



Context awareness in collaborative environments

Guest Lecturer: Shin'ichi Konomi
konomi@cs.colorado.edu

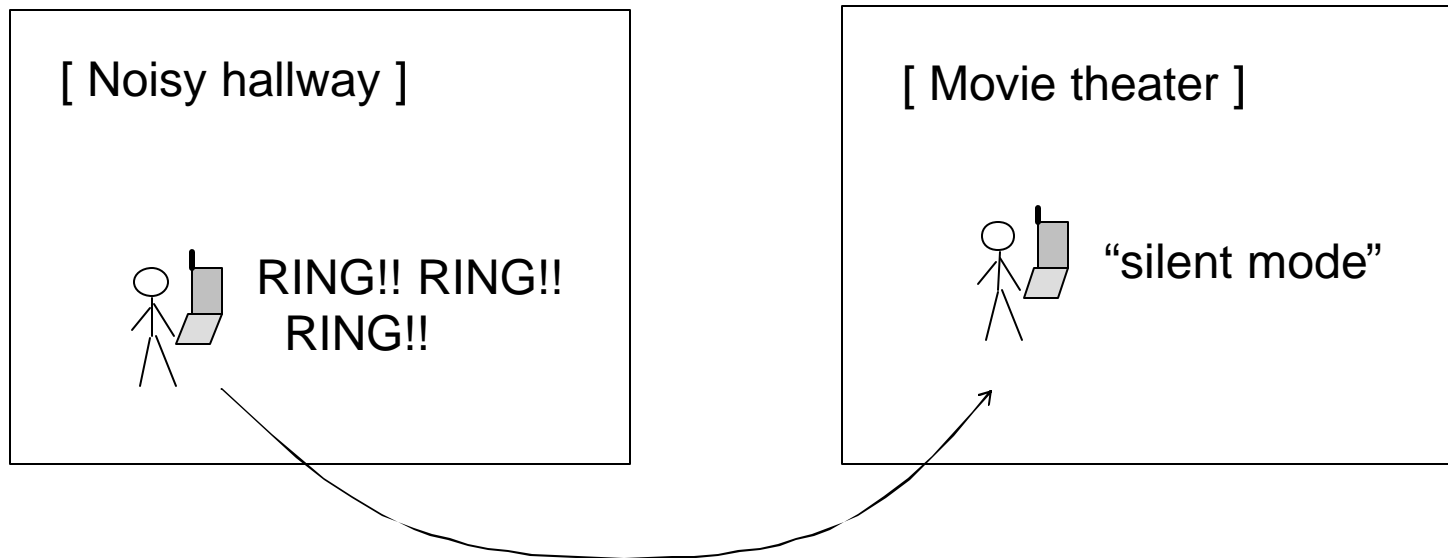


Outline

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

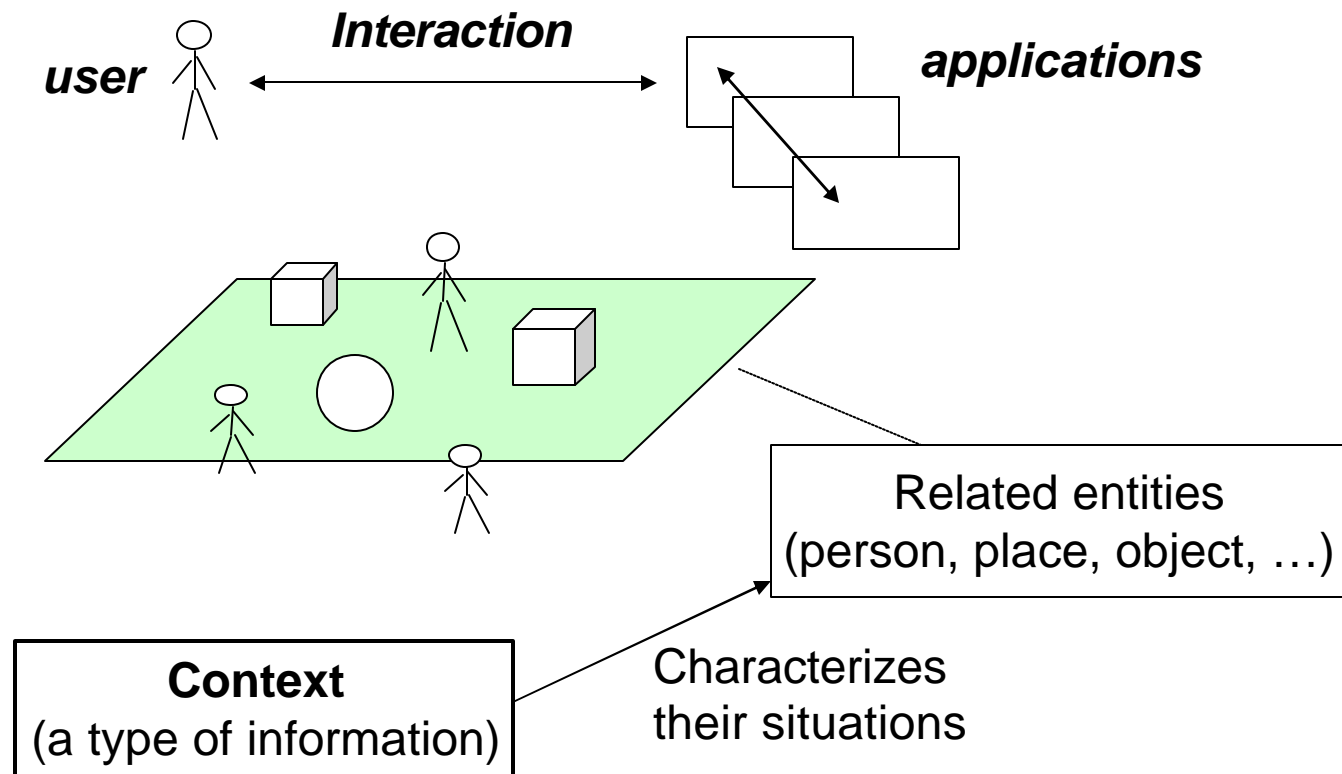
What is *context*?

