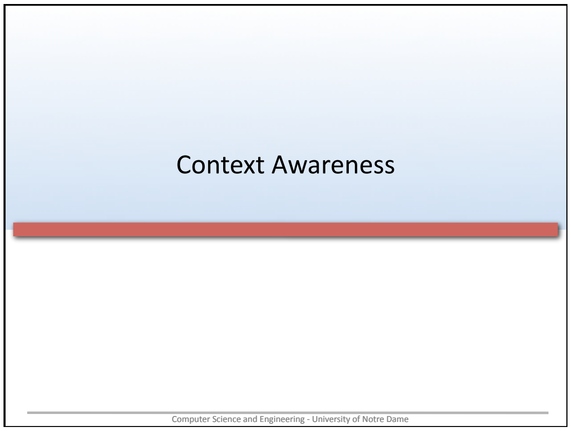
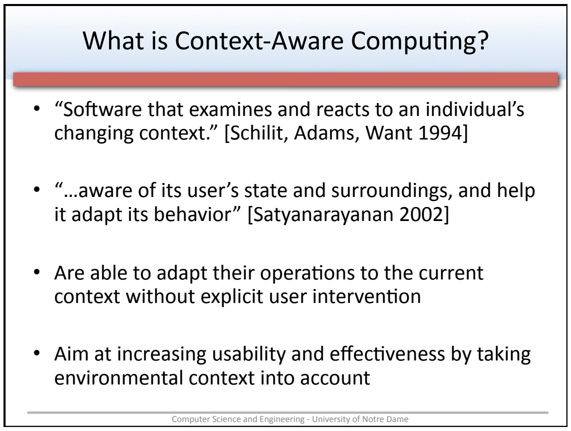
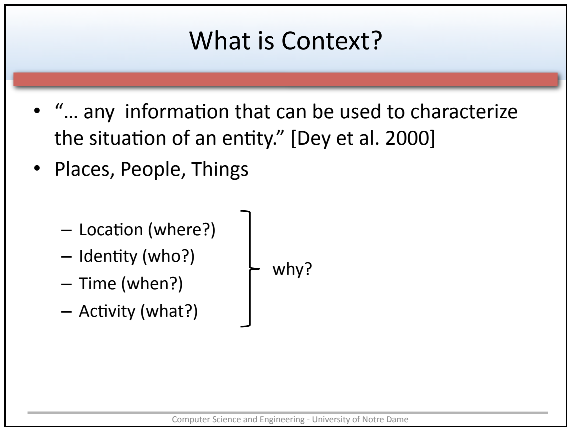


Context Awareness



What is Context-Aware Computing?

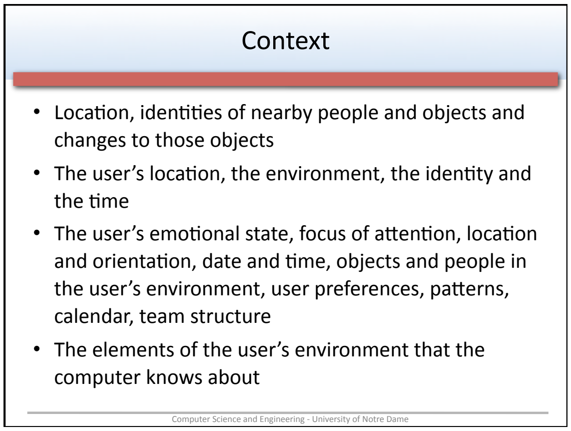
- "Software that examines and reacts to an individual's changing context." [Schilit, Adams, Want 1994]
- "…aware of its user's state and surroundings, and help it adapt its behavior" [Satyanarayanan 2002]
- Are able to adapt their operations to the current context without explicit user intervention
- Aim at increasing usability and effectiveness by taking environmental context into account



What is Context?

