission to support a world-class research network that was increasingly global, and had deepened its support of education by connecting the full range of students from kindergarten through graduate and professional school.

"It was sort of natural. We had always had a strong partnership with Washington (state) and Ron Johnson," said Silvester. "He's a very smart guy and thinks way ahead of everybody else. We had peering relationships to the Pacific Rim, and USC and [the] University of Washington were interested in connecting through LA and Seattle to hook up with these other networks. So it was natural to expand the network structures with Asian countries so that our academic institutions could connect with international institutions. Science is global, and the NSF saw that and provided funding for some of that."

The NSF investment was leveraged by CENIC and the University of Washington's Pacific Northwest Gigapop to develop Pacific Wave, an important initiative for research and science.

"Increasingly, research is multidisciplinary, multi-institutional, and multinational," said CENIC CEO Louis Fox. "Take any important research concern—healthcare, environment, energy. These are not issues bounded by countries. They are issues faced by citizens of every country in the world, and the ability for a researcher to connect to a scientific tool or a resource elsewhere is of huge import. Our international activity is a significant part of the CENIC portfolio."

So much of what has been accomplished within and through CENIC was born out of relationships supportive of making dreams a reality. And in a state like California, those dreams can be big.

David Wasley, for example, was among those concerned that CENIC might lose its focus as a high-end research network with its move to provide connectivity to community colleges and K–12 schools. Now he sees that move as allowing CENIC to be more important to a much larger range of institutions. "The research world can be very small and the real world is much bigger," said Wasley. "I think the world should be considered one place, with very bright people, and we should bring them all in so we can share knowledge more broadly."

Futurists like Larry Smarr imagine a "virtual California," with sensors throughout the state feeding real-time environmental data—on the snow pack, run off, ground water, vegetation changes, and so on—to data centers at the county level. That information would be used to develop a continually updated, giant simulation of California's environment.

"CENIC could be the technical reservoir of technical expertise," said Smarr. "And the memory of how that is done in all of these places could support a consortium of non-profits in proposing public policy decisions related to environmental changes."

Equally inspiring are current initiatives, such as the effort to enhance the underwater observation capacity off the Northwest coast of the U.S., along a ridge of volcanic activity.

"Research leaders have conceived of a laboratory on the ocean floor where there is fiber optic cable, power, and instruments every 50 kilometers or so on the sea floor," said Fox. "There are remote operating vehicles, high-definition cameras, and all kinds of experimentation across multiple disciplines. And the amount of data coming from those instruments is phenomenal because they're going every minute of every hour of every day. That requires extraordinary networking capacity to allow researchers to analyze and create knowledge from what they're gathering."

Work is already underway on the Pacific Research Platform, a kind of scientific DMZ, in which researchers across campuses, states, and even nations can access scientific tools regardless of location, along with the computational resources, data, and collaborative partners required for top-tier results.

"I think the world should be considered one place, with very bright people, and we should bring them all in so we can share knowledge more broadly."

Dave Wasley, formerly at UC Office of the President

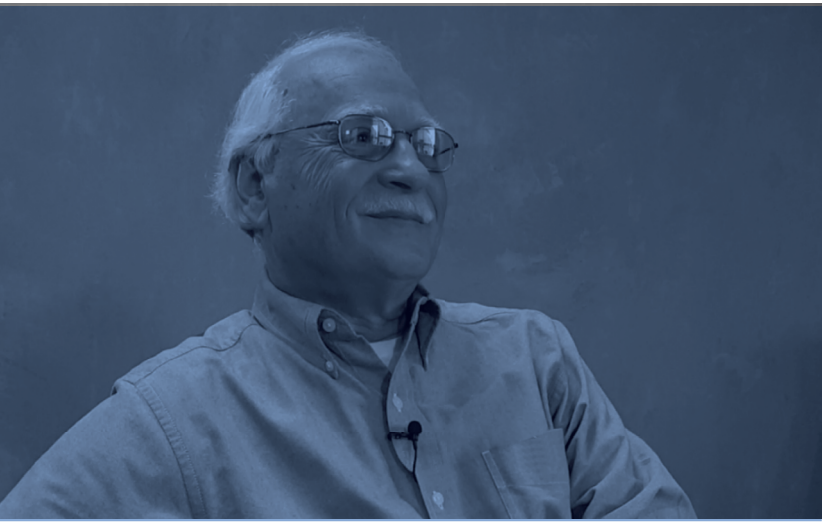
"My colleagues at the Energy Sciences Network suggest that the network itself is a scientific tool, just like a radio telescope or the Large Hadron Collider," said Fox. "That's the approach we're taking with the Pacific Research Platform, with our thinking about cyber security, with the directions we're going in international networking—seeing the network as a valuable tool to advance research."

Most involved with CENIC see its continual drive to the innovative edge as ensuring that the network remains important and relevant into the future. "We plant seeds, working in collaboration with the research universities, on things like our cyber infrastructure or the cybersecurity initiative. And we make the important investments to go from a ten- to a hundred-gigabit network," said Fox. "We do all this in order to put these resources and tools in the hands of very bright people, whether they're students or faculty or researchers or patrons in a library. And I expect these users will invent things that will absolutely amaze us, and that we can't even imagine now."

