

# Ubiquitous computing

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CS 376

# Announcements

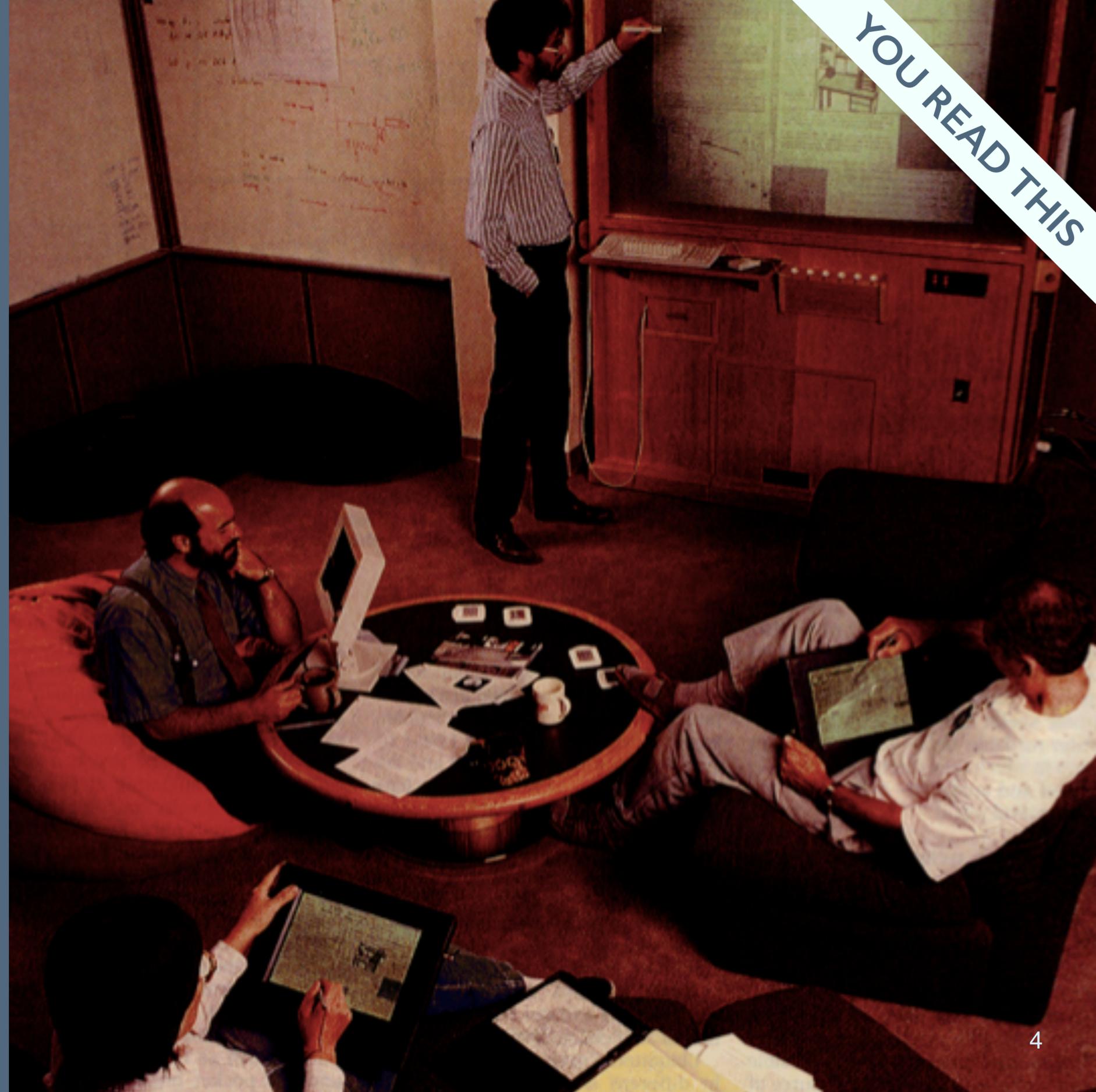
- Abstract drafts due Friday
- Project Ideas Round 2 feedback
  - You can iterate, pivot and ideate based on our feedback
  - Don't feel compelled to go exactly with the ones we liked

# Course Overview

INTRO	week 1	Intro to Interaction; Intro to Social Computing
	week 2	Intro to Design; Interaction
DEPTH	week 3	Interaction; Social Computing
	week 4	Social Computing
	week 5	Design
BREADTH	week 6	AI+HCI; Media
	week 7	Foundations
	week 8	Access; Programming
	week 9	Collaboration; Visualization
	week 10	Education; Critiques of HCI

# Recall...

- Mark Weiser's ubiquitous computing vision: computing that fades into our attentional background
- Computing distributed through the environment at several scales: pads, tabs and boards



# Recall...

- Wearable computing



# Recall...

- Context-aware computing

## **Towards a Better Understanding of Context and Context-Awareness**

Anind K. Dey and Gregory D. Abowd

Graphics, Visualization and Usability Center and College of Computing,  
Georgia Institute of Technology, Atlanta, GA, USA 30332-0280  
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**Abstract.** The use of context is important in interactive applications. It is particularly important for applications where the user's context is changing rapidly, such as in both handheld and ubiquitous computing. In order to better understand how we can use context and facilitate the building of context-aware applications, we need to more fully understand what constitutes a context

