Lecture 1
Introduction
Pervasive & Mobile Computing
MIT 6.883

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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

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Cricket Indoor Location
Bluetooth GPS
iPaq
Bluetooth
Nokia Symbian 60 Phones
N800 Tablet

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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)

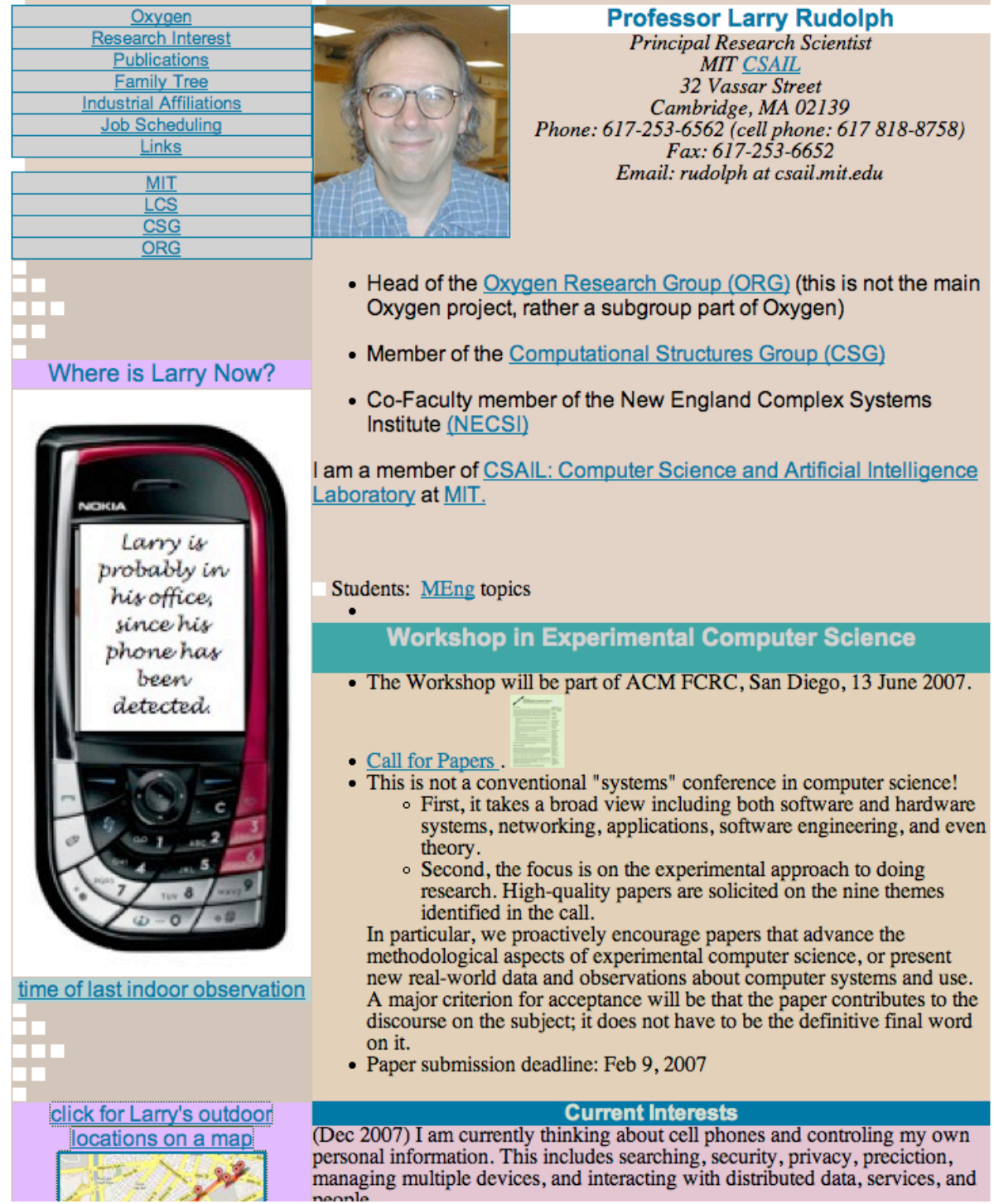
Problem Sets

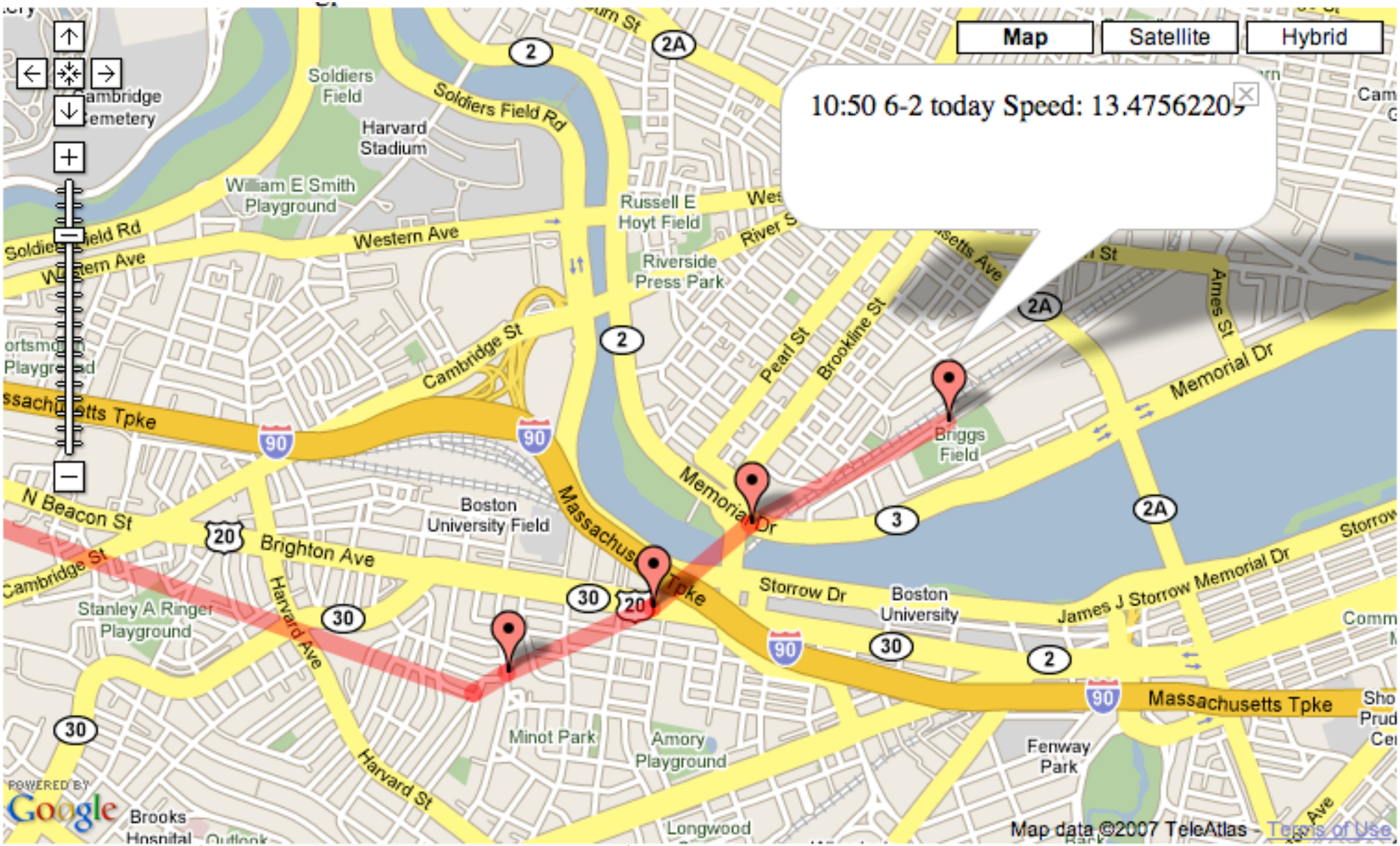
- Preliminary Ideas:
  - Analyze a data set that contains cell towers and the gps coordinates where my phone "heard" the tower
  - geographically distributed "race"
  - 2-d boggle
  - location-aware lying
  - parallel search over the brains of your friends
  - guided tour of campus
  - conference kiosk support

Where to find me?