CENIC | Jim Dolgonas, CENIC COO, 2002–2004, & CEO, 2004–2012

In the mid-1990s Jim Dolgonas was working in the University of California Office of the President when he first heard the concept behind what would become CENIC. As he noted, "I don't think any of us had any idea at the time it would evolve into what it became." It would be fair to note that he could not have imagined the role he would play in its first twenty years.

"I was working for Stuart Lynn at the UC Office of the President when he had the foresight to realize that California would benefit from having its own network. The Internet was pretty immature in terms of how we look at it today and how ubiquitous it is. I don't think people were looking past networking research universities in the state at the time."



"I tried to instill in CENIC staff a culture in which we are working in concert with our members. I think that culture has been a very important component of CENIC's success."

Jim Dolgonas, CENIC CEO Emeritus

In 2000, Dolgonas was still at UCOP, working for then President Dick Atkinson, when CENIC promoted and received state funding for the Digital California Project to connect K–12 to the CENIC network. That funding was allocated through the UC system rather than directly to K–12.

"I advised Dick against taking the money because I thought it was too big a risk. I told him it was fraught with all kinds of headaches and problems and UC could get blamed for something it didn't have a lot of control over. But Dick never said no to anything. So he accepted, and then told me to make sure it worked."

Dolgonas took that admonition to heart, ultimately leaving UCOP and agreeing to serve as CENIC's Chief Operations Officer for CEO Tom West, who was in the midst of the hard work involved in bringing K-12 into the network.

"When I joined CENIC in 2002, there were one or two people on staff—Tom West and his secretary, who I don't think worked full-time. There were maybe three people on loan from Cal State or the University of California. It was tough

in those early years. A lot of people would have walked away from this job. We had no staff and no money. But I tend to be an optimistic person and I always thought CENIC required an optimistic leader. Actually, much more than optimistic—someone who wasn't going to throw in the towel."

Jim Dolgonas is recognized not only for his optimistic leadership, but as the leader who moved CENIC from its start-up phase into the legitimate business operation it is today.

"I tried to instill in CENIC staff a culture in which we are working in concert with our members. We're not telling them what the answers are. We're providing a service to them, and in some cases suggesting best directions, but we're not in charge. I think that culture within the staff has been a very important component of CENIC's success."

"I do believe that organizations are reflections of their CEO. Some people think anybody could be CEO and that everything that goes on below the top of the organization is the same regardless of the CEO. I don't believe that at all. I think the CEO affects the style of the organization, the culture of the organization, and contributes to the success or the non-success of the organization."

"By the time I left in 2012, there were more than 50 people supporting the growth of the network. And I interviewed everybody before they got hired. I made sure that when they were hired they understood our goals and objectives and our style. And I think it has served the institution well."

Beyond instilling a positive culture within the staff, Dolgonas is credited with building a participatory model for the Board and its various committees that has effectively brought diverse voices and perspectives into an engaged governance structure. For example, he recognized early that bringing in the Cal State system onto the network would, in effect, bring in the 113 campuses of the California Community Colleges who were already on the CSU system.

"The community colleges wanted to be equal participants and serve on the board from the beginning. But the Board was initially concerned with non-higher-ed institutions - including the community colleges and K–12 as well - that they'd somehow bring down the level of discussion and support for research universities. I felt very strongly it wasn't the case, that we needed to make them all equal members."

"I had some worry that all those voices at the table might inhibit needed discussions, so I felt that in order to build a sense of community I had to get people more involved. There were advisory groups identified in the CENIC bylaws, like the Business Advisory Council and Technical Advisory Council. I really nurtured these because they had involvement from people other than Board members. I also created two other councils when we brought in K–12 and

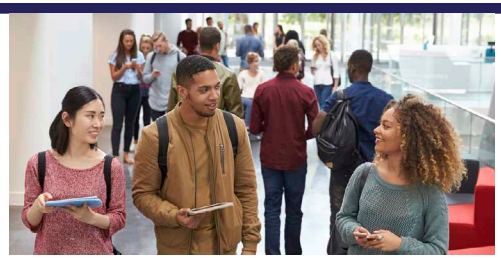
the community colleges, giving the technical networking staffs of those institutions a chance to be involved in CENIC and provide their input and advice to the board."

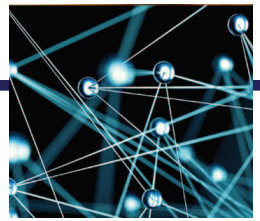
Dolgonas saw his role as critical to knitting together the leading-edge requirements of top research organizations with the core democratic potential underlying the power of cost-effective, high-bandwidth networking capacity.

"I really thought that coming to CENIC was a chance to do something good for the state. I like challenges, and it was a chance to do what was right for California. I've said many times that this is the most successful cross-segment project ever. CENIC is more comprehensive in that we serve libraries through K–12, through universities. There are not many who do all of that. At the same time, I think more than in many other states, our network and the services we provide need to respond to the expectation that California is going to be a leader in research and innovation."

"I really thought that coming to CENIC was a chance to do something good for the state."

