Instrumented Environments

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Mon, 10-12 Uhr, Theresienstr. 39, Room E 46

Final examn (Corrected!)

- In contrast to what I said in the first lecture, there will be no lecture certificate („Schein“)
  - Lecture certificates can only be given for exercises
  - We don‘t have any exercises…

- You can use this lecture as a topic for examns
  - If I hold the examn, I will check whether you have understood the main principles from the lecture
  - You should be able to explain them on examples
  - No need to blindly memorize slides…

Next week no lecture (1.11.)

- Holiday: Allerheiligen
- I will be in Korea from 1.11. - 6.11.

Topics Today

- Ubiquitous Computing
  - Origins, definitions
  - People, institutions
  - Visions, prerequisites
- Ubicomp displays
  - Display classes
  - Some technologies
  - Some prototypes

Mark Weiser

Chief Technologist Xerox PARC

(1952-1999)

First origins of ubicomp date back to 1988.
Fundamental paper September 1991

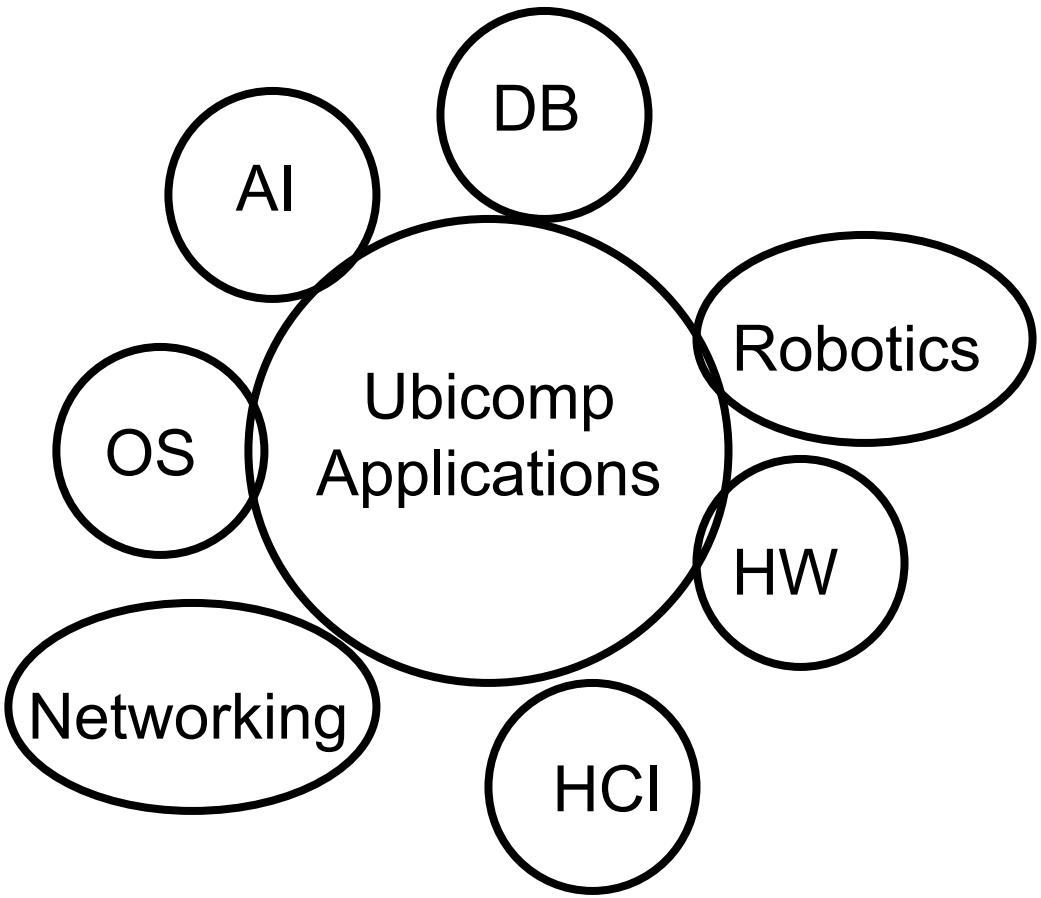
It is invisible, everywhere computing that does not live on a personal device of any sort, but is in the woodwork everywhere.

Important Institutions

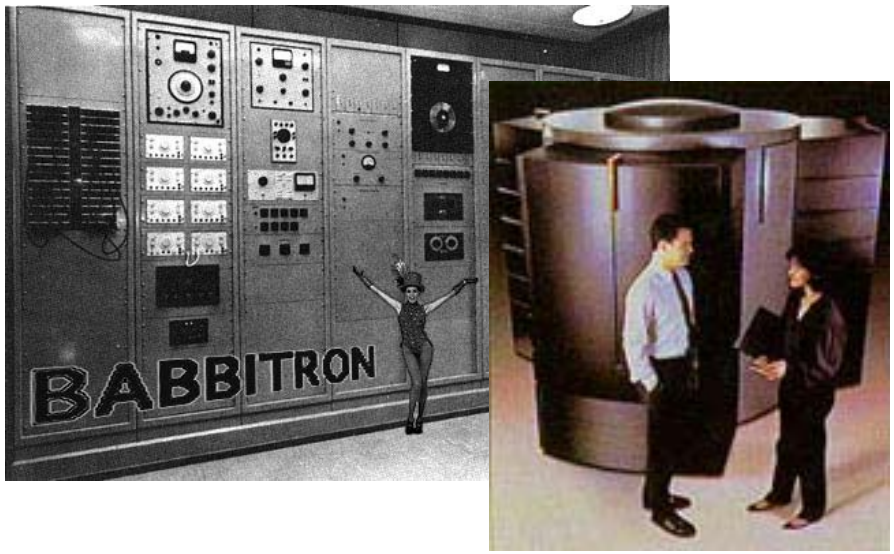
- MIT, Xerox Parc, Georgia Tech, IBM, Intel, Univ. of Washington, Georgia Tech
- In Europe: Univ. of Lancaster, Karlsruhe, ETH Zürich, Göteborg, Fraunhofer

- D. Norman: Information Appliances
- H.W. Gellersen: SmartIts
- N. Streitz: Roomware
- …many more

Contributing areas



Three generations of computing paradigms



2. Generation:
Desktop Computing

1. Generation:
Main frame Computing

3. Generation:
Ubiquitous Computing

Vision of *Ubiquitous Computing*

- Computer embedded in everyday things
- Seamless integration into our environment
- All components are connected
- All components can exchange information

=> Computer in the world, instead of a world in the computer.

