Pervasive Computing

MICHAEL BERNSTEIN

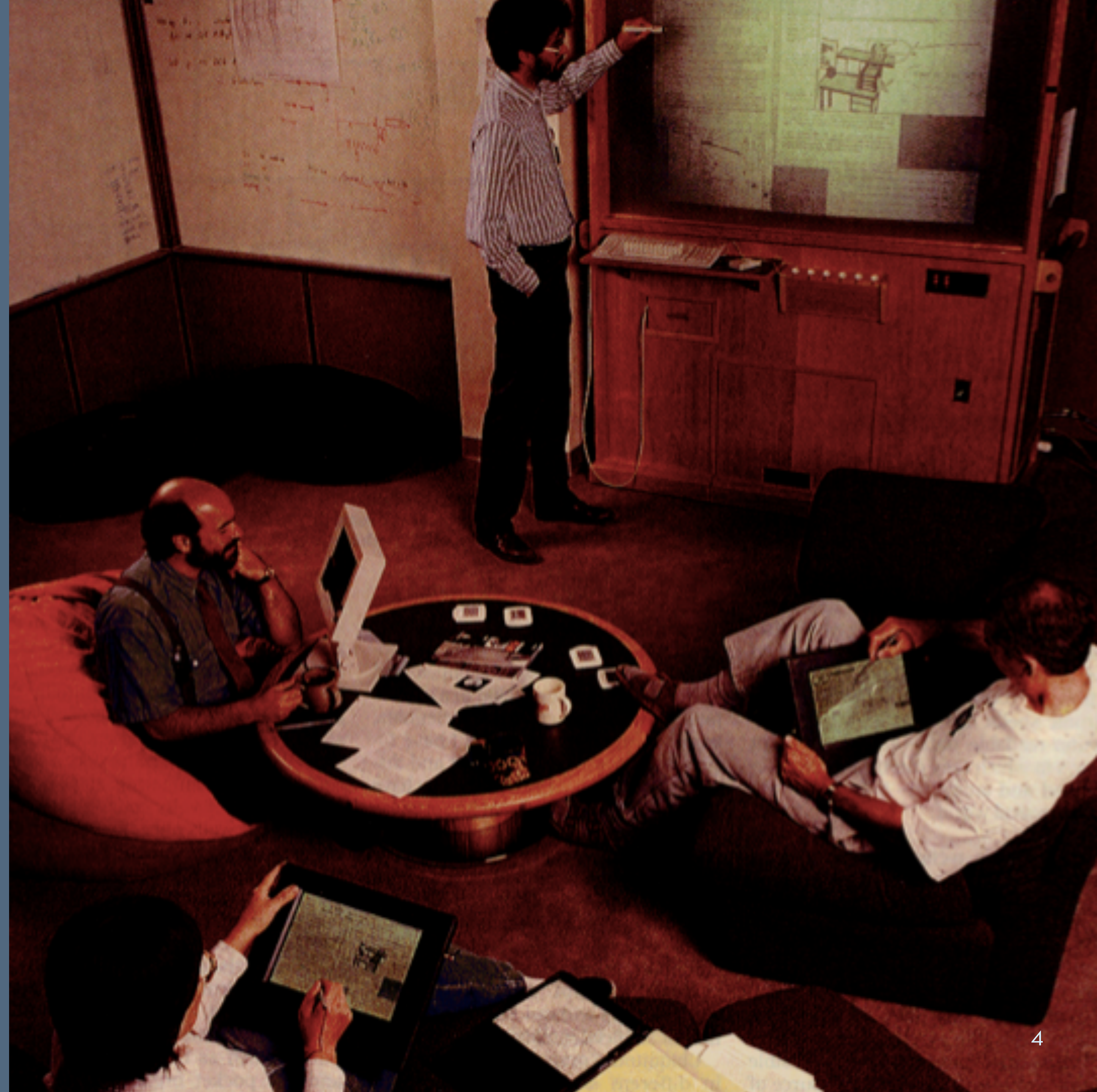CS 376

Project Abstracts

This week: ubiquitous computing

- Today: pervasive computing
  - Distributing computation out into the world
  - Physically embodied computation
  - Sensing across large environments
