Bringing Sensing to the Masses

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Toward Practical Ubiquity

- ## Ubiquitous Computing (Ubicomp)

  - ### Computing everywhere

- ## Large-scale deployments in the home remains a challenge
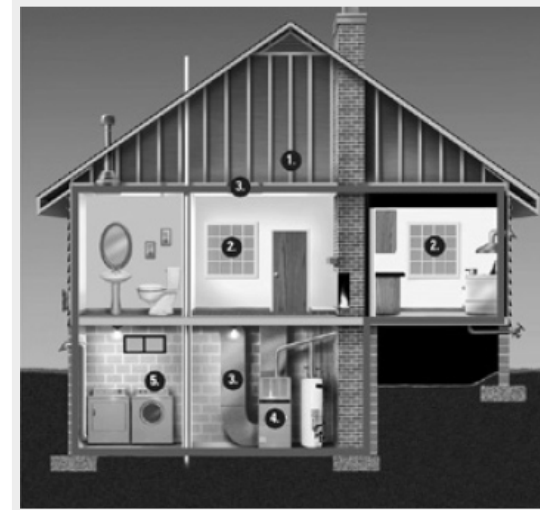
Sensing in the Home

- ## How can we enable large-scale deployments of activity and location sensing within a home?

  - ### Important problem in Ubicomp

  - ### Enable a variety of applications

    - Elder care