- I track my indoor and outdoor locations.
- My website lists some of these

http://people.csail.mit.edu/rudolph





clear the map | Reveal locations in reverse order

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

Monday	Tuesday	Wednesday	Thursday	Friday
Feb 6 *(Reg Day)*	Feb 7 **L1: Overview**	Feb 7	Feb 8 **L2: Mobile Phones**	Feb 9
Feb 12	Feb 13 **L3: Python, Connectivity**	Feb 14	Feb 15 **L4: Socket Programming & Bluetooth**	Feb 16
Feb 19 President's Day	Feb 20 Monday Schedule	Feb 21	Feb 22 **L5: Location -- GPS**	Feb 23
Feb 26	Feb 27 **L6: Location -- Cell Towers**	Feb 28	March 1 **L7: Location -- Cricket**	March 2
March 5	March 6 **L8: C++ on Series 60**	March 7	March 8 **L9: User Interface, GUIs**	March 9 (add date)
March 12	March 13 **L10: Flash Programming**	March 14	March 15 **L11: GUI's Keyboards**	March 16
March 17	March 18 **XWand & Arrays**	March 19	March 20 **QUIZ**	March 21
March 26 **SPRING BREAK**	March 27 **SPRING BREAK**	March 28 **SPRING BREAK**	March 29 **SPRING BREAK**	March 30 **SPRING BREAK**

March 26 **SPRING BREAK**	March 27 **SPRING BREAK**	March 28 **SPRING BREAK**	March 29 **SPRING BREAK**	March 30 **SPRING BREAK**
April 2	April 3 **L12**	April 4	April 5 **L13: Speech**	April 6
April 9	April 10 **L14: Speech II**	April 11	April 12 **L15: Vision**	April 13
April 16 (no class -- patriot's day)	April 17 (no class -- patriot's day)	April 18	April 19 **L16: Kiosk**	April 20
April 23	April 24 **L17: Sketching**	April 25)	April 26 (drop dat*)* **L18: Security** PUFs	April 27
Apr 30	May 1 **L19: Debugging**	May 2	May 3 **L20**: **Publish-Subscribe & Middleware**	May 4
May 7	May 8 **Project Presentations**	May 10	May 11 **Project Presentations**	May 12
May 14	May 15 **Fun**	May 16	May 17*(Last day of classes)****Fun***	

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***

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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

