Context Awareness and Privacy in Collaborative Environments

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Outline

- Ubiquitous computing
  - New opportunities and challenges for *design, learning and collaboration*
- Case study -- "store of the future"
- Discussions
  - How context awareness may support *collaboration*
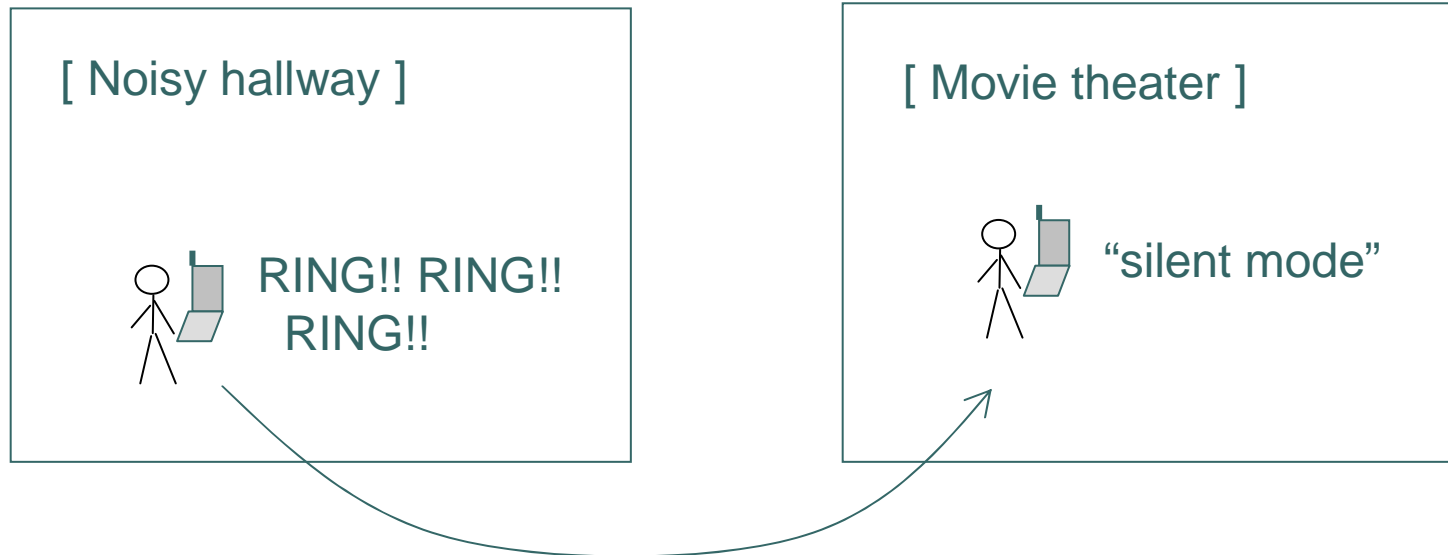 - How context awareness may violate *privacy*
- Summary

