

# CS4220 Embedded Systems CS6235 Real-Time Systems

## 3A: Weiser's Vision

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## Agenda

- What was Ubiquitous Computing in 1993?
- Phases of Development
- A New Form of Computer Science
- Hardware Issues
- Applications
- Where are We Now?

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## UbiComp in 1993

- Very new to the field of CS
  - Ubiquitous Computing was introduced by Weiser in 1991
- Main goal was (and still is) to get the computers “out of the way of everyday activities”
- Technology finally caught up to the proposed ideas for “environmental computing”

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## UbiComp in 1993 (Cont.)

- Some thought Virtual Reality was the ideal UbiComp solution, but the technology was not advanced enough
- Ruled out GUIs as the complete solution
- Identified several key needs of a successful UbiComp device
- Still struggling with some of the same problems today

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## Phases of Development

- Researchers at Xerox PARC identified the initial set of ubiquitous computing “phases”
  - Construct
  - Deploy
  - Evaluate
- Realized that Phase One would not achieve the “optimal invisibility”

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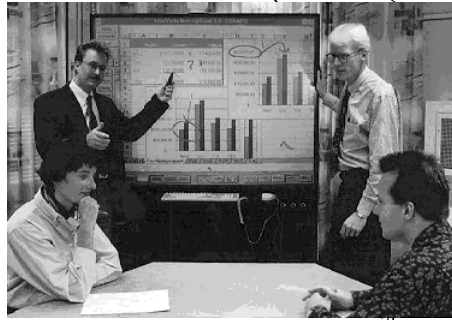
## Potential Platforms

- Devices of various sizes
- Enough diversity to give some sense of scope
- Must be found in everyday life and used frequently
- Above all, they must be unobtrusive

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## Large-Size Prototype

- LiveBoard! (Look to the right!)
- Main idea was to simulate an office whiteboard
- Order of 1 per office



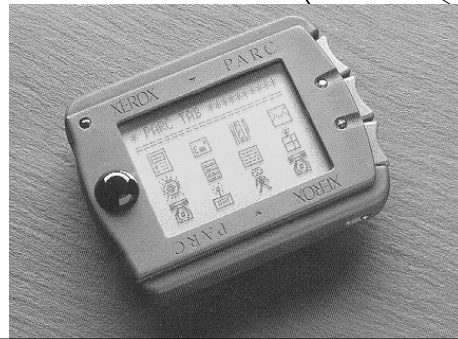
## Medium-Size Prototype

- XPad
- Main goal was to simulate a personal notebook
- Order of 10+ per person



## Small-Size Prototype

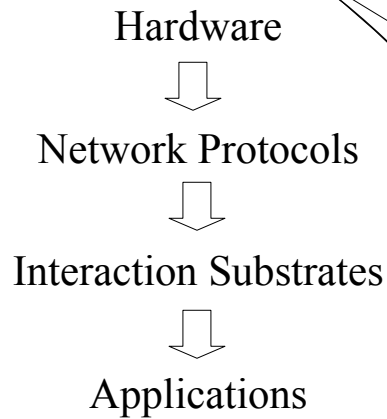
- ParcTab
- Main goal was to simulate PostIts
- Order of 100+ per person



## New Form of CS

- Valuable lessons learned from the early prototypes
- Development of a new hierarchical abstraction specific to UbiComp framework
- Main goal of this paper is to discuss the motivations behind this new form of CS and the current obstacles

# New Hierarchical Abstraction



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# Hardware Requirements

- Low Power
  - Speed can be sacrificed
- Wireless
  - One low-speed (64kbps) per person
  - Remember this is 1993
- Pens
  - Wireless (IR beams)
  - Available without touching the screen and up to several feet away

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# Network Protocols

- IP was not the proper protocol because it assumed a static location of the computer
- A “media access” protocol is required
- Some applications require guaranteed bandwidth (voice and video)
- Example – MACA [Karn 90]
  - Uses a handshake algorithm that verifies communication channel and lets others know of upcoming transmission

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# Network Protocols (Cont.)

- Real-Time Protocols
  - Focus on packet-switched networks
  - Attempt to eliminate bottlenecks at basestations
  - Work in progress at the time (no concrete details are provided)
- “Secondary” or “Virtual” IP
  - Adds a level of indirection to account for user mobility

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## Interaction Substrates

- IR Pens
- “No look” touch screens
- Palm size keyboard
  - Found to be only half as fast
- Window migration tools
- “Low Bandwidth X” [Fulton 93]

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## Early Applications

- Active Badge
  - An employee tracker
  - AT&T Labs in Cambridge
- Slate
  - Shared media tool
  - Xerox PARC
- Both widely used even outside of the labs

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## New Theoretical Problems

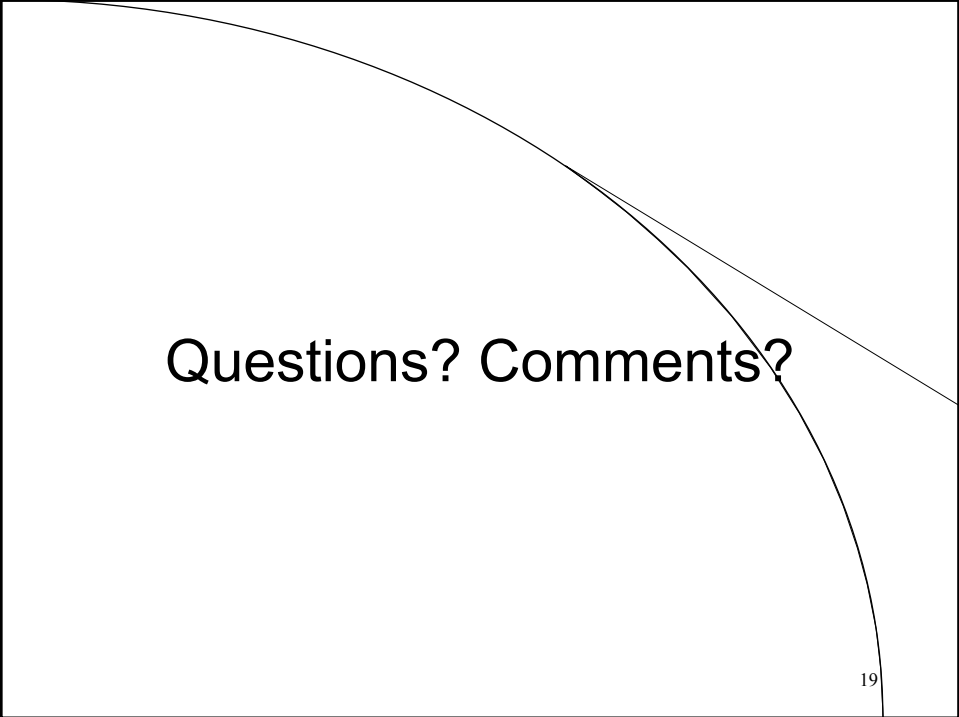
- UbiComp has unveiled several new theoretical problems that need to be solved. For example:
  - Optimal Cache Sharing Problem
    - Optimal strategy for partitioning memory between compressed and uncompressed pages
    - Led to the development of the Lower Bound Theorem for Caches [Bern 93]

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## Where Are We Now?

- Still developing new technologies
- Have met the demands for:
  - Wireless Networking (IEEE 802.11)
  - Low Power CPUs (300+ MHz at 1.1v)
  - Real-Time Packet Switching (Numerous algorithms)
  - Applications (Entire OSs have been built)

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Questions? Comments?