Jim Dolgonas, CENIC CEO Emeritus






CENIC | Expanding Access

By 2000, the power and potential of the high-speed, high-bandwidth network built by California's elite universities to serve research and higher education proved an attractive draw for those seeking to link the state's K–12 schools to the future through connectivity. How to achieve that goal, however, proved a political as well as technical challenge.

Among the stories of how the Digital California Program came to be is one that involved several sales reps from Cisco.

"Laura Reynolds and Carol Stillman worked at Cisco, and Laura wanted to retire to be with her kids," recalled Tom West. "So they thought, we need to get K–12 hooked into CalREN. They went to Cisco CEO John Chambers and he went to Dick Atkinson, President of the UC system, and they worked together to figure out how to expand the network."

"Chambers and Atkinson went to the governor's office to say, 'Hey, if you want Cisco to stay in California, we need a better connected system for community colleges and the CSUs so our employees can get advanced degrees wherever they are—without having to go to a campus for a year—and better K–12 programs for our employees' children to ensure they're technologically literate.' So those two people went to the governor to get the money to K–12 to improve schools for Cisco employees."

"I think having John (Chambers) engaged with President Atkinson at the time, along with the chancellors of each of the UC campuses, was really what made it work," recalled Carol Stillman. "I don't think there was enough appreciation of creating a public-private engagement in which everyone invests and it's good for everyone. Those are really hard things to do, because each constituency wants to know what's in it for them."

"I wasn't initially supportive," said USC's John Silvester. "Initially there was a lot of concern that we would lose focus, so there wasn't strong support for it—particularly from the privates."

"The board meetings were getting testy and people were getting mad," recalled John Dundas, who was at Caltech at the time. "We were all worried about how that would work."

Tom West recalled that funding made all the difference. "The next thing I know, I got a call from the governor's assistant saying, 'How much money do you need to connect the K–12 schools to the CENIC network?' I said, 'Well, I can get you that answer. When do you need it?' 'I need it in four hours.' So I went to Dave Reese and I asked if we could add K–12 as we did with the community colleges. And later that afternoon, I called back the assistant to the governor and said, 'It will take $32 million a year.' That's how that all got started."

"In retrospect, adding the K–12 schools makes sense and I'm sure glad we did it," said Jack McCredie. "But in the early days, we weren't sure about it. It was pretty risky. I remember being in discussions with teachers in which they were saying, 'you are trying to get us fired up about high-end networking and we don't have a music program any more or even textbooks.'"

"We knew that the education of yesterday can happen without a CENIC," said Stillman. "But the question was, can the education of today and tomorrow happen without a high-speed connection?"

State funding for the Digital California Project: K–12 Statewide Network, intended to connect the 58 County Offices of Education and 10,400 schools in the state to the CENIC network, was approved in October, 2000. This marked a significant shift in both mission and focus for a dedicated high-speed network originally conceived as a critical tool for top-flight research universities. Convincing state government of the need to fund the initiative, however, turned out to be the easy part of the work.

Governor Gray Davis' staff was concerned that, if the funding went directly to K–12, too much would be wasted on administrative overhead rather than used directly for wiring districts and schools. Yet CENIC, as a private non-profit,

could not receive a direct appropriation of state dollars. On the advice of his staff, Davis decided to entrust the public University of California system with the annual $32 million in funding.

"We had to create a governance model that would work for everyone, with CENIC in the middle," recalled Cisco's Carol Stillman. "It had to work for the governor's office and for K–12, so the UC Office of the President had the role of contracting with the state. It was a lot of hard work, but it proved to be as valuable as we all thought it would be."

When the money was first allocated, Jim Dolgonas was working in the UC Office of the President. He advised President Atkinson against taking the funds, as he thought it too big a risk—both fiscally and politically.

But Dick Atkinson had worked hard to convince the Governor of the rationale for including K–12 in the CENIC network. So the money was accepted, and Dolgonas was charged with making sure everything worked well.

"When K–12 joined, it wasn't their initiative. It was the governor's initiative," said Dolgonas. "Frankly, they resented that, and they resented that the dollars were passing through the University of California to CENIC."

Although there was broad recognition within the K–12 community that the California schools needed better access to the information and knowledge available through the Internet, proposed solutions to meet the needs of the schools were numerous, reflecting the diversity of populations and districts. And few of these proposals focused on CENIC as the solution.

As Jim Dolgonas noted, the K–12 community had two problems with the CENIC plan: It wasn't their idea, and the dollars were being funneled through the University of California system rather than being allocated directly to K–12. In addition, CENIC as an entity was only a few years old, and its genesis was firmly embedded in the higher education community. With little to no previous interaction between CENIC and the California school districts, there were no existing relationships to build on.

The most difficult period was during 2003 and 2004. Jim Dolgonas was operations lead at CENIC at the time, and remembers interacting with the county superintendent of Imperial County, John Anderson.

As he recalls, Anderson was doing all he possibly could to cast doubt on the capacity of the UC system to oversee the expenditures flowing to CENIC. With a fundamental distrust of the UC system, Anderson was able to raise major concerns with the state auditor, demanding an audit and legislative review of CENIC's operations.

"There was a horrible budget committee hearing where we were accused of doing horrible things, and they did a great job of raising doubt in peoples' minds," said Dolgonas. "I'm not sure anyone on the board fully understood how challenging those years were."

