Intro to Context-Aware Computing

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05-899

Special Topics in Ubiquitous Computing

Readings

- Context-Aware Computing Applications, by Bill Schilit, Norman Adams, and Roy Want
- Ask not for whom the cell phone tolls: Some problems with the notion of context-aware computing, by Tom Erickson
- Challenges in Implementing a Context-Aware System, by Satya
- WhereWare, by Eric Pfeiffer

What it is…

Context-aware computing is:

"software that **examines** and **reacts** to
an individual's changing context."

- Schilit, Adams, & Want 1994

"…aware of its user's **state** and
surroundings, and help it **adapt** its behavior"

- Satyanarayanan 2002

What is context?

"any information that can be used to characterize the situation of an entity." (Dey et al., 2000)

- Identity (Who)
- Activity (What)
- Time (When)
- Location (Where)

Who + What + When + Where ➔ Why

Categories

	manual	automatic
information	proximate selection & contextual information	automatic contextual reconfiguration
command	contextual commands	context-triggered actions

Table 1: Context-Aware Software Dimensions

From Schilit, Adams, & Want 1994

Proximate Selection / Contextual Info

- Manually retrieve information based on context

Name	Room	Distance
caps	35-2200	200ft
claudia	35-2108	30ft
perfector	35-2301	20ft
snoball	35-2103	100ft

(a)

Distance	Name	Room
20ft	perfector	35-2301
30ft	claudia	35-2108
100ft	snoball	35-2103
200ft	caps	35-2200

(b)

Name	Room	Distance
caps	35-2200	200ft
claudia	**35-2108**	**30ft**
perfector	**35-2301**	**20ft**
snoball	35-2103	100ft

(c)

Name	Room	Distance
caps	35-2200	200ft
claudia	35-2108	30ft
perfector	35-2301	20ft
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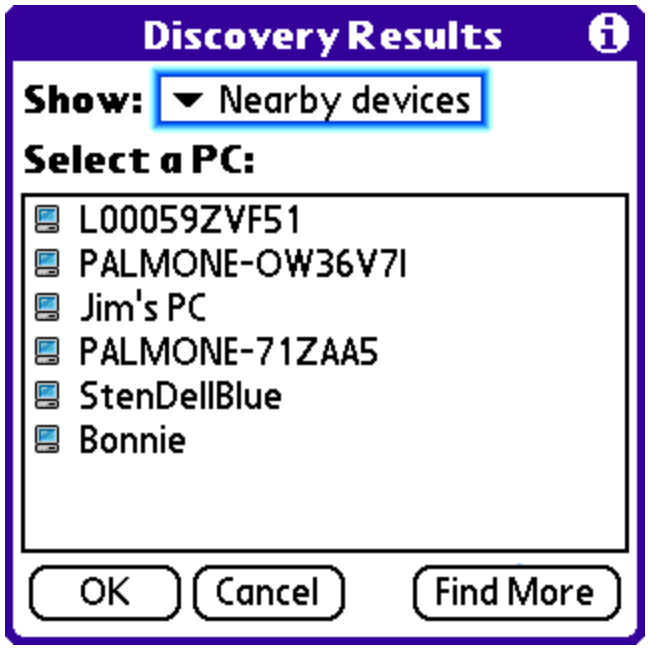
(d)

Table 2: UI Techniques for Proximate Selection

	manual	automatic
information	proximate selection & contextual information	automatic contextual reconfiguration
command	contextual commands	context-triggered actions