- Next time: interaction and input
  - Sensing
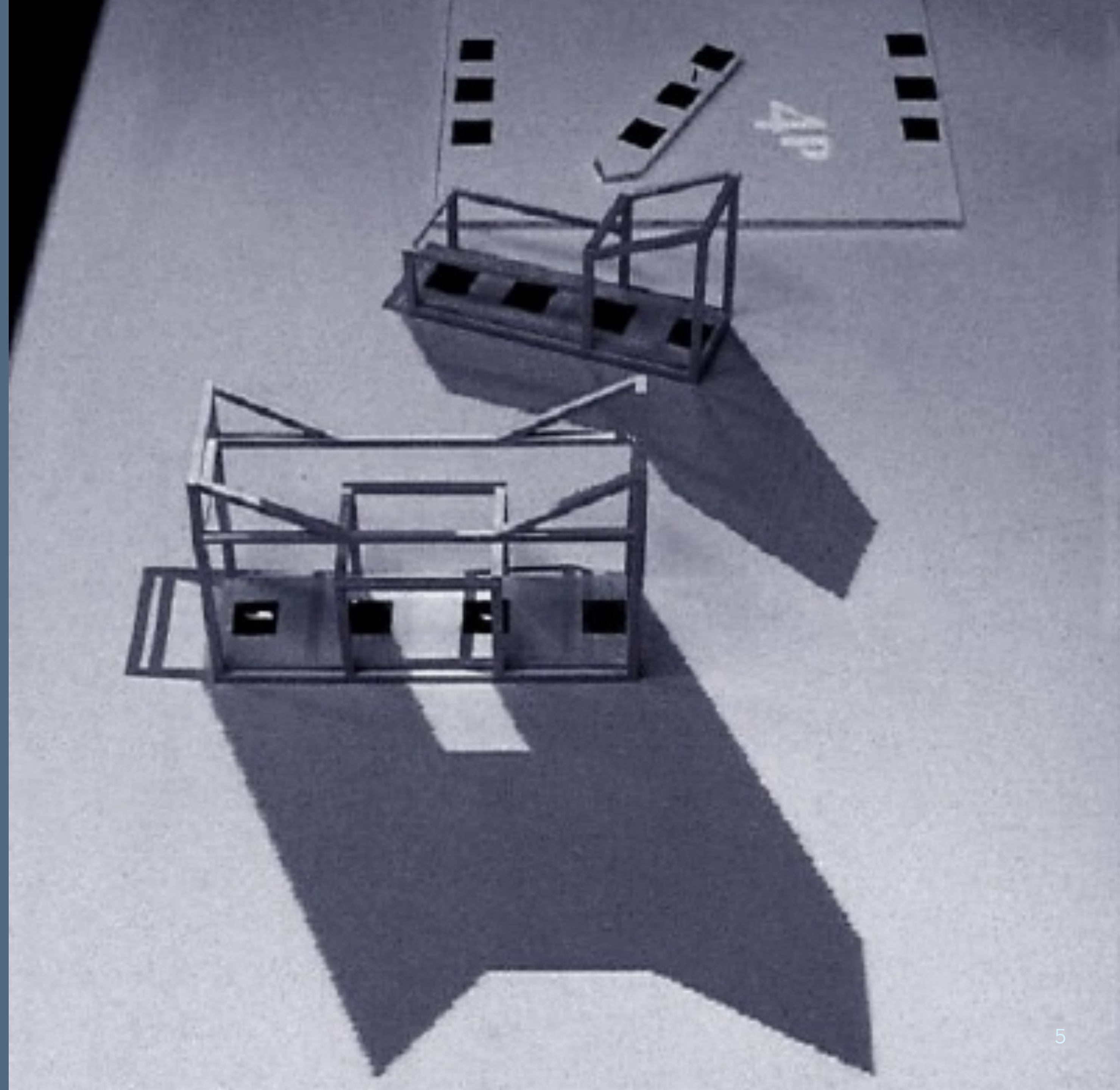 - 3d printing
  - Fabrication

Recall…

- Mark Weiser's ubiquitous computing vision: pads, tabs and boards

Recall...

- Tangible Computing

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
{anind, abowd}@cc.gatech.edu