    - Studying human behavior

    - Energy and resource monitoring
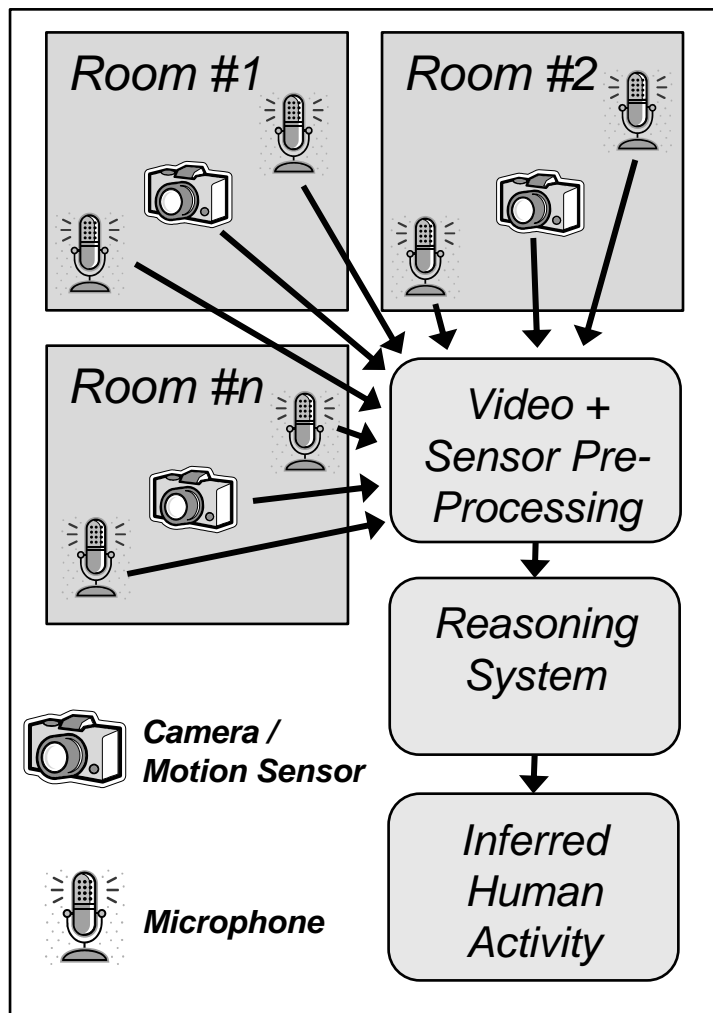
Living Laboratories
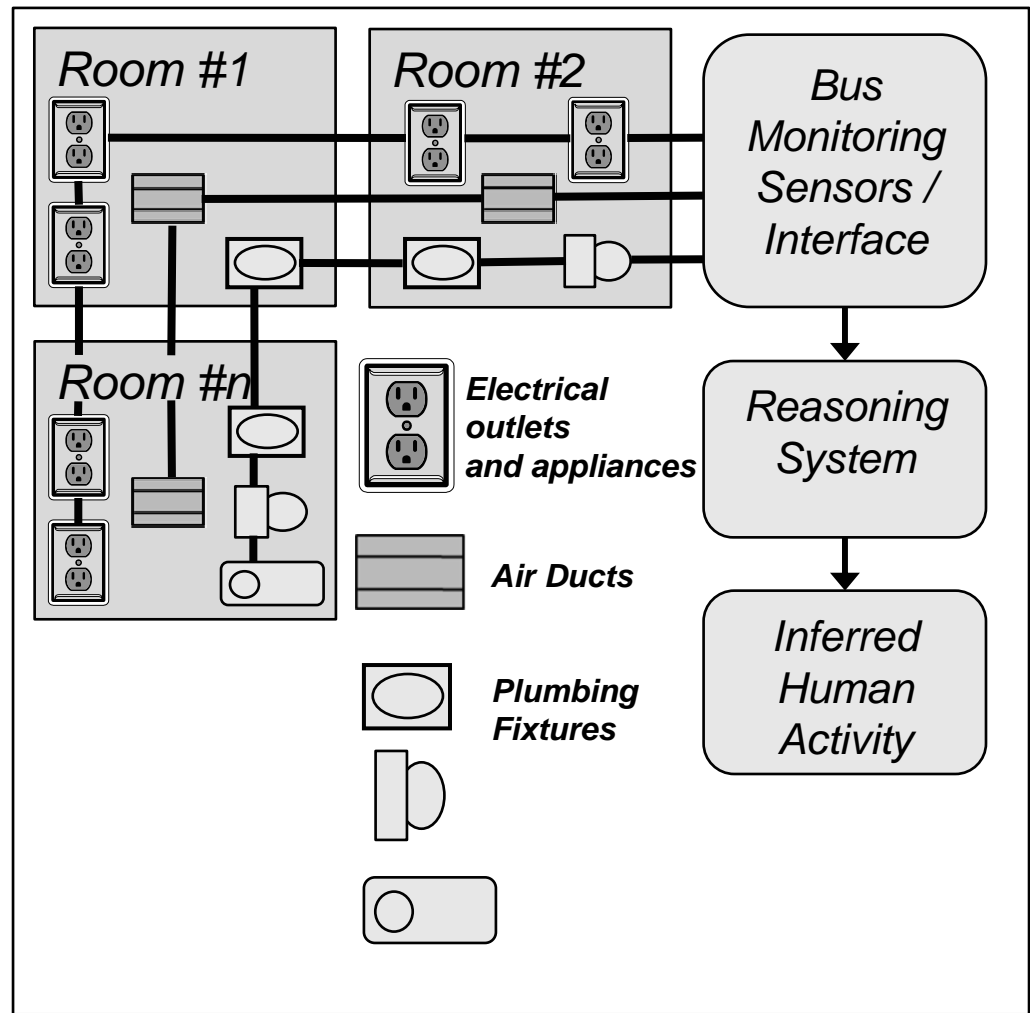
Existing Home Infrastructures

- ## Home utilities are already ubiquitous

  - ### Electrical

    - "Electricity … surges invisibly through the walls of every home, office, and car. …electricity becomes so commonplace, so unremarkable, that we forget [its] huge impact on everyday life."
      – *Mark Weiser*