Proximate Selection / Contextual Info

- Bluetooth®



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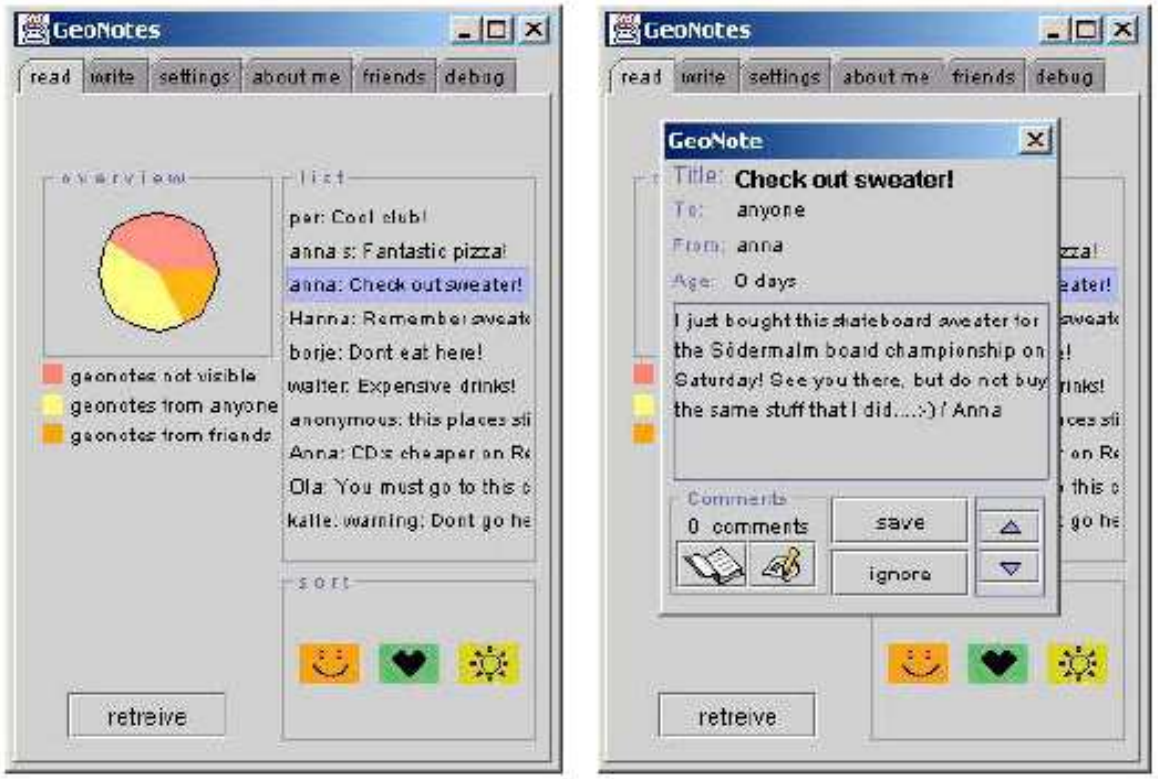
Proximate Selection / Contextual Info

- Geonotes (http://geonotes.sics.se)



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Automatic Contextual Reconfiguration

- Add, remove, or alter components based on context

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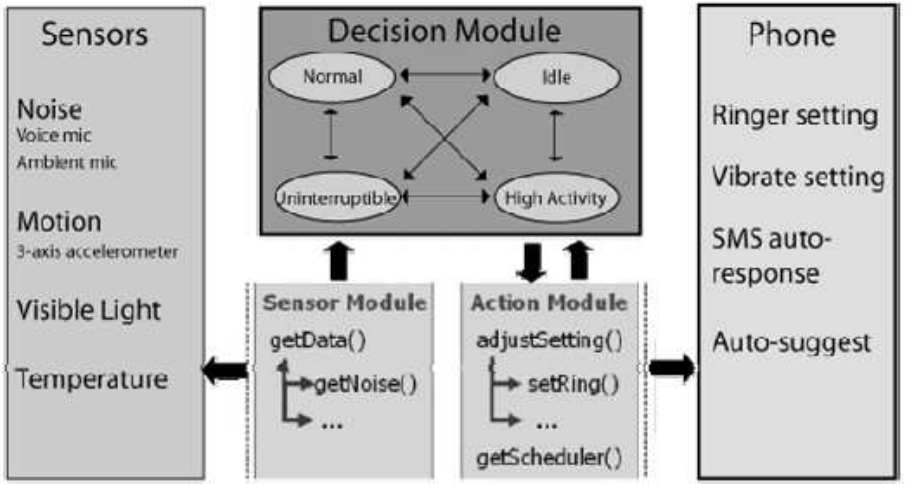
Automatic Contextual Reconfiguration

- Add, remove, or alter components based on context
- SenSay (Siewiorek et al, 2003)



