Ubiquitous Computing: Applications

Topic 3

Many Computer Scientists Use Have A Circular Definition

- The application of my work is any user who needs my techniques.

But what do users mean when we say application?

- Some task they want done
- That (if you want to stay in business) they would be willing to pay for
    - ▷ Directly
    - ▷ Indirectly
    - ▷ Or rent (subscription based)

- Here we mean computational applications

I prefer the user's definitions, so I tend to consider

- Some applications are:

    ▷ Productivity Software (e.g. word processor, spread sheet, etc.)
    ▷ Drawing programs
    ▷ Web Browsers (borderline middleware tool?)

- These things are not applications:

    ▷ Middleware
    ▷ Compilers
    ▷ Database systems (borderline application)
    ▷ Operating Systems/Systems Software
    ▷ A theoretical conjecture on what others might do with an algorithm

Brown et al. [1]

Example of what I mean as NOT an applications paper

- But still interesting, it gives a nice intro to context awareness.

What is context awareness?

- Being able to determine ones context
- Context refers to the user's state as well as his/her surroundings.

Context and time

- Current context (take a snapshot)
- Historical context (extend context across time)

Context and Privacy

- Each user is control of their personal information
- Users must be able to understand how their personal information may be used by others
- Users should only have access to information that was available to them at that time (in context).

Richness in both capture and behaviors

- Proactive triggering of information display and reactions

  ▷ The last time you performed this task (or a similar task) here are the steps you performed.

  ▷ When your friend was recently here, they saw this.

  ▷ Here is how an expert did this.

  ▷ Your audience is interested in this aspect of your topic, please emphasize this in your presentation.

- Streamlining interaction

- Remember Past Events

  ▷ I think this is a killer app, but very hard to do right.

- Reminders for future events

  ▷ Using Triggers, e.g. when I meet X tell him

- Sharing Experiences

  ▷ Tell my daughter about my grandmother's horses when she visits a farm.

SenSay - A Context Aware Mobile Phone

Siewiorek [2] et al. developed a context aware Mobile Phone (SenSay).

Who should remember what?

- Should the user remember state information about the phone?
    - ▷ Set the ringer off for class or in the movies.
    - ▷ Which call must I answer?
    - ▷ What if I'm in a rock concert, should my phone vibrate?

- Or should the phone "remember" (respond to) the user's state?
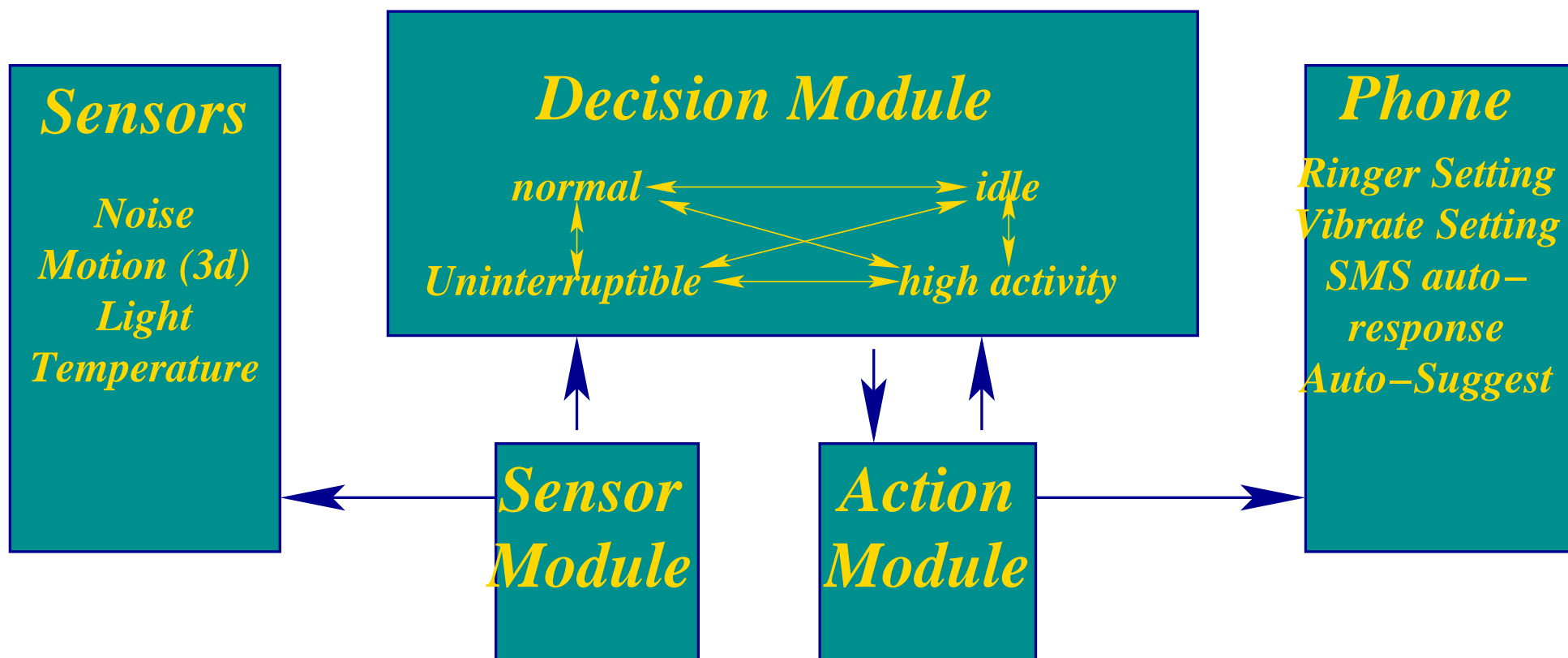
How can the phone learn the user's state?