  - ### Plumbing

  - ### Heating & Cooling (HVAC)
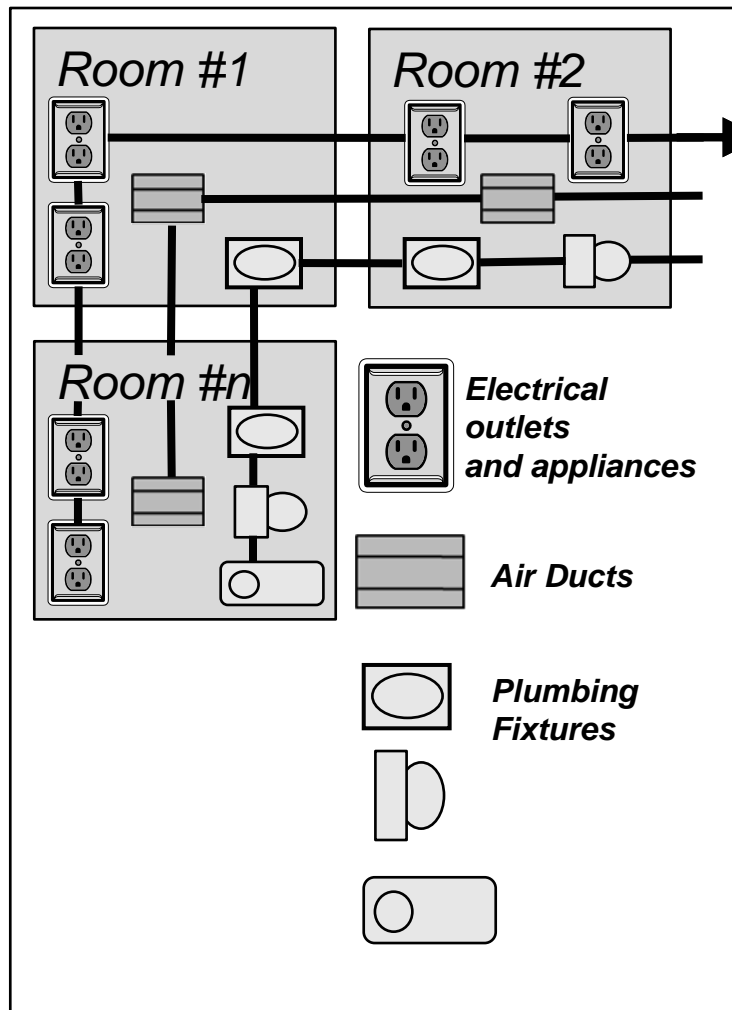
  - ### Gas, telephony, etc

Two Approaches to Sensing

Distributed Direct Sensing

Room #1

Room #2

Room #n

Video + Sensor Pre-Processing

Reasoning System

Inferred Human Activity

Camera / Motion Sensor

Microphone

Infrastructure Mediated Sensing

Room #1

Room #2

Room #n

Bus Monitoring Sensors / Interface

Reasoning System

Inferred Human Activity

Electrical outlets and appliances

Air Ducts

Plumbing Fixtures

Example IMS Systems

Room #1

Room #2

Room #n

Electrical outlets and appliances

Air Ducts

Plumbing Fixtures

- Detect Electrical events over the power line
- Single point of sensing

- Power Line Positioning
- Indoor localization
- Using the power line as a signaling antennae

