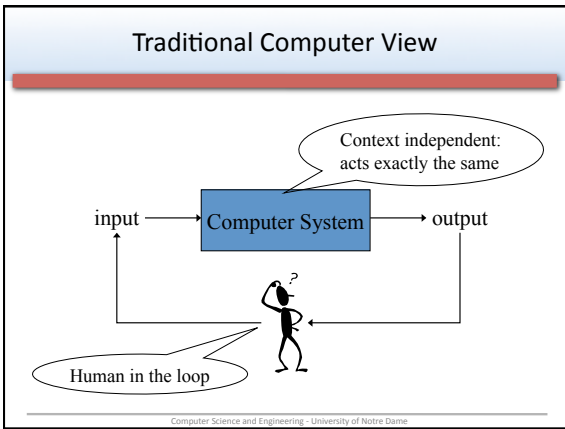
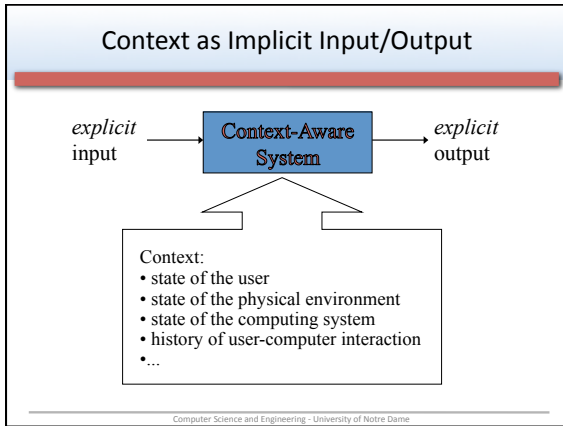


Context-Aware Computing

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- ### From Abstraction to Context Sensitivity
-
- Traditional black box view comes from the desire for abstraction
 - This is based on several assumptions:
 - Explicit input/output: slow, intrusive, requiring user attention
 - Sequential input-output loop
 - Move away from the black box model and into context-sensitivity
 - human out-of-the-loop (as much as possible)
 - reduce explicit interaction (as much as possible)
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- ### Context-Aware Computing
- Let computer systems sense automatically, remember history, and adapt to changing situations
 - Identity, activity, feeling/mood
 - Spatial: location, orientation, speed
 - Temporal: date, time of day, season
 - Environmental: temperature, light, noise
 - Social: people nearby, activity, calendar
 - Resources: nearby, availability
 - Physiological: blood pressure, heart rate, tone of voice
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- ### Challenges
- **Obtaining information** needed to function
 - How to **represent context** internally? How to combine it with system and application state? Where to store?
 - How often to **update** and **consult** context information?
 - What **services** does infrastructure have to provide?
 - How to **track** location and **sense** surroundings?
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Why Context-Aware Computing?

Existing Examples	Context Types	Human Concern
Auto Lights On / Off	Room Activity	Convenience
File Systems	Personal Identity & Time	Finding Info
Calendar Reminders	Time	Memory
Smoke Alarm	Room Activity	Safety
Barcode Scanners	Object Identity	Efficiency

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Why Context-Aware Computing?

Potential Examples	Context Types	Human Concern
Auto Cell Phone Off In Meetings	Identity	Convenience
Tag Photos	Time	Finding Info
Proximal Reminders	Location	Memory
Health Alert	Proximity	Safety
Service Fleet Dispatching	Activity	Efficiency
	History	
	...	

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- ### Why Context-Aware Computing?
- Presentation of information/services to a user according to current context
 - Automatic execution of a service when in a certain context
 - Tagging context to information for later retrieval
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Example: Active Badges



Active Badge

- Badges emit infrared signals
 - Provide rough location + ID
- Teleport
 - Redirect screen output from "home" computer to nearby computer
- Phone forwarding
 - Automatically forward phone calls to nearest phone

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Example: Active Badges

- Interface follow-me (location)

ORL/STL Active Badge Project					
Name	Location	Prob.	Prob.		
P Answorth	X343 Acor	100%	J Martin	X310 Me Rm	100%
T Blackie	X222 DVI Rm.	80%	C Mason	X307 Lab	77%
M Chopping	X410 3302	TUE	D Milway	X305 Dtl	AWAY
D Clarke	X316 R321	10:30	B Minars	X202 DVI Rm.	10:40
V Falser	X318 R425	AWAY	P Masi	X213 PA	11:20
D Garnett	X232 R310	100%	J Porter	X386 Lab	100%
J Gibbons	X3 Rm.	AWAY	B Robertson	X307 Lab	100%
D Graves	X304 F3	MON.	C Turner	X307 Lab.	MON.
A Hopper	X404 A11	100%	R Watt	X308 Meet. Rm.	97%
A Jackson	X206 A2	90%	M Wilkes	X306 MW	100%
A Jones	X210 Coffee	100%	I Wilson	X307 Lab.	100%
T King	X200 Meet. Rm.	11:20	S Wray	X304 DW	11:20
D Leopold	X304 R311	100%	K Zielinski	X402 Coffee	100%

