# “The Always-On Internet"

**Invited Talk Warren College**
**Parents Day**
**UCSD**
**La Jolla, CA**
**February 25, 2006**

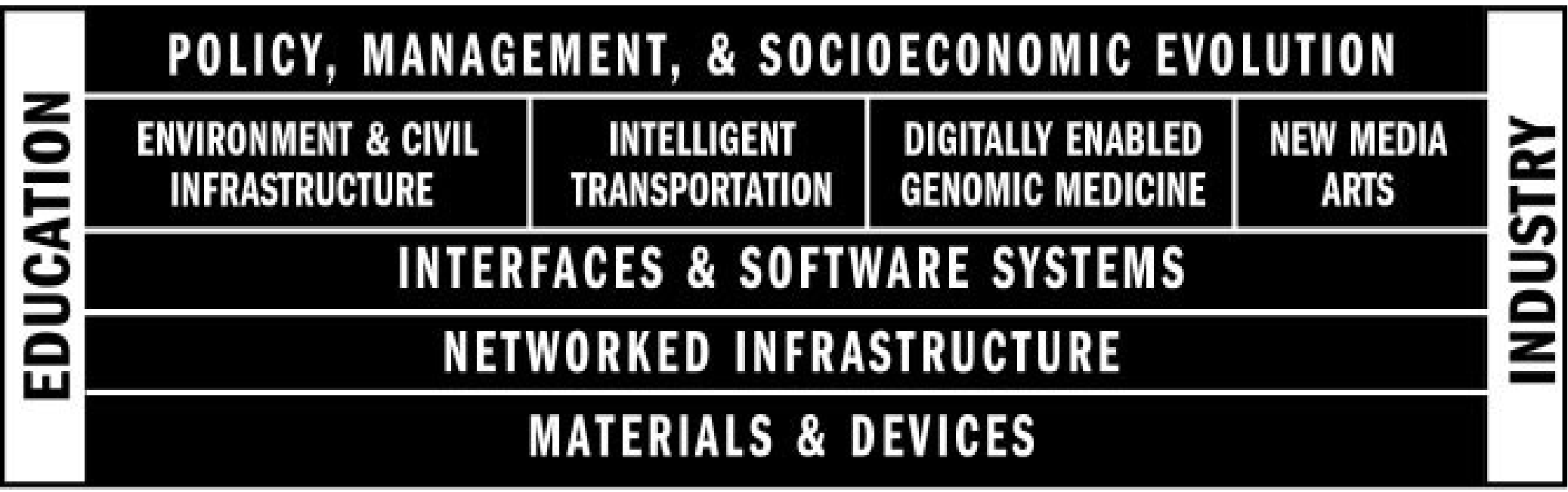
**Dr. Larry Smarr**
**Director, California Institute for Telecommunications and Information Technology**
**Harry E. Gruber Professor,**
**Dept. of Computer Science and Engineering**
**Jacobs School of Engineering, UCSD**

UCSD
UCIrvine

it²

# Calit2 -- Research and Living Laboratories on the Future of the Internet

## UC San Diego & UC Irvine Faculty
## Working in Multidisciplinary Teams
## With Students, Industry, and the Community



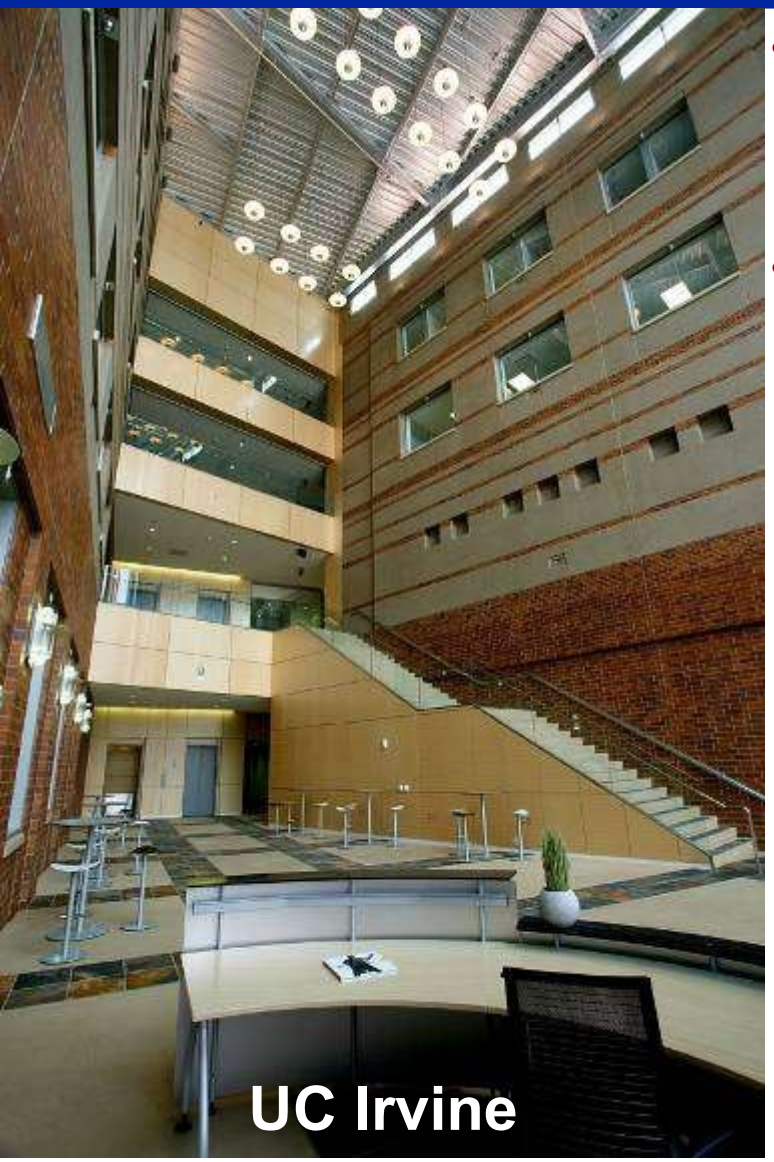

**www.calit2.net**

California Institute for Telecommunications and Information Technology . Cal-(IT)$^2$



Extending the Internet Throughout the Physical World

# Two New Calit2 Buildings Will Provide Major New Laboratories to Their Campuses




- New Laboratory Facilities
  - Nanotech, BioMEMS, Chips, Radio, Photonics, Grid, Data, Applications
  - Virtual Reality, Digital Cinema, HDTV, Synthesis
- Over 1000 Researchers in Two Buildings
  - Linked via Dedicated Optical Networks
  - International Conferences and Testbeds

Richard C. Atkinson Hall Dedication Oct. 28, 2005



www.calit2.net

UCSD
UCIrvine

Preparing for an World in Which Distance Has Been Eliminated…

it²

# Calit2 Works with Undergraduates In a Number of Programs

- Summer Research Scholarship
- Student Robotics Contest
- Teams In Engineering Service (TIES) Program
- Undergraduate Bioinformatics Scholar Awards
- Student Design Studio
- Design Courses
- Pacific Rim Undergraduate Experiences (PRIME) Program
- Student Employment

UCSD
UCIrvine

www.calit2.net/education/ucsd/ugrad/index.php

it²

# Calit2 Undergrad Research Summer Research Program

Calit2@UCSD
UGRAD RESEARCH SCHOLARSHIP
FEB. 27th DEADLINE




SURF-IT
CALIT2 IRVINE





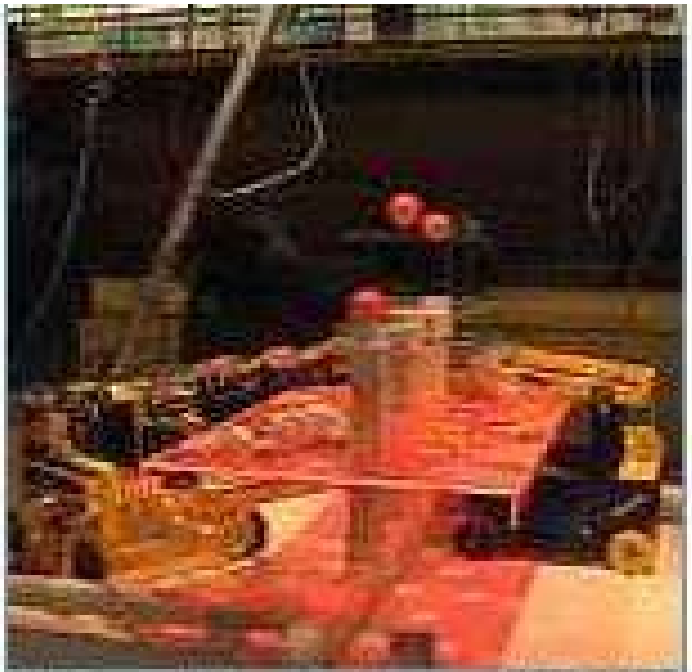

UCSD
UCIrvine

**Bioengineering, Chemistry, Chemical Eng., Cog Sci, CSE, ECE, IR/PS, Music, Physics, SIO, Visual Arts**

it2

# Calit2 Supports UCSD Undergraduate Robotics Outreach and Design Contest

- Mechanical and Aerospace Engineering Lecturer Nathan Delson
- Collaboration with Preuss School was Sponsored by Calit2
- The Object of the Contest is to
  - Collect the Balls from the Air Vent and
  - Bring the White Ones Back to the Bin and
  - Bring the Orange Ones Back to the Triangular Corals



Final contest on "center court": at right is the ultimate winner, designed to slide under the playing field



