

Mobile Systems and Applications

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Based on material by
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Mobile Computing: Not a new idea...



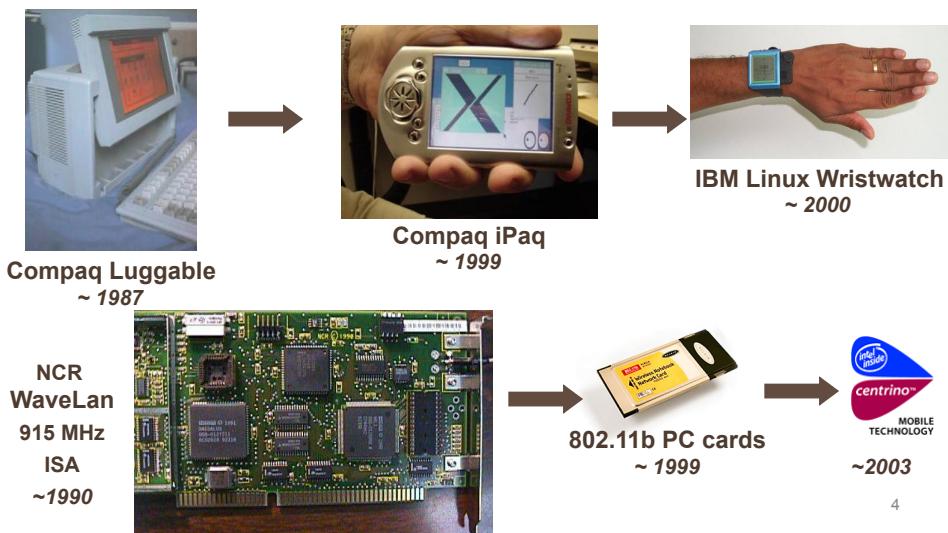
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Early 90s...



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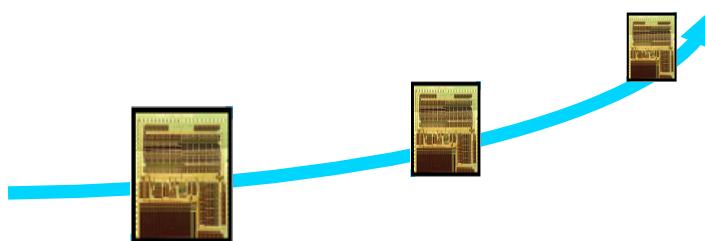
Hardware Progress



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Moore's Law

- Number of transistors per integrated circuit doubles every 18 months
 - Not necessarily power, speed
- Exponential increase



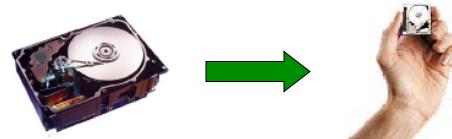
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Moore's Second Law

- Capital cost of semiconductor fabrication also increases exponentially over time
- Consequence:
 - scaling down

Problems:

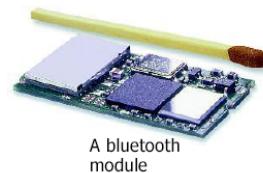
- increasing cost
- energy



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Communication

- Bandwidth of single fibers ~10 Gb/s
 - 2002: ~20 Tb/s with wavelength multiplex
 - Powerline
- Wireless
 - mobile phone: GSM, GPRS, 3G, 4G
 - wireless LAN
 - WaveLAN: 2 Mb/s
 - 802.11g: 54 Mb/s
 - 802.11n: 600 Mb/s
 - 802.11ac: 1 Gb/s
 - Bluetooth
- Room networks, body area networks
- Internet-of-things
 - Internet-enabled hot pot...



A bluetooth module

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Ubiquitous Information

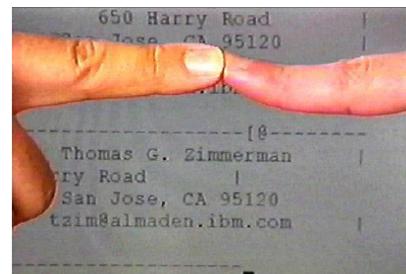


PAN: Personal area network

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Body Area Networks

- Very low current (some nA), some kb/s through the human body
- Possible applications:
 - Car recognize driver
 - Pay when touching the door of a bus
 - Phone configures itself when it is touched

