Context awareness in collaborative environments

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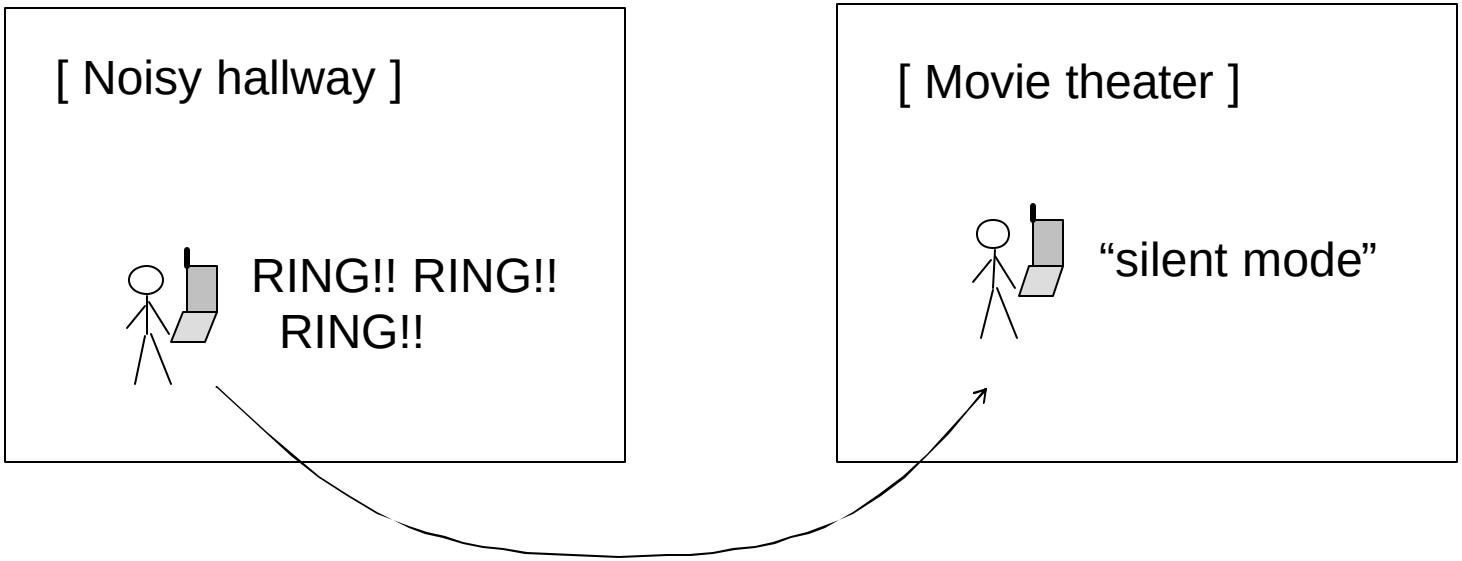
Outline

- Context awareness and collaboration
  - What is context?
  - How should context be used to support ***collaboration?***
  - Examples
  - Design issues
  - Privacy issues
  - Summary

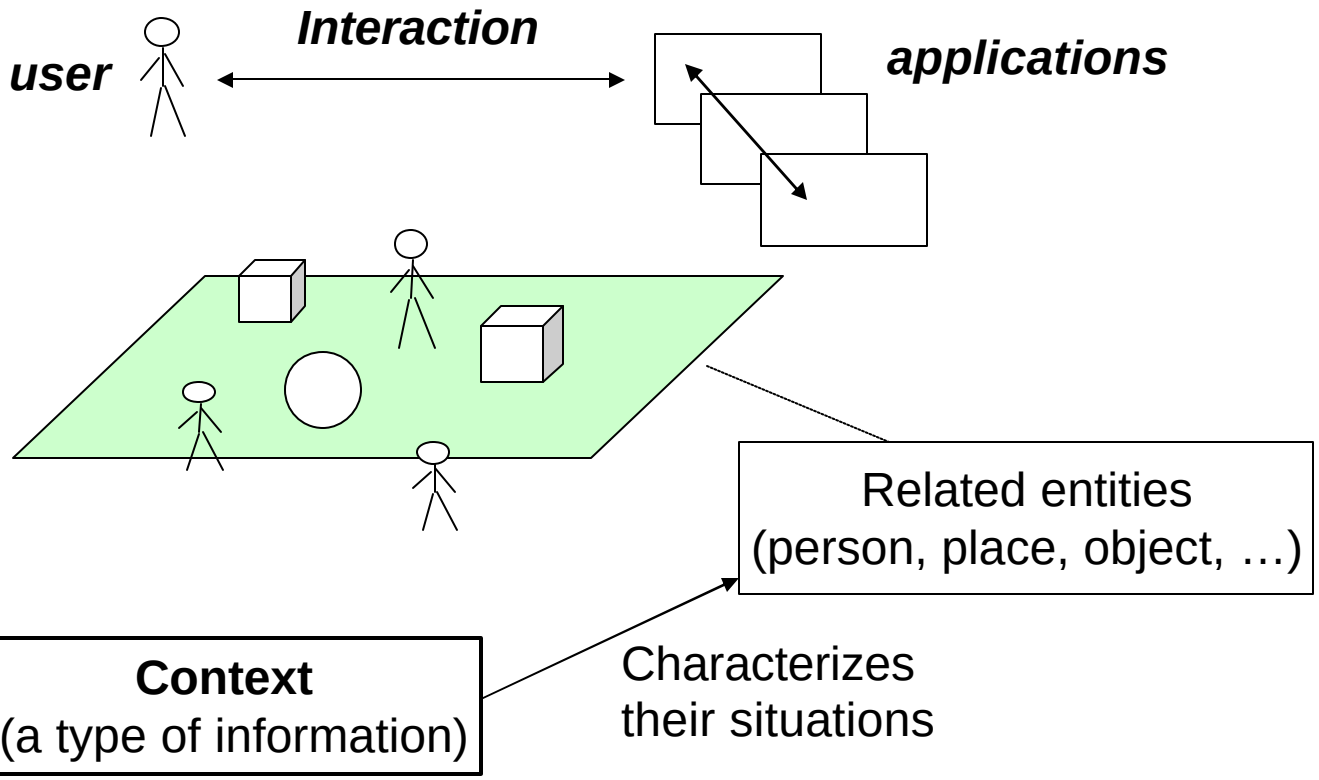
What is *context*?