Preuss students working on projects

UCSD
UCIrvine

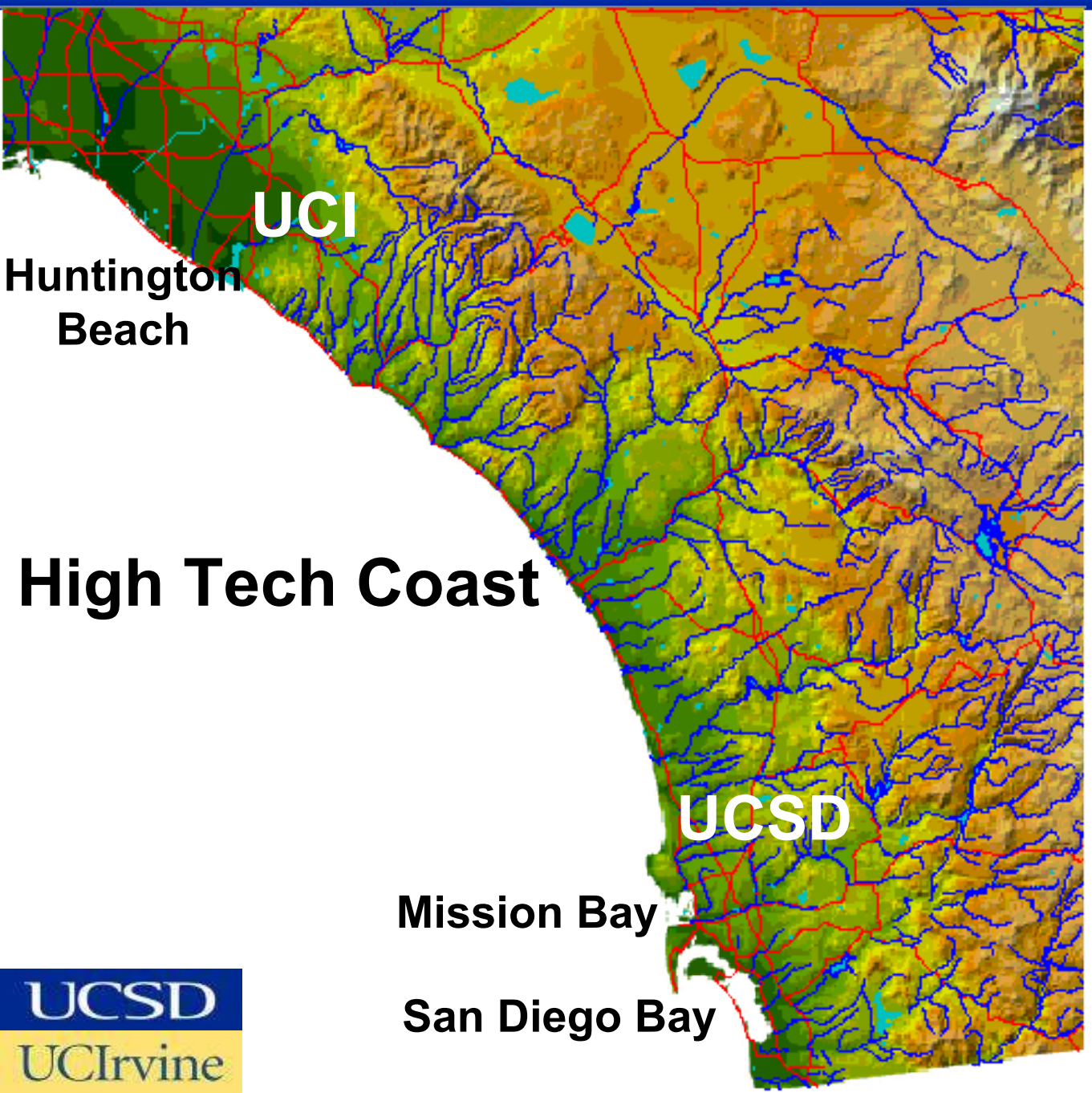
www.calit2.net/newsroom/article.php?id=242

# Pacific Rim Undergraduate Experiences PRIME 2005

- **Preparing Students for the Global Workplace of the 21st Century**
  - **14 UCSD Undergrads**
    - **NSF- Funded with Calit2**
  - **Students Work With Researchers During Summer in:**
    - **Australia, Japan, Taiwan, China and Thailand**
  - **Chemistry, Biomedical, Ecology, Networking**



# Can a Connected World Help Us Avoid the Downsides of Prolonged Growth?

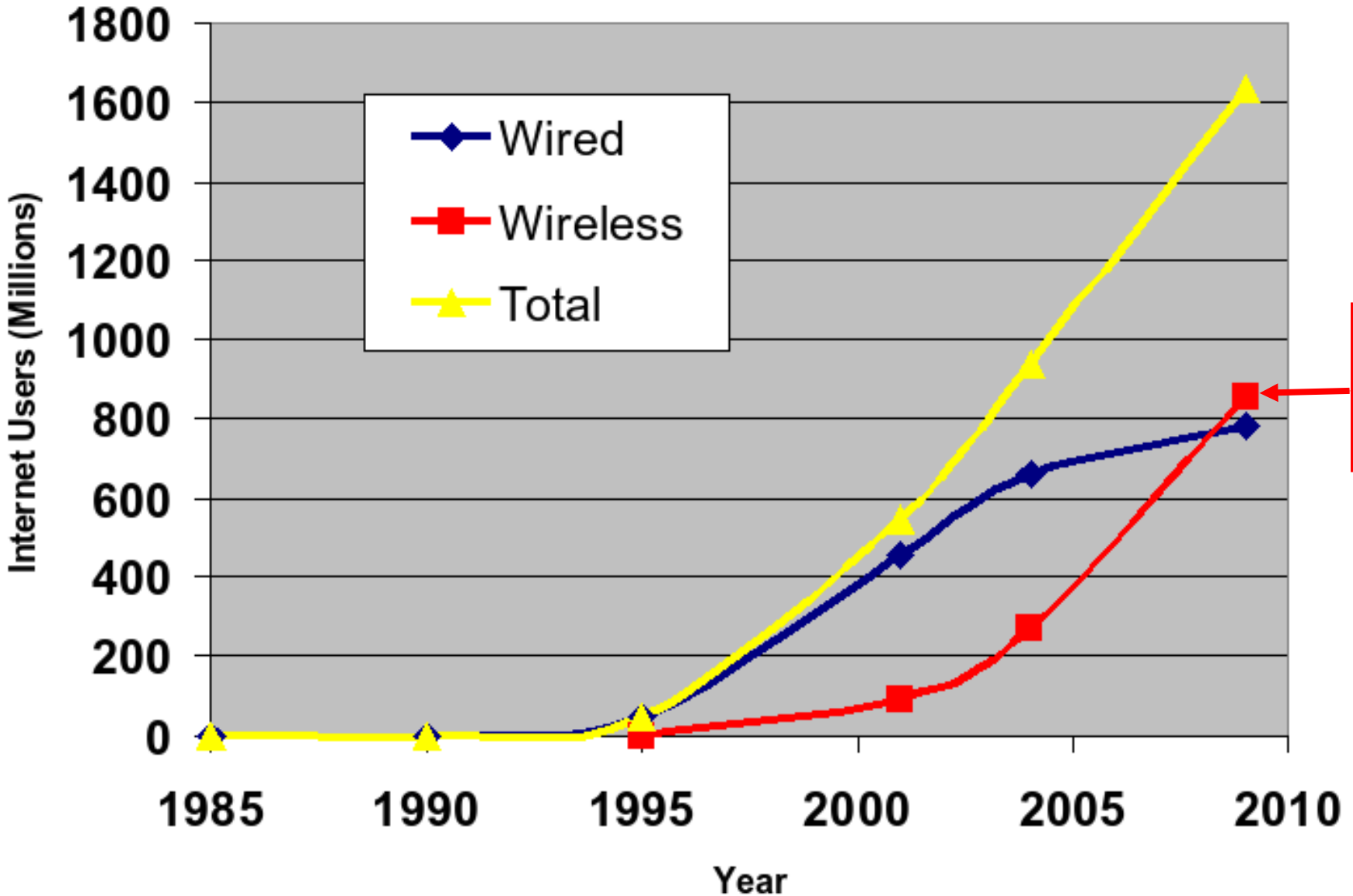



- Add Wireless Sensor Array
- Build GIS Data
- Focus on:
  - Pollution
  - Water Cycle
  - Earthquakes
  - Bridges
  - Traffic
  - Policy
- Work with the Community to Adapt to Growth

UCSD
UCIrvine

it²

# Transitioning to the "Always-On" Mobile Internet




http://www.etforecasts.com/products/ES_intusersv2.htm

# Broadband Wireless Internet is Here Today

- **Wireless Internet "Watering Holes"**
  - **WiFi and WiMax**
    - **Real Broadband--11 mbps Going to 54 mbps**
    - **Security and Authentication can be Added**
- **Cellular Internet is Rolling Out**
  - **CDMA2000 1xEVD0**
    - **Verizon San Diego, DC Rollouts Fall 2003**
    - **South Korea Fast Growth**
  - **GSM GPRS and EDGE**
    - **Cingular, T-Mobile**
  - **"A Cable Modem in the Sky"**



UCSD
UCIrvine

# Using Students to Glimpse the Future of Widespread Use of Spatially Aware Wireless Devices

- **Broadband Internet Connection via Wireless Wi-Fi**
- **Year- Long "Living Laboratory" Experiment 2001-02**
  - **500 Computer Science & Engineering Undergraduates**
- **300 Entering UCSD Sixth College Students—Fall 2002**
- **Experiments with Geo-Location and Interactive Maps**





