# An Experimental Comparison of Physical Mobile Interaction Techniques: Touching, Pointing and Scanning
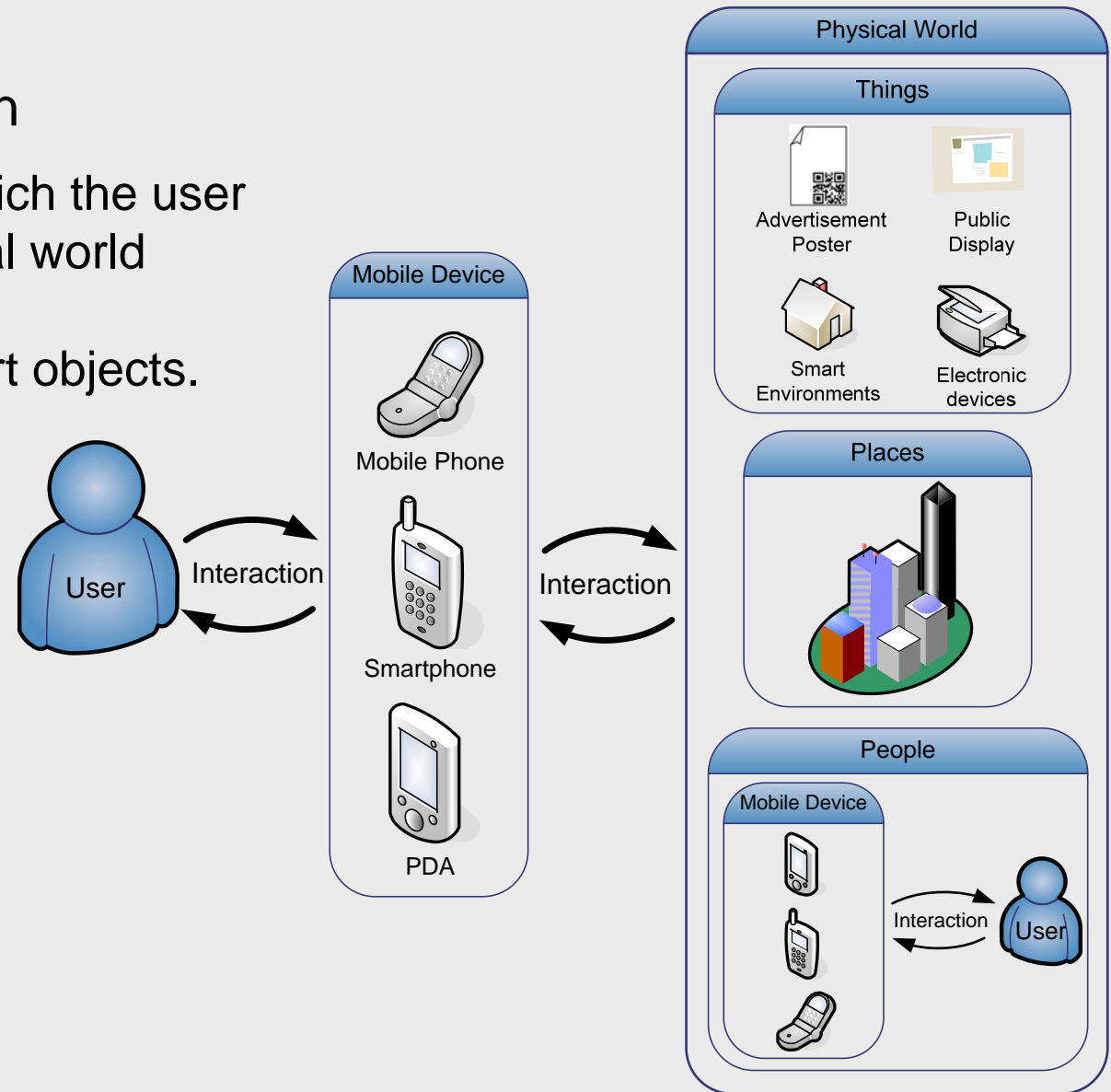
**Enrico Rukzio[1], Karin Leichtenstern[2/1], Vic Callaghan[2], Paul Holleis[1], Albrecht Schmidt[1], and Jeannette Chin[2]**