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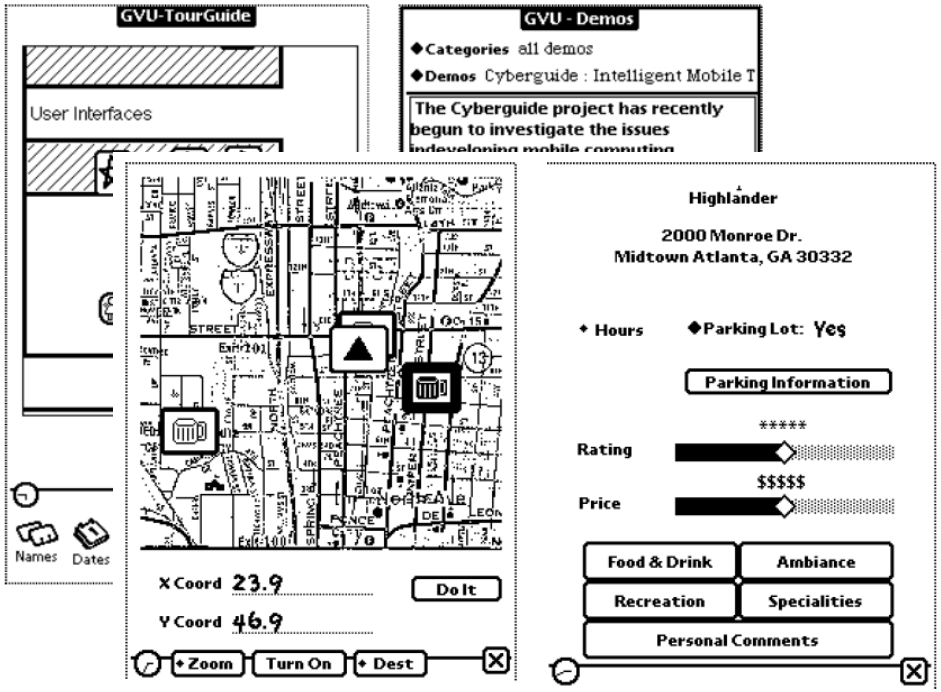
Automatic Contextual Reconfiguration

- CyberGuide (Abowd et al., 1997)



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Contextual Commands

- User can parameterize commands with context-filtered values
- Execution changes based on context

- Example: truly universal remote control

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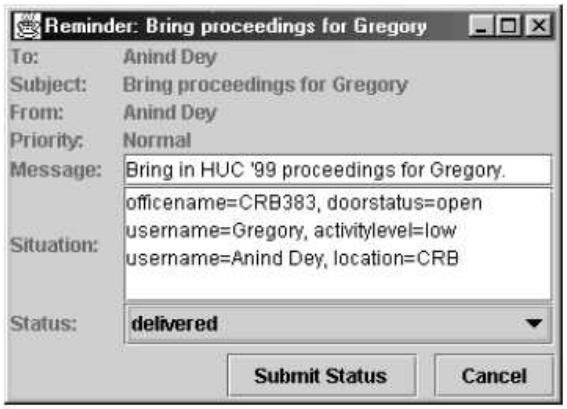
Context-triggered Actions

- Simple if-then condition-action rules, automatically invoked
- Contextual Reminders: if I go walk by kitchen, remind me to get coffee

Active Badge (Want et al., 1992)



CybreMinder (Dey & Abowd 2000)

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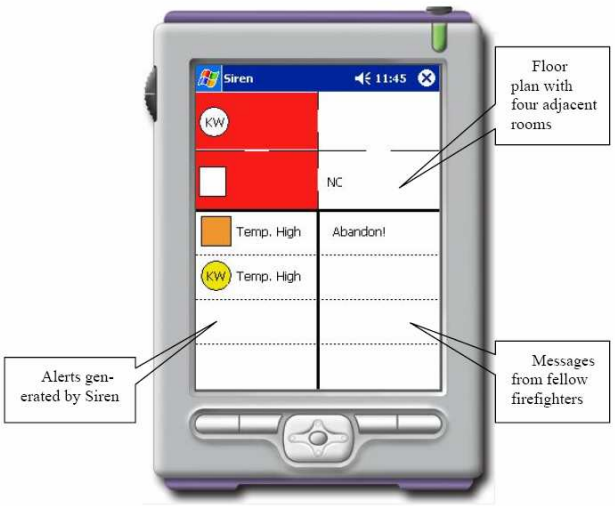
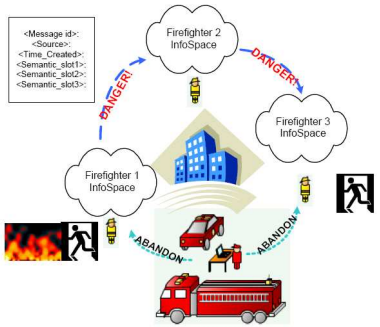
Context-triggered Actions

- Challenges:
  - Expressiveness of language for rules
  - Accuracy of context information

Siren (Jiang et al., 2004)






```
IF (firefighter F1 IN room A) AND
   (surrounding temperature > 1500F)
THEN (generate_alert(firefighter F1 in danger)) AND
     (generate_alert(room A is a dangerous place))
```

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Context-awareness as a cushion

- Pervasiveness of technology
- Context-awareness helps technology "get it right"

But…

- Context is hard to sense
  - Lots of it
  - Subtle
- Computers are not "self-aware" like humans

Errors

- When the system does the wrong thing
  - Auto-locking car doors
  - Screen saver during presentation
  - Microphone amplifying a whisper

- In these examples, is the system or the user at fault?

