

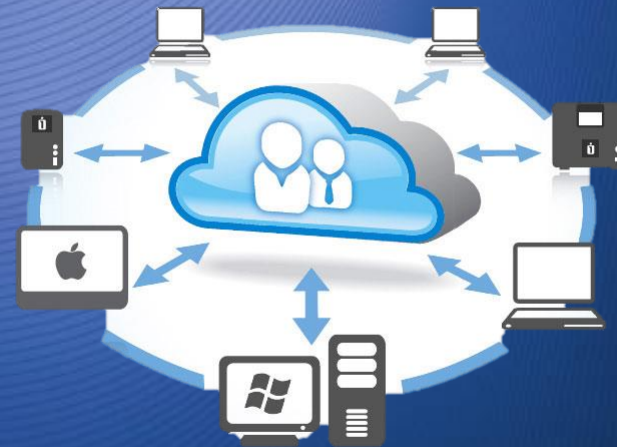
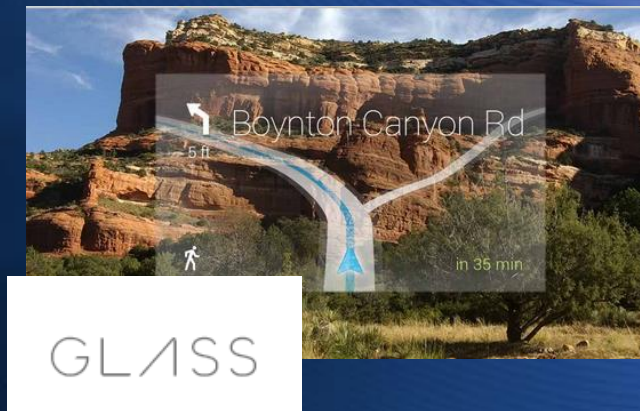
Pervasive Displays

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PART I: PERVASIVE DISPLAYS



Pervasive Displays

- Just “screens everywhere” ?



Not really...

Pervasive Displays

- Pervasive
 - “*spreading* widely throughout an *area* or a *group of people*”
- Display
 - “*electronic device for visual presentation*”
 - “*printing the arrangement and choice of type in a style intended to attract attention*”
 - “*a collection of objects for public viewing*”

- Oxford English Dictionary

Pervasive / Ubiquitous Computing

- Pervasive displays as part of pervasive / ubiquitous computing
- Principles of 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*.”

- Mark Weiser
(1952-1999)



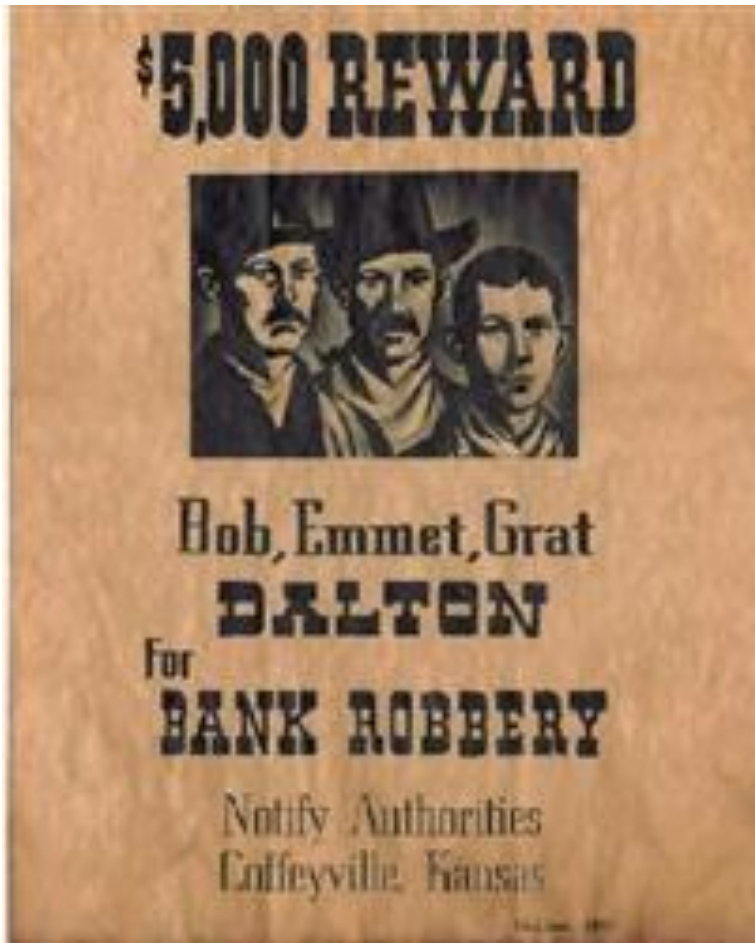
*“Today’s public display systems are largely closed and
isolated, with tightly controlled screen access.”*

Analogy:

Old mobile phones – current public display systems

- Nigel Davies et al.

In the early days...



Public Information



Advertisement

... and today



Information / News Display



Electronic Advertising

- **Information** presented to the user interleaved with ads
- Content is very **repetitive**: User gets **bored**
- **No interaction** or possibility to change content
- Showed content may be **moving** / flickering to attract the attendance

... and today

- Interaction needs **application** (tag reader) or sending SMS
- **Augmentation** is sometimes **inaccurate** / impossible without location service
- Maps just show “Here are you” indicator (hard to find)



Poster Advertising



Augmentation

Display Types

■ Static Displays:

- Cannot change the content shown
 - Provide no direct feedback
 - Cheap (big surface)
 - Require no energy
-
- Posters, Maps, Objects



■ Dynamic Displays:

- Can change content shown dynamically
 - Can provide direct feedback
 - Relatively expensive
 - Require energy and actively driven input
-
- LCD Screens, Projectors



Both may be location / environment aware

Are today's displays pervasive?

