Perspective on
Ubiquitous Computing

Vorlesung „Augmented Reality"
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Perspective on Ubiquitous Computing

- Ubiquitous computing
  - History, definition
  - Classic projects
  - Core ideas
  - How AR can simulate UbiComp
- Lecture summary

Post-PC Era
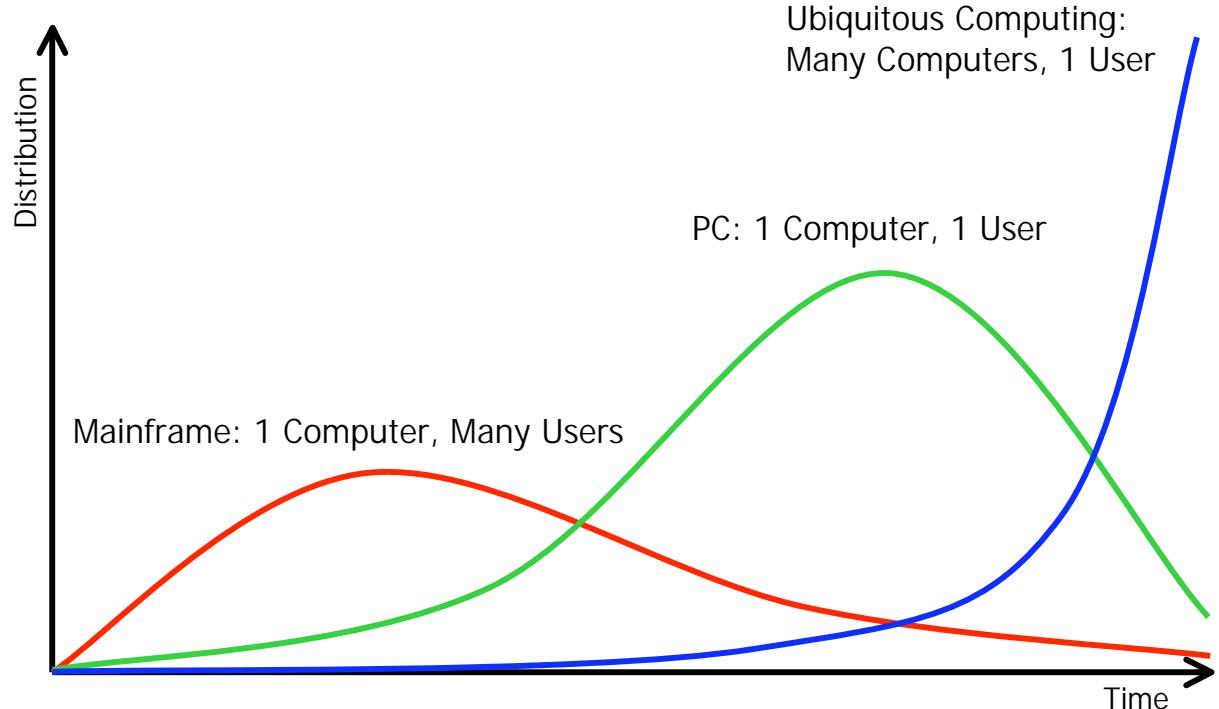
Distribution

Mainframe: 1 Computer, Many Users

PC: 1 Computer, 1 User

Ubiquitous Computing:
Many Computers, 1 User

Time

Source: Mark Weiser

Ubiquitous Computing

- Computers everywhere
- The real world contains virtual information
    - In contrast to: virtual worlds
    - More closely related to Augmented R
- Out of sight and senses
- All devices are highly connected
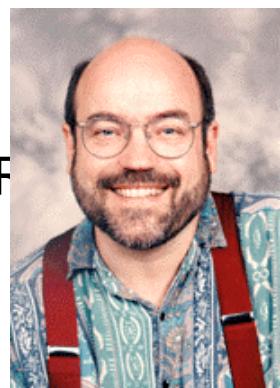
Mark Weiser: What Ubiquitous Computing Isn't
Ubiquitous computing is roughly the opposite of virtual reality. Where virtual reality puts people inside a computer-generated world, ubiquitous computing forces the computer to live out here in the world with people.

Mark Weiser

Chief Technologist Xerox PARC

(1952-1999)

First origins of ubicomp date back to 1988.
Fundamental paper September 1991:
„The Computer for the 21st Century"

It is invisible, everywhere computing that does not live on a personal device of any sort, but is in the woodwork everywhere.

Three generations of computing paradigms

2. Generation:
Desktop Computing

1. Generation:
Main frame Computing

3. Generation:
Ubiquitous Computing

Terminology of *Ubiquitous Computing*

- *Computers disappear* and human-computer interaction concentrates on the human.
  => Computers should be simple and easy to use

- *Calm Technology*
  => *calm*: Technologies move to the background, beyond awareness

- *Readiness to hand*
  => Good tools should not distract our attention and should be easy to use.
  – Examples: glasses, pencils etc..

Example of Calm Technology: Writing and Reading

- Disappearing "unaware" technology
- Easy and simple long-time storage of information
- Writings are ubiquitous in our society
- Technology, that helps to write and read stays in the background
- Reading is a completely unaware process (after approx. 16 years of learning it ;-)
  => Written information is instantly available (in contrast to most digital information).

