CENTER FOR INFORMATION TECHNOLOGY RESEARCH

IN THE INTEREST OF SOCIETY

CITRIS

IMPACT REPORT

2014-2015

CITRIS
CENTER FOR INFORMATION TECHNOLOGY RESEARCH
IN THE INTEREST OF SOCIETY

citris-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**.

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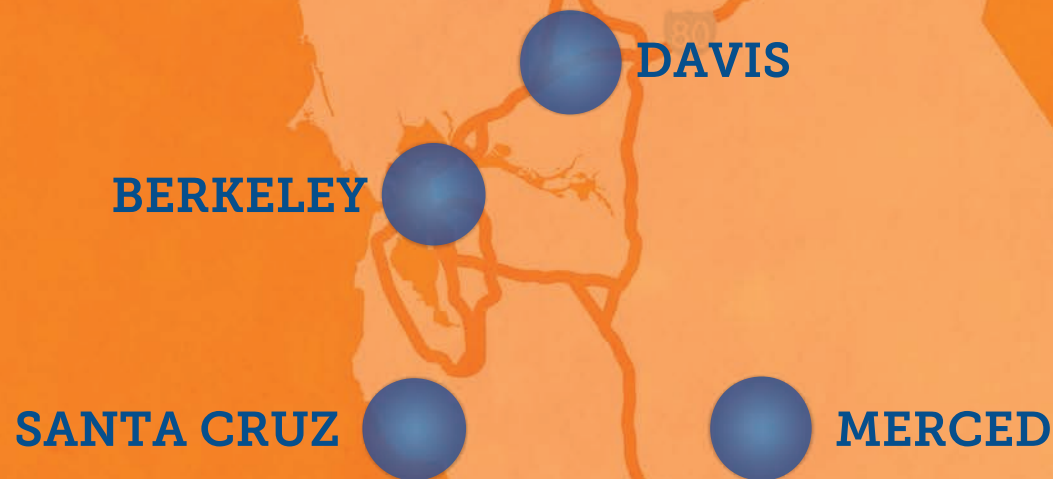
UNIVERSITY OF CALIFORNIA

CITRIS generates information technology solutions for many of the most pressing environmental and social challenges.

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:

ENERGY

INFRASTRUCTURE

HEALTH CARE

DATA & DEMOCRACY

ENERGY

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.

The Intelligent Infrastructure Initiative (Water, Transportation, Cities) develops and deploys intelligent cyber-physical systems to better manage scarce resources; promote resiliency; and realize the social, cultural and economic potential of communities.

INFRASTRUCTURE

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 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, new media and creative expression.

DATA & DEMOCRACY
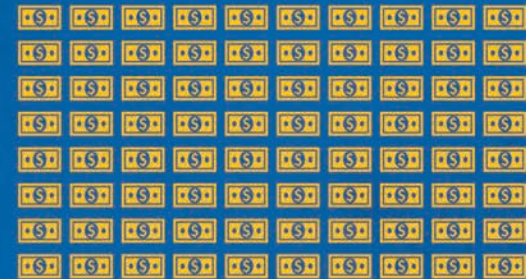
Our Impact & Reach

With more than 1,600 affiliated researchers, faculty and students applying insights from over 100 disciplines across the four UC 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

$80–95M

in outside research funding

=

1850%

return on overall investment

Our Impact & Reach

CITRIS seed grants
issued since 2008

$6.7M

>

Subsequent
funding

$38M

=

Return on
seed grant investment

470%

The CITRIS seed grant program directly funds multi-disciplinary, multi-campus research that supports the long-term viability and vibrancy of the university.

51

Startup companies
made possible with
CITRIS research assets.

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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Autonomous Robot Surgery: Performing Surgical Subtasks without Human Intervention

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. This project has the potential to improve patient health by enhancing surgeon performance, reduce tedium and thus medical errors, and reduce costs by reducing operation time. Researchers are evaluating their techniques on a da Vinci robot (dVRK) donated by Intuitive Surgical.

Collaborations

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

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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 and CITRIS Chief Scientist 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.

