# Instrumented Environments

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Fri, 12:15-13:45, Theresienstr. 39, Room E 045

# Topics today

- **Interaction in IE: more examples**
  - Classics in detail: ParcTab & Active Badges
  - Some Projects from Saarbrücken
    - Resource adaptive systems
    - Multimodal output
    - Multimodal input
  - Some of Jun Rekimoto's projects
  - Some projects at MSR

# Special Lecture on 07.07.



- Visit by Bill Buxton, Abigail Sellen and Shahram Izadi (Microsoft Research Cambridge)
- All working on interaction with Instrumented Environments
- Expect a Guru-level presentation!
  - Detailed topics yet TBD
- Bring friends!
- Fri, 7.7.06, 12-14:00h, as usual
- Theresienstr. Room 112
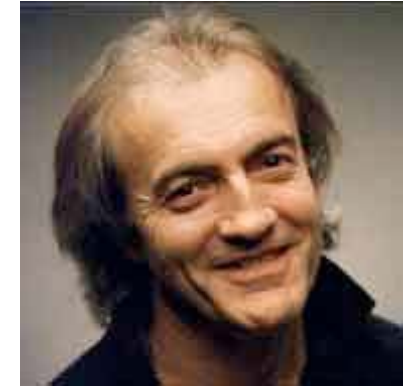
# Example project: Active Badges

## 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
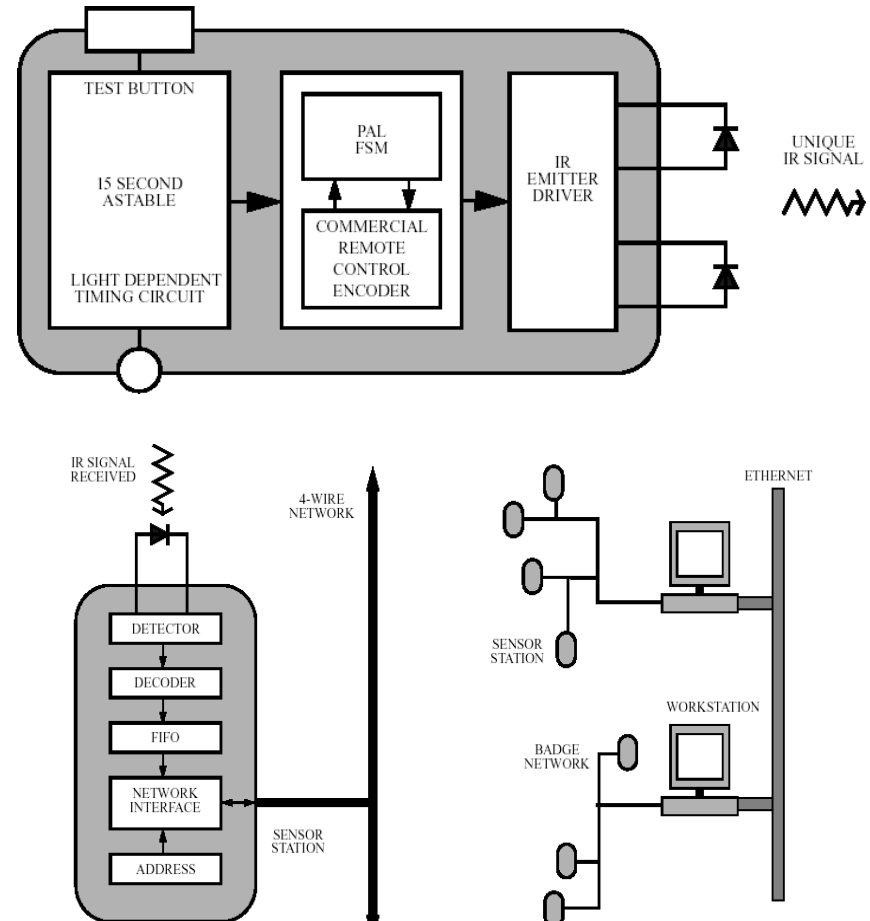


"A disadvantage of an infrequent signal from the badge is that the location of a badge is only known, at best, to a 15-second time window. However, because in general a person tends to move relatively slowly in an office building, the information the Active Badge system provides is very accurate." ;-))

# 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

http://sandbox.parc.xerox.com/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
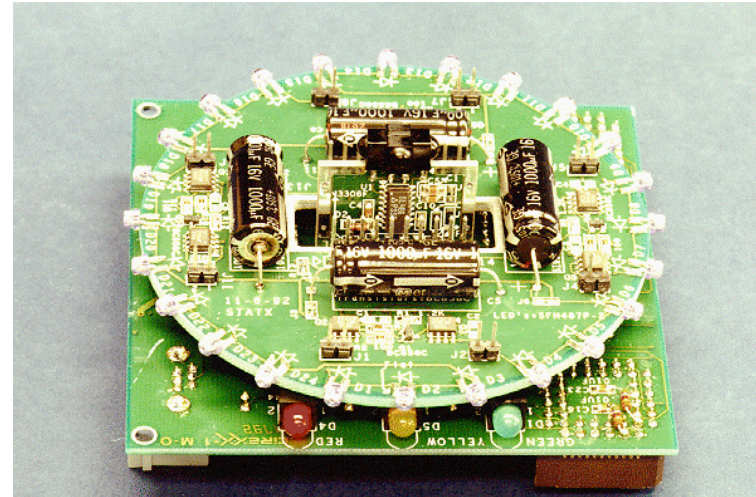
# Information Access



- Weather (Internet/local)

- Dictionary, Thesaurus

- UNIX file browser

- WWW browser (with limitations ;-)

- Calendar manager (Sun's cm)

- Dateimanager (location dependent)

# 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

# General Techniques in Context-Aware Computing [(Schilit et al. 1994)](#)

- Proximate selection
  - E.g., list closest devices first
- Automatic contextual reconfiguration
  - E.g., automatically select nearby devices for output
- Contextual information & commands
  - Commands with different meanings in different contexts
- Context-triggered actions
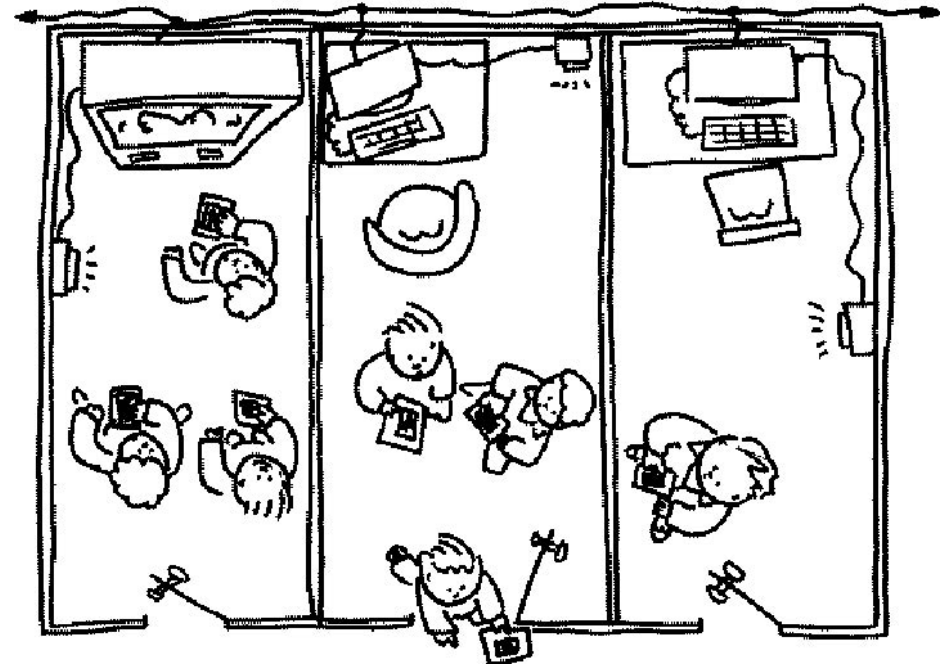
# Context-triggered actions

- Simple If-Then Rules, similar to Unix CRON-Demon:
    - Coffee　　　Kitchen　arriving　„play -v 50 /sounds/rooster.au
    - schilit　　　*　　　　attention „emacs -display $NEARESTHOST:0.0"

- Contextual reminders: information is displayed under certain conditions. Example:

    > $DATE=„after April 15"
    > AND $TIME=„after 10"
    > AND $room=„35-2-200"
    > AND $WITH-USER=Adams"
    > AND Color($DISPLAY)=„true"

# Multimodal interaction

## Some examples from projects at the university of Saarbrücken

# REAL (Saarland University, 1998-2004)
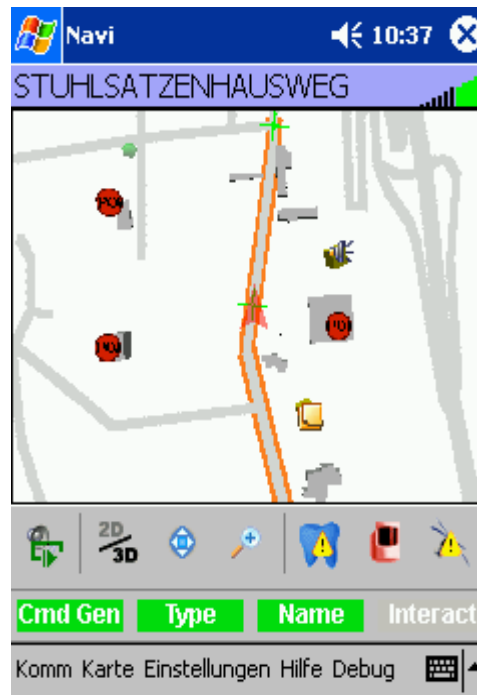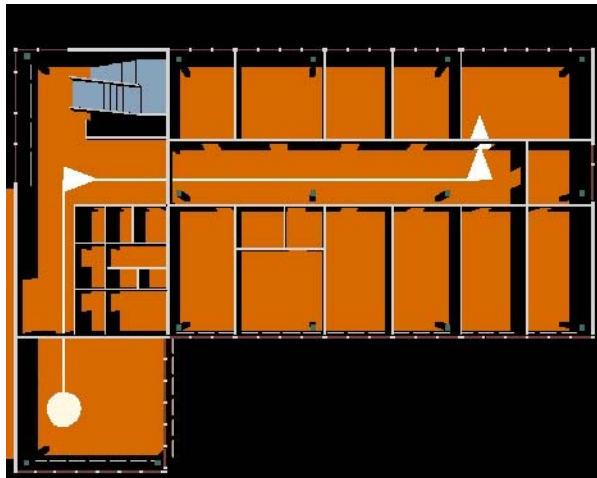
# Research Problems

- Given an instrumented environment and a user's navigation task

  - How to adapt route descriptions to

    - the technical resources of the environment?

    - the cognitive resources of the user?

  - How to adapt presentations to

    - technical resources of the environment?

    - user preferences and interests?