- “Yes” in the sense of Oxford dictionary
- **No** in the sense of ubiquitous computing
 - People have adapted to **ignore** the displays
 - **Fast moving** pictures distract calmness
 - Almost **no interaction** / non-intuitive interaction
 - Interaction / augmented reality is “**plug-and-play**” instead of “arrive-and-operate”
 - Displays provide **no / too less help** in doing something



Observation: Smartphones are everywhere



“The first truly pervasively available interaction devices”

- Robert Hardy

Observation: Smartphones are everywhere

- Equipped with various sensors, radio interfaces, acoustic & haptic feedback and touch displays
- **Problem:** Interaction with displays using smart phones today is inconvenient, not always working and clumsy
- **Idea:** use of technology provided by the smartphone in a smart way for interaction

The vision in the movies



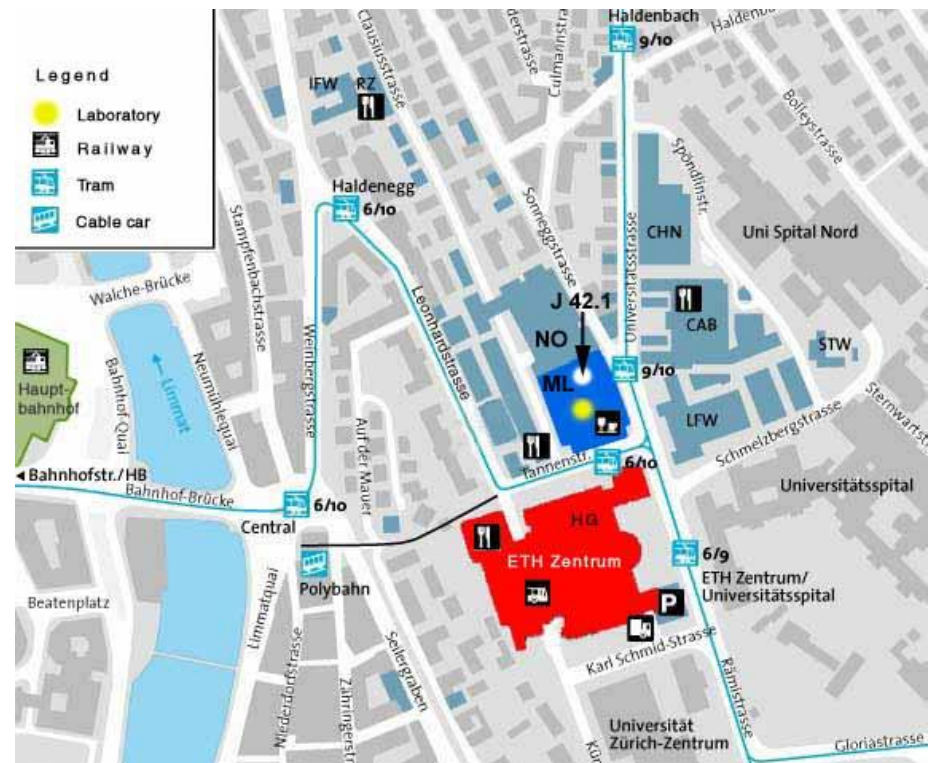
Minority Report,
DreamWorks Pictures



Avatar
20th Century Fox

Interactive Street Map

- Intuitively select an element on the map
- Get **related information** of selected object
- **Query / Filter:**
Get list of all restaurants in a specific area
- Show directions to object



Interactive Mensa Menu

- Show **additional information**:
 - Menu ratings
 - Alternative Menus at other location
 - Filter according to preferences
- Example: Diet help
 - Caloric values directly added to diary
 - Do not show menu which do not fit
- Example: Allergic / Health
 - Hide menus containing certain ingredients
 - Show warnings



<http://a5.mzstatic.com/us/r1000/103/Purple/ef/b1/26/mzl.jlmdxofp.320x480-75.jpg>

Passive Interaction with Displays

- No need for taking the phone out of the pocket
- Walk-by / be present as interaction event
- Display **spontaneously** react to your presence and shows content you like (pictures, videos)
- Example: Screen at CAB Foyer
 - You like to see images of D-INFK events
 - Your phone tells the screen wirelessly
 - Screen displays selection of photos

Privacy?



Personalized Content

- Content is chosen according to **personal preferences**
 - Switch paintings of e-gallery
 - Show news you're interested in / weather of your location
 - Show tailored advertisement
- Showing **related information** to query
- Several **social issues**
- Example: Team Support
 - A group of soccer fans meet
 - The displays show the colors of the favorite team