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

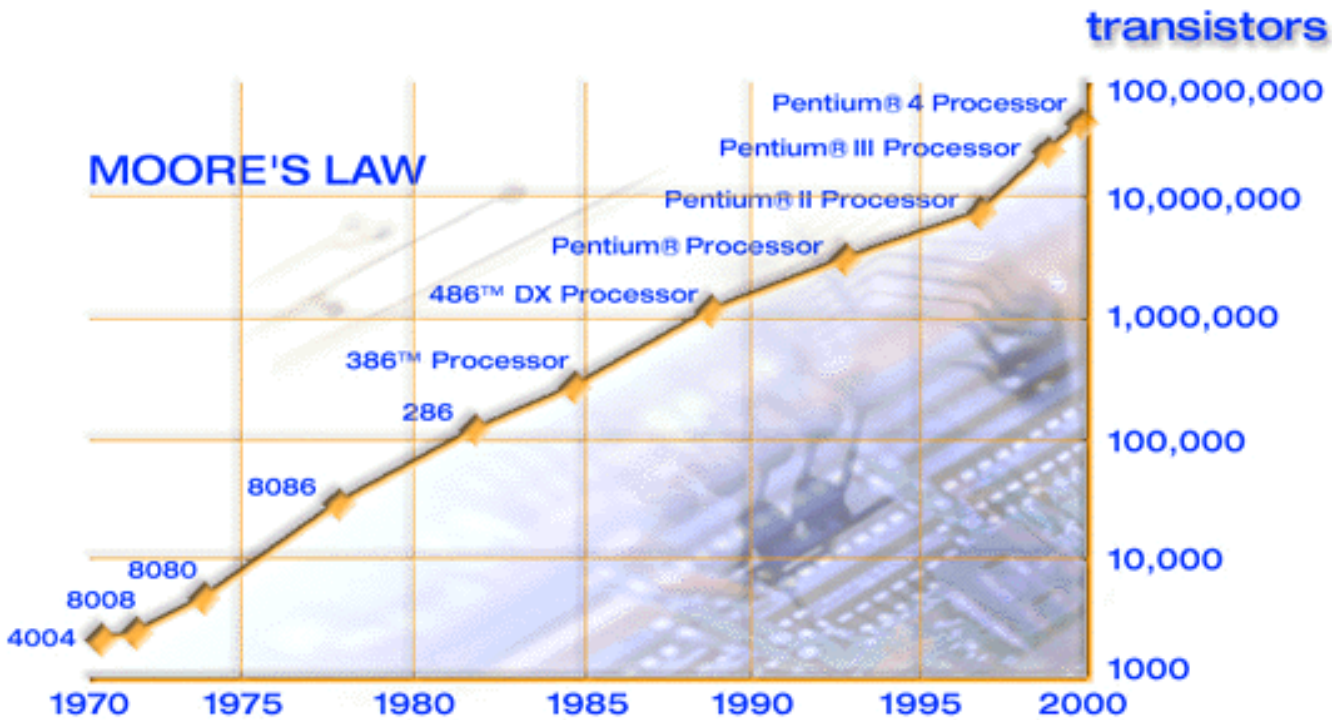
Potential application areas

- Public space
  - airports, shopping centers, museums, hospitals, parks & beaches, mountains, restaurants, streets, surveillance
- Industry
  - proof of origin, storage, …
- Education
  - lectures, CSCW, laboratory zones
- Private space
  - entertainment, home office, communication

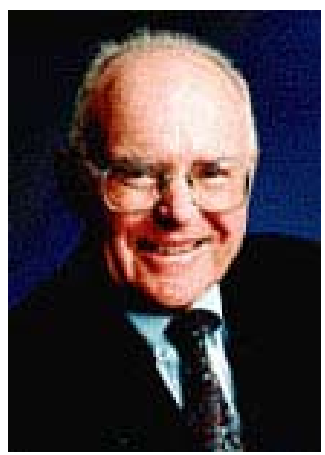
Some technical implications

- Miniaturization
- Integration, new materials
- Communication capabilities
- Power supply

Miniaturization of transistors



Source: www.intel.com



Moore`s Law (Gordon Moore, 1965):
Number of Transistors doubles every 18 months

Miniaturization of hard disks

2002: IBM Microdrive CF-Slot, 1.2 GB
2004: Hitachi Microdrive 4GB

Density of data:
Increases by 50% each year
=> 4x density in 3 years

More problematic: access speed
Increased by only 10% in the last 10 years

Network communication

- Fiber optic cable (10 Gbit/s)
- Ethernet (100Mbit/s)
- Wireless LAN IEEE 802.11 (11 or 54 Mbit/s)
- IrDA (up to 4Mbit/s)
- Bluetooth (up to 1 Mbit/s)

- Bandwidth doubles every 6 months

Important observation:
Ubicomp needs small netork cells, since the number of communicating devices is very high.

Integration into everyday things

Polymer displays

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

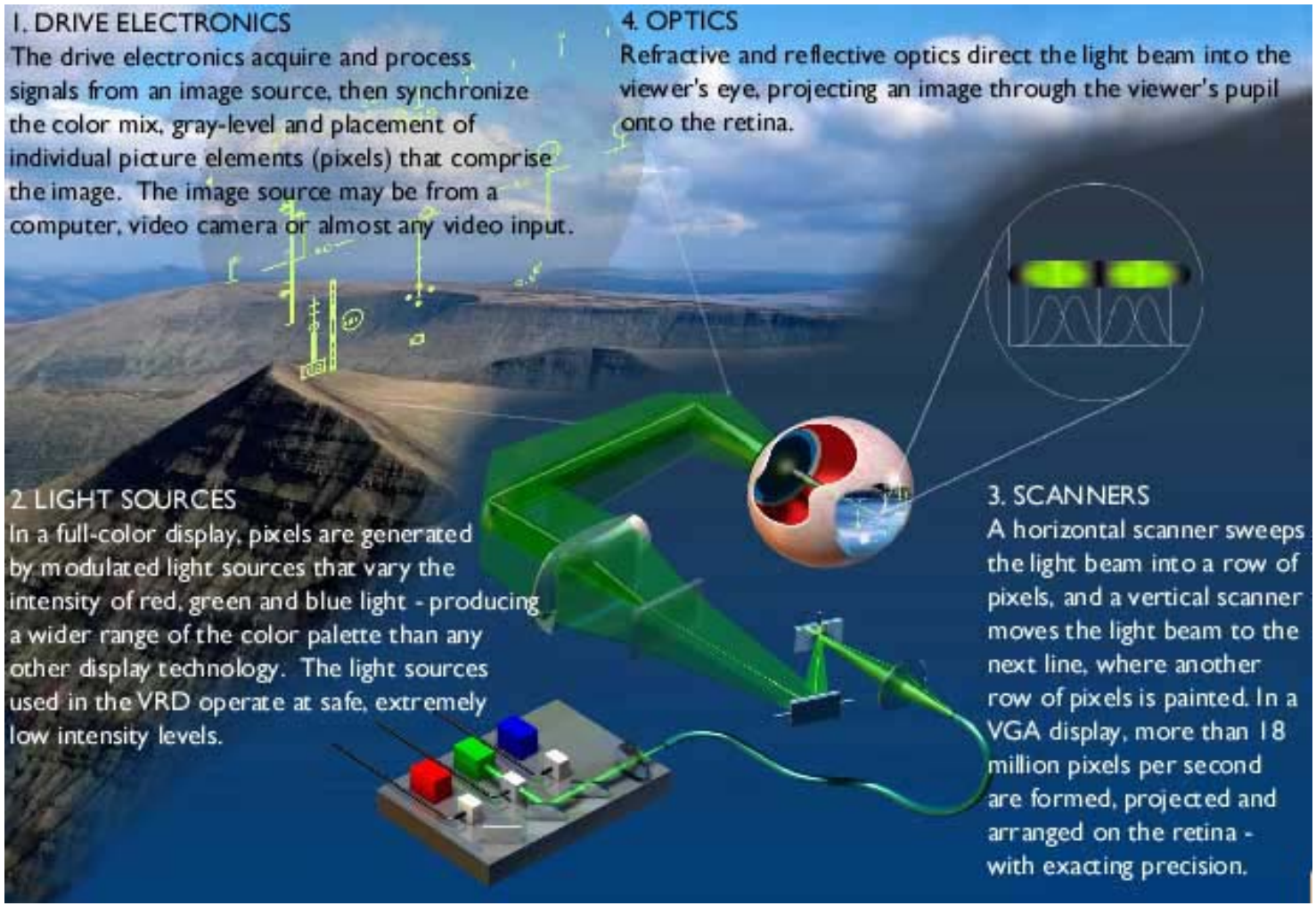
- Power of Ubicomp stems from the interaction of all devices.
- Ubicomp can „awake“ lifeless things (books, overhead slides, etc.)
- Problem: today it‘s easier to read a book than to sit down at a complicated Personal Computer
- Transition will happen in small steps