# Limited Resources

- Technical resources (of the environment)
  - Available media: e.g. displays, loudspeakers
  - Media attributes: screen size & resolution, colors
  - Quality of positional data: user's location (e.g. indoor/outdoor), orientation and speed
  - Available CPU-power and memory
  - Communication bandwidth

# Limited Resources (2)

- Cognitive Resources (of the user)
  - Cognitive load:
    - Use of working memory
    - Time pressure
  - Familiarity with the environment
  - Personal preferences:
    - Media, content and presentation styles
  - Limited vision, hearing, motor skills, etc.
  - Communication abilities: limited use of modalities, e.g. use of gesture and speech

# Approaches

technical resources X cognitive resources X user's task

?
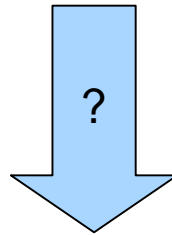
Reaction of the intelligent environment
- Content presentation
- Interaction possibilities

A1: Design an architecture that supports resource adaptivity at several levels.
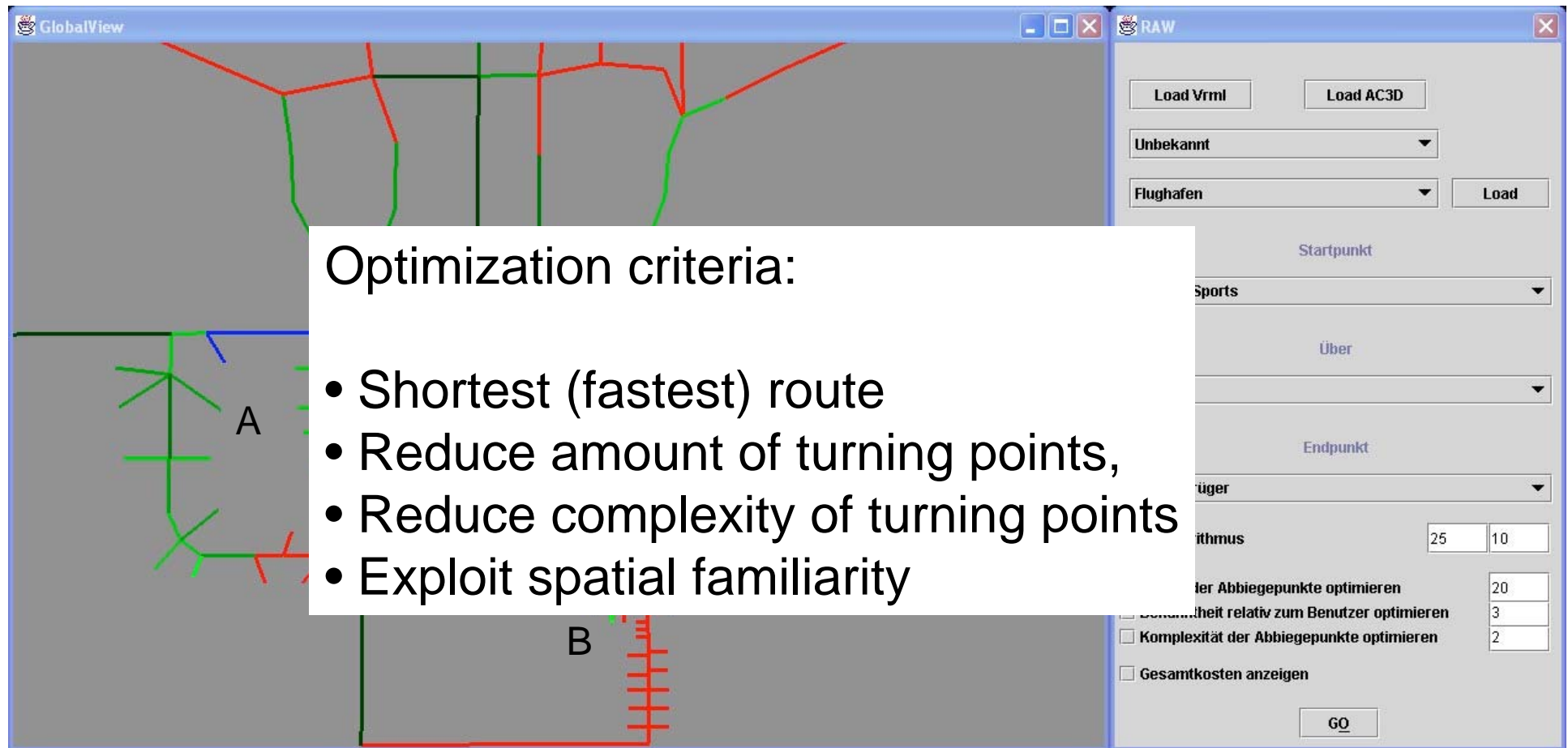
A2: Use a declarative approach to specify system behavior under limited resources, represent what has to be presented!

# Adaptive graphical route descriptions
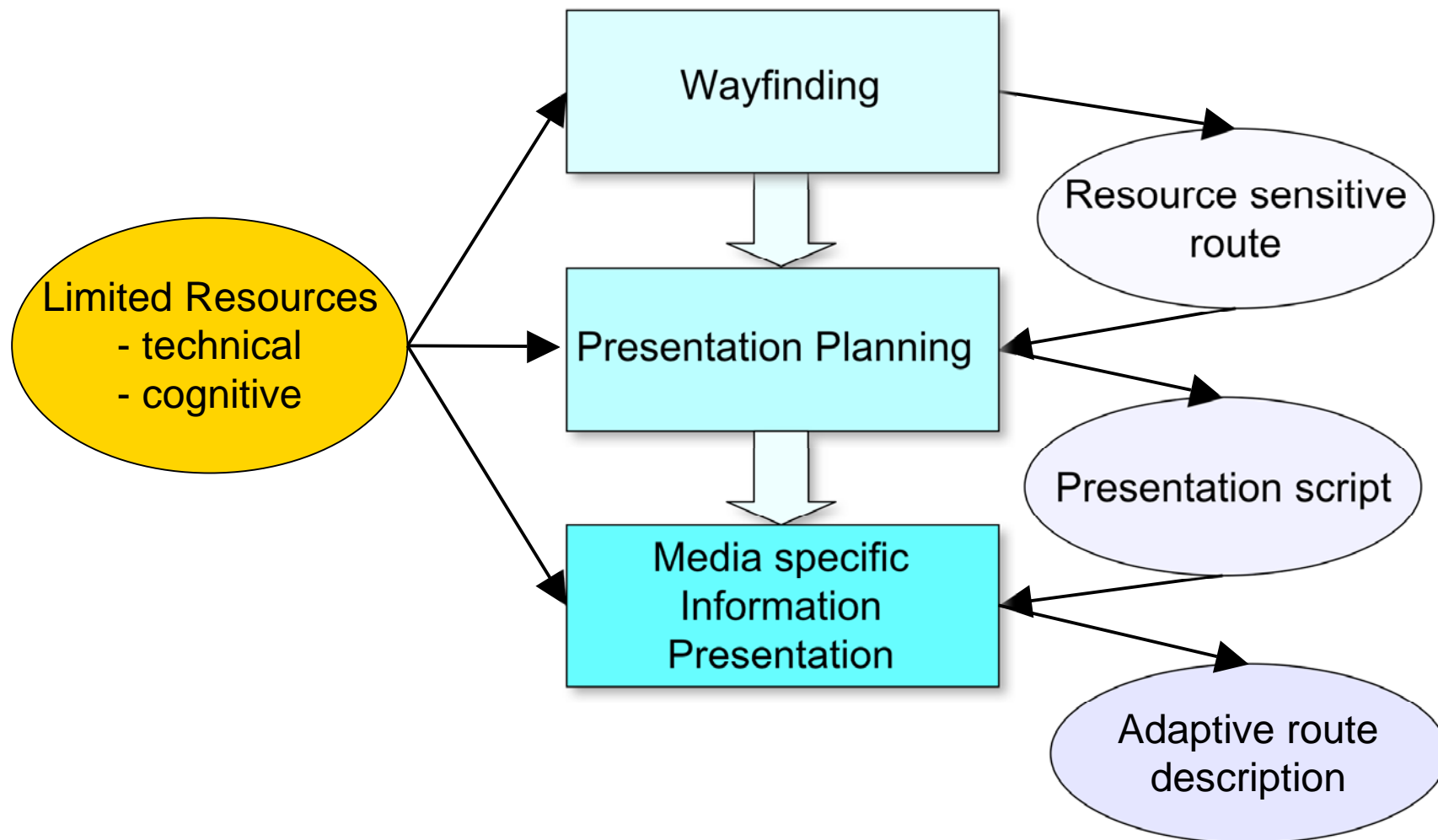
# Resource-adaptive route finding

Optimization criteria:

- Shortest (fastest) route
- Reduce amount of turning points,
- Reduce complexity of turning points
- Exploit spatial familiarity

