Lecture 1
Introduction
Pervasive & Mobile Computing
MIT 6.883

Larry Rudolph (MIT)
Course Structure Overview

• Class is “hands-on” but also lectures
  • Mostly, you will enjoy and learn from programming for the problem sets
  • The price you pay is listening to my lectures
• Materials (which is why enrollment is limited)
  • Nokia Series 60 Phones (Symbian OS)
  • Hand-held linux machine (iPaq and/or N800)
  • Bluetooth GPS, Crickets, Bluetooth dongle
• Slides, handouts, notes (raw)
  • some readings
Nokia Symbian 60 Phones
Cricket Indoor Location
Bluetooth GPS
Bluetooth
iPaq
N800 Tablet
Pervasive Computing MIT 6.883  Spring 2007 Larry Rudolph
Administration

- Official Web Site
  - web.mit.edu/6.883
    - (http://people.csail.mit.edu/rudolph/Teaching/home883.html)

- Official Wiki
  - Last year’s site: http://org.csail.mit.edu/mode
  - A new twiki will be setup and visible by the world and people will come to view it.

- Grade: 30% problem sets, 30% quiz, 30% project, 10% participation
The good, the bad, the ugly

• The course should be fun because
  • you get to program cell phones  get a glimpse of the future

• The course should be challenging because
  • if covers a large range of topics and you may have to discover a lot by yourself

• It should be frustrating because there is not enough support (welcome to the real world)
Problem Sets

• Preliminary Ideas:
  • Analyze a data set that contains cell towers and the GPS coordinates where my phone “heard” the tower
  • geographically distributed “race”
  • 2-d boggle
  • location-aware lying
  • parallel search over the brains of your friends
  • guided tour of campus
  • conference kiosk support
Where to find me?

• I track my indoor and outdoor locations.

• My website lists some of these

http://people.csail.mit.edu/rudolph
Organization of material

- Top-down
  - would be nice to start writing apps
  - but we are not there yet
- Bottom-up
  - Build on what is known
    - Keyboard, mouse, pen
    - Location, Speech, Multimodal
  - Integrative Technologies
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<td>Feb 8 L2: Mobile Phones</td>
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<td>Feb 26</td>
<td>Feb 27 L6: Location -- Cell Towers</td>
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<td>March 5</td>
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What is pervasive computing?

- Post PC -- PC not the center
- Digital devices all around us
- Ubiquitous Computing
- Mark Weiser -- Calm Computing
The origin of the course: Project Oxygen

To bring an abundance of computation & communication within easy reach of humans through natural perceptual interfaces of speech and vision so computation blends into peoples lives enabling them to easily do tasks they want to do:
- collaborate,
- access knowledge,
- automate routine tasks
Pervasive, Human-Centric Computing

What do these words mean?

• Computers are already pervasive
  • even in Boston

• Computers are already human-centric
  • are they for the birds?

• It’s not really about computing
  • we already know how to do that
So, what do we mean?

- **Pervasive**
  - Should be where we need them
    - not have to go to them or set them up

- **Human-centric**
  - Computers should adapt to humans
    - computation enters our world/environment

- **Computing**
  - Computer-mediated function
    - digital media
Look back to see ahead

- Monolithic Programs & Hardware
- Decompose into interactive pieces
- Compose to build large thing
- Continue decomposing into autonomous, interacting components
Finding and naming stuff

• Few items
  • Use list
• Many items
  • Use hierarchy
• Very many items
  • Use multi-index
Linux on Handheld

- Why Linux?
  - Linux allows full access to all software
  - Common development with desktop
  - Can use open source code from many sources
- Porting Linux to a handheld device
  - More difficult than standard PC or Laptop
    - Non-standard interfaces (screen, control FPGAs, touch screen, …)
    - Requires rewritable Flash ROMs
Linux Handheld Devices

- Linux phones are coming (here already)
  - we only care if linux is exposed to user
- OpenMoko -- open source linux phone
  - why is this important?
- Lots of other devices. Some alive some gone.
  - Add any that you find to our wiki
HP iPAQ 3870

