SensorKit: Rapidly Deployable Water, Energy, and Traffic Monitoring
Sustainability Drivers

- **Cost savings through efficiency**
  - Achieving the **triple bottom line** of People, Planet and Profits

- **Increased revenue:**
  - Competitive advantage
  - New market creation

- **Legislation:**
  - California AB 32
    - Mandatory reporting begins in 2009 with 2008 data
    - 800 facilities identified in 6 sectors

- **Confirmed benefits**
  - Motivate new submetering architecture
• Investigation by New York State Energy Research and Development Authority:
  – submetered buildings use less energy
  – Carlyle Towers - Size: 194 units (15 floors)

- Average Monthly KwH/Apartment after submetering
- Before submetering
  - After submetering
Benefits of Energy Sub-Metering

- Investigation by American Water Works Association (AWWA):
  - 12.5% reduction solely from sub-metering
  - Additional 20% reduction by upgrading homes with efficient systems: dishwasher, clothes washer and toilets

<table>
<thead>
<tr>
<th></th>
<th>Sub-metered homes</th>
<th>Non-sub-metered homes</th>
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<tbody>
<tr>
<td>Water Use: Gal/Household/Day</td>
<td>119</td>
<td>136</td>
</tr>
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SensorKit Sustainability System

- **Metering:**
  - Accurate detection and characterization
  - Support of wide range of sensor systems
- **Retrofit capability**
  - Non-intrusive integration of sensing system
- **Scalability:**
  - Rapid deployment and upgrade
- **Continuous monitoring and analysis**
  - Analyze real time as well as historical data
- **Applications**
  - Energy
  - Water resources
  - Infrastructure
  - Environment

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**Key Features:**
- Accurate Detection
- Adaptability
- Continuous Monitoring
- Scalability
- Rapid Deployment
- Reliability
SensorKit Sustainability Systems

- **Our mission** today: Provide Sensor Networks for Sustainability
  - End-to-end integration
  - Ready for rapid, global deployment
  - Permanent or survey applications
  - Many customized product streams

- **SensorKit integrated system**
  - Hardware systems from National Instruments partnership
  - Software systems based on National Instruments LabVIEW
  - Network systems rely on standards
  - Database systems rely on standards
SensorKit Sustainability Systems

• SensorKit Applications
  – Water Metering
  – Energy Metering
  – Water Treatment Control Systems
  – Traffic Monitoring
  – Structural Health Monitoring
    • Los Angeles Department of Building Safety
  – Water resources
    • San Joaquin River
    • Argentina Lake Systems
    • NSF WATERS national program
  – Carbon budget in ecosystems
    • La Selva, Costa Rica
SensorKit at La Selva: Integration with Google Earth
SensorKit at La Selva: Integration with Google Earth
Accurate accounting of vehicle, bicycle, and pedestrian flow and parking system control
SensorKit Traffic Monitoring

SensorKit Traffic Monitoring

Systems duplicated here

Passive Infrared / Ultrasonic Vehicle and Bicycle Counting

SensorKit Enclosure

Thermal Infrared Pedestrian Counting

Roadway

Sidewalk

CENTER FOR EMBEDDED NETWORKED SENSING

UCLA USC UCR CALTECH UCM
SensorKit Energy Metering

- Rapid deployment in existing structures
  - Detailed per-circuit analysis
  - Summary level
  - Waveform level
- Rapid retrofit
  - Hot-pluggable
  - CB Panel
  - Distribution Panel
SensorKit Water Treatment Remote Control

- M3 Modular Water Treatment System
  - UCLA WaTeR Center
- Real Time Control
  - Flow, direction, pressure, and sequencing
  - Energy usage
- Remote access and supervisory control
  - Global access
Energy Monitoring with Smart Panel at Shanghai NIDays
• **SensorKit**
  – Rapidly deployable water and energy resource monitoring
    • Hot water, cold water, wastewater
  – Mandatory reporting
  – Resource cost reduction
  – Verification of resource usage reduction methods

• **Collaboration with Los Angeles Mayor’s Office and LA Department of Water and Power**
  – Residential housing (affordable housing programs)
  – Tall buildings (Century Park)
  – UCLA Campus Residence Halls (typical 7 story / 96 monitoring points)
SensorKit Building Resource Usage

• SensorKit and LEED
  – Leadership in Energy and Environmental Design (LEED) Green Building Rating System
  – Potential revenue benefits for organizations
  – Requirements for measurement and validation

• LEED Building Program
  – EVO Building
  – 1111 South Grand Avenue, Los Angeles
SensorKit Water Metering Survey Systems

• Objective
  – Enable verification of water conservation devices and practices

• Deploy SensorKit nodes in structures
  – Depend on available high precision sensor systems
  – Depend on ultrasonic transducers whenever applicable
  – Depend on audit and calibration procedures

• Require no impact on IT resources
  – All data web accessible
  – Establish secure, independent wireless links
  – (Can operate with existing IT network infrastructure)

• Monitor and record
  – Usage at high time resolution
  – Provide instantaneous and summary results
  – Searchable, standard database
SensorKit Water Metering Installed Systems

• **Objective**
  – Continuous monitoring and optimization of resource usage

• **Permanent Deployment**
  – SensorKit end-to-end system
  – Retrofit sensors
  – Available sensors

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  – All data web accessible
  – Establish secure, independent wireless links
  – (Can operate with existing IT network infrastructure)

• **Monitor and record**
  – Usage at high time resolution
  – Provide instantaneous and summary results
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SensorKit Water Metering Survey Deployment

SensorBase

LAN

WAN

Cellular Data Network

SensorKit Control Unit

SensorKit Wireless Multiplexer

Ultrasonic Water Flow Sensors

SensorKit Wireless Multiplexer

Ultrasonic Water Flow Sensors

National Instruments
SensorKit Water Metering Survey Deployment

Real Time Visualization
Data Archive
SensorBase
Standard SQL Interface
Enterprise Systems

SensorKit Control Unit
Ultrasonic Water Flow Sensors
SensorKit Wireless Multiplexer
LAN
WAN
Cellular Data Network

SensorKit Wireless Multiplexer
Ultrasonic Water Flow Sensors

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SensorKit Based on Open Standards

• Wireless Networking
  – Bluetooth
  – WiFi
  – Leverages experience in wide area WiFi systems (cross-continent deployment)

• Security
  – Bluetooth protocol
  – SSH protocol
  – Secured database access

• User Interfaces
  – Web – *rapidly customizable*
  – Local systems – *rapidly customizable*