Context-Aware Systems: the Location Variable

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sliding door

motion sensing light switch

Audio tour guide

What is Context?

- Context
  - Identity
  - Location
  - Time
  - Activity
- Designer
  - Understanding
  - Response

Dey and Abowd (GIT-GVU-99-22)

What is Context?

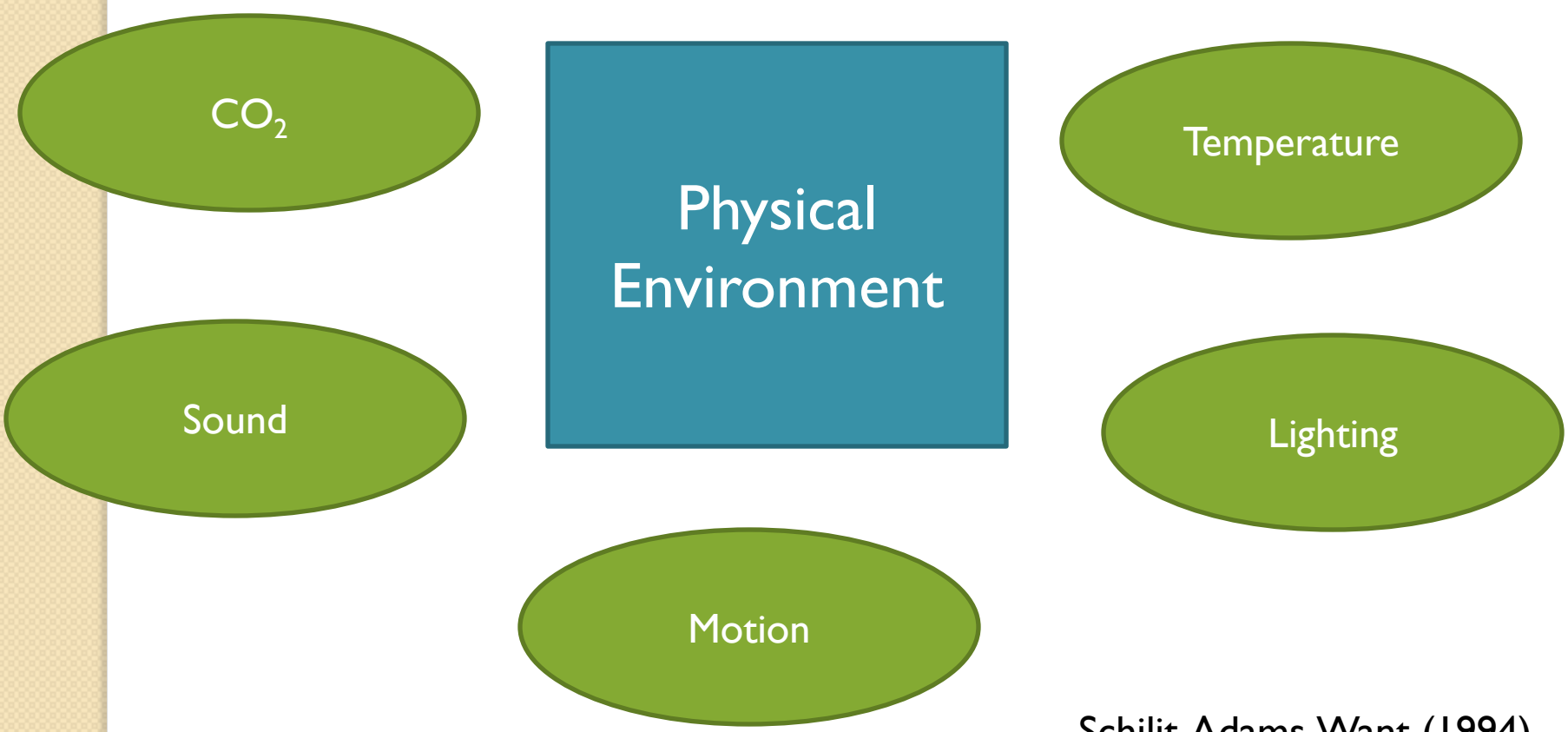
- Context
  - Identity — who
  - Location — where
  - Time — when
  - Activity — what
- Designer
  - Understanding — why
  - Response — how

Dey and Abowd (GIT-GVU-99-22)

What is Context?

