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MobiSys : Mobile Systems, Applications and Services

myexperience

A System for *In Situ* Tracing and Capturing of User Feedback on Mobile Phones

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dub design: use: build:

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intel

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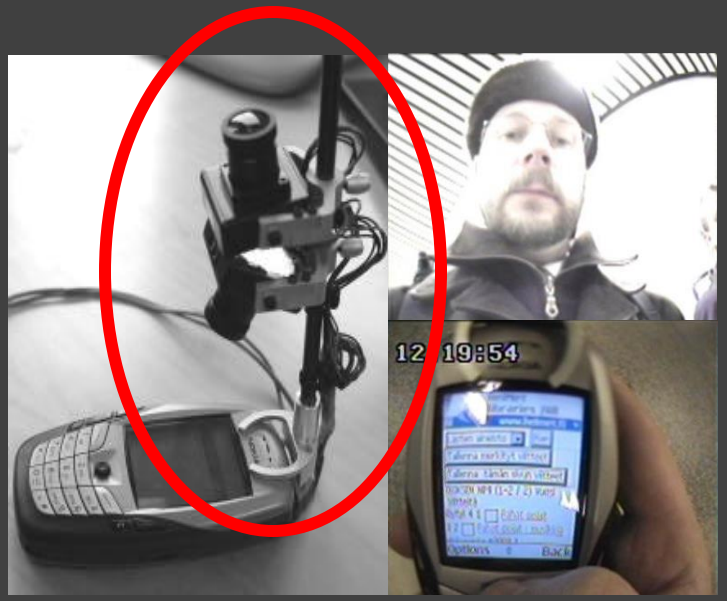
mobile computing

Mobile devices are used in a variety of contexts

lab methods



For example, past research has looked at translating lab-based methods into a “mobile setting”

goal

- Create a software tool that collects data about *real* device usage & context *in the field*



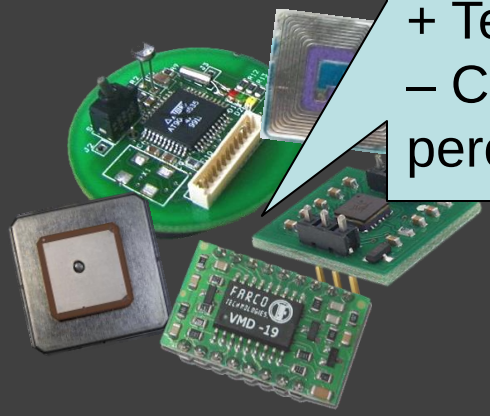

- Data can be used to
  - Better understand actual device/system usage
    - E.g., how mobility patterns affect access to WiFi
  - Inform the design of future systems
    - E.g., optimize battery utilization algorithms based on charging behaviors

research challenges

1. Coverage: collect rich information about features of interest
2. Scale: collect large amounts of data over long periods of time
3. Extensible: easily add new data collecting capabilities
4. Situated: collect *real* usage data in its natural setting
5. Robustness: protect or backup data collected in the field

the myexperience tool

sensors



Device usage and envi
state are automatically
and logged.

+ Technique scales we
– Cannot capture use
perception, or reaso

+

Users respond to short context-triggered surveys on their mobile device.

+ Can gather otherwise imperceptible data
– Lower sampling rate than sensors

context

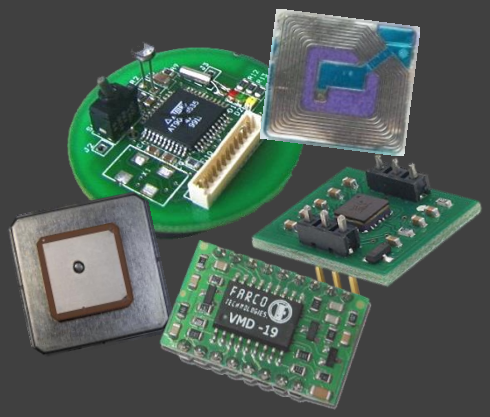
self-report

myexperience

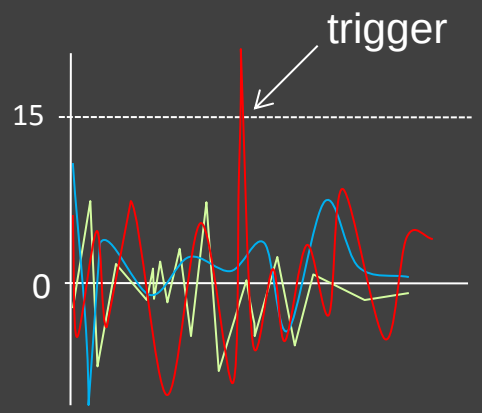
MyExperience combines automatic sensor data traces with contextualized self-report to assist in the *design* and *evaluation* of mobile technology

sensors, triggers, actions

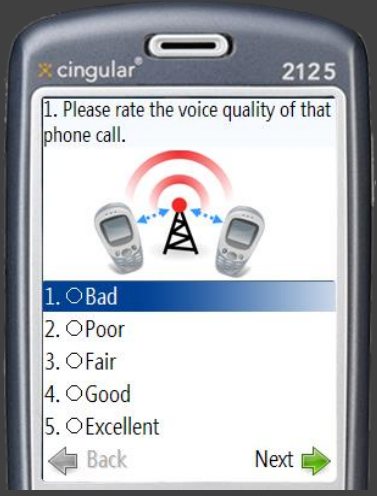
Sensors



Triggers



Actions



Example Sensor:

