

Power Reduction: Reflections of an IC Designer

CalPlug Workshop

12 May 2015



Michael M. Green
Professor, Dept. of EECS
Univ. of California, Irvine

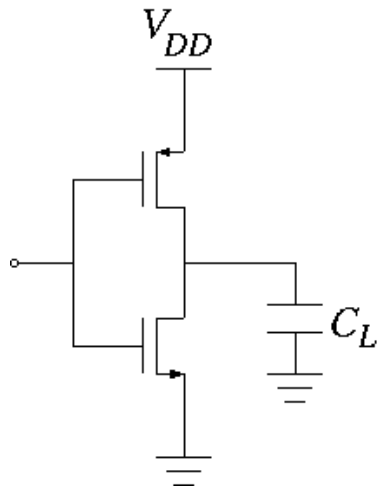


Creating Connections. Powering Innovation. Boosting Efficiency.

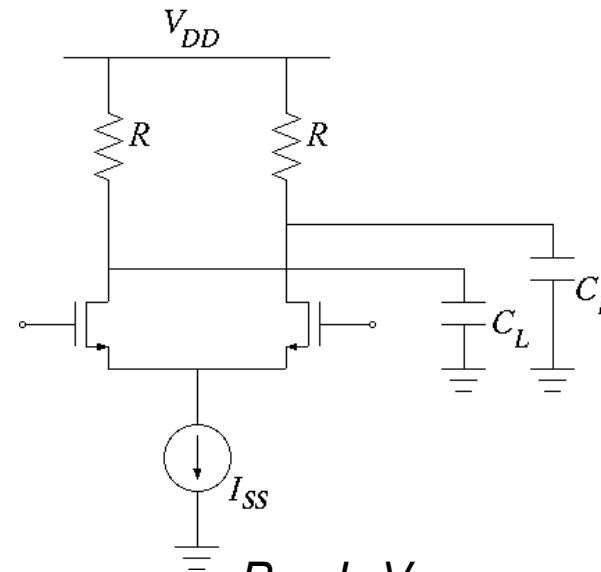


Power Dissipation in Communication ICs

For a given fabrication process, higher speed \rightarrow higher power dissipation