Ubiquitous Computing

Virtual Reality

Embodied Virtuality   {ubiquitous computing}
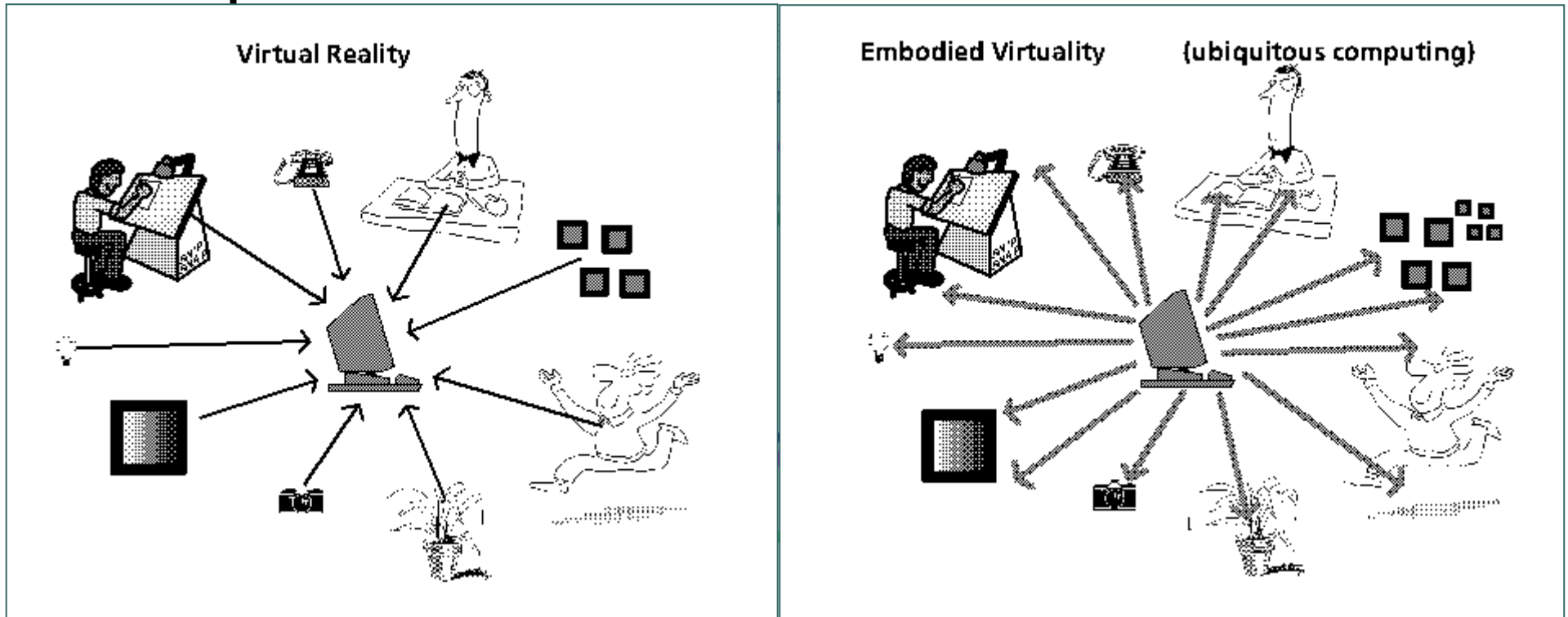
○ ***Context awareness*** **is the key to "right embedding" of information and services**

Original graphics at http://www.ubiq.com

A context-aware cell phone

[Noisy hallway]

RING!! RING!! RING!!

[Movie theater]

"silent mode"

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What is context?

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

Interaction

user *applications*

Related entities
(person, place, object, …)

Context
(a type of information)

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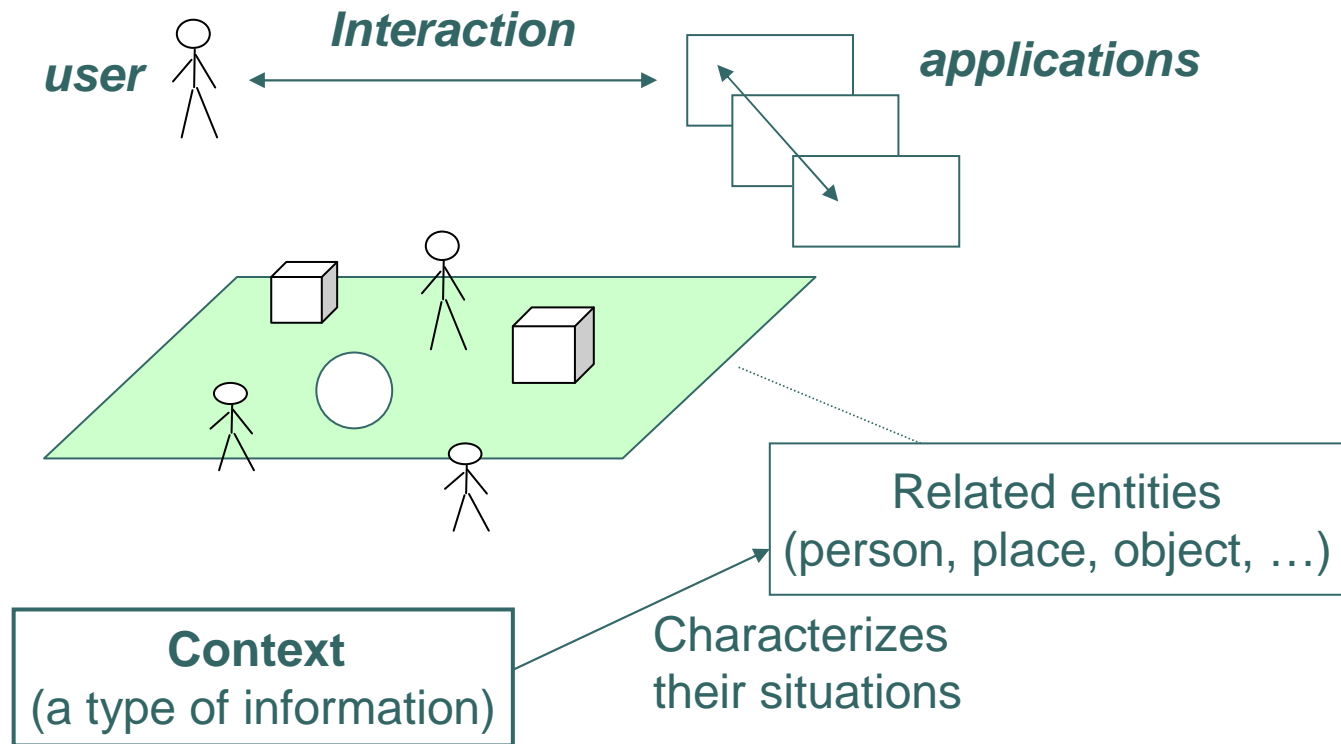
Examples:
location, identity and state of people, groups and computational and physical objects