More ubicomp displays

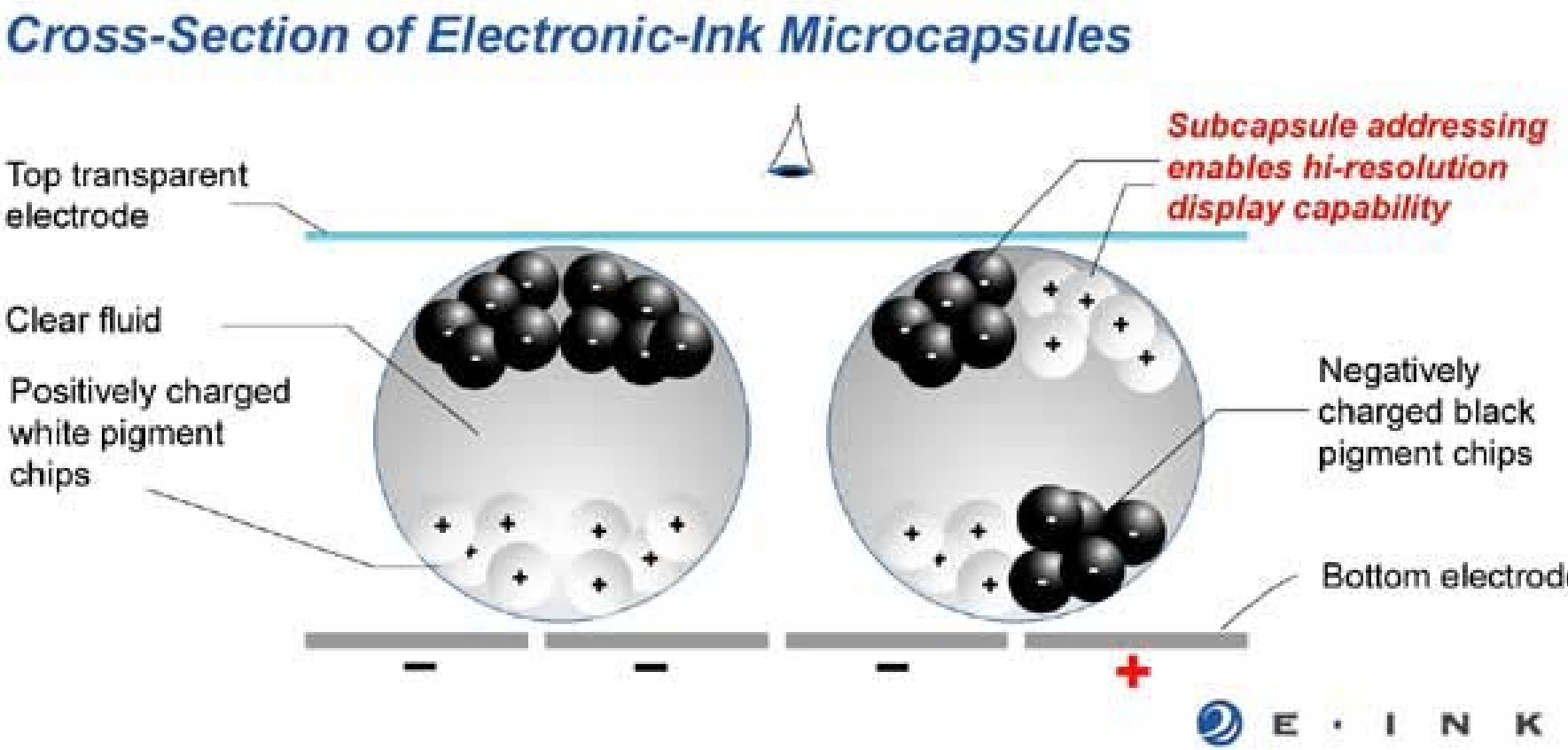
retinal displays

clip-on

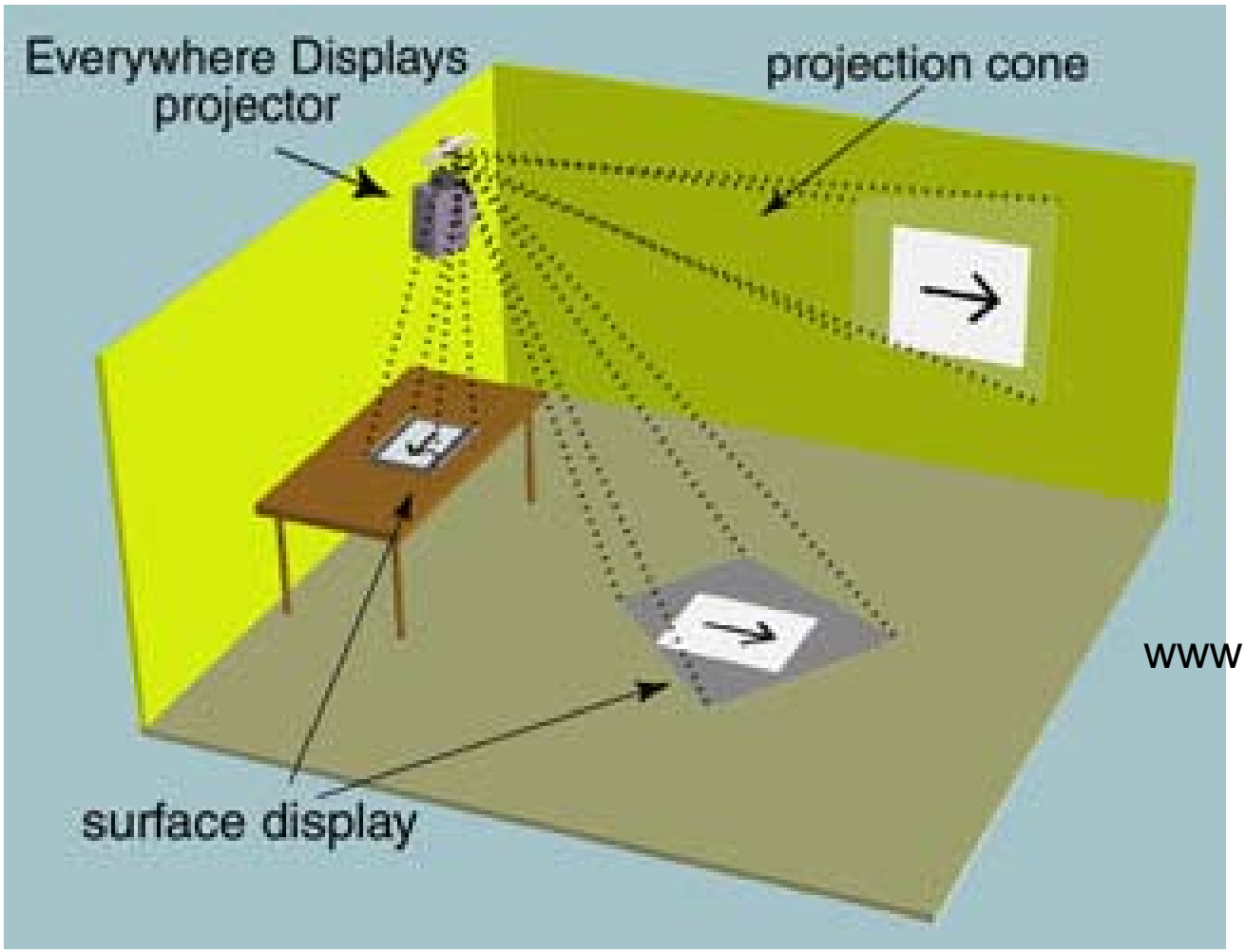
Retinal displays



Electronic-ink



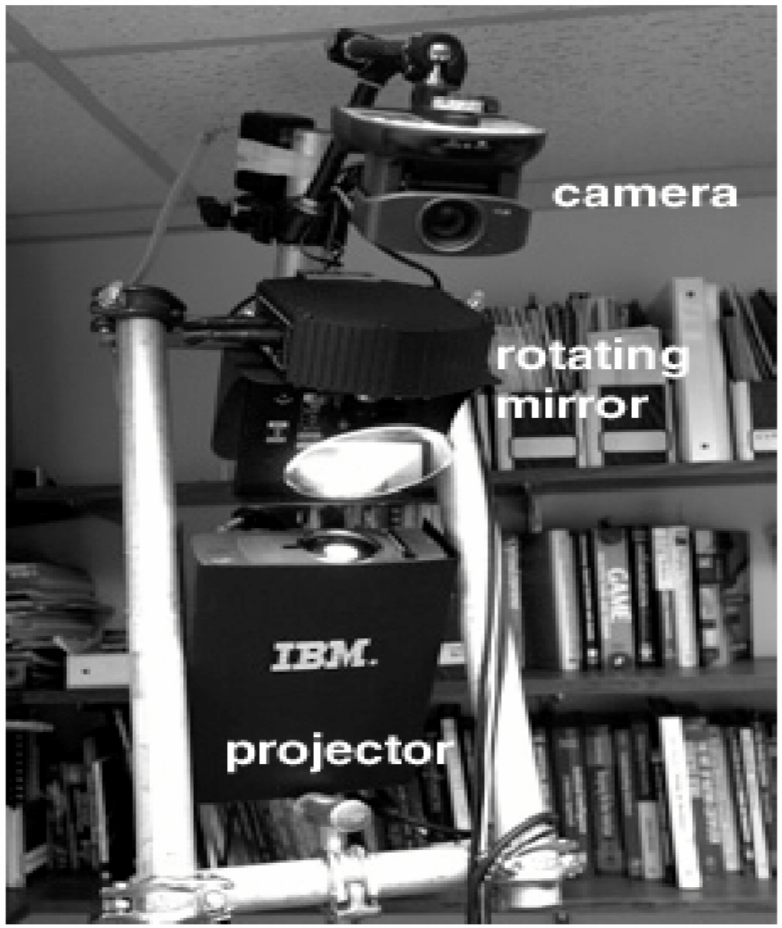
