Topics for Today

- Review the history of ubiquitous computing (ubicomp)
- Fundamental concepts
- Important research themes
The Plateau

User Productivity

WIMP (Windows)

Command Line

Batch

1940s – 1950s
1960s – 1970s
1980s – Present

Time

Paradigm: Ubiquitous Computing

- Person is no longer user of single device but occupant of computationally-rich environment
- Computers everywhere
  - Desktops, laptops, tablets, mobile phones
- Can no longer neglect macro-social aspects

Innovator: Mark Weiser

- CTO of Xerox PARC
- Introduced notion of “calm technology”
  - It’s everywhere, but recedes quietly into background
  - “The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it.”

Ubiquitous Computing

- Move beyond the desktop
- Computing is embedded everywhere in the environment
- Technology supports a task
  - The task should be the focus…not the technology
Crucial Elements

- **Location**
  - “If a computer knows merely what room it is in, it can adapt its behavior in significant ways without requiring even a hint of artificial intelligence.”

- **Scale**
  - “Ubiquitous computers will also come in different sizes, each suited to a particular task.”

Scales of devices

- **Tabs**
  - Inch scale
- **Pads**
  - Foot scale
- **Boards**
  - Yard scale

Already a Reality

Head Mounted Displays

*Micro optical displays*
Three Research Themes in Ubicomp

1. Automated capture and access
2. Context-awareness
3. Natural/Implicit interaction

1. Automated Capture

- Motivation
  - Record-taking is hard
  - Multiple streams of information need to be captured
  - Machines are better at some of these things than we are

Examples
- Meeting capture (e.g. Weiser, Xerox PARC)
- Classroom 2000

LiveBoard
2. Context-Aware Computing

- Computing services sense the environment (location, user emotion,...) and tailor provided services
- Walk into a meeting, phone is silenced
- Requires sensor innovation

Examples
- Active Badge & PARCTab
- Temperature adjusted automatically

Sensing Techniques for Mobile Interaction
3. Natural/Implicit Interfaces

- Making computing interfaces more natural interaction tools
  - Pen input
  - Speech
  - Gesture
  - Tangible interfaces
Examples

- Pen applications
- H. Ishii’s tangible UI work

Hollywood Visions

Ubicomp is...

- Computing everywhere
- Mobile computing
- Wearable computing
- Augmented reality
- It is NOT virtual reality.

Dangling String
Where are we now?
- Machine learning
- Cloud computing
- Mobile computing is a given
- New opportunities for designers
- Lots of sensors

Environmental vs. Local Processing
- Environmental
  - Lower cost, lower power
- Local
  - Supports mobility
  - Privacy preserving

Remaining Challenges
- Ease of deployment/install
- Security/privacy
- Power
- Engineering challenges
  - At odds with traditional engineering practices
Battery Trends

Low-power Wireless Sensing

Power Harvesting
- Mechanical
- Inertial/Motion-based
- Magnetic
- Inductive coupling
- RF power harvesting
- Thermoelectrics
- Piezoelectrics
- Resonator

Leverage Existing Sensors and Infrastructure