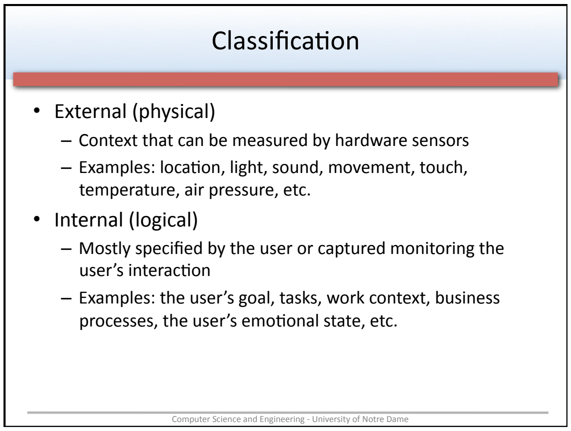
- "… any information that can be used to characterize the situation of an entity." [Dey et al. 2000]
- Places, People, Things
  - Location (where?)
  - Identity (who?)
  - Time (when?)
  - Activity (what?)

why?



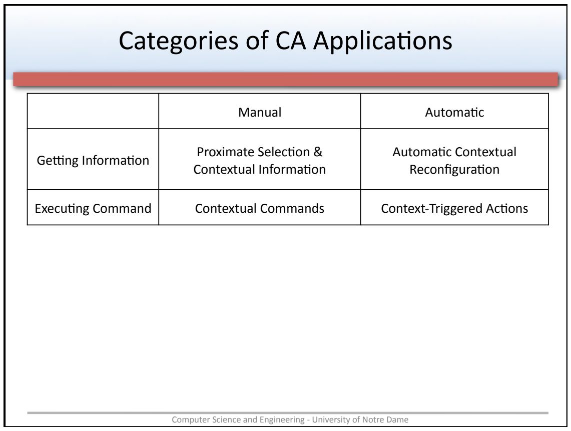
Context

- Location, identities of nearby people and objects and changes to those objects
- The user’s location, the environment, the identity and the time
- The user’s emotional state, focus of attention, location and orientation, date and time, objects and people in the user’s environment, user preferences, patterns, calendar, team structure
- The elements of the user’s environment that the computer knows about



Classification

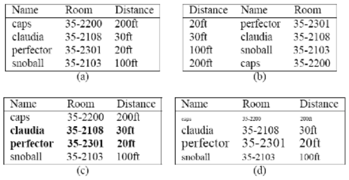
- External (physical)
  - Context that can be measured by hardware sensors
  - Examples: location, light, sound, movement, touch, temperature, air pressure, etc.
- Internal (logical)
  - Mostly specified by the user or captured monitoring the user’s interaction
  - Examples: the user’s goal, tasks, work context, business processes, the user’s emotional state, etc.



Categories of CA Applications

	Manual	Automatic
Getting Information	Proximate Selection & Contextual Information	Automatic Contextual Reconfiguration
Executing Command	Contextual Commands	Context-Triggered Actions

Proximate Selection/Contextual Information



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)

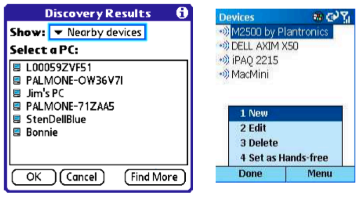
Name	Room	Distance
caps	35-2200	200ft
claudia	35-2108	30ft
perfector	35-2301	20ft
snoball	35-2103	100ft

(d)

Table 2: UI Techniques for Proximate Selection

Proximate Selection/Contextual Information

- Bluetooth



Discovery Results

Show: Nearby devices

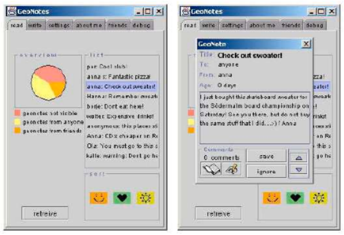
Select a PC:

- L00059ZVF51
- PALMONE-OW36V7I
- Jim's PC
- PALMONE-71ZAA5
- StenDellBlue
- Bonnie

Devices

- M2500 by Plantronics
- DELL AXIM X50
- iPAQ 2215
- MacMini

Proximate Selection/Contextual Information



geonotes not visible
geonotes from anyone
geonotes from friends

par: Cool club!
anna s: Fantastic pizza!
anna: Check out sweater!
Hanna: Remember sweat
berle: Dont eat here!
walter: Expensive drinks!
anonymous: this places sti
Anna: CDs cheaper on R
Ola: You must go to this
kalle: warning: Dont go he

GeoNote

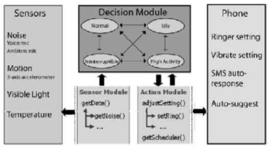
Title: Check out sweater!
To: anyone
From: anna
Age: 0 days