# Recall...

- Activity recognition



# Activity sensing

(As opposed to UIST, which was mostly about sensing user input)

# Infrastructure-mediated sensing

- Rather than sensing the human, place sensors at critical points in the environment
- Resolves the tension of sensing quality vs. invasive per-human or per-room sensors

# Recall...

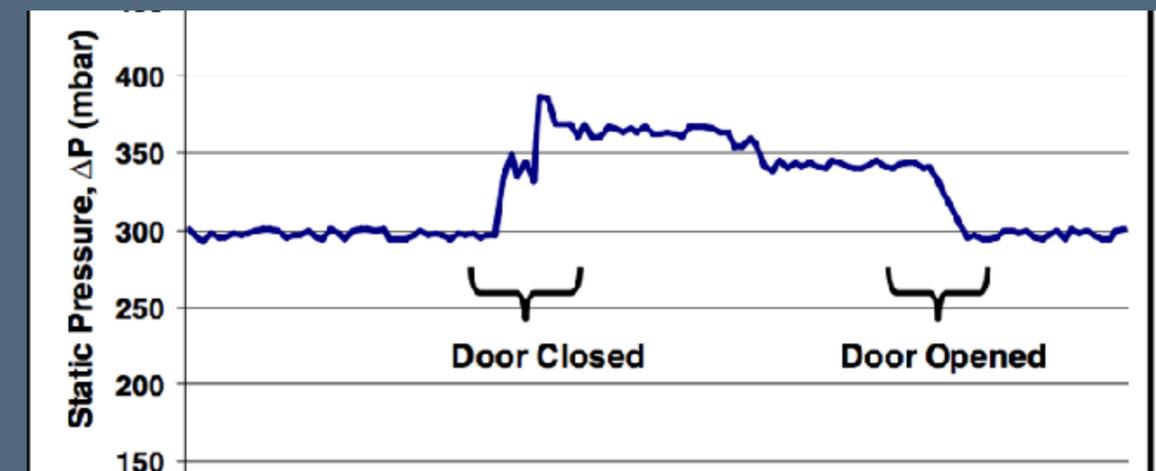
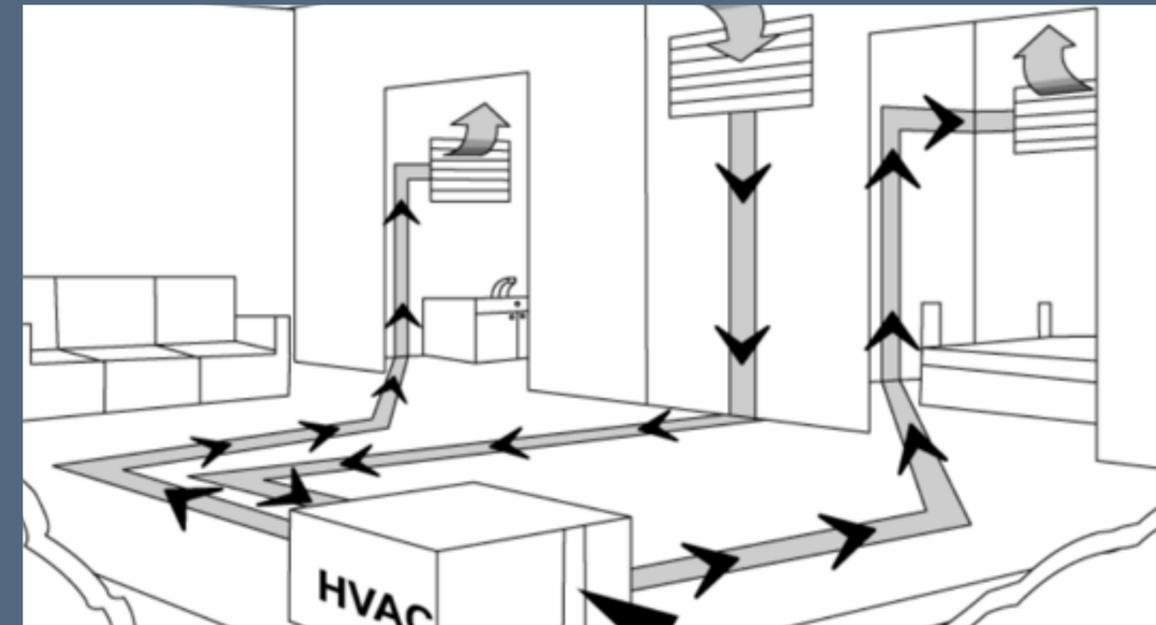
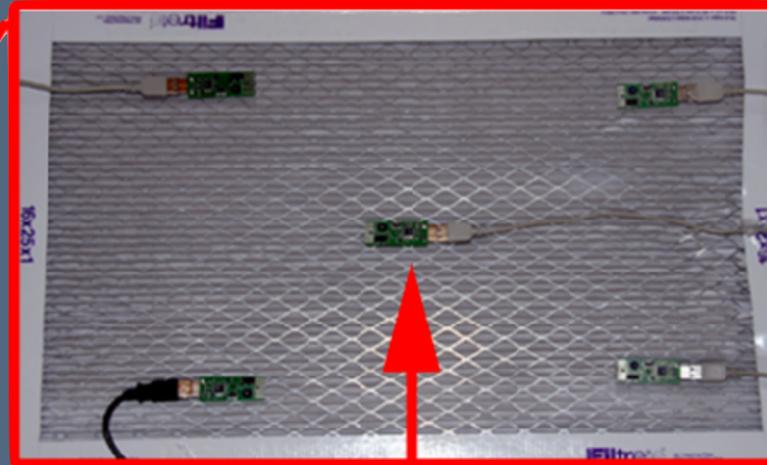
Custom  
Powerline  
Interface