- DeviceIdleSensor
- PhoneCallSensor
- RawGpsSensor
- PlaceSensor
- WiFiSensor

Example Triggers:

- DeviceIdle > 15 mins
- PhoneCall.Outgoing == true
- Gps.Longitude == “N141.23”
- Place.State == “Home”
- WiFi.State == “Connected”

Example Actions:

- SurveyAction
- ScreenshotAction
- VibrationAction
- SmsSendAction
- DatabaseSyncAction

xml / scripting interface

- XML : Declarative
  - Define sensors, triggers, actions, and user interface
  - Set properties
  - Hook up events

```
<sensor name="Place" type="PlaceSensor">
 <prop name="PollInterval">00:00:01</prop>
</sensor>
```

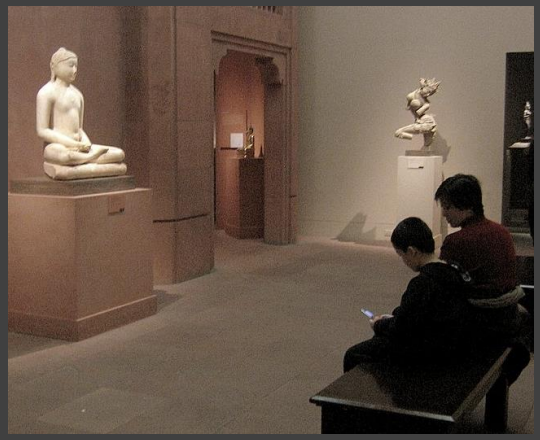
- Script : Procedural
  - Create fully dynamic behaviors between elements specified in XML
  - Interpreted in real time
  - New scripts can be loaded on the fly

```
<trigger name="Silent" type="Trigger">
  <script>
    placeSensor = GetSensor("Place");
    if(placeSensor.State = "Work"){
      ... do some action ...
    }
  </script>
</sensor>
```

example: phone profile

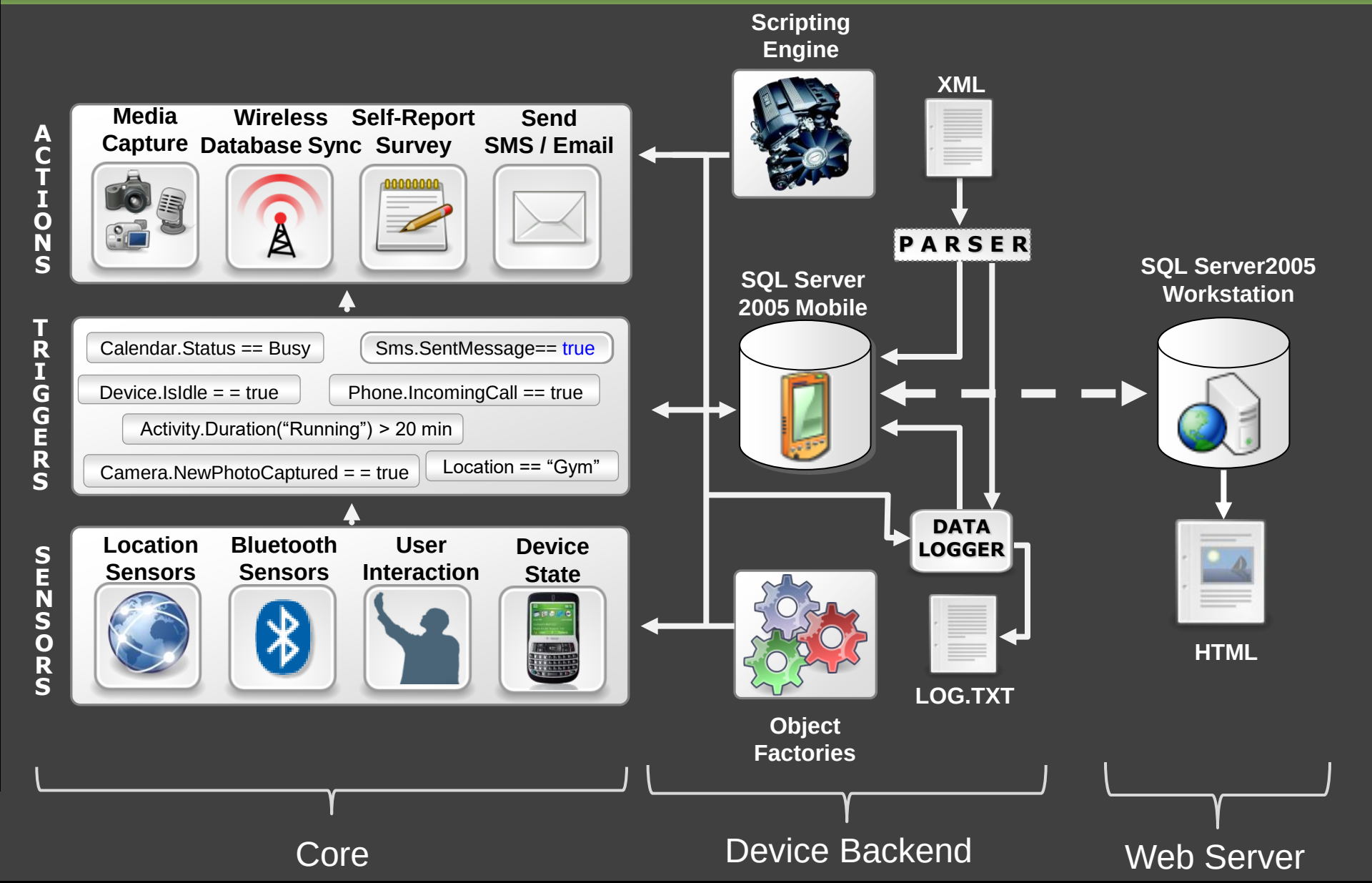
- We would like to build a model of phone profile behavior (i.e., setting the phone to silent)