I just bought this skateboard sweater for the Södermalm board championship on Saturday! See you there, but do not buy the same stuff that I did... :) / Anna

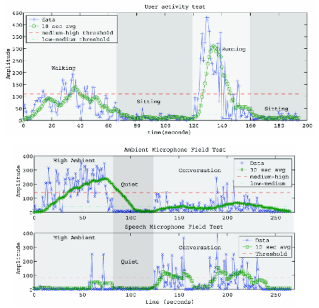
Comments
0 comments

Automatic Contextual Reconfiguration

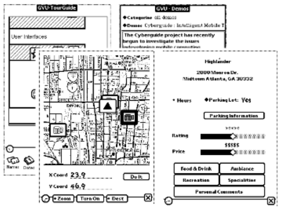
- Add, remove, or alter components based on context
- SenSay project: context-aware mobile phone



Automatic Contextual Reconfiguration



Automatic Contextual Reconfiguration



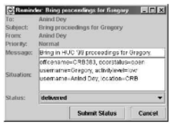
CyberGuide

Contextual Commands

- Users can parameterize commands with context-filtered values; execution changes based on context
- Example: universal remote control

Context-Triggered Actions

- Simple if-then condition-action rules, automatically invoked
- Reminder: if I step into the car on weekday morning and don't have suitcase with me, remind me to get it
- CybreMinder:

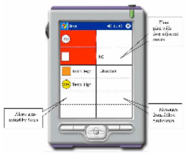


Reminder: Bring proceedings for Gregory

To: Anind Dey
Subject: Bring proceedings for Gregory
From: Anind Dey
Priority: Normal
Message: Bring in HUC '99 proceedings for Gregory.
Situation: officename=CRB383, doorstatus=open
username=Gregory, activitylevel=low
username=Anind Dey, location=CRB
Status: delivered

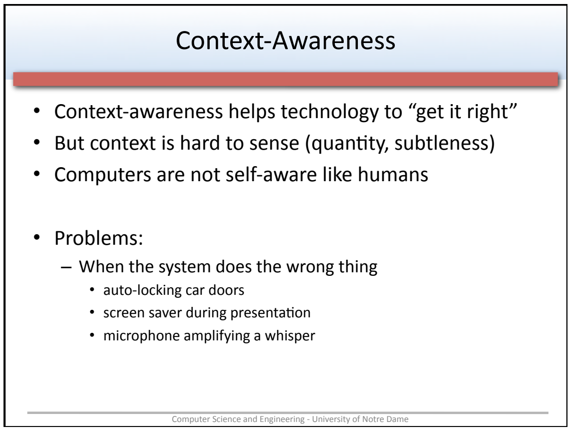
Context-Triggered Actions

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



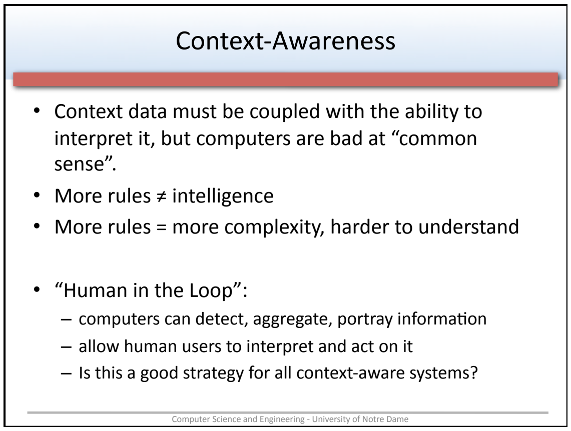
Siren
Temp High
Temp High
Floor plan with two adjacent rooms
Alerts generated by Siren
Messages from fellow firefighters

```
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))
```