Module 1

Module 2

Example IMS Systems

Room #1

Room #2

Room #n

Electrical outlets and appliances

Air Ducts
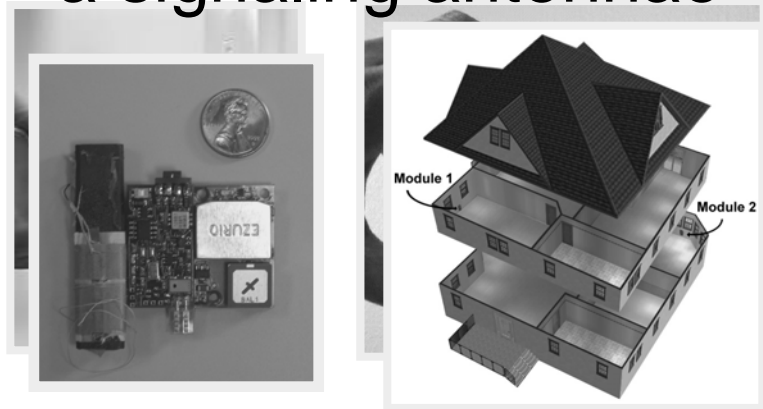
Plumbing Fixtures
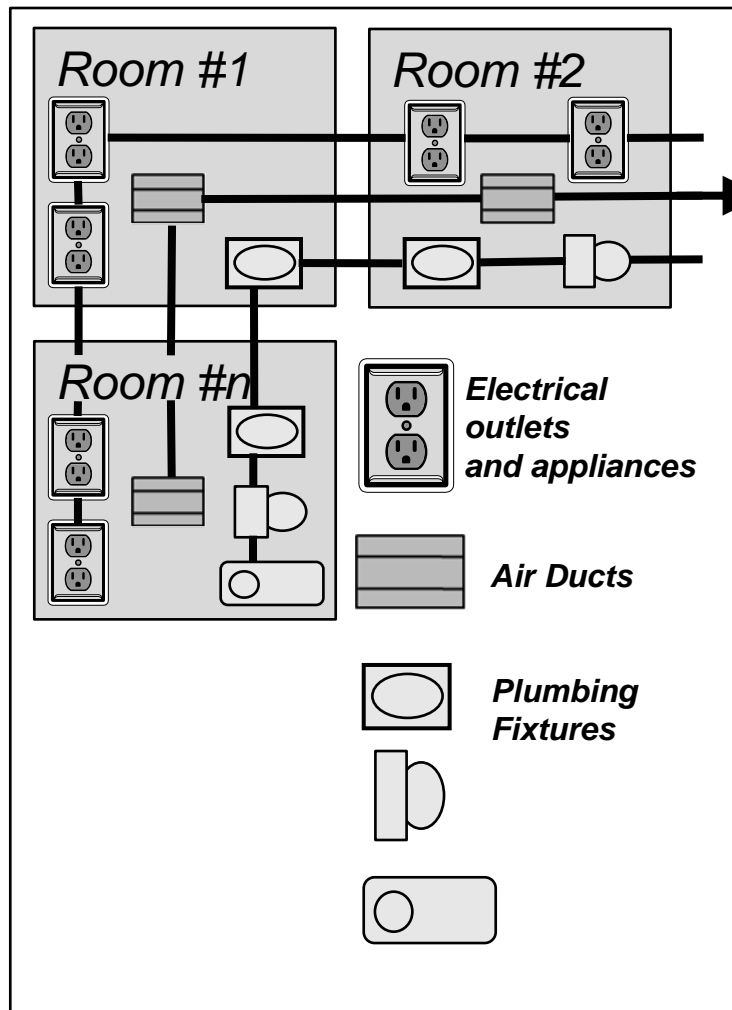
- Sensing within the HVAC