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:

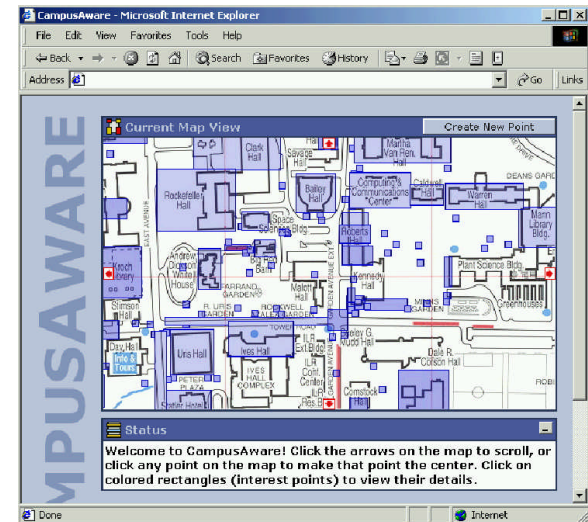
People enter a meeting room → a meeting agenda automatically shown on the wall-sized screen

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

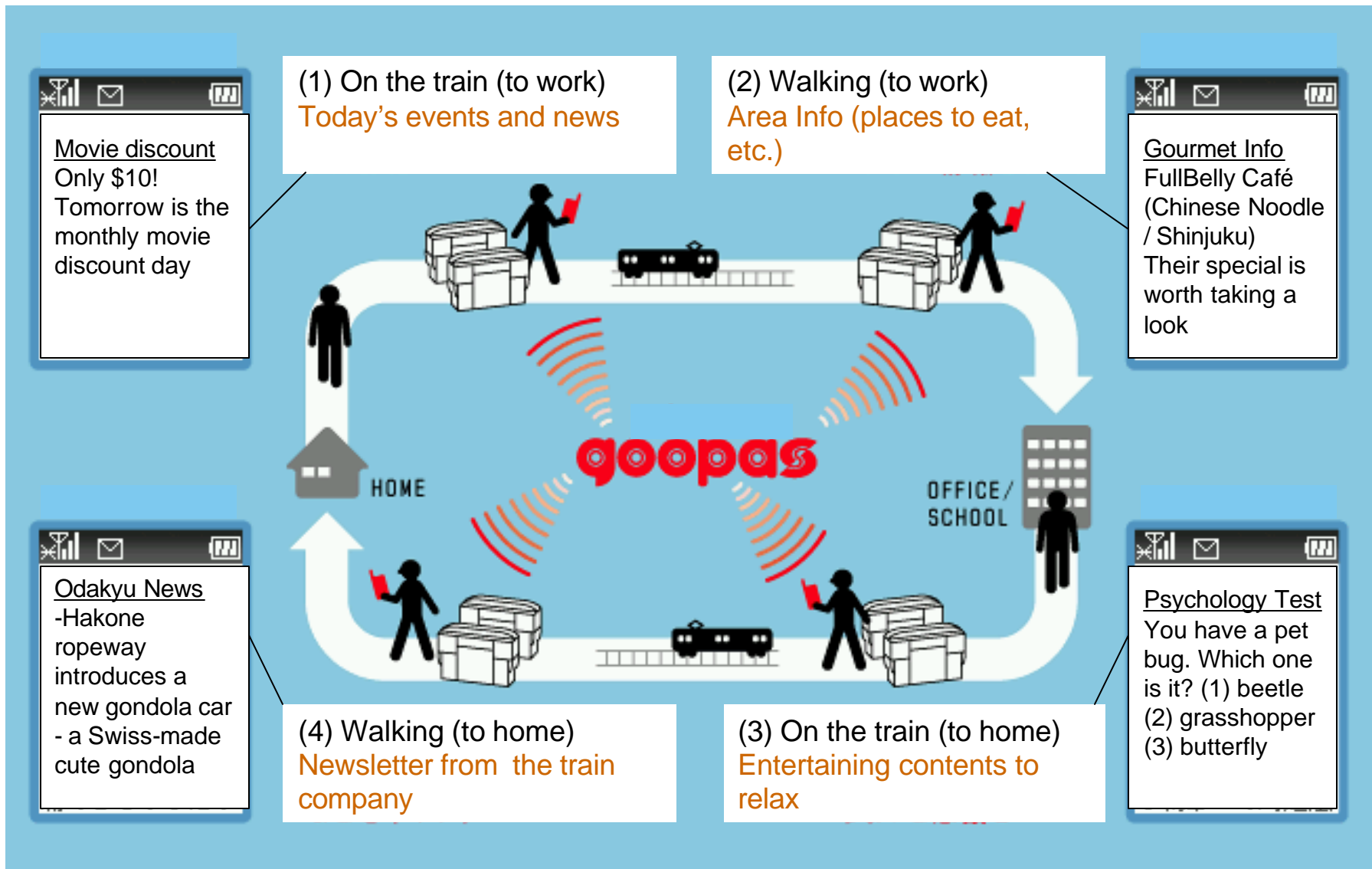
- Campus Aware (Cornell University)
- **Learning**, planning and navigating



