Ubiquitous Computing

Summary

- Introduction to Ubiquitous Computing
- History of Ubiquitous Computing
- Challenges and Requirements

Introduction to Ubiquitous Computing

- What is
- Characteristics
- Goals

What is (1/3)

- the method of enhancing computing use by making many devices (services) available throughout the physical environment, but making them effectively invisible to the user (Mark Weiser)

Computing Everywhere

Ubiquitous means:

- present everywhere
- simultaneously encountered in numerous different instances
- computers become a useful but invisible force, assisting the user in meeting his needs without getting lost in the way

What is (2/3)

- tries to construct a universal computing environment (UCE) that conceals (hides):
  - computing instruments
  - devices
  - resources
  - technology

  } from applications or customers

- invisible to users

What is (3/3)

- *computing everywhere*

- many embedded, wearable, handheld devices communicate transparently to provide different services to the users

- devices mostly have low power and short-range wireless communication capabilities

- devices utilize multiple on-board sensors to gather information about surrounding environments

Characteristics of Ubicomp Applications

- context-awareness (also a key-characteristic of perceptual interfaces)

- improvised and dynamic interaction

- interactions among applications are based on specific context

Goals

- the promise of ubiquitous computing:
  a life in which our tasks are powerfully,
  though invisibly, assisted by computers

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History of Ubiquitous Computing

- History
- Mark Weiser
- Experiments

History

- Active Badge
  - Andy Hopper
- Xerox PARC 1991-2000
  - Mark Weiser (until, sadly,April 1999)
- Calm Technology

Mark Weiser:
the father of ubiquitous computing

- researcher in the Computer Science Lab at Xerox's PARC (Palo Alto Research Center)

- first articulated the idea of ubiquitous computing in 1988

- has called UC "…highest ideal is to make a computer so embedded, so fitting, so natural, that we use it without even thinking about it."

Ubiquitous Computing

- During one of his talks, Weiser outlined a set of principles describing 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.
- In Designing Calm Technology, Weiser and John Seeley Brown describe *calm technology* as "that which informs but doesn't demand our focus or attention".

Xerox PARC 1991-2000

- PARC = Palo Alto Research Center
  - 41 people immersed in ubiquitous computing environment

- virtual UCE with several interconnected devices such as notepads, blackboards and electronic scrap papers

- difference from a standard PC:
  people using these devices do not perceive them as computers anymore and can therefore focus on the actual tasks

Active Badge 1988

- smart telephone networks

- problem of automatically routing telephone calls to the correct place in a building