$$P_D = \frac{1}{2} C_L V_{DD}^2 \cdot f_{ck}$$



$$P_D = I_{SS} V_{DD}$$

Current state-of-the-art strives for energy on the order of pJ/bit



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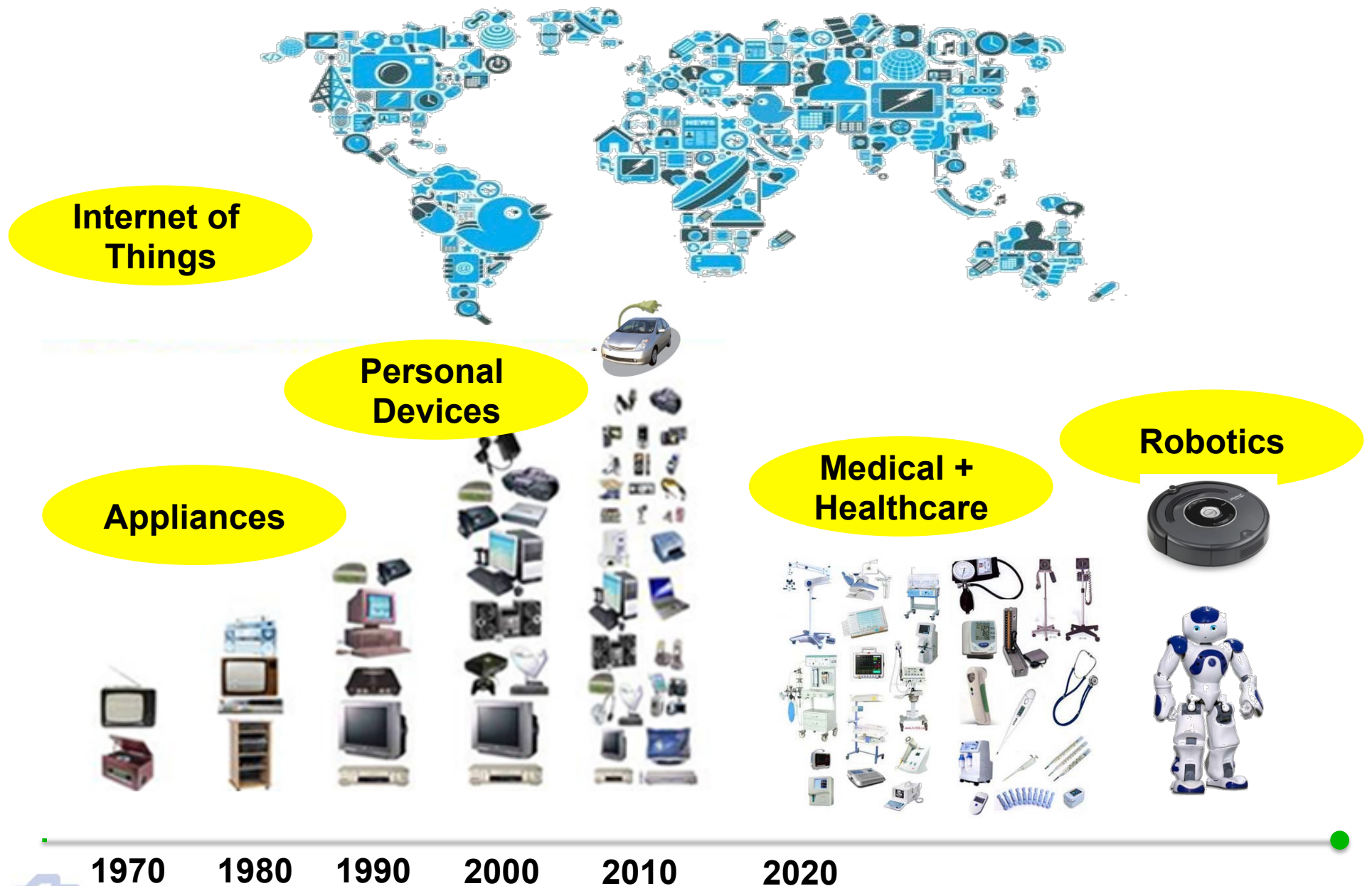
California Plug Load Research Center

- Help California and U.S. improve energy efficiency in appliances and electronic devices
- In the residential and commercial sectors
- Through research, demonstration, education
- About engineering, incentives, codes and standards, and user behavior



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Residential and Commercial Plug Loads



1970

1980

1990

2000

2010

2020

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UC Irvine Campus Building EE Initiatives

- UC Irvine has a history and reputation of being the top eco-friendly and green campus
- 19 MW cogeneration facility
- 20 GWh annual electricity savings since 2009
- Solar panels enough to power 500 homes
- All new buildings are required to be LEED Silver