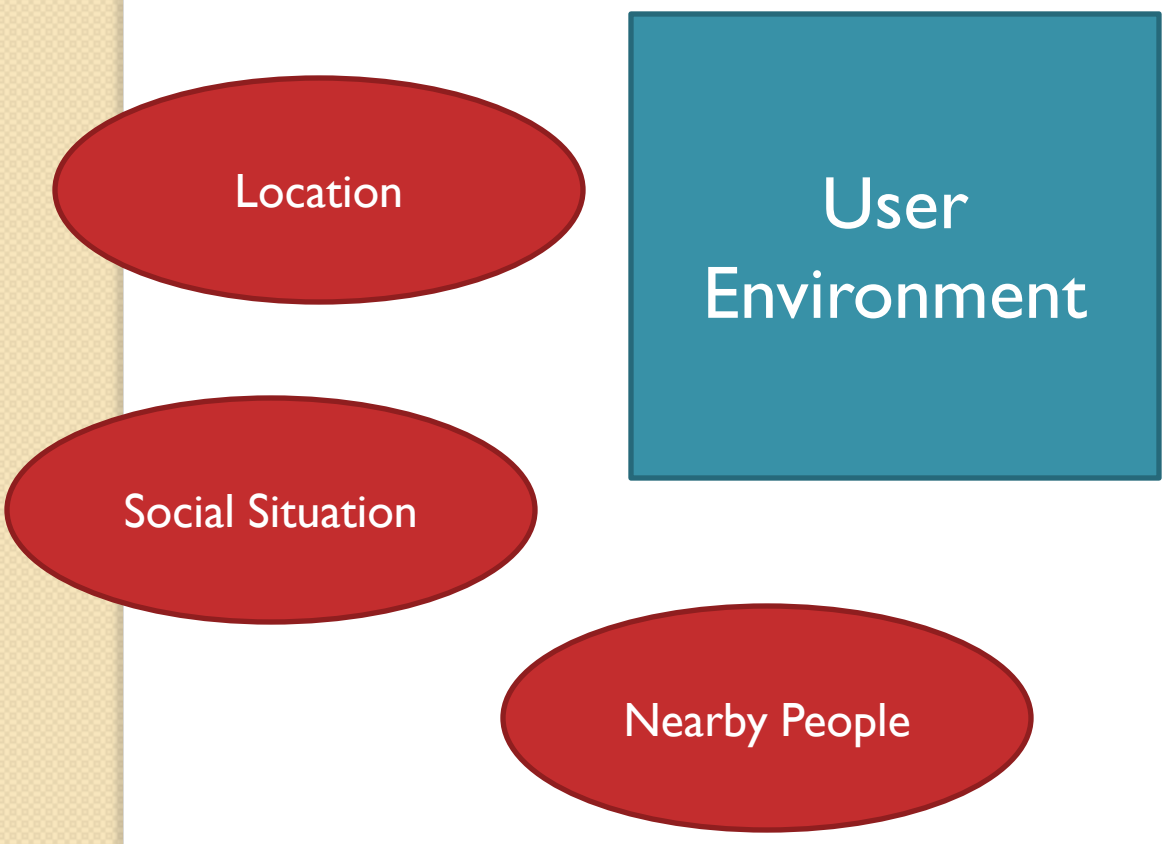
- Context
  - Identity — who — object
  - Location — where — near switch
  - Time — when — now
  - Activity — what — motion
- Designer
  - Understanding — why — looking
  - Response — how — turn on light

Context (alt. 1)