Related terms to Ubicomp

- Calm Computing (Weiser + Brown, 1995)
- Pervasive Computing (IBM, concentrates on „Smart Devices")
- Nomadic Computing (similar to mobile Computing + context, location)
- Embodied virtuality
- Information appliances

Calm Computing

- Computers are part of the environment
- Interface to the unconsciousness
- Designs that make users relax and still are informative
- Peripheral information delivery
- Example: *the Dangling String*

Periphery

- == Border area of perception

- Everything we perceive without paying attention
- Example: Driving a car

- Periphery is not unimportant

- One physical object can serve both aspects

Summary: Calm Technology

- CT can easily switch between center and periphery
  - moving things to the periphery enlarges the range of your perception
  - moving things to the center enables us to react to events
- Although the amount of information increases, there is no *Information Overload*.
- Not every technology is calm
  - Example: video games
  - Designs often concentrate on the main object and its properties, but neglect the usage context.

Embodied Virtuality

- Everyday things take on computing capacity
- Virtuality of data is brought into the physical reality
- Data becomes tangible
- Information can be obtained right from the environment
- Exactly when and how you need it
- Two factors are important:
  - location and environment → enables adaptive behavior
  - size → depending on requirements and task
- Hundreds of devices in a room
- Frightening idea, but the more you use them, the more you forget their existence
- Example: electricity

Information Appliances

- Definition:
  - specialized for a narrow set of activities in contrast to the *universal machine*

- Examples: E-books, Organizer, Web TV, Smart Phone, GPS receiver

- Appliances vs. Computer

- Computers are just tools!

What Ubicomp isn't

- NOT Laptops, BUT small networked devices
  - Information accessible everywhere
- Multimedia as a tool, not just to show off!
- Virtual Reality
  - the opposite of Ubicomp
  - VR excludes most of the world
  - Isolation of humans in VR from the Real World
  - VR simulates the world – Ubicomp enhances it

Integration into everyday things

Polymer displays

Digital ink

Flexible keyboards

Tabs, pads and boards (Xerox)

Tabs

Pads

Boards

Tabs, pads and boards (cont.)

- Tabs, inch-sized (1 Inch = 2.54 cm)
  - small handheld networked devices
- Active badges
  - specialized tabs, enable localization
- Pads, foot-sized (1 Foot = 30.47 cm)
  - mixture of laptop, palmtop, sheet of paper

- Disposable computer, no identity, impersonal
- Provide a solution to the lack of space on windows based systems

Tabs, pads and boards (cont.)

- Boards, yard-sized (1 Yard = 0.914 m)
  - used as book shelves, TVs, display boards

- Power of Ubicomp stems from the interaction of all devices.
- Ubicomp can „awake" lifeless things (books, overhead slides, etc.)
- Problem: today it's easier to read a book than to sit down at a complicated Personal Computer
- Transition will happen in small steps

Example project: Active Badges
Olivetti / AT&T, Schilit, Hopper, Harter, et al.

- Teleport
  - Redirect screen output from "home" computer to nearby computer
- Phone forwarding
  - Automatically forward phone calls to nearest phone

Active Badges: Technology

- Badges emit infrared (IR remote) signals
- 1 signal every 15 sec.
- Avoid 2 badges in sync
  - use high tolerance components
  - Light sensor changes interval
  - → switched off when in the dark
- Button to trigger events
- Sensors distributed in the building
- Central server scans regularly for „badge sightings"
- Over 1500 badges and 2000 sensors used worldwide
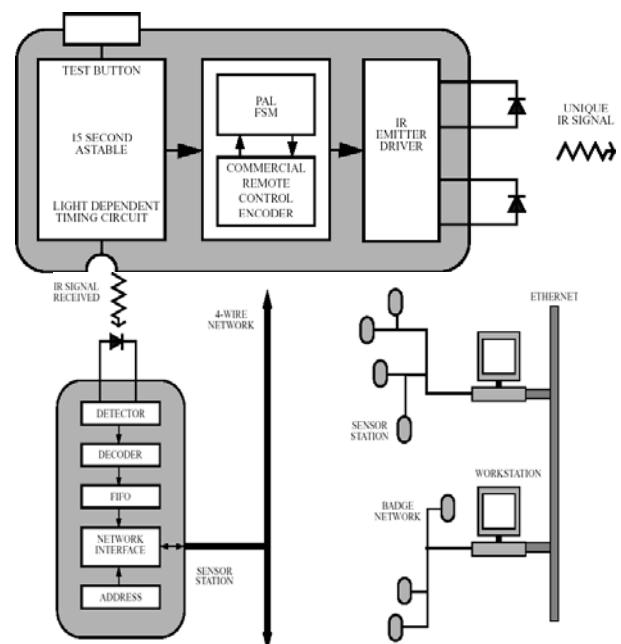
"A disadvantage of an infrequent signal from the badge is that the location of a badge is only known, at best, to a 15-second time window. However, because in general a person tends to move relatively slowly in an office building, the information the Active Badge system provides is very accurate." ;-))