A context-aware cell phone



What is context?

Definition based on (Dey, Abowd, & Salber, 2001)



Examples:
location, identity and state of people, groups and computational and physical objects

Other examples

- *Context-aware services*
  - Meeting support
  - Smart tour guides
  - Information services for commuters
  - Smart care
  - Store of the Future
  - Next generation retail technology
  - Online medical cabinet and wardrobe

Meeting support

http://www.roomware.de

Sample Scenarios:

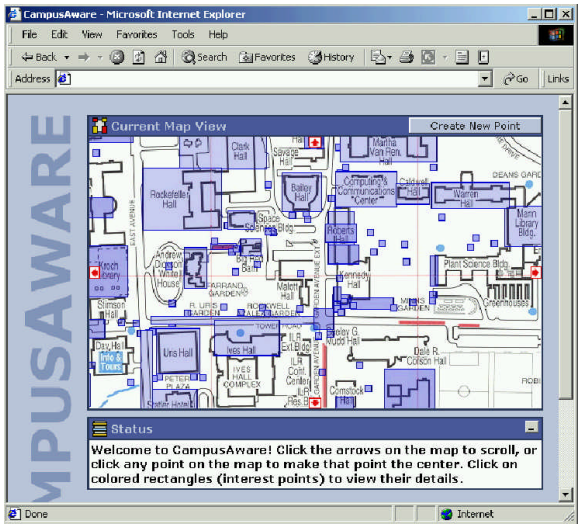
People enter a meeting room ➔ a meeting agenda automatically shown on the wall-sized screen

Person A stands near the screen and puts a physical token on the blue area ➔his data appear on the screen

Person B and C move their chairs so they can see each other ➔ a collaboration tool automatically launched on the “chair computers”

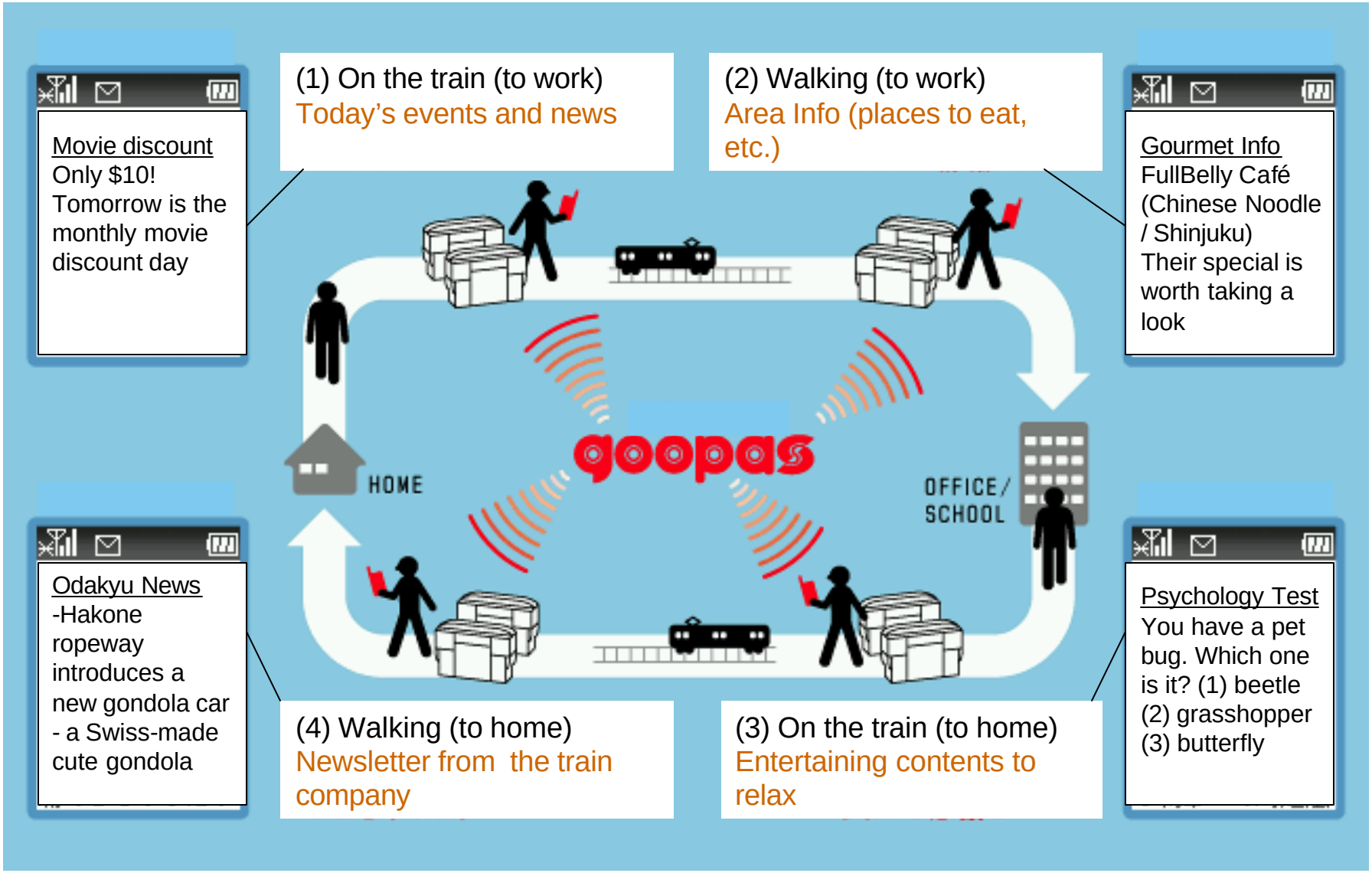
Tour guides

- Campus Aware (Cornell University)
- **Learning**, planning and navigating

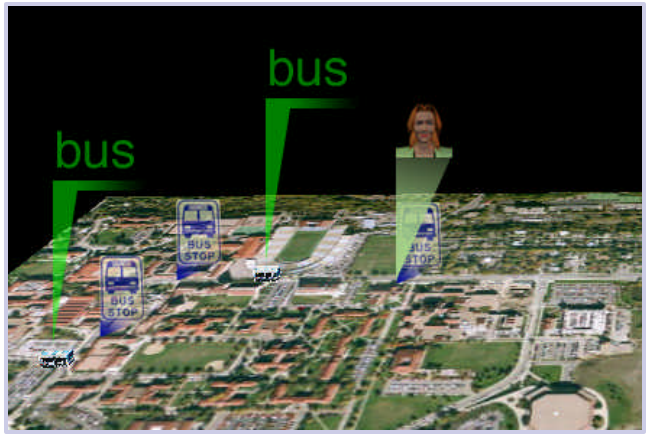


Users' locations and how much they liked each location (color-coded)
➔ *Social Navigation*

