



# IMPACT REPORT



**[citrisc.uc.org](http://citrisc.uc.org)**





The Center for Information Technology Research in the Interest of Society (CITRIS) provides a model for **revolutionizing university research and expanding its impact on society.**

We **spark innovation** by bringing together leading technology researchers from our four partner campuses to **create unique opportunities for interdisciplinary collaboration.**





CITRIS creates information technology solutions for many of the most pressing environmental, social and health care problems.

Together, CITRIS researchers and activities **form an essential hub in the innovation ecosystem of California and the nation.**

CITRIS research focuses on four main areas:



HEALTH CARE



ENERGY



INFRASTRUCTURE



DATA & DEMOCRACY





HEALTH CARE

**The CITRIS Health Care Initiative**—delivering “Quality Health Care Everywhere” for Californians—uses information technology to improve access and reduce disparities and costs in health care across the state by developing and integrating advances in telehealth, sensors, services and gaming.

**The CITRIS Energy Initiative**, i4Energy, focuses on two fundamental areas that offer great promise to produce stable and sustainable energy for California—sensors and system integration.



ENERGY



INFRASTRUCTURE

**The Intelligent Infrastructure Initiative** (Water, Transport, Cities) develops and deploys intelligent “cyber-physical” systems to better manage scarce resources and promote sustainability.



DATA & DEMOCRACY

**The Data and Democracy Initiative** creates tools to foster public engagement for the people of California and around the world. Platforms for this engagement include interactive media, video applications, online education, and new media and creative expression.

## Leverage & Metrics

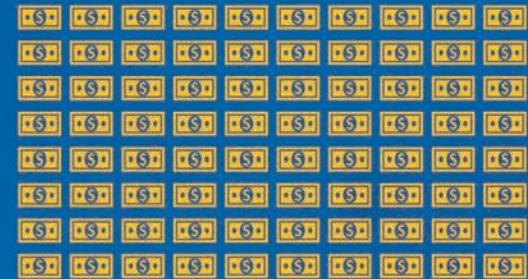
With more than 1,600 affiliated researchers, faculty and students across the four campuses, CITRIS produces results that are more than the sum of its parts.