CSE

ACTIVE CAMPUS .UCSD.EDU

Microsoft Research

hp invent

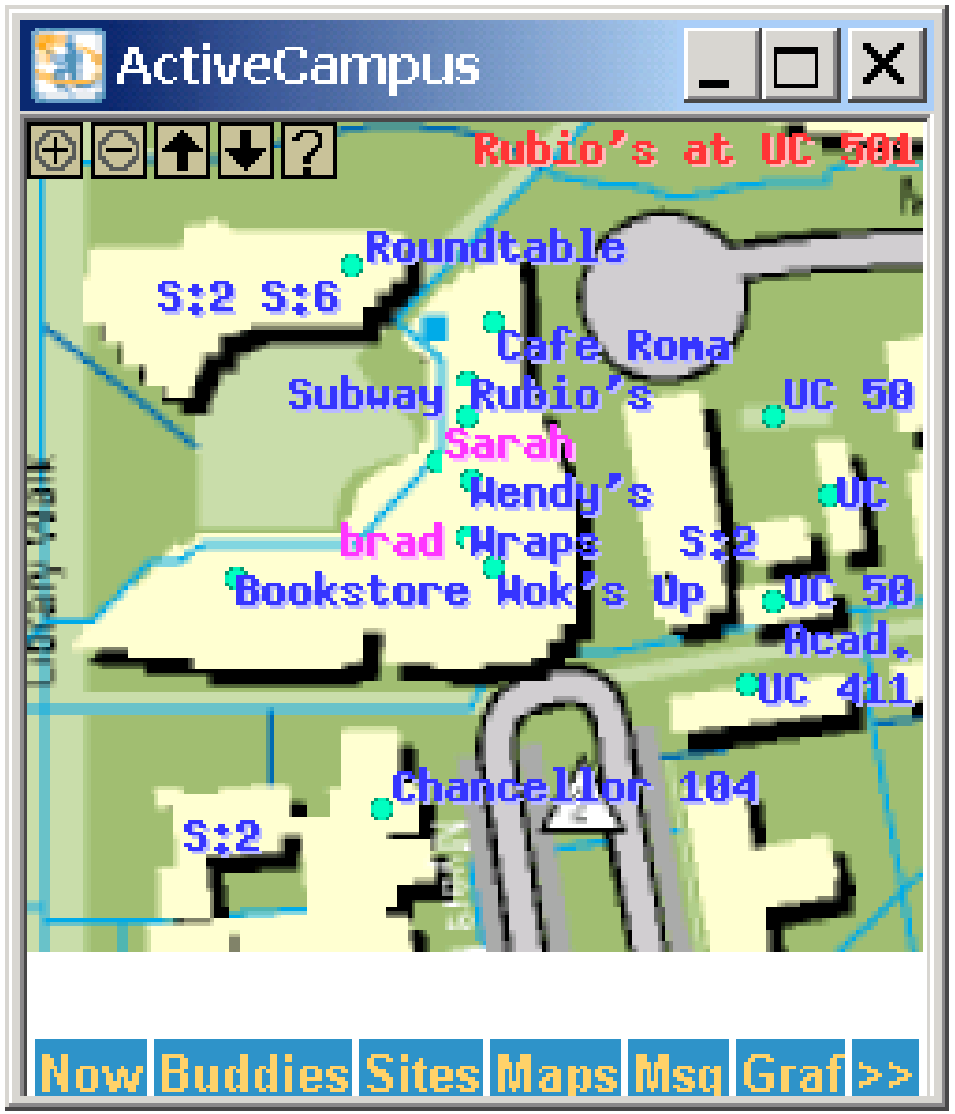
UCSD

UCIrvine

**Calit2 Team: Bill Griswold, Gabriele Wienhausen, UCSD**

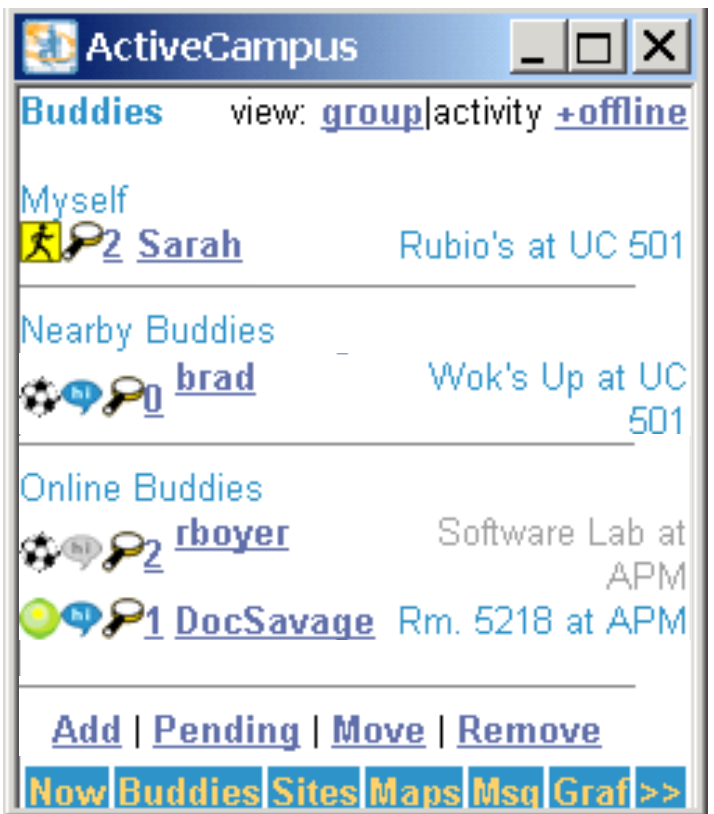
it²

# Spatially Aware World—Everyone and Everything Knows Where the Others Are




UCSD ActiveCampus – Outdoor Map

- **Technologies of Geolocation**
  - GPS chips
  - Access Point Triangulation
  - Bluetooth Beacons
  - Gyro chips




Source: Bill Griswold, UCSD

# Calit2 Provides Real Time Personalized Commute Information



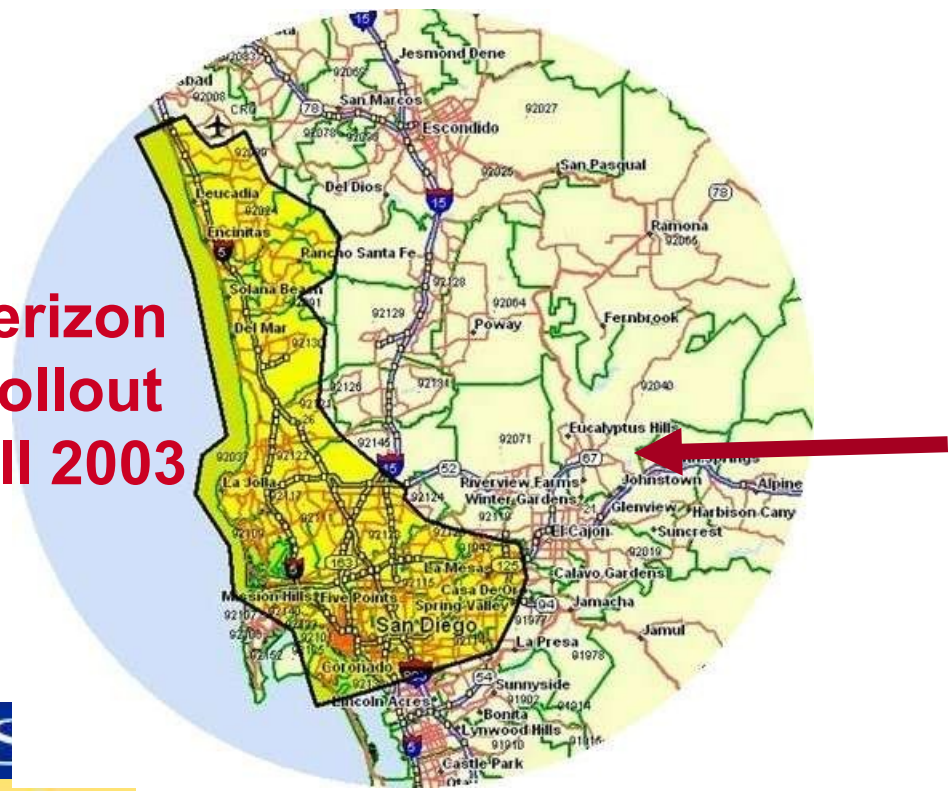

http://traffic.calit2.net/index.jsp

# Only Three Years From Research to Market
# New Broadband Cellular Internet Technology

- First US Taste of 3G Cellular Internet
  - UCSD Jacobs School Antenna
    - Three Years Before Commercial Rollout
- Linking to WiFi Mobile "Bubble"
  - Tested on Campus CyberShuttle
- Verizon Introduces in San Diego




Rooftop Qualcomm
1xEV Access Point




Verizon
Rollout
Fall 2003



CyberShuttle March 2002

UCIrvine

www.calit2.net/news/2002/4-2-bbus.html

# Students Are Creating New Uses of the "Always-On" Internet










UCSD
UCIrvine

# Collaborating with City, County, State Agencies
## Rethinking Public Safety in an Always-On World

- **Project RESCUE**
  - Transforming Data Collection, Management, Analysis, Sharing, and Dissemination to Improve Crisis Response
  - Five-Year $12.5 Million Large ITR Award-Started Oct 1, 2003
  - Twenty-Five Researchers and Professors
    - UCI PI: Sharad Mehrotra, ICS
    - UCSD PI: Ramesh Rao, ECE
    - Univ. Maryland, Univ. Of Illinois, BYU, Univ. Colorado, ImageCat
  - Community and Industrial Partners
    - Cities of Los Angeles, Irvine, and San Diego
    - County Partners: of Los Angeles
    - State of California
    - Ericsson, HNS, HP, Intersil, Parity, SAIC, SBC, Symbol, Qualcomm





UCSD UCIrvine

www.calit2.net/briefingPapers/unexpectd.html

it²

# RESCUE Community Advisory Board

Ellis Stanley – Chair
**General Manager, City of Los Angeles**
**Emergency Preparedness Department**

Jim Watkins (retired)
**Governor's Office**
**Emergency Services**

Bob Garrott
**Los Angeles County**
**Office of Emergency Mgmt.**

Paulette Murphy
**Space and Naval Warfare**
**Systems Command**
**(SPAWAR)**

Dawna Finley
Tom Hume
Eileen Salmon
**City of Irvine**

Karen Butler
**Program Manager**
**Communications Division**
**San Diego Police Department**

William Maheu
**Assistant Chief of Police**
**City of San Diego**

David Rose
**Lieutenant Officer**
**UC San Diego Police Department**

Linda Bogue
**Emergency Mgmt. Coordinator**
**Environmental Health and Safety**

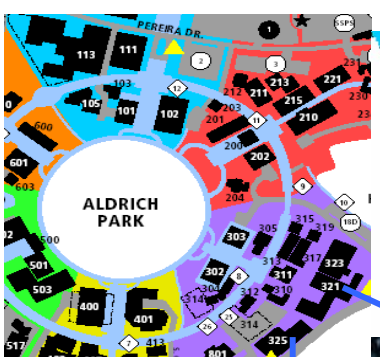


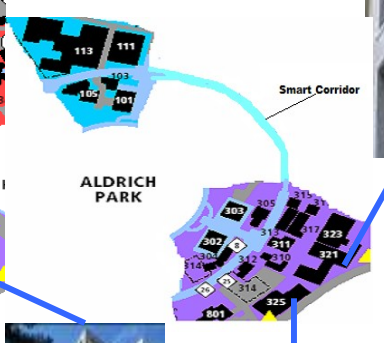
# NSF-Funded ResponSphere Establishes Calit2 Project Rescue Testbeds in Irvine and in San Diego

- **Localized Site-Specific Disasters Via Crisis Response Drills**
- **Explore Privacy vs. Public Safety Issues**
- **GLQ (*Gaslamp Quarter*, San Diego/UCSD)**
  - **Ubiquitous Wireless Coverage in Downtown San Diego**
  - **Test Network Architecture Enhancement and New Applications**
- **CAMAS (*Crisis Assessment, Mitigation, And Analysis*) – UCI Campus**
  - **Field-Test and Refine Research on Information Collection, Analysis, Sharing, and Dissemination in Controlled yet Realistic Settings**