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
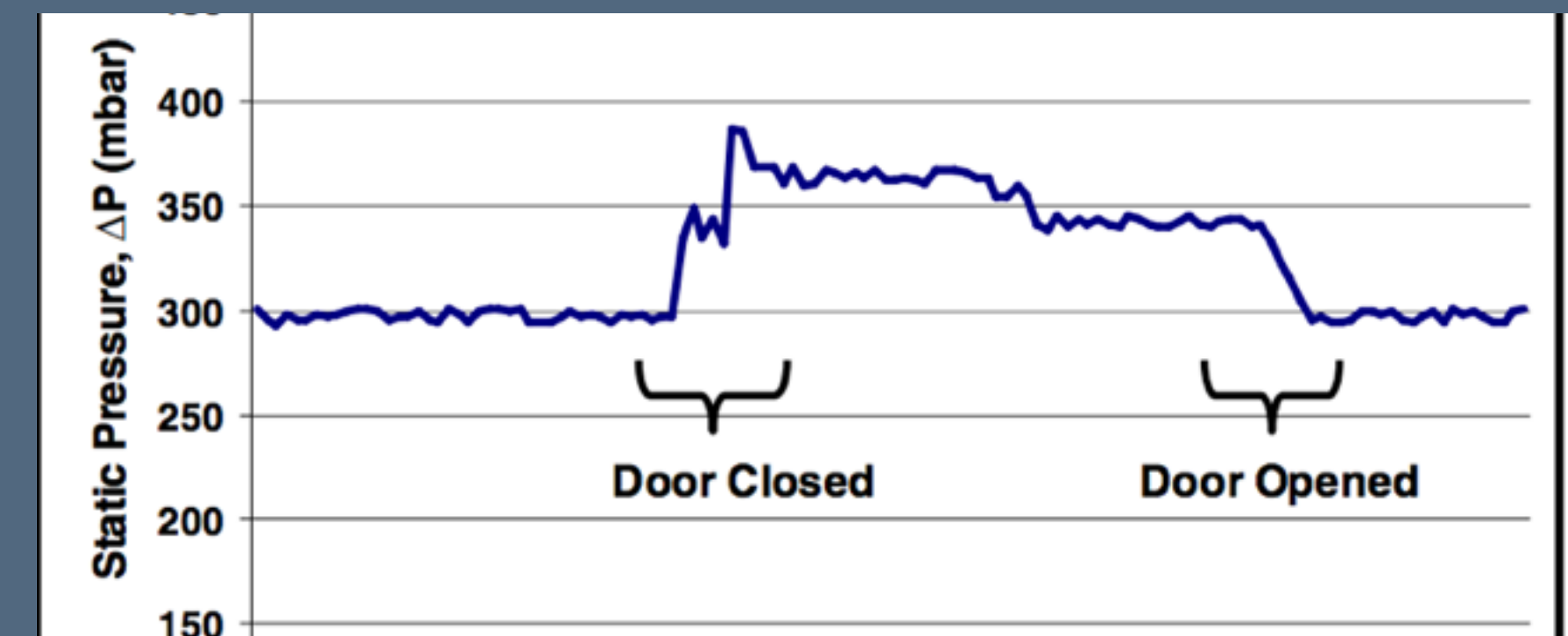
Recall...