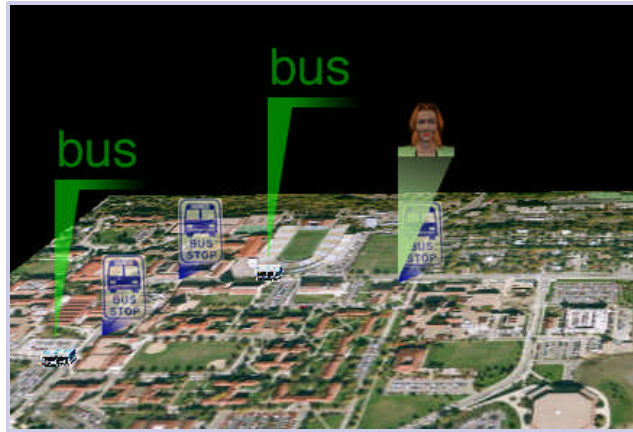
Users' locations and how much they liked each location (color-coded)

➔ *Social Navigation*

Information services for commuters



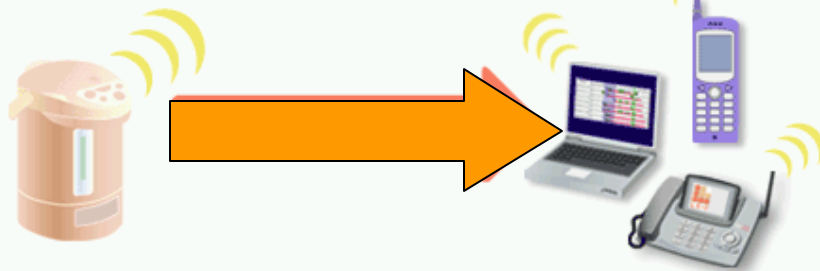
Elder care; support for cognitively handicapped people



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



(Zojirushi)

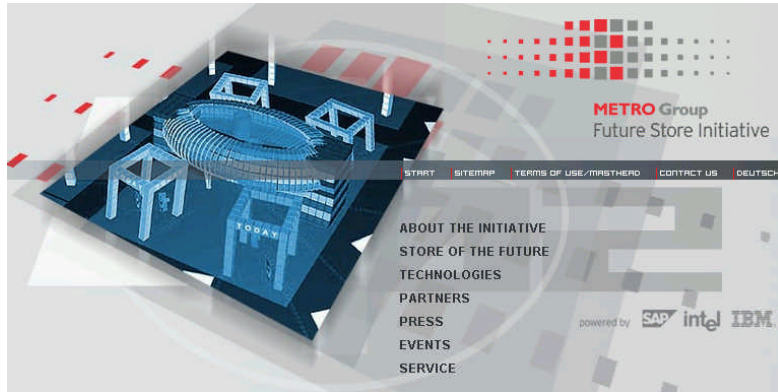


"This water heater tells you if your elder parents are fine"

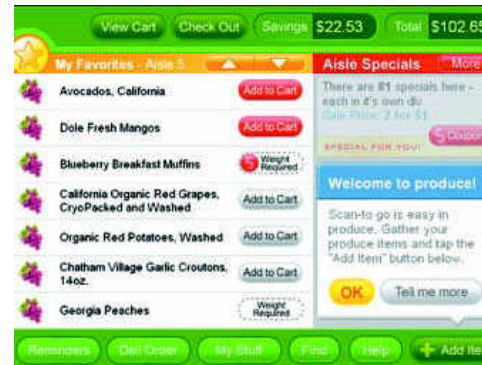


A glove for an elder (Intel)
Detects touched household objects

Store of the Future



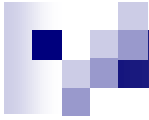
Future Store (Rheinberg, Germany)
<http://www.future-store.org/>



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_12/index.html



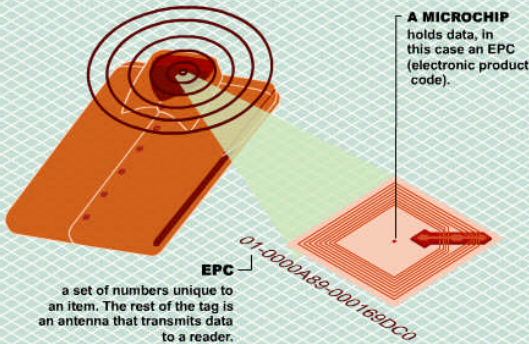
Next Generation Retail Technology

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

Sponsored by:  imagination at work

RFID: RADIO FREQUENCY IDENTIFICATION

WHAT IS RFID? THE TAG




A MICROCHIP holds data. In this case an EPC (electronic product code).

EPC
a set of numbers unique to an item. The rest of the tag is an antenna that transmits data to a reader.

01-0000189-000189DC0

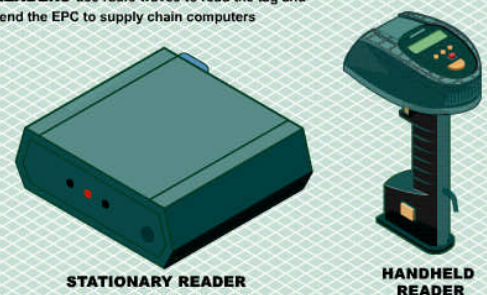
◀ BACK NEXT ▶

Sponsored by:  imagination at work

RFID: RADIO FREQUENCY IDENTIFICATION


WHAT IS RFID? THE READER

READERS use radio waves to read the tag and send the EPC to supply chain computers



STATIONARY READER HANDHELD READER

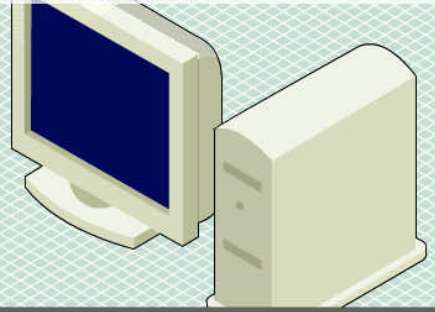
◀ BACK NEXT ▶

Sponsored by:  imagination at work


RFID: RADIO FREQUENCY IDENTIFICATION

WHAT IS RFID? COMPUTER NETWORK

Each computer in the supply chain recognizes the EPC and pulls up information related to an item, such as dates made and shipped, price, and directions for use, from a server maintained by the manufacturer. The computers track the item's location throughout the supply chain.