PI: Magda El Zarki, ICS, UCI
www.responsphere.org

# NSF RESCUE Strongly Coupled with NIH WIISARD Grant

## Wireless Internet Information System for Medical Response in Disasters

## Calit2 is Working Closely with the First Responder Community



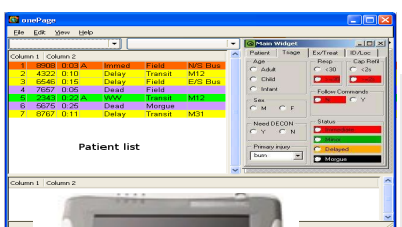




Triage

First Tier





Patient list



Mid Tier



802.11 pulse ox



Wireless Networks



Command Center







Reality Flythrough
Mobile Video

# Calit2 Cybershuttle Operations Base for Disaster Drills With Rapid Setup Wireless Mesh Network




**Self Configuring Mesh Network with Multiple Access Points that Aggregate Uplink Bandwidth with Auto-Reconfiguration and Fail-Over**

# Wireless Video Transmission Capability
# Major Improvement for Hazmat and Medical Units







# Quickly Re-Establishing Communications: Calit2 Mesh Network R & D



Disaster site

Hospital

Ground Zero



Incident command center

Deploy Portable Relay Nodes



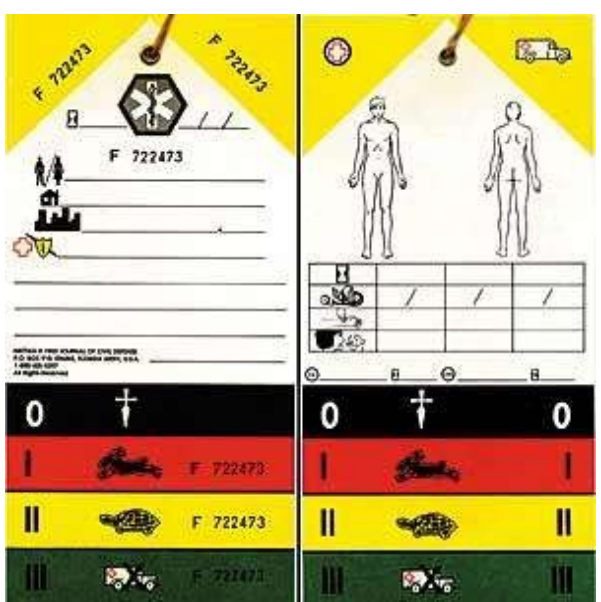
responsphere

rescue

it²

# Calit2 Prototype--Active RFID Triage Tag Built on WiFi Embedded Systems Technologies

- **Build from Commercial Components**
  - Dpac WiFi Module
  - Ubicom Application and Web Server Processor
  - Rapid Association with Network and Battery Conservation Cycle
- **TCP/IP Communications**
  - Heart Beat + Geolocation
  - Receives Instructions from Command Center Systems & Responds
  - Displays Triage Status & Alerts With LEDs
  - Stores Medical Data in Flash ROM for Offsite Access