**[1] University of Munich (Germany)**
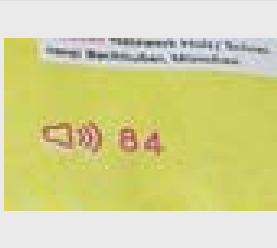**[2] University of Essex (UK)**

- Physical Mobile Interaction

  - Mobile interactions in which the user interacts with the physical world trough a mobile device which interacts with smart objects.
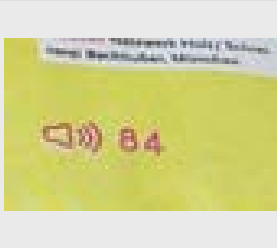
- ## NTT DoCoMo i-mode Felica

  - Mobile phones support Near Field Communication (NFC)

  - Services: mobile wallet, boarding pass, electronic key

  - 15 million devices with i-mode Felica expected in Japan by end of 2006 [1]

- ## Semapedia.org

  - Visual marker represent a link to a Wikipedia article

  - Taking a picture of the marker using the built-in camera

  - Open the Wikipedia webpage on the mobile phone

- ## QR Code

  - 30 million mobile phones with a QR Code reader in Japan [2]

  - Magazine, newspapers, house walls (up to 10 x 10 meter)

| Interaction technique | Touching | Pointing | Scanning | Location based object interaction | User mediated object interaction | Indirect Remote Controls |
|---|---|---|---|---|---|---|
| Description | Touching the smart object with the mobile device | Pointing on the smart object with the mobile device | Scanning the environment, get a list of smart objects, select one | An smart object is because its proximity selected | The user types in information provided by the object | User interacts with mobile device to control a remote application |
| Illustration | [4]  | [3]  | [3]  |  |  |  |
| Mobile Device – Real World | Radio: RFID / NFC | Visual: Visual Marker, Infrared beam | Location: Bluetooth, WLAN, GPS | Location: GPS, WLAN, Bluetooth | No direct link. | Data connection (Bluetooth, WLAN, UMTS) |
| Physicality (dist. object – mobile device) | Visible (circa 0 to 10 cm) | Visible (circa 10 cm to 10 m) | Visibility not needed (0 to 10 m to 90 m) | Visible | Visible | Visible |

- In which context is which interaction technique preferred by a user?

- Which interaction techniques should be supported by the smart objects?

- What are the advantages and disadvantages of the interaction technique from the users point of view?

→ Need for corresponding studies and guidelines

- Physical mobile interaction with objects in a smart environment (living environment, domestic home)

  - Reading the manual of a microwave after touching it

  - Requesting direct support for a device

  - Remote control of objects (status of the washing machine)

# Physical Mobile Interactions: Touching, Pointing and Scanning

| Interaction technique | **Touching** | **Pointing** | **Scanning** | Location based object interaction | User mediated object interaction | Indirect Remote Controls |
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- Online survey

  - Which services are useful?

  - Which physical mobile interaction technique in which context?

- Web based questionnaire: 134 participants (40% male, average age 28, 41% university degree, 95% own a mobile phone)