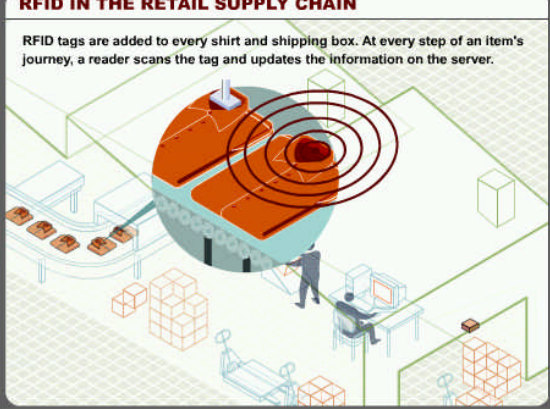
◀ BACK NEXT ▶

Sponsored by:  imagination at work


RFID: RADIO FREQUENCY IDENTIFICATION

RFID IN THE RETAIL SUPPLY CHAIN

RFID tags are added to every shirt and shipping box. At every step of an item's journey, a reader scans the tag and updates the information on the server.



◀ BACK NEXT ▶

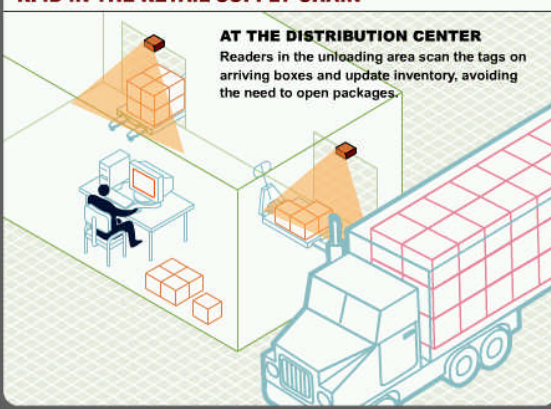
Sponsored by:  imagination at work

RFID: RADIO FREQUENCY IDENTIFICATION


RFID IN THE RETAIL SUPPLY CHAIN

AT THE DISTRIBUTION CENTER

Readers in the unloading area scan the tags on arriving boxes and update inventory, avoiding the need to open packages.



◀ BACK NEXT ▶

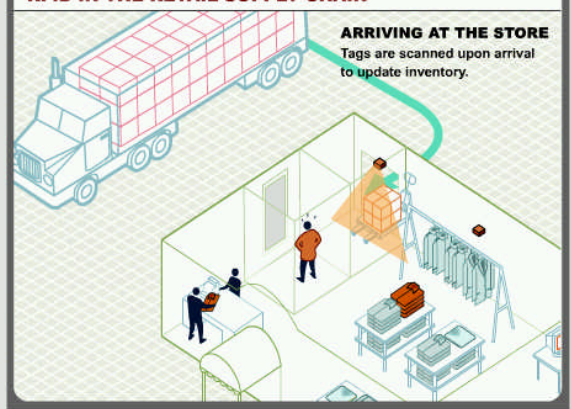
Sponsored by:  imagination at work

RFID: RADIO FREQUENCY IDENTIFICATION

RFID IN THE RETAIL SUPPLY CHAIN

ARRIVING AT THE STORE

Tags are scanned upon arrival to update inventory.




◀ BACK NEXT ▶

Next Generation Retail Technology

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


RFID: RADIO FREQUENCY IDENTIFICATION

Sponsored by:  imagination at work

RFID IN THE RETAIL SUPPLY CHAIN

AT THE CHECKOUT COUNTER

A cashier can scan individual items with a handheld reader. As items leave the store, inventory is updated.



◀ BACK

NEXT ▶

RFID: RADIO FREQUENCY IDENTIFICATION

Sponsored by:  imagination at work

RFID IN THE RETAIL SUPPLY CHAIN

ON THE RACKS


A readers scans the tags as shirts are stocked.



◀ BACK

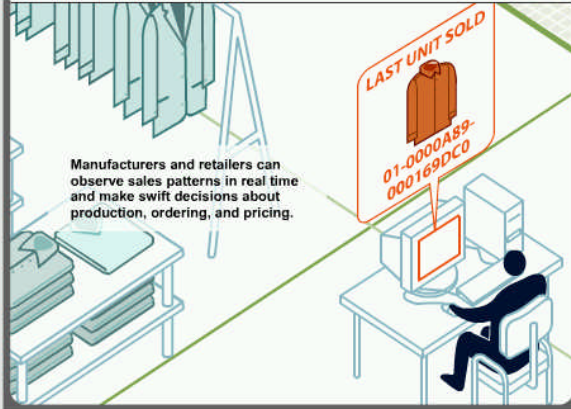
NEXT ▶

RFID: RADIO FREQUENCY IDENTIFICATION

Sponsored by:  imagination at work

RFID IN THE RETAIL SUPPLY CHAIN


Manufacturers and retailers can observe sales patterns in real time and make swift decisions about production, ordering, and pricing.