The Everywhere Display

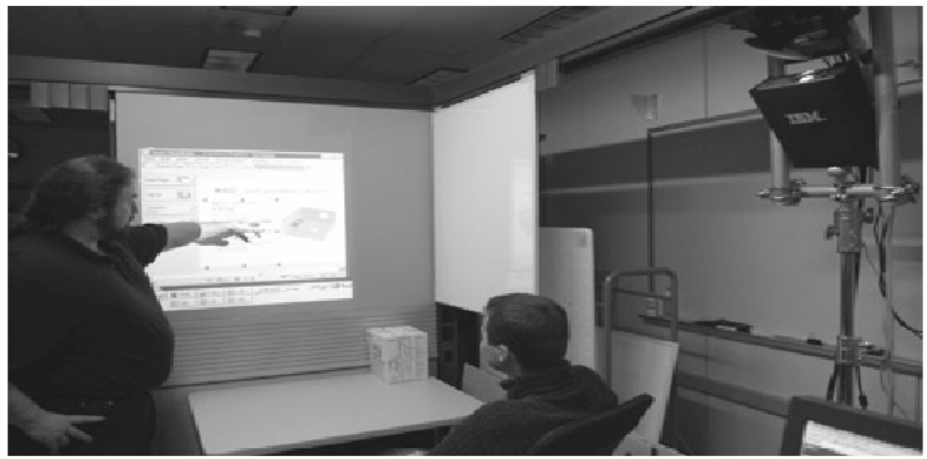


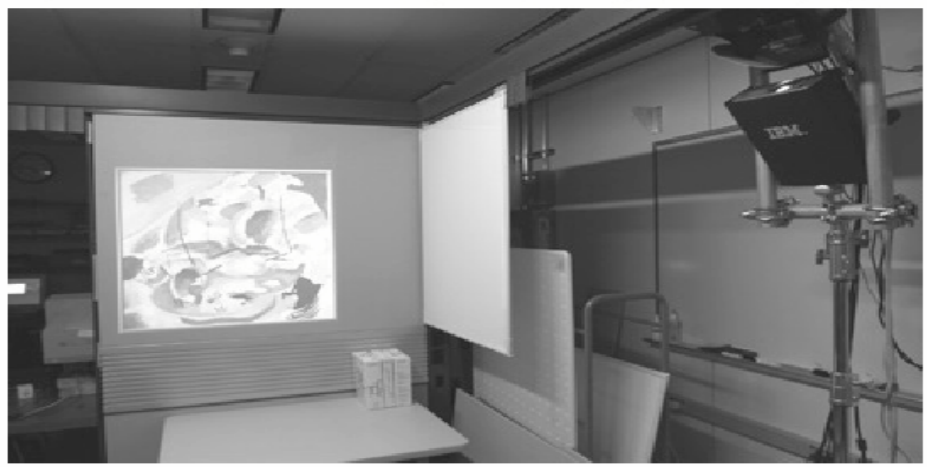
Claudio Pinhanez

www.research.ibm.com/ed/

Everywhere display (cont.)