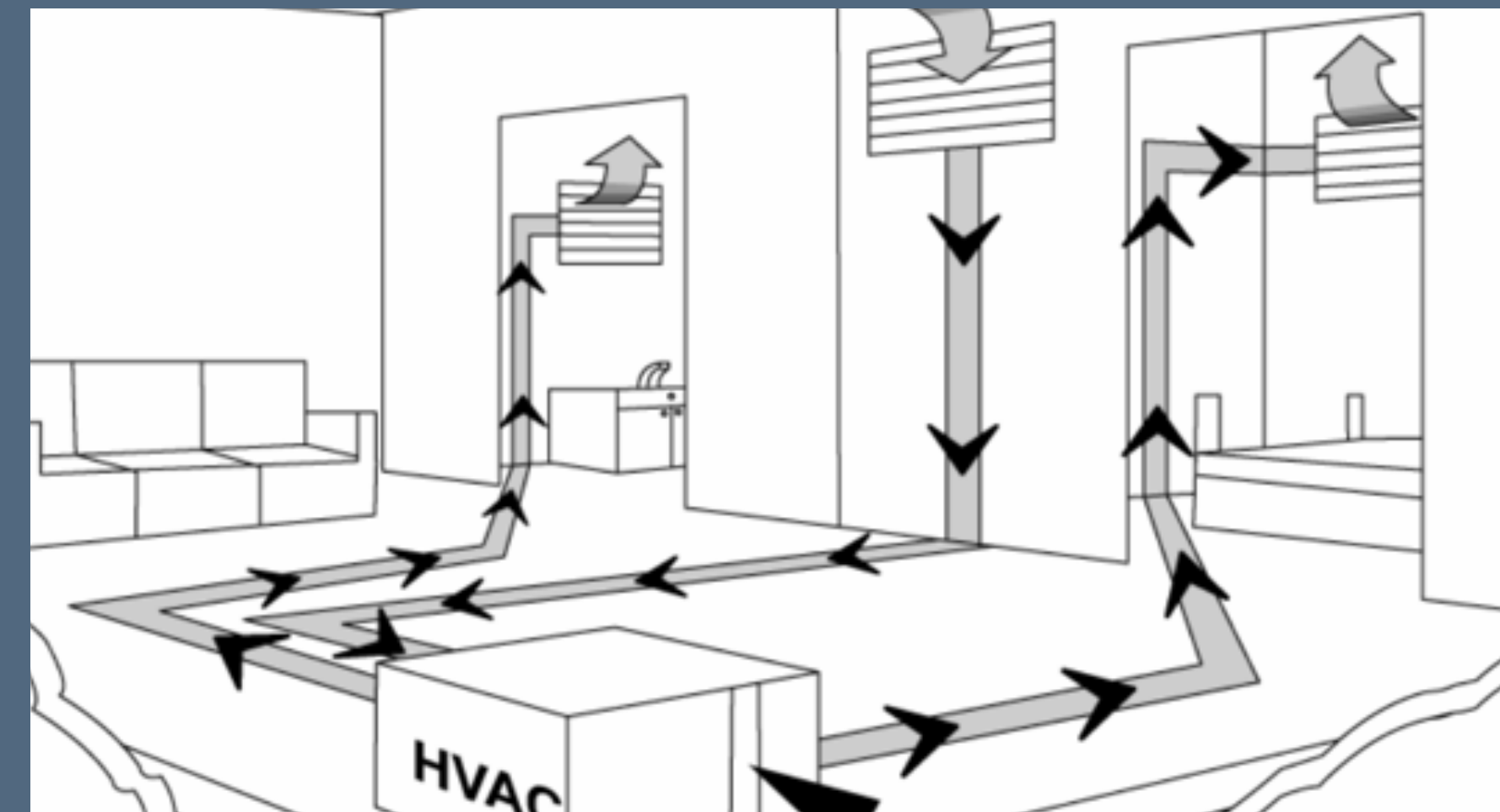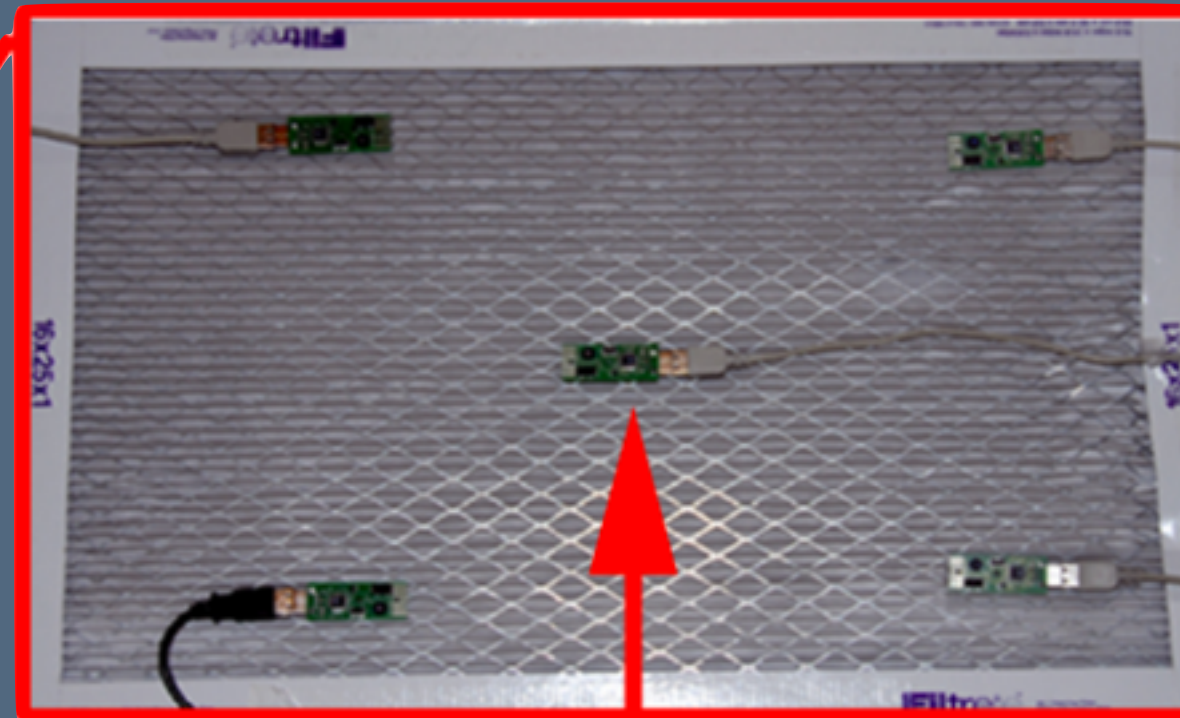
- Activity recognition