◀ BACK

NEXT ▶

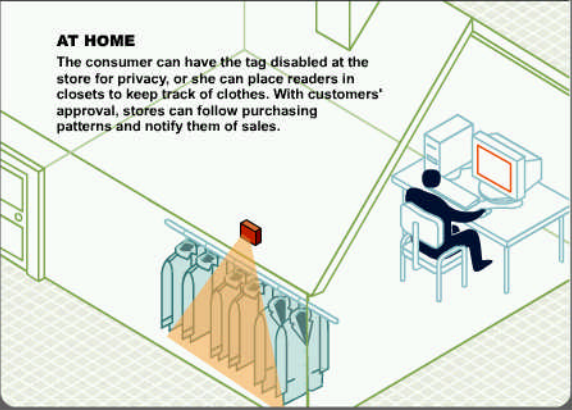
RFID: RADIO FREQUENCY IDENTIFICATION

Sponsored by:  imagination at work

RFID IN THE RETAIL SUPPLY CHAIN

AT HOME


The consumer can have the tag disabled at the store for privacy, or she can place readers in closets to keep track of clothes. With customers' approval, stores can follow purchasing patterns and notify them of sales.



◀ BACK

NEXT ▶

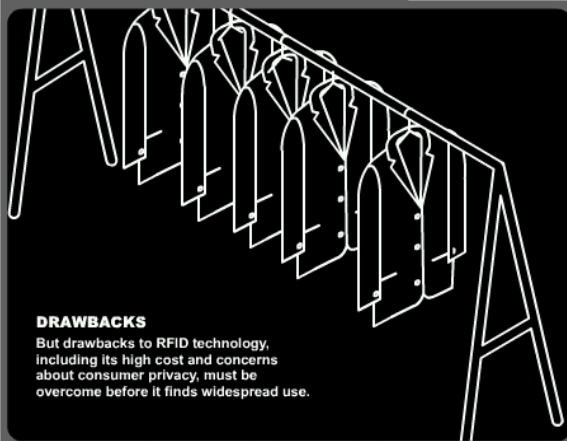
RFID: RADIO FREQUENCY IDENTIFICATION

Sponsored by:  imagination at work

RFID IN THE RETAIL SUPPLY CHAIN

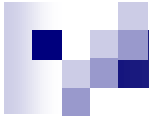
DRAWBACKS

But drawbacks to RFID technology, including its high cost and concerns about consumer privacy, must be overcome before it finds widespread use.



