

**Press Release: January 17, 2013**

## **UC Berkeley-Led Team Awarded \$27.5M for New TerraSwarm Research Center**

Researchers at UC Berkeley's Electrical Engineering and Computer Science (EECS) department are spearheading a multi-university team that is being awarded \$27.5M for the new *TerraSwarm Research Center*. The center is addressing the huge potential (and associated risks) of pervasive integration of smart, networked sensors and actuators into our connected world. The five-year grant is being awarded by the industry members of the Semiconductor Research Corporation (SRC) and the Defense Advanced Research Projects Agency (DARPA) as a part of the Focus Center Research Program (FCRP).

In the TerraSwarm view, “the swarm” is an extension of “the cloud” that goes well beyond information technology to improve our energy efficiency, safety, comfort, security, and human effectiveness by integrating the physical world with the cyber world. It leverages recent advances in the variety, cost, size, and power consumption of sensing and actuation devices and the associated communication networks. Sensors can collect a range of data — such as embedded vision, audio, location, movement, temperature, and air quality — that can be used by computing systems to direct the control of physical devices in smart buildings, transportation systems, medical systems, security systems, and homes.

Sensor and actuator swarms were originally conceived and developed in the mid-1990's, but thus far they have primarily been used in the context of single, localized applications -- such as monitoring and controlling the temperature in commercial data centers. A key goal of the TerraSwarm Research Center is to enable swarms to be deployed at a much larger scale, extending across a city and beyond, and to interact synergistically with each other, with pervasive networked handheld devices, and with the computing “cloud.” Swarm data can then be combined with information already available from cell phones and social networking applications, dramatically increasing the potential for sophisticated data analysis and correlation. The net result? An unprecedented ability to create complex, customized, societal-scale services that use cloud-connected sensors and actuators to improve aspects of the society’s operation.

Clearly, it's an ambitious scope, and it comes with risks.

"Connecting sensors and actuators to the cloud is like giving our cyber world eyes, ears, hands, and feet," said Edward A. Lee, the center's director and the Robert S. Pepper Distinguished Professor in Berkeley's EECS department. "We can use these capabilities to provide large-scale services like better traffic control, energy efficiency, and emergency response, not to mention improvements in quality of life. But these services must come with assurances of safety, security, and privacy, a far-from-trivial challenge."

“The open swarm platform concept, proposed by the TerraSwarm Research Center, opens the door for a wave of unparalleled creativity and innovation, leading most likely to applications and functions we cannot even predict today,” says Jan Rabaey, the center’s associate director.

The range of possible applications is stunning — but so are the challenges. Of significant concern are data privacy and security. If the cloud is able to affect the physical world, it is essential that it can withstand malicious tampering and sensor failures. And no-one wants information about their location and activities to (inadvertently) be made public.

"People already use mobile devices and software that collect a range of personal information, and by now they're pretty aware of the privacy issues this raises," said Prof. Lee. "Networked sensors are already becoming our reality — so we want to make sure that TerraSwarm's data collection and storage systems are designed from the ground up with data security in mind. "

A further challenge is that TerraSwarm applications must be able to dynamically identify and recruit local resources — such as sensors, mobile display screens, communication channels, or even unmanned vehicles — to respond to service requests. This capability will require significant advancements in operating systems and resource allocation algorithms. In addition, these applications will require new paradigms for development and verification — how do you design and verify an application whose resources and constraints are dynamically changing, and whose communication may be intermittently disrupted?

To address the multi-disciplinary challenges associated with TerraSwarm applications, the team includes twenty engineering faculty members at a total of nine research universities: UC Berkeley, UC San Diego, Univ. of Illinois at Urbana-Champaign, Univ. of Washington, Univ. of Texas at Dallas, Carnegie Mellon University, California Institute of Technology, University of Michigan, and University of Pennsylvania. In addition, the center has collaborations with the Intel Science and Technology Center on Secure Computing in Berkeley, Texas Instruments, IBM, and United Technologies. Experts in data security, sensors, actuators, operating systems, development tools, robotics, energy efficiency, and communications will use the TerraSwarm Research Center as a home base for sharing ideas, developing applications, and developing an open extensible platform that can unleash the creativity of millions of potential “swarm app” developers. Together, they will work towards the center's long-term vision of recruiting technology for the betterment of society.

Additional information is available at <http://terraswarm.org>.