An annual investment from the  
UC Office of the President of

# \$4–5M



IS  
LEVERAGED INTO



# \$70–80M

in outside research funding

=

# 1600%

return on investment



## Leverage & Metrics

Seed grants  
since 2008

**\$6.2M**



Subsequent  
funding

**\$37M**

**=**

Return on  
investment

**600%**

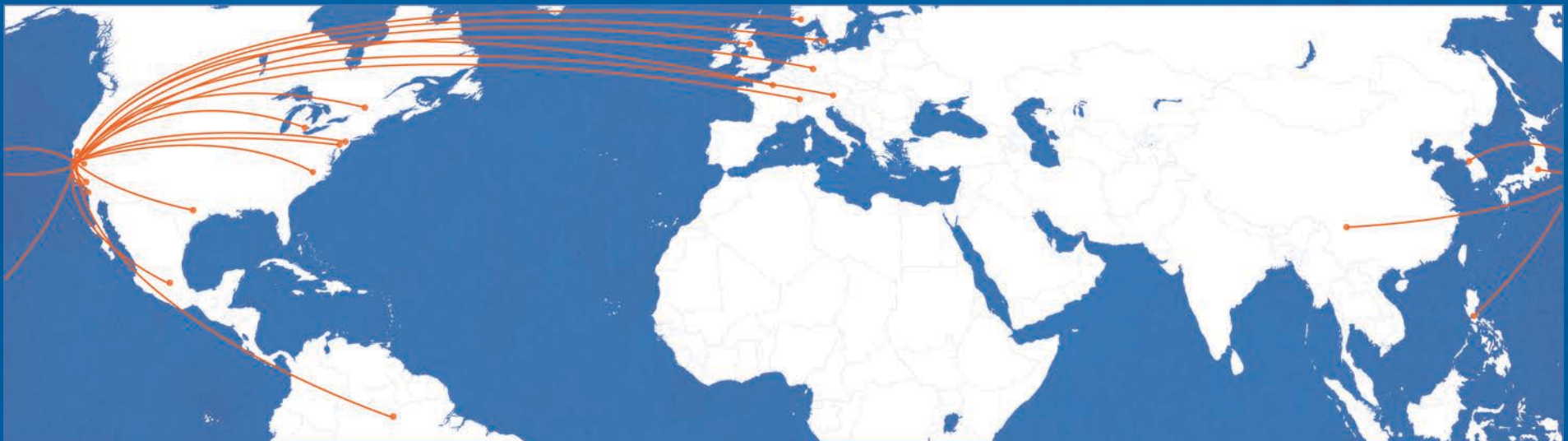


**35**

Startup companies have  
been created.

These grant awards not only support cutting-edge research but also represent investment in the long-term sustainability of the university.

Researchers come to CITRIS from **locations around the world**, as well as from throughout California.





# Collaborations

Collaborative research is at the heart of the CITRIS enterprise.

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## **The RAVEN Surgical Robotic System: Robot-Assisted Tele-Surgery for Tele-Health**

A CITRIS meeting brought together researchers from the Santa Cruz, Berkeley and Davis campuses to create a pioneering technology for robotic surgery. Faculty members Jacob Rosen (UC Santa Cruz), Ken Goldberg and Pieter Abbeel (UC Berkeley), and surgeon Doug Boyd (UC Davis Medical Center) were awarded a CITRIS seed-funding grant to develop their prototype, which resulted in a \$3.5M award from the National Science Foundation.





# Collaborations

We find that the greatest innovations appear at the intersection of disciplines.

## Motion Interfaces for Physical Therapy

Real-time motion capture and immersive 3D computer-generated environments are emerging as a powerful approach to numerous challenges, including remote delivery of health care.

Engineering professor Marcelo Kallmann (UC Merced) and Medical Director of the CITRIS Health Care Initiative Dr. Jay Han (UC Davis) explore the potential for these technologies to contribute to physical and cognitive-behavior therapy, telemedicine, stroke rehabilitation and pain management.





# Collaborations

CITRIS was created to “shorten the pipeline” between university research and real-world implementation.



## MATTER

The MATTER Center (Maximizing Abilities Through Technology, Education and Research) comprises faculty members in Engineering, Psychology, Nursing and Rehabilitation from UC Santa Cruz, UC San Francisco and UC Davis. The Center covers a broad spectrum of research areas related to developing technologies to help persons with special needs in activities of daily living. Based at the Baskin School of Engineering at UC Santa Cruz, MATTER is supported by CITRIS and QB3 (the California Institute for Quantitative Biosciences).





# Collaborations

We accomplish this by bringing together experts from a range of disciplines to share expertise and creative insights.

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## Measuring Water Systems in the Sierra Nevada

CITRIS faculty researchers Roger Bales (UC Merced) and Steven Glaser (UC Berkeley) were awarded a \$2M grant from the National Science Foundation to support development of an integrated hydrologic observation system in the Sierra Nevada Mountains. The system will transmit real-time observations over a wireless communications network to a central information management system that will be open for public access via the web. The system will focus on an ecosystem that supports the water needs of both California's Central Valley agribusiness empire and tens of millions of California residents.





# CITRIS Projects

With our cutting-edge laboratories and renowned faculty experts, CITRIS serves as an incubator for translating new ideas into working prototypes. The combination—information technology research with state-of-the-art facilities creating products for the benefit of society—distinguishes us from other interdisciplinary research centers.

## Our iterative process has four steps:

**LEARN** - We are committed to meeting UC's educational mission and sparking the desire to learn among students and faculty alike.

**BUILD** - We offer unparalleled facilities to build prototypes and demonstration models for projects large and small.

**LAUNCH** - Once a proof of concept has been tested and refined, it is ready to launch to the broader community of experts, agencies, or the interested public.