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Environmental DNA Sampling Using UAVs

Monitoring aquatic biodiversity in hard-to-reach regions is the focus of a project between YangQuan Chen (UC Merced) and Michael Miller (UC Davis). The team uses Chen's small, low-cost and rugged unmanned aerial vehicles (UAVs) to conduct surveys of mountain rivers and other remote aquatic ecosystems. Miller is developing a procedure that extracts and sorts DNA to identify the various species living in the body of water from which the sample is taken.

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 and Martha Conklin (UC Merced), together with Steven Glaser (UC Berkeley), received a $5 million award from the National Science Foundation to support integrated hydrologic observations in the Sierra Nevada of California. Their wireless sensor networks in this remote, seasonally snow-covered area will enable hydrologic and related research into sustainability of the ecosystem services provided by mountain forests. The observatory also provides a testbed for how a new-generation water-information system can enhance water security in a period of rapid change.

CITRIS Projects

With our cutting-edge laboratories and renowned faculty experts, CITRIS serves as an incubator for translating new ideas into working prototypes. This intersection of information technology research, advanced fabrication and testing facilities, and a mission to create products for the benefit of society distinguishes CITRIS from other interdisciplinary research centers.

Our iterative process has four steps:

LEARN - We are committed to furthering UC's educational mission and creating opportunities to learn emerging skills.

BUILD - We offer unparalleled facilities to develop prototypes and demonstration models for projects from the nanoscale to urban scale.

LAUNCH - Once a proof of concept has been tested and refined with support from CITRIS resources, it is ready for introduction to early adopters.

CONNECT - The final step is to connect these innovations with the partners that will benefit from and promote their implementation.
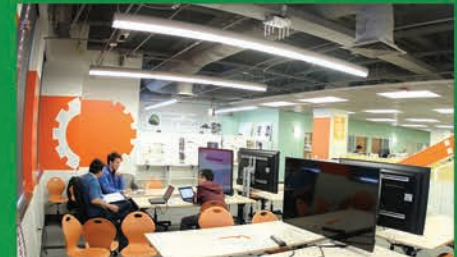
CenSEPS

California Report Card

Connected Corridors

The Foundry at CITRIS

CITRIS Projects

CenSEPS

Center for Sustainable Energy and Power Systems

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)**. The development of UC Santa Cruz's **Sustainable Engineering and Ecological Design (SEED) Program (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)**.

CITRIS Projects
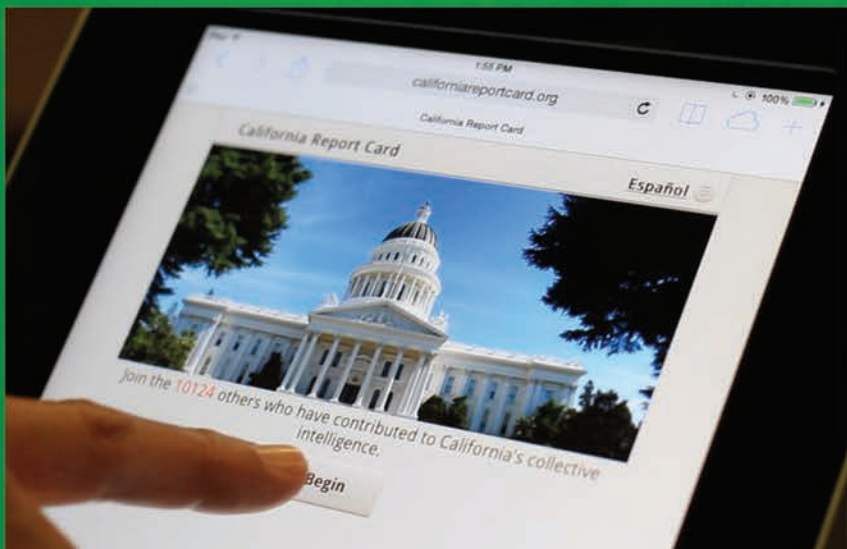
California Report Card

California Report Card

californiareportcard.org

In early 2014, the Data and Democracy Initiative launched a new online platform for civic engagement, the California Report Card. Developed in collaboration with the Office of Lt. Governor Gavin Newsom, the interactive tool offers participants an opportunity to grade the state on a range of timely topics and suggest issues deserving increased attention. Building on previous platforms for crowdsourcing public opinion, the California Report Card (CRC) explores how technology can engage the public by providing an opportunity for expressing individual views, rating the suggestions of others, and streamlining communication with elected leaders.