- Wearable sensor inputs (light, sound, motion)
- Phone assumes states in response to user's state
    - ▷ Uninterruptible (don't interrupt user, don't ring)
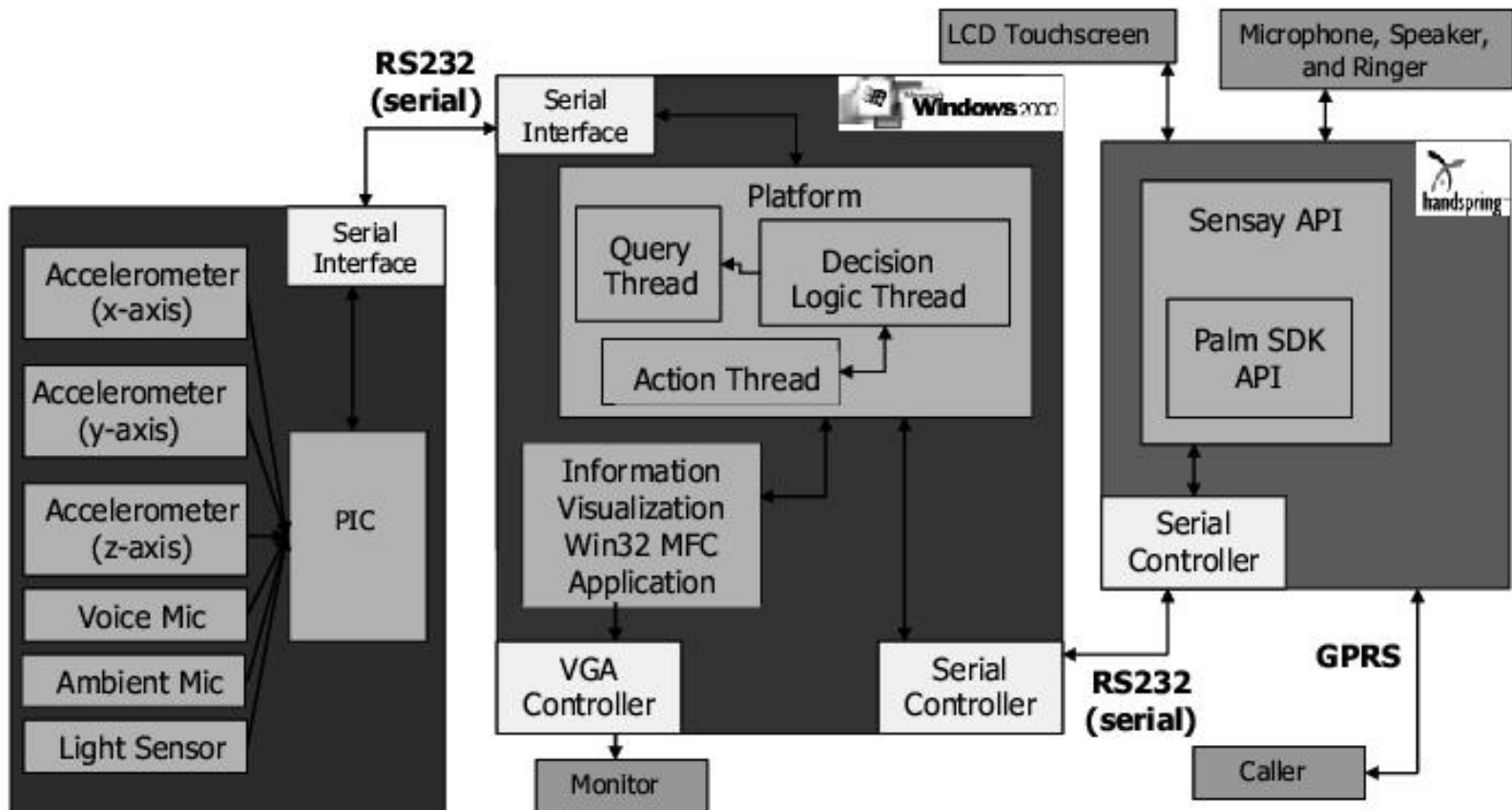   - ▷ Idle
    - ▷ Active
    - ▷ Default