**CONNECT** - The final step is to connect these innovations with the sector or group that will benefit and promote its adoption or implementation.



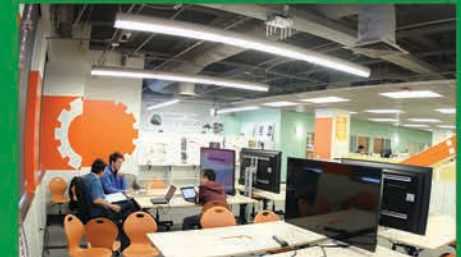
**CenSEPS**



**Rashomon Project**



**Connected Corridors**



**The Foundry**



# CITRIS Projects



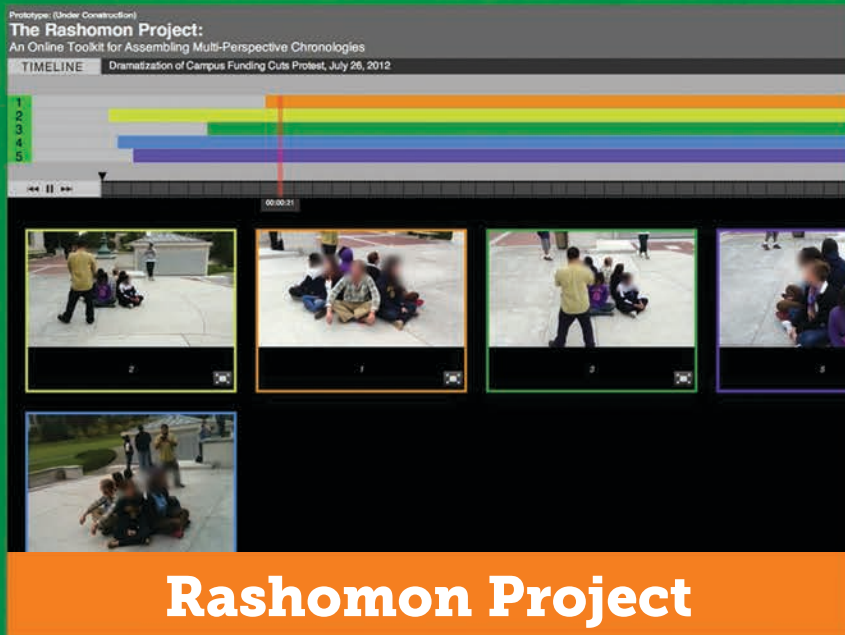
## **Center for Sustainable Energy and Power Systems**

**[censeps.soe.ucsc.edu](http://censeps.soe.ucsc.edu)**

The Center for Sustainable Energy and Power Systems (CenSEPS) focuses on the research, design and implementation of innovative technologies in clean and sustainable energy. The goal of the Center is to promote renewable energy communities and transform social norms to make localized renewable energies an integrated and accepted element of daily life. CenSEPS, in collaboration with CITRIS, has installed a wind turbine on the Santa Cruz Municipal Wharf as part of the **Green Wharf Project** (**[greenwharf.soe.ucsc.edu](http://greenwharf.soe.ucsc.edu)**). The development of UC Santa Cruz's **Sustainable Engineering and Ecological Design (SEED) Program** (**[seed.soe.ucsc.edu](http://seed.soe.ucsc.edu)**) has also emerged from CenSEPS to take a holistic approach to integrating the technical engineering, environmental and social aspects of renewable energy initiatives. The project was recently awarded a grant from the National Science Foundation for a collaborative project with researchers and students in Denmark, including the **California-Denmark Summer School on Renewable Energy** (**[localrenew.soe.ucsc.edu](http://localrenew.soe.ucsc.edu)**).