UCSD
UCIrvine

UBICOM™

# Undergrad Electrical Engineers Develop Wireless Pulse Oximeter Prototype for Emergency Response



Ivan Wong, Kuochao Tseng, Ben Pouladian, Jon Dunbar, and Rick Pan

## Electrical and Computer Engineering 191



UCSD
UCIrvine

www.calit2.net/newsroom/article.php?id=390

it²

# Embedded Systems WiFi Pulse Oximeter: Low Cost Improved Aid Stations

WiFi Module







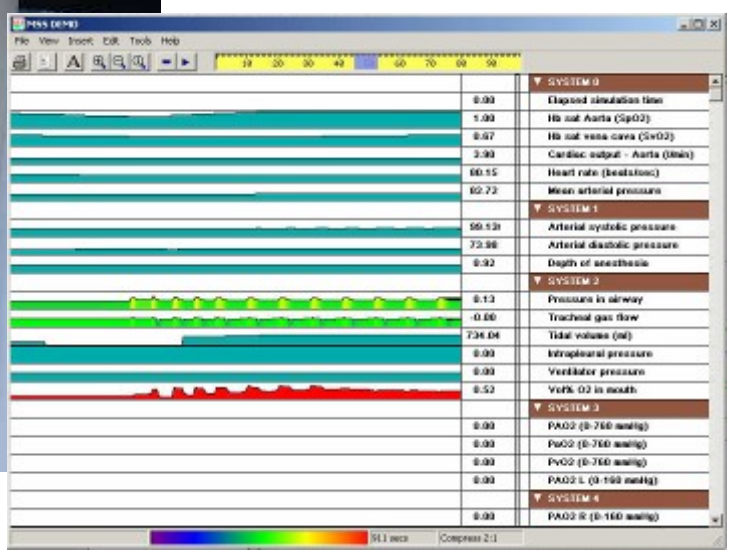
Waterproof Case With LCD/LED



Nellcor MP100 OEM Pulse Oximetry Board



Nellcor Forehead O2 Sensor



Windows XP Monitoring App

UCSD
UCIrvine

WISARD

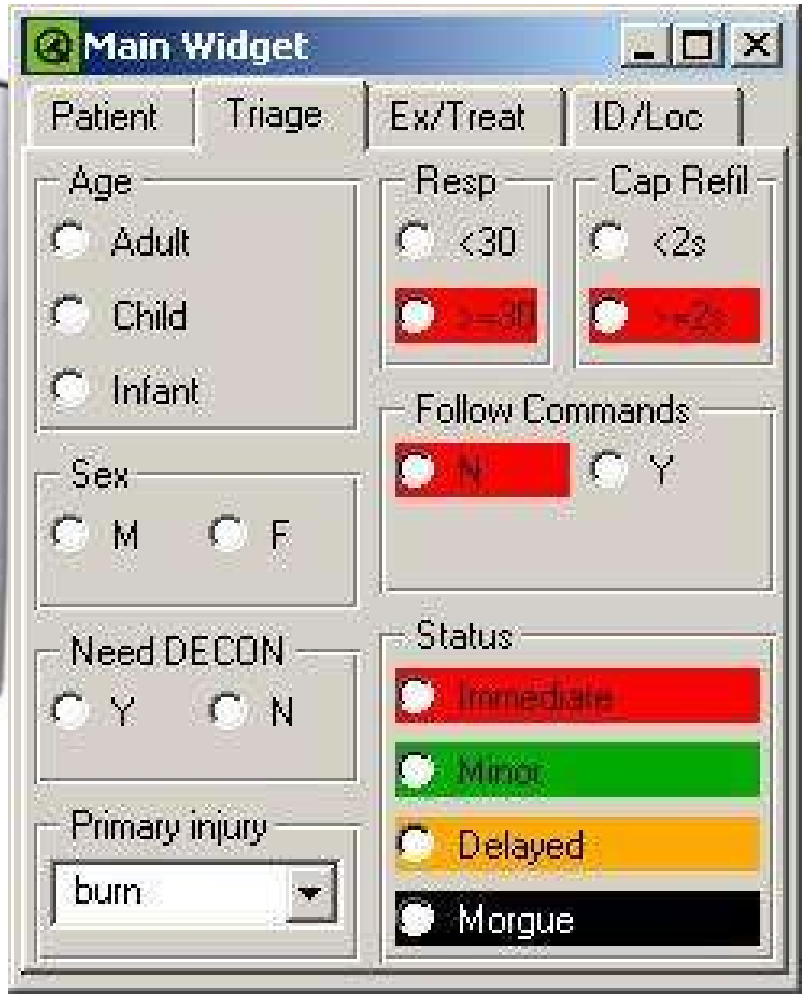
it²

# First Tier Provider
# Handheld WiFi Systems



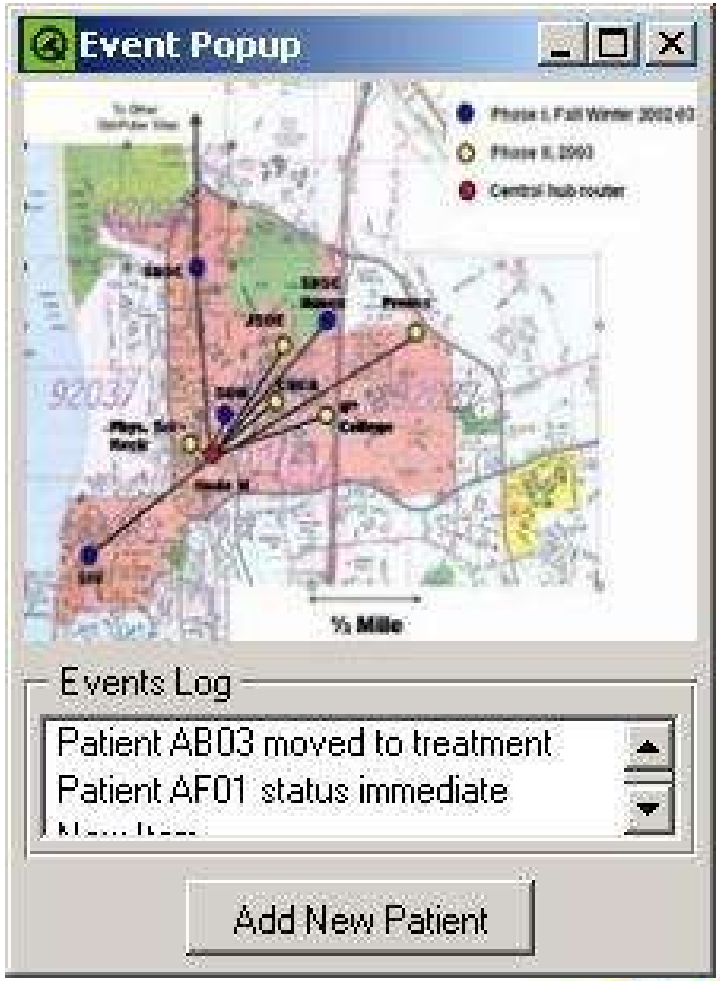




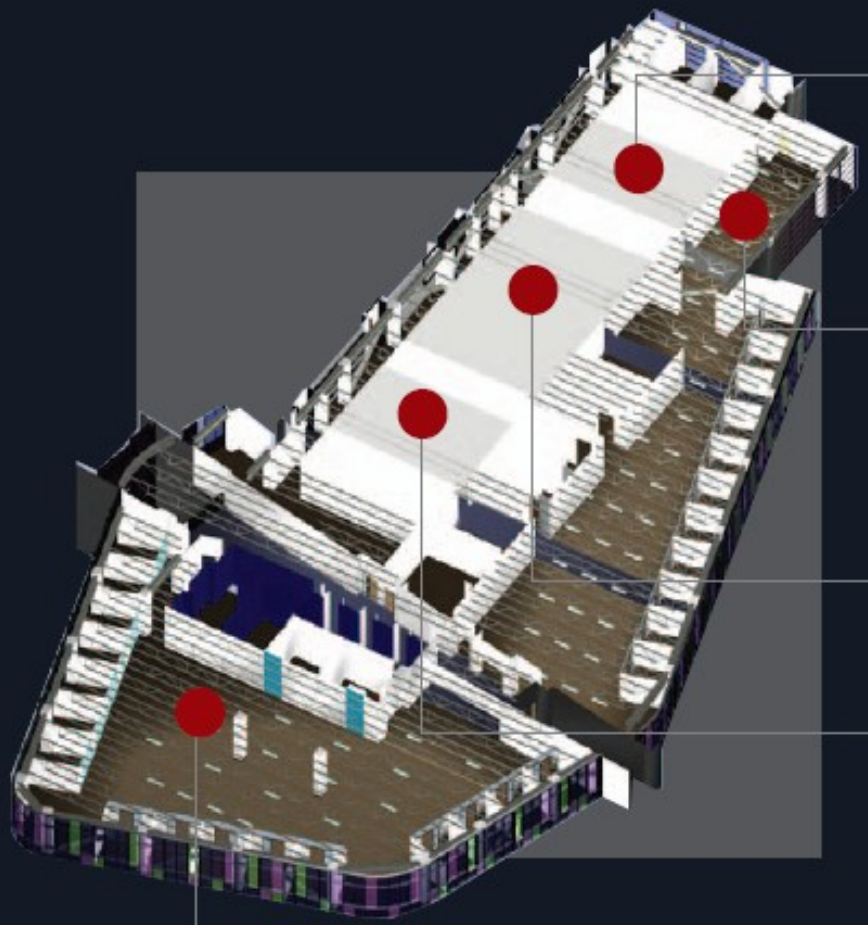



## Triage and Care

## Tactical Maps and Communications



# Wireless SensorNets Driving an Ultra High Bandwidth Fiber Optic Backbone Create a Planetary Scale Computer



**Systems-on-Chip Laboratory**

SOC lab provides infrastructural support for hardware/software platforms, including CalRadio, and research on networking protocols and embedded processing for mobile applications.

**Undergraduate Research Laboratory**

This lab supports undergraduate research as part of senior-level, project-based courses as well as the Calit2 Scholars summer research program.

**Photonics and OptIPuter Laboratory**

Photonics research and OptIPuter network infrastructure development.

**Wireless Platforms Laboratory**

Current platforms under development and test include portable software defined radio, bench-top software defined radio, wireless pulse oximeter, wireless/paperless patient tag, ground-based wireless mesh network nodes, wireless smart-door control, wireless patient drug dosage monitor, and UAV-based wireless mesh network nodes.

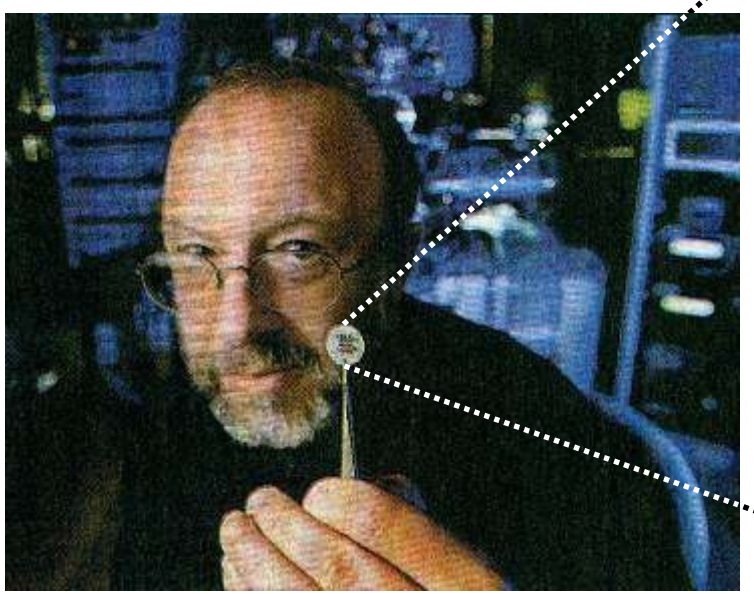
**Calit2 Academic Professionals**

Calit2 staff researchers range from recent Ph.D. graduates to seasoned engineers from the private sector.