Uses Commodity off the shelf (COTS) hardware

- Future versions will have integrated components

Software used to provide interface and functionality

SenSay Hardware

Hardware

- Sensor Box - noise, light, temperature and motion sensors + controller
- Sensor Module
  - ▷ Polls sensor box (1 time / second)
  - ▷ Communicates via Serial Cable (RS 232) with decision module
  - ▷ Recieves data sends control signals
  - ▷ To reduce overhead. not every measure is taken each polling cycle (e.g. temperature)
  - ▷ Highly variable data (e.g. sound volume) may have statistics taken (min/var/min/max) over the polling period
  - ▷ A simple protocol with small packets is used.

- Decision Module - does more complex logic and analysis
  - ▷ Buffers 10 minutes of sensor values (for trend analysis)
  - ▷ Holds state history

- Action Module - Handles changes in setting and operation as per decision module
  - ▷ Ringer/Vibrate control
  - ▷ Send SMS to caller
  - ▷ Make Call Suggestions
  - ▷ Provide calendar access

SenSay State Transition Control
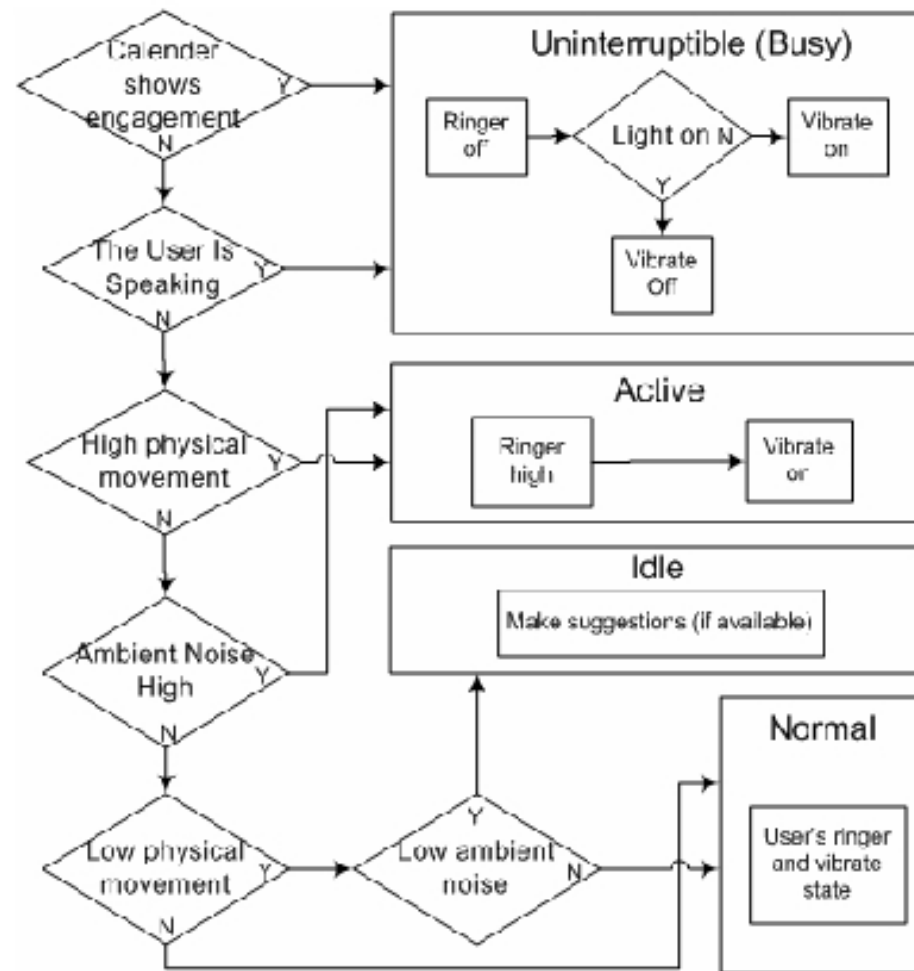
Decision logic for phone in uninteruptible state