Augmented Displays

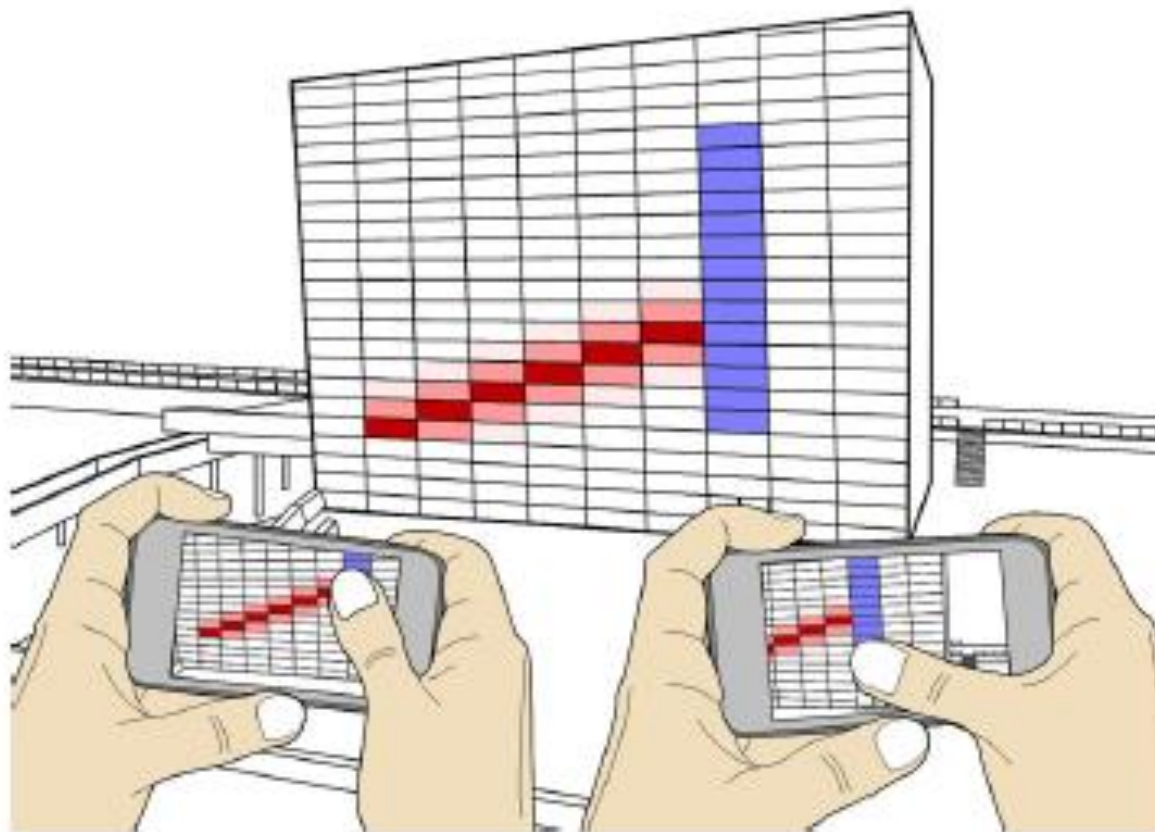
- A tablet's display **augment the view** of the current display
 - Different angle / layer
 - Annotations
- Show **additional information** of the elements shown
- Example: Doctors
 - Different experts analyze a patient
 - Cardiologist
 - Sinologist
 - Surgeon
 - All have different interests concerning the patient's health state



<http://jordster4000.blogspot.ch/2011/09/layout-design-research.html>

Houses as Displays

- Using the façade of a house as a game display



Projected Displays

- Video:
- http://www.youtube.com/watch?feature=player_embedded&v=df1NO7MoAUY

PART II

INTERACTION WITH DISPLAYS



1. Physical Buttons

- Select elements by pressing buttons
- Buttons can be marked to distinguish them **blindly**
- Drawbacks:
 - Not always clear what different buttons do
 - **Unclear element highlighting**
 - No button adaption to different content
 - Button interface is **not extensible**



2. Touch Screens

- Interact by **touching the element** directly on the screen
- More intuitive than physical buttons, **adaptable interface**
- Drawbacks:
 - Indistinguishable buttons (no blind navigation)
 - Dirty displays
 - Not well suited for very large screens
- Not working with
 - Displays behind security glass
 - Displays far away
 - Wet fingers / gloves



https://activecaptain.com/articles/mobilePhones/iPhone/iPhone_Keyboard.jpg

3. Bluetooth Device Names for Interaction

- **Idea:** send service requests to displays wirelessly
- Issues tackled:
 - SMS: untrusted number (premium service), need to know display ID
 - App: download necessary (inconvenient)
 - Touching may not be possible
- **Observation:** many users have device supporting Bluetooth and have set a custom USB device names
[Nigel Davis et al]
- **Approach:** Use of Bluetooth device discovery and Bluetooth device names to send requests