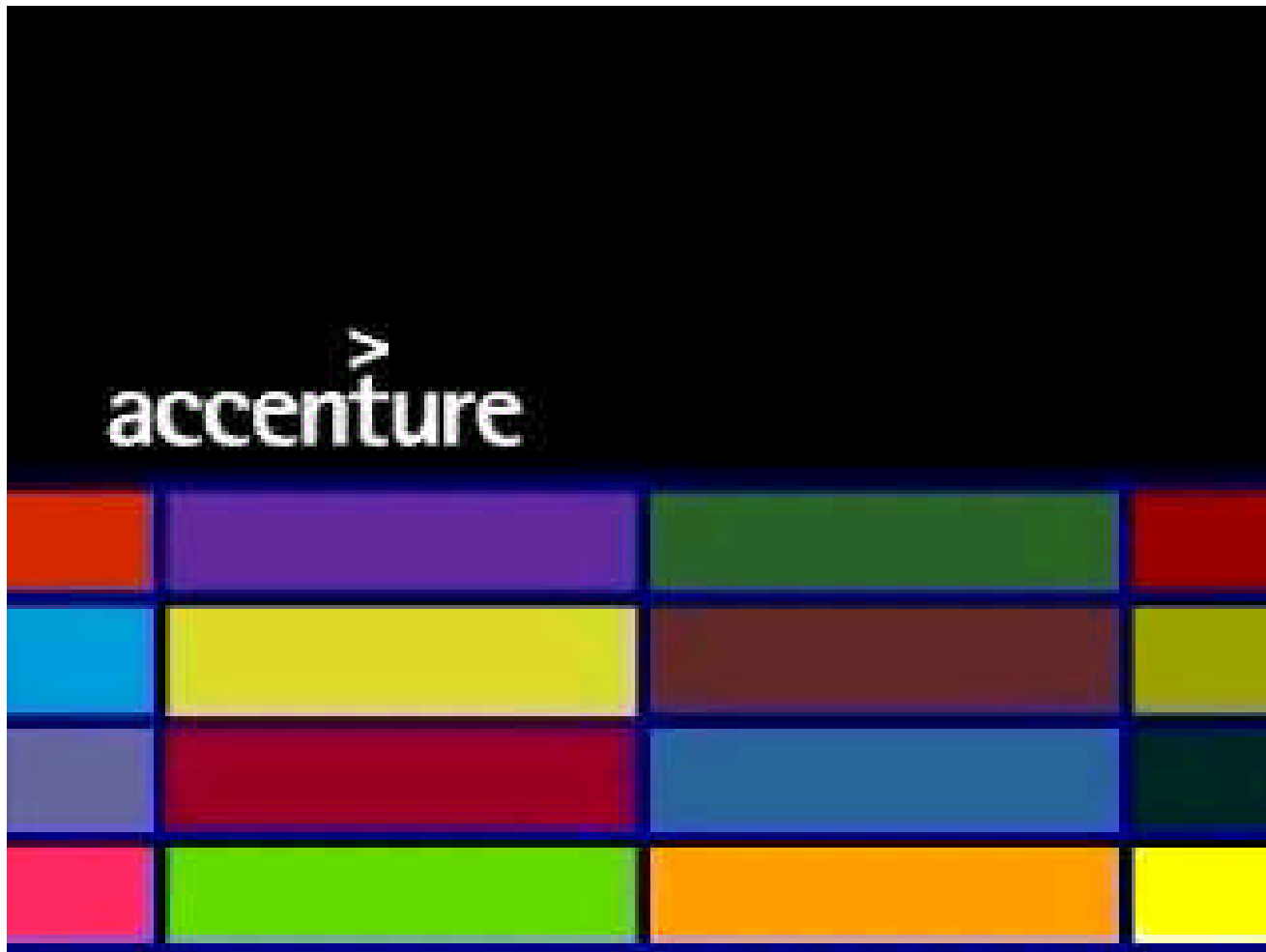
◀ BACK

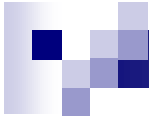
NEXT ▶



Online Wardrobe

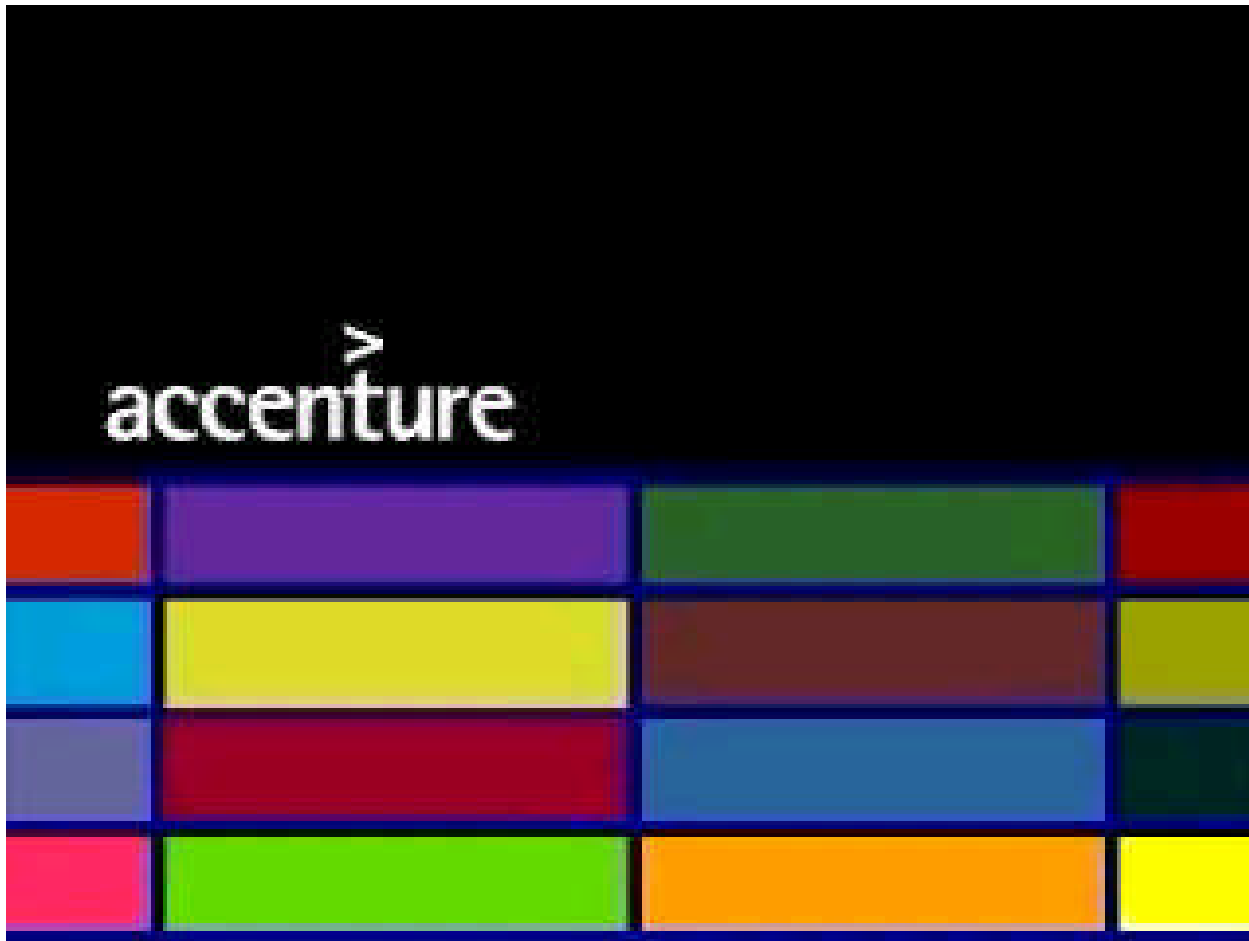
http://www.accenture.com/xd/xd.asp?it=enweb&xd=services%5Ctechnology%5Cvision%5Csil_what.xml





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)

1 Fickle fitting rooms



Doors that turn from clear to opaque confuse shoppers and frequently fail to open on cue.

2 Failed RFID



Touchscreens meant to spring to life when items are placed in the RFID "closets" are often just blank.

3 Pointless PDAs



Salesclerks let the handhelds gather dust and instead check the stockroom for inventory.

4 Neglected network



A lag between sales and inventory systems makes the wireless network nearly irrelevant.



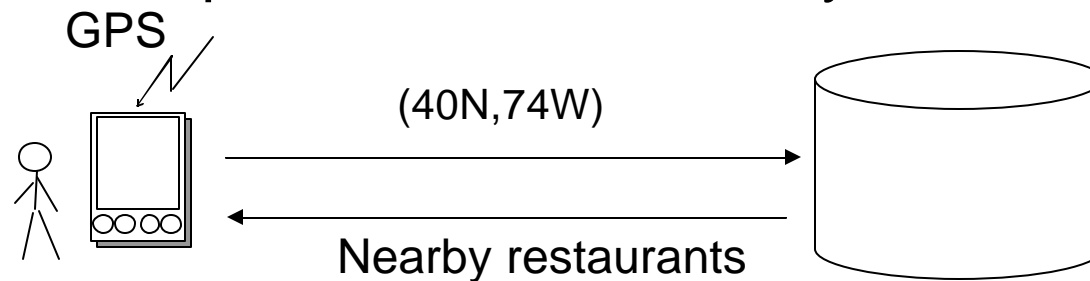
How should *context* be used to support collaboration?