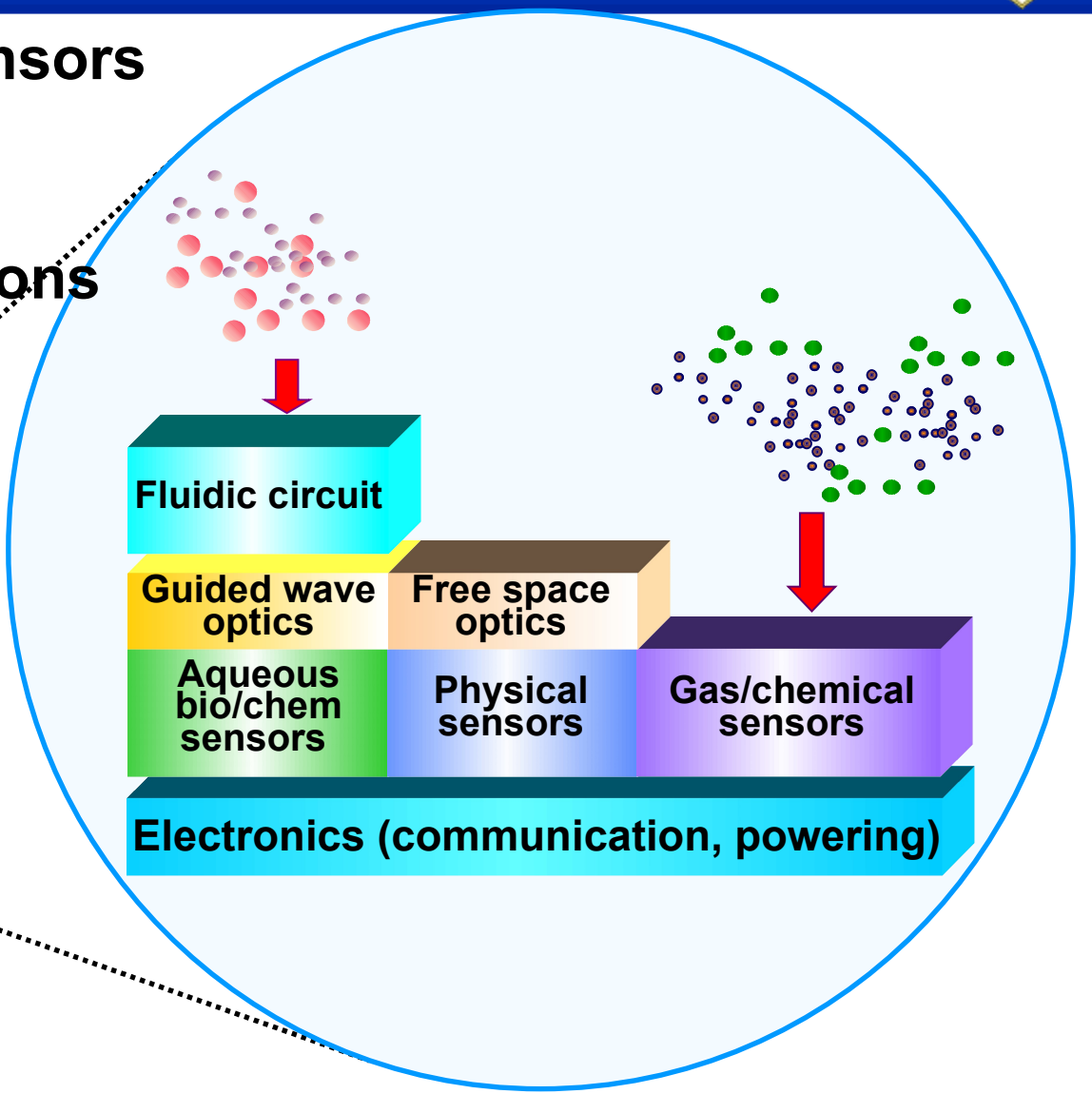
UCSD
UCIrvine

# A World of Distributed Sensors Starts with Integrated Nanosensors

## Developing Multiple Nanosensors on a Single Chip, with Local Processing and Wireless Communications



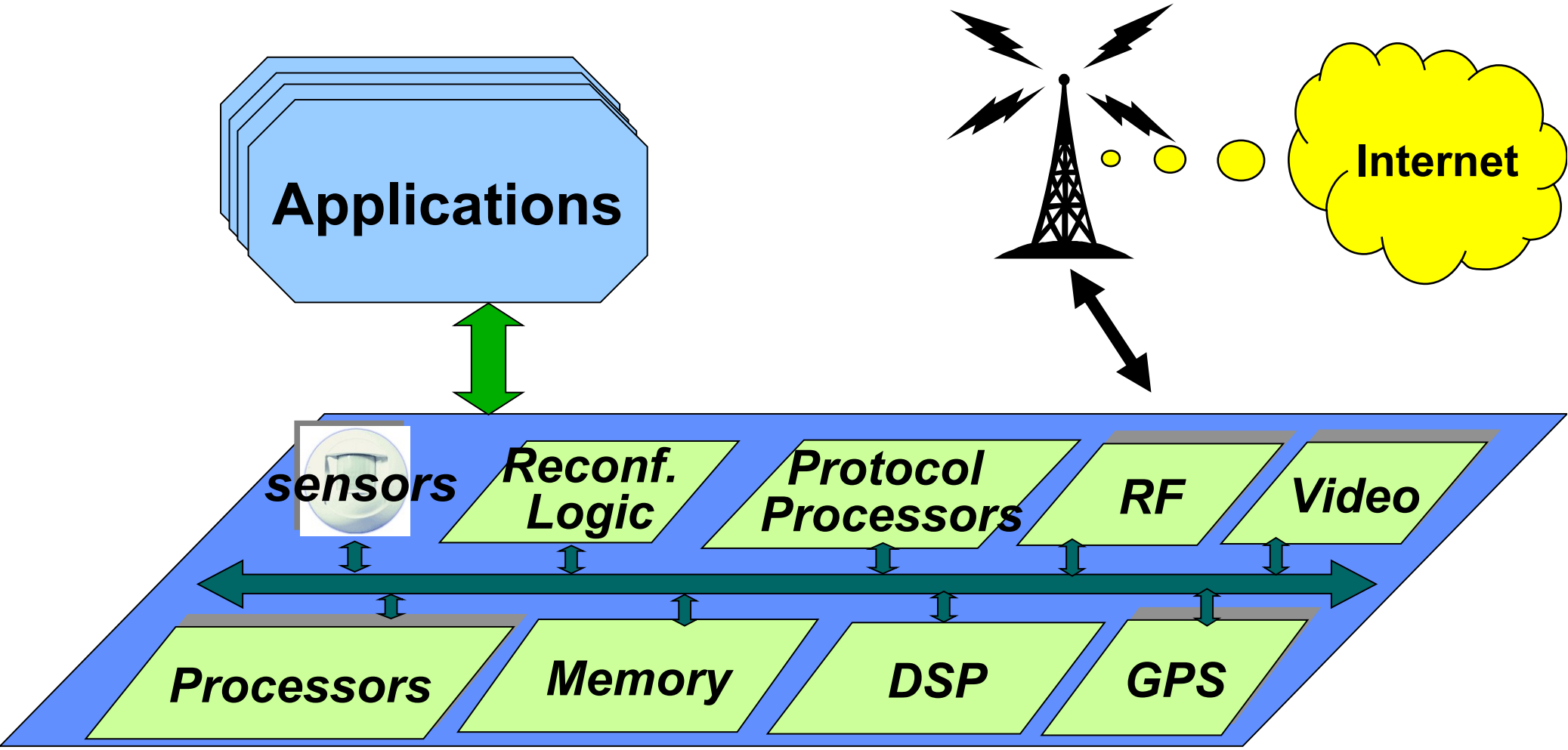
I. K. Schuller holding the first prototype




UCSD
UCIrvine

I. K. Schuller, A. Kummel, M. Sailor, W. Trogler, Y-H Lo

# Convergence of Embedded Computers and Radios to Create "Smart Radios"



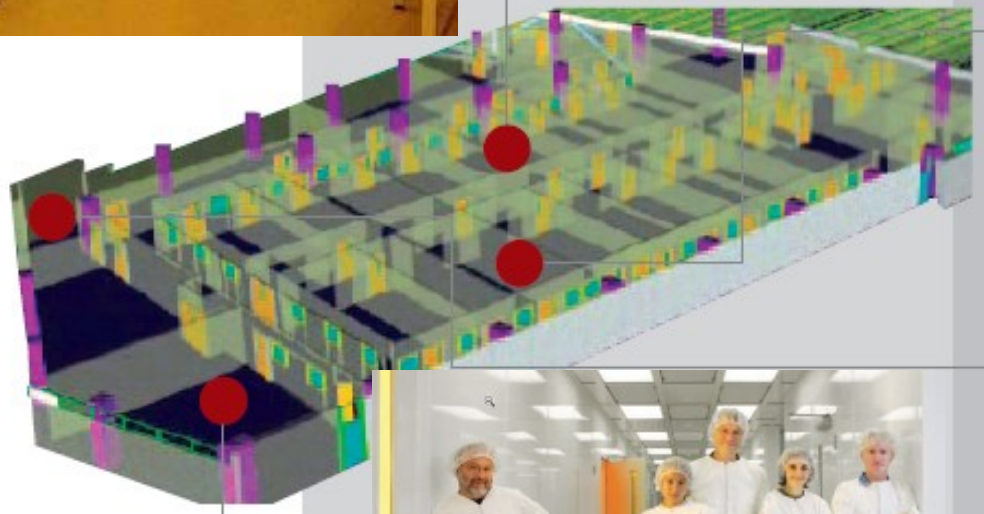

UCSD
UCIrvine

Source: Sujit Dey, UCSD ECE

it²

# Calit2@UCSD Creates a Dozen Shared Clean Rooms for Nanoscience, Nanoengineering, Nanomedicine







**Class 100 Clean Room Modules: Nano/microlithography**

Areas with no more than 100 particles larger than 0.5 microns per cubic foot of air. Facilities include e-beam lithography and photolithography modules.

**Class 1000 Clean Room Modules: Nano/microfabrication**

No more than 1,000 particles larger than 0.5 microns per cubic foot of air. Areas include metallization/thin film deposition, advanced dry etching, metrology, thermal and back-end processes.

**Advanced Structural Characterization**

Techniques include scanning electron microscopy (using electrons rather than light to form an image) and scanning probe microscopy. Ultrahigh vacuum surface analysis. Optical characterization.

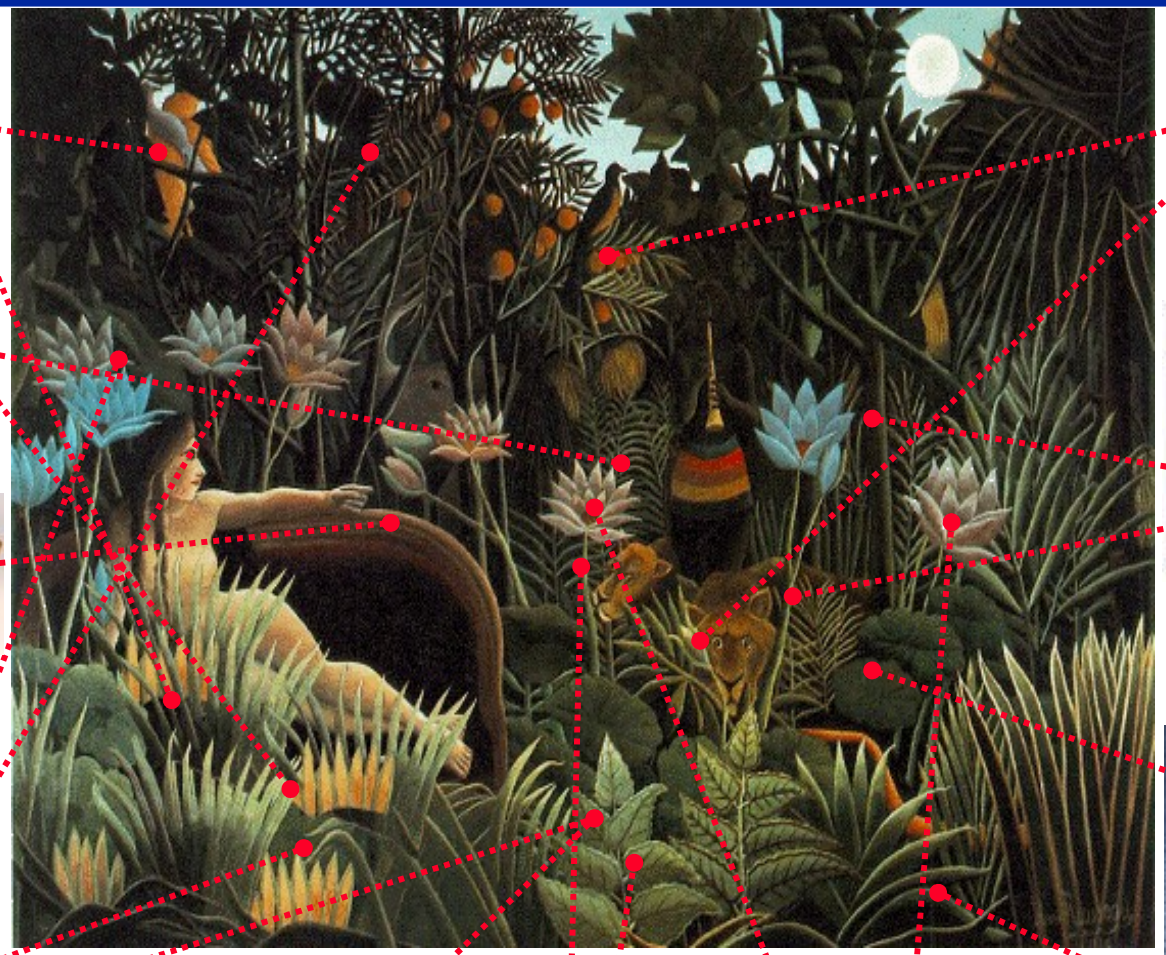
OTHER FACILITIES INCLUDE:

**Metal-Organic Chemical Vapor Deposition Facility**

MOCVD technique used for thin film growth in advanced, compound semiconductors and nanostructures.

Photo Courtesy of Bernd Fruhberger, Calit2

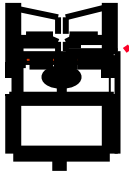
# Distributed Sensors Can Read Out the Micro-States of the Macro-Environment