12:00 1st January 1990

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Example: ParcTab



ParcTabs

- Active badge + wireless
 - Rough location + ID
 - Showing information of the room the user is in
 - Help find resources
 - Show all files in a directory when entering a room
 - Locate others
 - Different control choices in different rooms
- (location, time, nearby devices, file system state)

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Auto-Diaries and Proximate Selection

Name	Room	Distance
caps	35-2-2-00	20ft
claudia	35-2-1-08	30ft
perfector	35-2-3-01	20ft
snoball	35-2-1-03	100ft

Subject field

Filter field

Title line

Biography

Mike's biography.

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In/Out Board (Georgia Tech)

Gregory Abowd	Out 10:50am	Jen Mankoff	In 12:09pm
Jason Brotherton	In 9:28am	David Nguyen	In 11:08am
Anind Dey	In 12:08pm	Rob Orr	Out 1:25pm
M. Futakawa	In 12:06pm	Maria Pinentel	Out 5:54pm
Y. Ishiguro	Out 10:57am	Daniel Salber	In 10:14am
Rob Kooper	Out 5:26pm	Brad Singletary	Out 2:59pm
Kent Lyons	Out 12:27pm	Khai Truong	Out 1:25pm


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DUMMBO (Georgia Tech)

- Dynamic Ubiquitous Mobile Meeting Board:
 - Digitizing whiteboard to capture and access informal and spontaneous meetings
 - Capture ink written to and erased from whiteboard, and audio discussion
 - Activated when two or more people gathered around
 - Context: ID, time, location of whiteboard

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CyberGuide (Georgia Tech)



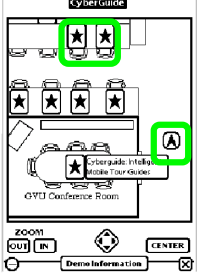
Cyberguide

- GPS or infrared tracking
 - Fairly precise location
- Display location on screen
- Predefined points of interest
 - Automatically pop up if nearby
- Travel journal
 - Keep log of places seen and photographs taken
- Context: location, time

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CyberGuide

CyberGuide



ZOOM
OUT IN CENTER
Show Infrared Line

CyberGuide



ZOOM
OUT IN POSITION

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GUIDE (Univ. of Lancaster)

- Context: location through WLAN, user preference

GUIDE - Evaluation

Applications: Browser, Evaluation, Log

General information on Lancaster Castle



The Castle is owned by Her Majesty the Queen, who is the Duke of Lancaster. As well as being a fortification, the Castle is also one of Europe's longest serving operational prisons.

The Castle has not always existed in its present format but was built on the site of a Norman Fortress. The Castle is made up of several different buildings that have been erected at different times over the years. To find out more click here - [Inside the Castle](#) (Little castle image)

Inside, it is possible to see the Grand Jury Room


Your location is: Lancaster Castle - Shire Hall Entrance
Status: Currently receiving location updates

Text Output / Radio Guidance
 Create: Refresh: Status
 A: List: Next
 Trail: Introduction: Instructions: Message: Tables

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Encourage Healthy Dietary Behaviors


- Interactive game to assist teachers to improve dietary behaviors of kindergarten children ("smart lunch tray")



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AudiIndex

- Allowing visually impaired to browse and search audio books. Main device around neck, earpiece with audio feedback, pointing device on index finger.



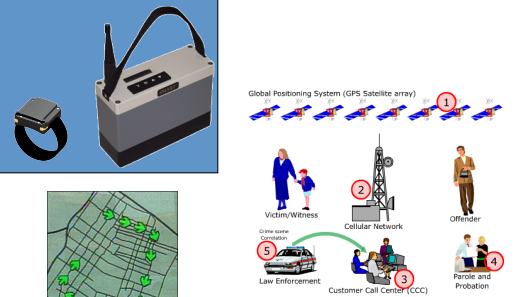
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Emergency Medical Response




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Protech Parolee Monitor



The image shows the Protech Parolee Monitor hardware, including a small black ring and a larger grey base unit with an antenna. A diagram illustrates the system's components and flow: 1. GPS Satellite array (Global Positioning System) receives signals from the offender. 2. Cellular Network transmits the data. 3. Customer Call Center (CCC) processes the information. 4. Parole and Probation receives the data. 5. Law Enforcement is alerted. Other icons include a Victim/Witness and an Offender. A map shows green location markers on a grid.


Parent Pager



- A "child safety product"
- Activates an alarm when a child wanders more than 15 feet from the adult "base" unit
- Also alarms if submerged in water

The image shows a blue lanyard with a black base unit and a small child. A small photo shows a child in a blue shirt standing in a store aisle.

Garmin's Rhino GPS + FRS



- Garmin's Rino GPS Radio gives users the ability to beam their location to other Rino users within a two-mile range and carry on conversations at the same time.