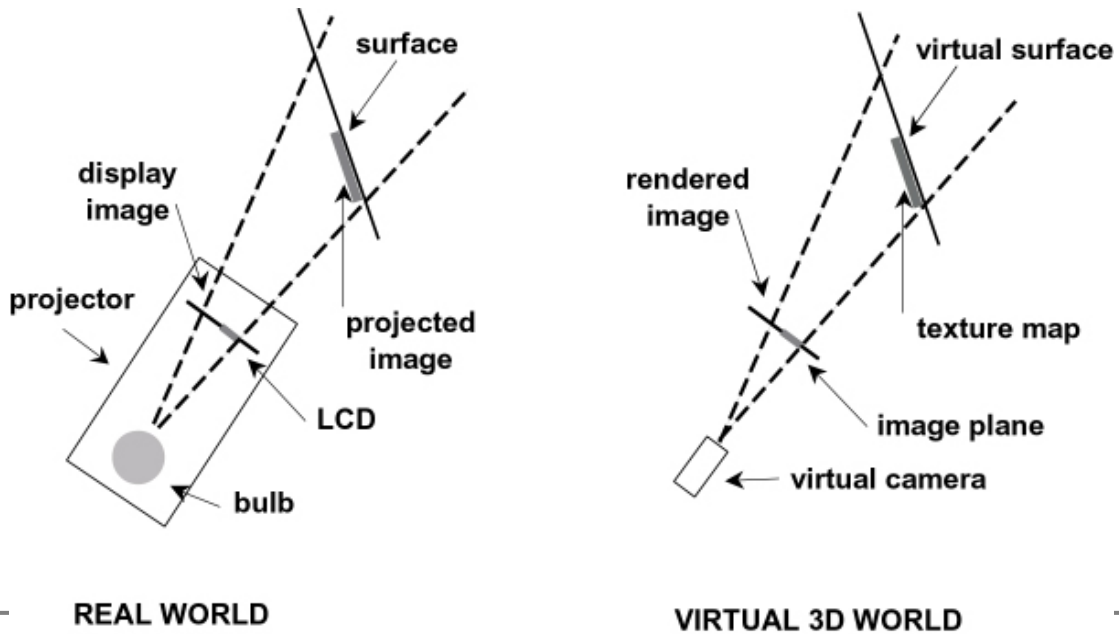




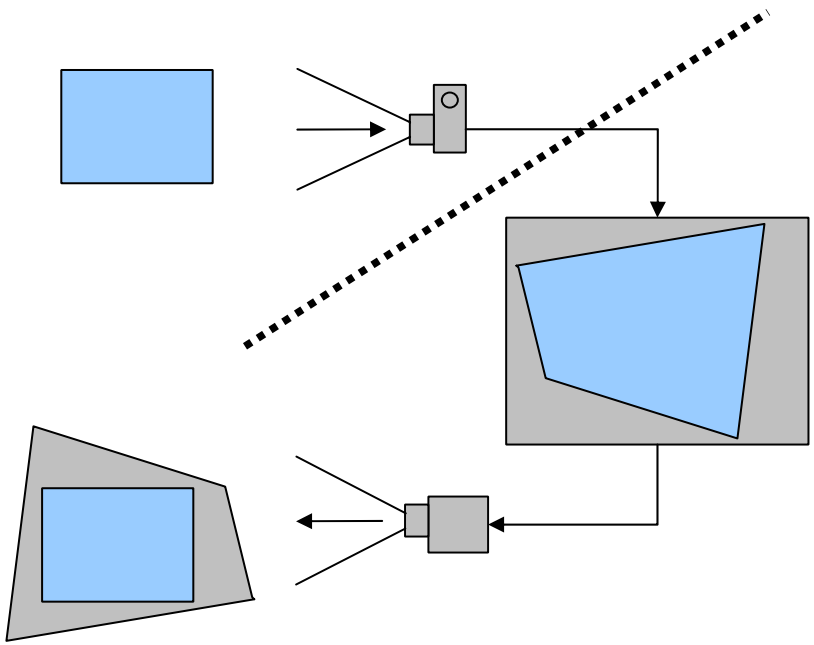
Components: a projector, a camera and a rotating mirror

Everywhere display (cont.)

- Correct distortions
  - Use the fact that camera and projectors are geometrically the same (optically inverse)
- Use standard HW components
  - 3D-Graphics board and VRML-world



Undistorting the projected image



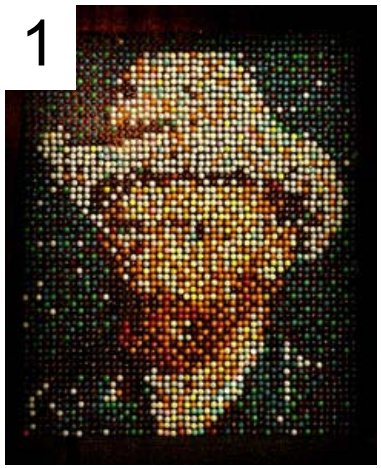
- Place original image in the 3D model
- Camera image shows it distorted
- Project the distorterd image from 3D model with the real projector

– Distortions cancel each other out IF virtual camera and physical projector are in the same location

Everywhere display (cont.)

Collaborative experience at SIGGRAPH 2001

1



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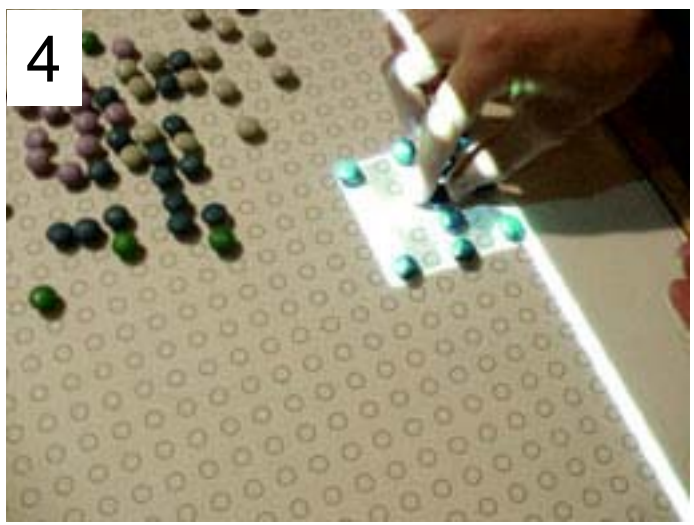

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Everywhere display (cont.)