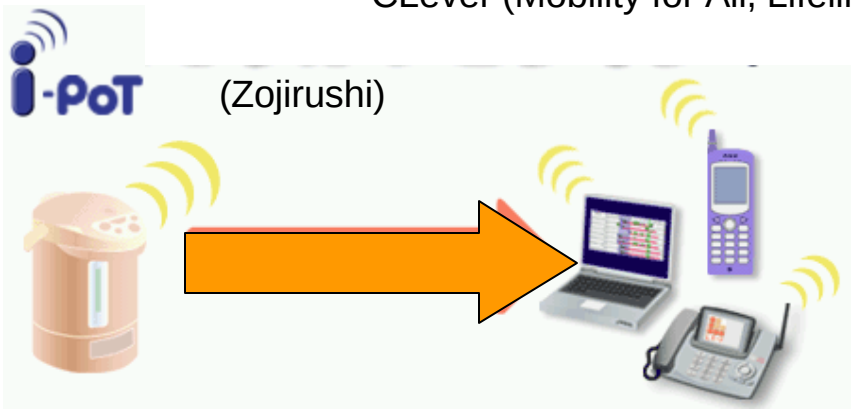
Information services for commuters



Elder care; support for cognitively handicapped people



CLever (Mobility for All, Lifeline, MAPS, …)



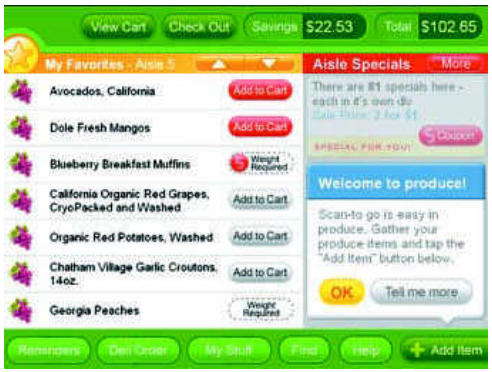
(Zojirushi)

“This water heater tells you if your elder parents are fine”

A glove for an elder (Intel)
Detects touched household objects

Store of the Future

Future Store (Rheinberg, Germany)
http://www.future-store.org/



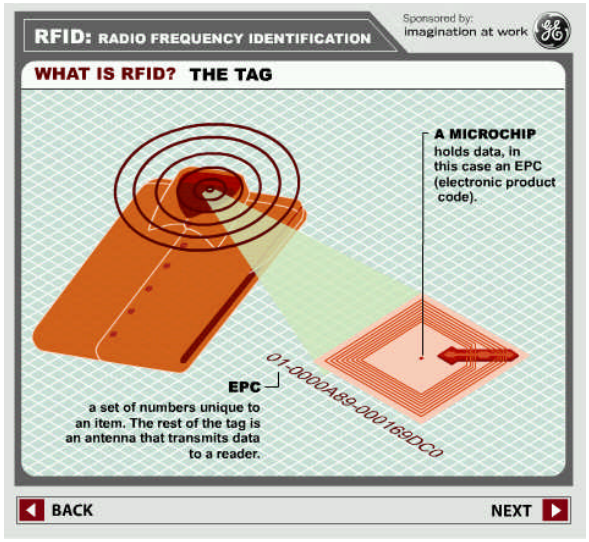
Shopping Buddy (Kingston, MA)
http://www.kioskbusiness.com/janfeb_03/article1.html
http://www.cbsnews.com/stories/2003/08/11/earlyshow/contributors/lauriehibberd/main567720.shtm

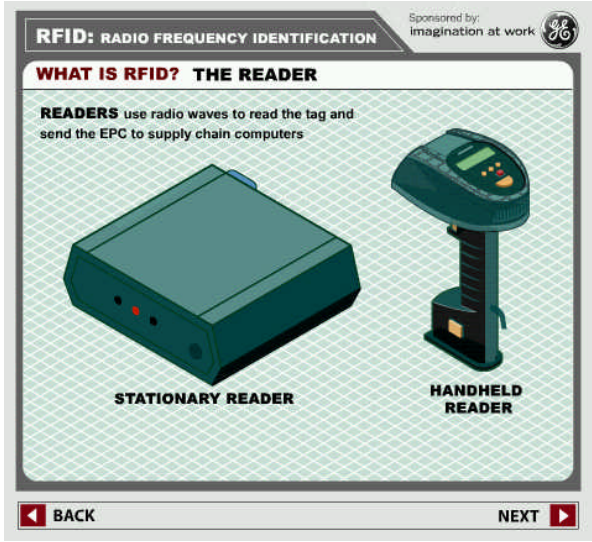
Future Store (video)

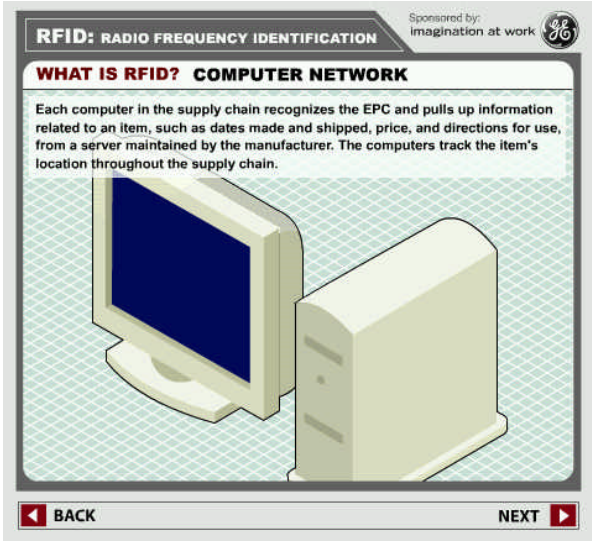
http://www.future-store.org/servlet/PB/menu/1002197_l2/index.html