Total LEED for New Construction: 83

Total LEED for Existing Buildings: 18

Total LEED for Commercial Interiors: 28

Total LEED for Homes: 13

Total LEED for Core and Shell: 1

TEN COOLEST SCHOOLS

By Avital Andrews

3: University of California, Irvine

← PREVIOUS 10/13 NEXT →



← PREVIOUS 10/13 NEXT →

3

UNIVERSITY OF CALIFORNIA, IRVINE
Irvine, California

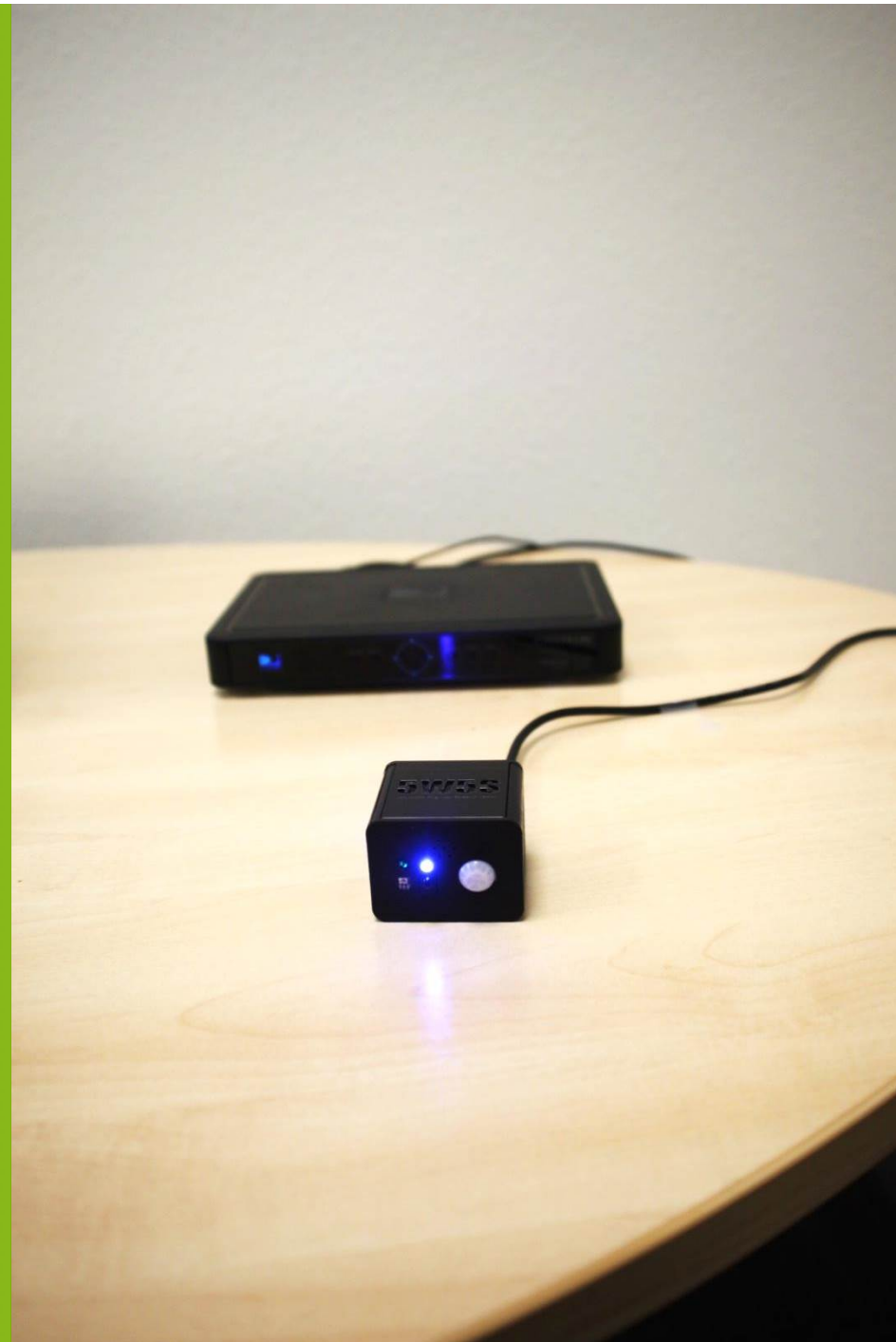
SCORE: 794.30 | STUDENTS: 27,479

UC Irvine's 19-megawatt cogeneration facility and other energy-preserving projects have helped the school save 20 million kilowatt-hours of electricity per year since 2009—and solar panels generate enough power to run 500 homes for a year. The 1,475-acre campus is anchored by a 16-acre botanical garden, and all new buildings must be certified at least LEED Silver. Living green is important at UCI: Meatless Mondays are strongly encouraged, and a dozen student clubs focus on eco-issues. Above, graduate students in UCI's Earth System Science Department learn about Mono Lake's geology, ecology, natural history—and about environmentalists' efforts to protect the lake—during a spring-break field trip.