BLUESPACE office scenario

Roomware

Streitz et al., FhG

Connectable Displays

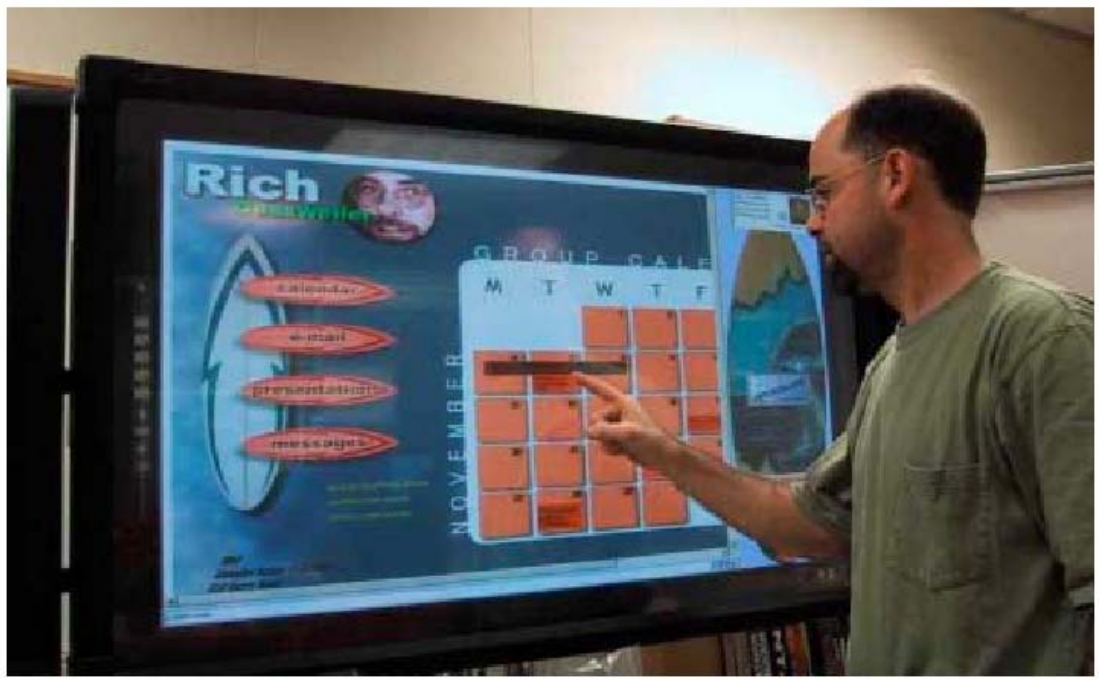
Streitz et al., FhG

Single usage

Connected usage

BlueBoard, IBM

- Large Display (XGA), touchscreen, badge-reader
- Provides fast and easy access to personalized information

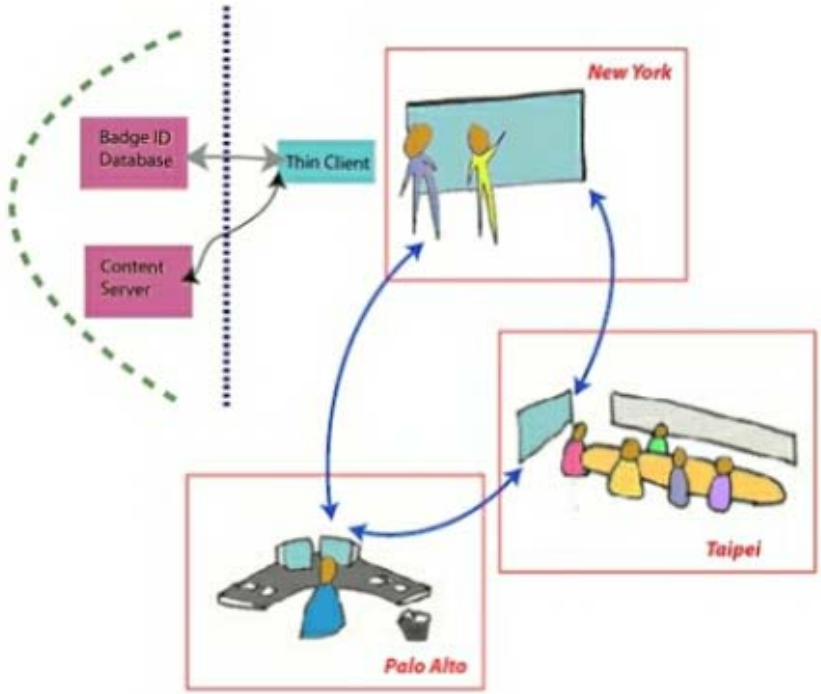


BlueBoard (cont.)

- For individual and group use
- Individuals: look up their calenders, mail
- Groups: transfer data, synch calenders

BlueBoard (cont.)

Working principle



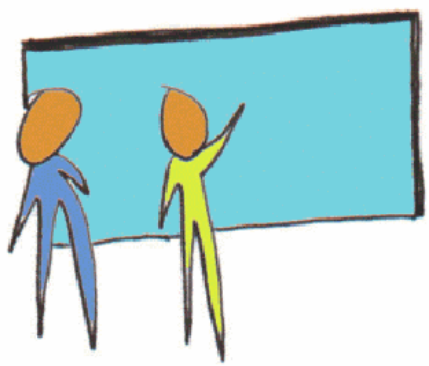
Badge ID Database
(ID #s, authentication, images, home page URLs, etc)

Content Database
(personal content)

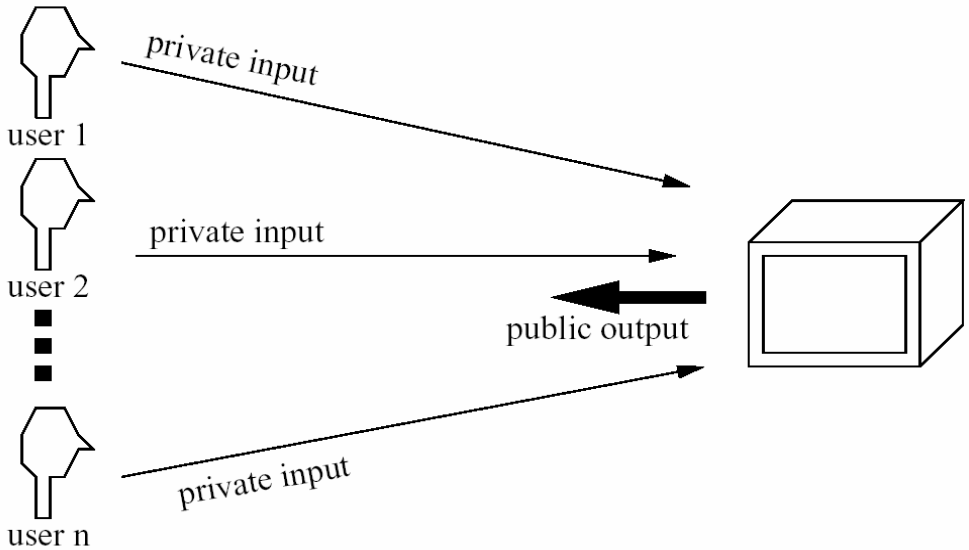
BlueBoard Local Client

display

sensors
(badge reader, camera, microphone, location sensor...)