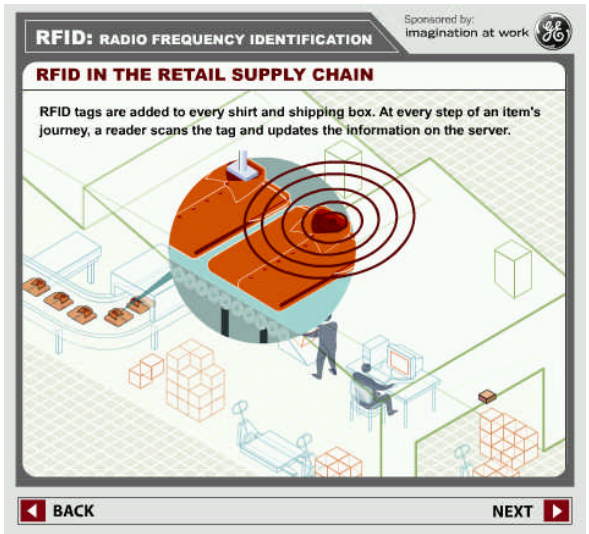
Next Generation Retail Technology

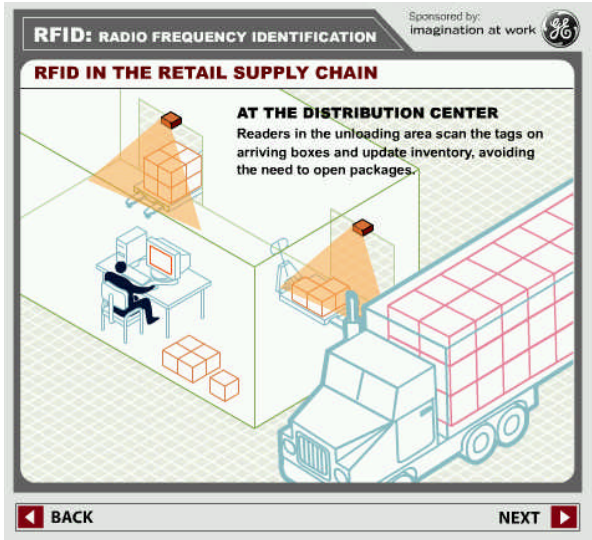
http://www.technologyreview.com/articles/visualize0304.asp