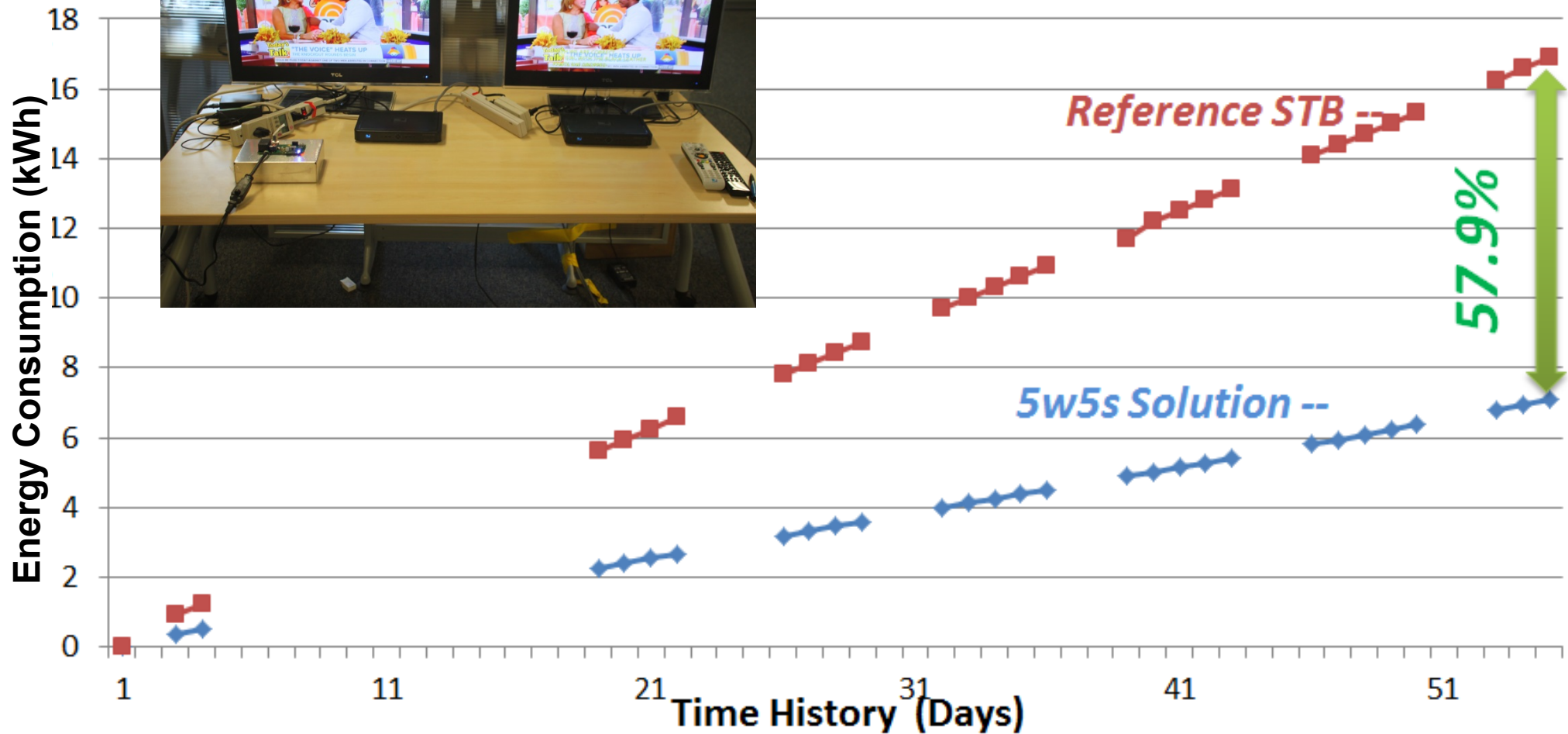
Photo courtesy of Kathleen Johnson/UC Irvine

Intelligent Sleep— *CalPlug's 5W5s Solution*

A consumer centric solution that adapts to the current set-top box (STB) infrastructure. Consumer input, sensor response and usage pattern are factored in for optimum delivery of service, without “consumer frustration”.