Active Badges: Initial Services

- **FIND (name)**
  - Provides the current location of the named badge and, if it has recently moved, a list of all the locations it has been sighted at in the last five minutes along with the likelihood of finding it at each.
- **WITH (name)**
  - Locates a named badge and provides information about other badges that are in the immediate locality of that badge.
- **LOOK (location)**
  - Allows an investigation to be made of the badges that are currently near the specified location.
- **NOTIFY (name)**
  - An alarm mechanism that generates an audible indication of when the named badge is next sighted after executing the command. 'NOTIFY' is particularly useful when trying to deliver an urgent message to a member of staff who is out of the office on business for long periods of time.
- **HISTORY (name)**
  - Generates a condensed report of the location history for the named badge during a one-hour period. The system intentionally does not record any location data on a permanent storage medium, to dispel concern about long-term monitoring of an employee's movements.

Xerox ParcTab

- Infrared network
  - Base stations in the ceiling
  - Low bandwith, modulated carrier
  - Transmission radius ~7m

- Mobile tab-sized devices
  - Unistroke input via pen

- Context-aware applications:
  - Information access
  - Communication
  - Collaboration
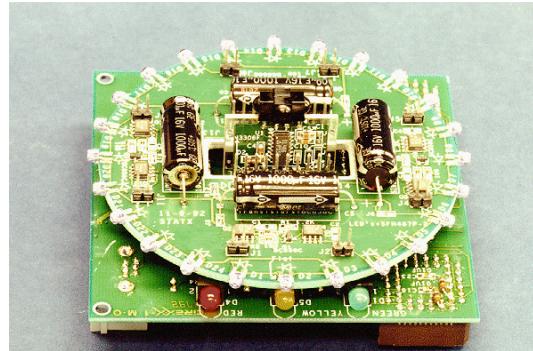
Information Access

- Weather (Internet/local)
- Dictionary, Thesaurus
- UNIX file browser
- WWW browser (mit Einschränkungen)
- Calendar manager (Sun's cm)
- Dateimanager (ortsabhängig)

Communication

- email: permanent access
- pager
- locator
- „Communicator", media-space controller
  - Tab proposes best communication devices in the surroundings and initiates connection

Collaboration

- Tab as pointing device
  - Remote pointer control for liveboard
  - Move pointer with pen on the tab screen
- Tabdraw: collaborative drawing
  - One canvas per room
- Arbitron (Tool for voting)
  - Tell the presenter to speed up or slow down

Other Applications

- ## Remote Control
  - Control of physical environment
  - Universal (self-configuring) remote control

- ## Local (on Tab) applications
  - For offline use
  - Note pad for memos

Simulating UbiComp with AR

- Display information on „dumb" objects
  - Make them appear „smart"
- Provide interaction with overlaid info space
- HMDs make virtual info space visible
- Tracked handheld displays can be used as a physical magic lens

But:
- Virtual layer in UbiComp is not necessarily spatial
- AR mostly instruments the user, not the environment
- Technically, AR technology can be seen as a very special subset of UbiComp technology

Lecture summary

Anwendungen der AR

- Industrie
  - Konstruktion, Reparatur
- Medizin
  - Operationsunterstützung
- Transport
  - KFZ, Flugzeuge
- Unterhaltung, Bildung
  - Museen
  - Fernsehen

Tracking (Ortsbestimmung)

- Grundlagen der 3D Geometrie
- Vorstellung verschiedener Trackingverfahren
- Sensorfusion
- Kamerabasiertes Tracking:
  - Kameramodelle
  - 3D-Rekonstruktion aus 2D Daten

Displaytechnologien

- Head Mounted Displays (HMDs)
  - See-through vs. Video-based
- Handheld displays
- Stationäre displays
- 2D Projektion in der phys. Umgebung
- 3D-Displays

Programmierung von 3D Szenen

- Szenengraphen

- Beschreibungsformate

- Modellierung realer Objekte zur korrekten Verdeckungsdarstellung

- Performanceaspekte

Interaktionstechniken für AR

- Techniken aus der VR
  - 3D-Eingabegeräte
  - Selektion
  - Manipulation
  - Navigation

- Techniken aus der PC-Welt
  - Menüs, Annotationen

- Techniken aus der phys. Umwelt
  - Spezialisierte Werkzeuge
  - Tangible UIs

Nichtvisuelle AR

- Räumliches Audio
  - Kopfhörer
  - Lautsprecher
- Haptik
- Force Feedback
- Gravitationssimulation
- Geruch

Softwaresysteme für AR

- Kurze Einführung in das Software Engineering
- Systemaspekte für AR
  - Verteilung
  - Echtzeitfähigkeit
  - Designalternativen
- Überblick über existierende AR-Systeme

Authoring von AR-Anwendungen

- Problembereiche des Authoring
- Vorstellung von Authoringsystemen
  - Alice
  - DART
  - AMIRE

Ausblick: Ubiquitous Computing

- Kernideen UbiComp
- AR zur Simulation von UbiComp

Schönes Wochenende (nach der Vorlesungsumfrage).