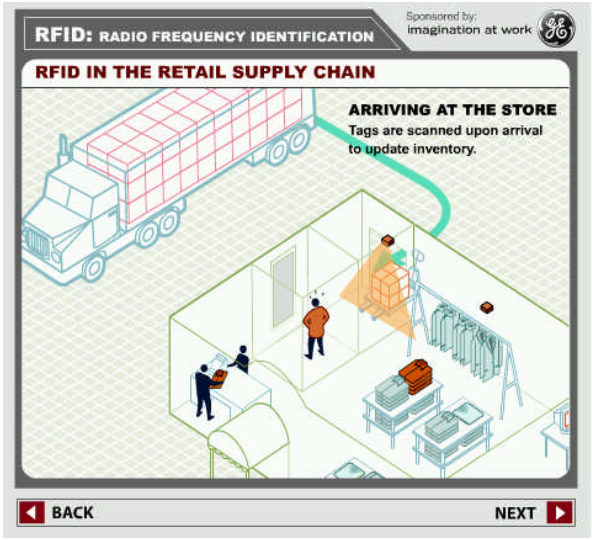












Next Generation Retail Technology

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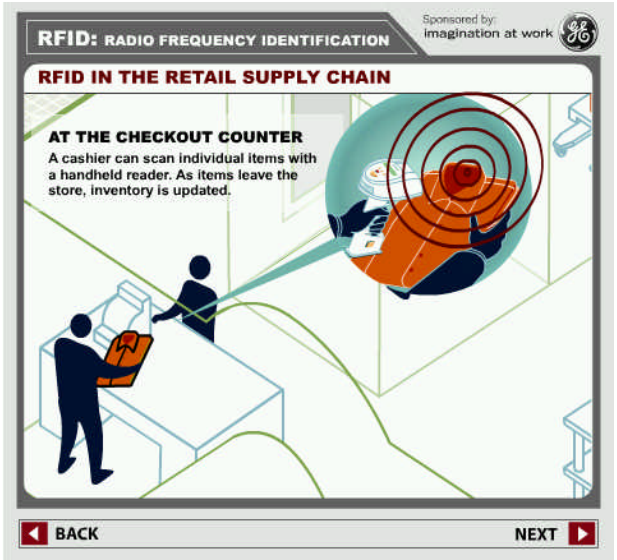
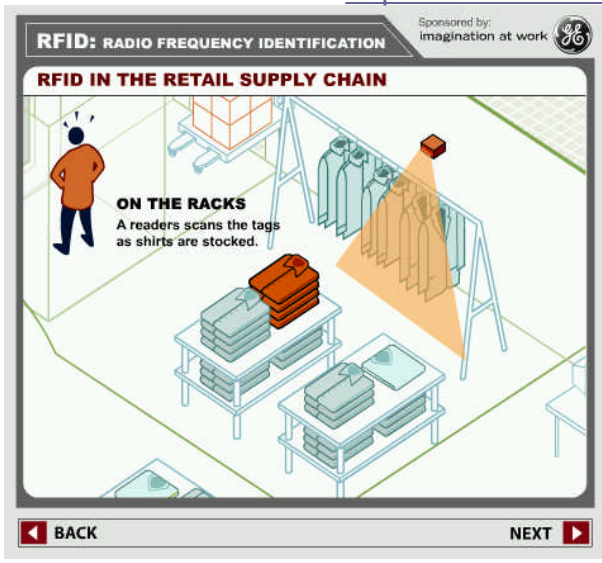
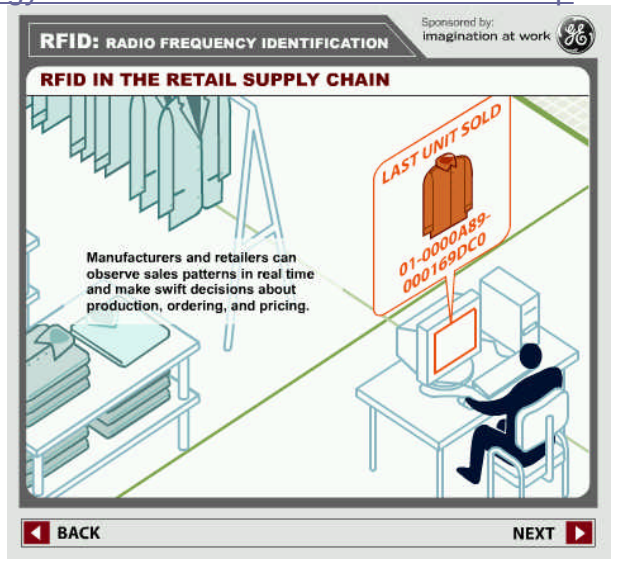
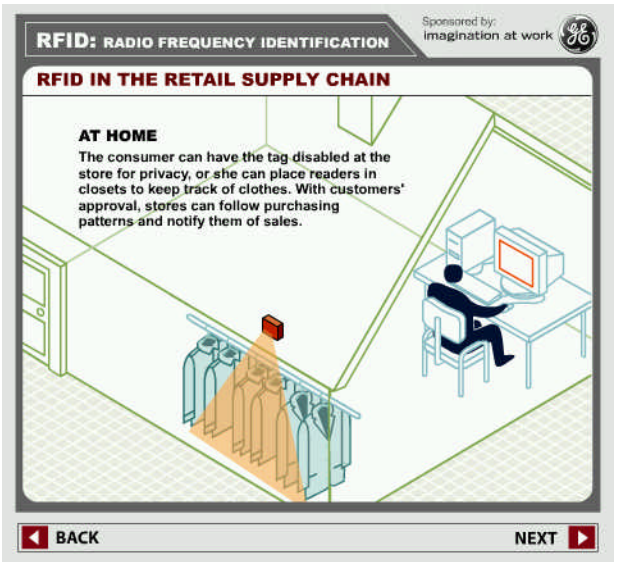
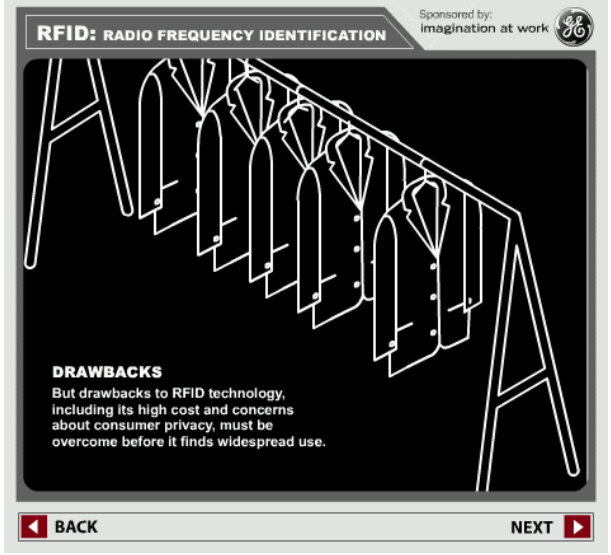










Online Wardrobe

http://www.accenture.com/xd/xd.asp?it=enweb&xd=services%5Ctechnology%5Cvision%5Csil_what.xml

Online Medicine Cabinet

http://www.accenture.com/xd/xd.asp?it=enweb&xd=services%5Ctechnology%5Cvision%5Csil_what.xml

Enabling technologies

- GPS (Global Positioning System)
- RFID (Radio Frequency Identification)
- Sensors
  - Infrared, ultrasound, temperature, light, vibration, vision, sound, etc.
- Wireless networks
  - Wireless LAN, Bluetooth, Ultra Wide Band, Near Field Communication, etc.
- Information appliances
- Data management systems (middleware and databases)
- Software development platforms (e.g., GeorgiaTech's Context Toolkit)

Lessons learned so far

Prada Epicenter (Manhattan, NYC)

(Busuness 2.0, March 2004 issue)

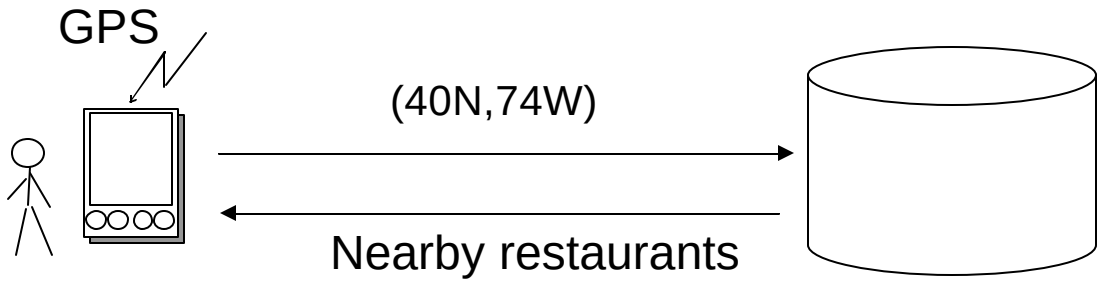
How should *context* be used to support collaboration?

- Creating context-aware applications is not an end in itself, but it is a *means to an end.*

“How can contextual information empower users to live, work, learn, and collaborate more easily and more productively?”

Beyond location awareness

- One of the simplest location-aware systems



- **Can we go beyond that? What are possibilities and challenges?**
  - How can we capture the larger (often unarticulated) context of what users are doing?
  - How can we increase the richness of resources available for computer programs to understand their uses?

What is context, really?