USB Data  
Acquisition/  
Oscilloscope

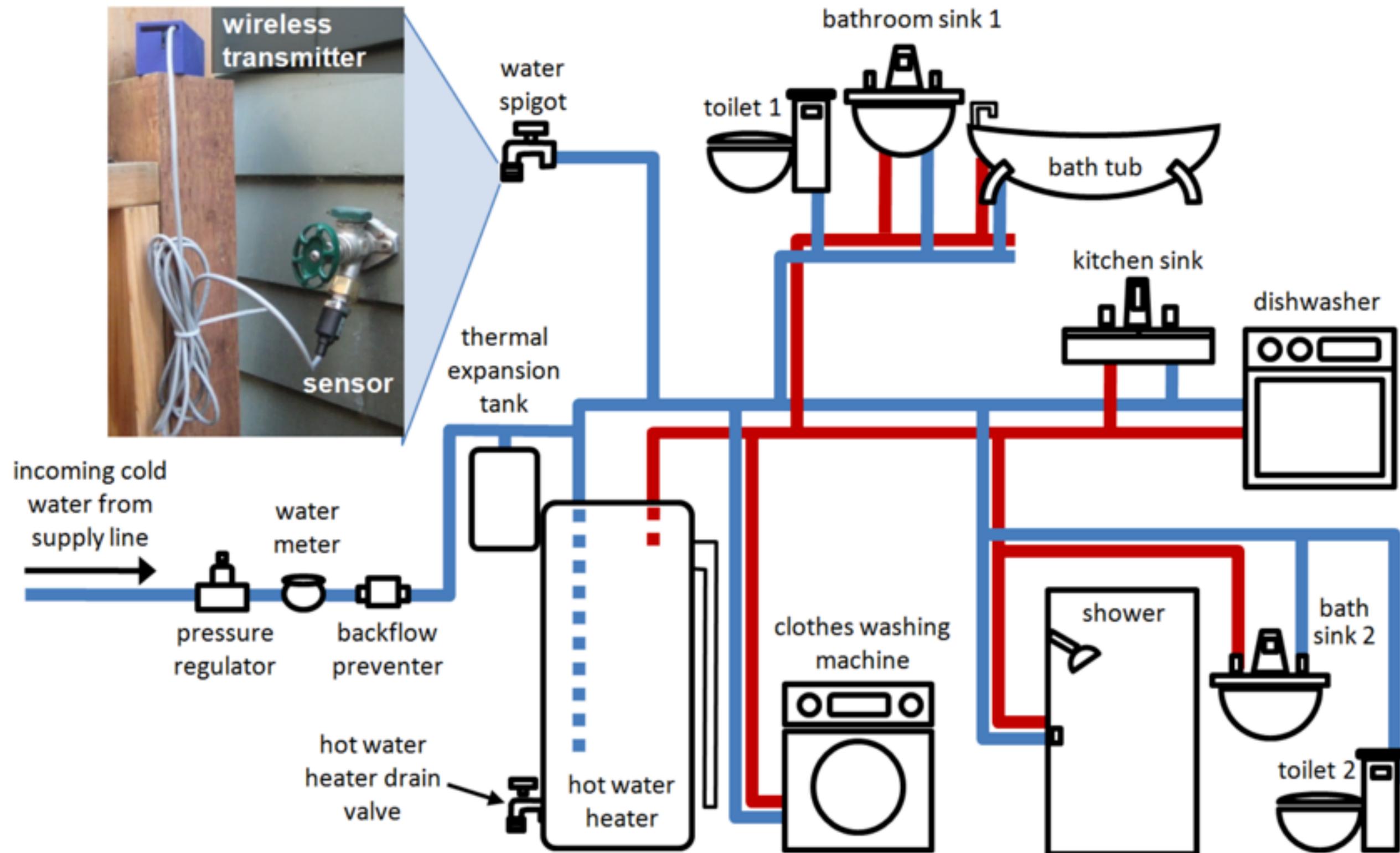
PC

Patel et al. At the Flick of a Switch: Detecting and Classifying Unique Electrical Events on the Residential Power Line. Ubicomp '07.