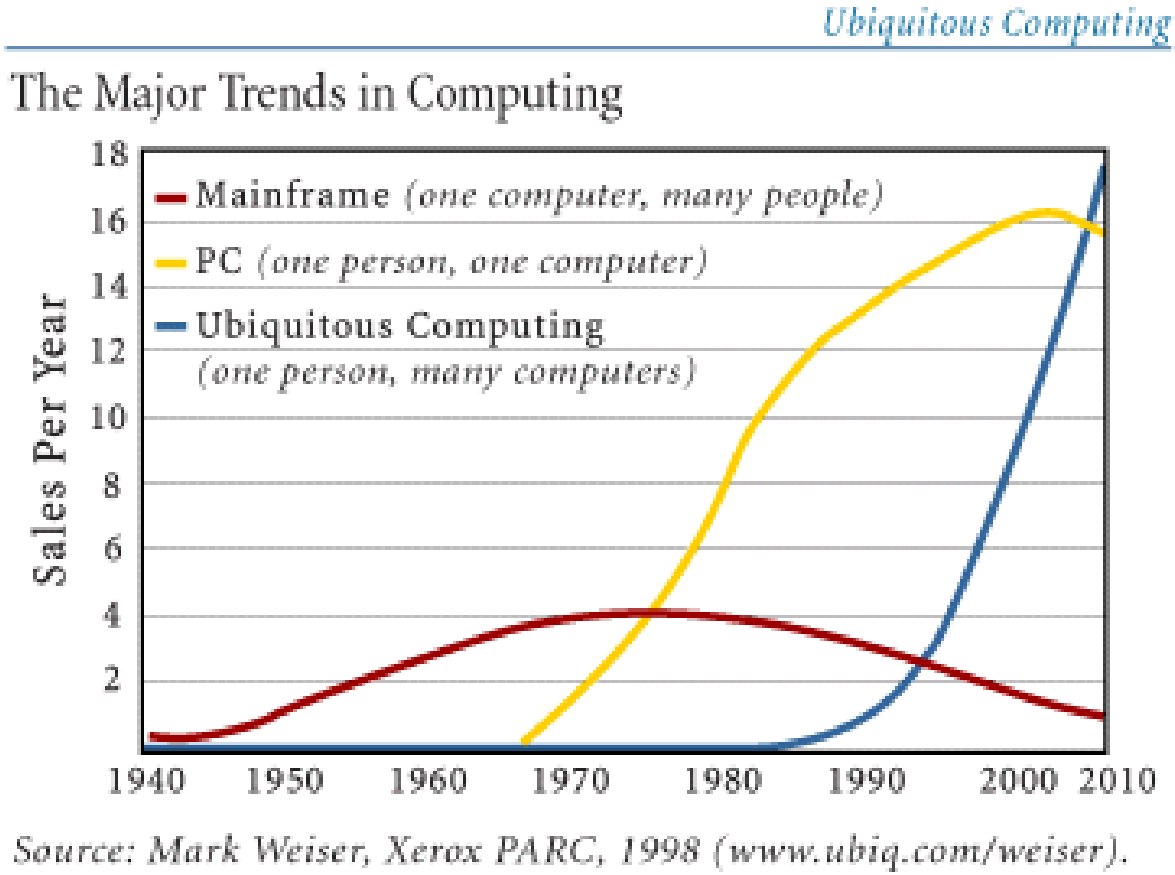
- opened up a whole new area of research and helped to realize a new opportunity for context based computing

Calm Technology (1/3)

The Major Trends in Computing

Mainframe many people share a computer
Personal Computer one computer, one person
Internet - Widespread Distributed Computing . . . transition to . . .
Ubiquitous Computing many computers share each of us

Calm Technology (2/3)



Calm Technology (3/3)

Today Internet is carrying us through an era of widespread *distributed computing* towards the relationship of *ubiquitous computing*, characterized by deeply embedding computation in the world.
Ubiquitous computing will require a new approach to fitting technology to our life, an approach called "calm technology".

Experiments

- Tabs
- Pads
- Boards

1988 – 1994 at PARC Xerox

- SAAMPad (Software Architecture Analysis Method Pad)

- The Conference Assistant

Experiment at PARC - TAB

TAB

- prototype handheld computer
- was 2x3x0.5", had a 2 week battery life on rechargeable batteries, and weighed 7 oz
- used a Phillips 8051 processor with 128k NVRAM
- featured an external I^2C external bus, a custom resistive touch screen, and a 128x64 mono display
- included an infrared base station in the ceiling for LAN connectivity