Sensor Web



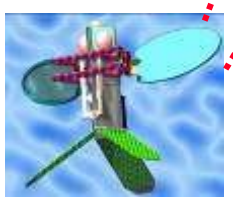
Micromet Station



Chem-Lab on a Chip



Artificial Insect



Multi-Analysis Soil Probe

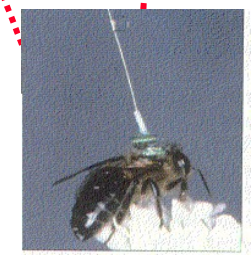




Electronic Tongue



Electronic Nose



Micro-Telemetry

Radio Frequency Communication



Sap Flow Sensor



Automated Minirhizotron

UCSD
UCIrvine

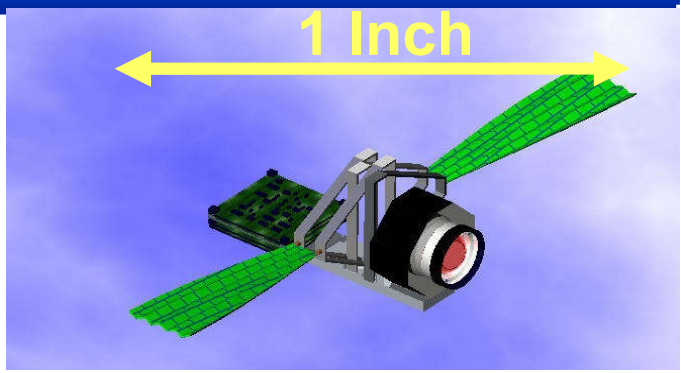
Source: Gregory Bonito, LTER

it²

# Shrinking Flying Wireless Sensor Platforms: From Predator to Biomimetic Robots

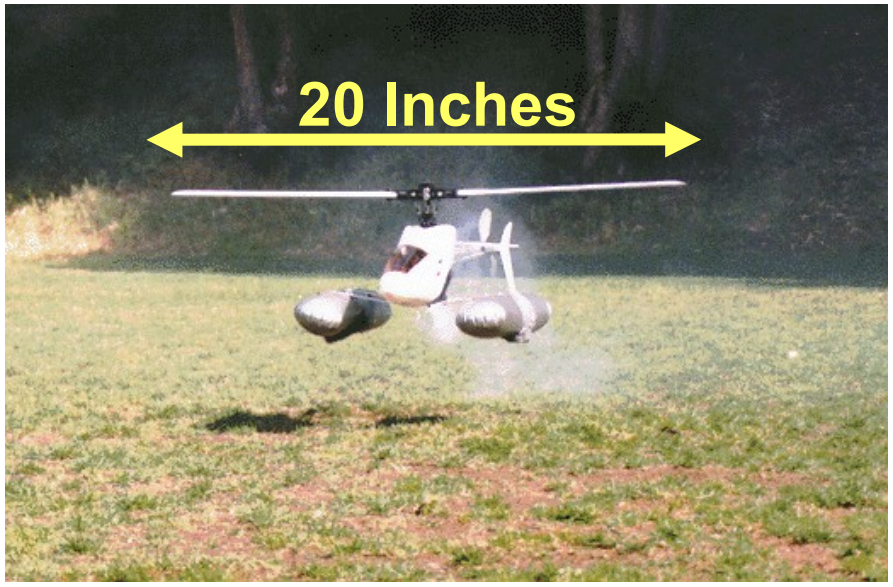



**General Atomics Predator**
**(Air Force, CIA)**




**UC Berkeley Micromechanical Flying Insect Project**

**(DARPA, ONR)**




**UC Berkeley Aerobot**
**(ARO, DARPA, ONR)**

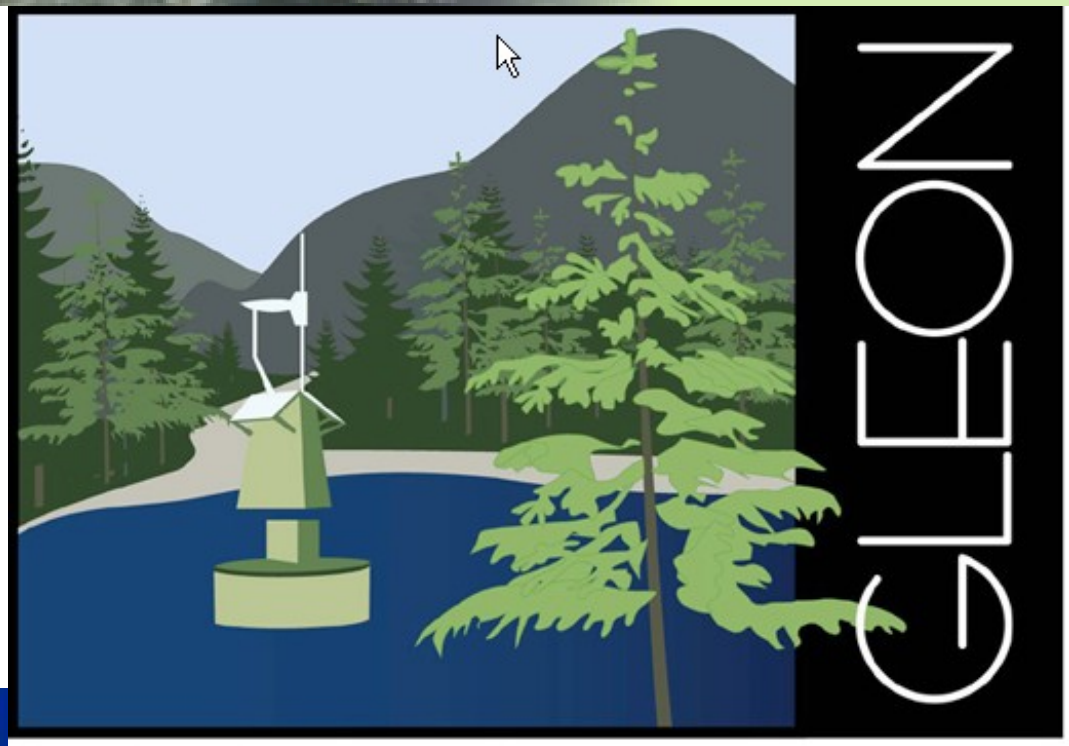
UCSD
UCIrvine

it²

# Schools Will Be Able to Monitor Remote Environments in Real Time



Coral Reef Environmental Observatory Network



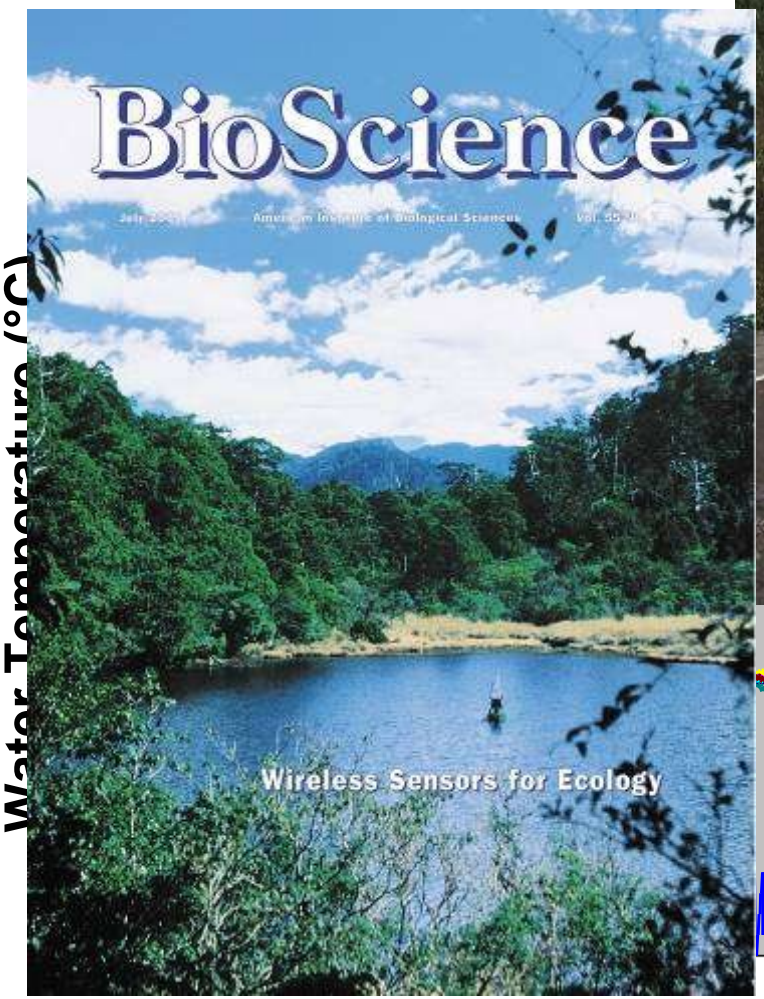

**Workshop**
**29th to 31st March 2006**
**Townsville, Australia**

UCSD
UCIrvine
global lake ecological observatory network

it²

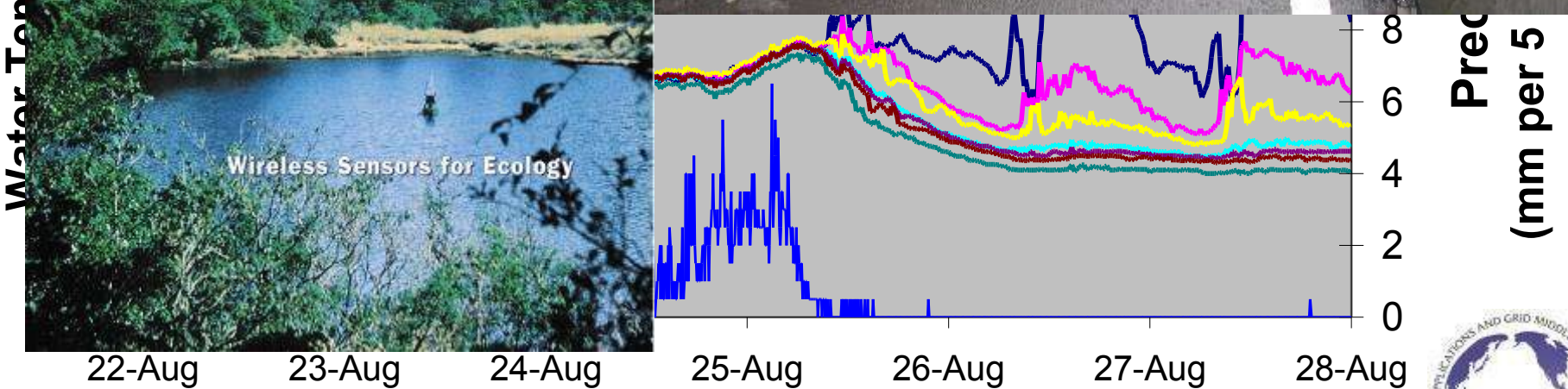
# Remote Observation of Episodic Events in Water-Based Ecological Systems

Used by NSF Director Feb 2005










Part of a growing global lake observatory network - http://lakemetabolism.org

*Source: Tim Kratz*

UCSD UCIrvine

PRAGMA

Supported by Moore Foundation

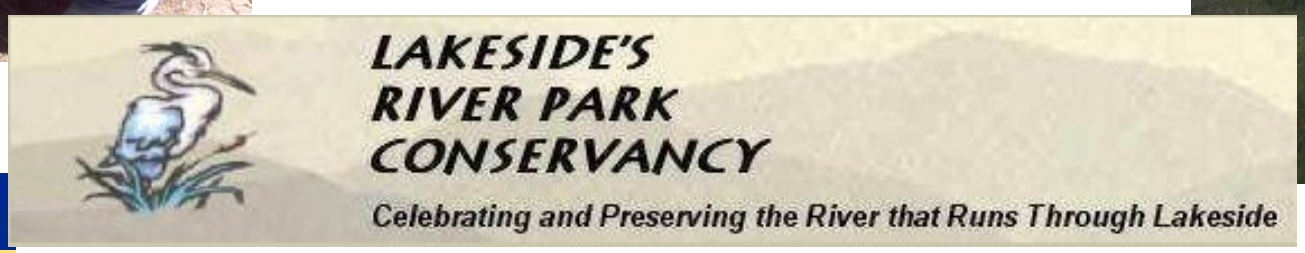
# Calit2 Teams with the UCSD Jacobs School to Provide Community Service for Undergrads