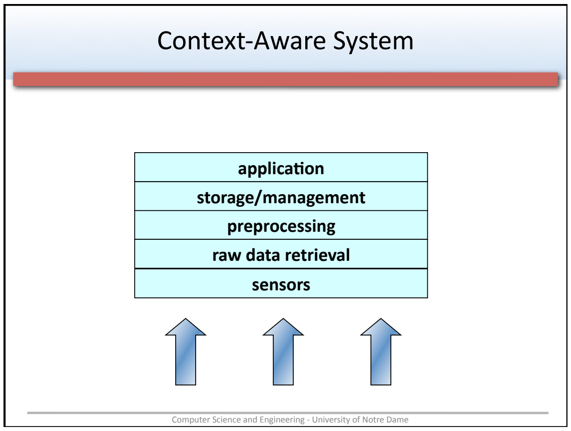
Context-Awareness

- Context-awareness helps technology to “get it right”
- But context is hard to sense (quantity, subtleness)
- Computers are not self-aware like humans
- Problems:
  - When the system does the wrong thing
    - auto-locking car doors
    - screen saver during presentation
    - microphone amplifying a whisper



Context-Awareness

- Context data must be coupled with the ability to interpret it, but computers are bad at “common sense”.
- More rules ≠ intelligence
- More rules = more complexity, harder to understand
- “Human in the Loop”:
  - computers can detect, aggregate, portray information
  - allow human users to interpret and act on it
  - Is this a good strategy for all context-aware systems?



Context-Aware System

application

storage/management

preprocessing

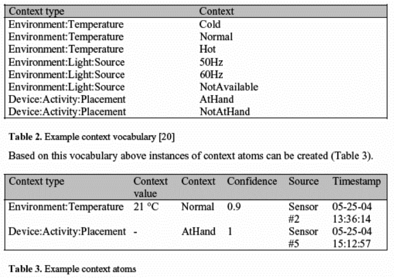
raw data retrieval

sensors

Context Models

- Goals when designing a context ontology
  - Simplicity
  - Flexibility and extensibility
  - Generality
  - Expressiveness
- Context Atom Attributes
  - Context type
  - Context value
  - Description
  - Time stamp
  - Source
  - Confidence

Context Models



Context type	Context
Environment:Temperature	Cold
Environment:Temperature	Normal
Environment:Temperature	Hot
Environment:Light:Source	50Hz
Environment:Light:Source	60Hz
Environment:Light:Source	NotAvailable
Device:Activity:Placement	AtHand
Device:Activity:Placement	NotAtHand

Table 2. Example context vocabulary [20]

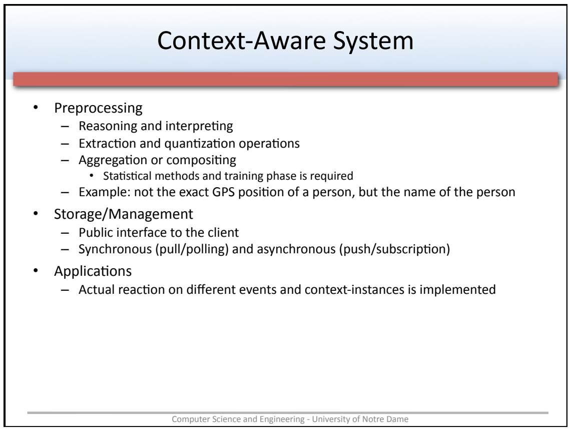
Based on this vocabulary above instances of context atoms can be created (Table 3).

Context type	Context value	Context	Confidence	Source	Timestamp
Environment:Temperature	21 °C	Normal	0.9	Sensor #2	05-25-04 13:36:14
Device:Activity:Placement	-	AtHand	1	Sensor #5	05-25-04 15:12:57

Table 3. Example context atoms

Context-Aware System

- Sensors
  - Physical sensors
    - Sensor, camera, microphone, accelerometer, GPS, thermometer, biosensors
  - Virtual sensors
    - From software: browsing an electronic calendar, a travel booking system, emails, mouse movements, keyboard input
  - Logical sensors
    - Combination of physical and virtual sensors with additional information from databases: analyzing logins at desktop PCs and a database mapping fixed devices to location information
- Raw data retrieval
  - Drivers and APIs
  - Query functionality (example: getPosition())
  - Exchangeable



Context-Aware System

- Preprocessing
  - Reasoning and interpreting
  - Extraction and quantization operations
  - Aggregation or compositing
    - Statistical methods and training phase is required
  - Example: not the exact GPS position of a person, but the name of the person
- Storage/Management
  - Public interface to the client
  - Synchronous (pull/polling) and asynchronous (push/subscription)
- Applications
  - Actual reaction on different events and context-instances is implemented