- Participants saw benefits of mobile interaction in smart environments

  - Practical, comfortable, saving time, benefits for older and handicapped people

- Disadvantages: security issues, dependence on technology



**Control a Device**
- Useful: 73%
- Neutral: 17%
- Not Useful: 10%

**Status Information**
- Useful: 64%
- Neutral: 22%
- Not Useful: 14%

**Related Web Sites**
- Useful: 37%
- Neutral: 36%
- Not Useful: 27%
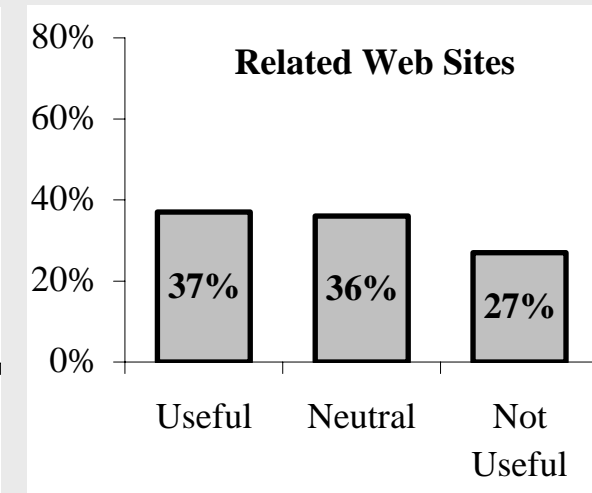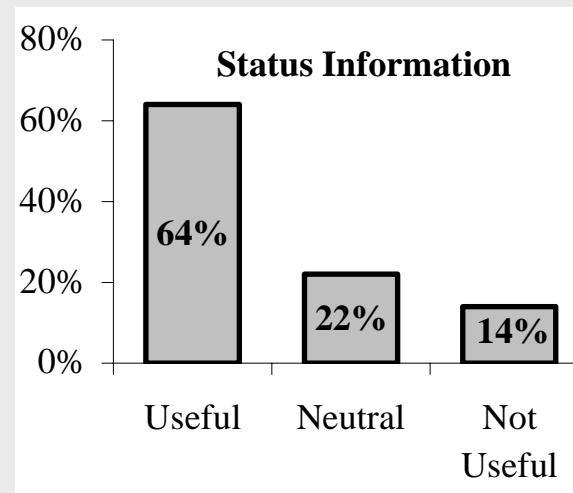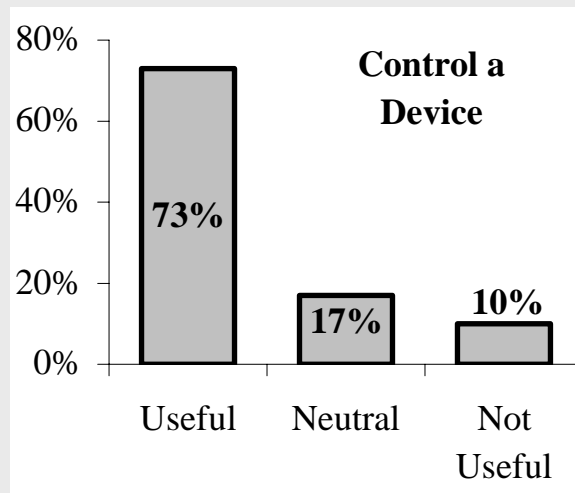
- Explained touching, pointing, scanning

  - Touching: high physical effort, unambiguous / accuracy, intuitive, secure and trustworthy

  - Pointing: intuitive, little physical effort, easy to use, quick, avoids a complex user interface, can select wrong device

  - Scanning: operates at distance, low physical effort, listing of all devices, complex user interface

**User Preferences**

| | Touching | | Pointing | | Scanning | |
|---|---|---|---|---|---|---|
| | Like | Dislike | Like | Dislike | Like | Dislike |
| | 25% | 75% | 58% | 42% | 46% | 54% |
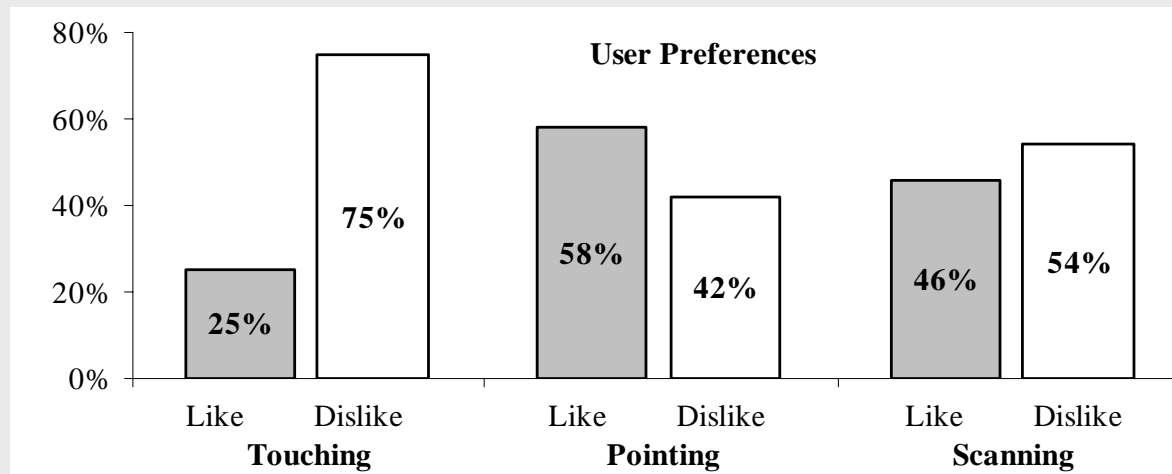
- Analysis: initial user opinion, verified through the next steps