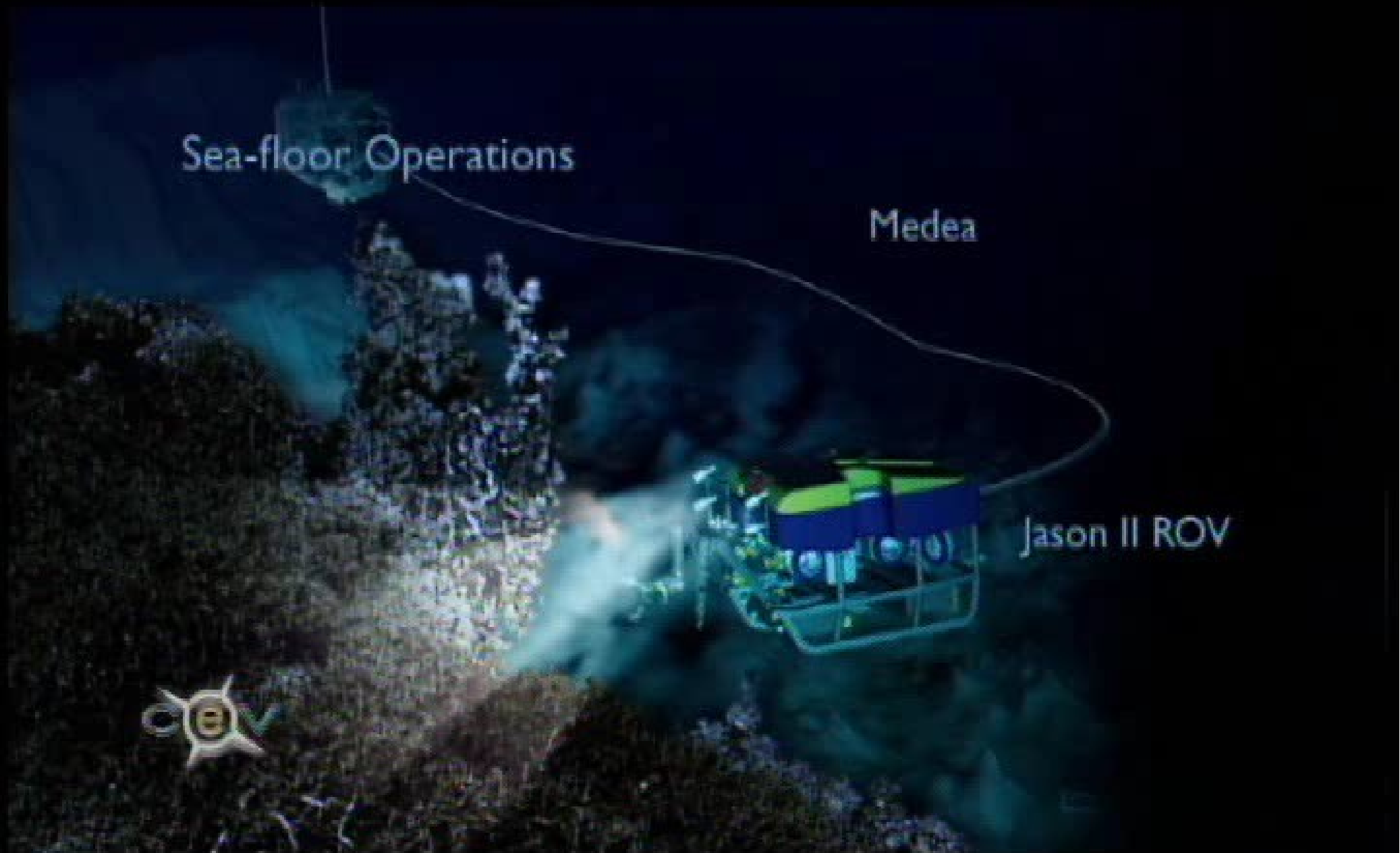


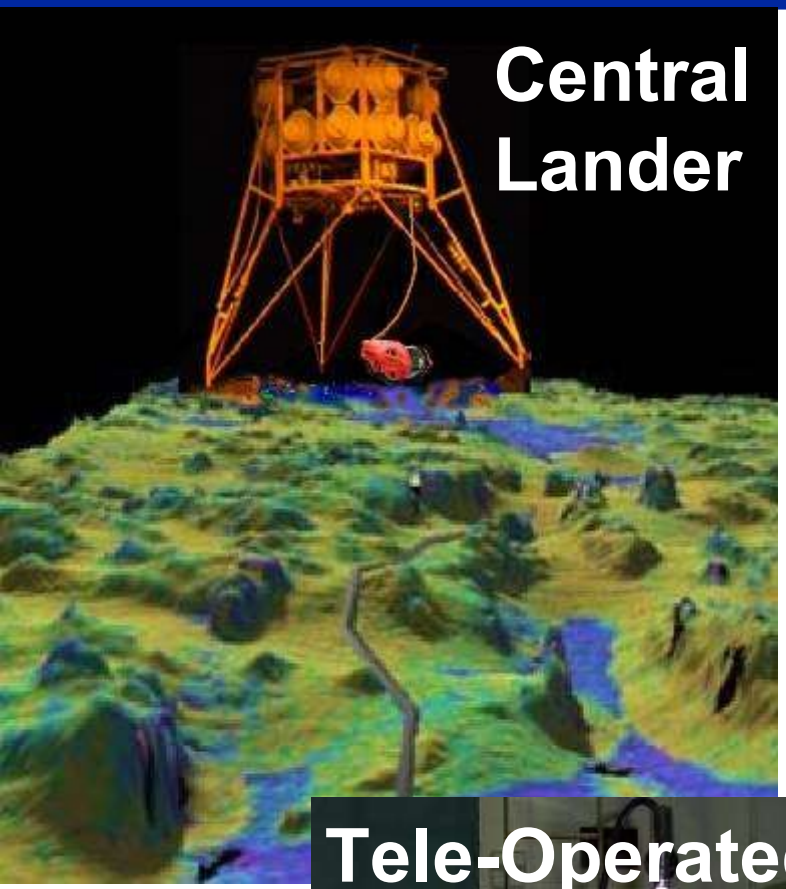

UCSD
UCIrvine

it²

# High Definition Video - 2.5 km Below the Ocean Surface

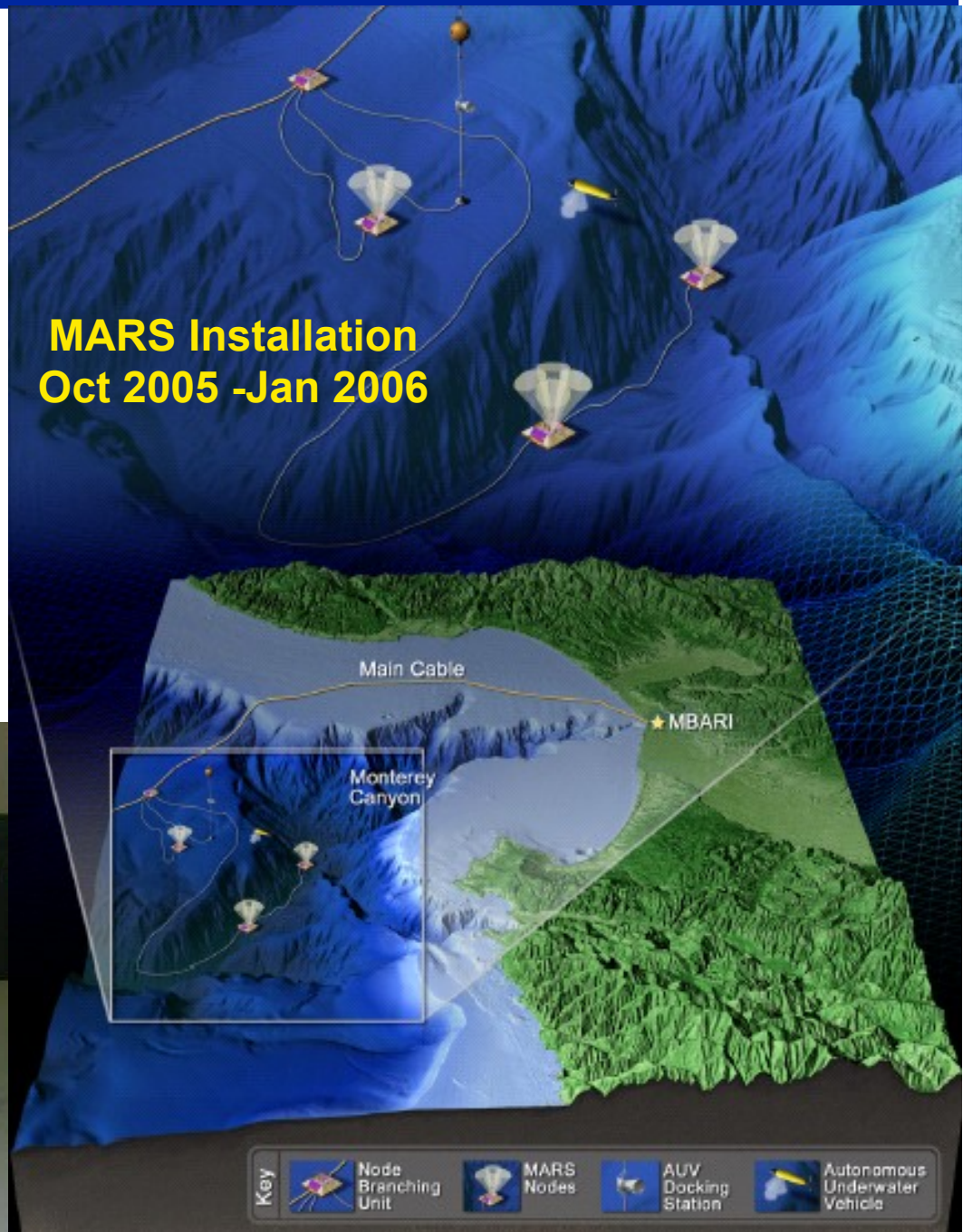


# MARS Cable Observatory Testbed – Calit2 Living Laboratory










**Source: Jim Bellingham, MBARI**

UCSD
UCIrvine

# A Near Future Metagenomics Fiber Optic-Enabled Data Generator




Source John Delaney, UWash