- Can we begin to predict phone profiles based on sensed context?
  - Time of day
  - Location
  - Transportation mode
  - Calendar appointments



```
<sensors>
  <sensor name="PhoneProfileSensor" type="PhoneProfileSensor"/>
  <sensor name="RawGpsSensor" type="RawGpsSensor"/>
  <sensor name="CalendarSensor" type="CalendarSensor"/>
  <sensor name="MobilitySensor" type="MobilitySensor"/>
</sensors>

<actions>
  <action name="PhoneProfileSurvey" type="SurveyAction">
    <property name="EntryQuestionId" value="PhoneProfileReason"/>
    <property name="TimeOutInterval" value="00:05:00"/>
  </action>
</actions>

<triggers>
  <trigger name="PhoneProfileTrigger" type="Trigger">
    <script>
      profileSensor = GetSensor("PhoneProfileSensor");
      if(profileSensor.StateEntered = "Silence"
          and GetRandom() < 0.2){
        GetAction("PhoneProfileSurvey").Run();
      }
    </script>
  </trigger>
</triggers>
```

architecture



implementation

- Windows Mobile 5
  - .NET CF 2 in C#
  - SQL Server Mobile 2005
  - A few open source libraries
  - Port of Simkin

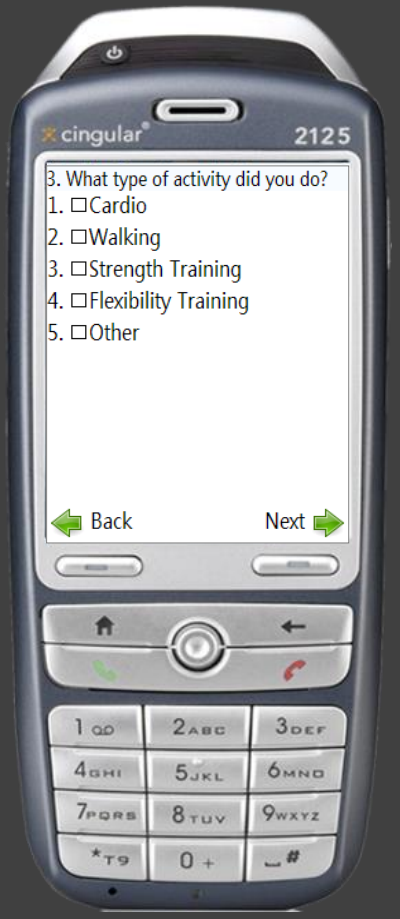
Pocket PC Devices

SmartPhones

Component	Lines of Code
MyExperience	16, 970
Roam	14,271
SimkinCS*	9,148
Total	**40, 389**