Bluetooth Device Names as Commands

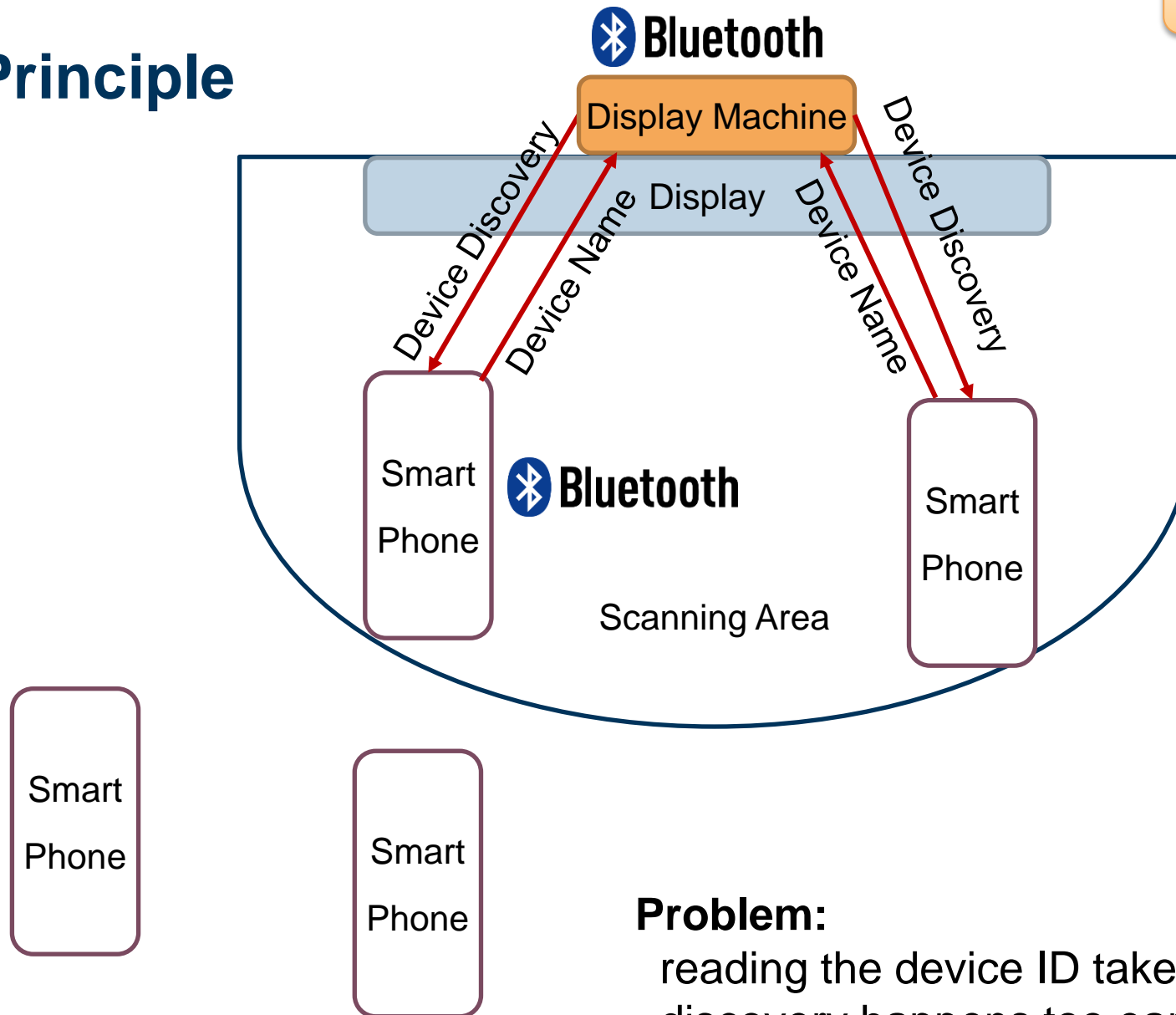
- No need for additional software
- Users set the device name to a **special command string**, to send a request command to the system

```
ec <service_name> <params>
```

- Identifier followed by service name
- Examples:

```
ec youtube: eth  
ec map: CAB H52
```

Principle

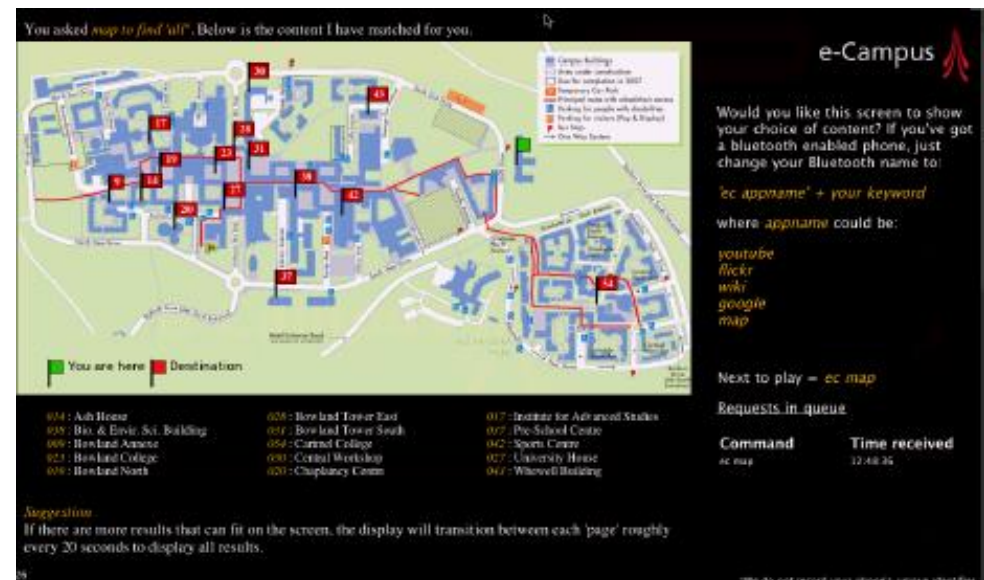


Problem:

reading the device ID takes time
discovery happens too early / late

Serving the Requests

- Each request (recognized command) is put into a queue
- Each request is served for a **maximum specified time**
- If a user leaves the display area, the requests is marked as served
- Social issues arise
ec youtube: puke



4. Visual Markers

-  type  ter  te 
- identify the display / element by  m  R  ed 
-  like  interactive  tar...