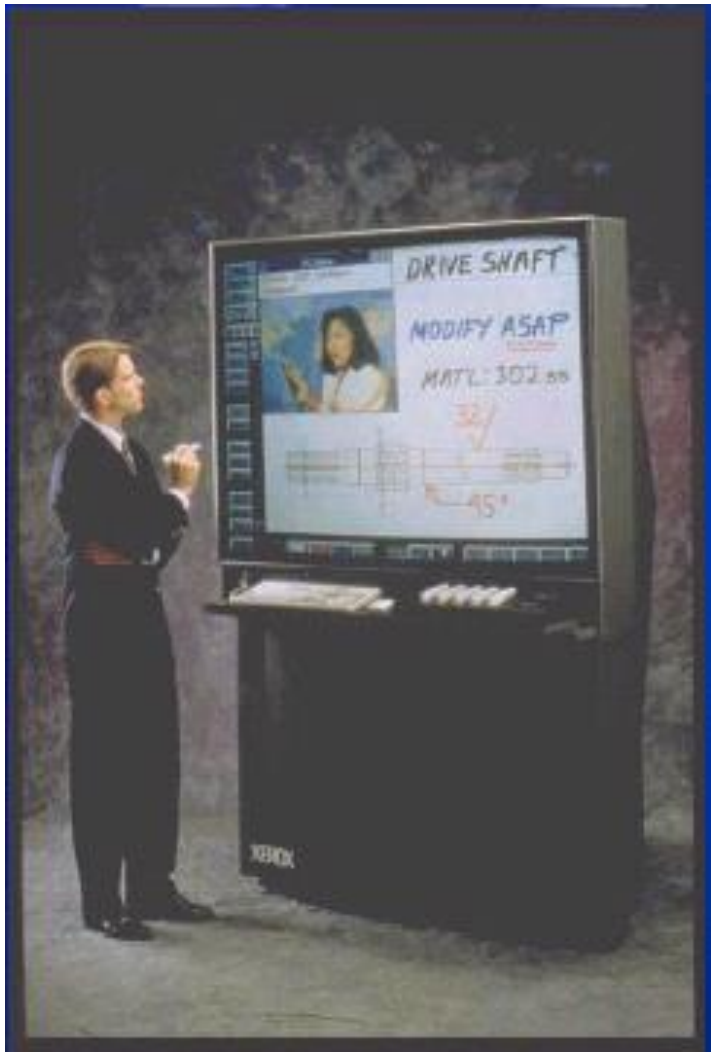
The Tab project is considered by many to be the most significant of the three prototyping efforts

ubiquitous computing

Experiment at PARC - PAD

Experiment at PARC – BOARD

Liveboard



Summary

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- History of Ubiquitous Computing
- Challenges and Requirements

Challenges and Requirements

- Hardware
- Applications
- User Interfaces
- Networking
- Mobility
- Scalability
- Reliability
- Interoperability
- Resource Discovery
- Privacy and Security

Nanotechnology (1/2)

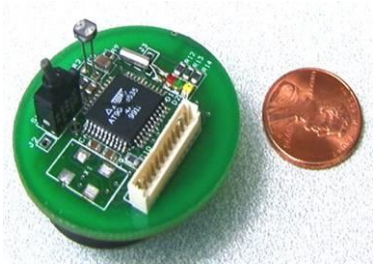
The trend toward miniaturization of computer components down to an atomic scale is known as nanotechnology

Nanotechnology (2/2)

- Mobile data technology
  - GSM, GPRS, UMTS, CDMA, WAP, Imode
- Wireless data technology
  - Bluetooth, 802.11b
- Internet data technology
  - IP over optical, Broadband
- Content services
  - Web & WAP
- Applications
  - Multimedia, Internet messaging

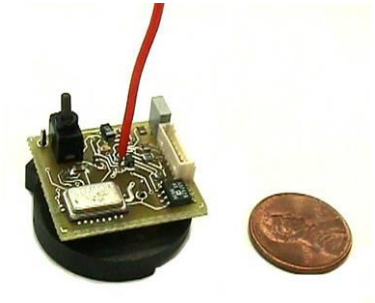
Smaller sensors

weC
codesigned by
James McClurkin



RF 916.5 MHz OOK
10kbps 20 meter range
Sensors: light, temperature

Mini Mote
codesigned by
Christina Adela



RF 916.5MHz OOK
10kbps 20 meter range
Sensors: temperature

New Technologies:
Light Emitting Polymers

- Plastic displays (~ 1 mm thick)
- Applications are emerging (e.g., curved or flexible displays)