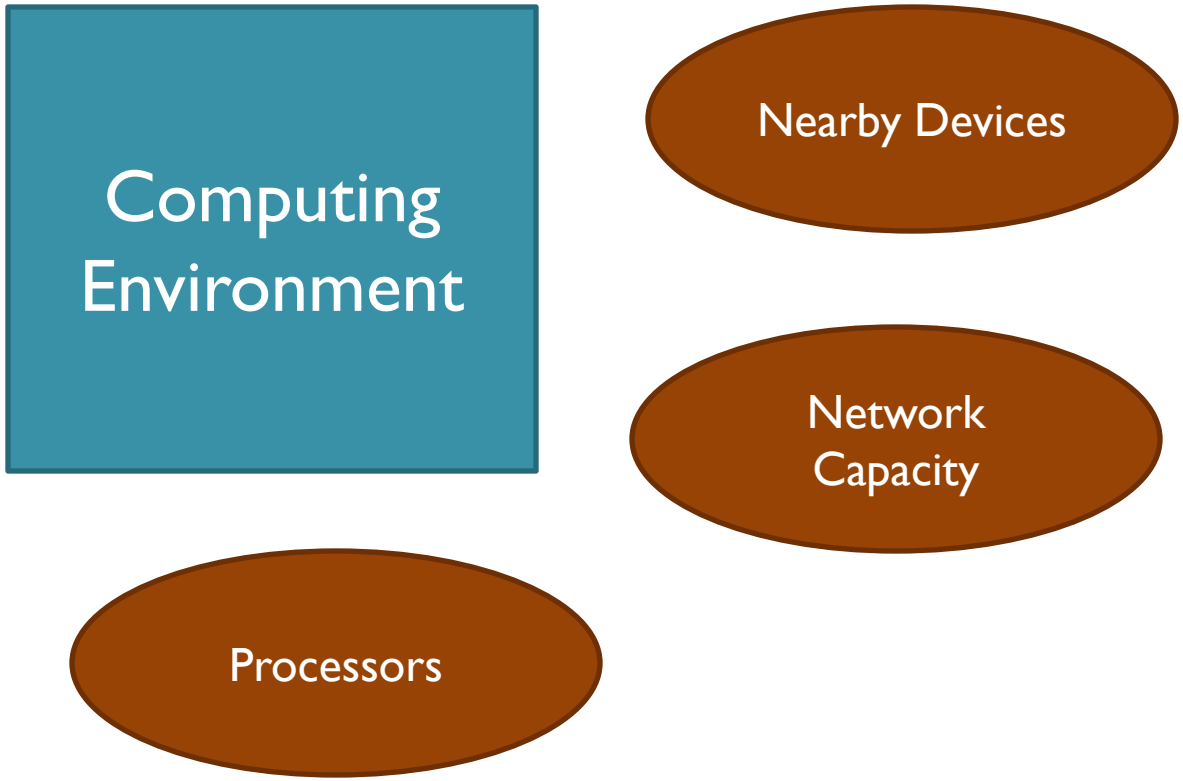
Schilit, Adams, Want (1994)

Context (alt. 1)



Schilit, Adams, Want (1994)

Context (alt. 1)



Schilit, Adams, Want (1994)

Context Aware System

A system is context-aware if it uses context to provide relevant information and/or services to the user, where relevancy depends on a user's task.

Dey and Abowd (GIT-GVU-99-22)

How do we use location?

Dimensions of Location

1. **Reference:** local vs. global
2. **Initiative:** human vs. system
3. **Offering**: command vs. information
4. **Response:** environment vs. device

		Local		Global	
		Environment	Device	Environment	Device
Human	Information				
	Command				
System	Information				
	Command				

Reference: local vs. global

- Local: { $\mathbf{Q_1}$ }
- Global: { $Q_1, Q_2, \mathbf{Q_3}, Q_4, Q_5 \ldots$ }

- Does the system maintain relationship(s) to other entities?

Audio Tour Guide (Bederson), Cyberguide Librarian (Abowd)

- Input:
  presence nearby Q_1
- Action:
  provide information that is associated with Q_1
- (Abowd et al, p. 423)

Cyberguide Map (Abowd)

- Input:
  user is at location (X,Y,Z)
- Action:
  provide a map with user's location and surrounding
- Example:
  Google Maps on smart phone

Reference: Local vs. Global

2

Initiative: human vs. system

- Human:
  - the system waits for the user to decide what action to take
- System:
  - the system takes action without consulting the user
- Has the system conducted an action without your consent?

Ju, Lee, Klemmer, 2008

Audio tour guide (Bederson)	Cyberguide librarian (Abowd)
• Plays sound automatically when within range	• User chooses what to read
• What happens when sound does not play nearby?	• What is relevant?
• Why does the audio track switch part way through?	

