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." [Satyanarayan 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

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<thead>
<tr>
<th></th>
<th>Manual</th>
<th>Automatic</th>
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<tr>
<td>Getting Information</td>
<td>Proximate Selection &amp;</td>
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<tr>
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<td>Contextual Information</td>
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<td>Contextual Commands</td>
<td>Context-Triggered Actions</td>
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Proximate Selection/Contextual Information

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<tr>
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<th>Room</th>
<th>Distance</th>
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<tbody>
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<td>2102</td>
<td>2008</td>
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Table 1: CI Techniques for Proximate Selection
Automatic Contextual Reconfiguration

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

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:

Context-Triggered Actions

• Challenges:
  – Expressiveness of language for rules
  – Accuracy of context information

• Siren:
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

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Context Models

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<td>Normal</td>
<td>Sensor</td>
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Table 1: Example context vocabulary [20]

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Table 3: Example context atom

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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 logs 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 quantisation operations
  - Aggregation or composing
  - 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