*SimkinCS is a port of Simkin, a java-based scripting language

performance



HTC Tornado
SmartPhone

HTC Universal
Pocket PC Phone

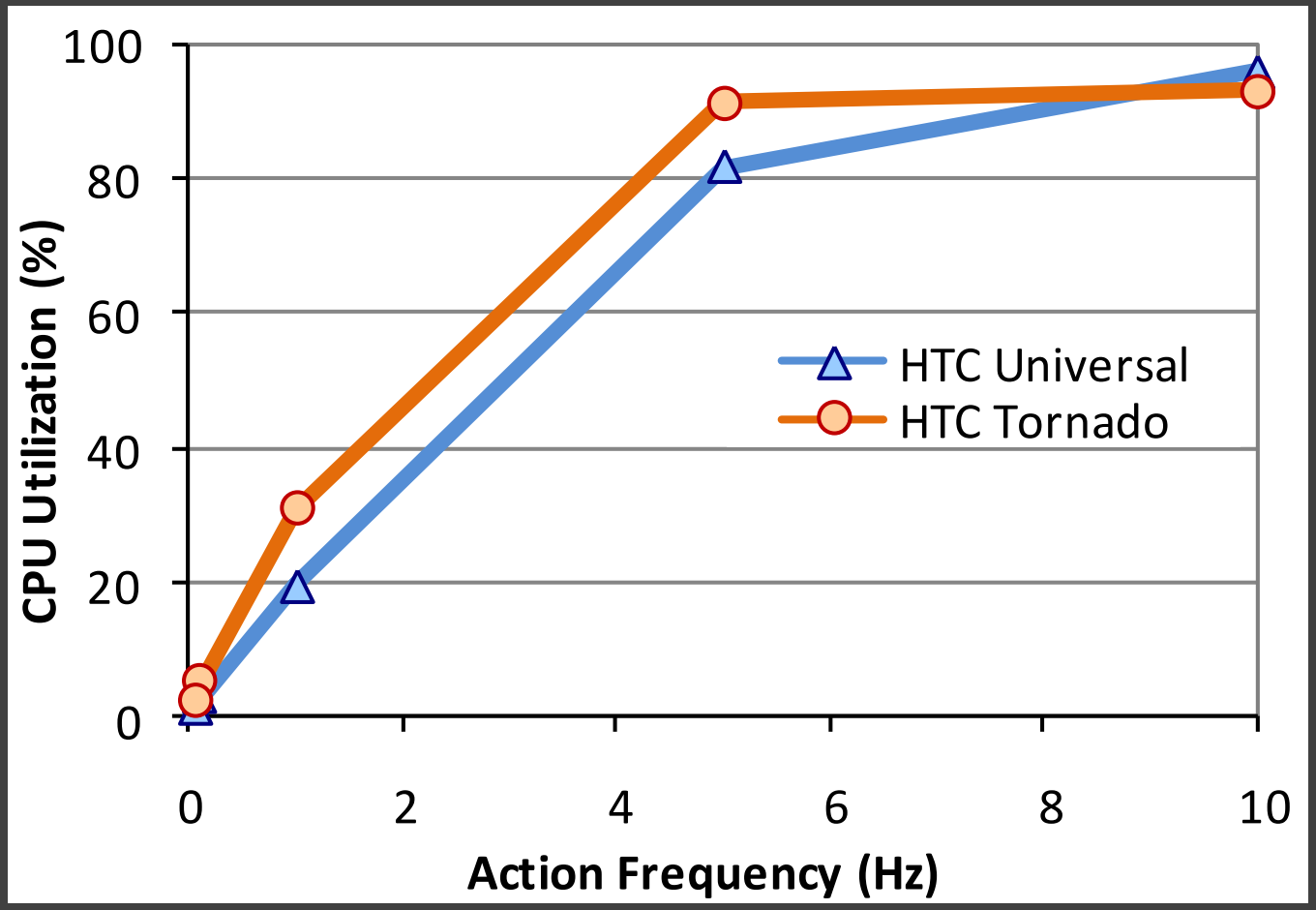
installation size & memory

- Current build of MyExperience is 1.56 MB
  - Includes ~150 sensors (e.g., Sms, Phone, GSM)
  - 11 actions (e.g., Surveys, Database Sync)
- Phone must also have SQL Server Mobile 2005 and .NET CF 2
  - Windows Mobile 6 comes with this installed
- Memory footprint
  - 4.32 MB of memory (< 20% available on most devices)

battery life

- Baseline
  - 4 days, 17 hours
- With MyExperience
  - 140 active sensors
  - 20 survey actions / day
  - 4 days, 3 hours (~12% decrease)
- WiFi, Bluetooth based sensors will decrease battery life substantially (~50%)

cpu utilization



< 3% utilization at a rate of 4320 actions / day

sensor performance

- It takes approximately 1ms for a sensor state change to propagate through system and be stored in local database
- Sensors that fire rapidly ~1,000 Hz can starve the CPU
  - We designed our sensors to run at 1 – 10 Hz
  - GPS sensor and mobility sensor run at 1Hz
  - Accelerometer-based sensor runs at 4Hz