- User Study: 8 participants, Place: kitchen in our office

- Explained touching, pointing and scanning, paper prototype

- Task 1: selecting the fridge to open cooking recipes webpage, line of sight, to far for touching → 6/8 pointing, 2/8 scanning

- Task 2: set the timer of the microwave, distance: 2-3 meter → 7/8 pointing

- Questions:

  - Most secure: 8/8 touching

  - Intuitive: 4/8 pointing (TV remote control), 4/8 touching

  - Speed: 5/8 touching, 3/8 pointing

  - Least error-prone: 8/8 touching (error resistance / security)

  - Highest cognitive effort: 6/8 scanning, 2/8 pointing

  - Highest physical effort: 8/8 touching
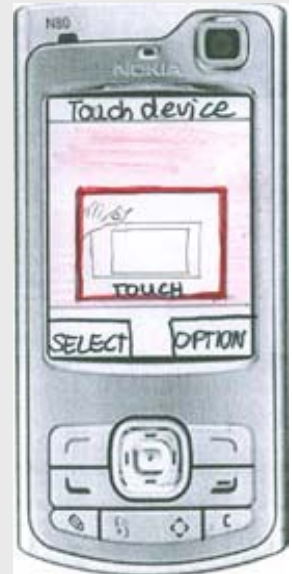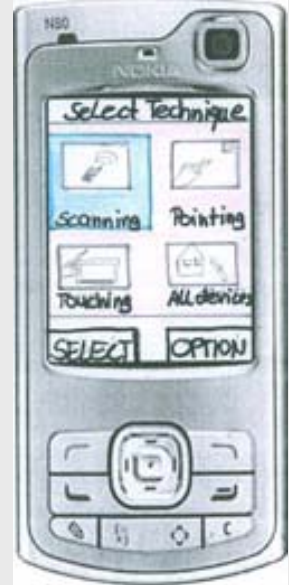
- Evaluate the previous findings in a more practical context

  - Technical constraints (e.g. time needed for scanning) can not be emulated in a paper prototype