SenSay Logic

Context sensitivity means relying on:

- Current State
- Recent State
- Local information (from sensors)
- User preference (allows manual override and training)

Suppose state change triggers on a threshold

- Fixed threshold can cause many state changes if environmental conditions are near threshold
- This is bad (unstable)
- How to fix? Hysteresis - change threshold based on state.

SenSay States

Uninterruptible state

- Do not ring or vibrate during
  - ▷ Scheduled events (check calendar)
  - ▷ When the user is in a conversation (speaking or listening)

- Permit high priority calls to ring through

- Permit SMS or call suggestions to be made (Call mom!)

- Requires significant sensor data to leave this state

Active State - permits access in spite of environmental constraints

- Loud Noise (music) or activity (dancing) detected

- Ringer/Vibrate settings attempt to compensate.

- Requires significant sensor data to drive it into this state.

Idle state - When the user is available (interruptible)

- Good time for the phone to forward alerts to the user

- Should not be entered lightly, don't want to pester the user

Normal state - default, applies user's last selected settings

# GOTO and KAMBAYASHI's Passenger Support System

Interdisciplinary Success Story

- GOTO from Railway Technical Research Institute
- KAMBAYHASHI from Koyto University

Apply ubicomp to help old and handicapped users in railway stations.

- User employs mobile devices to access central DB for creating a travel plan.
- The central system offers several alternative plans
- The users selects a plan and reserves tickets
- During the travel, the mobile device queries local and central DB's to get travel info and schedules
- Data provided can be classified by:
  ▷ Delivery method (On Demand vs. Broadcast).
  ▷ Mobility of Data source (Moving vs. Fixed)
- System must not fail under high load (e.g. during emergencies).
- Mobile Nodes handle Dynamic Integration, Personalization and filtering.

Passenger Support System Requirements
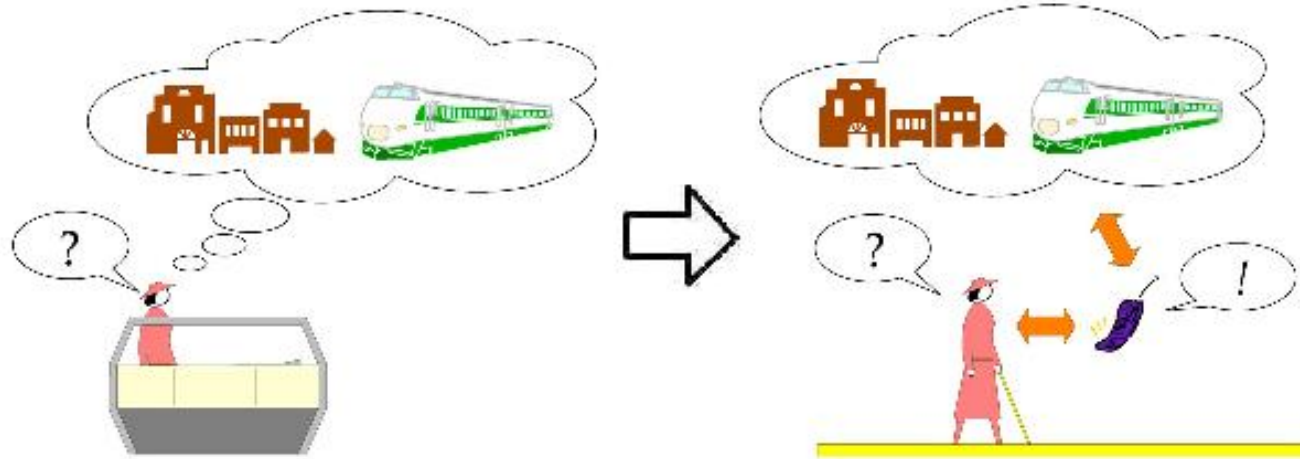
Advocates use of an "attendent" ubicomp.