case study 1: charging behavior

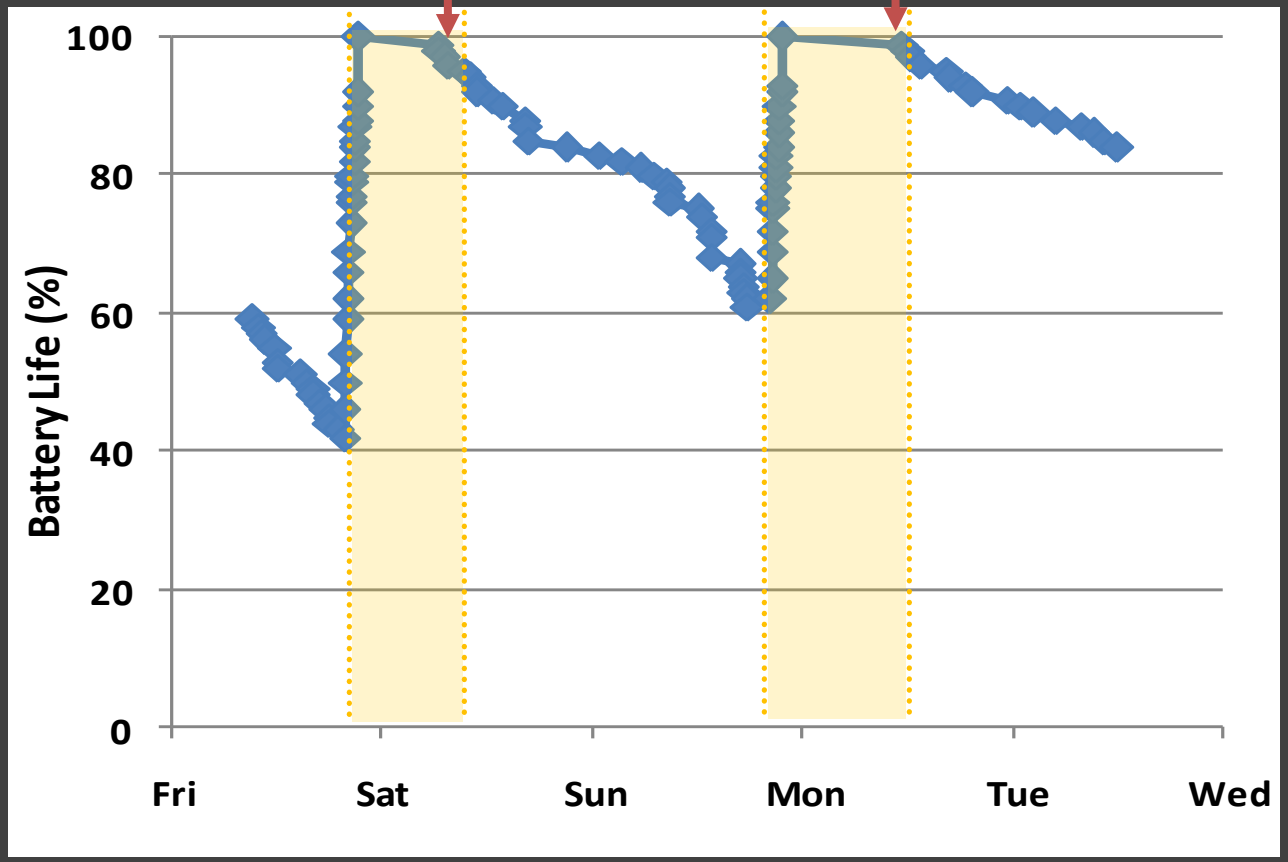
- Motivation
  - Battery life has long been a challenge in mobile computing
  - Dependent on usage:
    - WiFi, video, length of calls
- Study
  - 2 week pilot study with 4 people
  - Log device usage (e.g., phone calls, WiFi, active applications)
  - Actively track battery life
  - Survey at moments of charging

```
<sensors>
  <sensor name="SystemStatesSensor" type="SystemStatesSensor"/>
  <sensor name="BatteryLifeSensor" type="BatteryLifeSensor"/>
  <sensor name="PowerChargingSensor" type="PowerChargingSensor"/>
</sensors>

<actions>
  <action name="BatteryLifeSurvey" type="SurveyAction">
    <property name="EntryQuestionId" value="CurrentLocation"/>
  </action>
</actions>

<triggers>
  <trigger name="BatteryLifeTrigger" type="Trigger">
    <script>
      powerSensor = GetSensorSnapshot("PowerChargingSensor");
      if(powerSensor.StateExited = "Charging"){
        GetAction("BatteryLifeSurvey").Run();
      }
    </script>
  </trigger>
</triggers>
```

battery life & user response

At home
Battery was getting low
Recharged using AC adapter

At Work
Needed to sync data
Recharged using USB



further exploration

- Further exploration could uncover:
  - The average distance from home or work when suffering battery loss
  - The primary reason people run out of battery (e.g., talk time, WiFi utilization)
  - The number of places people charge their devices and the power source used.

