History and Visions

Ubiquitous Computing

- *"The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it.",* Mark Weiser 1991

Xerox PARC: Tab

- PARCTAB (or "tab")
- Touch sensitive panel (use with finger or stylus), with 128x64 resolution, can flip for left-hand use
- 3 buttons, speaker (different tones)
- Infrared (19.2k baud)
- Localization using "room-sized communication cells"
- 12MHz Intel 8051 microcontroller
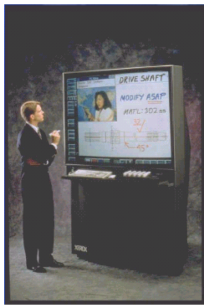- Can operate for 10mins/hour, 8 hours per day, 1 week before recharging

Xerox PARC: Pad

- Pad (Tablet), prototype pen computer (9x11x1")
- 4 hour battery life
- 5 lbs
- Motorola 683xx processor w/ 4MB RAM
- PCMCIA
- PAR Pen w/ built-in microphone
- 640x480 display
- Infrared

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Xerox PARC: Board

- Bulletin boards, white boards, flip charts, book case, ...
- 40" by 60", 1024x768
- Wireless electronic "chalk"

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Active Badge

- Olivetti Research, Roy Want
- Workers could automatically unlock areas to which they had been granted access
- Phone calls routed to wherever they are
- Create running diaries of meetings
- Could be tracked (Olivetti's public web site allowed visitors, at one point, to find location of employee)

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Active Badge

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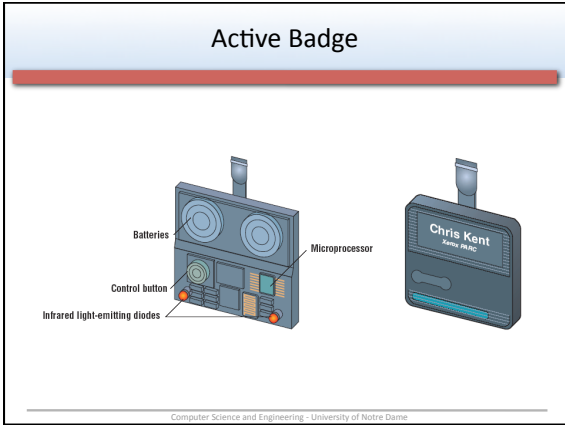
Active Badge

- Identity + Room level location + Button
- Relatively "simple" technology led to lots of applications
  - Door opens only to right badge wearer (Bill Gates' house)
  - Rooms greet people by name
  - Telephone calls automatically forwarded
  - Computer terminal can quickly pull your settings from "home computer" ("teleporting")
  - Automatic diary

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Predictions

- Displays (http://www.americhip.com/)
- CPU speeds
- Storage
- OS
- Migration of screen content
- Networks

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The Sal Story

- "Coffee?"
  - Coffee machine only knows "Yes" and "No"
  - No other speech input devices nearby, or can ignore
  - Coffee machine knows if it has coffee grounds inside

- "She sees electronic trails that have been kept for her of neighbors coming and going"
  - Window has some computer vision
  - Window can also display information

The Sal Story

- "She can see that [her kids] got up 15 and 20 minutes ago"
  - No plausible deniability for kids anymore!
  - Possibly sensors in bed, microphones in bedrooms, or location tracking

- "She wipes her pen over the newspaper's name, date, section and page number and then circles the quote. The pen sends a message to the paper, which transmits the quote to her office"
  - How does the pen know who to send to?

The Sal Story

- "[Sal] can press a code into the opener and the missing manual will find itself"
  - These days would probably be web based
- "She spots a slowdown ahead and also notices on a side street the telltale green in the foreview of a food shop"
  - Advertiser-based hardware? Install this and 10% off price?
  - Or somehow configure it? Configure lots of devices?

The Sal Story

- "Sal glances out her windows: a gray day in Silicon Valley… meanwhile it has been a quiet morning at the East Coast office"

Figure 1. It will get stormy in the next few hours.

Figure 2: It will freeze tonight, better wear gloves.

The Sal Story

- "The telltale by the door that Sal programmed her first day on the job is blinking: fresh coffee"
  - End-user programming, how to do this in ubicomp?
  - Coffee seems to be popular in Silicon Valley

The Sal Story

- "Sal picks up a tab and waves it to her friend Joe"
  - Have to be careful of accidental data sharing!
  - How does it know what to share?
  - How to differentiate if multiple people there?

- "The two have given each other access to their location detectors and to each other's screen contents and location"
  - How to easily configure?
  - Would co-workers find this acceptable? Social conventions?
  - Forgetting to remove permissions?

The Sal Story

- "A blank tab on Sal's desk beeps and displays the word "Joe"... Joe wants to discuss a document with her, and now it shows up on the wall"
  - These days would probably be initiated via IM
  - Easy to share data and talk real-time

What's Missing?