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Context-awareness: examples

- Office work
- Tourism
- Commute
- Healthcare
- Events and entertainment
- **Retail / Shopping**

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Office work (meeting)

http://www.roomware.de

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Sample Scenarios:

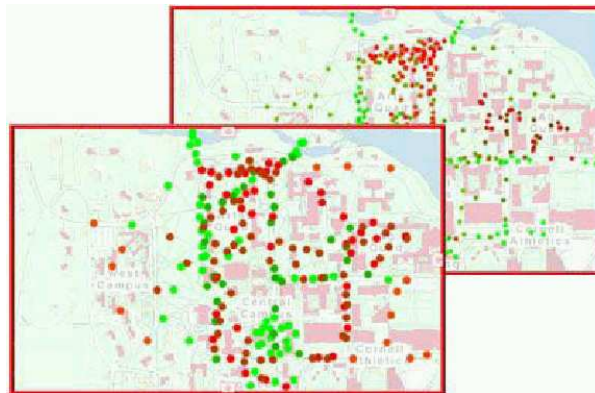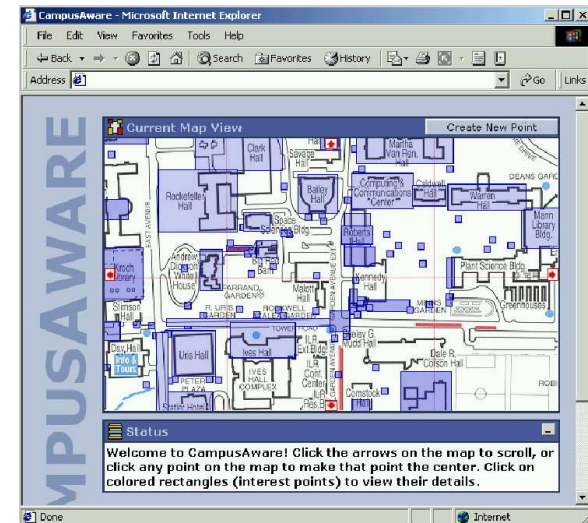People enter a meeting room ➔ a meeting agenda automatically shown on the wall-sized screen