Sensing

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

Sensing via HVAC

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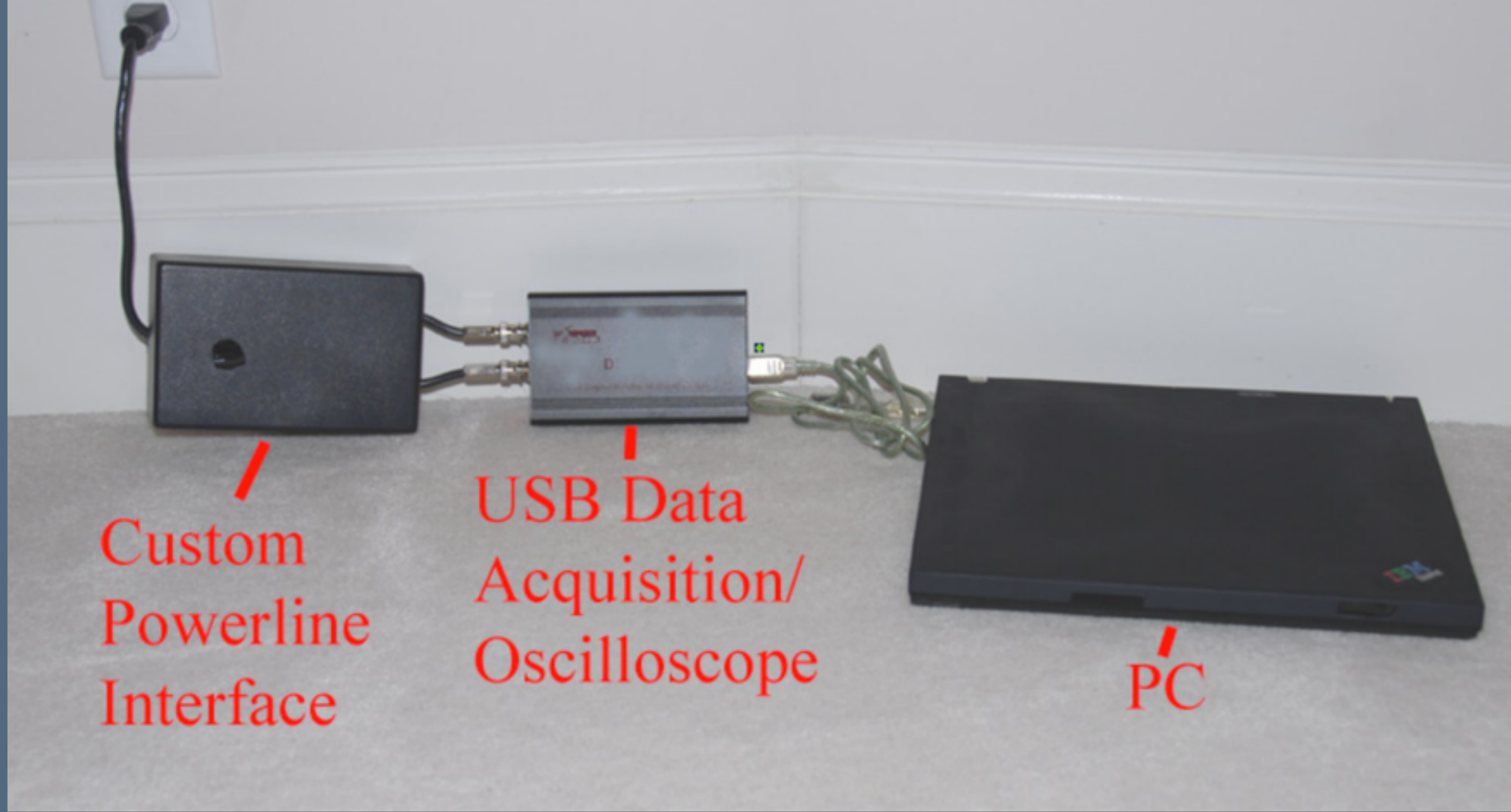
Custom Powerline Interface