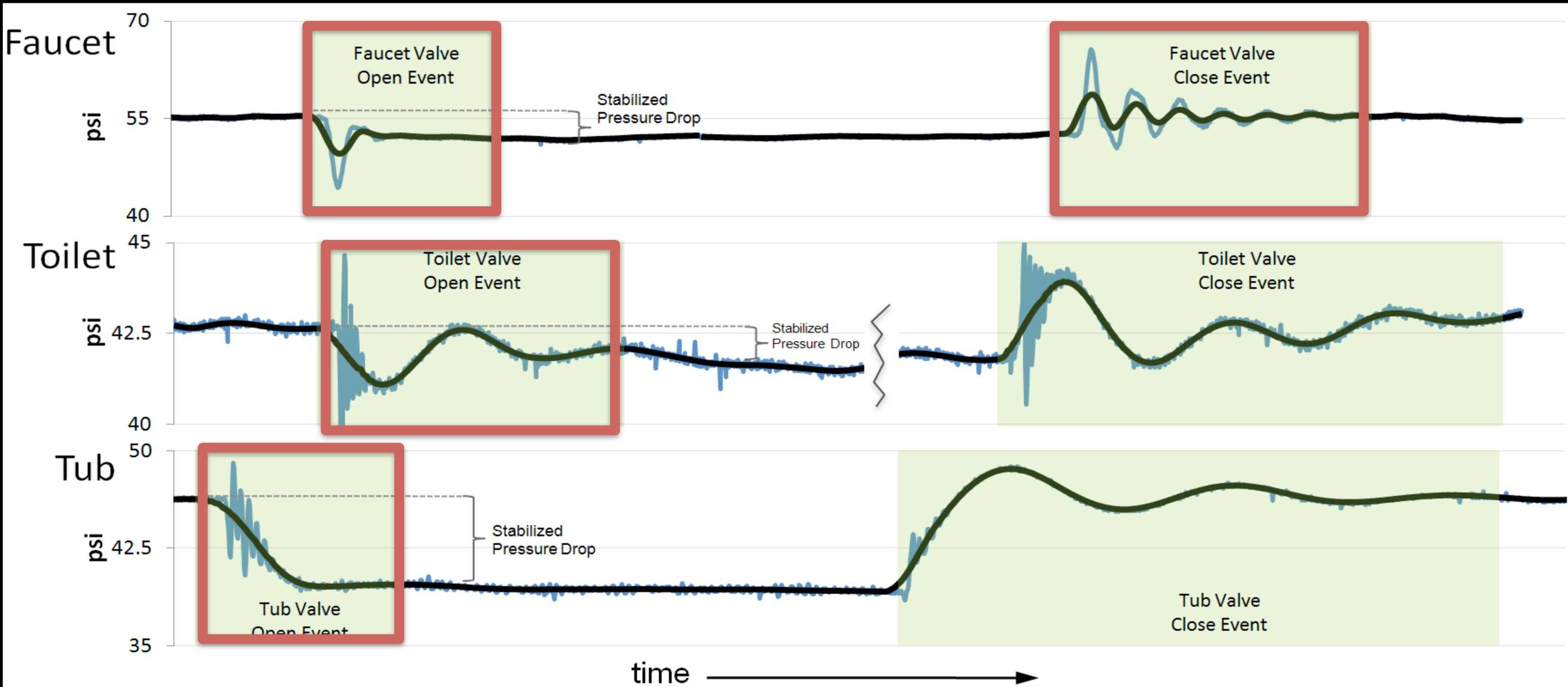
# Sensing via HVAC



Patel, Reynolds, Abowd. Detecting Human Movement by Differential Air Pressure Sensing in HVAC System Ductwork. Pervasive '08.



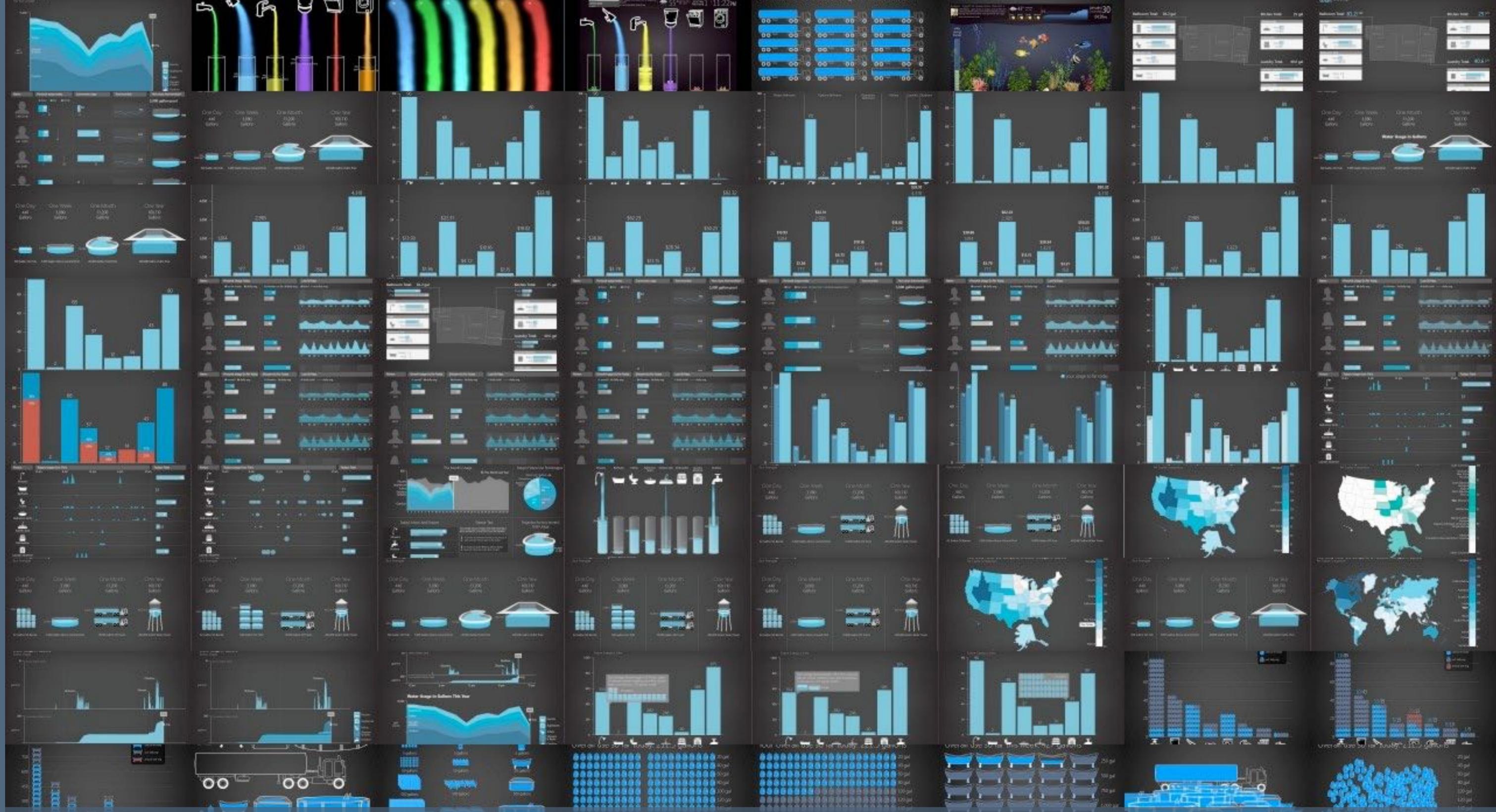
Froehlich et al. HydroSense: infrastructure-mediated single-point sensing of whole-home water activity. Ubicomp '09.