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"
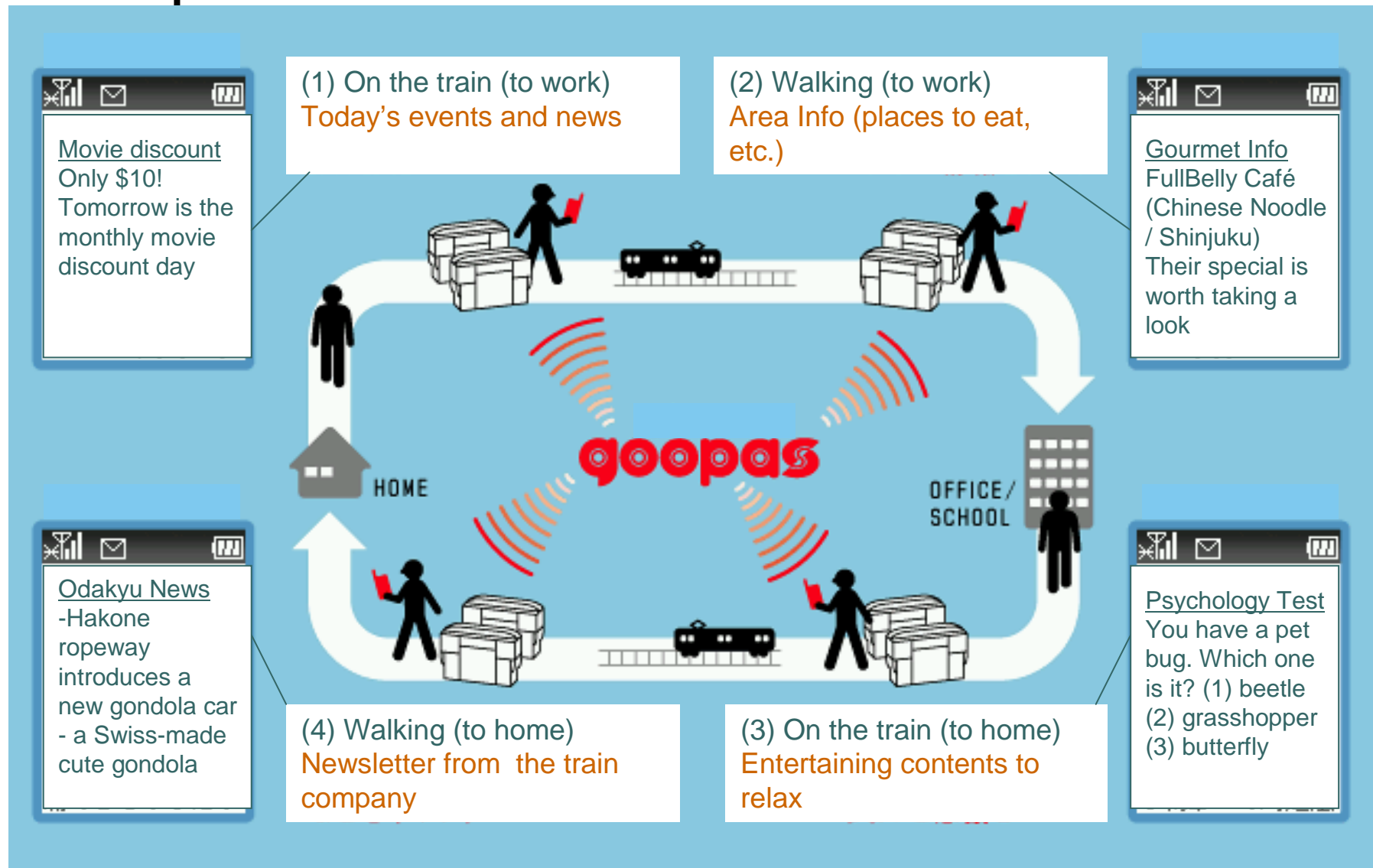
Tour guide

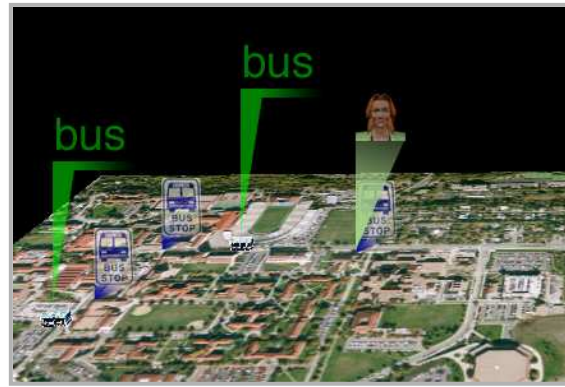- Campus Aware (Cornell University)
- Learning, planning and navigating

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

Commute

Movie discount
Only $10!
Tomorrow is the monthly movie discount day

(1) On the train (to work)
Today's events and news

(2) Walking (to work)
Area Info (places to eat, etc.)

Gourmet Info
FullBelly Café (Chinese Noodle / Shinjuku)
Their special is worth taking a look

Odakyu News
-Hakone ropeway introduces a new gondola car - a Swiss-made cute gondola

(4) Walking (to home)
Newsletter from the train company

(3) On the train (to home)
Entertaining contents to relax

Psychology Test
You have a pet bug. Which one is it? (1) beetle (2) grasshopper (3) butterfly