- Touching

  - Nokia 3220 + Near Field Communication (NFC) Shell + Mifare NFC tags

  - Range: 0 - 3 cm

- Pointing

  - Laser pointer attached to Nokia N70

  - Light sensor (feedback) attached to smart object

  - Particle Computer platform

- Scanning: Bluetooth, Nokia N70
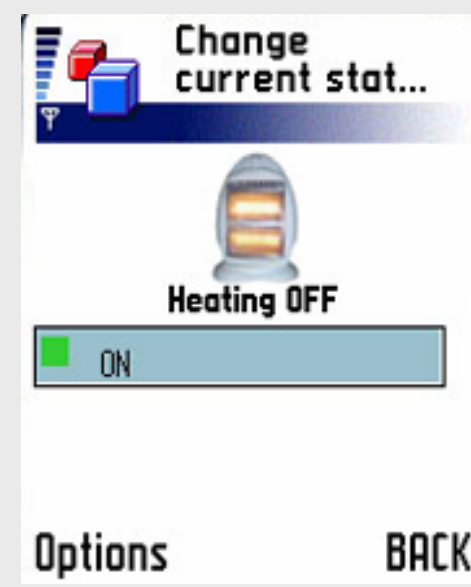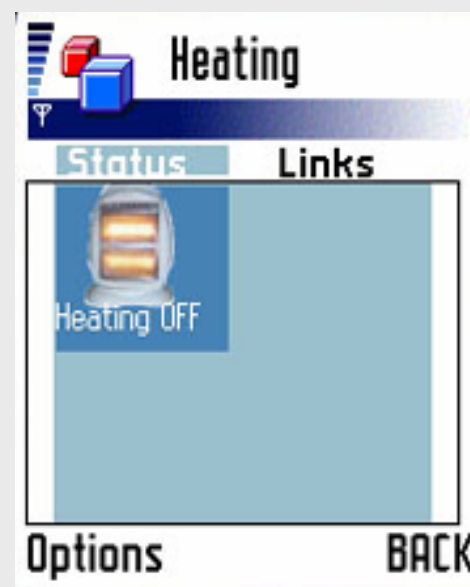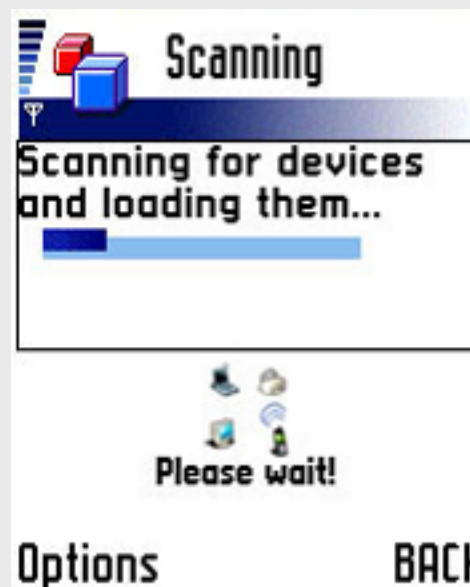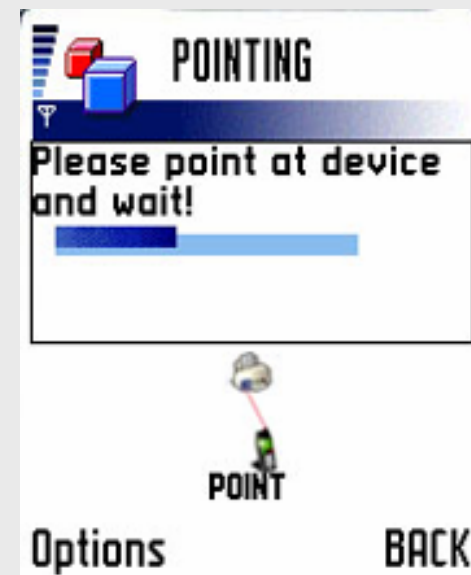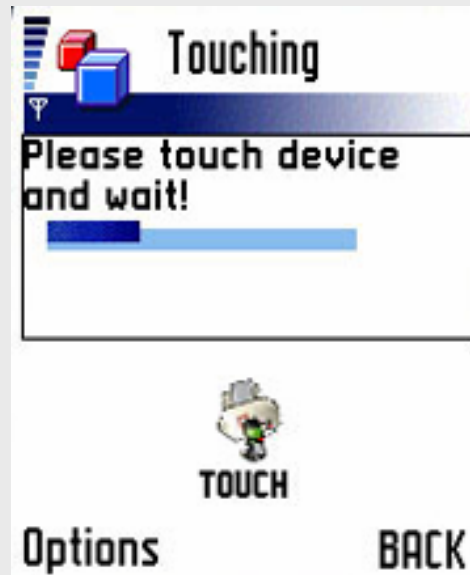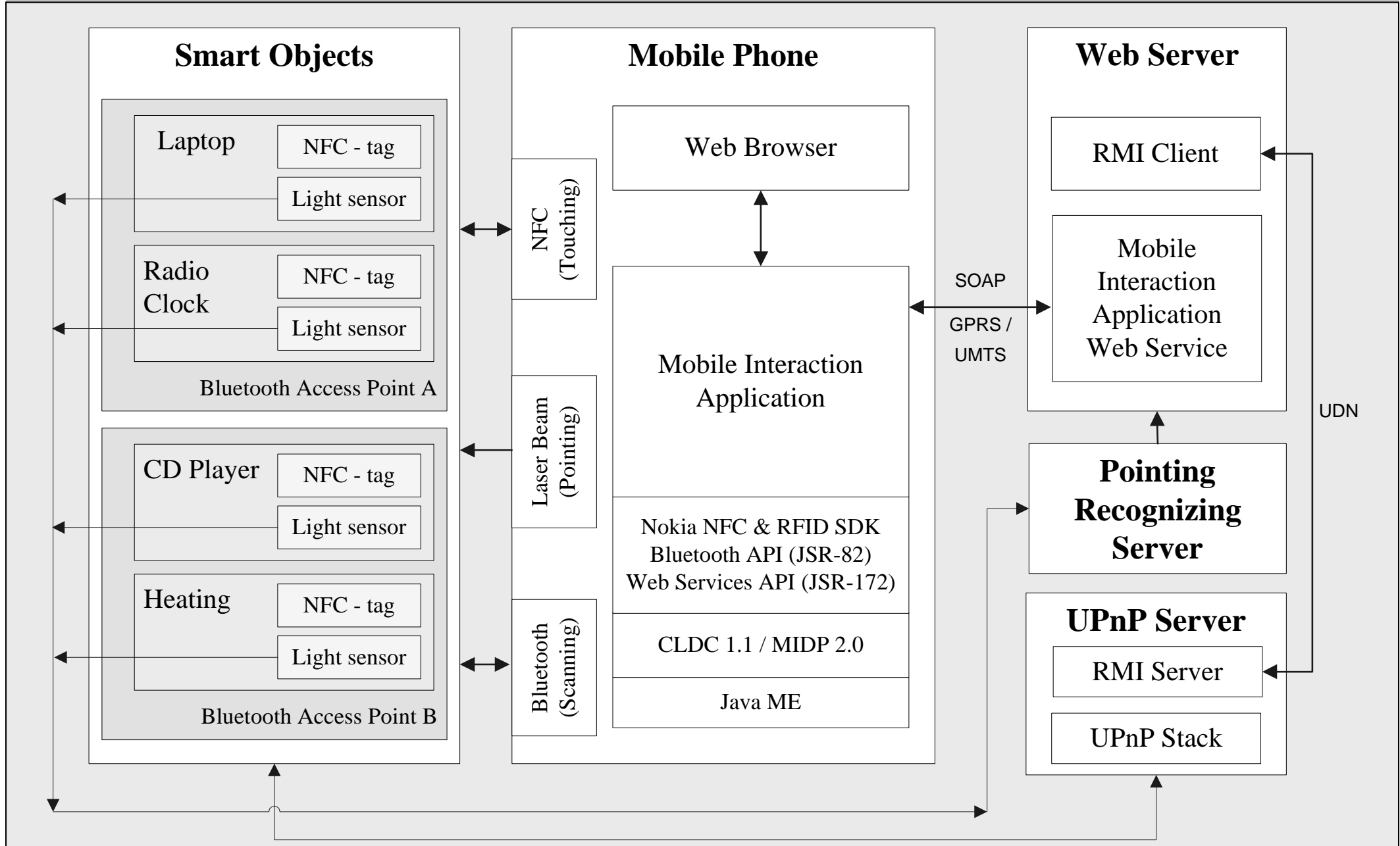
- User Study: 20 participants, aged 9 to 52, average age 28, 35% male, 70% academic education