# CITRIS Projects



## The Rashomon Project: Online Toolkit for Multi-Perspective Video Chronologies

[j.mp/rashomon-project](http://j.mp/rashomon-project)

The Rashomon Project is developing an open-source, online toolkit that will facilitate rapid assembly and public review of "Multi-Perspective Chronologies" where videos are time-aligned and displayed simultaneously. Such a toolkit will benefit the public, citizen journalists and courts or commissions charged with investigating disputed incidents. Our goal is to allow the public (potentially hundreds of thousands of viewers) to gain a better understanding of contested events from user-generated photos and video than is currently possible.

Funded in part by the Knight Foundation and NSF/Mozilla Ignite Challenge, this project is organized by the UC Berkeley CITRIS Data and Democracy Initiative in collaboration with WITNESS, the Guardian Project, the Berkeley Human Rights Center and the UC Santa Cruz Digital Arts & New Media Program.



# CITRIS Projects



## Connected Corridors

### Connected Corridors

[traffic.berkeley.edu](http://traffic.berkeley.edu)

Led by UC Berkeley Engineering Professors Alex Bayen and Roberto Horowitz, the Connected Corridors project uses new technologies to help the California Department of Transportation gather and analyze traffic data to make real-time, whole-system traffic management recommendations. Connected Corridors is an outgrowth of two projects: **Mobile Millennium** ([citris-uc.org/research/projects/mobile\\_millennium](http://citris-uc.org/research/projects/mobile_millennium)), which employed data from mobile-phone-using volunteers to power a traffic-mapping application; and Tools for Operations Planning, which employs novel algorithms to model traffic.

Within the next three years the Connected Corridors project will implement a prototype traffic-advisory system for a major highway in California. The system will enable highway operators to evaluate traffic conditions in real-time, predict how they might develop and support better decision-making to optimize highway performance to improve environmental sustainability, economic competitiveness and livability.



# CITRIS Projects



**The Foundry**

## **The Foundry**

**[foundry.citris-uc.org](http://foundry.citris-uc.org)**

The Foundry @ CITRIS was created in 2012 to help entrepreneurs build companies that make a significant impact on the world. A new economy is developing at the intersection of hardware, software and services. The Foundry provides access to design, manufacturing and business development tools, along with a community of entrepreneurs and experts to transform entrepreneurial teams into founders.



# CITRIS Facilities

Among CITRIS's distinguishing features is the scale of cutting-edge facilities it offers faculty, students and outside researchers from California and around the world. Each of the four CITRIS campuses boasts unique state-of-the-art labs, advanced computing capacity and innovative teaching facilities.

## Berkeley



## Berkeley

Much of the innovative work developed by CITRIS researchers is supported by CITRIS's world-class facilities. CITRIS headquarters is located in one of the newest buildings at UC Berkeley—Sutardja Dai Hall (SDH), which houses 141,000 square feet of space of laboratories for collaborative research, offices, the 149-seat Banatao Auditorium, conference rooms on every floor, and fully equipped classrooms. SDH is a living laboratory for energy research, equipped with hundreds of sensors and sophisticated systems for monitoring and controlling energy use. SDH also hosts the new Invention Lab, used by Foundry teams, manufacturing design classes and others. It includes advanced fabrication tools such as 3D printers, laser cutters and PCB mills.

The Marvell Nanofabrication Laboratory (NanoLab) serves researchers from the four CITRIS campuses, UC San Francisco, and more than 90 Bay Area companies. The NanoLab occupies a two-story, 70,000-square-foot wing of SDH and is available to develop prototypes for new biosensors, photonics devices, and other MEMS/NEMS sensors that will further CITRIS's mission. It played a key role in the recent \$24.5M National Science Foundation award to establish a multi-institutional Science and Technology Center: the Center for Energy Efficient Electronics Science, led by researchers at CITRIS and partner universities which could eventually result in a million-fold reduction in the power consumption of electronics.



# CITRIS Facilities

## Davis



## Davis Medical Center



## Davis

UC Davis has a dynamic sustainability research ecosystem requiring state-of-the-art information technology and progressive cutting-edge research. The Electrical & Computer Engineering and Computer Science departments feature nearly 1,000 undergraduate, Masters, and PhD students working year-round on real-world IT problems and solutions.