- Many conventional systems are limited by the designers' simplistic definitions/views of context
- Defining context is not easy
  - Context is dynamic
  - Context emerges throughout the design process
  - Context plays a critical role in shaping, interpreting and understanding an action
  - Users are situated in some settings of people, places, and things Features of the world become context through their use
- How can we build better context-aware applications based on these considerations?

c.f., Journal of Human-Computer Interaction, Vol. 16. Special Issue on Context-aware Computing. Laurence Erlbaum Associates, 2001

Context, context, context

- The location identity and state of people, groups and computational and physical objects

- **In addition:** domain, artifact under construction, user's intentions and goals, background knowledge, social interactions, specification components; physical features, user profile, list of preferences, domain description, collection of background beliefs, record of past conversations, immediately preceding utterances, expectations about the future, scientific hypothesis, religious beliefs, anecdotal memories, general cultural assumption, beliefs about the mental state of the speaker (user); physical, organizational, social, cultural context, temporal and interactional context (within a larger pattern of activity); temporal, attentional, social, organizational context; physical, device, and informational context; buildings and architecture; "entry points", "activity landscape" and "coordinating mechanisms" in an office; institutions, buildings, framework for practices ("rules for a game"); and so on.

c.f., Journal of Human-Computer Interaction, Vol. 16. Special Issue on Context-aware Computing. Laurence Erlbaum Associates, 2001

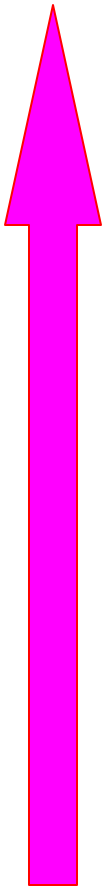
Unarticulated design intent

- **A large fraction of context-relevant information cannot be inferred from the environment** because the context resides outside the environment, is unarticulated, or exists only in the head of a designer.

- **If a system provides mechanisms to articulate intentions explicitly and designers are willing to do so**, the additional context can be used to identify the breakdown situation and provide designers with opportunities for reflection and learning.

(G. Fischer et al., 2004)

How much information is out there?



- *Moore's law → Ultimate iPod in 2020??*
- *If Wal-Mart attaches RFID tags on all goods, they may produce more than 7 terabytes a day*

Yotta Byte

Zetta Byte — Current *collective* global information

Exa Byte — all photographs taken (1 yr)

Peta Byte — all TV and radio programs (1 yr)

Tera Byte — all movies made (1 yr)

all music records sold (1 yr)

information that can be consumed by watching TV for one's entire life

Giga Byte

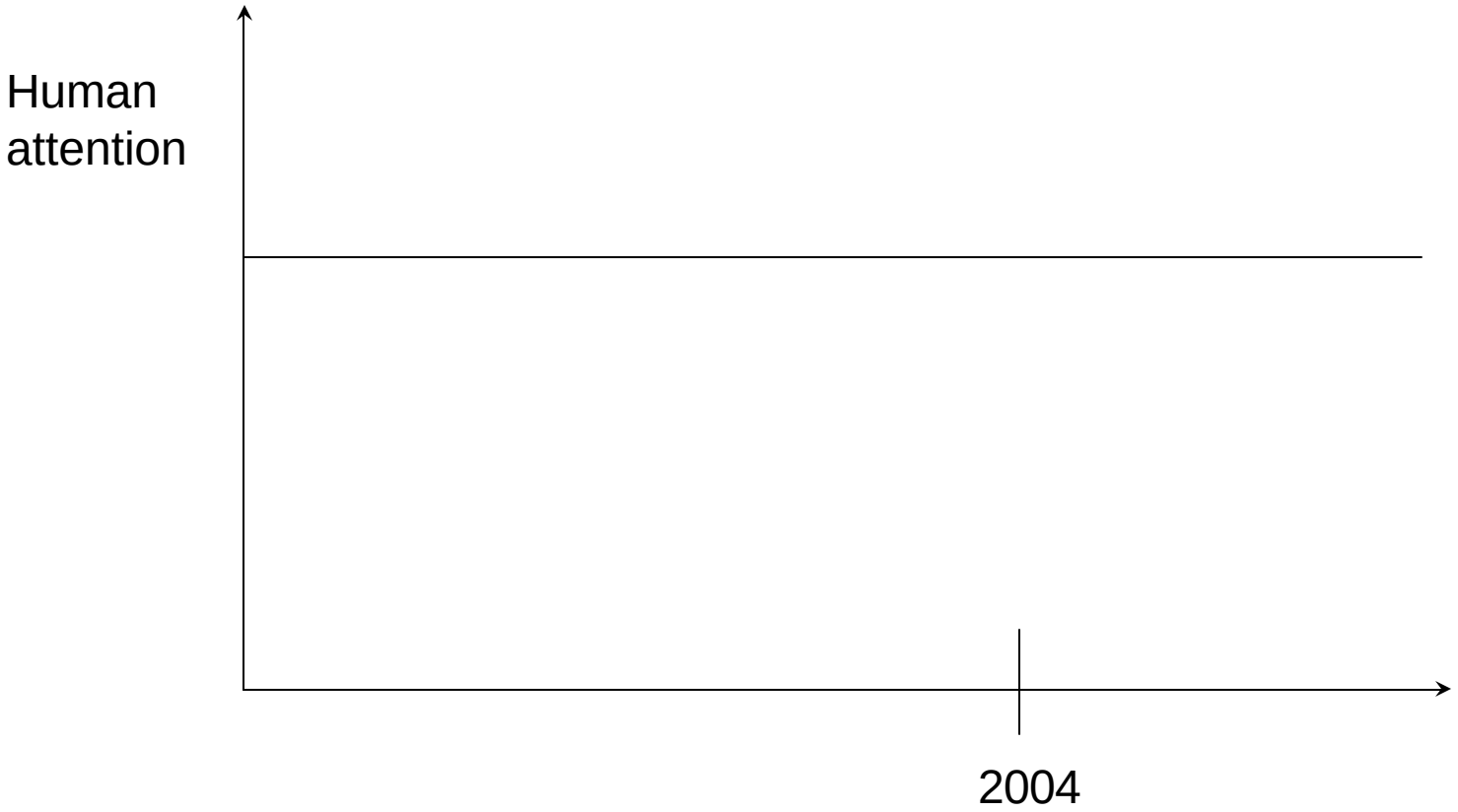
Mega Byte — a book

Kilo Byte

Human attention is the scarce resource

http://www.lesk.com/mlesk/ksg97/ksg.html

Human attention is the scarce resource



Context awareness

- **Context awareness 1:** “anytime/anywhere”
- **Context awareness 2:** “right thing at the right time in the right way”