In its first ten months online, the CRC attracted more than 11,000 people from all 58 counties to assign over 30,000 grades to the State of California. Additional features for the CRC include automated language translation to enhance interaction among English- and Spanish-speaking Californians. The Spanish-language version of the California Report Card launched in partnership with a team at UC Merced to facilitate outreach to community organizations in the Central Valley. Additional versions of the platform are being developed to promote disaster preparedness and response in California and to assess effectiveness of humanitarian interventions in developing countries.

CITRIS Projects

Connected Corridors

Connected Corridors

http://connected-corridors.berkeley.edu/

Led by UC Berkeley Engineering Professors Alex Bayen and Roberto Horowitz, the Connected Corridors projects 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/transportation/project/mobile-millenium)**, 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 at CITRIS

The Foundry at CITRIS

foundry.citris-uc.org

The Foundry incubator launched in 2013 to help university-affiliated 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 resources within a community of experts that help transform entrepreneurial teams into founders.

The first 10 teams have collectively raised $7.2M from a variety of sources, including angel investors, venture capital, crowd funding and federal Small Business Innovation Research (SBIR) grants. Foundry companies are bringing new solutions to market in areas such as semiconductors, low-cost robotics, air quality monitoring, and medical diagnostics. New teams are invited to apply twice yearly.

CITRIS Facilities

One of CITRIS's distinguishing features is access to leading-edge facilities for faculty, students and outside researchers from California and around the world. Each of the four CITRIS campuses offers specialized labs, advanced computing capacity and innovative teaching facilities.

UC Berkeley

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 for collaborative research laboratories, offices, the 149-seat Banatao Auditorium, conference rooms on each floor, and modern classrooms. The building itself is a living laboratory for energy research, equipped with hundreds of sensors and sophisticated systems for monitoring and controlling energy use. SDH is also home to the CITRIS Invention Lab, a rapid design and prototyping facility used by Foundry startup teams, manufacturing design classes and other applied programs. The lab includes advanced fabrication tools such as 3D printers, laser cutters and PCB mills.

The Marvell Nanofabrication Laboratory (NanoLab) currently serves researchers from the four CITRIS campuses, UC San Francisco, and more than 20 Bay Area companies. The NanoLab occupies a two-story, 15,000 sq. ft. wing of SDH and is available to develop prototypes for new biosensors, photonics devices, and other MEMS/NEMS sensors. The NanoLab 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

UC Davis

UC Davis Medical Center

UC Davis has a robust research ecosystem for sustainability-related applications. The recently-commissioned Sustainability and Computing Lab (SACLab) is an on-campus research hub connecting students to projects in big data analysis, global sustainability, visualization, and IT security.

The Electrical & Computer Engineering and Computer Science departments support nearly 1,000 undergraduate, Masters, and PhD students in their work on information technology challenges and solutions.

UC Davis Medical Center

At the UC Davis Medical Center campus in Sacramento, the Center for Health and Technology and the Center for Virtual Care bring innovative programs together under one roof to improve health care quality through education, training and specialty care services. The 52,000 sq. ft. facility hosts classrooms with high-definition AV capabilities, digital displays, four telehealth learning exam rooms, an inpatient room, outpatient clinic, and technology showroom.

The Center for Virtual Care features a full-sized 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 custom-built production studio, three HD studio cameras and media control room. Collectively, these advanced technology centers connect our most modern hospitals and medical schools with remote clinics across California.

CITRIS Facilities

UC Merced

The **robotics lab (http://robotics.ucmerced.edu/)** 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)**, established in 2006 to pursue novel multidisciplinary research topics in interactive immersive environments, computer animation, computer simulation and humanoid robotics.

CITRIS Facilities

UC Santa Cruz

Research assets at CITRIS @ Santa Cruz include the "**Opti-Puter**" (iti.soe.ucsc.edu/optiputer), a room-sized, tiled display wall that incorporates forty 30″ HP monitors and an optical networking computational cluster. Developed at Calit2 and partially funded by QB3 and the School of Engineering, the optical networking cluster allows large amounts of data to be distributed over multiple computing systems for dramatically accelerated processing. This technology advances research in astronomy and astrophysics, as well as cancer genomics and other fields, by providing the equipment necessary to analyze high-resolution stellar images and large data sets.