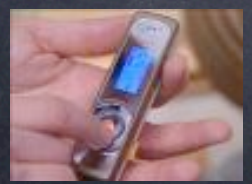
5500 iPAQ

- 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

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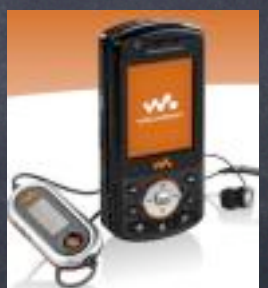
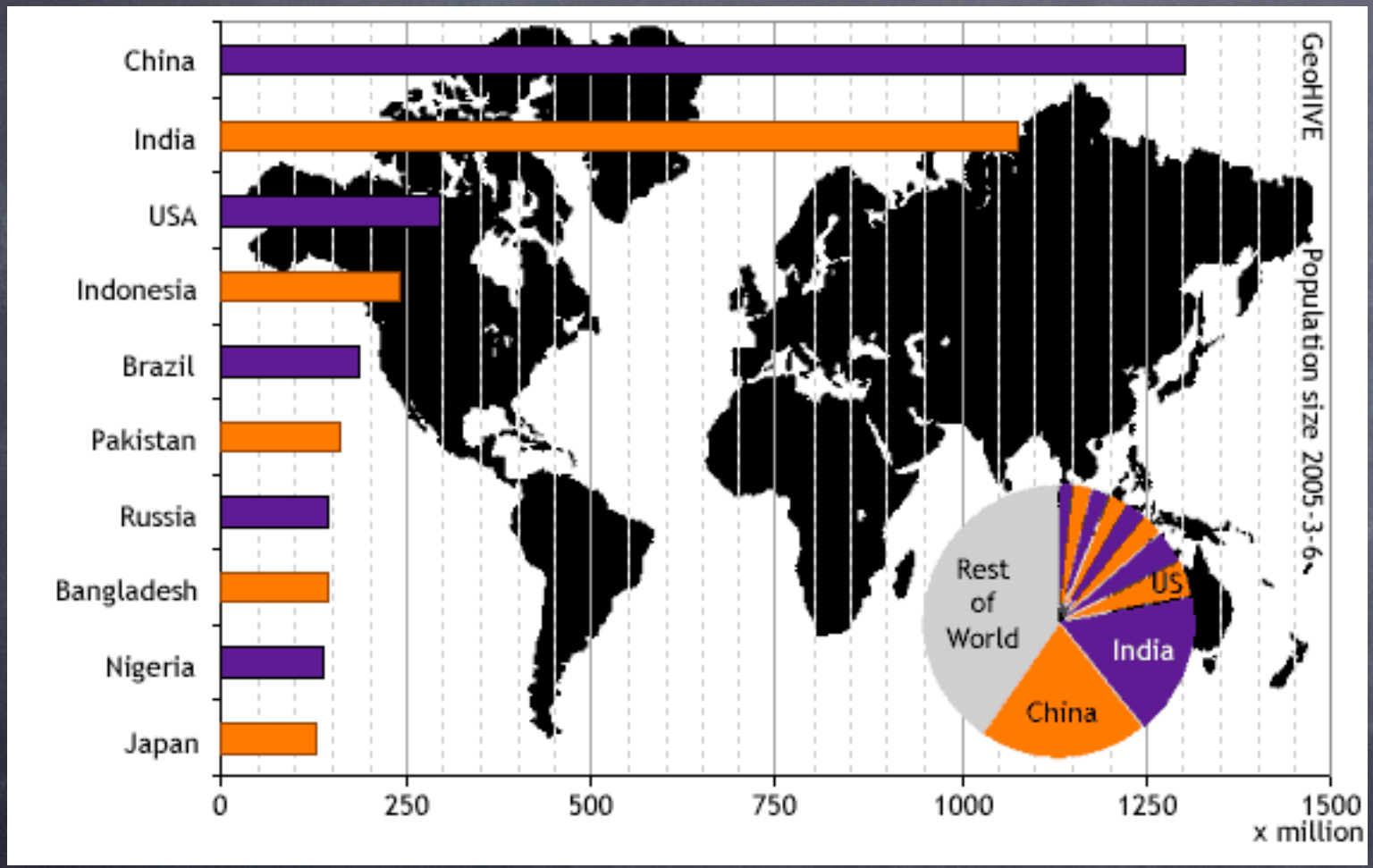


- September 18, 2005 -- 2 Billion connections.

Perspective



- 6.4 Billion people
- 2 Billion mobile phones sold

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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

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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?