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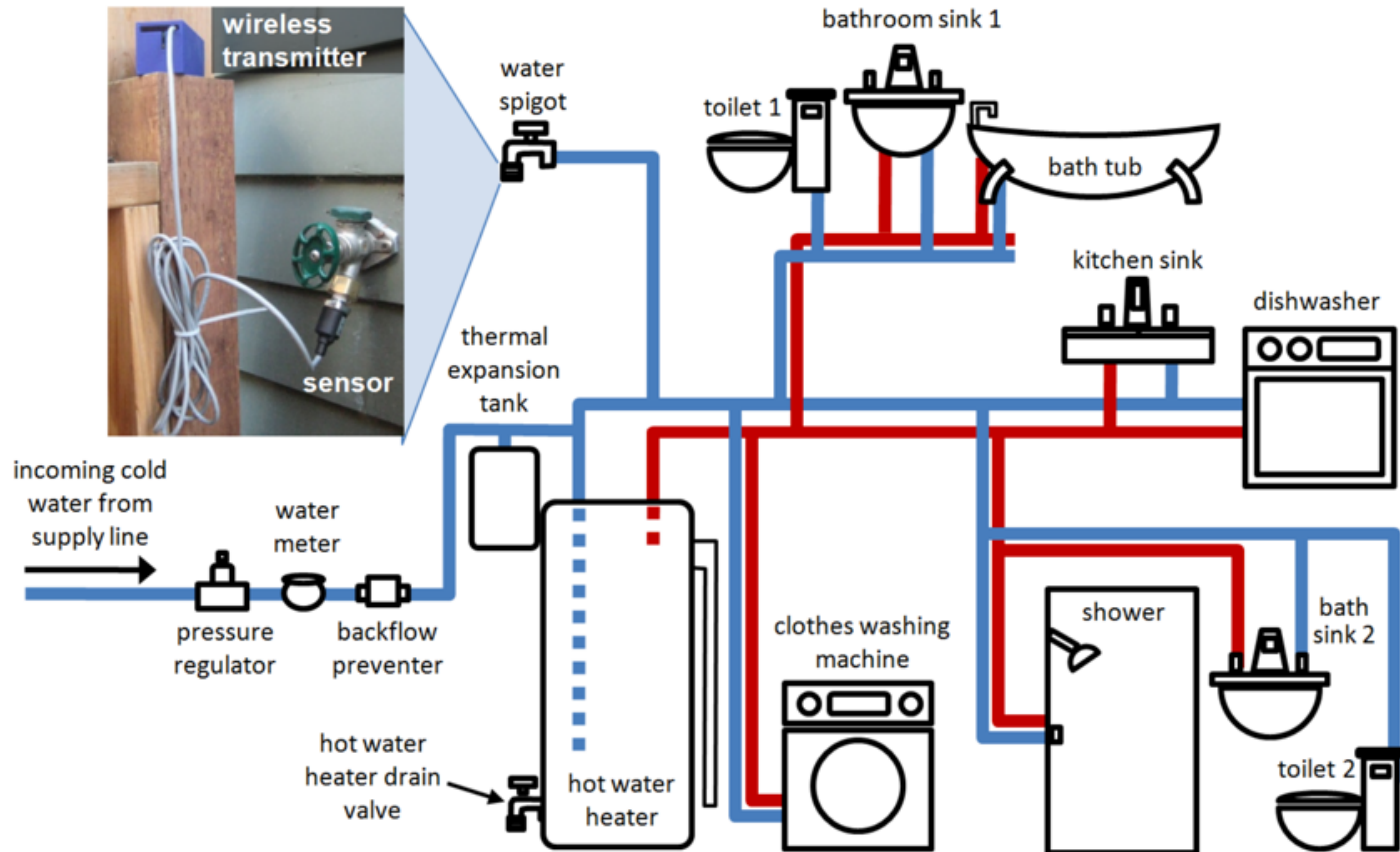
Froehlich et al. HydroSense: infrastructure-mediated single-point sensing of whole-home water activity. Ubicomp '09.

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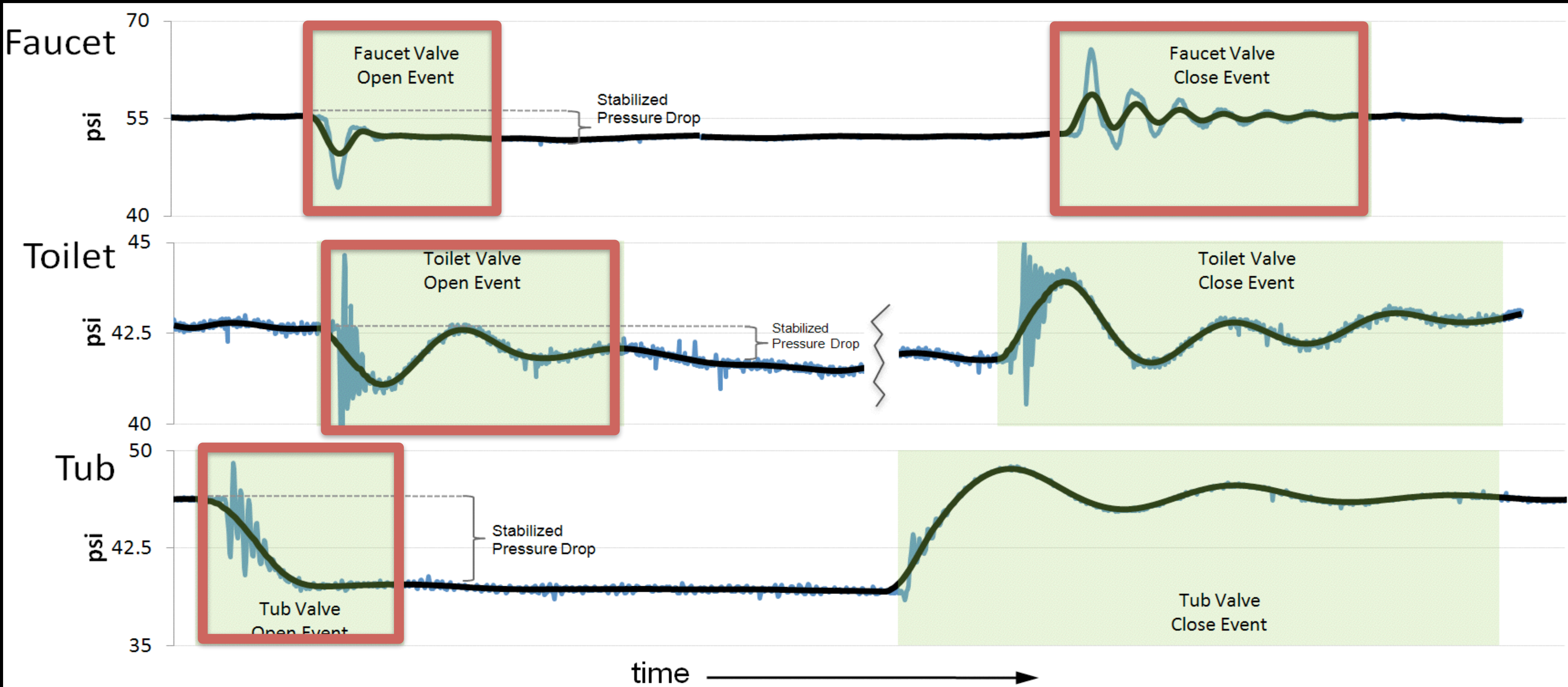
Froehlich et al. HydroSense: infrastructure-mediated single-point sensing of whole-home water activity. Ubicomp '09.