The image shows two Garmin Rino GPS radios, one black and one yellow. A small inset shows the device's screen displaying a map with location markers and a list of nearby locations: PAT, K, JAY, 0.0mi, CAT, SEV, and Ignore.

Context-Aware Communication

- Communication is a killer app for ubicomp
- Example activities:
 - Staying in touch
 - Coordinating with friends and family
 - Being aware of activities of friends and family
- Non-ubicomp evidence
 - Popularity of Social Networking web sites
 - Popularity of sharing sites
 - Popularity of blogs and message boards

Problems with Keeping in Touch

- Irrelevant messages
 - Vacation mail, surveys, junk email
- Interruptions
 - During meetings, concerts, movies, dinner, driving
- Lack of awareness on callee side
 - Phone tag, time zone issue
- Information overload
 - Can make it hard to find useful messages (e.g., delayed flight)
- Device overload
 - Fax, email, landline phone, mobile phone, IM



Context-Aware Communication

- Main idea:
 - Use sensors and other pieces of context...
 - to improve awareness of and communication with others...
 - while minimizing overload, irrelevancy, and interruptions

Context-Aware Communication

- Apply knowledge of people's context (and activities) to reduce person-to-person communication barriers
- Subset of Context-Aware Computing
 - Does not include, e.g., control of environment, or apps that filter information about nearby restaurants and printers
- Information versus communication
 - Is the chirping Lovegeety an information or communication device?

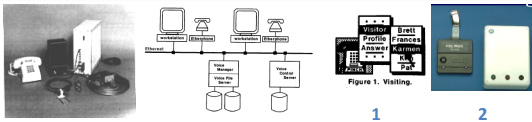


Example: Routing

- Directing communication to nearby & appropriate devices (ubiquitous message delivery)
- PARC's Etherphone system
- Olivetti's Active Badge aiding a telephone receptionist

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PARC Etherphone



- 50 Etherphones
- Location registered by
 - Logging in
 - "Visiting"
- Distinctive ring tones


ORL Active Badge "Aid to a Receptionist"




- Infrared emitting badges and network of receivers
- Initial application was an "aid for a telephone receptionist"
- Give a person info for tracking down callee

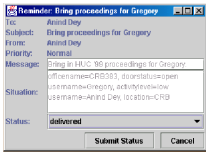
Context-Aware Mailing List

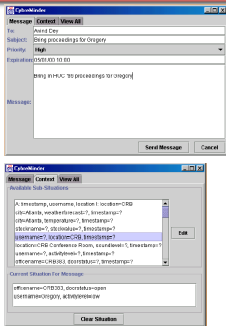
- In-out board using RF tags
- Dynamic e-mail list for directing email to people who are in the building
 - "let's get lunch"
 - "talk in 5 minutes"



CybreMinder

- To-do items associated with location and context
- Can be sent to other people
- Context include "forecast is for rain and Bob is leaving home."





Audio Aura

- Auditory cues as people walk around an office place
- Going to an empty office creates an audio cue about how long it has been empty
- A “group pulse” if people are meeting
 - Automated sensing
 - Little automated communication

Figure 2: The Audio Aura System

Calls.Calm

- Calls.Calm uses web phones to mediate communication with subscribers.
- A person (a) selects who to call and
- (b) is greeted by the callees contact page *contextualized and customized for the caller*; or if the caller is unknown,
- (c) a generic page.

5 Design Considerations

1. Improving relevance
 - Deciding when a communication is relevant to the person’s current (or near future) situation.
 - For example, getting notification about an email from your travel agent regarding itinerary changes while packing to leave for the airport.
2. Minimizing disruption
3. Improving awareness
4. Reducing overload
5. Selecting channels

5 Design Considerations

1. Improving relevance
2. Minimizing disruption
 - Deciding when and how to notify people that they have a communication.
 - For example, your phone should vibrate and not ring, when you are at the symphony (unless it is truly urgent).
3. Improving awareness
4. Reducing overload
5. Selecting channels

5 Design Considerations

1. Improving relevance
2. Minimizing disruption
3. Improving awareness
 - Deciding what information and mechanisms can help people make intelligent communication decisions.
 - For example, the caller should be told you are at the movies before the call goes through.
4. Reducing overload
5. Selecting channels

5 Design Considerations

1. Improving relevance
2. Minimizing disruption
3. Improving awareness
4. Reducing overload
 - Deciding how to reduce the number of communications that don't apply given your context.
 - For example, filtering out emails about going to lunch when you are away from the office (or already at lunch).
5. Selecting channels

5 Design Considerations

1. Improving relevance
2. Minimizing disruption
3. Improving awareness
4. Reducing overload
5. Selecting channels
 - Deciding which communication device should be used to get in touch with somebody.
 - For example, routing calls to your home phone instead of your cell phone when you are at home and cellular reception is poor.