- Movement detection

HVAC

Sensor

Example IMS Systems

Room #1 Room #2

Room #n

Electrical
outlets
and appliances

Air Ducts
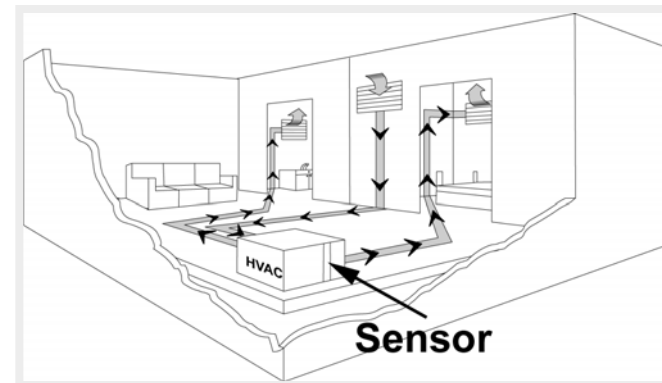
Plumbing
Fixtures
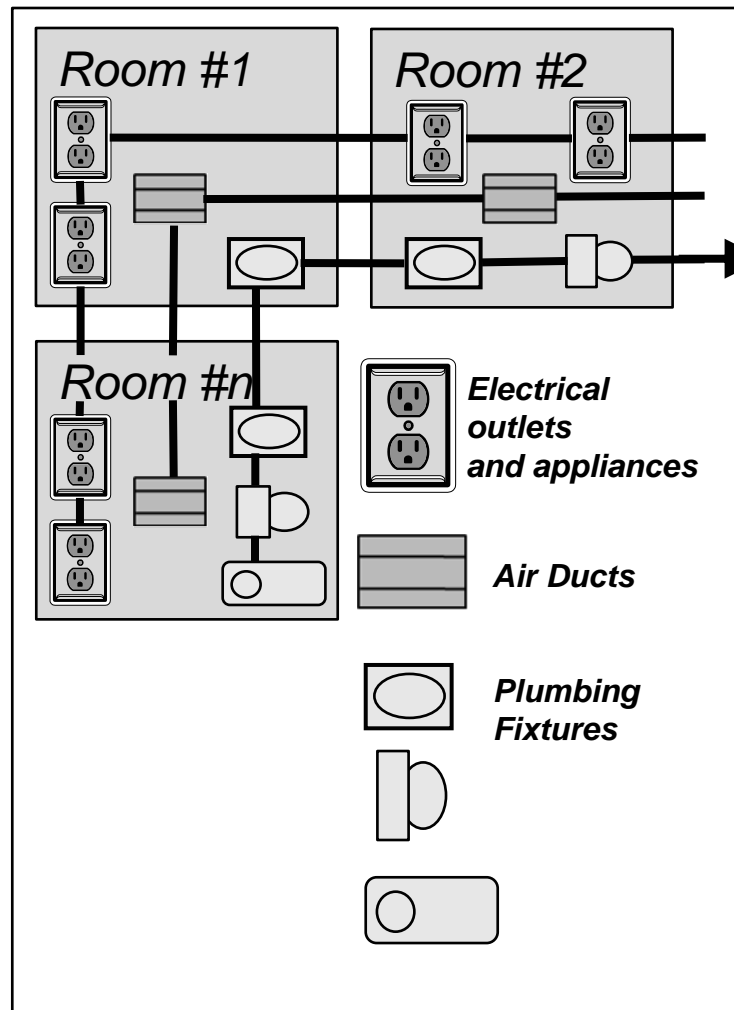
- Detecting water events
- Single pressure transducer

wireless transmitter

sensor

Open/Close Pressure Waves

Faucet

Toilet

Tub

time
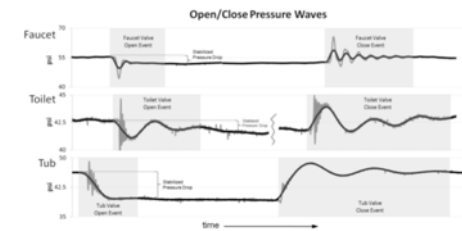
Applications

- ## Resource monitoring and feedback

  - ### Fixture and appliance level monitoring

- ## Linking activity and consumption

- ## Working with utilities and municipalities
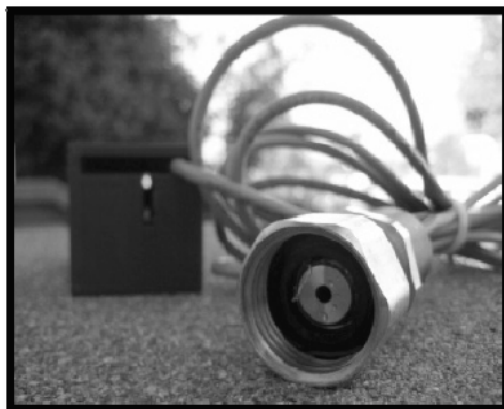
Data Collection for Rehabilitation

- Need for empirical evidence

- Augment self-report

Summary

- New strategies for moving into real homes

- The retrofit problem is still critical

- Using the utility infrastructure as a sensor