The newly commissioned Sustainability and Computing Lab (SACLab) is the on-campus research hub connecting students to projects in big data analysis, worldwide sustainability, visualization, and IT security.

## Davis Medical Center

The Center for Health and Technology and the Center for Virtual Care bring together under one roof innovative programs to improve the quality of health care through education, training and specialty care services. The 52,000-square-foot facility hosts classrooms with full high-definition AV capabilities, digital displays, four tele-health on-site learning exam rooms, an inpatient room, outpatient clinic, and technology showroom.

The Center for Virtual Care features a full-size emergency room trauma bay, operating room, inpatient unit, six-bay simulation area, standardized patient exam rooms, and student debrief rooms. The Media Production Suite showcases a full custom designed production studio, three HD studio cameras and full production control room. Collectively these advanced technology centers at the UCD School of Medicine connect our best hospitals and medical schools with clinics in remote areas all over the state of California.



# CITRIS Facilities

## Merced



## Merced

The **robotics lab ([robotics.ucmerced.edu/Robotics](http://robotics.ucmerced.edu/Robotics))** at UC Merced, established in 2007 by Professor Stefano Carpin, investigates topics related to multi-robot systems and humanoid robots. Examples of past and ongoing research include:

- Cooperative multi-robot systems for urban search and rescue
- Pursuit-evasion games and intruder detection
- Robotic search
- Robot performance evaluation and benchmarking
- Multi-robot map merging
- Cooperative manipulation

Merced also hosts the **Computer Graphics Lab ([graphics.ucmerced.edu](http://graphics.ucmerced.edu))**, established in 2006 to pursue novel multidisciplinary research topics in interactive immersive environments, computer animation and simulation and humanoid robotics.

# CITRIS Facilities

## Santa Cruz



### Santa Cruz

Special resources at CITRIS @ Santa Cruz include the "**Opti-puter**" ([www.iti.ucsc.edu/optiputer](http://www.iti.ucsc.edu/optiputer)) (developed at Calit2, and shared with and partially funded by QB3 and the School of Engineering), a large tiled wall display that incorporates forty 30" HP monitors and an optical networking computational cluster. The optical networking cluster allows for large amounts of data to be distributed over multiple computing systems for dramatically accelerated processing. This technology is used to advance research in astronomy and astrophysics, as well as cancer genomics and other fields, as it provides the equipment necessary to analyzing high resolution stellar images and big data.

CITRIS @ Santa Cruz also provides high-tech experimental teaching rooms capable of high definition video conferencing, web- and telecasting, multiple high-definition display screens, recording capabilities, high-definition projectors and assistive listening technologies to improve student experience in the classroom. The popular **Network Management and Operations** ([nmo.soe.ucsc.edu/home](http://nmo.soe.ucsc.edu/home)) (NMO) Lab, sponsored by CITRIS, Cisco and UCSC, is focused on addressing real-world problems in complex networks, in a variety of topics that include quality of service, customer support and intelligent and automated management of network devices.

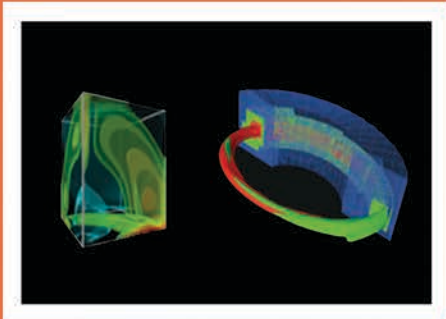


# Student Support

As an institute within the world-leading University of California system, CITRIS has a strong history of supporting students directly as well as creating new ways for them to learn outside the classroom.



**CITRIS Seed Funding** has provided support for 81 students over the last three years. These grants allow students to work as part of multi-disciplinary, multi-campus teams on projects with potential for social economic impact. CITRIS also sponsors the category of Information Technology for Society within Berkeley's **Big Ideas** competition. Since 2010, CITRIS has awarded \$90,000 to 13 students from all four campuses.