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 latest collaborative project under the CITRIS, Cisco, and UCSC sponsored **Network Management and Operations** (nmo.soe.ucsc.edu/home) **(NMO) Lab** is the eSupport Content Development Project which engages students at the graduate and undergraduate levels. These students develop content for the online Cisco Small Business Support Community by conducting product testing and publishing their findings as support documents for use by Cisco Small Business customers.

Student Opportunities

As a public-facing institute within the University of California system, CITRIS has a strong track record of educational support while creating new ways for students to apply their knowledge beyond the classroom.
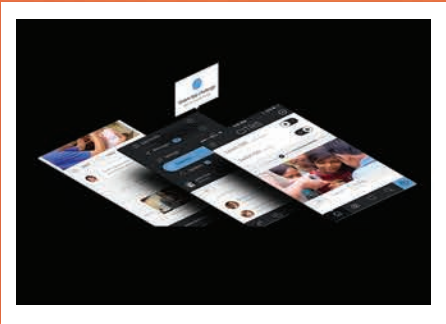
The **CITRIS Mobile App Challenge**, co-sponsored with the Social Apps Lab at CITRIS, is a semester-long student competition to develop innovative mobile applications for today's most pressing societal needs. Launched at UC Berkeley in spring 2014, this rigorous 3-month program guided students through the design, prototyping and pitching of their apps. The Challenge culminated in a Demo Day with juried prizes to recognize student achievements. The Mobile App Challenge originated at UC Merced and is now listed as a course in UC Berkeley's general catalog. CITRIS directors at Davis and Santa Cruz plan to launch the program on their campuses in the near future.
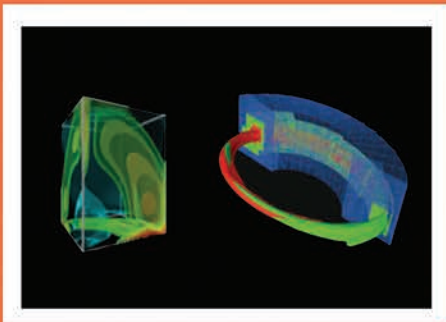
CITRIS sponsors a **Designated Emphasis in Computational Science and Engineering**. This interdisciplinary graduate minor recognizes the integral role of advanced computational techniques for mathematical modeling and simulation in a range of fields for the analysis of complex physical systems, such as computer chip manufacturing, battery modeling, turbine design, aircraft prototype testing, climate change and star formation, among others.

Entrepreneurial Opportunities

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

The Foundry at CITRIS is a 6-12 month incubator program that helps students, faculty, and UC-affiliated entrepreneurs transform their ideas into reality using design, manufacturing and business development tools. The Foundry has supported 40 student entrepreneurs since it launched in January 2013.

The CITRIS Invention Lab is a rapid prototyping and teaching facility that works in conjunction with the Marvell Nanofabrication Lab on the UC Berkeley campus. It offers unique opportunities for researchers on all four campuses to design, produce, and package prototypes for testing and pitching to potential customers.

The Social Apps Lab at CITRIS promotes creativity and interdisciplinary collaboration in the form of web and mobile applications that encourage citizen participation, urban knowledge, and crowdsourced solutions for significant social problems.

Hosted Centers

Sutardja Dai Hall provides offices and collaborative space for leading-edge interdisciplinary research centers.

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 Berkeley Energy and Climate Institute (BECI) serves as a coordinating hub for UC Berkeley's energy and climate efforts by ensuring the integration of science, engineering, social science, market and policy research. Signature programs include the Philomathia Center and Cal Energy Corps.

TIER (Technology Infrastructure for Emerging Regions) is a multidisciplinary research and development group at UC Berkeley that studies the design and deployment of new technologies that bring the information technology revolution to developing regions of the world. 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

From their inception, CITRIS has supported two Science and Technology Centers that were awarded multi-year funding from the National Science Foundation: TRUST and E3S.

TRUST (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 is supported by a range of forward-looking public and private partners. Our pioneering work is made possible in collaboration with government agencies, industrial members, private foundations, and individual donors.