- 4 Tasks: different context of location and activity (sitting, lying, standing), living room

  - Select a CD player and turn it on, distance 3 meter, line of sight → 95% used pointing, 5% scanning

  - Open a website related to a radio show, radio in a graspable distance → 100% touching

  - Change the heating in a remote room → 100% scanning

  - Select a laptop to open a Wikipedia link, no line of sight, distance 4-5 meter → lying / sitting: 100% scanning; standing: 5% scanning, 25% pointing, 65% touching
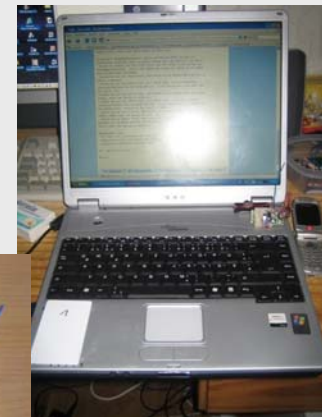
- Direct interaction techniques (touching and pointing)

  - Preferred when close to the device or line of sight

  - Correspond to everyday behavior

  - Preferred by older users who avoid input on mobile device

- Indirect interaction techniques (scanning)

  - Seen as a complex interaction technique

| | Touching | Pointing | Scanning |
|---|---|---|---|
| Natural Interaction, Intuitiveness | Good | Good | Average |
| Felt error resistance, non-ambiguous | Good | Average | Bad |
| Performance (within interaction distance) | Good | Average | Bad |
| Cognitive Load | Low | Medium | High |
| Physical Effort (outside interaction distance) | High | Medium | Low |

- Which interaction technique in which context?

- Findings:

  - Users tend to switch to a specific physical mobile interaction technique dependent on location, activity and motivation.

  - The current location of the user is the most important criterion for the selection of a physical mobile interaction technique.