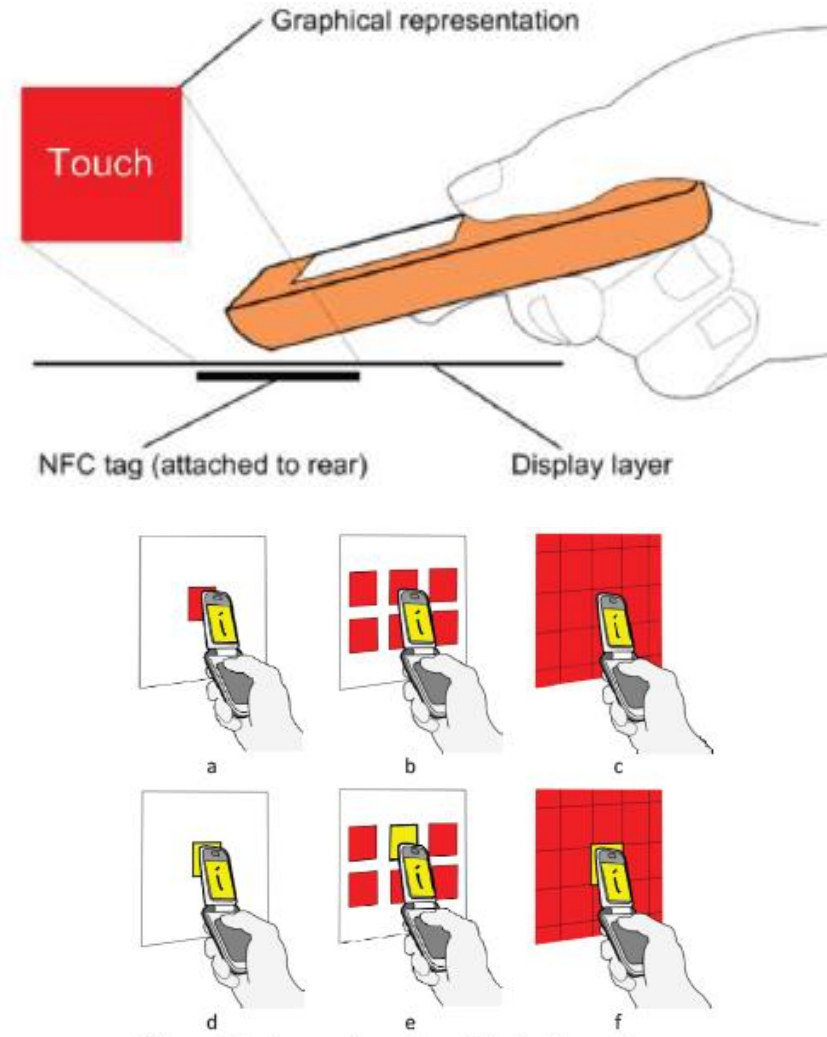
5. Mobile Interaction with NFC enabled displays

- Near field Communication
 - Wireless communication technology, Point-to-Point
 - **Small Range:** $< 0.2\text{m}$
 - Frequency: 13.56 MHz
 - Bandwidth: 424 MHz
 - **Set-up time:** $< 0.1\text{s}$
 - Low-Power, tag is unpowered
- Applications
 - Payments (Credit Cards, ...)
 - Keys
 - Data Exchange (Business Cards)