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.

Sensing location using wireless signals

- Overcomes major hurdle in location-aware devices: location
  - GPS has mainly solved this outdoors, but wifi works indoors as well!
- Spotters log visible signals to a shared DB
  (e.g., bluetooth, wifi, cell towers)
- Trackers model location using the traces

LaMarca et al. Place Lab: Device Positioning Using Radio Beacons in the Wild. Pervasive '05.

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:

Human prostheses

Supporting special needs

- Record and track care for people with special needs (e.g., autism)
- Data capture is often difficult: so, lower the bar
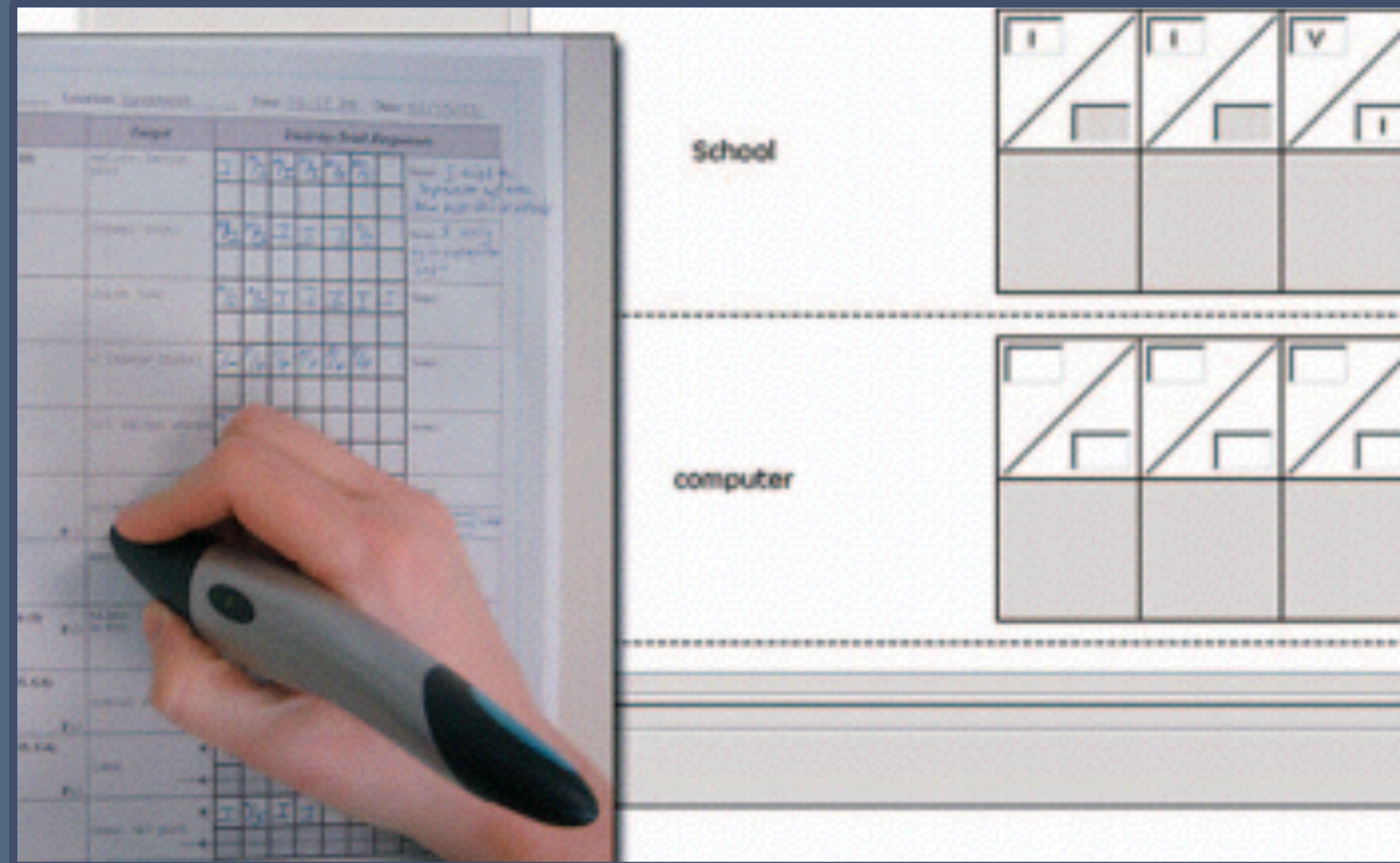
Kientz et al. Pervasive Computing and Autism: Assisting Caregivers of Children with Special Needs. IEEE Pervasive Computing '07.