"It forced us to spend a lot of time going to legislative hearings and public events to describe what we did," said former CENIC Board Chair David Ernst. "It was a huge challenge. That probably challenged us more than any single turning point in CENIC history."

A first audit was done through the Imperial County office with an outside auditor. When Dolgonas challenged the resulting report, the outside firm noted that they were not following audit rules because they were engaged to do a review, which was different than an audit. When Dolgonas and others protested, the state auditor took over. The result was a new set of oversight procedures that enabled CENIC to demonstrate its tight management of funds.

"Those were very difficult years," recalled Dolgonas. "A lot of people would have walked away from these challenges, but I really thought it was a chance to do something good for the state."

Board members who served during those years remember the long and contentious meetings.

"There were some not-so-pretty meetings, and what evolved is pretty miraculous," said CENIC Board Chair Bill Clebsch. "Part of that was leadership. Part of that were the good people at CENIC, and part of that were the institutions involved."

David Ernst's unique perspective, having served both CSU and the UC system as CIO, provided an important balance to the board during the years of both the K–12 and community college integration efforts. "It proved to be a transition or a metamorphosis of CENIC, coming from being a high-speed research network to being open to education overall," recalled Ernst. "It was a key turning point."

"Once we had our place at the governing table, that worked for the community colleges," said Patrick Perry, who served as Dean of Information Systems in the Chancellor's Office of the California Community Colleges. "It was thanks to Jim Dolgonas' leadership style that we were there. He knew how to integrate with other systems."

Others agreed, and now recognize that adding K–12 and the community colleges to the network actually benefitted higher education rather than detracting from it.

"A lot of us thought it was a big mistake", said Cliff Frost, formerly of Berkeley. "I was not a proponent of bringing them in. And I thought they were so different that we don't understand what it means, so it was dangerous to get involved. I was right in the short term, and wrong in the visionary term."

"The truth is that we got through this and we did just fine. It made the networking much better," said Clebsch. "After all, networking is a scaled business and the larger the network, the better and more efficient it becomes."

What resulted was the evolution of a three-tiered system. At the highest end was the network serving the researchers who were sending large data sets and conducting research with colleagues across the world. A majority of users of the Cal State system and the community colleges used the middle tier, and K–12 was served by the basic broadband access that connected teachers and students to educational content.

"I was the architect of that network," said Dave Reese. "(CENIC's) Sherilyn Evans was hired to be part of that program side, and several others were brought in to help out with that project."

Those tiers opened up the opportunity to bring public libraries into the network, with a 2014 state appropriation targeted to expand statewide access to their collected resources and knowledge. Working with Califa and the California State Library, CENIC jumpstarted the project by loaning the necessary equipment and waiving the fees to connect the San Francisco Public Library and the Peninsula Library System as pilot sites to its network.

In the first two years, nearly 800 libraries have been connected at gigabit speeds, with some at 10 or 100 Gbps, making California the first state in the nation to connect all of its libraries with a high-speed network at gigabit speeds.

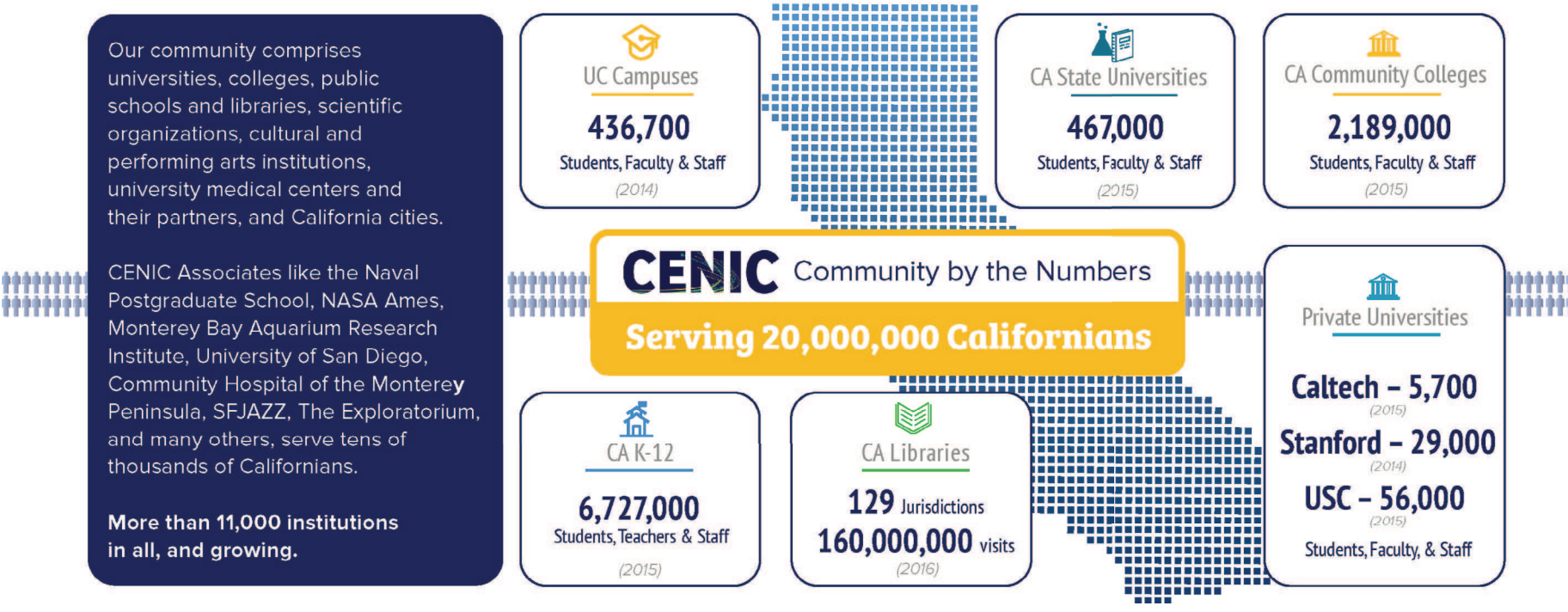
Beyond libraries, arts and cultural institutions also see the value of linking, via CENIC, to lifelong learning audiences—from kindergarten on up. Institutions like the SFJAZZ Collective and the Exploratorium, San Francisco's public learning laboratory, have been eager to share their performances and programs in order to engage with new audiences at libraries, schools, and universities.