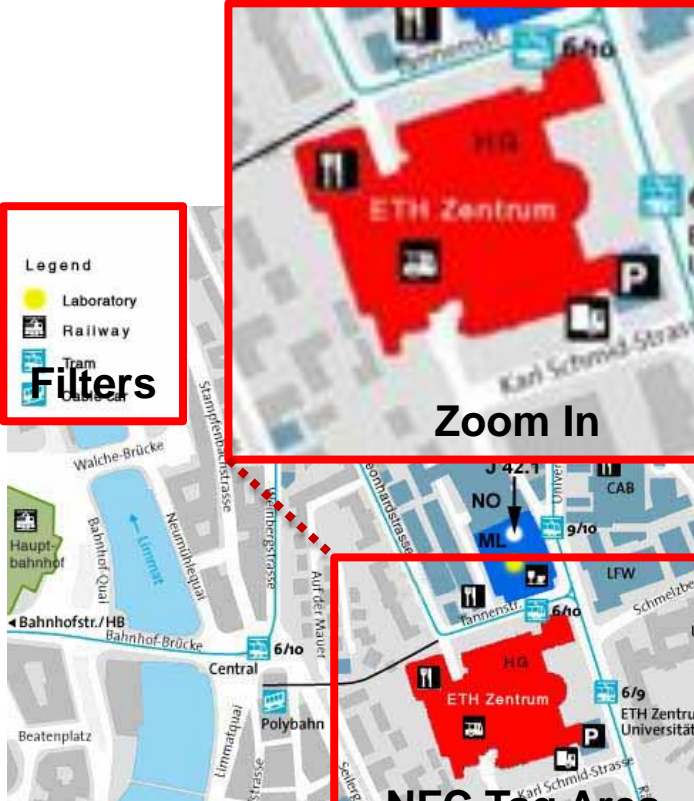
NFC enabled displays

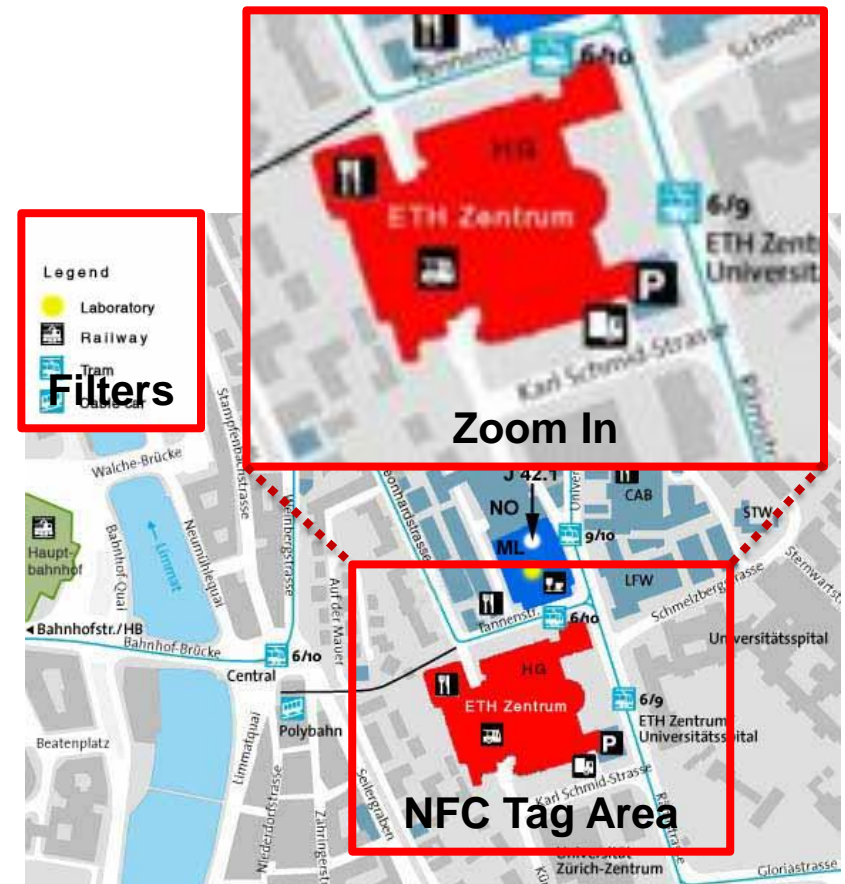
- A **mesh of NFC tags** attached to the rear, no need for visual markers
- Interaction by “touching” i.e. holding the device close
- Mobile device **reads** content of the **NFC tag**:
 - Object ID to look up on internet
 - Self contained information (no lookup)
- Mobile device may augment the display by showing information



Robert Hardy, Enrico Rukzio, Paul Holleis, Matthias Wagner
Mobile interaction with static and dynamic NFC-based displays

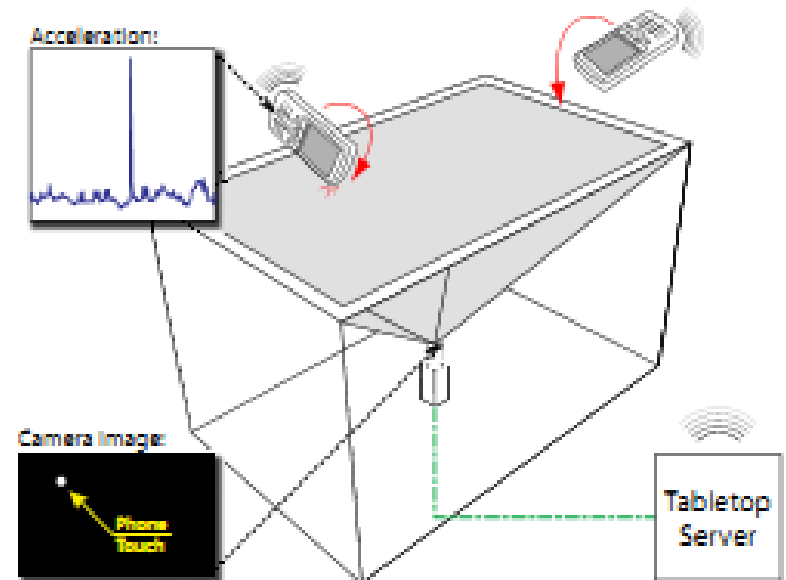
Resolution Problem of NFC Enabled Displays

- **Resolution Problem:** Mesh grid of NFC tags is coarse. One tag covers many elements
 - **Dynamic Solution:**
 - “Zoom in”: Show pop up
 - **Static Solution:**
 - Show list on mobile phone
 - **Generic Approach: Filtering**
 - Enable filter to reduce the result set
- 



6. Accelerometers: PhoneTouch

- **Goal:** Distinguish multiple users interacting with a touch screen at the same time
- Touchscreen registers location of touch event
- Phone registers movement using accelerometer
- Tabletop server matches touch event with phone movement to identify user



PhoneTouch: A Technique for Direct Phone Interaction on Surfaces

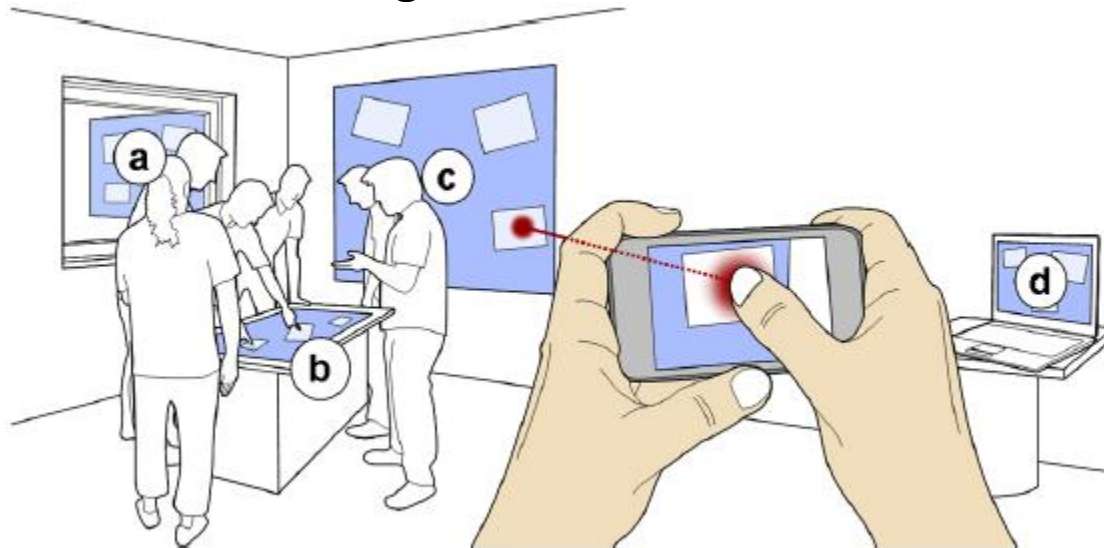
Dominik Schmidt, Fadi Chehimi, Enrico Rukzio, Hans Gellersen
Computing Department, Lancaster University, Lancaster, UK