Froehlich et al. HydroSense: infrastructure-mediated single-point sensing of whole-home water activity. Ubicomp '09.



Froehlich et al. The Design and Evaluation of Prototype Eco-Feedback Displays for Fixture-Level Water Usage Data. CHI '12.



Froehlich et al. The Design and Evaluation of Prototype Eco-Feedback Displays for Fixture-Level Water Usage Data. CHI '12.

# Development

# Toolkit support

- Abstract away the complexity of sensors making it easier for developers
- Example: IdentityPresence widget

## **Attributes**

Location

Location monitored

Identity

Last user sensed

Timestamp

Time of last arrival

## **Callbacks**

PersonArrives(location, identity, timestamp)

PersonLeaves(location, identity, timestamp)

Salber, Dey and Abowd. The Context Toolkit:  
Aiding the Development of Context-Enabled Applications. CHI '99.

# Toolkits and end-user programming

- Today, startups like IFTFF:

**if**  **then** 

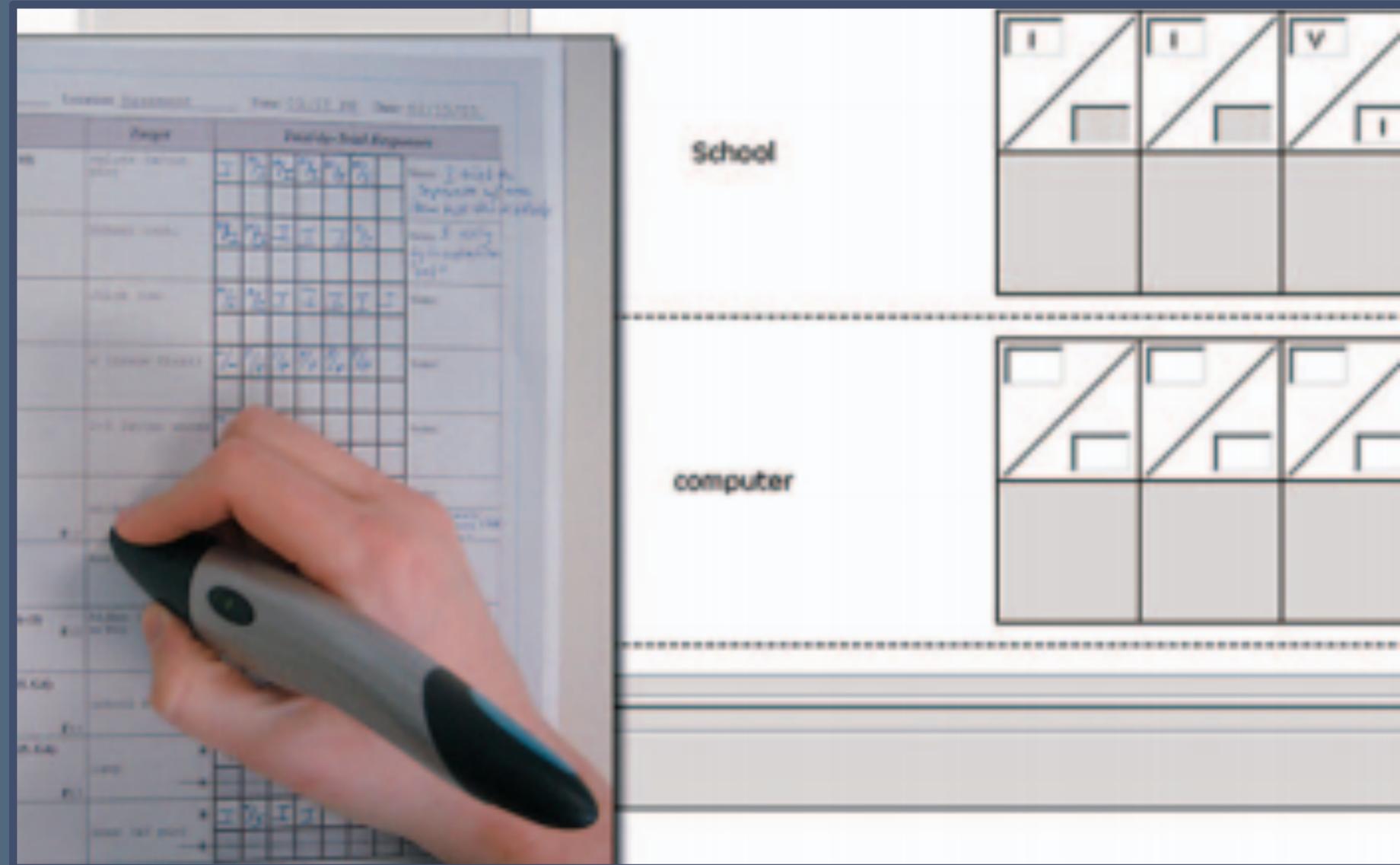
Any new check-in on  
Foursquare

Send me an email at  
msb@cs.stanford.edu

# Human prostheses

# Supporting specific needs

- Record and track care for people with special needs (e.g., autism)
- Data capture is often difficult: so, lower the bar



Kientz et al. Pervasive Computing and Autism: Assisting Caregivers of Children with Special Needs. IEEE Pervasive Computing '07.

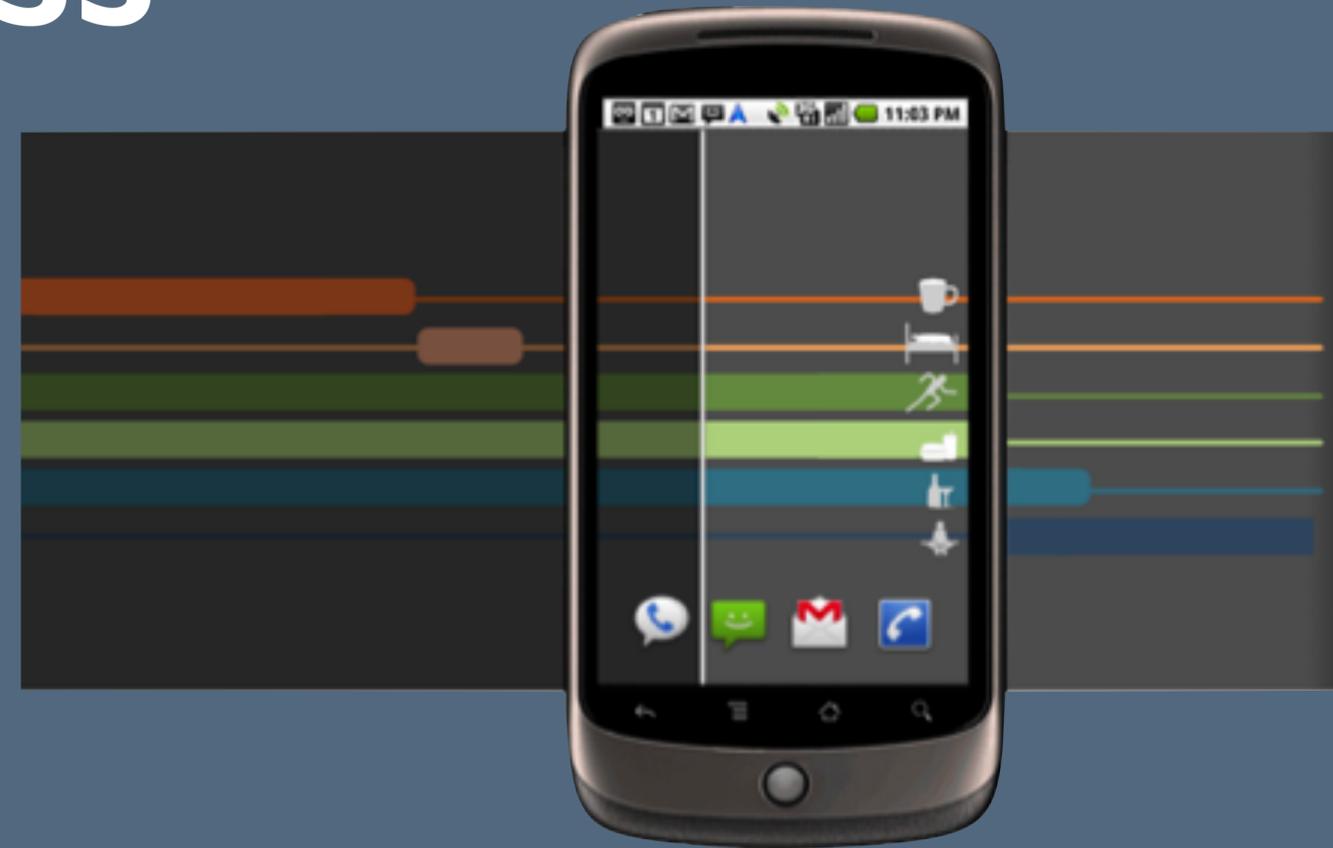
# Elder care

- Noninvasive sensors can identify when seniors need assistance
- Relieve caregivers from manual recordkeeping
- Sensors: locator badge, weight sensors in apartments

Stanford. Using Pervasive Computing to Deliver Elder Care.  
IEEE Pervasive Computing '02.