"Having a network like CENIC available to us allows us to realize our vision of sharing the spontaneity and art of jazz with those who might not otherwise have access," said Mount Allen III, director of operations for SFJAZZ.

Our community comprises universities, colleges, public schools and libraries, scientific organizations, cultural and performing arts institutions, university medical centers and their partners, and California cities.

CENIC Associates like the Naval Postgraduate School, NASA Ames, Monterey Bay Aquarium Research Institute, University of San Diego, Community Hospital of the Monterey Peninsula, SFJAZZ, The Exploratorium, and many others, serve tens of thousands of Californians.

More than 11,000 institutions in all, and growing.



CENIC | Louis Fox, CENIC President & CEO, 2012–Present

At the University of Washington, one of Louis Fox's responsibilities as Vice Provost for Community Partnerships was to focus on knowledge and technology transfer to communities typically outside of these concerns, including the K–12 community. Because of his success in Washington State, in 2000 Fox was asked by Internet2 to figure out how to make the network productive for education institutions beyond the research community—the "K–20 community"—and that's where he met Tom West and got to know CENIC.

"I remember trying to introduce the K–20 initiative in California, and people would say, 'Well, it's different here. You just don't understand," said Fox. "And I wondered how different California could be from the other 49 states. At the time, I didn't really understand how big, how complicated, how diverse, and how much like a country California is."

After leading CENIC for nearly five years, Fox notes that it is precisely the complicated diversity of California that makes CENIC so vital to the state.

"CENIC is this place where the broad educational community in California comes together and does something that's beneficial to the entire community," said Fox. "In many states, you'll find one or two strong research universities. In very few states do you find anything like the ten University of California campuses, Stanford, Caltech, USC, the Naval Postgraduate School, twenty-three CSU campuses, and seven university medical centers."

"Just like networks are enriched by the number of participants in them, so is CENIC enriched by its diverse community."

Louis Fox, CENIC President & CEO

"The diversity and breadth of the research activity is phenomenal. You have the relationship between Silicon Valley and the research universities, and the kinds of capital that creates. You see all kinds of innovations coming out of the research universities and developing into new companies that make up a significant portion of our contemporary economy. It is an economic force in ways that few states can claim.

And then there's the scale here. A thousand school districts with ten thousand schools—it really creates its own value. Just like networks are enriched by the number of participants in them, so is CENIC enriched by its diverse community."

Under Fox's leadership, CENIC has leveraged its reach to advocate for California's needs both nationally and internationally. One example involves a federal subsidy called E-Rate, directed by the Federal Communications Commission through the Universal Service Fund. This program, which involves a complicated process, assists schools and libraries with Internet access.

"CENIC has organized the largest E-Rate consortium in the U.S. for California's K–12 school system," said Fox. "And we're in the process of organizing the second largest for libraries. The policies that govern E-Rate are really important to California."

CENIC and Fox are leading a similar effort to bring broadband access to the vast rural areas of California, completing projects in the Central Valley and Central Coast, bringing gigabit speeds and the CalREN network to nearly 100 CENIC institutions. Signifigant projects are also underway in K-12, connecting hundreds of geographically remote schools, supported by $76M from the California State Legislature, and in California's Community Colleges, upgrading connections for many of California's 113 community colleges and related satellite sites.

"Many people don't understand how rural California is," said Fox. "We work really closely with all of the carriers and all of the organizations that build fiber to provide adequate access. We help by advocating at both the state and national levels for the resources that allow the infrastructure to be extended to communities, and that in turn allow all of us to serve more of the state. And we work with other organizations, like the California Emerging Technologies Foundation, California Telehealth Network, and California's Broadband Consortia to ensure *all* Californians have access to broadband."

Beyond advocacy on behalf of its members and extending access to greater geographic areas of California, CENIC has also made important investments to enable its members to take advantage of leading-edge federal grants.