7. Touch Projector: Touch Screen from Distance

■ Observation:

- Not all display support touch input
- Displays may be out of arm's reach
- Elements cannot be moved between displays easily

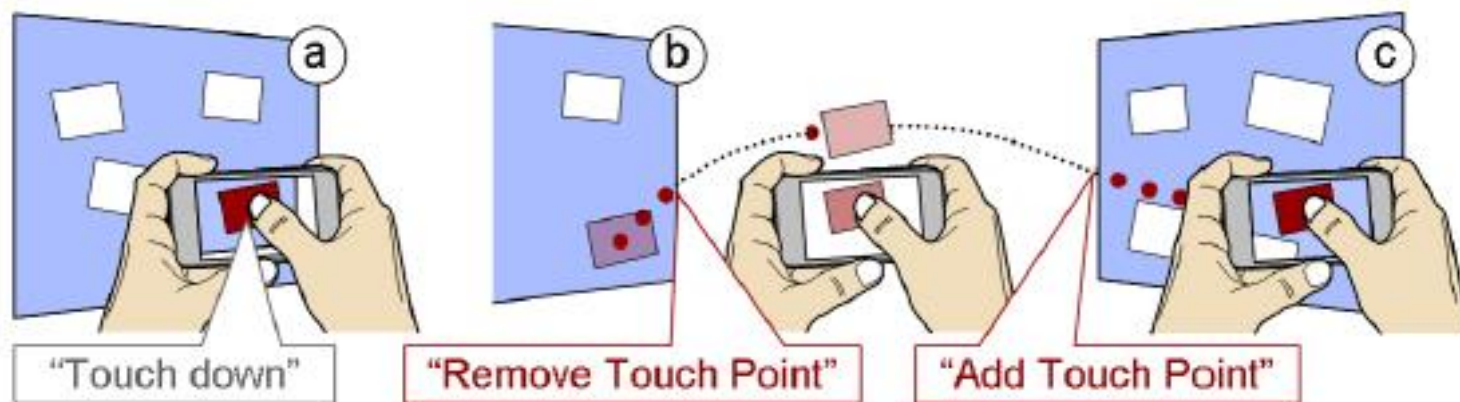
■ Idea: interaction through live video



Sebastian Boring, Dominikus Baur, Andreas Butz, Sean Gustafson, Patrick Baudisch
TouchProjector: Mobile interaction through video

Touch Projector Usage

- All touch events are routed through a server (the **environment manager**)
- Basic Usage:
 - User points at display and touches element
 - User moves element within / between screens
 - User releases touch and element is placed on new location



Touch Projector Implementation Issues

- Screen too small on mobile device: **Automatic zoom** in when display is recognized
- Device needs to be pointed on screen: **Freeze image** on mobile device for stability and fine tuning
- Display identification based on **computer vision** may result in incorrect identification

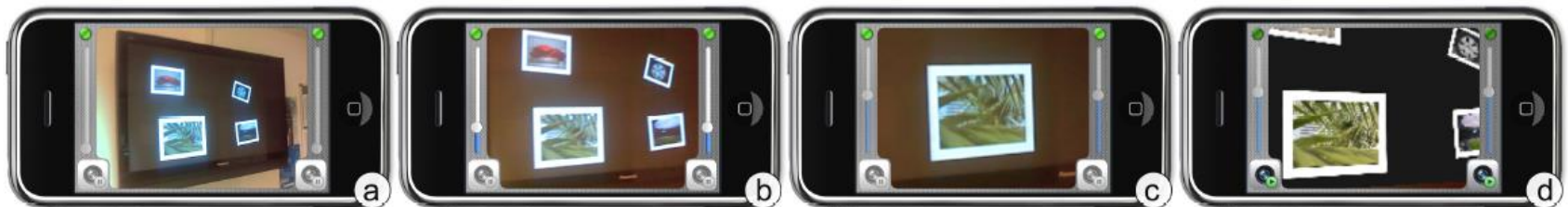


Figure 9. The different Touch Projector interfaces: (a) Original camera interface. (b) Manual zoom capabilities. (c) Automatic zooming. (d) Freezing the camera image with temporary overlay for precise interaction.