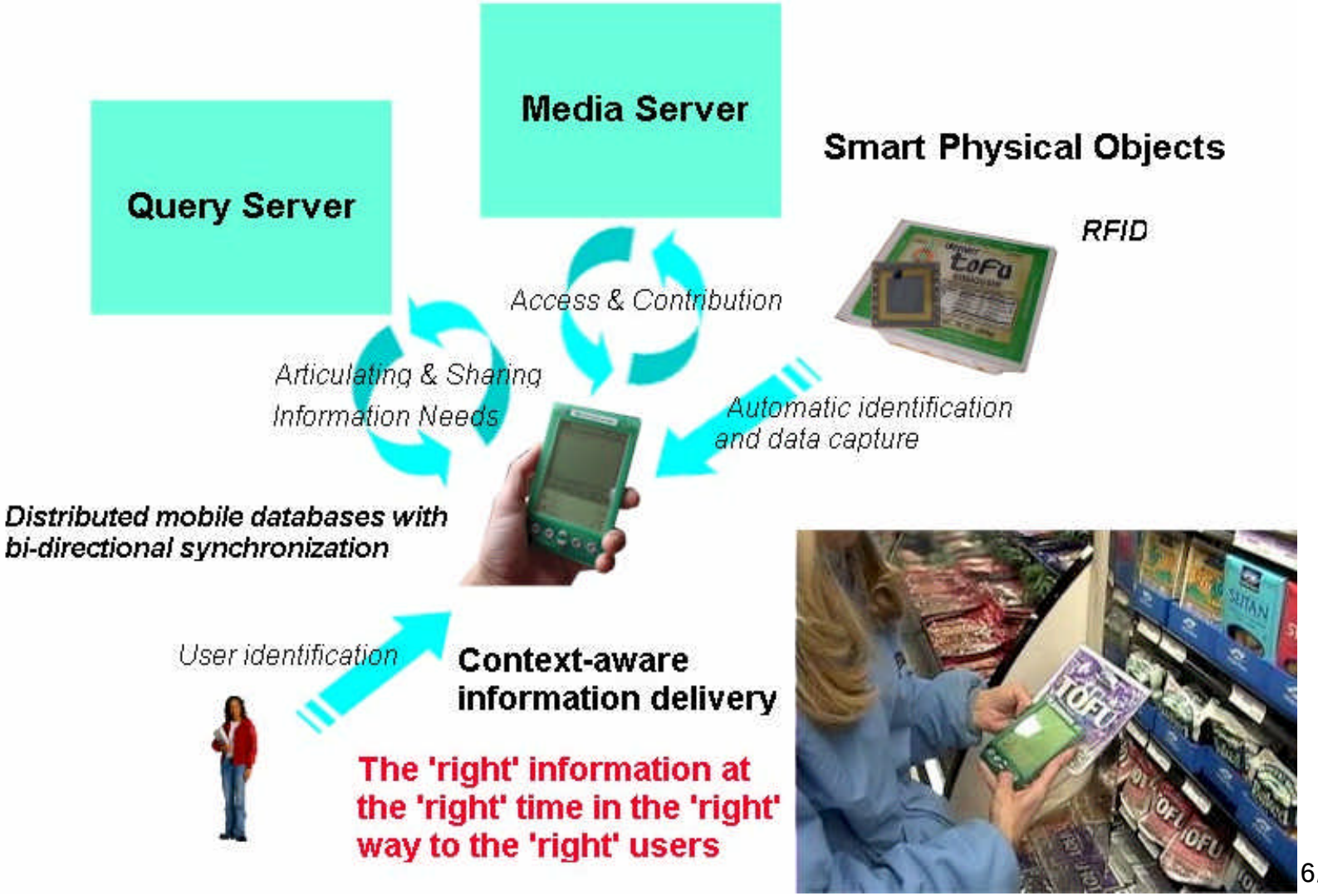
Information work is often fragmented (people change working spheres)

Challenge for context awareness is to enable people to integrate their information

- **Context awareness 3:** “The right thing at the right time in the right way with the right kind of integration

(G. Mark 2004)

Context-aware information delivery (QueryLens)