- User does decision making

  ▷ User on the left is in transit, and cannot plan

- Mobile Attendant handles details/gets information

  ▷ Personalization - observes your state and environment
  ▷ Integration - Combines information for useful presentation
 ▷ Filtering - Selects which information to emphasize

Passenger Support System Approach
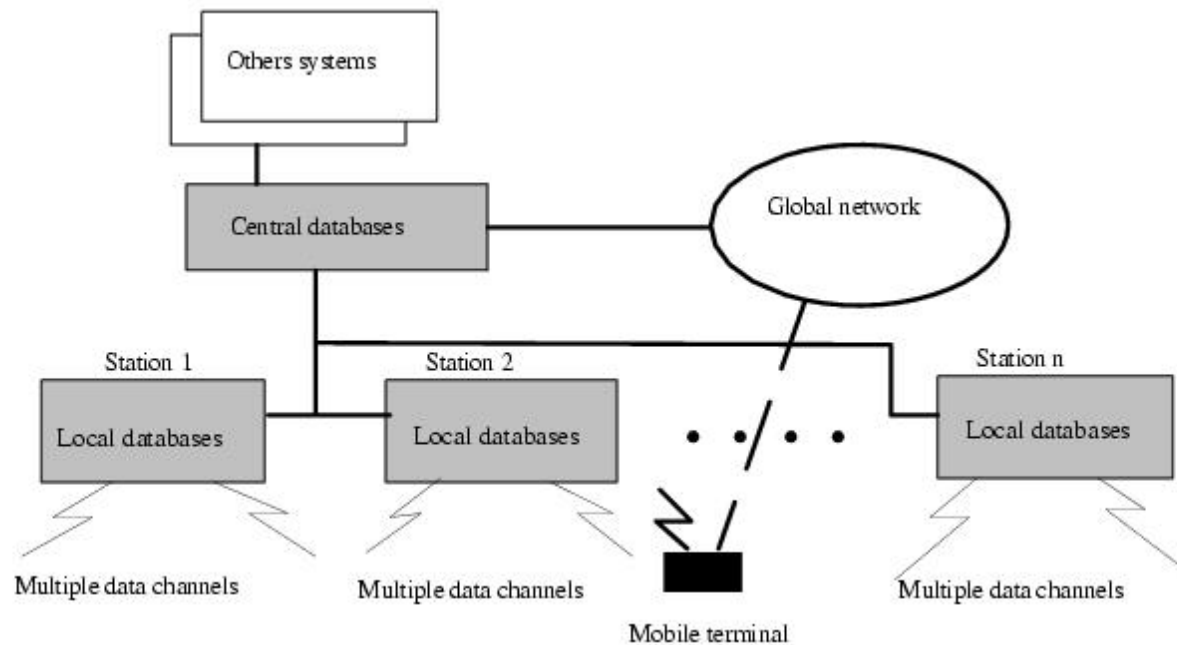
There Data resides in 3 places

- Central DB - Has general use data, fewer details (but supports travel planning).
- Local DB - Has more details (e.g. local station map, platform info, etc.)
- Mobile/Traveling - Requires Handoff (like Cell Phones) between base stations and mobiles