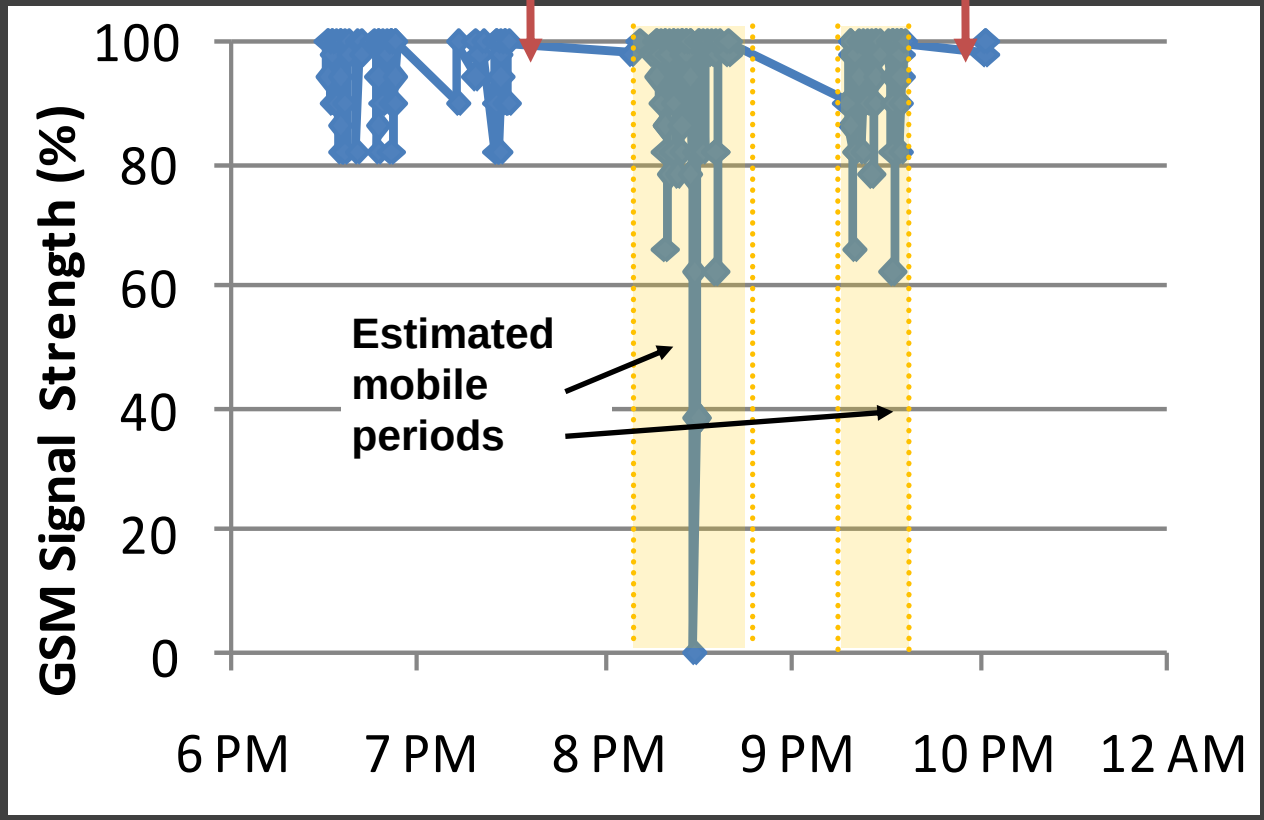
case study 2: sms usage

- Motivation
  - 1 trillion SMS messages sent worldwide in 2005
  - Explosive growth begs research:
    - Why SMS vs. voice?
    - Where do people use SMS?
- Study
  - Similar setup as before
  - Asked questions after SMS sent
    - User's location
    - Reason for using SMS

sms usage, mobility and response

Location: work
Reason: couldn't use voice

Location: home
Reason: did not need immediate response

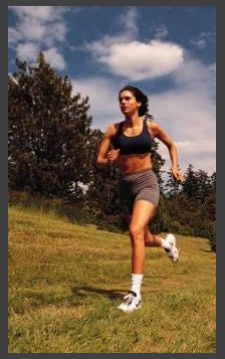


further exploration

- Further exploration could uncover
  - The link between mobility patterns and application usage
    - Do people SMS more when stationary than moving?
  - How often users suffer from low cell signal strength and how this affects voice vs. sms