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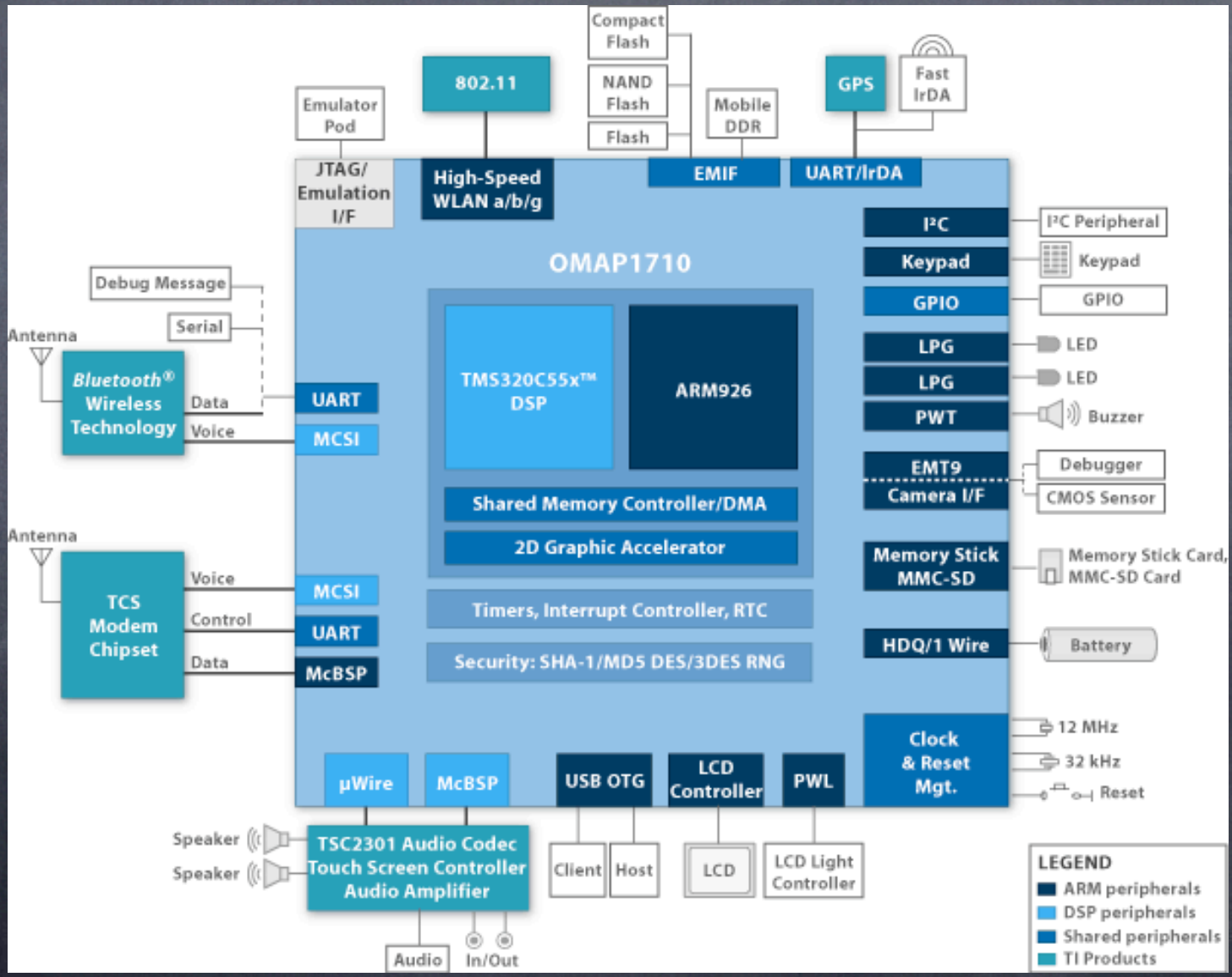
1996 Pentinum

- 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



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Not really the same

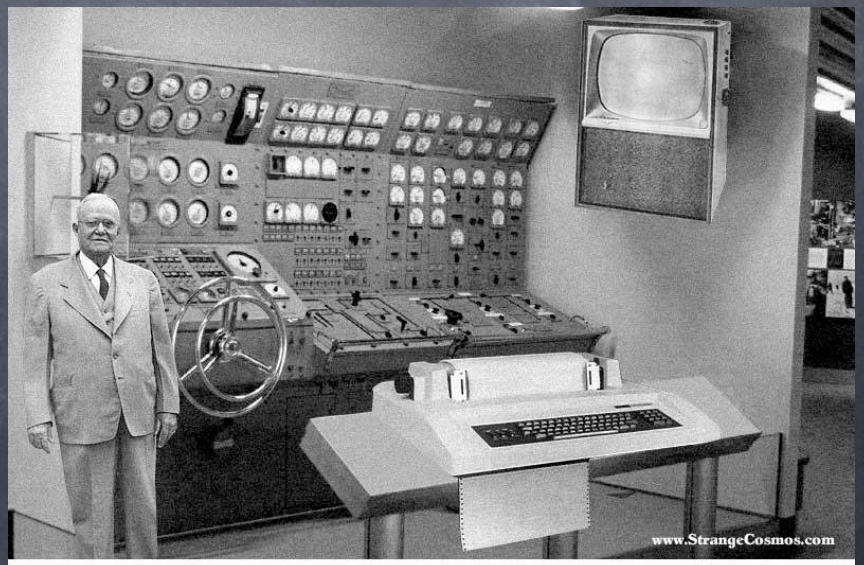
- More connectivity
- More parallelism
- More advanced in
  - Hardware features
  - Software features & necessities
- More sophisticated expectations
  - cannot turn back time; people have evolved

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!



Scientists from the RAND Corporation have created this model to illustrate how a "home computer" could look like in the year 2004. However the needed technology will not be economically feasible for the average home. Also the scientists readily admit that the computer will require not yet invented technology to actually work, but 50 years from now scientific progress is expected to solve these problems. With teletype interface and the Fortran language, the computer will be easy to use and only

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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...

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