Single Display Privacyware

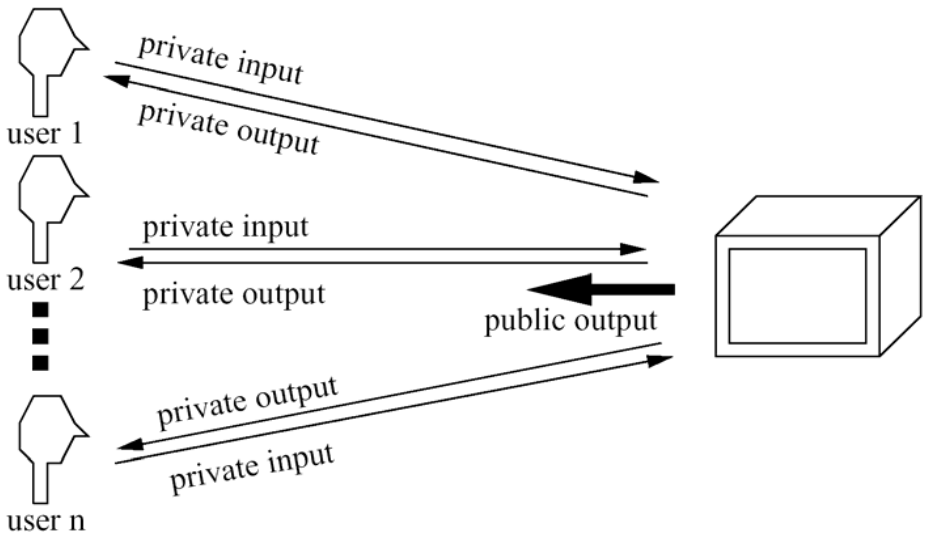


Shoemaker et al.
Simon Fraser U.
Canada, 2001

Problem: multiple users want to access private information from a public screen. Conventional solution:

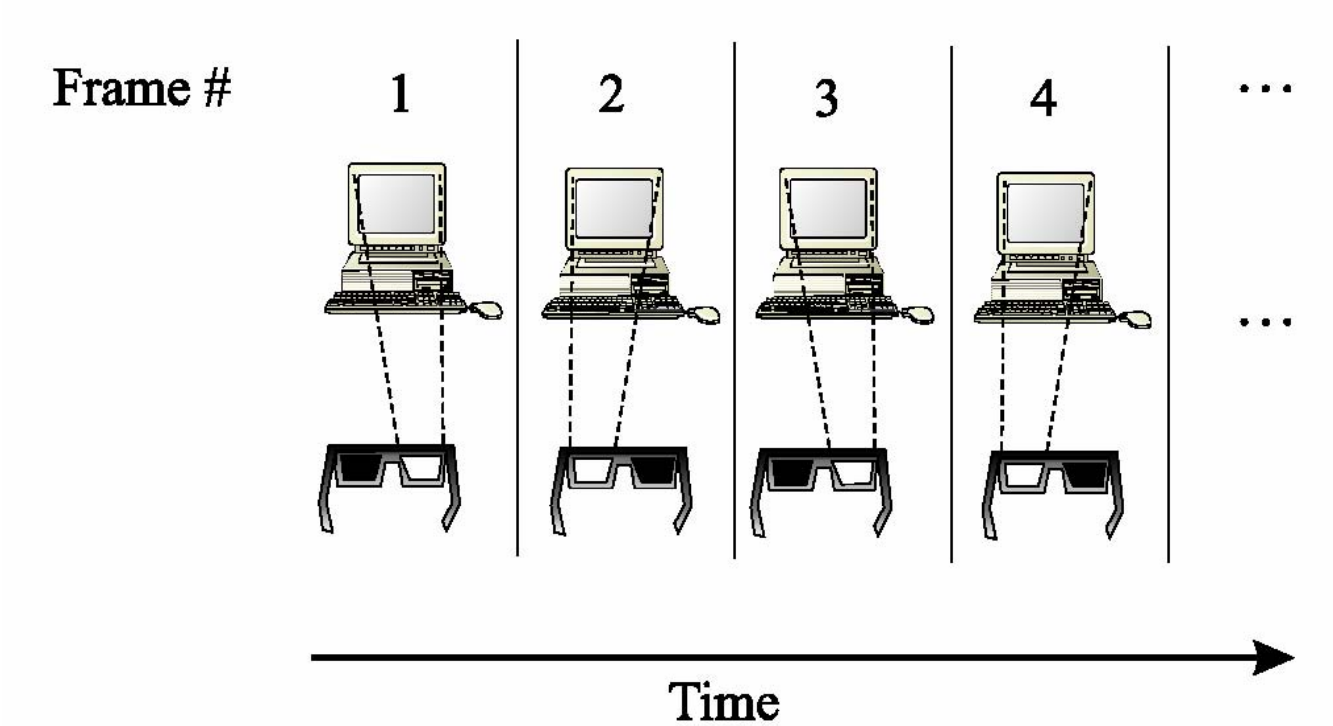
- Individual input, public output on a large display
- Individual input, private output on a small display (PDA)

Single Display Privacyware (cont.)