CITRIS sponsors a **Designated Emphasis in Computational Science and Engineering**. This interdisciplinary graduate minor recognizes the integral role of advanced computational techniques for mathematical modeling and simulation in a range of fields for the analysis of complex physical systems, such as computer chip manufacturing, battery modeling, turbine design, aircraft prototype testing, climate change and star formation, among others.



CITRIS@Davis awarded its first **Sustainability Award** to the five-student Ocean Power team for their wave-energy converter, capable of producing renewable energy from the motion of ocean waves near shore. The group uses readily available parts so others can replicate the design.



# Support for Innovation & Training

CITRIS offers facilities and programs for students to gain hands-on training in product development, business principles and design innovation.



**The Foundry** at CITRIS, a one-year incubator program, helps students, faculty and outside entrepreneurs take their ideas from vision to reality using design, manufacturing and business-development tools. In its first year, the Foundry has supported 21 student team members.



**The Invention Lab** is an onsite rapid prototyping and packaging lab that works in conjunction with the Marvell Nanofabrication Lab. It offers a unique opportunity for researchers on all four campuses to create, produce and package a prototype that can be tested and ultimately pitched to industry representatives or venture capital firms.



**The Network Management and Operations Lab**, sponsored by CITRIS, Cisco and UCSC, offers student interns the opportunity to work with industry engineers at Cisco on real-world problems in complex networking. More than 50 students from three CITRIS campuses have participated in this program to date.

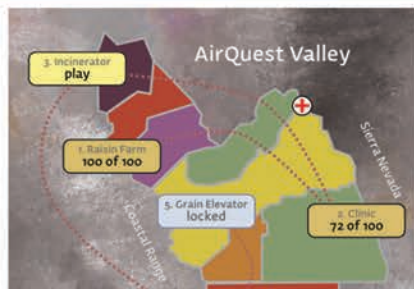


# Hosted Centers

Sutardja Dai Hall provides offices and collaborative work space for cutting-edge, interdisciplinary research centers and application design studios.



**The Berkeley Center for New Media** analyzes and helps shape developments in the use of new media for projects at the intersection of the humanities, technology and the public interest. BCNM catalyzes research, educates future leaders, and facilitates public discourse through courses, lectures, symposia and special events.



**The Social Apps Lab** at CITRIS focuses on the potential of cell phones and other mobile locative media to harness the participatory energies of game-play to address social issues. Its objective is both to study this potential and to produce new applications that generate opportunities for research, citizen participation and urban knowledge.



**TIER (Technology Infrastructure for Emerging Regions)** is a multi-disciplinary research and development group at UC Berkeley that studies the design and deployment of new technologies for poverty relief in developing countries. CITRIS has aided TIER by facilitating cross-campus involvement, providing space for students and research projects, and supporting a regular TIER networking event.

# NSF Science and Technology Centers

CITRIS has supported since their inception two Science and Technology Centers that went on to win prestigious multi-year grants from the National Science Foundation: TRUST and E3S.



**TRUST (The Team for Research in Ubiquitous Secure Technology)** develops cybersecurity science and technology that strengthens the ability of organizations to design, build and operate trustworthy information systems for the nation's critical infrastructure. Established in 2005, TRUST addresses technical, operational, privacy and policy challenges via interdisciplinary projects that combine fundamental science and applied research to deliver breakthrough advances in financial systems, health informatics and physical infrastructures.



**E3S (Center for Energy Efficient Electronics Science)** was established in 2010 to develop transformative science and technology to reduce energy consumption in electronic systems by orders of magnitude. It also aims to inspire and train a diverse generation of scientists, engineers and technicians to apply these developments for broad social benefit. Housed in Sutardja Dai Hall, E3S conducts much of this research in the nearby Marvell Nanolab.