- 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.



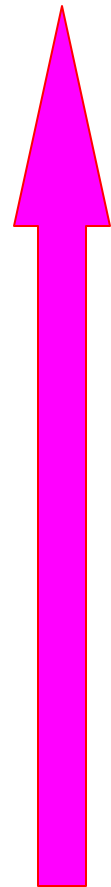
Unarticulated design intent

- **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

Exa Byte

Peta Byte

Tera Byte

Giga Byte

Mega Byte

Kilo Byte

Current *collective* global information

all photographs taken (1 yr)

all TV and radio programs (1 yr)

all movies made (1 yr)

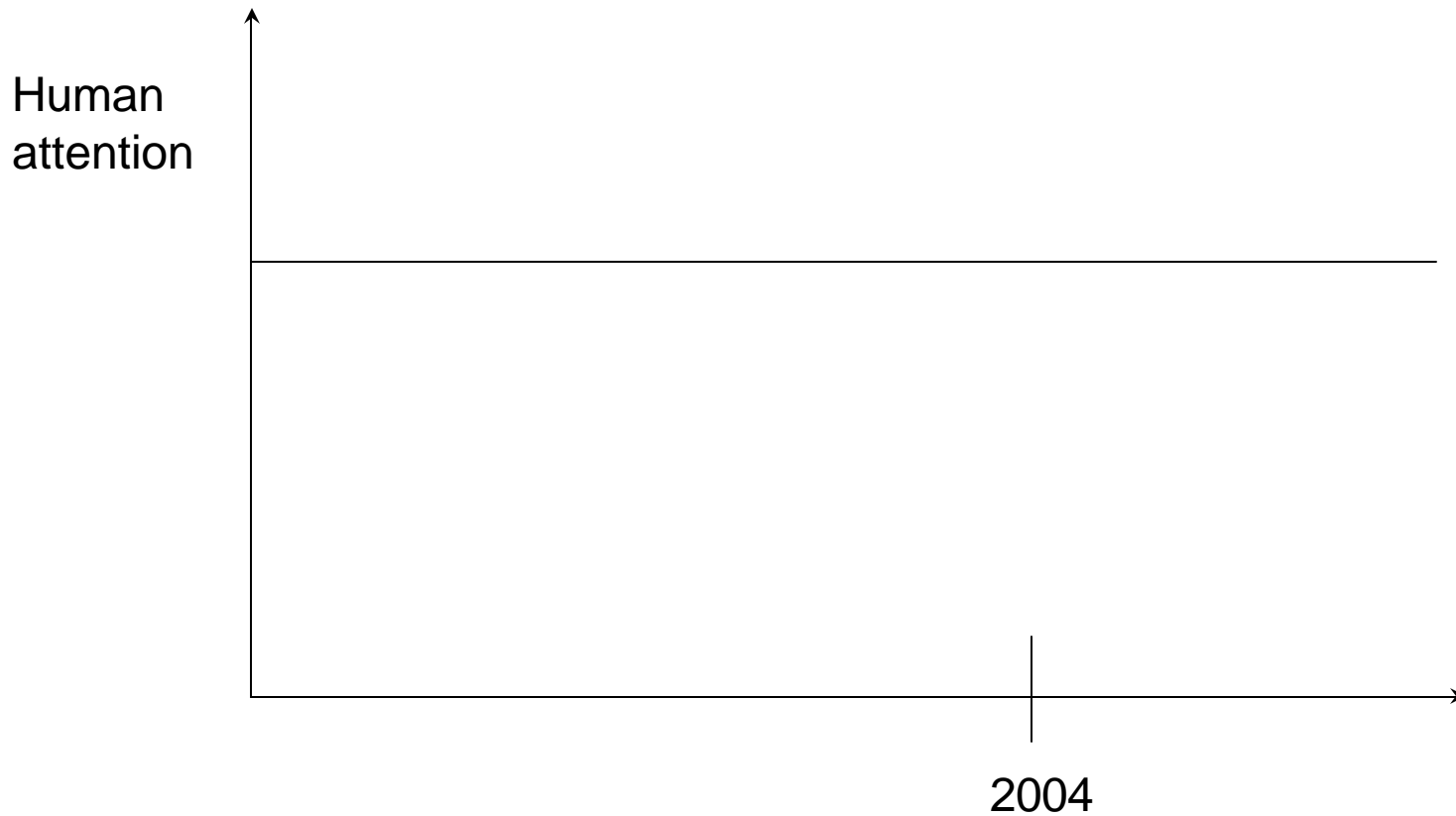
all music records sold (1 yr)

a book

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

Human attention is the scarce resource

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”