8. Augmented Displays

- **Problem:**

One screen – different people and different interests



- **Idea:** Augment main display with different views / layers

The Magic Lens Metaphor

- Show alternate view of the data
- Show annotations / information on the object



7. Gesture Recognition using Kinect



- Improved hygiene: no need to touch

SOCIAL ACCEPTANCE ISSUES

Security

Content

Privacy



Security: SMS / QR Codes

- Sending an SMS can end in a premium service
- QR codes may refer to phishing sites
- QR codes / SMS numbers may be forged



Privacy Concerns: Unveiling Personal Data

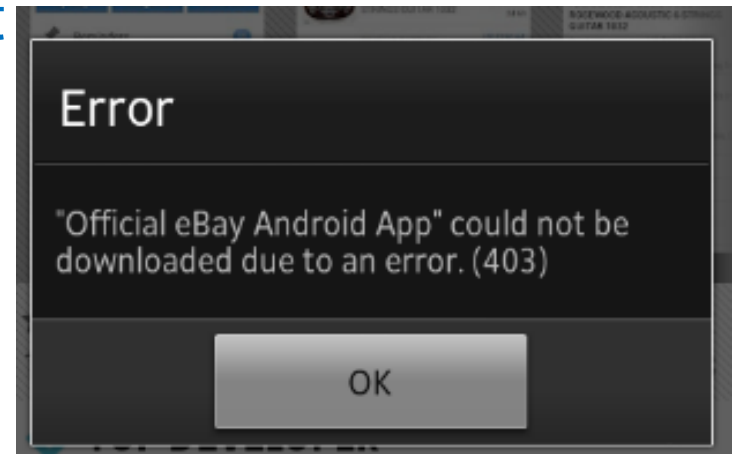
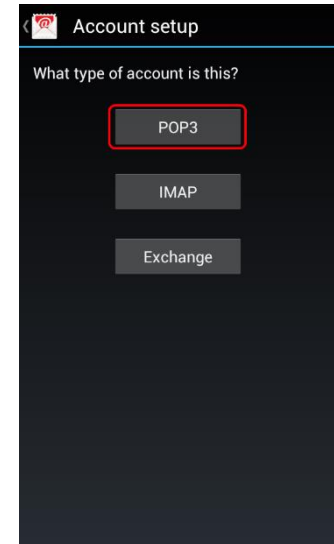
- Personalized display content unveil personal data
 - e.g. advertisement of products recently bought
 - e.g. support for political party / sports team
- User may need to fill in his preferences
- Scanning QR code / sending SMS unveils phone ID
- Technology may be used to track the user where he goes



http://medaidpharmacy.com/wp-content/uploads/2011/05/top-logo_small3.png
<http://www.masterfile.com/stock-photography/image/400-05059664/speaker-or-film-director-and-screen---cartoon-style>

Effort Needed to Use the Displays

- Must be kept as low as possible
- No plug-and-play but **arrive-and-operate**: the use has to be intuitive
- Effort needed is percept as **cost**



<http://helpdesk.nex-tech.com/print.php?id=657>
<http://tutzn.net.com/2966-fix-google-play-store-error-403-android/>

Content

- User decides what to display
 - May be inappropriate (e.g. offensive views)
 - May distract other people (e.g. music styles)



Sunrise Demonstration Incident

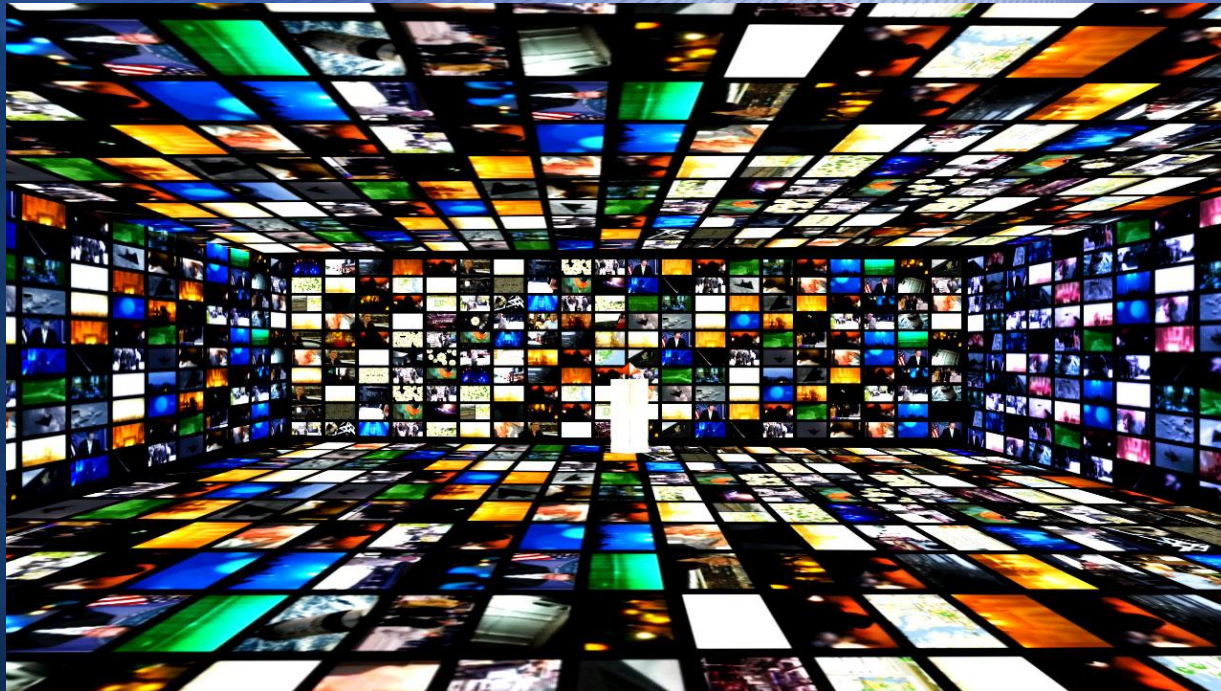
- The content providers must be **trusted**
 - Not all display owners want all contents on their display
 - Concept of “Trusted Store” like an app store
- Content war between users

Summary of Today

- Today's displays are **not really pervasive** (not helpful)
- Intuitive interaction with displays needed to turn them into **helping assistants**
- There are many **technical & social issues** to solve
- Most of the basic technology is already available



THANKS



Questions ?

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