# Health and wellness

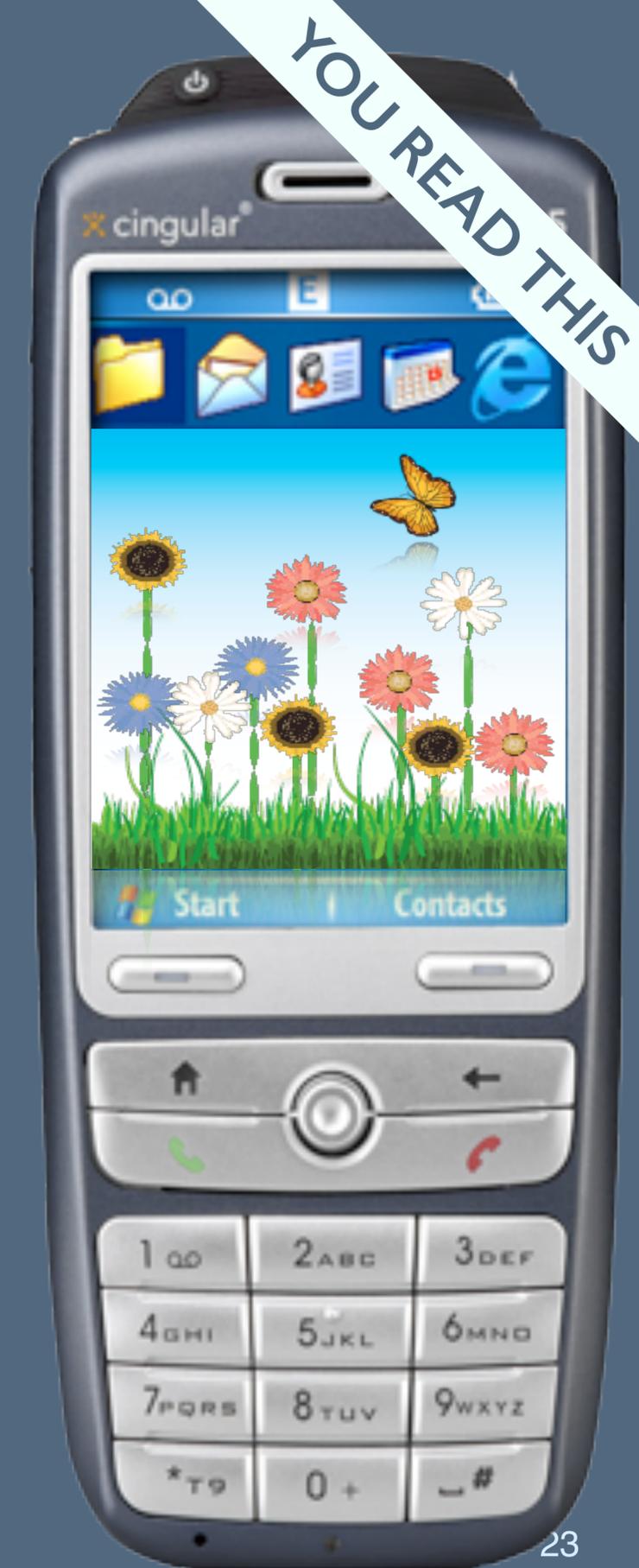
- Sleep tracking  
[Bauer et al., CHI '12]
- Embedded assessment  
[Morris, Intille, and  
Beaudin, Pervasive '05]



“Our early studies indicated that to be tolerable to end users, assessment needed to be embedded not only with the environments of daily living, but also within accepted compensatory and preventive health strategies.”

# Health and wellness

- Ubifit: activity inference to produce an ambient display rewarding regular exercise



Consolvo et al. Activity Sensing in the Wild: A Field Trial of UbiFit Garden. CHI '08.