"In order to ensure that our campuses in California could take advantage of a new NSF program designed to enhance campus connectivity, CENIC invested in its own network infrastructure to move from 10 gigabits to 100 gigabits," said Fox. "And we actually took that capacity directly to each of the research campuses so that they could leverage it and take their resources and focus on upgrading their campus infrastructure. Ultimately, those investments allowed us to build the Pacific Research Platform. Without the CENIC investment, the NSF investment, the expertise of important partners like ESnet, and local campus investments, none of this would have been possible."

Fox sees that investment in CENIC's infrastructure as serving its international mission as well. By increasing the network's speed and capacity, its partnership with the Pacific Northwest Gigapop allows research institutions from around the Pacific Rim to connect seamlessly to CENIC and to the rest of the research community in the U.S. through Pacific Wave. And the potential for education is only beginning to emerge.

"We've barely scratched the surface of what's possible when you start thinking about education and Pacific Wave," said Fox. "All of a sudden we're connected to the rest of the educational community in the world and students can experience other cultures, other resources, other issues without ever leaving their own location. I think that's going to become increasingly important."

"Even in informal education, I look at California and its diversity, and think about all the different cultures of origin represented in our state. Wouldn't people here like to have access to their cultures, to resources, and to family via their library? That's now possible with libraries linked to CENIC, and with CENIC connected via Pacific Wave to the Asia Pacific region, connected through our Chicago partners (StarLight) to Europe, and connected through our partners in Florida (AMPATH) to Central and South America and the Caribbean and soon Africa. Most of the world is now connected via these research and education networks."

As CENIC approaches its next decade with Fox at the helm, its founding commitment to serve the leading-edge needs of its top-tier research and education universities is well balanced by its broadened scope and ability to provide equitable access to its network through public libraries and other important community institutions, including cultural, scientific and arts organizations.

"We've begun, for instance, to work in different ways with academic medical centers to assist them with their specific patient and other data strategies," said Fox. "Their requirements are different from our historical requirements, meaning we'll do things in new ways to serve them. We are also engaged in networking their numerous sites to each other and to CalREN, including working with urban and remote partner sites."

"But it turns out that doing those new things in new ways will ultimately benefit all the rest of the communities that we serve. So I think CENIC's future is both one of deepening our commitment to the things we have done historically and looking at new activities that bring value to California, that bring value to our existing CENIC community, and that really enrich the network."


CENIC | Right Leaders, Right Time

In the beginning there were few who believed it possible to craft a unified network among California's systems of higher education and its renowned private universities. It took an exceptional optimist to imagine the network's potential, and leaders of exceptional drive at all levels to bring it to its current state.

"I've worked directly for all of the CENIC leaders, and can tell you that what Stuart and every CENIC CEO have in common is remarkable passion for their work," said Sherilyn Evans, CENIC's Vice President and Chief Operating Officer. "They each have such a strong sense of how important this is for research in California, and now more broadly for education as well."

Many believe that the high-speed R&E network would not exist today if M. Stuart Lynn had not been in his role as CIO with the University of California Office of the President in 1996.

"Stuart did what was obviously right," recalled former UC Berkeley engineer Cliff Frost. "He was willing to bulldoze political objections. Doing what is obviously right is not always successful."

"The idea, the original initiative was from Stuart Lynn," said former CEO Jim Dolgonas, who worked with Lynn at UCOP. "Stuart had the foresight to realize that California would benefit from having its own network."

"He really had the fire in his belly, and was a beacon to many of us when we would start to doubt anything," said Stanford's Bill Clebsch. "It was his insistence from the very beginning that this was about the faculty, the people who are enhancing knowledge in this country."

That singular focus on why a high capacity network was critical to California's future enabled Lynn and his colleagues to overcome great skepticism about the possibility of success.

"I worked for Stuart at UCOP and he was very demanding," recalled Sherilyn Evans. "None of us thought he would ever convince the CSU and UC systems to agree, and to work with the three independents. We thought he was nuts to try, but Stuart brought his passion to bear on forming CENIC and got it done."

Lynn acknowledges his role, but noted that he was helped by having relationships with smart engineers and technology leaders throughout the state.

"I was the first pioneer. If I hadn't taken it on, it wouldn't exist," said Lynn. "Dave Wasley (at UCOP) and I spent a lot of time talking about how to make this happen. And I talked with my counterparts at institutions like Stanford and Caltech and USC, as well as the other UC campuses, to figure out how to make a collaboration work."

"What helps define CENIC leadership is they are men who think about things in different ways — who have the passion, the drive, or the utter self-confidence to say 'We're going to do this,'" said Evans. "Stuart's vision was important. Tom's ideas were game changers, and Jim was the guy who got things done. Jim is the one who turned CENIC into a legitimate business. And Louis now is moving us into new areas."

When Tom West joined CENIC as CEO in 1999, he was the first employee hired.

"I remember the all-day meeting we had when we were deciding whether we should have an employee or not," recalled Caltech's Rich Fagen. "I remember thinking we didn't need to spend money on an employee because this was an all-volunteer effort. But others realized that CENIC would become much bigger than it was."

Sherilyn Evans was among the first people West brought into the organization. She had worked for Stuart Lynn at UCOP and then with Jim Dolgonas when Lynn retired. Stuart had given Sherilyn's name to Tom West as he left CENIC's board, and a few days later, Jim Dolgonas did the same.