# Hierarchical Planning Formalism
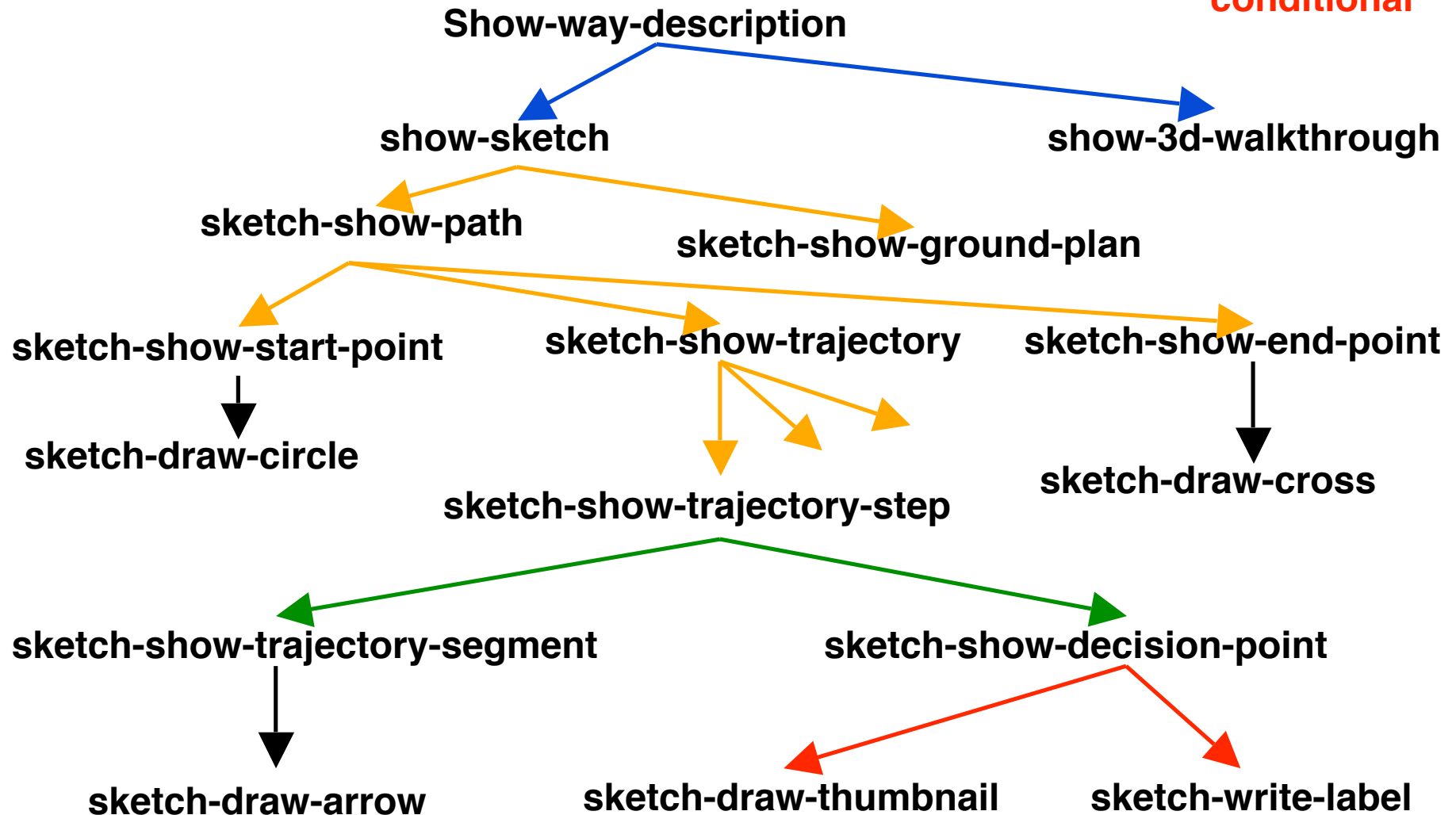
# Output for different devices + contexts



**Information Booth**

**Presentation Server**

Mobile Indoor

**Mobile in/outdoor**
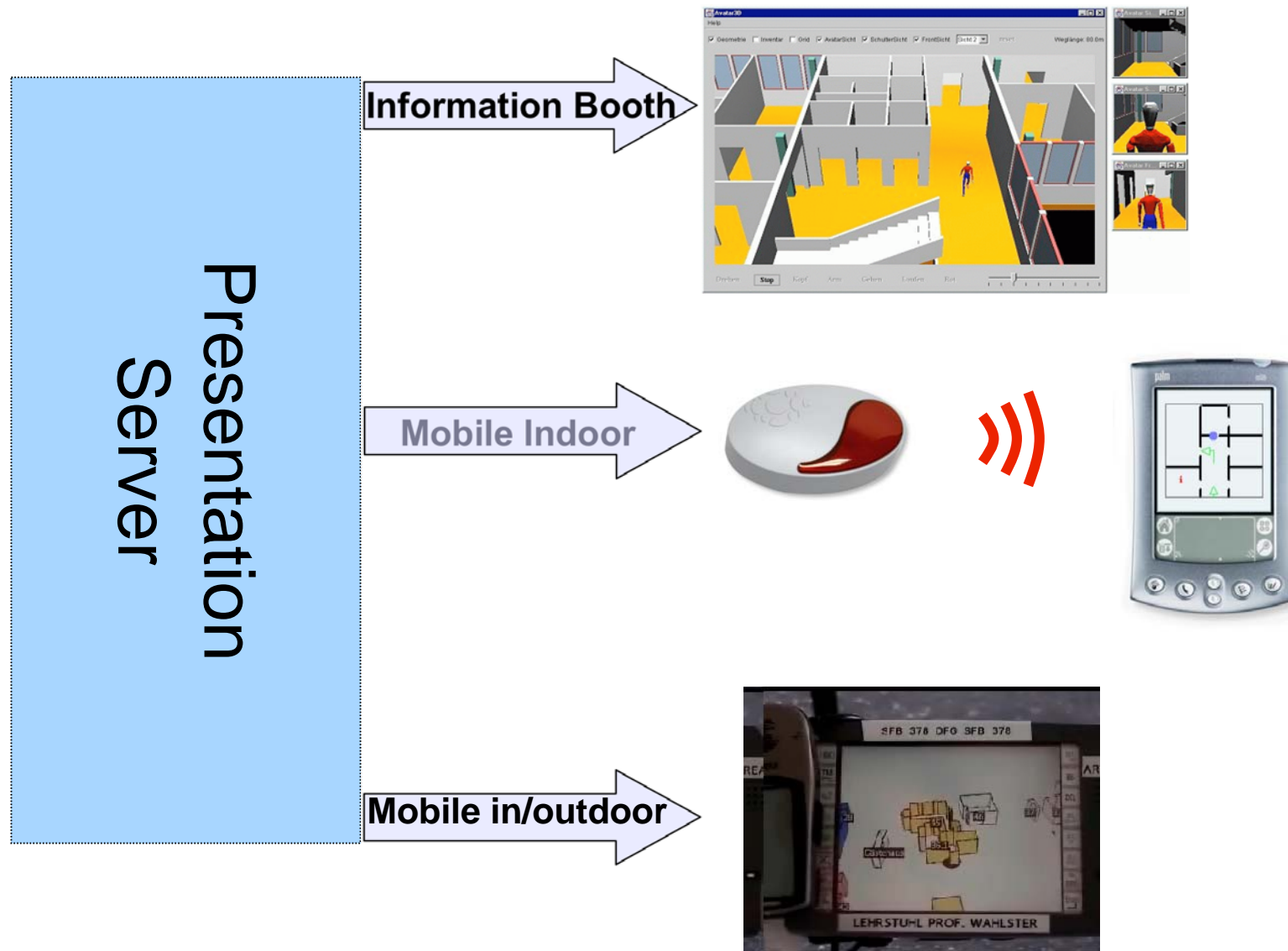
# Using Information Kiosk and PDA



Requesting a route description at the Information kiosk without time pressure



Requesting route descriptions on the fly. A Special transmission protocol adapts the level of detail to the user's speed

# Adaptation: Information Kiosk
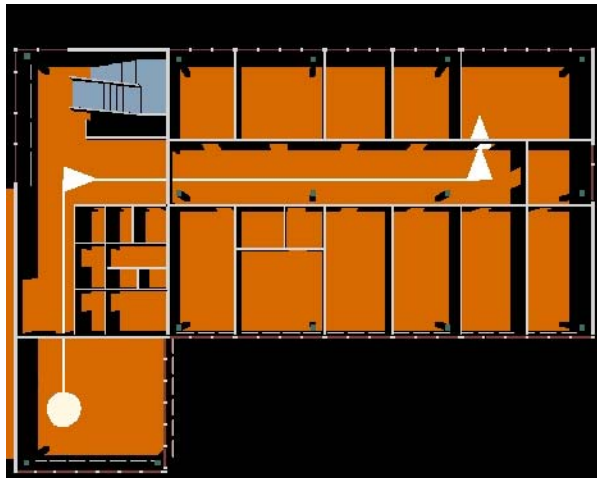
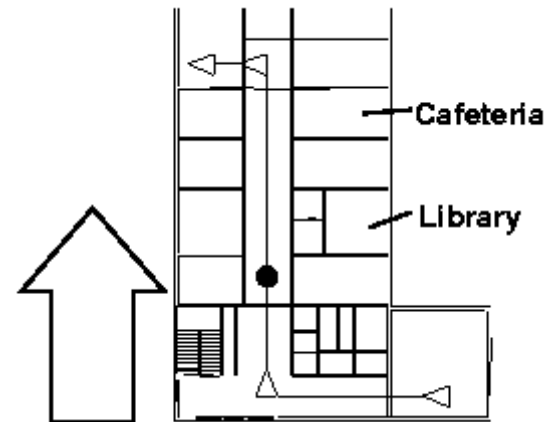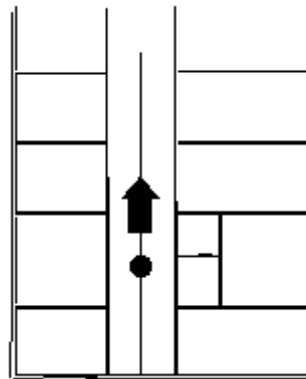**static map**    **animated map**    **walkthrough**
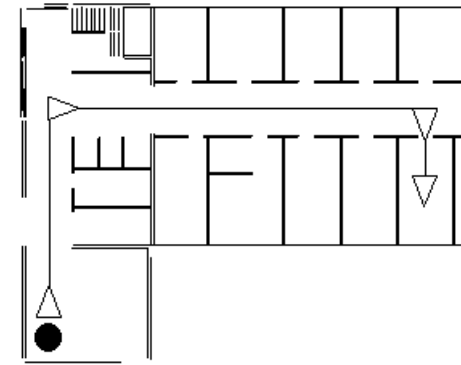