  - The user's motivation to make any physical effort is generally low.

- Location: graspable → touching (intuitive, fast), pointable → pointing (fast), otherwise scanning (no line of sight, physical effort)

- Activity: standing → motivation to move for touching or pointing

- Motivation: security (older people prefer touching, no risk to select the wrong device), speed (critical situation → preference for touching and pointing, scanning is time consuming), intuitiveness (direct interaction techniques touching and pointing are preferred)

- Physical Mobile Interactions in Smart Environments

- Touching, Pointing and Scanning

- Online Survey, Paper Prototype, High-Fidelity Prototype

- Findings and Guidelines: When (location, activity, motivation) which interaction technique?

- Future Work

  - Further physical mobile interactions (LBS) and implementations (visual marker)

  - Long term studies

  - Further application areas and studies: Tourist Guides, Museum Guides, Mobile Advertising, Mobile Learning, Mobile Commerce

Analysis → Online Survey → Results
basis for
Design → Low Fidelity Prototype (Paper Prototype) → User Study → Findings & Guidelines
basis for
Implementation → High Fidelity Prototype → User Study
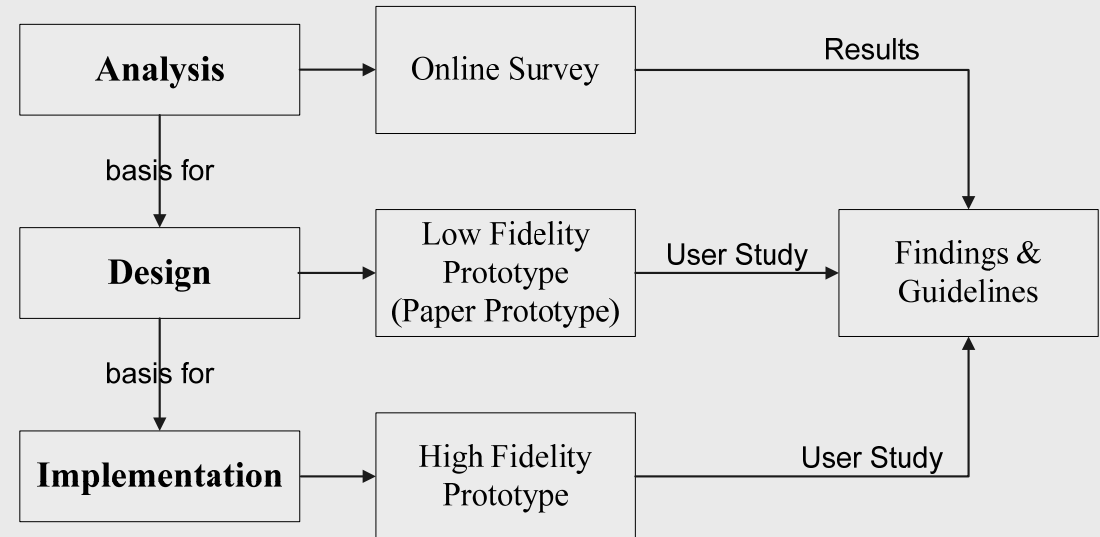
- Questions?


- Further Information

    - Enrico Rukzio: http://www.mimuc.de/team/rukzio

    - Research project Embedded Interaction: http://www.hcilab.org

    - Intelligent Inhabited Environments Group (iDorm2): http://iieg.essex.ac.uk

# **References**

[1] J. Boyd. Here comes the wallet phone [wireless credit card], IEEE Spectrum, 42(11). 2005.

[2]  Geoffrey A. Fowler. QR codes: In Japan, Billboards Take Code-Crazy Ads to New Heights. Wall Street Journal 10.10.2005

http://www.mindfully.org/Technology/2005/QR-Codes-Japan10oct05.htm

[3] PointMe: Välkkynen, P., Korhonen, I., Plomp, J., Tuomisto, T., Cluitmans, L., Ailisto, H., Seppä, H.,"A user interaction paradigm for physical browsing and near-object control based on tags", In: 5th Human Computer Interaction with Mobile Devices and Services, Udine, Italien, September 2003

[4] Philips, Nokia und deutscher Rhein-Main Verkehrsverbund testen NFC Handy-Ticketing. 29. April 2005.   http://www.philips.at/about/news/press/halbleiter/article-15004.html