goopas

HOME

OFFICE/ SCHOOL

Smart care

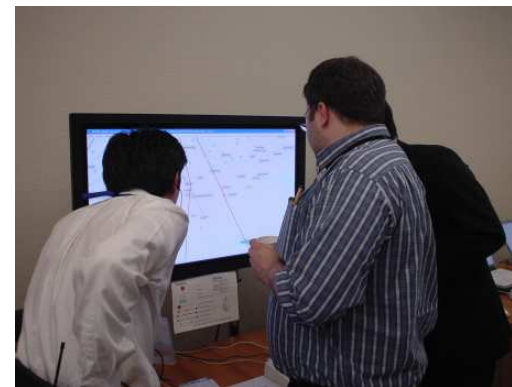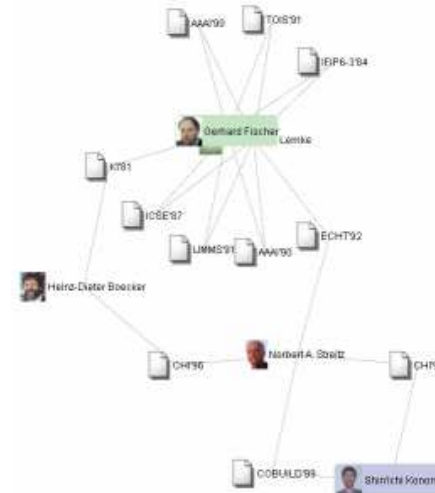CLever (Mobility for All, Lifeline, MAPS, …)

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

Online medicine cabinet
(Accenture)

Event (academic conference)

- RFID conference badges worn by conference attendees

- Social networks connecting the attendees (based on publication records)

- Support for informal communication ("ice breaker")

Case study "store of the future"

Early adopter of context-aware systems

Supply chain

Storefront

Video clips

- Shopping
- Smart Shelf
- Inventory Management

Deployment in the real world: Mitsukoshi (Tokyo)

- Item-level RFID in a store (led by Mr. Nishida)

Women's Shoes Shop (real use)　　Designer Jeans Shop (recent pilot test)

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Success [Nikkei Realtime Retail, April 7, 2005]

Overall:
- Less "out-of-stock situations"
- Half time spent for each customer
- 10% increase of sales

System:
- Ease of use enabled by RFID
- Durability of RFID tags
- Better item replenishment (by makers and wholesalers)

Customer behavior:
- Customers hesitate less: asking "do you have X in the stockroom?"
- Customers tend to believe the information the system displays. Therefore, there is no need to go to a stockroom and double check.
- No customer complaints even though RFID read accuracy < 100%
  - System doesn't read what doesn't exist (unlike barcodes)

Issues

Technological limitations and social tensions:

- Insufficient read range of RFID tags (Usage of UHF bands restricted by Radio Law)
- System integration
- Tag still too expensive
- Security (e.g., strict security policy imposed by the company)
- Privacy

Unexpected user behavior:

- Initially, sales agents were reluctant to use the system
  - They thought "running to a stockroom" makes them (and customers) feel better.
  - "affects visual presentation of sales floor"
- Customers don't use touch panel kiosks
  - Customers are not accustomed to "using a PC in a store"
  - But, sales agents used the touch panel with a customer
- Lack of support for special requests
  - laid down items, ordered items, "end size" items

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Discussion

○ Context-awareness and collaboration

○ Information overload

○ Context-awareness and privacy

Context-awareness and collaboration

○ Collaboration
  - Sales agents and customers
  - Makers, wholesalers and retailers

○ Awareness
  - Of customers' locations and needs
  - Of sales items on the shelf
  - Status of a stockroom or a warehouse

Beyond mere location awareness

- Simple location-aware system

GPS

(40N,74W)

Nearby restaurants

- **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

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Context, context, context

physical, organizational, social, cultural context

framework for practices ("rules for a game")

buildings and architecture

temporal and interactional context (within a larger pattern of activity);

domain description

anecdotal memories

"coordinating mechanisms"

user's intentions and goals

scientific hypothesis

religious beliefs

"activity landscape"

user profile

location

physical features

specification components

buildings

list of preferences

identity

collection of background beliefs

general cultural assumption

state of people, groups and computational and physical objects

record of past conversations

beliefs about the mental state of the speaker (user)

expectations about the future

immediately preceding utterances

domain

background knowledge

"entry points",

artifact under construction

social interactions

institutions

temporal, attentional, social, organizational context

physical, device, and informational context

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)

Context awareness and information overload

Sensors and RFID tags can produce an enormous amount of of data

Context-awareness is one of the keys to coping with information overload

(1) Anywhere at anytime

(2) The right thing at the right time in the right way

(3) The right thing at the right time in the right way *with the right kind of integration* (G. Mark 2004)

<u>Right embedding of information</u>
"There is more information available at our fingertips during a walk in the woods than in any computer system, yet people find a walk among trees relaxing and computers frustrating" (Weiser, 1991)

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Context awareness and privacy

