Two Quotes... 

I think there is a market for maybe five computers worldwide.

—Thomas J. Watson, Chairman of IBM, 1943

The second important trend we are preparing for is called “pervasive computing”... So the networked world... will extend further to interconnect perhaps a trillion “intelligent” devices.

—Louis V. Gerstner, Jr., Chairman and CEO of IBM, 1998 [?]
Pervasive? Ubiquitous? Pervasive!

Ubiquitous: existing or being everywhere at the same time, constantly encountered

Pervasive: diffusing throughout every part of

- Ubiquitous is now... Boring!
- Pervasive is not yet... Exciting!
What is Pervasive Computing?

- **The Perfect Funding Tool:** by definition everything fits into PvC...
- **Computers disappear,** environment and computing devices blend into one another
- **“Age of calm technology”**[?]
- **Interconnected-ness**
- **Wide range of fields** (networking, UI, OS, distributed systems, security, DB, electrical eng, sociology, psychology, design,...)
Past the PC Singularity

Mainframes, servers

PC era
1:1

1:n

Mainframes...

PC Singularity

1950s 1980s 1990s 2000s 2010s

PvC era

n:1
Pervasive Big Blue

TJ Watson: multi-modal, web, gryphon, voice,...
Almaden: PAN, micro drive, TSpaces, DB, Blue Eyes,...
Austin: PowerPC, web timing,...
Tokyo: WatchPad, GinJo net, LCD, Dharma,...
China: M-Commerce, Chinese lang supp,...
India: Wireless net modelling & analysis,...
Haifa: Palm Pirate, internet telephony,...
Zurich: Mobile comp, security, service provisioning,...
Coming Up...

- Mobile (research) activities
  - Push Proxy GW
  - Intelligent Notification
  - Context Services
  - Multimodal
  - Fluid Communications
  - DAB Datacasting

- Secure client: JavaCard

- Devices
  - LinuxWatch/WatchPad
  - Microdrive
  - Direct-to-Digital GPS
  - OLED

A snapshot, really!
Zurich: Mobile: Intelligent Notification

Diagram showing components and interactions within a mobile intelligent notification system.
Zurich/Watson: Mobile: Context Services
Challenge: Distributed Location Information

Outdoor tracking technologies
- GPS Device Tracking database
- Verizon Cell Phone Location DB in the NYC Metro Area

Indoor tracking technologies
- Active Badge
- Bluetooth Wireless LAN
- 802.11 wireless LAN connection database
Tell me the direct flights from New York to San Francisco after 7:30 pm today
Today

Tell me the direct flights from New York to San Francisco after 7:30pm today.

There are five direct flights from New York's LaGuardia airport to San Francisco after 7:30pm today: Delta flight departing 7:30pm, American flight departing 7:55pm, United flight departing 8:30pm, Continental flight departing ....
Today

Tell me the direct flights from New York to San Francisco after 7:30pm today

There are five direct flights from New York's LaGuardia airport to San Francisco after 7:30pm today: Delta flight departing 7:30pm, American flight departing 7:55pm, United flight departing 8:30pm, Continental flight departing ...

Book me on the 8:30 flight
**Today**

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Book me on the 8:30 flight

**Tomorrow**

Show me the direct flights from New York to San Francisco after 7:30pm today
**Today**

- Tell me the direct flights from New York to San Francisco after 7:30pm today
- There are five direct flights from New York's LaGuardia airport to San Francisco after 7:30pm today: Delta flight departing 7:30pm, American flight departing 7:55pm, United flight departing 8:30pm, Continental flight departing ...
- Book me on the 8:30 flight

**Tomorrow**

- Show me the direct flights from New York to San Francisco after 7:30pm today
Zurich: Mobile: Fluid Communications

- Def. fluid: at any point in time the user can extend a communication session to a new device

- Alex is in "meeting mode"
- Vinod calls Alex
- Call simultaneously on PDA communicator and voice mail
- Server transcribes speech to text

Voice Mail Transcript
from: Vinod Nagarajan
hi alex my name is vinod nagarajan i am a colleague of romesh we have succeeded in integrate your software and were able to complete the first test scenario we are really

- Alex picks up call and extends to big display
Zurich: Mobile: DAB Datacasting

- How to reach millions of mobile devices? and distribute large content?

- **GSM, GPRS**: available, low bandwidth
- **UMTS**: 2003-4, expensive, high bandwidth only when stationary
- **Digital Audio Broadcast**: available, **high bandwidth** downlink (up to 1-2Mbit/s), inexpensive, high availability (indoors, outdoors, high-speed mobile)
- **DAB & Mobile**: interesting & attractive platform for mobile services
Zurich: Mobile: DAB Datacasting

- **DAB CA-PK**
  - Subscriptions mechanism for content distribution
  - Works for both DAB-only and DAB-mobile devices
  - No additional hardware required
  - Secure solution, consumer part of the protection chain

- **DAB/Mobile**
  - Combine DAB receiver with mobile (GSM/GPRS/UMTS) component
  - DAB: broadband downlink
  - GSM: narrow band uplink (e.g., SMS)
  - Apps: CD shop, “pump-or-dump”, games, voting, . . .
Zurich: Secure Clients: JavaCard

- JavaCard game changer for smart card industry
- IBM Research JavaCard state of the art
  - JavaCard + OP (= JCOP)
  - PKI
  - 1024-2048 bit crypto
- 16-32 KBytes free EEPROM
- Signing: 200-400ms
- Onboard key generation: 6-9s
- Current price point: USD 3.50

It really is a secure, embeddable coprocessor!
Tokyo/Watson: Devices: Linux Watch

Size: 65mm x 46mm x 16mm
Weight: 43g (w/o band)
CPU: Low power 32-bit, 18-74 Mhz
I/O: Touch panel, stem switch, buttons
Display: 320x240 B/W LCD
Memory: 8 MB low power DRAM, 16 MB Flash
Comm: Bluetooth, IrDA, serial
Power: Rech. Li-Ion
Speaker, mic, fingerprint sensor, accelerometer, vibrator
OS: Linux 2.4 w/ XFree
Almaden: Devices: Microdrive

- 1 GByte capacity
- 1.0 inch in diameter
- Less than 16g
- Compatible with CF (type II)
- Storage becomes available for smaller & smaller devices!
Watson: Devices: Direct to Digital GPS

- Direct to digital
- Complete solution
- SiGe radio front end
- 12 channels
- Antenna not included
- Apps: Tracking rail wagons, location aware devices, pervasive peer-to-peer
Zurich: Devices: OLED

- Very bright
- Very high resolution
- Very flexible
- Game changer?!
- High quality electronic paper (combine with DAB!), electronic picture frames, ...
And Much More

- **Voice recognition**: getting smaller and smaller
- **Ultra Wide Band RF**: pervasive very high bandwidth, pin-pointing location services
- **New Web technologies**: Freenet, peer-to-peer, ...
- **Face & gesture recognition**: mood based computing?
- **A Web of trillion devices**: service discovery, configuration, security, bootstrapping, managing—all in a world of a trillion connected devices?!