**Presentation time  (low to high)**

# Adaptation example PDA (1)
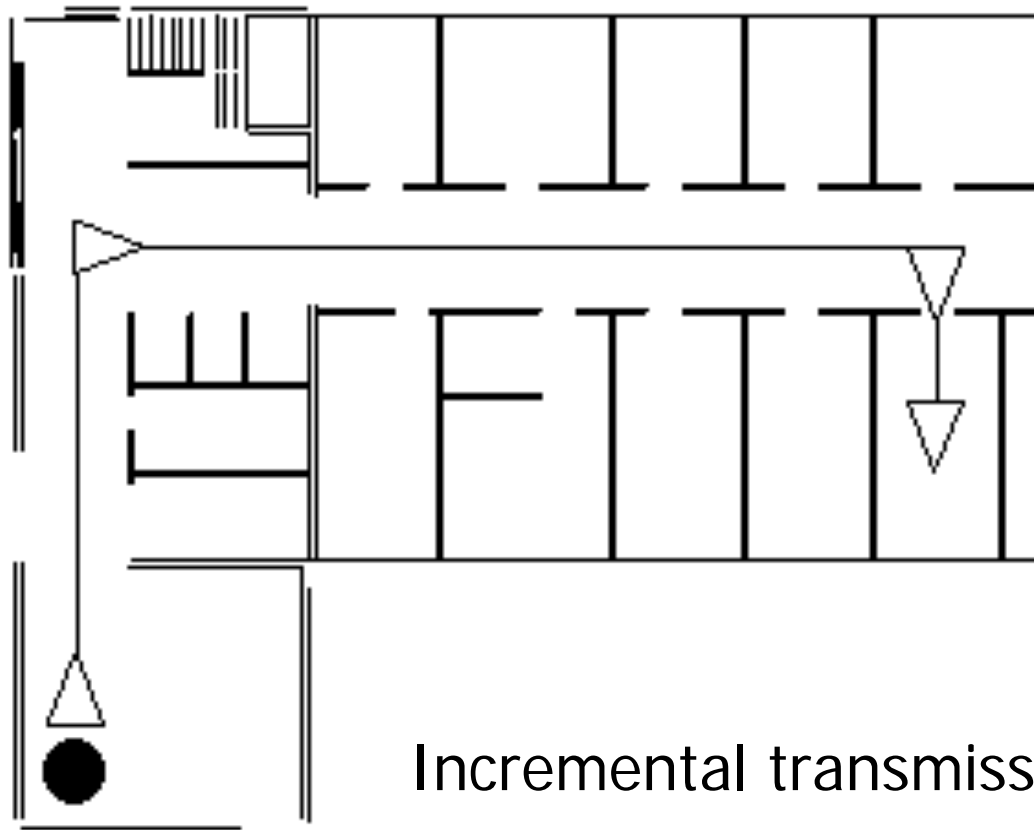
**Cognitive load (high to low)**

# Adaptation example PDA (2)



**Quality of positional information (high to low)**

# Coping with Limited Bandwidth

Incremental transmission of vector graphics
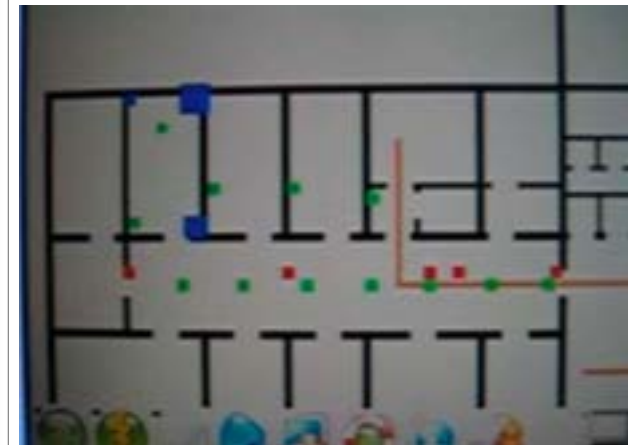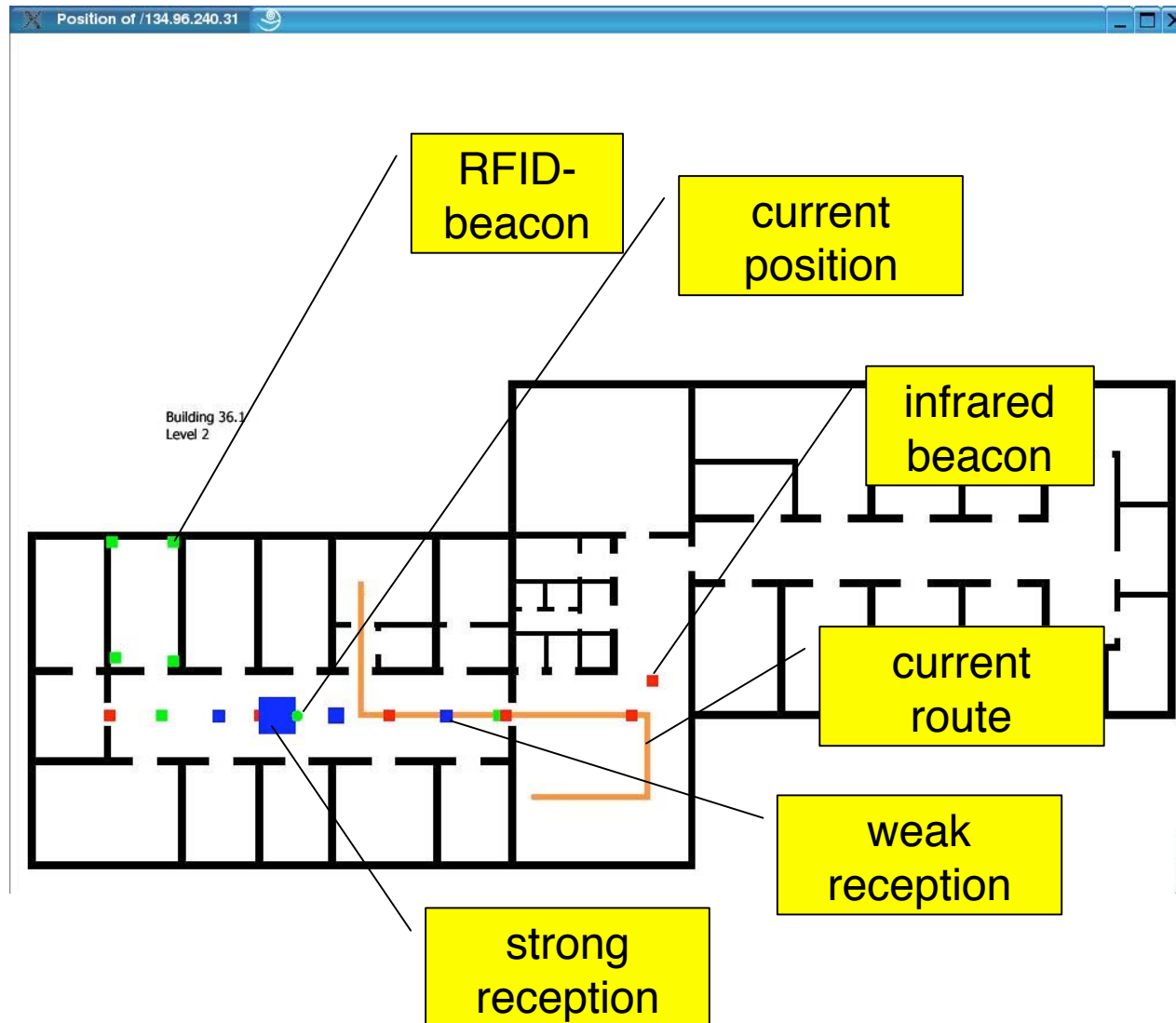
# Indoor-Outdoor Navigation



System adapts 3D-graphics to user's position and speed and uses different  positioning technologies (GPS, infrared).
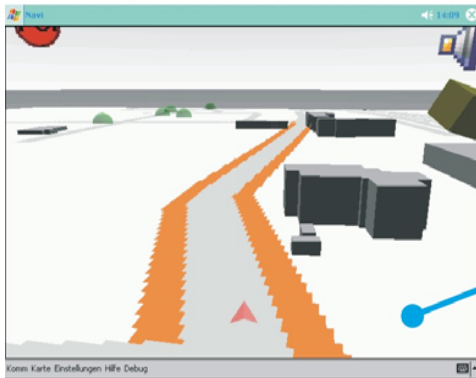
# Extensions of REAL → M3I

- Put all the functionality on a PDA

- Introduce speech and multimodal interaction

- Adapt to computational constraints by using resources of the environment
  - Speech processing on server
  - Use Displays/microphones in the environment

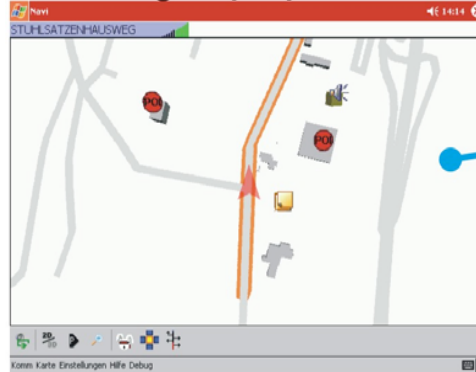# Hybrid positioning within a building



RFID-beacon

current position

infrared beacon

current route

weak reception

strong reception

Position of /134.96.240.31

Building 36.1
Level 2

# Another physical variation:
# The Bum Bag Navigator

**MicroOptical Display**
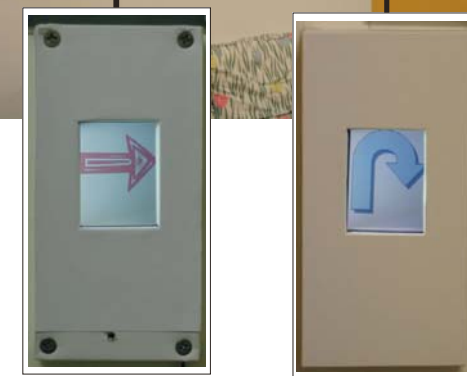


**Bum Bag Display**

# Using other displays in the environment



mobile client

steerable projector

intelligent door signs

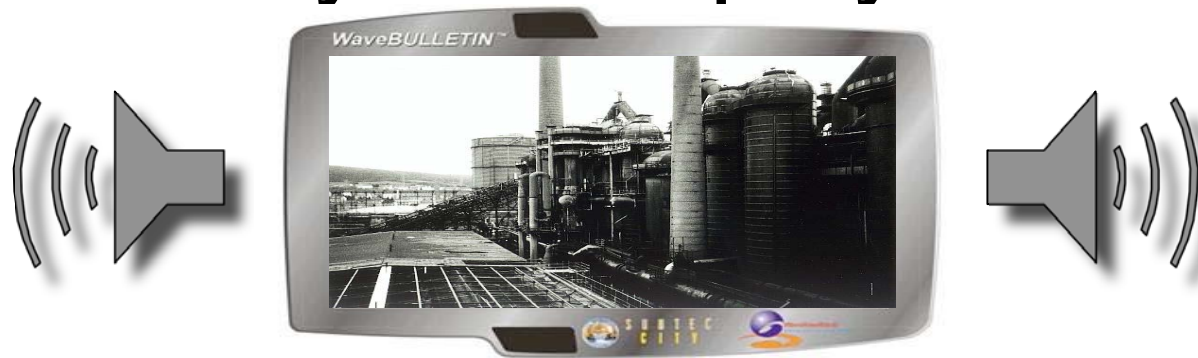# Implicit interaction and fusion across multiple modalities

# PEACH (DFKI + ITC IRST 2002-2005)

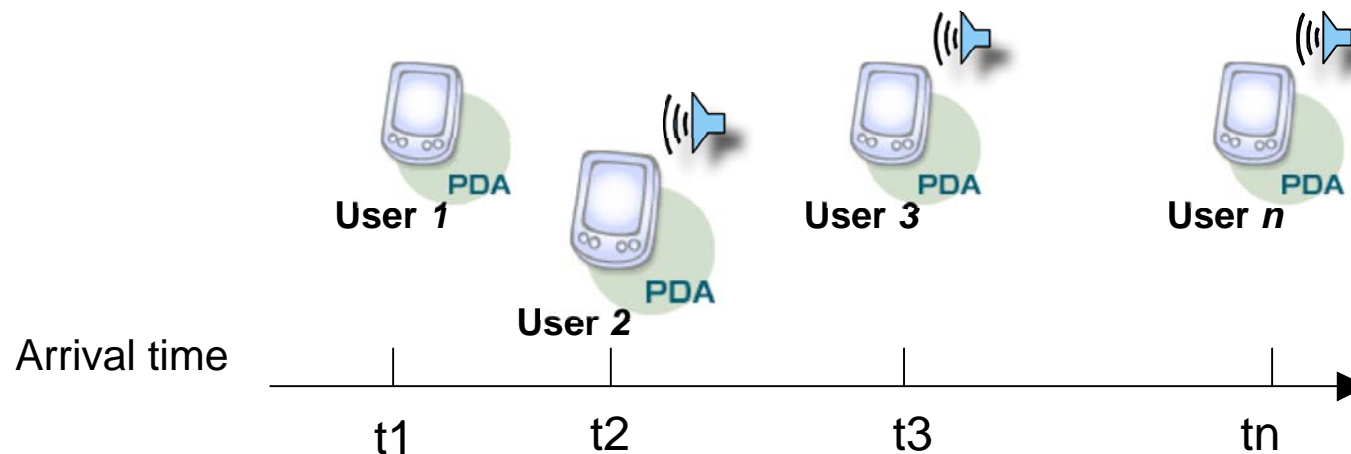## Slides courtesy of Antonio Krüger, Michael Kruppa