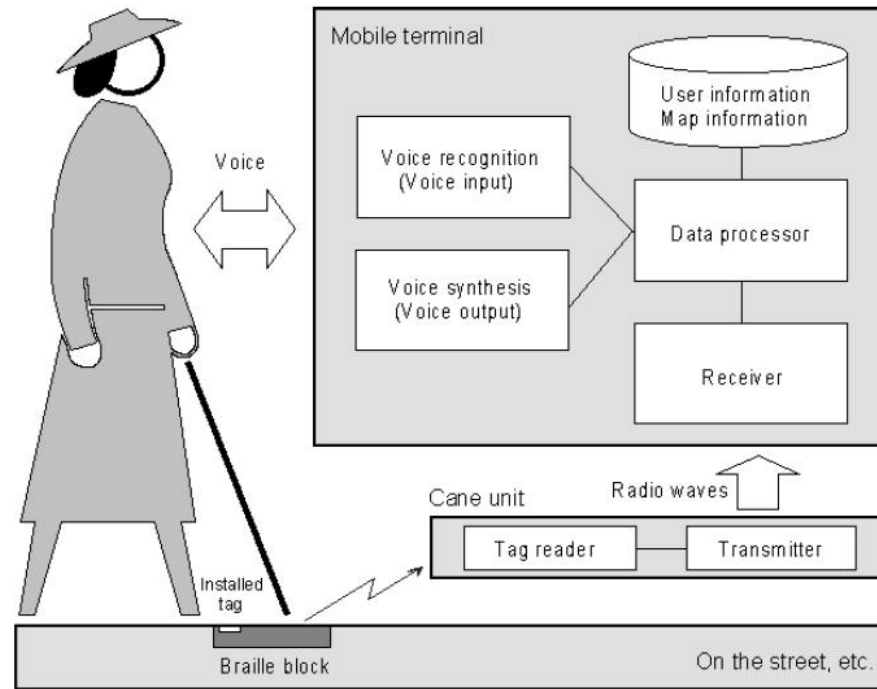# Fixed vs. Mobile Data Sources and Planning
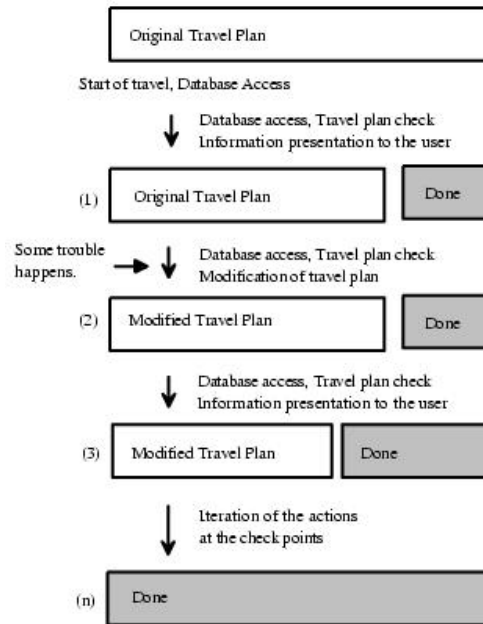
Fixed data sources provide location specific data

- What is in a store, where are the restrooms?

Mobile Data sources besides the hand helds are needed

- Trains - Is a train on time, can it hold more passengers?

Data Communication and UI for Handicapped Access

Handicapped People (e.g. the blind) need special UI devices

- So bury RF ID tags in the center of walkways
- Add antenna and receiver to cane
- Provide speakers and device for entering queries
- Provide fine grained feedback near transitions (e.g. corners)

Rememberer For Museum Visits

Based on HP Cooltown approach (Kindberg et. al).

- Premise - Users are nomadic (computationally at least)
- Computing and WWW are going to be ubiquitous.
    - ▷ The WWW may evolve out of its current form.
- Give every object a web presence
    - ▷ URLs need support resource discovery, not record where something is stored.
- Bridge the Physical and on-line worlds.
    - ▷ Computers (and batteries) are too expensive to deply everywher
    - ▷ So use cheap RF ID tags are added to things we want to identify
    - ▷ Identified objects are awarded URLs.
    - ▷ Data is accessed using web technology (auto generates URLs)
    - ▷ Users carry PDA, and bring home souviners with URL's on them.