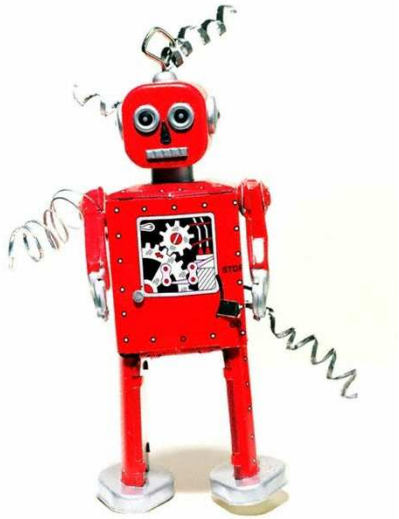
All About Actions

Claim:
context-awareness is ***not useful itself*** but
only useful for ***automatically triggering an action***

Anti-A.I.

Claim: context data must be coupled with the ability to ***interpret*** it, computers are ***bad at common sense***

- More rules ≠ Intelligence
- More rules = more complexity, harder to understand



Human in the Loop

- Computers can detect, aggregate, and portray information

- Allow human users to interpret and act on it.

- Q: Is this a reasonably strategy for all context-aware systems?
  - What will this strategy be ***good*** for?
  - What will this strategy be ***bad*** for?

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Challenges in Context-Aware Computing (Satya)

- How to represent context internally?
  - Storage
  - Data structures and algorithms
- How frequently does the system need to be updated on context changes?
  - How often to poll?
  - How often to change behavior?
- What sensors, infrastructure, or sensors are necessary?
  - What is the fallback condition?
- How to sense location information?
  - Technical details
  - History of location?

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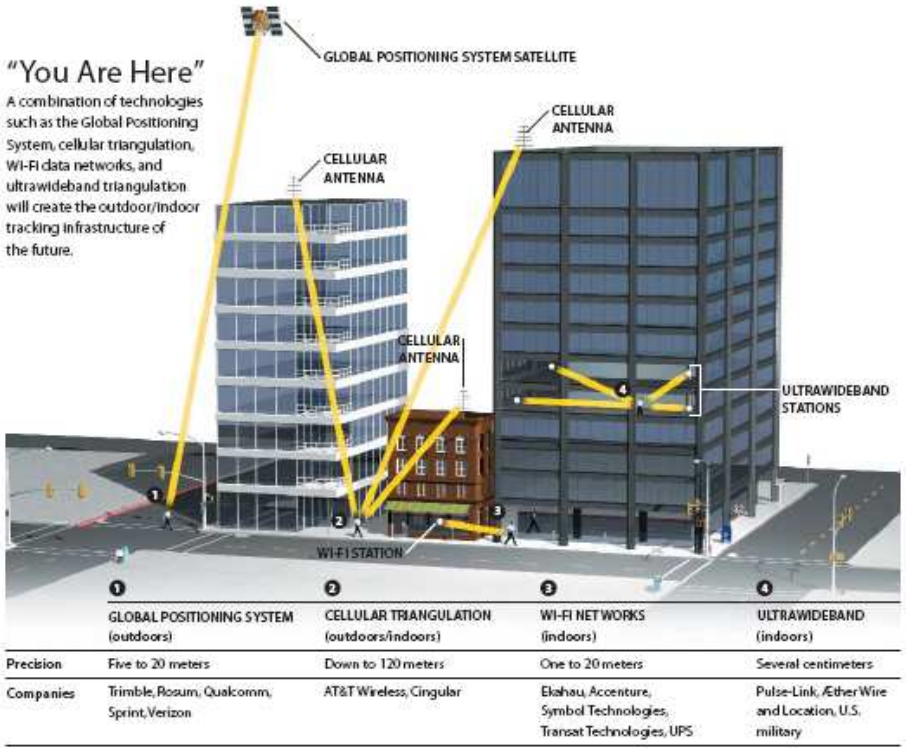
Location-tracking technologies

- GPS
- GSM
- Assisted GPS
- WiFi
- Ultrawideband

- Metrics
  - Accuracy, reliability, security

- Considerations
  - Buying new devices?
  - Business issues (coordinating service with infrastructure)
  - Killer app?

Location stack



Discussion

- How would you describe the context you are in now?
  - location, physiological state, emotional state, etc
  - What is the most “important” context at the moment?
- What are some types of context that people have not thought of before?
- What new or existing application can use this context?

Discussion

- How does context-aware computing fit in with ubicomp?

- Ubicomp
  - Mobile
  - Ambient
  - Tangible