# http://w5.cs.uni-sb.de/~mkruppa/pdemo.html

# Presenting information to multiple users with hybrid displays



Technical or social content tailored to groups or individuals



User 1    User 2    User 3    User n

Arrival time

t1    t2    t3    tn

Idea:use private channels to annotate and augment public presentations

# Putting the cocktail-party-effect to use
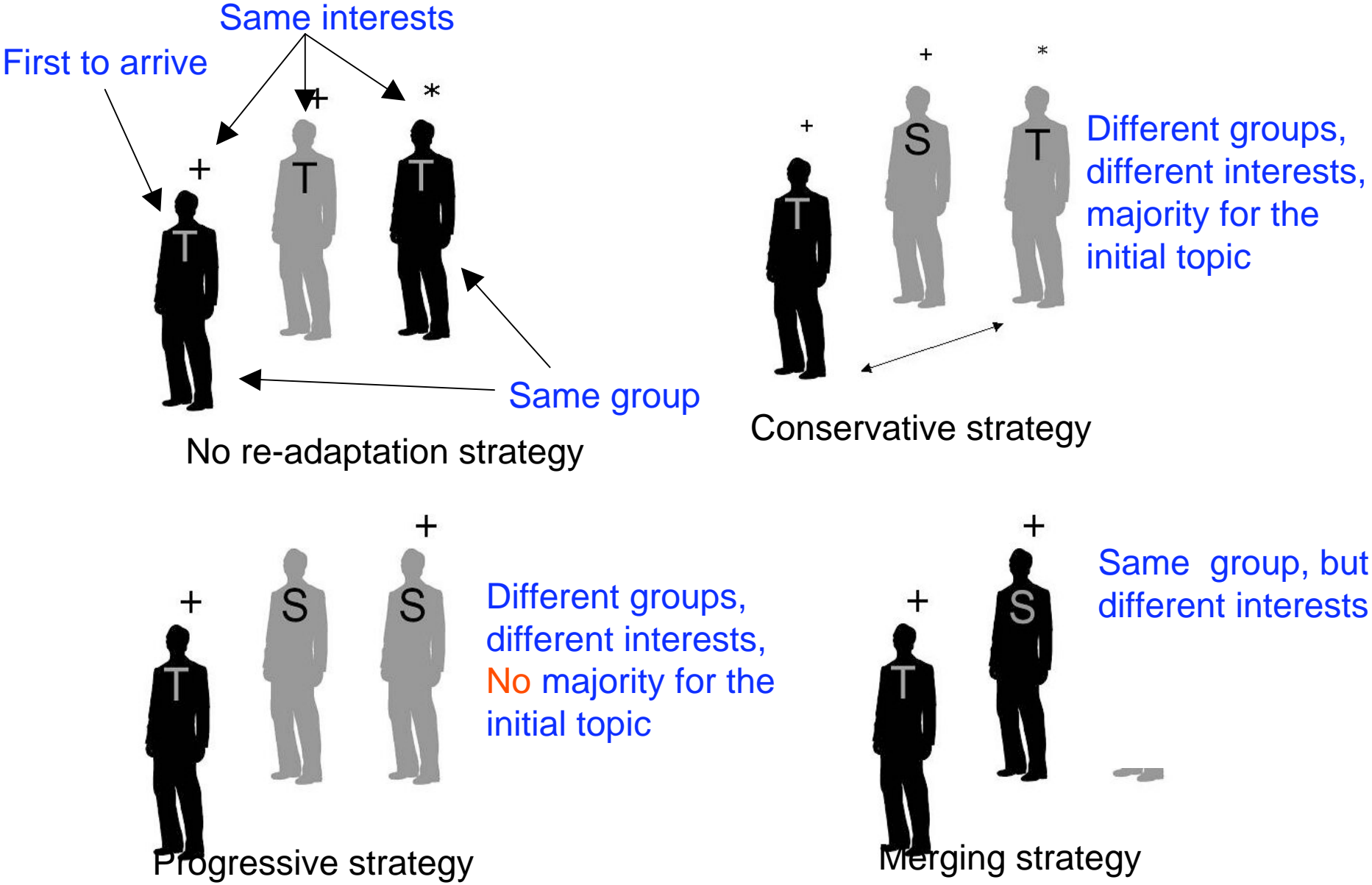
### A small user study (following B. Arons, 1992)

Setup:
- Public channel: loudspeakers
- private audio channel: one ear headphone
- messages were recorded in mp3 format and played by a desktop computer.
  - public channel: male voice
  - private channel: female voice

| Public | Public | Public |
|--------|--------|--------|
|        | Private |       |
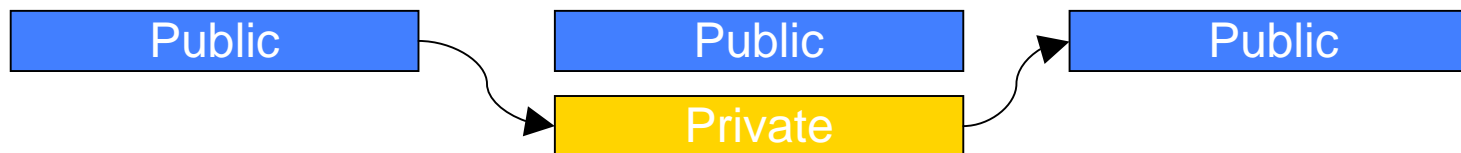
Result: The private channel is well perceived, if:
- it flows well from and back to a public thematic block
- use clearly distinguishable voices for different channels

# Re-adaptation strategies for public presentations

Same interests

First to arrive

+

*

+

T

T

Same group

No re-adaptation strategy

+

*

+

S

T

T

Different groups, different interests, majority for the initial topic

Conservative strategy

+

+

S

S

T

Different groups, different interests, No majority for the initial topic

Progressive strategy

+

+

S

T

Same group, but different interests

Merging strategy

| Private Audio | Public Audio | Private/Public Video |
|---|---|---|

t1

You're now standing at information board eighteen in the Voelklingen Old Iron Works blasting engine shed. This presentation will be about the gas driven blasting engines.
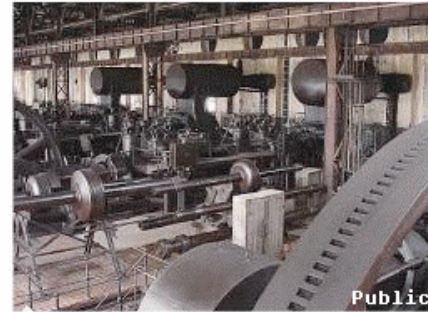
The idea of powering a machine with gas only came relatively late. The German engineers Otto and Langen constructed the first gas motor in eighteen seventy eight.


Public

t2

Meta Comment

Short Summary

The gas that drove the giant engines was very poisonous. It escaped into the air from leaky cylinders and gave the workers very severe headaches.

The workers did not have the opportunity in earlier times to escape from the noise and the dirt in their breaktime. They had to constantly supervise their machines.

Meta Comment

The engine is comprised of three parts. The heavy fly wheel is at the front, the actual motor is in the center, and the blast pistons are located behind this in the high casing.

The gas engine has to cope with a very heavy task at the start. It has to bring the giant fly wheel into motion. All the motor power is needed for this wheel with its diameter of nearly eight meters and weight of fourty five tons.

The blast cylinder is located in the rear part of the blasting engine. This creates the mighty air current needed much like an outsized airpump.


Public


Private


Public

t3

In eighteen ninety four the German mechanical engineering works built the first engine powered from blast furnace gas.

In the early days there were many problems with the gas powered engines, as with all technical innovations but the new drive was able to establish itself in the iron and steel industry. The gas engine replaced the steam engine as an energy supplier.
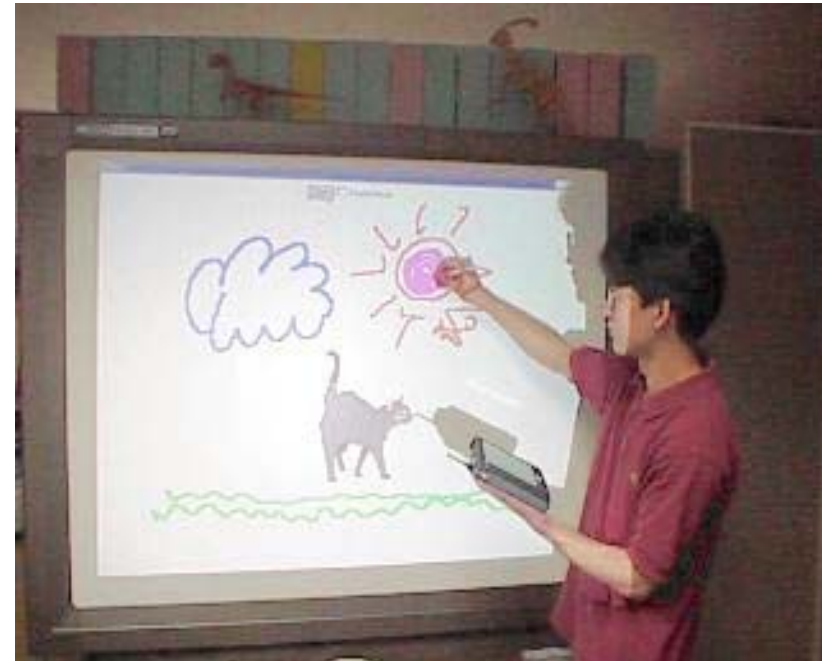

Public
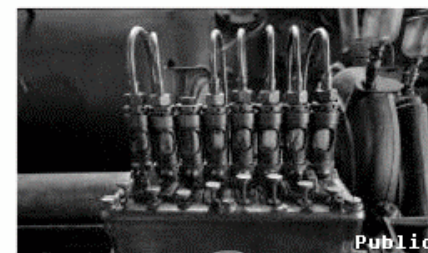
# Jun Rekimoto's projects at Sony CSL

# Pick-and-Drop

http://www.csl.sony.co.jp/person/rekimoto/pickdrop/



- Extension of Drag-and-drop across devices
- Solution: same pen recognized by both screens
  - Copy and paste data between devices
  - Use PDA as palette and paint on whiteboard

# Augmented Surfaces

- **Combination of mobile devices and projection surfaces**

- **Interaction techniques:**
  - hyperdragging
  - pick-and-drop
  - pick-and-beam
  - digital attachment
    - interaction objects for tangible interaction
    - Camera-based acquisition of images
    - Selection from physical catalogues
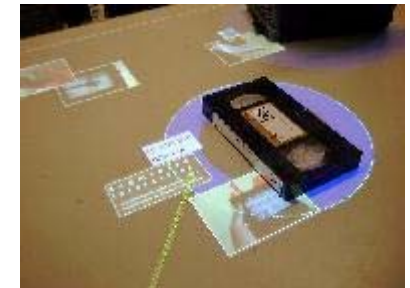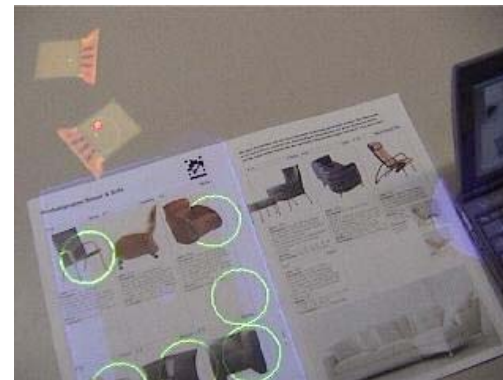
Video