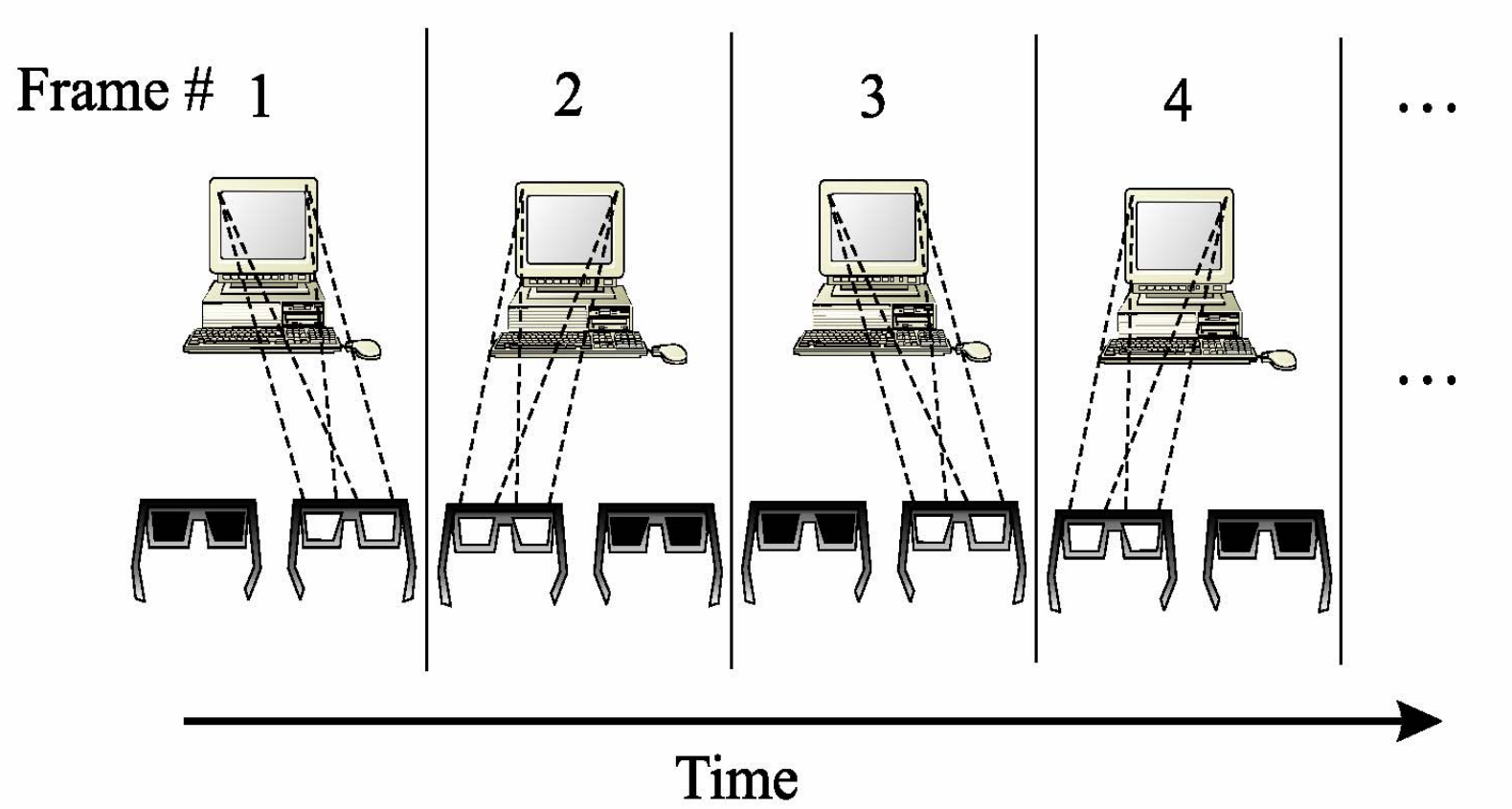


SDP: individual input and output on one screen

Single Display Privacyware (cont.)



Technical Solution: use shutter glasses



Apply this technology to multiple users (here: two users)
Positive: User studies report positive feedback
Negative: Approach does not scale very well ;-)

Calm Displays using change blindness

- Update lots of information in the environment without attracting attention of the user
- If the view is disturbed large changes can occur to scenes
- Psychological effect ***change blindness***
  - How is our rich visual experience achieved?
  - Internal vs. external visual memory

Change Blindness (cont.)

Worst case ubicomp scenario

Change blindness (cont.)

Example 1

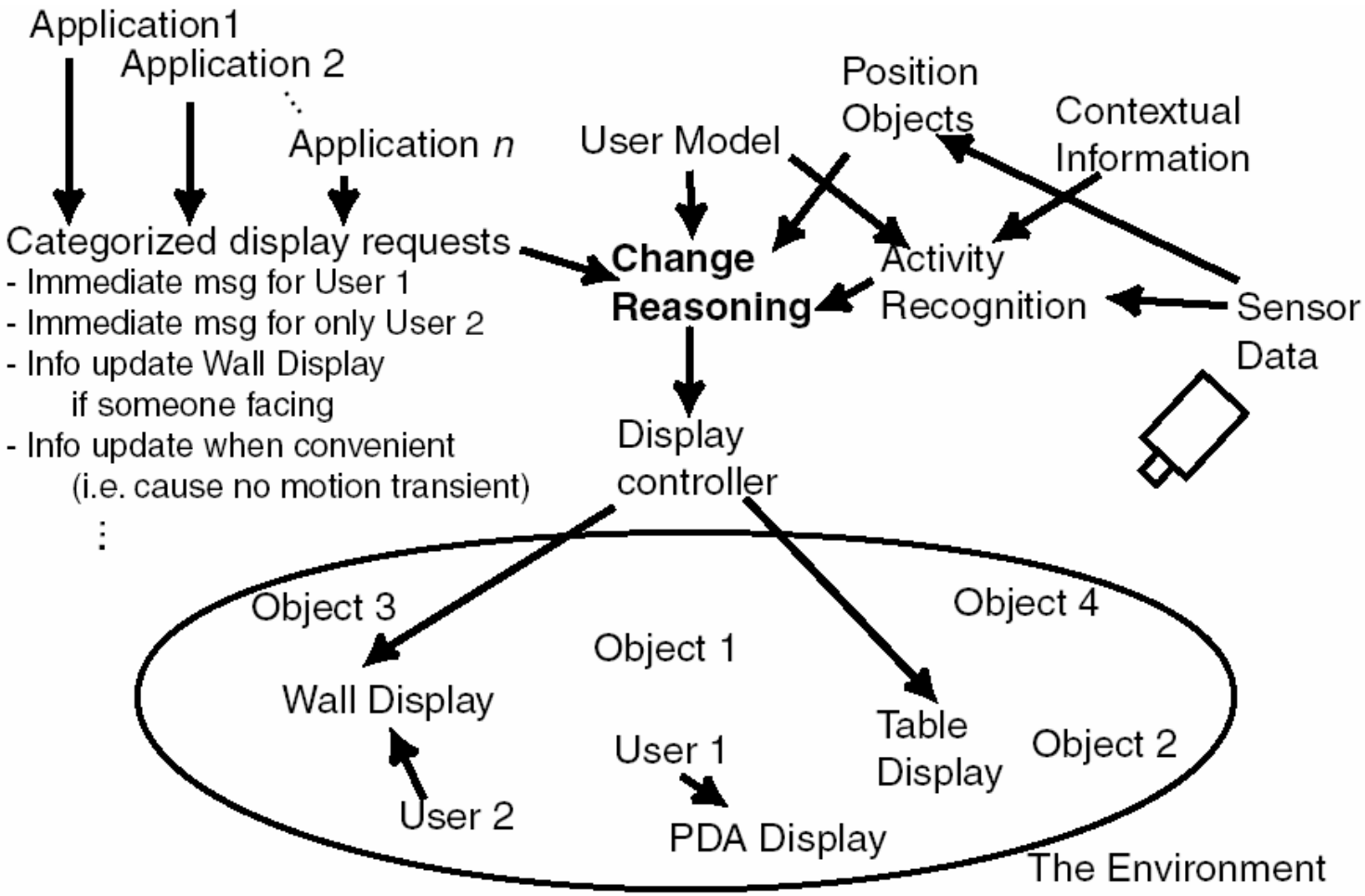
Change blindness (cont.)

Example 2

Change Blindness Information Displays

- System from MIT
- Creating Calm by minimizing perceived changes
- Change information when
  - Objects are occluded
  - Objects are out of view
  - Eye saccades occur

Change Blindness Information reasoning system



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