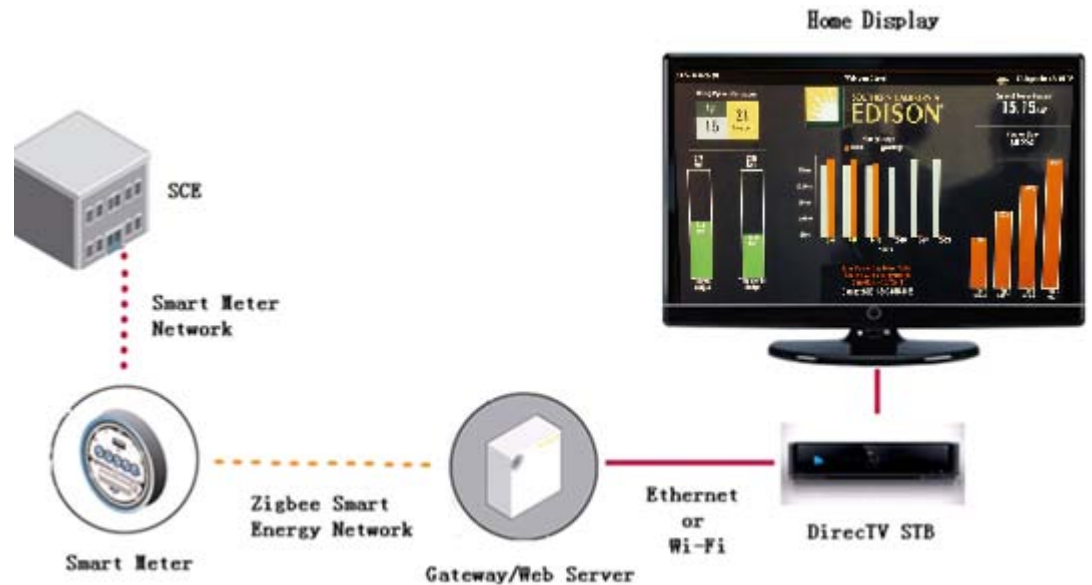


5W5s Achieved over 50% Energy Saving with Commercial STBs

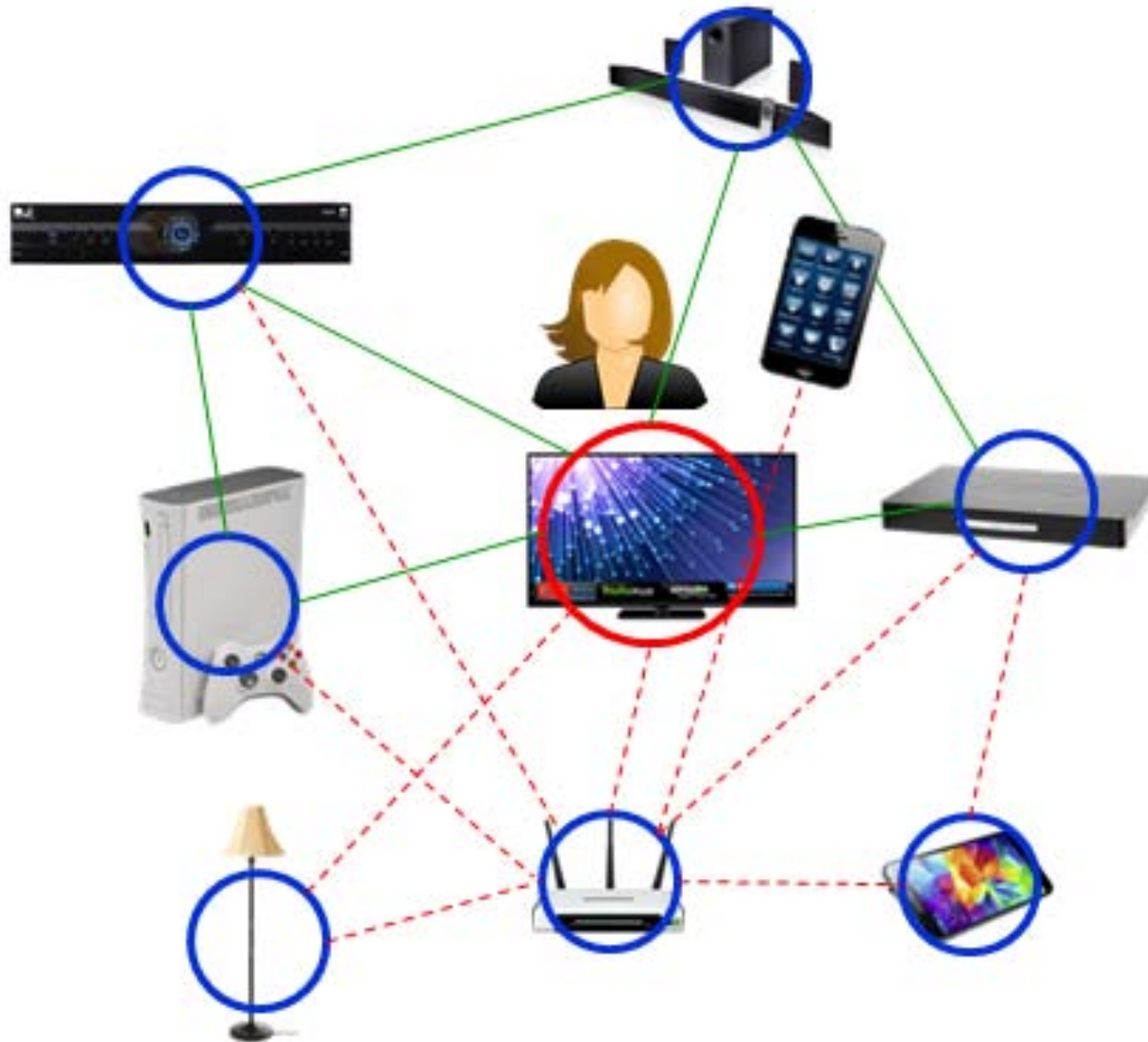


Smart Energy Display through STB Systems

- A unique energy information display channel
- Demand response pilot program
- Cross-platform display



Smart Home Entertainment System : Energy Negotiation Among Devices



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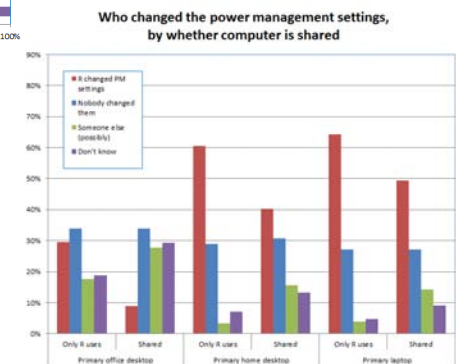
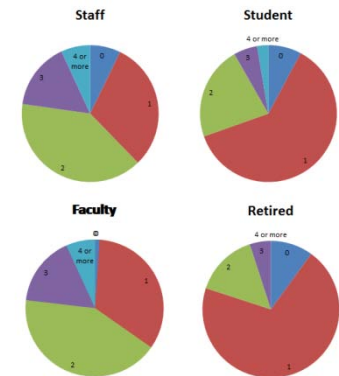
Smart Home Entertainment System : Negotiation Among Users and Contents



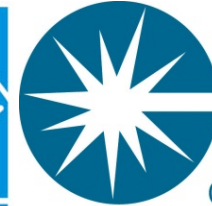
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Behavior Research: PC Power Management

- Target demographics
- Survey questions design
- Delivery instrument
- Data collection
- Analysis and report



Energy Testing Lab Service: Bench Top Tests



CEA
Consumer Electronics Association



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Energy Testing Lab Service: SIM-Labs