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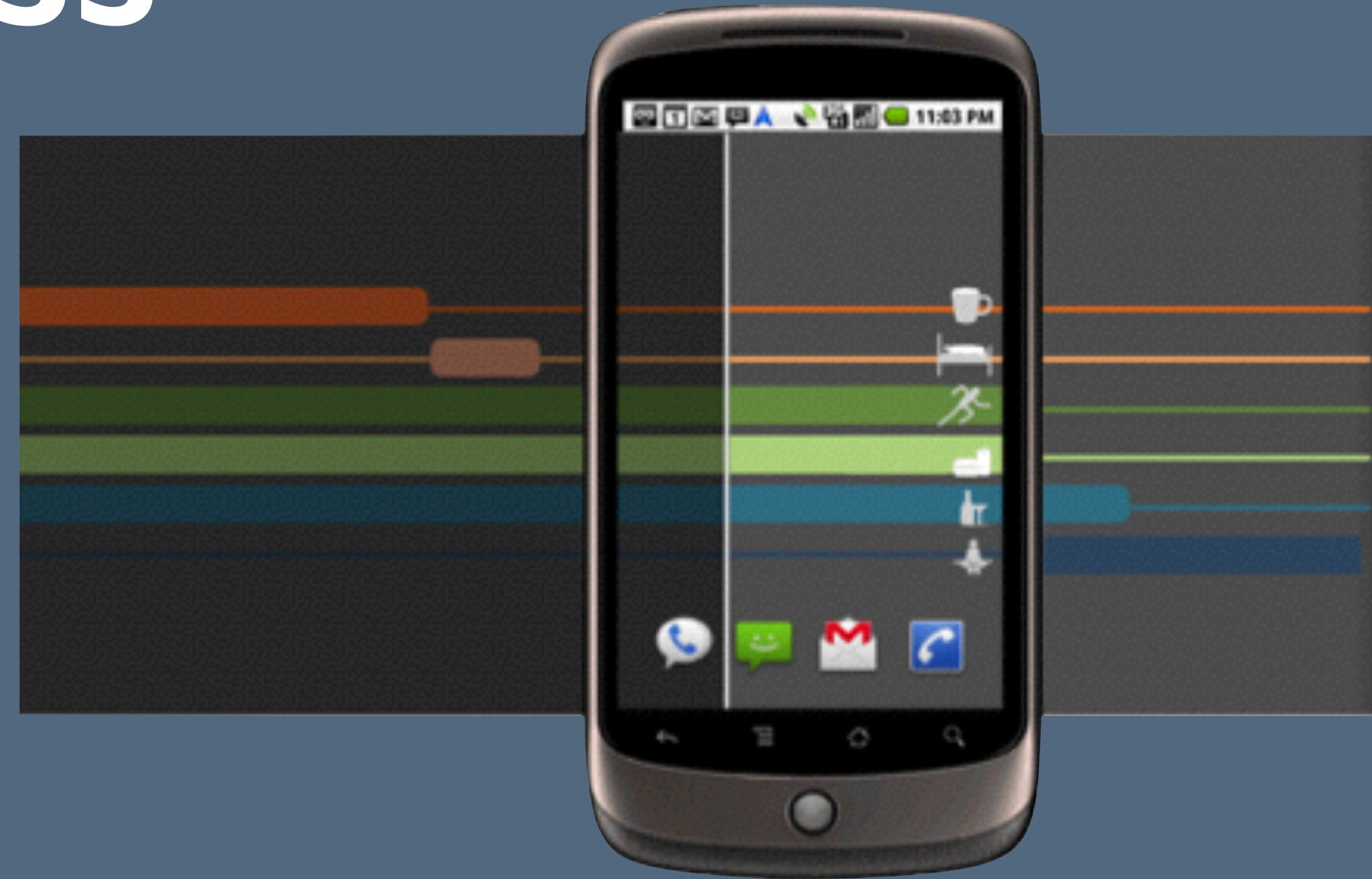
"Our early studies indicated that to be tolerable to end users, assessment needed to be embedded not only with the environments of daily living, but also within accepted compensatory and preventive health strategies."

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.

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

Where the Action Is

The Foundations of Embodied Interaction

Paul Dourish

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.