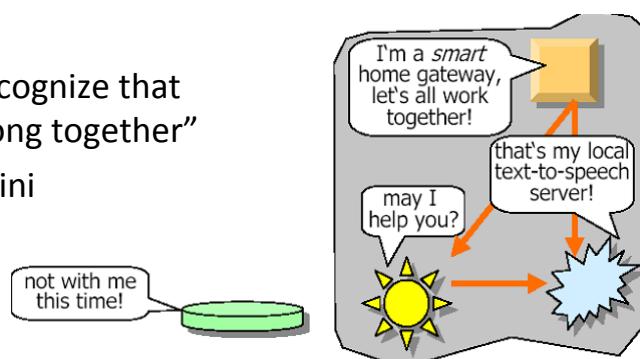


business card exchange (IBM)

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Spontaneous Networking

- Objects in an open, distributed, dynamic world find each other and form a transitory community
 - Devices recognize that they “belong together”
 - Example: Jini



Interactive Map

- Foldable and rollable



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Smart Clothing



- Conductive textiles and inks
 - print electrically active patterns directly onto fabrics
- Sensors based on fabric
 - e.g., monitor pulse, blood pressure, body temperature
- Invisible collar microphones
- Kidswear
 - game console on the sleeve?
 - integrated GPS-driven locators?
 - integrated small cameras (privacy issues)?

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Smart Glasses

- By 2009, computers will disappear. Visual information will be written directly onto our retinas by devices in our eyeglasses and contact lenses
- Raymond Kurzweil



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Smart Glasses Uh oh

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Smart Glasses



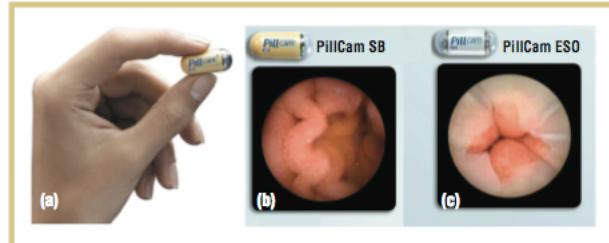
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From fantasy...



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...to reality



"Swallowable-capsule Technology."
McCaffrey, Chevalerias, O'Mathuna, Twomey.
IEEE Pervasive Computing 7(1), 2008.

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Sensors/Actuators

- Miniaturized cameras, microphones,...
- Fingerprint sensor
- Radio sensors
- RFID
- Infrared
- Location sensors
 - e.g., GPS
- ...



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Example: Radio Sensors

- No external power supply
 - energy from the actuation process
 - piezoelectric and pyroelectric materials transform changes in pressure or temperature into energy
- RF signal is transmitted via an antenna (20 m distance)
- Applications: temperature surveillance, remote control (e.g., wireless light switch),...

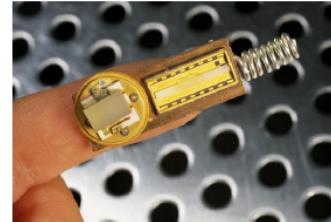
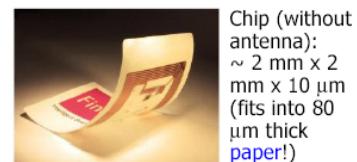
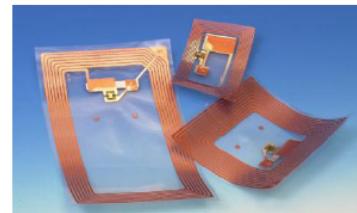


image source: Siemens

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RFIDs (“Smart Labels”)

- Identify objects from distance
 - small IC with RF-transponder
- Wireless energy supply
 - ~1m
 - magnetic field (induction)
- ROM or EEPROM (writeable)
 - ~100 Byte
- Cost ~\$0.1 ... \$1
 - consumable and disposable
- Flexible tags
 - laminated with paper



Chip (without antenna):
~ 2 mm x 2 mm x 10 µm
(fits into 80 µm thick paper!)