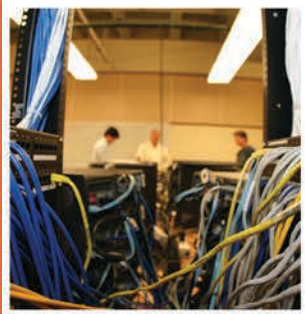


# Our Partners

CITRIS relies on a range of public and private partners to implement the cutting-edge research conducted here. We are grateful for the support of government agencies, industry partners, private foundations, and individual donors.



From its inception in 2008 to the end of 2012, a total of 23 Danish researchers have been visiting scholars. The **Danish Agency for Science, Technology and Innovation (DASTI)** works with CITRIS professors on research of particular interest to Denmark, such as energy and health care. Recent projects include the LoCal project, which aims to investigate new approaches for managing energy resources.



At the Network Management and Operations lab at UC Santa Cruz, students work with faculty sponsors on challenges proposed by **Cisco** engineers and managers. Participants gain experience with real-world problems in these complex networked environments. More than 40 students from UC Santa Cruz, UC Davis and UC Berkeley have gone through this program, and 11 are currently employed by Cisco.



In 2009, UC Berkeley collaborated with **Siemens** to create a state-of-the-art testbed for new energy conservation strategies. Today, a variety of innovative Demand Response measures are being developed, including optimizing the chilled water plant operation for further savings in utility costs and the student-created simple Monitoring and Actuation Profile (sMAP), which organizes siloed information from proprietary systems and makes it accessible and usable.



# Our Partners

## **CITRIS Partners (supporting core operations or cross-cutting research)**

- University of California, Office of the President
- UC Berkeley, Office of the Chancellor & Vice Chancellor for Research
- Banatao Institute Advisory Board
- Genentech
- IBM
- Philippine-California Advanced Research Institute (PCARI)
- Tecnológico de Monterrey (Monterrey Institute of Technology and Higher Education)

## **Democracy**

- Mozilla Foundation
- John S. and James L. Knight Foundation
- Information Technology Innovation Foundation
- UC Humanities Research Institute
- WITNESS

## **Energy**

- California Energy Commission
- California Air Resources Board
- Department of Energy, American Reinvestment and Recovery Act
- National Science Foundation, Cyber Physical Systems
- The Link Foundation
- The Energy Foundation
- Seeo
- CPV Consortium
- Korea Electronics Technology Institute
- California Public Utility Commission, California Solar Initiative
- Bosch, Energy Network Research Grant Program

## **Health Care**

- Intel
- US Federal Trade Commission
- CA Emerging Technologies Fund
- Cleveland Clinic Foundation

## **Water & Cities**

- California Department of Water Resources
- Sacramento Municipal Utility District
- El Dorado County Water Agency
- San Juan Water District
- Association of California Water Agencies
- The Sacramento Area Flood Control Agency
- Institut National de Recherche en Informatique et en Automatique (INRIA)
- City of San Francisco
- City of Paris



# CITRIS Events



**Can "Open Data" Improve Democratic Governance?**



**Research Exchange Seminar Series**

CITRIS produces conferences, lectures and workshops featuring well-known speakers throughout the year.

The Research Exchange seminars and numerous special events highlight areas of CITRIS research and foster a collaborative community of experts from engineering and the social sciences, arts and humanities, business, public policy and more, using technology for broad social impact.

State-of-the-art videoconferencing and webcasting facilities in Sutardja Dai Hall allow many of these events to be broadcast live over the web so that all CITRIS campuses and the general public can watch and participate in the discussion via social media. The talks are then archived and posted to the CITRIS YouTube channel, where they are viewed by a worldwide audience. CITRIS lectures have received over 1.2 million views to date.



## **Founding Corporate Members**

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**For more than 12 years, CITRIS has brought world-class research to bear on real-world problems. With continued support from the University of California, industrial partners, state agencies and philanthropic organizations, we will make strides to improve the lives of Californians for the next generation and beyond.**

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