"I answered the phone one day and there's Tom West," recalled Evans. "He says, 'You don't know me from Adam, but I'm pretty sure you're supposed to be working for me. Two people I respect a lot said you were the right person for this job.' And that's how I came to CENIC."

With full-time leadership in place, there was a focus on expanding the network to K–12 and acquiring dark fiber to achieve the expansion.

"Tom had to convince others to get K–12 involved, but it was a good thing," said Evans. "And Ron Johnson knew that Canada was getting into fiber optic networks, so he convinced Tom to take the lead in identifying fiber we could own to build out our network. He really made that happen."

"I think CENIC has extraordinarily good leadership," said University of Washington's Ron Johnson. "Each of the board chairs and each of the CEOs has been exceptional. I've never seen such a sequence of solid leaders."

Jim Dolgonas is recognized for his operational savvy, beginning with his role at UCOP before being recruited to CENIC as its first chief operating officer in 2002. By the time he became CEO in 2004, the organization was on firm footing.

"Jim is the one who turned it from a start-up into a legitimate concern," said Evans. "It was because of Jim Dolgonas that the community colleges brought their network into our network. He also had the vision to do the fiber builds for the network."

CENIC executives give a nod to the extraordinary nature of board leadership in the first decade, noting the remarkable engagement in working towards common goals, and the fact that many of those early founding leaders remain active to this day.

"I think success breeds involvement," said Dolgonas. "People like to be involved in something that is successful, something that is adding value and helping each of the institutions in their own way. That's part of the reason that I remain involved."

Dolgonas has company, with many of those attending the first board meeting remaining engaged today. Those include Russ Hobby, formerly of UC Davis, Caltech's Rich Fagen, the University of Washington's Ron Johnson, John Silvester of USC, CENIC's John Dundas and Dave Reese, and David Wasley.

According to Doug Hartline from UC Santa Cruz, the people initially appointed to the board by the various institutions were people of integrity, and those are the people who remain engaged today—for reasons ranging from a sense of connection with CENIC's culture to a delight in the challenges involved in leading-edge networking.

"One of the reasons it was such a close-knit group is that each of the institutions were building it, so there was a lot of skin in the game," said Hartline. "Initially, there was a lot more need to get participation amongst the institutions. We knew that in order to get what we wanted for our institution, we needed others to get what they wanted as well. That effort bred trust, and now we would move mountains for each other. I think that's one of the reasons we were able to get so much accomplished."

Bill Clebsch of Stanford was among those attending the first CENIC board meeting in November 1997. "I just remember having a wonderful time in those early days and thinking it was good and really important work," said Clebsch.

Today, twenty years later, he remains deeply involved and serves as board chair. In his eyes, CENIC's biggest asset is the deep trust built over time within each of its constituencies, creating a community in which things can get done and risks can be taken to further the goals of an effectively networked future.

"I actually think that CENIC's most important capital is the people and the relationships," said Clebsch. "We have deep relationships with our institutions, with senior people sitting on our board who can go back and engage with their faculty and their researchers. That's our biggest asset—these relationships of trust across all of these segments so that we can get things done."

Caltech's Rich Fagen was at that first meeting in 1997, and agrees that CENIC gets things done that others in networking might find remarkable.

"The robustness of the service and the attentiveness is high because it's us serving us," said Fagen. "It's responsive to the community because CENIC is the community."

Beyond service, Fagen and colleague Ron Johnson recognize the importance of CENIC's leadership. "We've had great leadership with Stuart (Lynn), Tom (West), Jim (Dolgonas), and now Louis (Fox)," said Fagen.

"What makes CENIC unique and incredibly special is its leadership," said UC San Diego's Larry Smarr. "Just imagine having Caltech and all of those universities, the community colleges, K–12, and the libraries as members. It took extraordinary leadership to negotiate the incredibly broad socio-political landscape to bring all of those together and create a happy family."

After twenty years of active engagement, some of CENIC's founders are pursuing active retirements. Some see this as a potential risk.

"The biggest threat CENIC has in the next few years is that people like me retire," said Frost. "Institutions then lose the memory of what it took to build CENIC, with the risk that it might be seen as merely a commodity."