3870 iPAQ
- 206 MHz Strong Arm
- 64 Mbytes SDRAM
- 32 Mbytes flash storage
  - Bluetooth
  - SD/MMC card slot
  - 16 bit color display

5500 iPAQ
- 400 MHz Xscale
- 128 Mbytes SDRAM
- 48 Mbytes flash storage
  - Bluetooth & WiFi
  - SD/MMC card slot
  - 16 bit color display
Nokia N800 Internet Tablet

CPU: 330 MHz TI OMAP 2420
OS: Linux (Maemo 3.0)
Connectivity: WiFi/Bluetooth (including Bluetooth DUN)
ROM: 256M Flash
RAM: 128M RAM
Hard Disk: None (internal SD up to 4GB)
Display: 800x480 LCD touchscreen, 4.1" diag.
Interface: Dual SD cards, USB, Earphones, microphone, power socket, retractable webcam
Keys: Power, 5D navigation, Home, Escape, Menu, zoom in, zoom out, fullscreen
Battery: 1500 mAh rechargable
GPS: None (Optional Bluetooth with Navicore software due Spring 2007)
Size: 144x75x13 mm
Weight: 206 grams
Mobile Phones
What's the big deal

- < 200 Million PC's sold last year
- > 200 Million Phones sold last quarter
- .5 Billion PC's in 2003
- 1.5 Billion consumers own mobile phones worldwide -- Economist, Jan 2006
- 3 Billion subscribers by 2008
September 18, 2005 -- 2 Billion connections.
Perspective

- 6.4 Billion people
- 2 Billion mobile phones sold
OK, so lots of phones ....

- But there are lots of digital watches as well
- they have chips inside, but who cares?
- Today, there are
  - Basic phones (modem chip)
  - Regular phones (modem + microprocessor)
  - Smart phones (modem + micro + ...)
- Tomorrow, will all be smart, difference in
  - extra features
  - extra fashion
Smartphones == 1996 PC?

- Smartphones (and PDA's) are like old PC’s
- If they are the same, then
  “been there, done that”
- If they are different, then in what ways?
1996 Pentinum

- 200 MHz CPU; 60 MHz memory bus
- Floating point; expansion bus for graphics, sound, other accelerators
- 3 million transistors; Voltage 3.3
- Primary Cache: 8 KB; Level 2: 512 KB
- Memory: usual ??? MB; Max 4 GB
- Disk capacity: ??? find out 160 MB ???
Phone's two major cores

- **DSP Core**
  - 220 MHz
  - 64 KB on-chip Ram; 24 KB Instr. Cache
  - 1/2 instructions per cycle

- **ARM Core**
  - 229 MHz
  - 32 KB Data Cache; 16 KB Instr. Cache
Phone == Lots of Integration
Not really the same

- More connectivity
- More parallelism
- More advanced in
  - Hardware features
  - Software features & necessities
- More sophisticated expectations
- cannot turn back time; people have evolved
Phones are different

- They are mobile
- They will always be bounded by power
- They will follow a different Mores' law
- The economics are different
  - different producer-consumer relationship
  - hw --> operators --> end users
  - ISP, independent software vendors, role?
The Point?

Phones are different from PC’s

Claim: people want PC functionality

They do not want the PC’s overhead

There will be billions of smart phones

Time to start taking up the challenge!
Research Areas I

- User Interface (Huge)
- Configuration
- Syntax-free
- Accessibility: physical & mental disabilities
- Security, Reliability, Fault Tolerance
- Naive users; harsh physical world
- Synchronization & Sharing
- Interoperability (no platform)
Research Areas II

- Architecture:
  - Phone chips as building blocks
  - Wireless expansion bus (no other board)
  - Power & heat management
    - e.g. streaming video via DSP or ARM
  - Local vs remote compute & store
  - No H/W upgrades
Research Areas III

Applications

Services not applications; easier on user
Finding features (e.g. 287 menu items)
Platform independence (?)

same app for server; pc; phone

too many models (binary rewrite?)

(location, user, env)-aware computing

Phone as Sensor+Actuator Server

Phone as (out-of-band) debugger
Conclusion

- Whatever your expertise, phones offer
  - different set of constraints
  - different levels of abstractions

If you think technology is frustrating today, just wait...