# Sustainable behavior

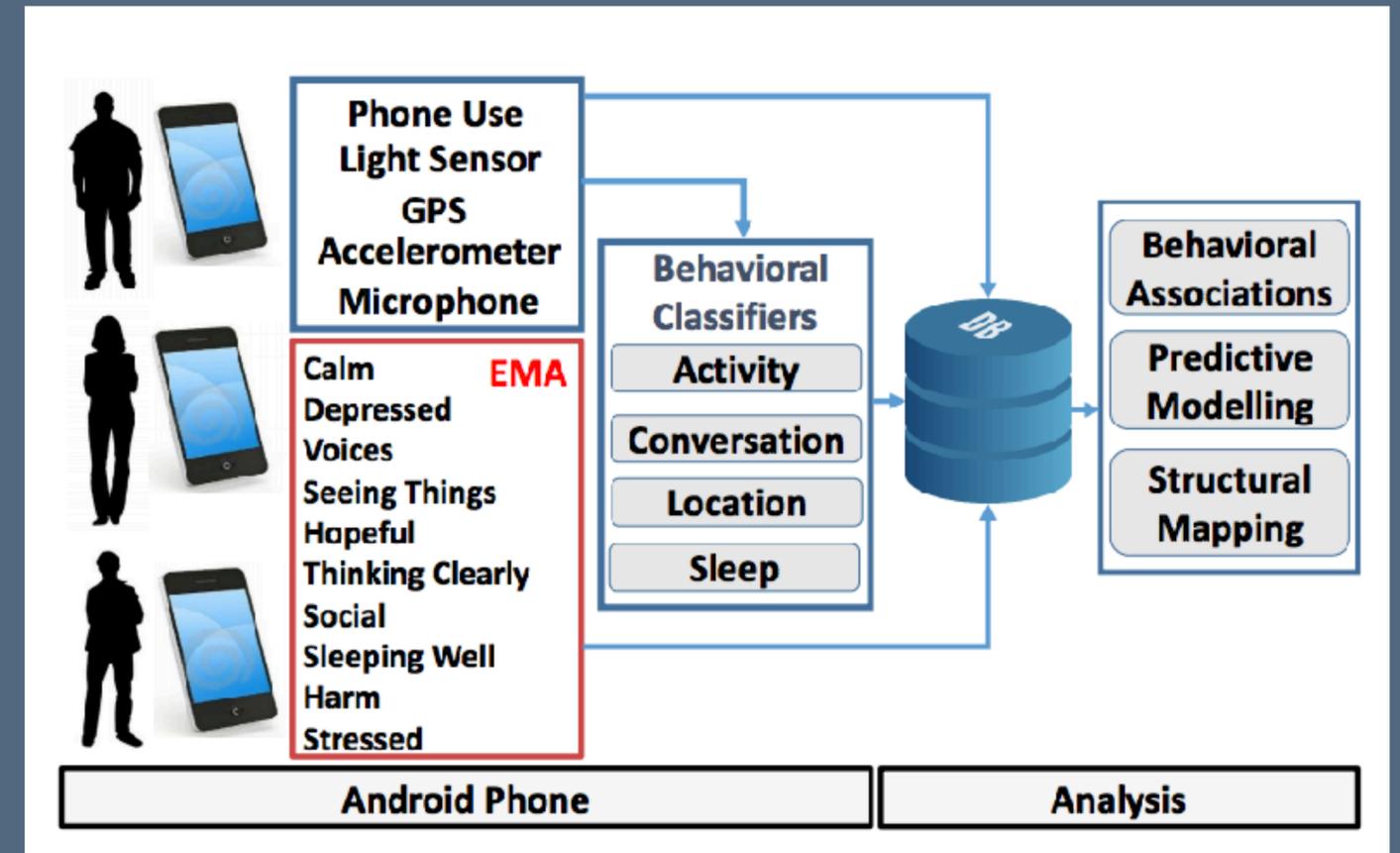
- UbiGreen: semi-automatically record transit activity and make it visible on the user's home screen



Froehlich et al. UbiGreen: Investigating a Mobile Tool for Tracking and Supporting Green Transportation Habits. CHI '09.

# Mental health

- Can we detect mental health changes before they are traditionally diagnosed?
- Question: why include each sensor? Fuse everything, use deep learning, and hope? Or do feature engineering?



Theory

# Implications and theory of ubicomp

- Embodiment as a core theme of both tangible and social computing
- Phenomenology as a guide for design: acting through our tools and infrastructure without reflection
  - e.g., Heidegger

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## Where the Action Is

The Foundations of Embodied Interaction

Paul Dourish

Copyrighted Material

# Space and place

- Space is the structure of the world: the 3D environment, relative position and direction
- Place is the understood reality, invested with understanding and meaning
  - Ex: hotel ballroom for a wedding vs. an academic conference

Harrison and Dourish. Re-Place-ing Space: The Roles of Place and Space in Collaborative Systems. CSCW '06.

# What we talk about when we talk about context

- Ubicomp typically considers context via a positivist viewpoint, which aims to reduce complex phenomena to simple, stable patterns
  - Amenable to engineering!
- A phenomenological viewpoint would posit that context is emergent and evolving, not stable
  - Sitting in a classroom is relevant, but temperature is not, because it is just ordinary

Dourish. What we talk about when we talk about context.  
Personal and Ubiquitous Computing '04.

# Yesterday's tomorrows

- Ubiquitous computing is driven not by a technological goal, but by a shared vision of the future.
- However, this vision is a future in 1991.
- What should the future of ubicomp be, from today's perspective?
- Bell and Dourish's proposal: messiness

Bell and Dourish. Yesterday's tomorrows: notes on ubiquitous computing's dominant vision. Personal and Ubiquitous Computing '06.

# Skill sets for Ubicomp research

- An interest in technology as it is embedded in users' activities and environments
- Can be as sensor focused as UIST, but also possible to “zoom out” to broader questions such as sustainability, health, and education
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