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Smart Phones



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Core Challenges

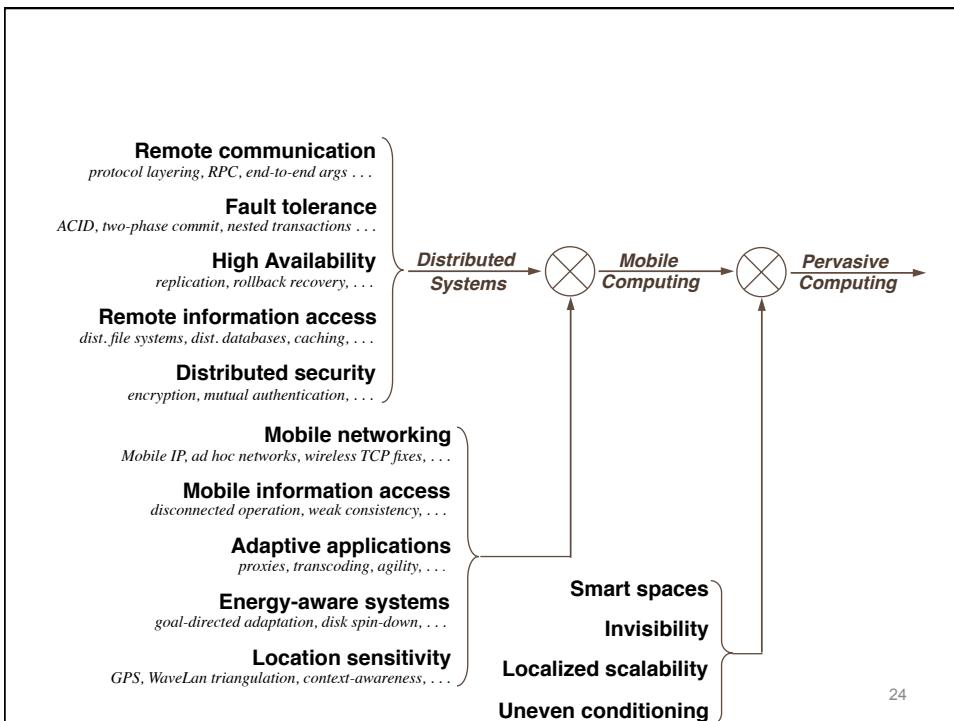
- **Resource poverty**
 - Vs static elements of same era
 - Weight, power, size constraints
 - Interface constraints
- **Communication uncertainty**
 - Bandwidth/latency variation
 - Intermittent connectivity
 - May cost real money
- **Finite energy source**
 - Actions may be slowed or deferred
 - Communication costs energy

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Core Challenges (cont'd)

- **Multi-modal interaction**
 - Hands and eyes occupied
 - speech/gesture recognition
 - Augmented reality
- **Scarce user attention**
 - Focus of attention elsewhere
 - Lower human performance
 - Higher error rate
- **Less security and robustness**
 - Theft destruction, destruction more likely
 - Greater exposure to subversion

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Pervasive/Ubiquitous Computing



- **Mark Weiser (1952-1999)**
 - A less-traveled path I call the **invisible**, its highest ideal is to make a computer so embedded, so fitting, so natural, that we use it without even thinking about it.
 - Provide hundreds of wireless computing devices per person per office, of all scales (from 1" displays to wall sized)...This is so different from PDAs, dynabooks, or information at your fingerprints. It is **invisible**, everywhere computing that does not live on a personal device of any sort, but is in the woodwork everywhere.
 - **Invisible Everywhere Computing**

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Smart Spaces

- **Convergence of IT and building technology**
 - allows each world to sense and influence the other
 - smart space influenced by presence of user(s)
 - computing space influenced by surroundings
 - Individual objects may also be smart

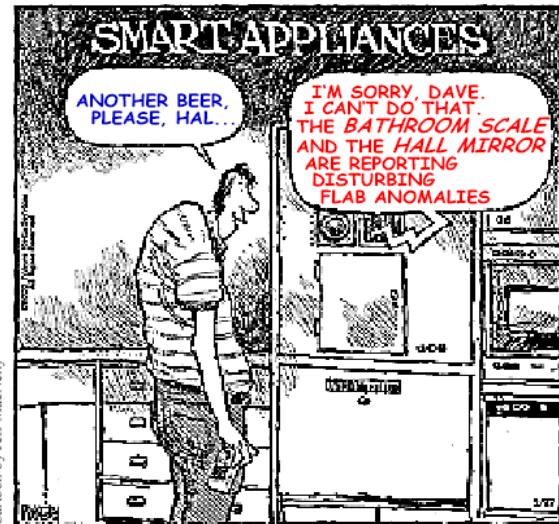


Automatic meeting transcription



Smart coffee cup

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Cartoon by Jeff MacNelly

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Invisibility



- Weiser's ideal: complete disappearance of technology
- Approximation: *minimal user distraction*
 - system meets user expectations continuously
 - *Situational awareness*
- Caveat: anticipation may avoid later unpleasant surprise
 - e.g. pain in a normally-unnoticed body part
 - *Proactivity* may sometimes be valuable
 - *User intent*

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This...



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...will become this...



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Goals of this Course

- Broad knowledge of issues in mobile computing
- Obtain hands-on experience with some aspects of it
 - Homework assignments using Android

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