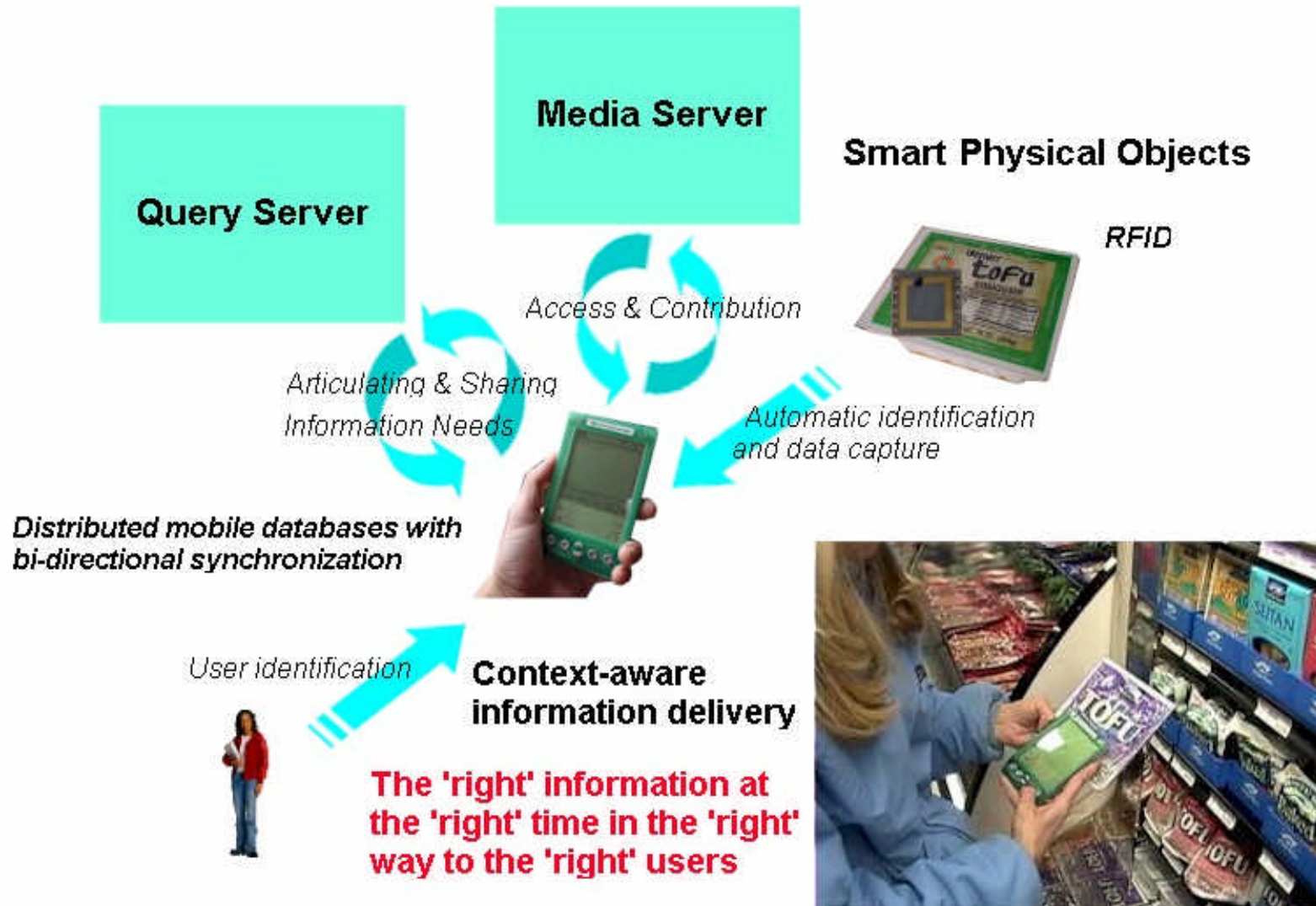
Information work is often fragmented (people change working spheres)

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)



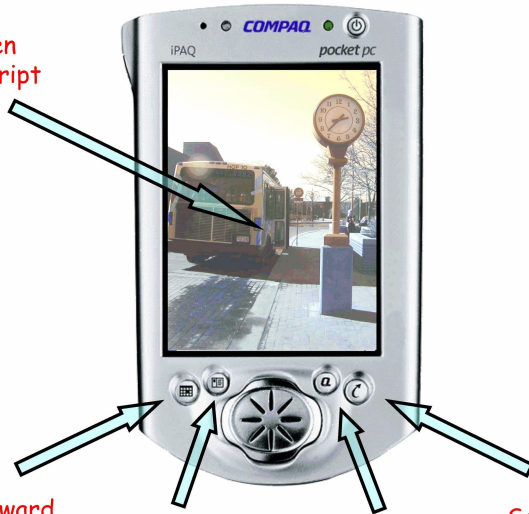


Context and Distributed Cognition

- 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)

Touch screen advances script



Script backward

Panic/Help button

Script forward

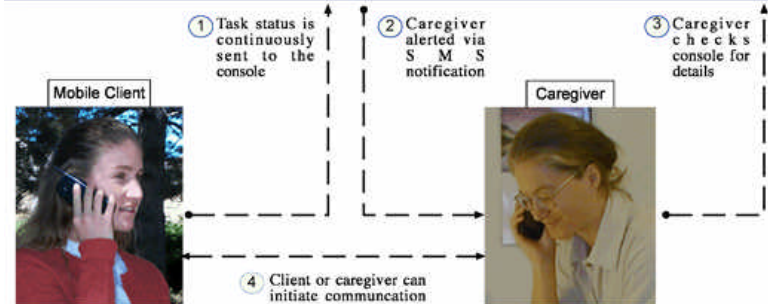
Lifeline: Amy Martin

Current Script	Go to Rec Center
Status	Arrived 10:36 AM
Current Location	East Boulder Rec Center
View Amy's profile and history	

Current Script Details: Go to Rec Center

Script Activity	Time
Script Activated	10:03 am 9/10/02
1. Go to bus stop, Baseline & 35th	Completed 10:15 am
2. Get on bus 203	Completed 10:28 am *bus arrived 6 minutes late
3. Get off bus at East Boulder Rec Center	Completed 10:36 am

Active Map





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 II-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 (Cols)
 - Cols bring together stakeholders from different CoPs and are defined by their collective concern with the resolution of a particular problem. Cols 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.spsychips.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>