# Proximal Interactions

Jun Rekimoto, Yuji Ayatsuka, INTERACT2003

- Problem: device pairing
- Solution: Exchange key over close distance channel (IR, RFID, …)
- Use key on regular network channel
  - to identify devices
  - to secure the connection

# SyncTap

Jun Rekimoto, Yuji Ayatsuka and Michimune Kohno, MOBILE HCI 2003





Synchronous user actions
(e.g., button press/release)

Network connection

- Problem: connecting 2 devices without fiddling with settings, menus, etc.
- Solution: synchronous button press/release
  - Very simple and intuitive two-handed action
  - Easy to do for one person
  - Can also be done over the phone
  - Technical problem (common time setting) can be solved
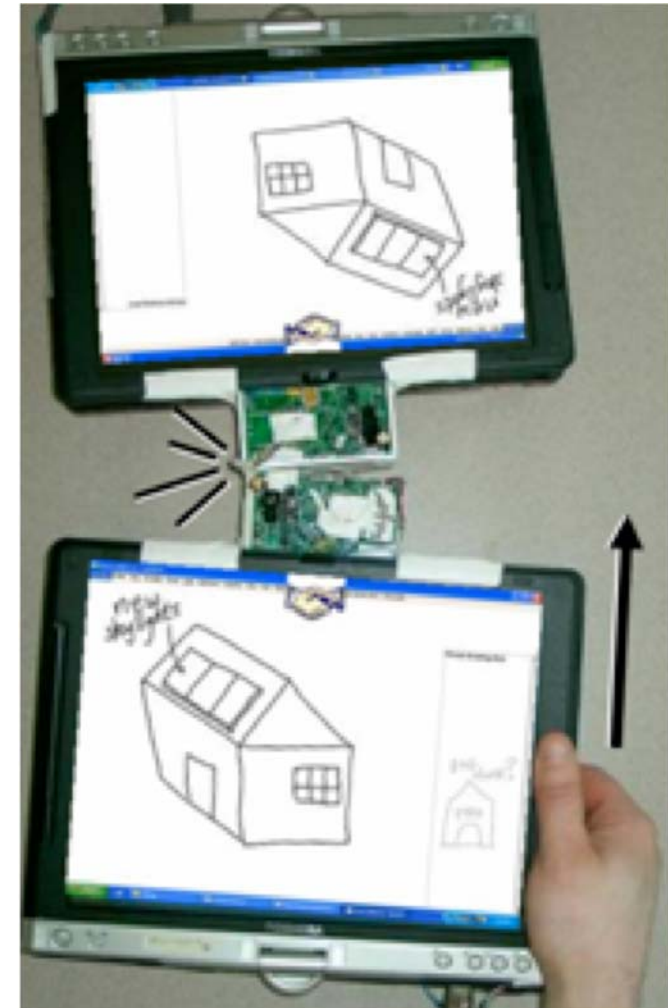
# Ken Hinckley's projects at Microsoft Research

# Synchronous Gestures

Hinckley, K., UIST 2003, Ubicomp 2003



- **Tablets equipped with acceleration sensors, sensing**
  - Tilting of the device
  - Vibration

- **Interaction technique:**
  - bump devices together to connect
  - Pour information from one to the other
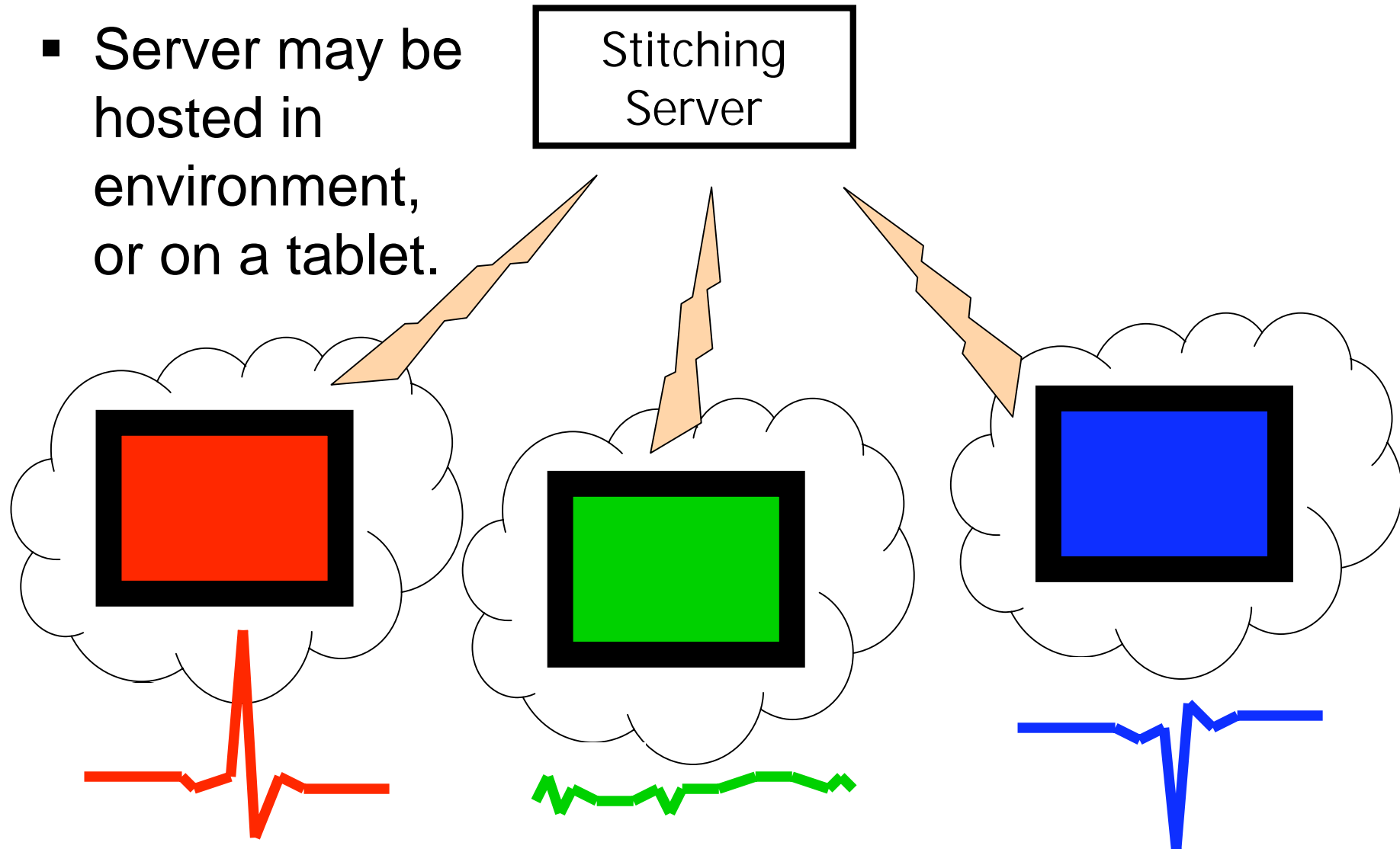
- **Following slides courtesy of Ken Hinckley**

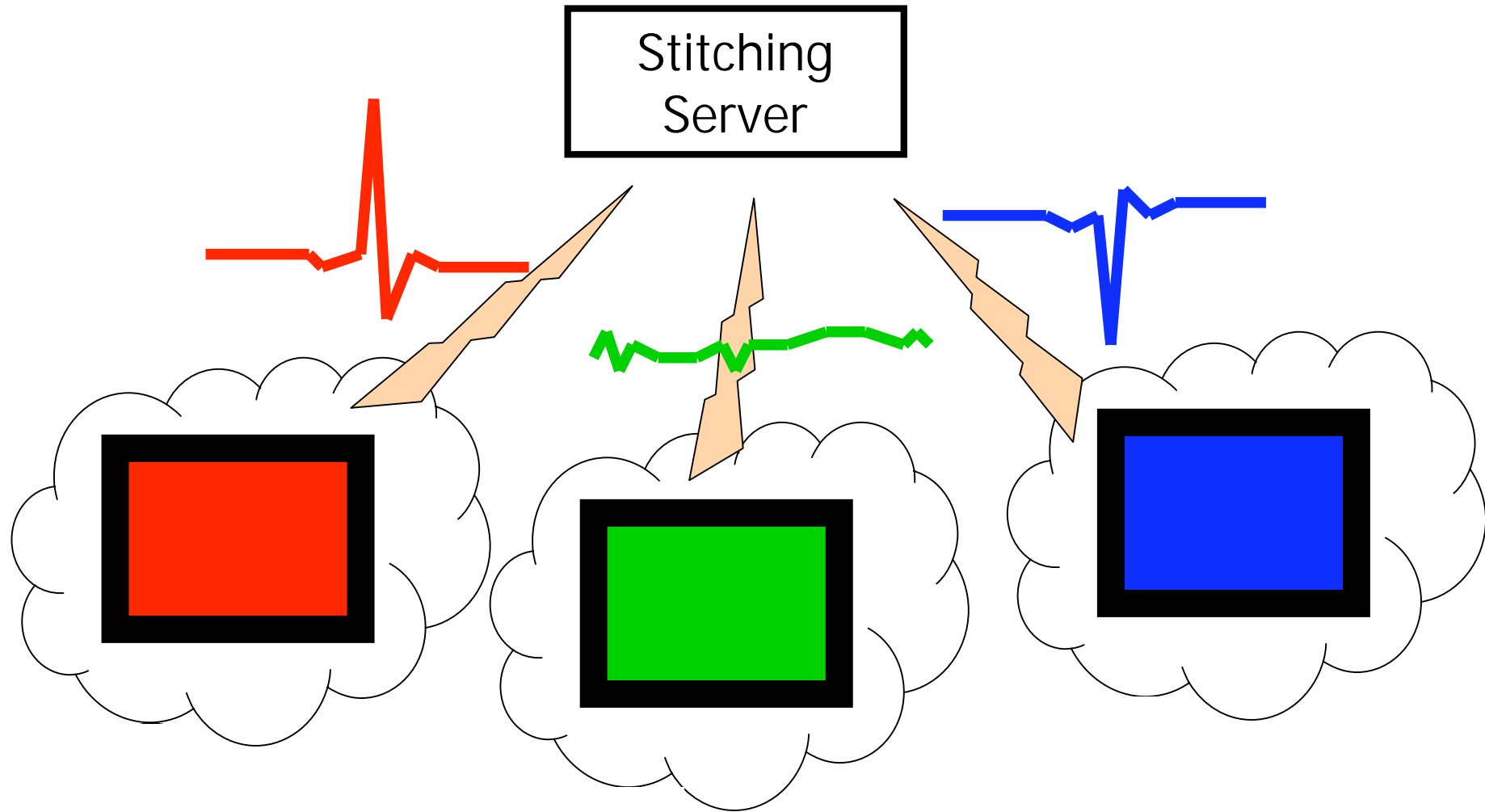# How Do Synchronous Gestures Enable Wireless Matchmaking?
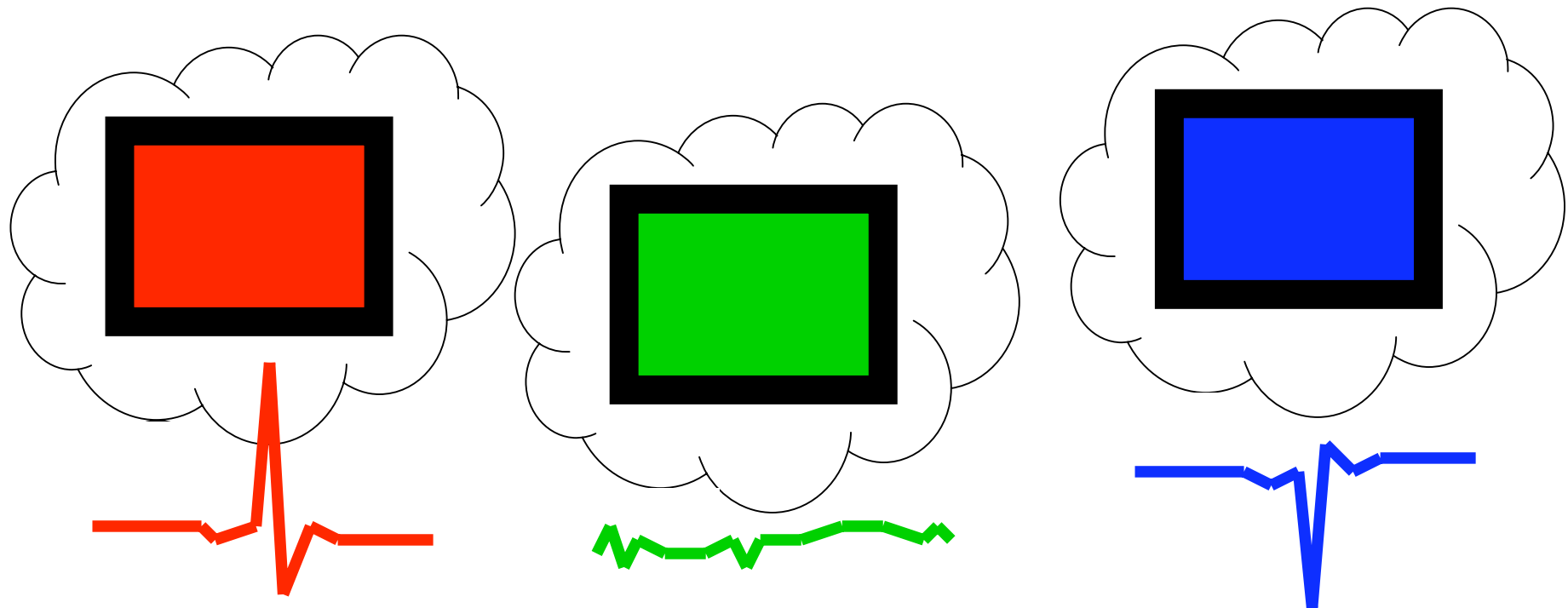
# Participating Devices Connect to Server