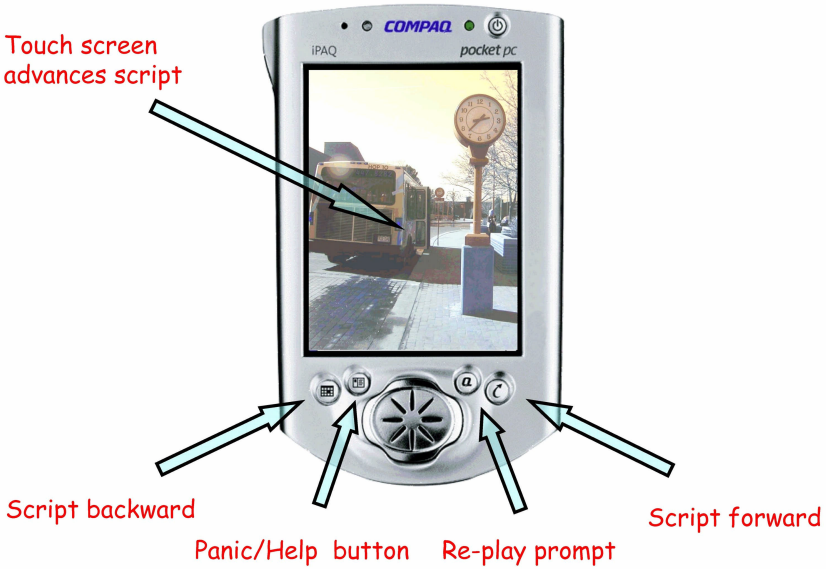


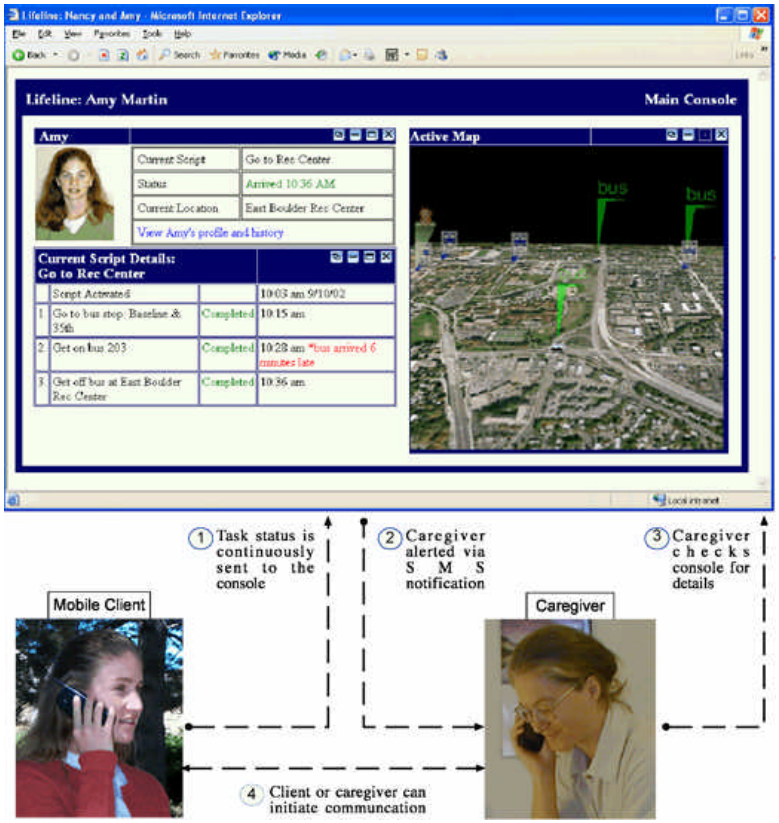
Context and Distributed Cognition

- In most traditional approaches, human cognition has been seen as existing solely ‘inside’ a person’s head, and studies on cognition have often disregarded the **physical and social surroundings in which cognition takes place.**
- ***Distributed cognition*** provides an effective theoretical framework for understanding what humans can achieve and **how artifacts, tools, and socio-technical environments can be designed and evaluated to empower humans beings and to change tasks** (Hollan, Hutchins, & Kirsch, 2001; Salomon, 1993);
- Distributed cognition considers how information, and information processing, has moved from a centralized paradigm from “in the head” or “on the desktop” **to a decentralized and distributed model that permeates one’s environment** (Fischer, 2003)

➔ What does Distributed Cognition inform the design of context-aware application?

Mobility for All (MAPS & Lifeline)





Design time and use time

- Difficult to imagine the use time at the design time
- More so in off-the-desktop computing

➔ Collaborative design of context-aware applications

➔ Toward Meta-Design

Collaborative design processes

- Generally Ill-defined
- Iterative
- Involve tradeoffs
- Multiple perspectives

Design communities

- Design communities
  - Social structures that enable groups of people to share knowledge and resources in support of collaborative design
- Communities of Practice (CoPs)
  - CoPs (Wenger, 1998) consist of practitioners who work as a community in a certain domain undertaking similar work
- Communities of Interest (CoIs)
  - CoIs bring together stakeholders from different CoPs and are defined by their collective concern with the resolution of a particular problem. CoIs can be thought of as “communities of communities” (John S. Brown & Duguid, 1991) or a community of representatives of communities.

Meta-design (in context-aware applications)

- Designing the design process
- Creating technical and social conditions for broad participation
- Owners of problem act as designers (extend the system to fit their needs)
- Meta-design allows various stakeholders to become co-designers not only at design time but also throughout the whole existence of the system

Open, evolvable systems

- Complex real-world problems are not solved once and for all, but instead are solved incrementally as they are better understood and as changes in the use situation require previous decisions to be revisited

Challenges for moving toward new forms of participation

- Need to confront the paradox that Individuals cannot really participate unless they are informed, yet they cannot really be informed unless they participate

(J.S. Brown et al., 1994)

- Need to understand that participation has limits that are contingent on the nature of each individual's situation, the issues, the problems, and the institutional designs, as well as the processes provided for participation and the available technology and media

➔ EDC & PitaBoard

EDC & PiTaBoard

Adaptive and adaptable systems

- Adaptive systems
  - Dynamic adaptation by the system itself to current task and current user
- Adaptable systems
  - User changes (with substantial system support) the functionality of the system

Social navigation

- Helps users cope with large information spaces
  - Making other users actions visible ➔ Use them to find our way / solve problems

- In the physical world people observe the behavior of others all the time to determine where to go or what to do. You see this every time people follow a crowd to see what's going on, follow a hiking trail, or even follow someone's gaze to see what they are looking at

(J. Burrell et al., 2002)

Privacy Issues

- RFID privacy debates
  - Privacy advocates who are against RFID
    - CASPIAN (Consumers Against Supermarket Privacy Invasion and Numbering)
      - http://www.nocards.org/
      - http://www.spychips.com/index.html
  - Currently available (or soon to be available) solutions
    - “Kill switch”, Blocker Tags
    - Privacy guidelines and legislation
- *"The fundamental thing about technology is that there needs to be cooperation as never before between governments, consumers and vendors" "Consumers cannot be passive. They have to state their rights and how they wanted to be protected."* (Art Coviello, RSA)

Information about RFID privacy and security (including cryptography) see http://www.rsasecurity.com/rsalabs/rfid/index.asp

More resources on RFID and privacy

- U.S. Military to Issue RFID Mandate
  - http://www.rfidjournal.com/article/articleview/576/1/1/
- Wal-Mart Draws Line in the Sand
  - http://www.rfidjournal.com/article/articleview/462/1/1/
- "German Retailer Halts Radio Chip Practice"
  http://www.siliconvalley.com/mld/siliconvalley/news/8060815.htm
- Target Issues RFID Mandate
  - http://www.rfidjournal.com/article/articleview/802/1/1/
- Handheld scanners are Albertsons newest technology
  - http://www.idahostatesman.com/Story.asp?ID=64308
- FDA Endorses RFID Technology
  - http://www.rfidjournal.com/article/articleview/801/1/1/

Summary

- Context awareness in collaborative environments
- What is context?
- Existing systems
- How should context be used to support collaboration?
  - Beyond location awareness
  - Distributed cognition
  - Collaborative design and meta-design

Related publication:
"Supporting Collaboration and Distributed Cognition in Context-Aware Pervasive Computing Environments", (with Ernesto Arias, Stefan Carmien, Hal Eden, Andrew Gorman, Shin'ichi Konomi, James Sullivan) Paper Presented at the 2004 Meeting of the Human Computer Interaction Consortium "Computing Off The Desktop", February 2004 - available at: http://www.cs.colorado.edu/~gerhard/papers/hcic2004.pdf