Applications

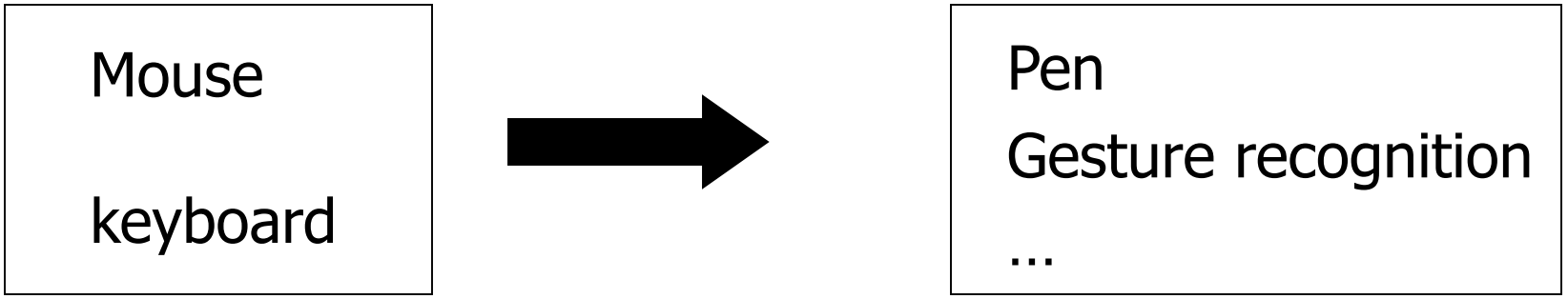
- main motivation of ubiquitous computing (Weiser 1993)

- need to have an awareness of their context:

  a combination of several factors, including the current location, the current user or if there are any other Ubicomp devices present in the near surroundings

Users Interface

The multitude of different Ubicomp devices with their different sizes of displays and interaction capabilities represents another challenge



Networking

Another key driver for the final transition will be the use of short-range wireless as well as traditional wired technologies

Mobility

Mobility is made possible through wireless communication technologies

Problem of disconnectivity!!!

This behaviour is an inherent property of the ubicomp concept and it should not be treated as a failure

Scalability

In a ubiquitous computing environment where possibly thousands and thousands of devices are part of scalability of the whole system is a key requirement

All the devices are autonomous and must be able to operate independently a decentralized management will most likely be most suitable

Reliability

Thus the reliability of ubiquitous services and devices is a crucial requirement

In order to construct reliable systems self-monitoring, self-regulating and self-healing features like they are found in biology might be a solution

Interoperability

This will probably be one of the major factors for the success or failure of the Ubicomp vision

This diversity will make it impossible that there is only one agreed standard

Resource Discovery

The ability of devices to describe their behaviour to the network is a key requirement.

On the other hand, it can not be assumed that devices in a ubiquitous environment have prior knowledge of the capabilites of other occupants.

Privacy and Security

In a fully networked world with ubiquitous, sensor-equipped devices several privacy and security issues arise

- the people in this environment will be worried about their privacy since there is the potential of total monitoring

- must be understandable by the user and it must be modelled into the system architecture

Examples

- Ambient Devices
  - Ambient orb
  - Ambient dashboard
  - Ambient weather beacon

Mobile Interface Design Guidelines

- iPhone design guidelines:
  - http://developer.apple.com/iphone/library/documentation/userexperience/conceptual/mobilehig/Introduction/Introduction.html
- Small Surfaces
  - http://www.smallsurfaces.com/
- Nokia design guidelines:
  - http://wiki.forum.nokia.com/index.php/Guidelines_for_Mobile_Interface_Design
- Cxpartners Mobile interface design:
  - http://www.cxpartners.co.uk/services/mobile_interface_design

Presentations next week

- The presentation schedule will be posted on the web page tomorrow (at the Schedule/Lecture Notes section)
- The presentations will be about 5-10 minutes, describing what you have done briefly.
- Any group member may make the presentation. It is OK if all the group members are not present during the presentation.

Project Reports

- For the final phase of your project, you are going to write a project report containing:
  - A description of the prototype or completed interface proposed in phase 1.
    - Textual description, snapshots, walkthrough of the system
  - Which design guidelines did you employ?
    - Visibility, mapping, user feedback, error-handling, etc.
  - Evaluation results
    - Which evaluation strategy did you use?
    - How many users?
    - What were the results?
    - Did you re-design your interface based on feedback from user evaluations?
- Final project reports are due on the last day of finals (send your reports via ODTU-Class. One report per group.).
- The report should also contain which group member did which task.