- Web
  - Notice no mention of the Internet, wasn't obvious at time
  - Makes the paper feel a little dated
  - Subtle difference in vision: original ubicomp about embedded chips in everything, web about information anywhere anytime, web services about mass scale

- Social sciences
  - Privacy
  - Really compelling applications

What's Missing?

- Do laptops still have a future in ubicomp?
  - Lots of devices and somehow your data gets to them
 - Laptops still central, but can easily share data

- How do cell phones fit into the ubicomp picture?

Famous Quote

- There is more information available at our fingertips during a walk in the woods than in any computer system, yet people find a walk among trees relaxing and computers frustrating.

- Machines that fit the human environment instead of forcing humans to enter theirs will make using a computer as refreshing as taking a walk in the woods

Synthetic Serendipity

- Vinge is well-known sci-fi writer
  - Story set in year 2020
  - Has to be plausible vision of future

- Combines lots of tech ideas:
  - Virtual reality
  - Digital libraries
  - Ubicomp
    - Wearable computers
    - Wireless
    - Sensor nets
    - User-machine interfaces
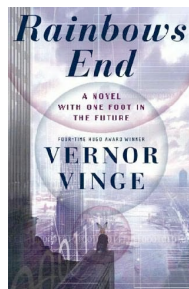
Another Vision of Ubicomp

We will reach a point where the combination of powerful processors, limitless data-storage capacity, ubiquitous sensor networks, and deeply embedded user interfaces will create a bond between human and machine "so intimate that users may reasonably be considered superhumanly intelligent."   - Vernor Vinge

Synthetic Serendipity

- Some interesting points
  - How Google, eBay, FedEx used in future
  - Not real cyborgs, but close to it
    - Real-time Google
    - Silent messaging
  - Information overlays on top of real world
    - Pipes, nav arrows, online games in world

Synthetic Serendipity

- Will wearable computers actually take off?
  - How to do input? How to avoid accidental input?
  - Non visual output? Or heads up displays?

http://ldt.stanford.edu/~jeepark/jeepark+portfolio/cs147hw8jeepark.html

Synthetic Serendipity

- Will it be harder to differentiate "reality"?
  - Live in "reality" or a world we created?
  - A Matrix of our own making? World of Warcraft addiction?

- How to make cost-effective?
  - Sensor nets not cheap
  - Wearable computers not cheap, plus recharging needs
  - Simple things we can do first?

Ubiquitous/Pervasive Computing

- Distributed systems
- Mobile computing
- Effective use of smart spaces (light/heat control in room)
- Invisibility (minimal user distraction)
- Localized scalability (scalable but constraint to local...)
- Masking uneven conditioning (will take long time before uniform penetration, "mask" dumbness of environments, e.g., device compensates for lack of wireless connectivity)

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Evolution of Pervasive Computing
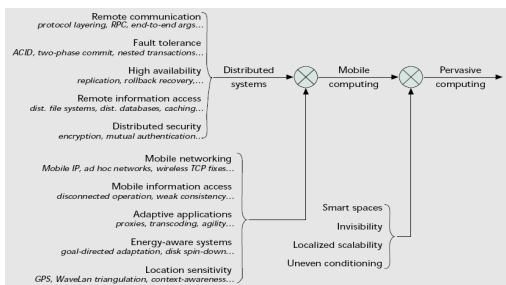
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Pervasive Computing

- During one of his talks, Weiser outlined a set of principles describing pervasive computing (also called ubiquitous computing):
  - The purpose of a computer is to help you do something else.
  - The best computer is a quiet, invisible servant.
  - The more you can do by intuition the smarter you are; the computer should extend your *unconscious*.
  - Technology should create calm.
- Calm technology
  - *"A technology that which informs but doesn't demand our focus or attention".*
  (Designing Calm Technology, Weiser and John Seeley Brown)

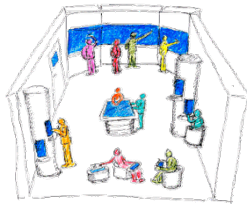Computer Science and Engineering - University of Notre Dame

Invisibility

- One does not need to continually rationalize one's use of a pervasive computing system.

- Having learnt about its use sufficiently well, one ceases to be aware of it.

- It is "literally visible, effectively invisible" in the same way that a skilled carpenter engaged in his work might use a hammer without consciously planning each swing.

- Similarly, when you look at a street sign, you absorb its information without consciously performing the act of reading.

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Common Terminology

- Ubiquitous Computing
- Pervasive Computing
- Calm Technology
- Internet of Things
- Things that think
- Everyware
- Pervasive Internet
- Ambient Intelligence
- Proactive Computing
- Augmented Reality

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Related Areas

- Sensor Networks
- Mobile Computing
- Wireless Networks
- Embedded Systems/Control
- Human-computer Interaction
- Artificial Intelligence
- Autonomic Computing

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Will It Come?

- Many powerful institutions vested in its coming
- Enormous market possibilities
- We're already there
- Location-based services and apps
- Tracking cell phones
- Great challenge for us, we like solving riddles
- Who will be most affected? Nontechnical, nonspecialist, ordinary citizens; won't even realize it's there (we will know)

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