Early experience reports needed for feedback to designers

- Researchers try an approach
- Users give feedback
- lather, rinse repeat

Exploratorium Requirements and Experiences

The Museum is called an Exploratorium, which is

- Hands on — learn by doing

- Boisterous — need rugged/robust devices

- Hard to Navigate/Identify — people go to museums to see unfamiliar things

User and Museum would benefit from having a:

- Informer — What am I seeing?

- Suggester — Push this button to see a display change

- Guider — Which display should I see next?

- Communicator — Allows users to share comments about exhibits

- Rememberer — Let's people access visit information after they return home.

Contrast traditional Museams (without Technology)

- Exploratorium Exhibits were played with (to figure out how it worked)

- Labels — Normally read when the user can't figure out the exhibit

- Social Behavior — One visitor assumes teacher role in groups

- Physical experience — Visitors drop what they are doing to play with poular exhibits.

The Prototype

Pi-station: beacon (infrared), barcode, RFID plus processing, I/O and networking
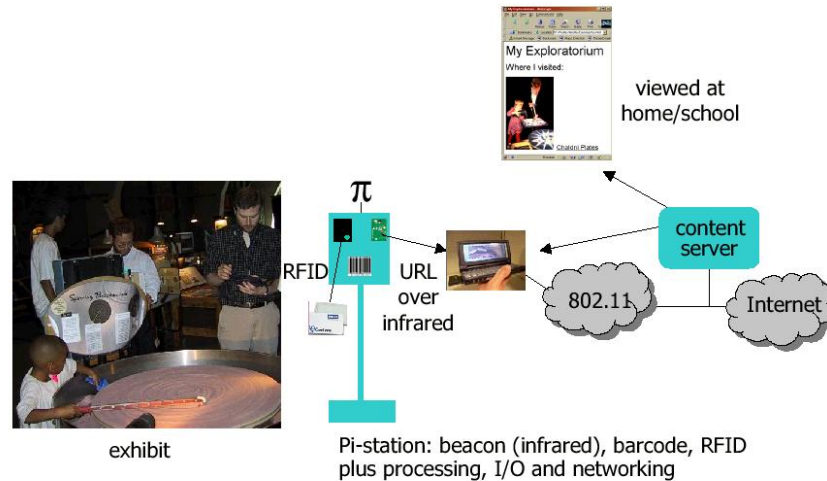
Electronic Guidebook — Several (around 6) exhibits instrumented

- Enhance Exhibit content — Deliver static web pages to visitor's PDAs
- Personal Scrap Book — Lets users bookmark pages
    - ▷ User privacy protected by generating pseudonyms

- Couldn't do whole museum, due to personnel and equipment limitations

Architecture: Use PDAs and Pi-stations (Points of Information).

Physical Hyperlinks

Central Aspect of "Cooltown"

- Id tag attached to object of interest
    - ▷ Barcode
    - ▷ Infrared Beacon
    - ▷ RFID Reader

- User points PDA at the object or gets a tag for the object

- Id is decoded into a URL using "resolution service"

Exploratorium User Feedback

Users liked it but it was intrusive.

Complexity lead to integration problems

Beacons sometimes were accidentally received, disrupting browsing

Some users wanted to buy the device

- Often with modifications (CD Player/GIS/etc.).

Web browsing on PDAs is hard due to small displays

Designing content was hard

- Just because you have a video camera doesn't make you Speilberg (Wes Kaplow).

Too Ambitious? Maybe focusing on subproblem is better

- The critical resource is the user's attention!

The Rememberer Approach

Seek to provide a few controlled features

- A remember this technology used to record objects during the visit
- A visit record, consisting of a few web pages (web scrapbook)
- A physical artifact commemorating the visit
    - ▷ Contains some Pictures
    - ▷ And the URL of the web scrapbook

References

[1] Peter Brown, Winslow Burleson, Mik Lamming, Odd-Wiking Rahlff, Guy Romano, Jean Scholtz, and Dave Snowdon. Context-awareness: some compelling applications. On line at http://www.dcs.ex.ac.uk/~pjbrown/papers/acm.html, submitted for publication.

[2] Daniel Siewiorek, Asim Smailagic, Junichi Furukawa, Neema Moraveji, Kathryn Reiger, and Jeremy Shaffer. SenSay: A context-aware mobile phone, 2003. On line at http://www-2.cs.cmu.edu/ aura/publications.html, submitted to the International Symposium on Wearble Computers, 2003.