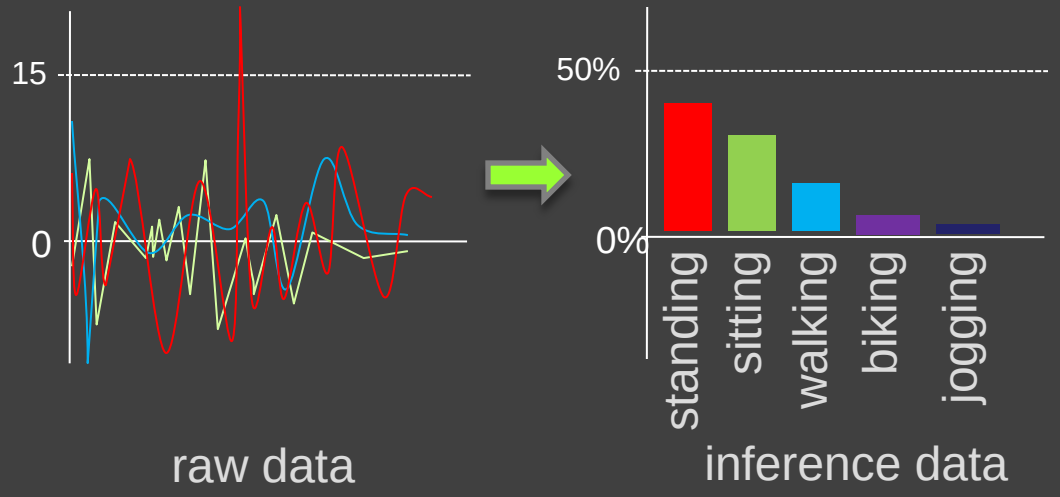
ubifit

- Initial 3-week study planned followed by longitudinal 3-month study
  - Female participants from Seattle area
  - Participants use *lab-provided* WM5 devices with ubifit instead of their own personal phones
- UbiFit application
  - Built off of MyExperience
  - Collects both inferred activity and self-report activity data
  - Data is sync'd with Intel Research's web server once/hr throughout the study



msp + myexperience

Bluetooth

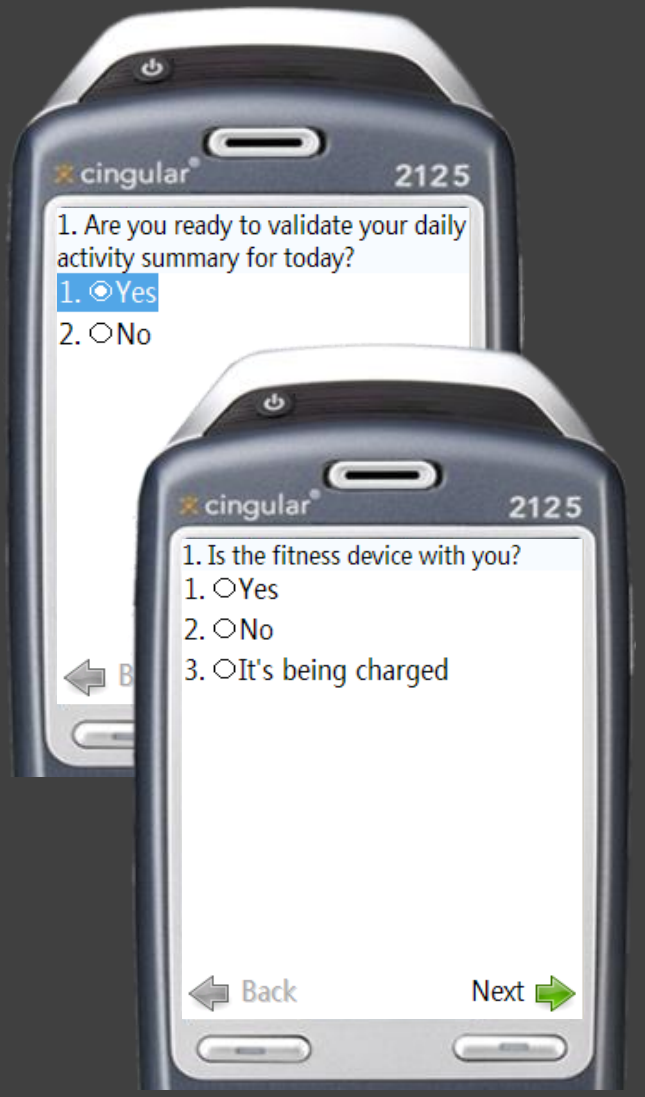


raw data

inference data

subset of ubifit triggers

- Journal reminder
  - If journal has not been used in ~2 days and it's past 8PM, launch journal reminder
- Uncertain activity occurred
  - If the system *knows* an activity occurred but couldn't determine the exact activity, a survey is launched
- MSP troubleshooter
  - If the MSP hasn't been seen in ~2 hrs and it's after 10AM, launch a troubleshooter