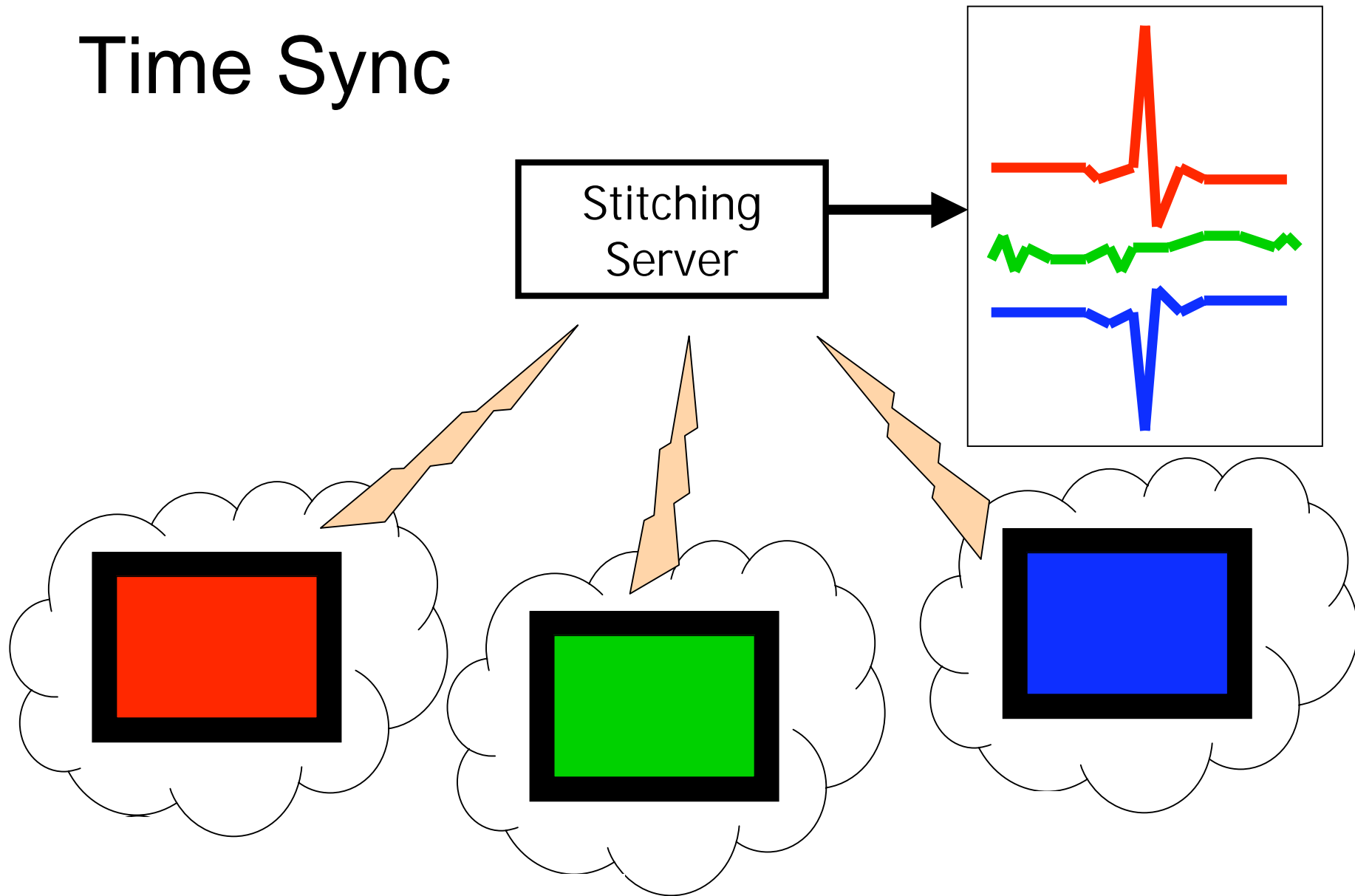- Server may be hosted in environment, or on a tablet.