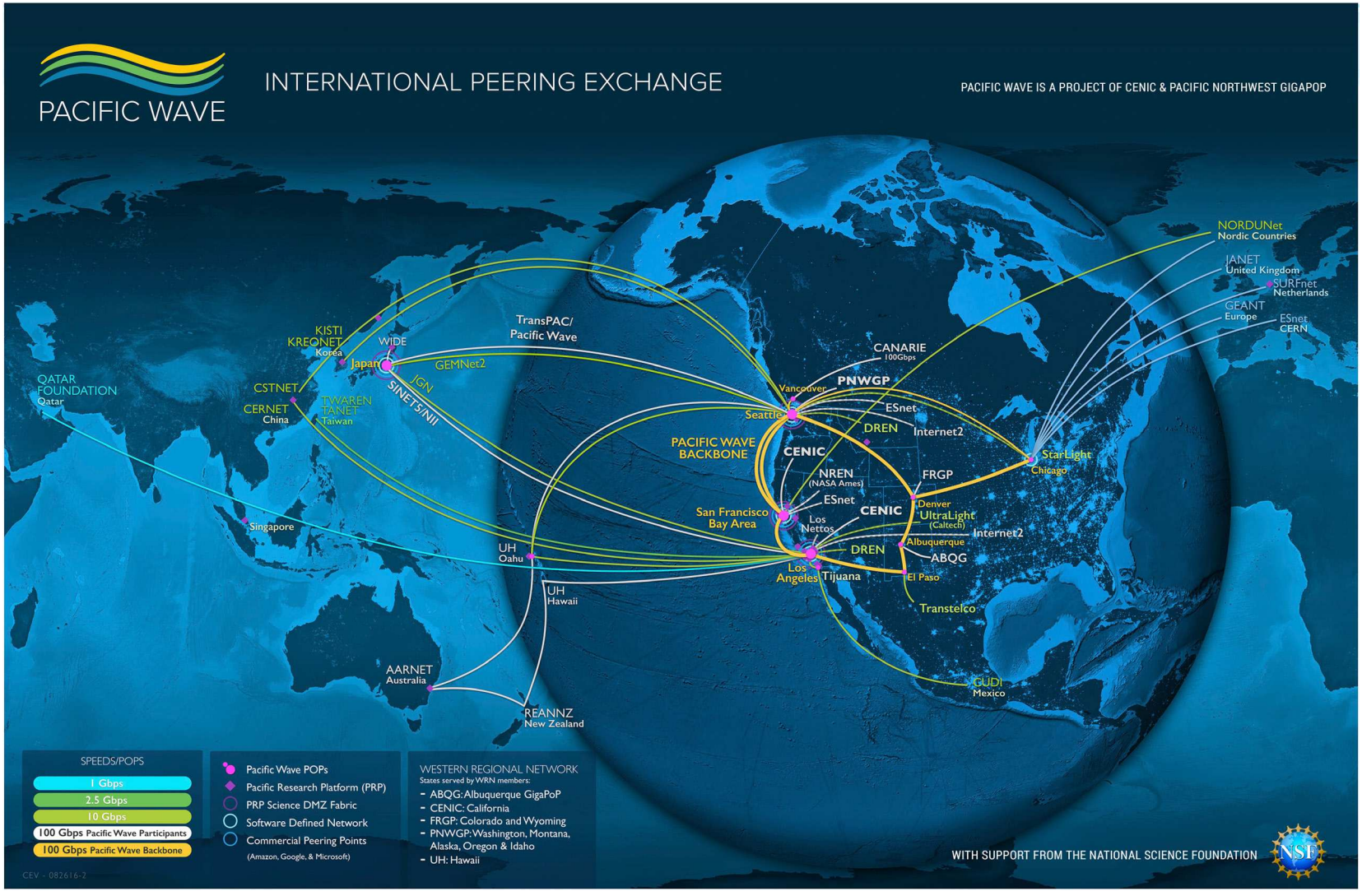
Others, including CENIC's current CEO Louis Fox, are not concerned that CENIC will lose the value of innovative memory. "There are a number of important people in our community who have retired from their roles but still stay engaged in CENIC," said Fox. "They don't have to. They want to. They still find value, impact, and deep meaning in their participation."

"What's is so encouraging about CENIC, and what attracted me and many others to CENIC in the first place, is this esprit that's created between those who have been here since the Internet began and young, up-and-coming engineers, researchers, administrators, and educators. I don't worry at all about whether there is anyone coming along behind a generation who may retire. All you have to do is look at the activities CENIC is involved in to see that participants are multigenerational."

Jim Dolgonas sees CENIC's culture as playing a critical role in retaining and sustaining cross-generational engagement. "We like the people we work with and we're doing good for the state," said Dolgonas. "We're doing good for educational institutions, we're doing good for research, and it's fulfilling."

"I have never worked in a community that has such palpable goodwill across the entire community, where you find somebody in a K–12 environment who is delighted to see what is going on at Calit2 at UC San Diego's research community," said Fox. "They know that the research community will eventually impact what they're doing in the K–12 community. It's a pretty rare thing."

"I believe CENIC is a force for good in the world," said Bill Clebsch.



Pacific Wave -Current January 2017

CENIC | Current Initiatives

- A 100Gbps upgrade to the CENIC backbone, making it one of the most heavily used research platforms in the world.
- A $77M Broadband Improvement Grant program in K–12, bringing 1Gbps speed to some of the least well-served schools in California, and involving commerical carriers in the work to accomplish this ambitious goal.
- Enhancements to broadband fiber infrastructure to support the California State University System.
- The Pacific Research Platform, an initiative supporting advanced big-data research at all of California's research universities.
- In a collaboration with commercial carriers, the connection of all California public libraries to CalREN—an effort that has connected nearly 800 libraries in the first two years of the initiatve, most at gigabit speeds, and some at 10 or 100Gbps, and has made California the first state in the nation to connect its public library system.
- Upgrades of 1Gbps to 10Gbps across the California Community College System.
- Support of two significant efforts connecting California's cities: the *California Cities Data-Sharing Project*, and the *Big Data, Big Cities Initiative*.