beyond technology studies

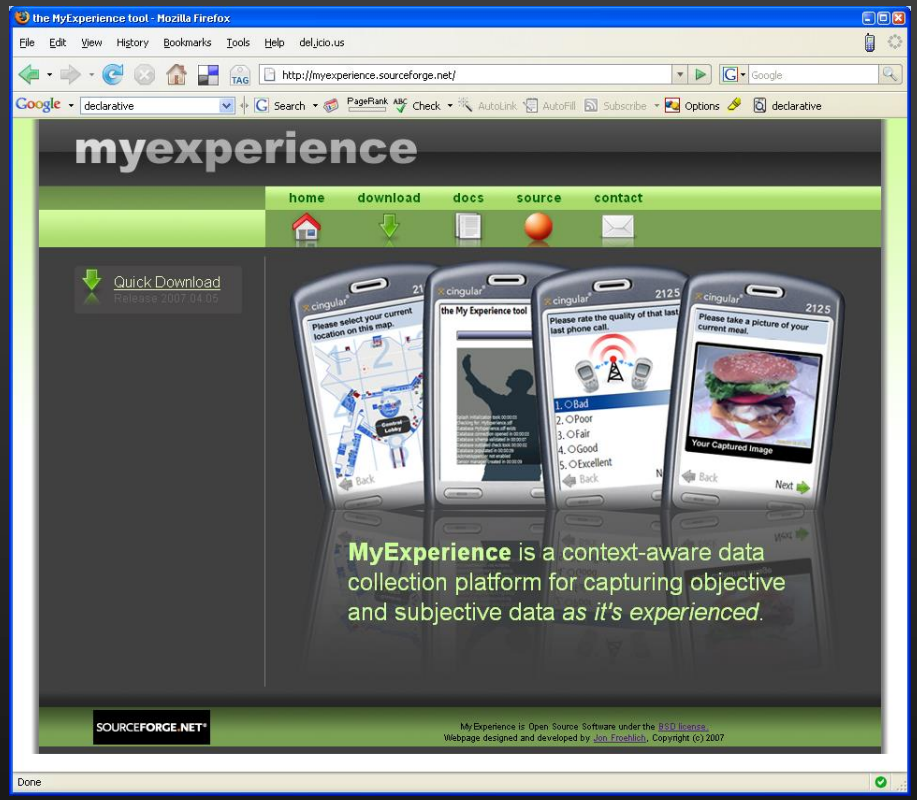
- Mobile therapy
  - Margie Morris, Bill Deleeuw, et al.
  - Digital Health Group, Intel
- Multiple sclerosis pain and fatigue study
  - Dagmar Amtmann, Mark Harniss, Kurt Johnson, et al.
  - Rehabilitative Medicine, University of Washington
- Smartphones for efficient healthcare delivery
  - Mahad Ibrahim, Ben Bellows, Melissa Ho, Sonesh Surana et al.
  - Various departments, University of California, Berkeley

conclusion

1. Coverage: collect rich information about features of interest
   - Combines sensors traces + self-report
2. Scale: collect large amounts of data over long periods of time
   - Sensor traces scale well, context-triggered self-report can be used intermittently
3. Extensible: easily add new data collectors
   - Sensors, actions, triggers, user interface can be extended
4. Situated: collect *real* usage data in its natural setting
   - Runs on a user's personal device
5. Robustness: protect or backup data collected in the field
   - Data can be opportunistically sync'd to research servers

thankyou

Source code available:
http://www.sourceforge.net/projects/myexperience



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Mike Chen, Sunny Consolvo, Beverly Harrison, and James Landay

ubifit

3. What type of activity did you do?

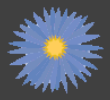
1. ☐Cardio
2. ☐Walking
3. ☐Strength Training
4. ☐Flexibility Training
5. ☐Other

Back Next

4. What type of cardio activity did you do?

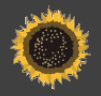
1. ○Running
2. ○Cycling
3. ○Elliptical trainer
4. ○Stair climber
5. ○Cardio class
6. ○Swimming
7. ○Roller-blading / Skating
8. ○Hiking
9. ○Rowing

Back Next

 strength

 cardio

 flexibility

 walk

 this week's goal met

 recent goal met

platform support

- Currently Windows Mobile
  - SmartPhones and Pocket PCs
- 2006 Marketshare (Canalys Report 2006)
  - Symbian: 67%
  - Windows Mobile: 14%
  - RIM: 7%
  - Linux: 6%
- 2010 Estimates (The Diffusion Group 2006)
  - Microsoft will overtake Symbian for marketshare
- We are exploring a Symbian port

prelim researcher feedback

- Surveyed 5 researchers
  - All but one were experienced programmers
- Positive comments
  - The ability to “trigger anything in response to such a wide range of events or combination of events.”
  - “an easy way for a semi-technical designer to set up user-experience studies for cell phone applications”
  - “the XML structure is excellent and is deeply expandable through C# extensions to MyExperience”
- Concerns
  - Needed examples to understand how to use
  - Desire to have script debugging tools