○ Systems that monitor users (and tailor services) may violate privacy

- Detailed monitoring of consumer behavior without notice or consensus
- "Unfair information practices" using context-aware technologies

Video

- *"The Catalogue"* by Chris Oakley

Monitoring school children using RFID

Recent pilot tests
- Rikkyo Elementary School, Tokyo
- Iwamura Elementary School, Gifu
- Kakogawa Daycare Center, Hyogo
- (California)

- Location, identity, time
- Surveillance camera
- Historical data

No tracking   Pervasive tracking
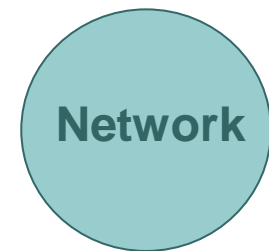
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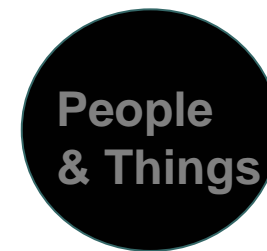*Privacy and freedom*   *Safety, peace of mind*

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RFID and privacy: existing approaches

- Killing tags
- Faraday cage
- Active jamming
- Sophisticated tags
- Blocker tags
- Local computation
- Information management
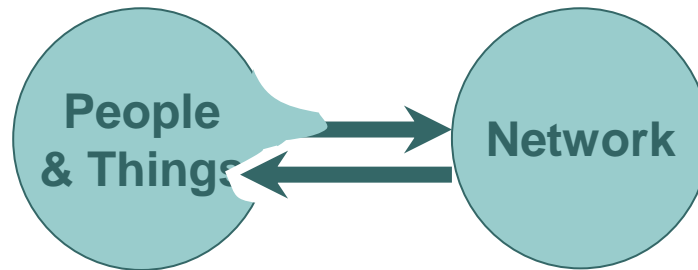- Social regulation

Mostly technologies for isolation

People & Things

Network

What is privacy?

○ Traditional view

  ● *"the right to be left alone"*

○ Alternative view
  (Altman, 1975; Palen and Dourish, 2003)

  ● *"selective control of access to the self (or to one's group)"*
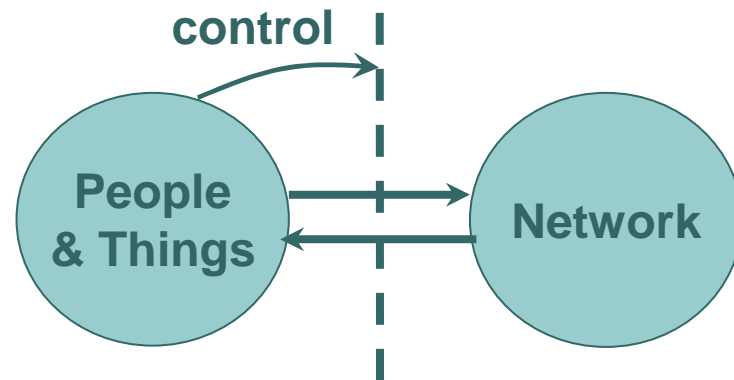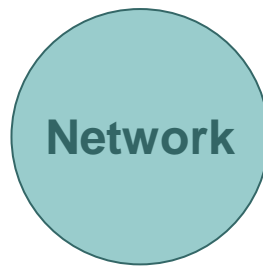
Towards a new class of privacy-enhancing technologies

People & Things → **Network**

Privacy problems

People & Things   **Network**

People & Things ⟷ **Network**   control

A. Technologies for isolation   **B. Technologies for boundary control**

Privacy-enhancing technology is necessary but not sufficient

○ Practical privacy is shaped by four strongly interacting forces (Lessig, 1998)

- Markets
- Social norms
- Legislation
- Technology

Issues closely related to privacy

- Trust
- Security
- Contextual factors
  - locations, personal preferences, cultural differences

"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)

RFID: opportunities and risks

Opportunities

Distributed intelligence approaches controlled by users

Sensor networks

Tracking medical wastes

Manufacturing

Food traceability

Supply chain

Tickets & payments

Timekeeping in sports

Keys & Access control

Gift-wrapping

Privacy

Smart assistive technologies

Libraries

Drug anti-counterfeit

Future store
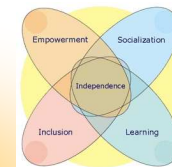
Tracking children

RFID injection

Techno-determinism

Risks

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Concluding remarks

- Context and privacy are both elusive concepts; difficult to define precisely
- Where is a practical middle ground? And how do we find it?
- 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?"

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