 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. CITRIS has hosted 32 visiting scholars from Denmark since DASTI's inception in 2008. To expand our international collaborations, CITRIS is also hosting five visiting tscholars and a seed grant program in 2014-15 with Mexico's **Monterrey Institute of Technology and Higher Education (ITESM)**.
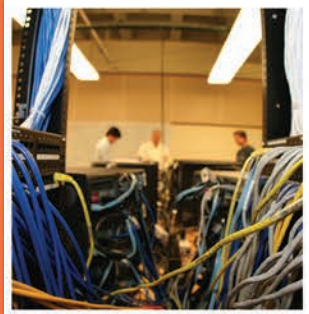
 At the **Network Management and Operations (NMO) Lab** at UC Santa Cruz, students work with faculty sponsors on challenges proposed by engineers and managers from **Cisco Systems, Inc.** to gain experience with real-world problems in complex networked environments. More than 60 students from UC Santa Cruz, UC Davis and UC Berkeley have participated and 16 have joined Cisco as employees.

 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 cross-cutting research or core operations)

- University of California, Office of the President
- UC Berkeley, Offices of the Chancellor and Vice Chancellor for Research

- Aalborg University
- AT&T, Inc.
- Berkeley Center for New Media
- Berkeley Energy and Climate Institute (BECI)
- Bill & Melinda Gates Foundation
- California Institute for Qualitative Biosciences (QB3)
- Carlos Slim Foundation
- Chalmers University of Technology
- Cisco Systems, Inc.
- Danish Agency for Science, Technology and Innovation (DASTI)
- Genentech, Inc.
- Goldman School of Public Policy, Center on Civility and Democratic Engagement
- Haas School of Business, Center for Responsible Business
- Humana Inc.
- IHI Corporation
- IBM Corporation
- Monterrey Institute of Technology and Higher Education (ITESM)
- Panasonic Corporation
- Samsung Group
- Siemens AG
- UC Office of the President, Educational Partnerships Office

Democracy
- Blum Center for Developing Economies and the Development Impact Lab
- De Novo Group
- John S. and James L. Knight Foundation
- Mozilla Foundation
- Office of Lieutenant Governor Gavin Newsom

Energy
- Bosch Energy Research Network
- California Air Resources Board
- California Energy Commission
- California Institute for Energy and Environment (CIEE)
- California Public Utilities Commission, California Solar Initiative
- Center for the Built Environment
- CPV Consortium
- Energy Foundation
- Green Tech Center, Denmark
- IT University of Copenhagen, Energy Futures
- Korea Electronics Technology Institute
- Korean Micro Energy Grid (K-MEG) Consortium
- LBNL, Environmental Energy Technologies Division
- The Link Foundation
- National Science Foundation, Cyber-Physical Systems
- Power Standards Lab
- Seeo, Inc.

- U.S. Department of Energy, American Reinvestment and Recovery Act
- University of Southern Denmark, Centre for Smart Energy Solutions

Health Care
- California Emerging Technology Fund
- Cleveland Clinic Foundation
- Federal Trade Commission
- Intel Corporation

Infrastructure
- Association of California Water Agencies
- California Department of Water Resources
- City & County of San Francisco
- Council of Paris
- El Dorado County Water Agency
- French Institute for Research in Computer Science and Automation (INRIA)
- Merced Irrigation District
- Placer County Water Agency
- Sacramento Area Flood Control Agency
- Sacramento Municipal Utility District
- San Francisco Public Utilities District
- U.S. Forest Service
- U.S. National Park Service, Yosemite National Park

CITRIS Events

Cal Hacks

CITRIS Research Exchange Seminar Series

Cal Hacks launched in 2014 as the largest undergraduate collegiate hackathon in the country. Student hackers and innovators from across the nation and all four CITRIS campuses converge on UC Berkeley's California Memorial Stadium to create hundreds of incredible software and hardware projects in a single weekend. Cal Hacks is co-hosted by CITRIS and organized jointly by two Berkeley student groups, The Kairos Society and Hackers@Berkeley.

CITRIS produces conferences, lectures and workshops featuring well-known speakers throughout the year. The **CITRIS Research Exchange Seminar Series** 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 (youtube.com/citris), where they are viewed by a worldwide audience. CITRIS lectures have received almost 1.5 million views to date.

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For almost 15 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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