Initiative: system vs. human

3

Offering: Command vs. Information

- Schilit, Adams, Want

  Context-Aware Computing Applications, 1994

  - Command = Verbs
  - Information = Nouns

Contextual Commands (Schilit)	Proximate Selection (Schilit)
• Example: Applications that can be run differ based on location • Scenario: Turn on/off projector associated to the room	• Example: Items to choose from are listed in order of distance • Scenario: Print dialog box lists nearby printers first

Offering: Command vs. Information

4

Response: environment vs. device

- Environment:
  - Context is changed
  - One response for several people
- Device:
  - Context is unaltered
  - Different responses to different people
- Are other people affected by a response?

Audio tour guide (Bederson)

- Response:
  sound played to the device's headphones
- Everyone experiences a different response

Music FX (McCarthy)

- Response:
  "preferred" music is played to satisfy as many people as possible
- Needs to balance between other users' preferences

Response: Device vs. Environment

		Local		Global	
		Environment	Device	Environment	Device
Human	Information				
	Command				
System	Information				
	Command	Door opening Motion lights			

		Local		Global	
		Environment	Device	Environment	Device
Human	Information				
	Command				
System	Information		Audio tour guide		
	Command	Door opening Motion lights			

		Local		Global	
		Environment	Device	Environment	Device
Human	Information		Cyberguide librarian		Cyberguide map
	Command				
System	Information		Audio tour guide		
	Command	Door opening Motion lights			

		Local		Global	
		Environment	Device	Environment	Device
Human	Information		Cyberguide librarian		Proximate Selection Cyberguide map
	Command				Contextual Commands
System	Information		Audio tour guide		Virtual white-board in each room
	Command	Door opening Motion lights			Context-Triggered Actions

		Local		Global	
		Environment	Device	Environment	Device
Human	Information		Cyberguide librarian		Proximate Selection Cyberguide map
	Command				Contextual Commands
System	Information		Audio tour guide	ActiveBadge	Virtual white-board in each room
	Command	Door opening Motion lights Music FX		Responsive office environ-ment: light, temperature	Context-Triggered Actions

Dimensions of Location

1. **Reference:** local vs. global
   hardware limitation
2. **Initiative:** human vs. system
   Bellotti and Edwards
3. **Offering**: command vs. information
   application-dependent
4. **Response:** environment vs. device
   possibilities

Reference

Hardware limitations ➔ "local" reference

Local

- Line of sight
  (IR at specific places)
- High-attenuation signal
  (RFID)
- Entry stamp

Global

- IR emitters everywhere
- WiFi routers
- GPS

2

Initiative (1/3)

- User Modelling
  - Can we predict what people want?
  - People behave in "unpredictable ways that are impossible to even model accurately"
  - Cannot model "nondeterministic" thinking

Bellotti and Edwards, 2001

2

Initiative (2/3)

- System
  - "Machines can take autonomous action on our behalf"
  - "Well-defined responsive behaviors that can be handled on their own"
- But:
  - There are "risks involved in allowing the system to take initiative in any activity in which human participants are involved"

Bellotti and Edwards, 2001

2

Initiative (3)

- Human
  - "Empowering them [users] to decide how best to proceed"
  - Design guidelines
    - Address, attention, action, alignment, and accident (feedback)

Making Sense of Sensing Systems: Five Questions for Designers and Researchers (Bellotti et al., 2002)

3

Offering

- Command vs. information: application-dependent
- Is Schilit et al. (1994)'s definition forced? Is it really that clear cut?

4

Response

- Device
  - Requires a personal device
    (e.g. what happens if you don't have one?)
  - Handles many users gracefully
  - In prior work

- Environment
  - Arbitrate user preferences among several users
    (e.g. room temperature)
  - Why empty on the chart?

		Local		Global	
		Environment	Device	Environment	Device
Human	Information	Hello.World	Cyberguide librarian	ST "Computer: where was Data last seen?"	Proximate Selection Cyberguide map
	Command			ST "Computer: initiate self destruct"	Contextual Commands
System	Information	Ambient displays	Audio tour guide	ActiveBadge Minority Report's targeted ads	Virtual white-board in each room
	Command	Door opening Motion lights Music FX		Responsive office environ-ment: light, temperature	Context-Triggered Actions

Summary

1. **Reference:** local vs. global
2. **Initiative:** human vs. system
3. **Offering**: command vs. information
4. **Response:** environment vs. device

Conclusion

- Investigated for mobile devices

- Environment-based:
  - Ambient displays??
  - Proxemics??