Stitching Server

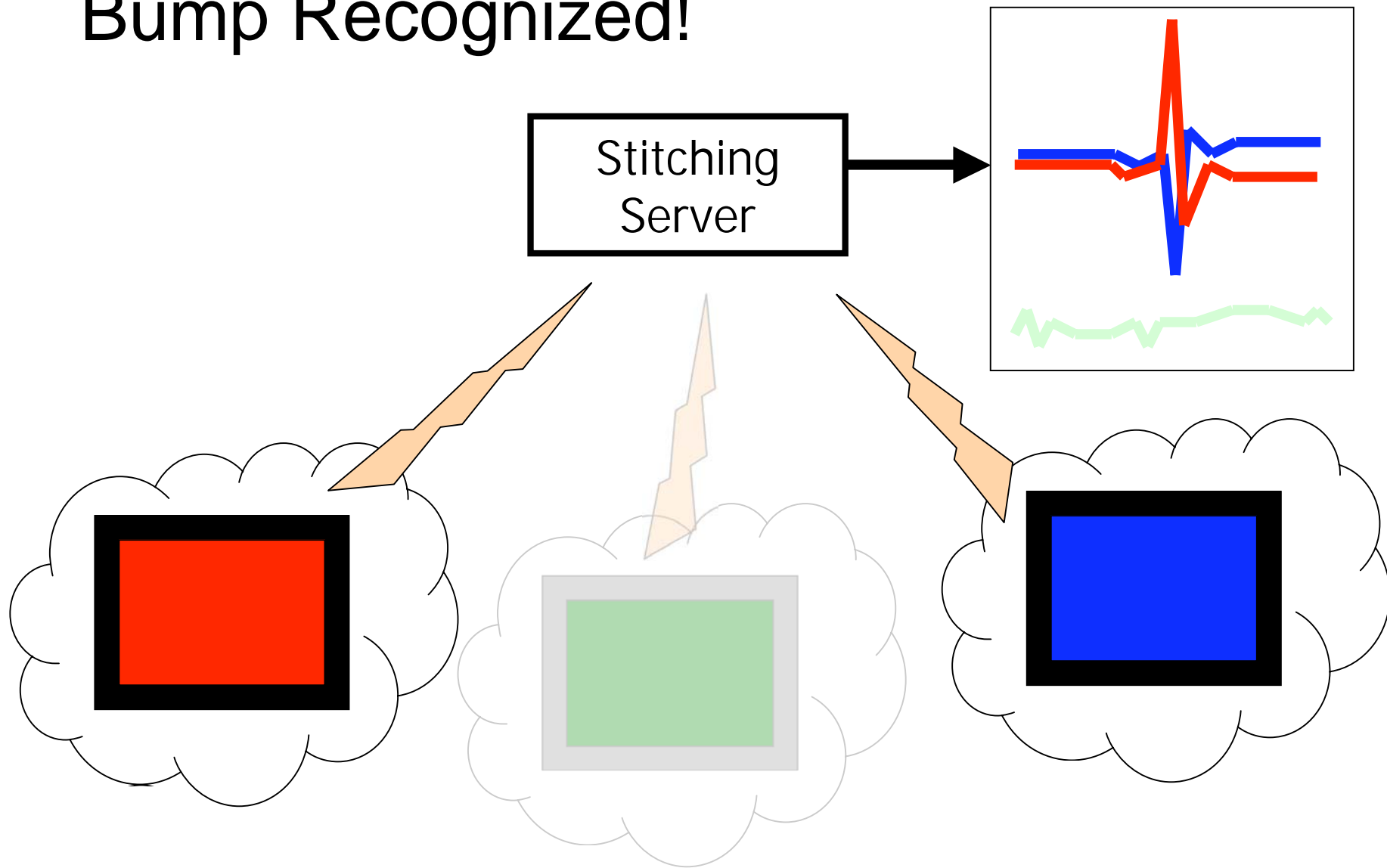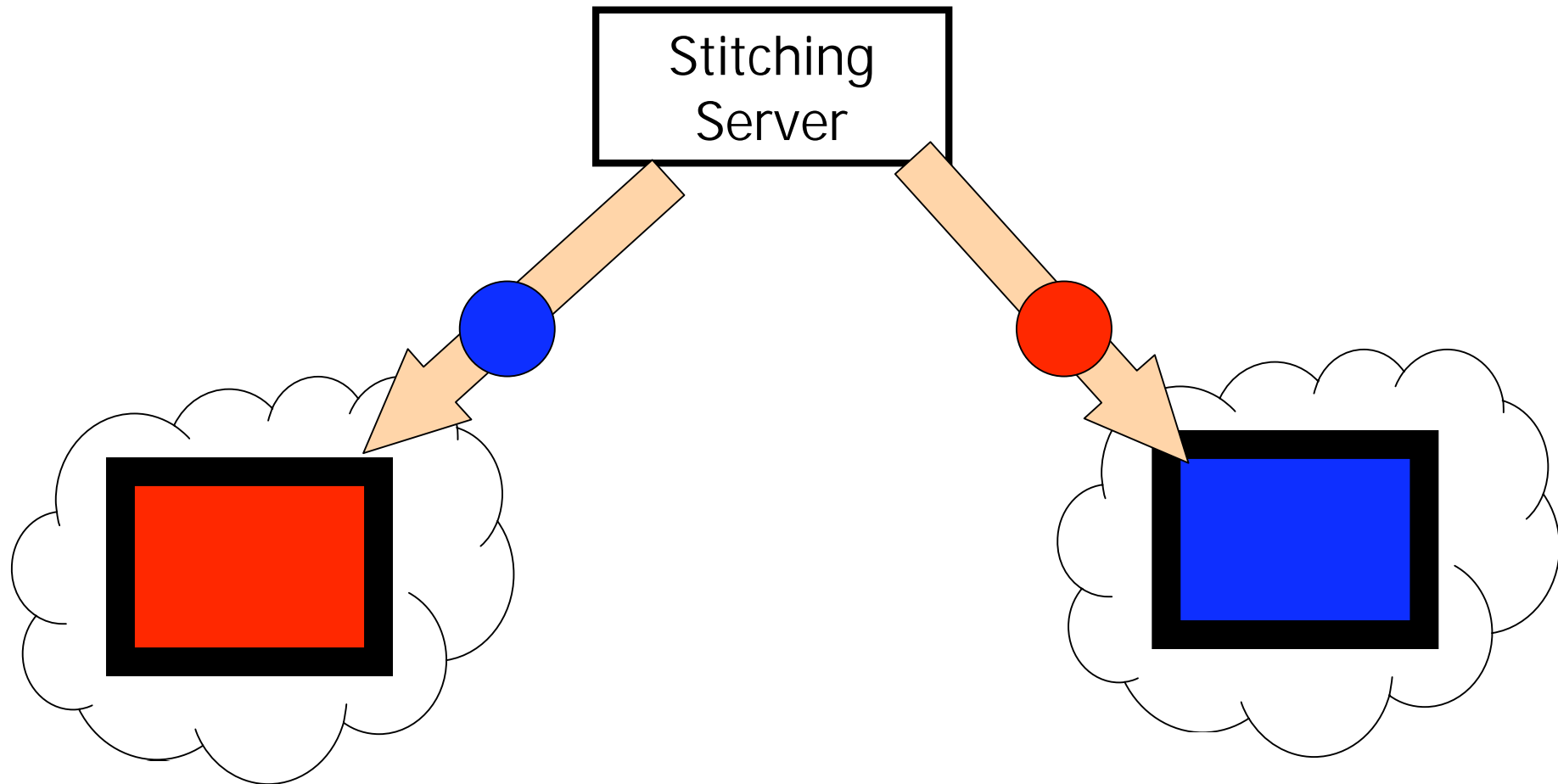# Send Sensor Data to Server
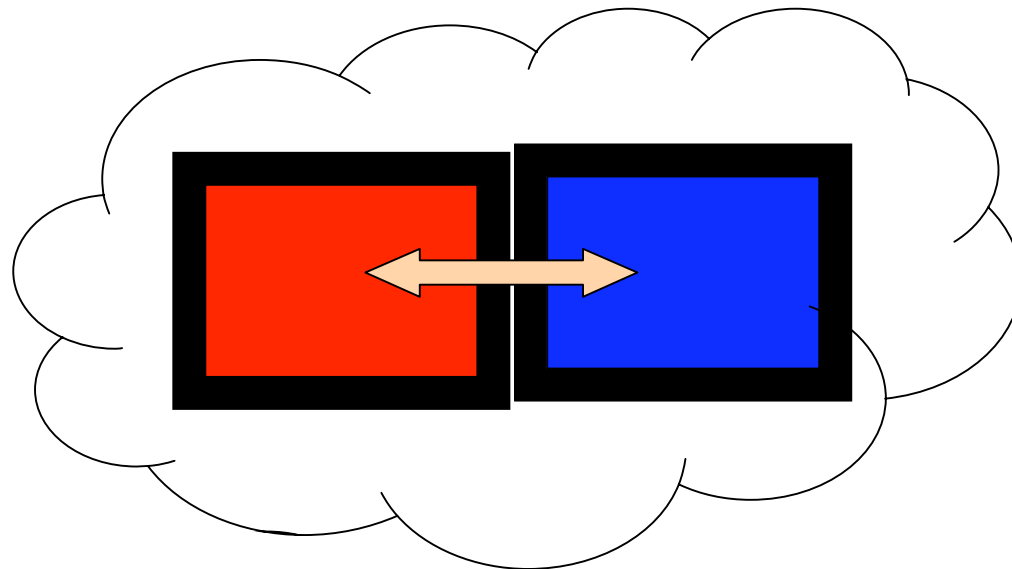
# Time Sync

# Bump Recognized!

# Server Gives Partners Each Other's IP Address



- Alternatively can have "private" connection via Stitching Server
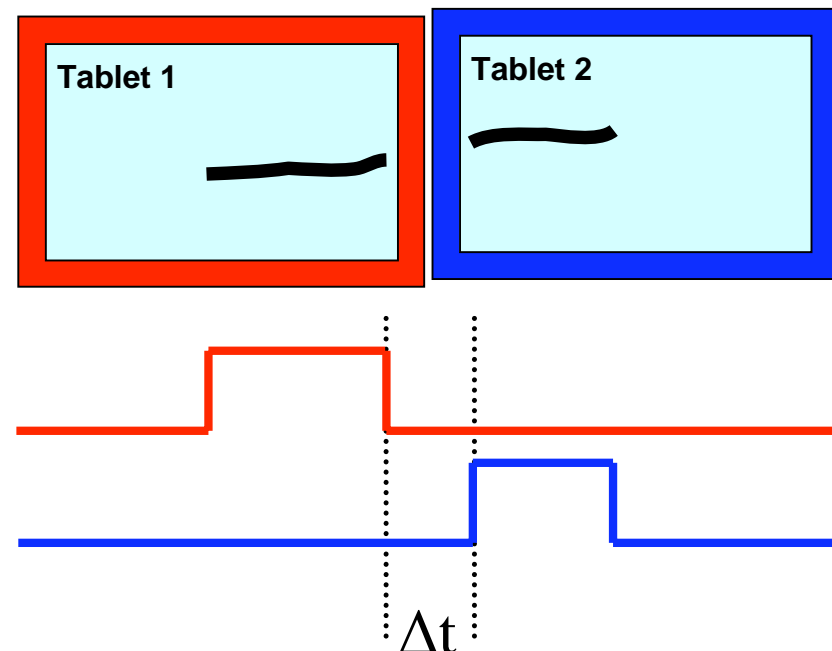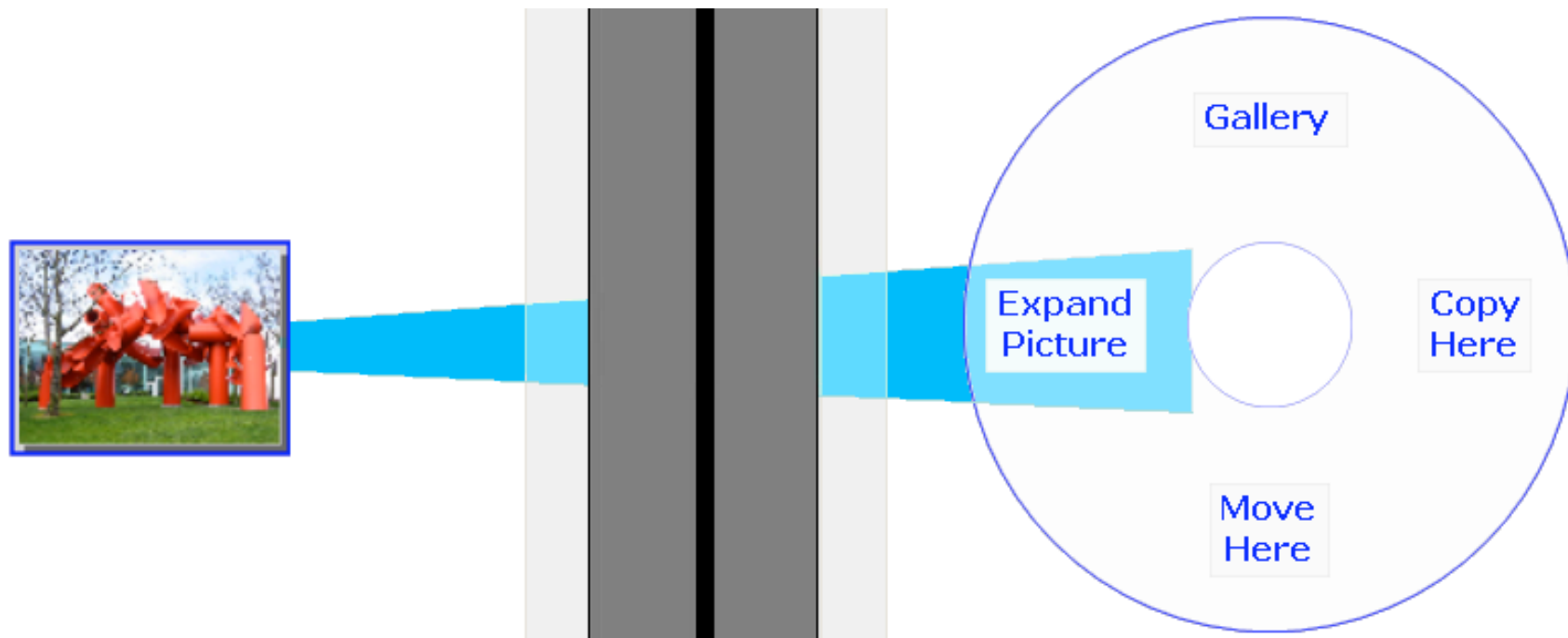
# Connect to Peer & Link Displays

# Stitching

Hinckley, K., Ramos, G., Guimbretiere, F., Baudisch, P., Smith, M., AVI 2004

- **Problem: connect two screens for interaction across them**

- **Solution: pen gestures across screens**

  - Drag and drop across screens

  - Using one screen to control second

  - Combine Screens

# Establish and Relax

- Users want to *Establish* a connection, but then *Relax* increasing social tension by quickly exiting

# Special Lecture on 07.07.

- Visit by Bill Buxton, Abigail Sellen and Shahram Izadi (Microsoft Research Cambridge)

- All working on interaction with Instrumented Environments

- Expect a Guru-level presentation!
  - Detailed topics yet TBD

- Bring friends!

- Fri, 7.7.06, 12-14:00h, as usual

- Theresienstr. Room 112

To get the taste:
# Bill Buxton's BoomChameleon