SIM Living Room



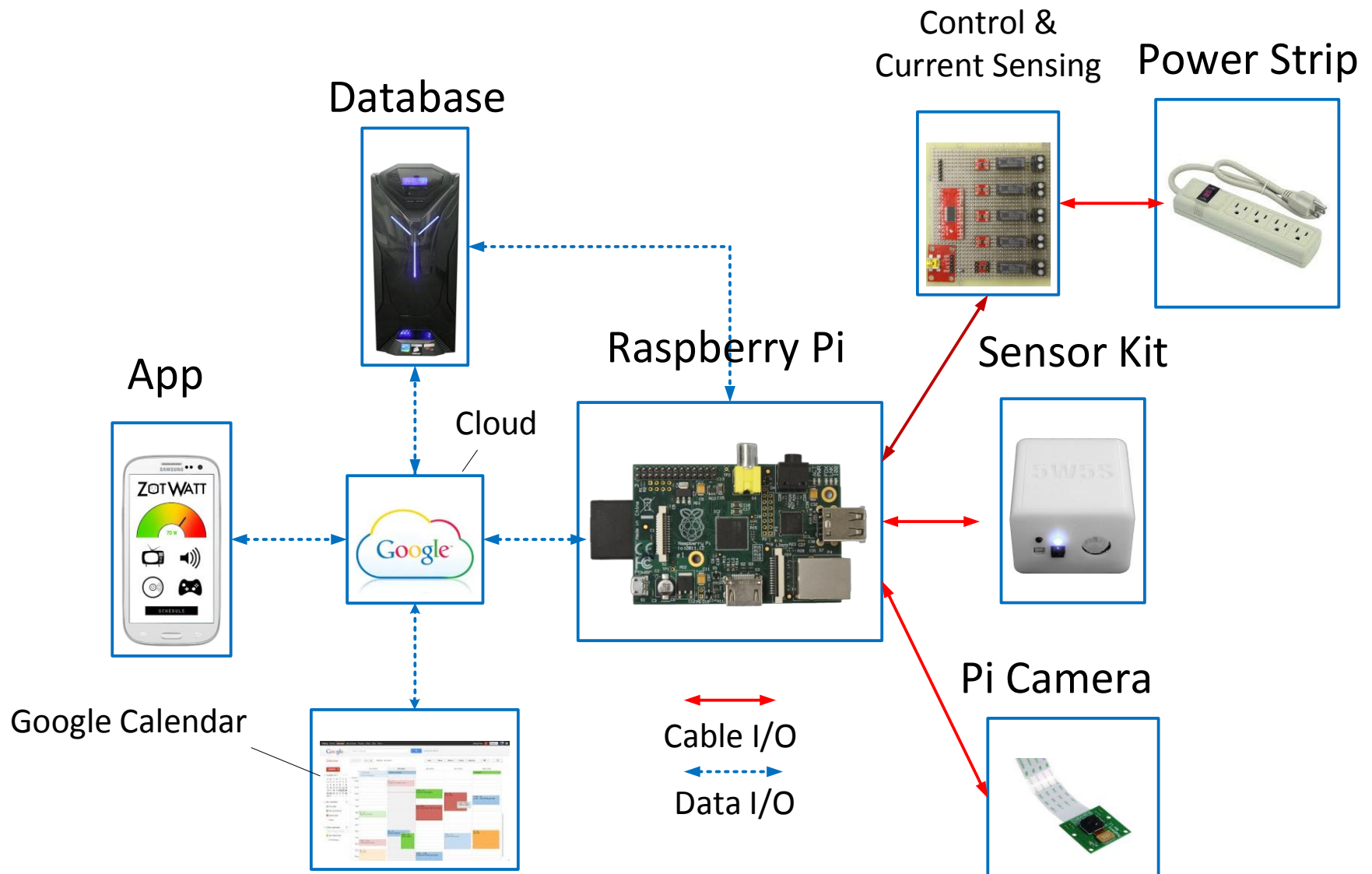
SIM Office



Purpose

To bridge the gap between bench-top tests and large scale pilot programs

ZotWatt System: User Behavior Adaptation



Power Dissipation in Apple Devices

<https://www.apple.com/environment/reports/>

- **iMac 27"**
 - 240 mW off
 - 940 mW sleep
 - 79.1 W idle (display on)
- **MacBook Pro 15"**
 - 4 mW no load
 - 290 mW off
 - 810 mW sleep
 - 16.8 W idle (display on)
- **iPad Air**
 - 90 mW no load
 - 150 mW sleep
 - 3.66 W idle (display on)
- **Airport Time Capsule**
 - 8.9 W idle
 - 11 W active
- **Apple TV**
 - 210 mW sleep
 - 1.98 W active



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NRDC Key Findings

- **145 million small network devices in use in American households, with average consumption of 94 kWh per year.**
- **Most devices draw nearly the same power when idle as when transmitting/receiving.**
- **Power required to run these devices produces 5 million metric tons of CO₂ emissions (equivalent to 1.1 million vehicles).**



A Holistic IT Solution toward ZNE Buildings

- Majority of plug load devices powered by DC sources or via wireless chargers in the future (new trend)
 - How to improve efficiency in plug load devices ?
- Emerging market demands of plug loads in home entertainments, social network, smart home, smart buildings, etc.
 - New measure for networked plug load efficiency in terms of energy saving?
- Integrated demand side management : plug loads and buildings
 - New protocol for building informatics and people-centric plug load informatics?
- Behavior based incentive for rapid adoptions of ever-improved energy efficient plug loads
 - Short consumer product cycle vs. standard?

