Mobile Device Platforms (ctd.)

Introduction to Mobile Interaction

Mensch-Maschine-Interaktion 2, WS 2010/2011

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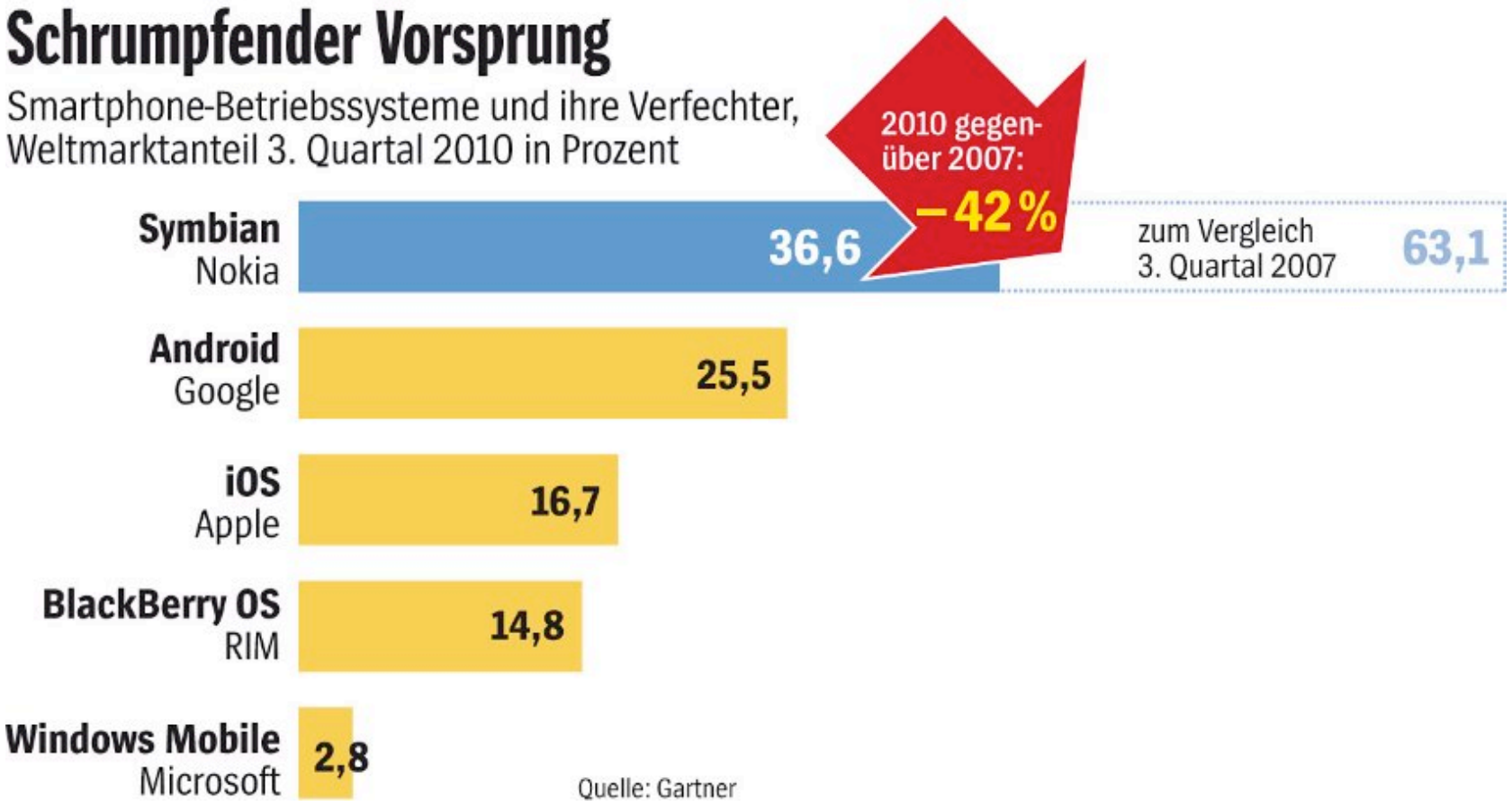
Lectures & Exercises

Lecture	Date	Topic
1	12.1.	Introduction to Mobile Platforms
2	19.1.	Introduction to Mobile Interaction
3	26.1.	Mobile Input and Output, Location & Context
4	2.2.	Prototyping and Evaluation of Mobile Systems
5	9.2.	User Interface Design for Small Displays

Exercise	Date	Topic
0		Developing countries + Android-Eclipse
1	10.1.	Recipe input
2	17.1.	Touch input, gestures
3	24.1.	Location-based Audio
4	31.1.	Evaluation of mobile LMU Web portal

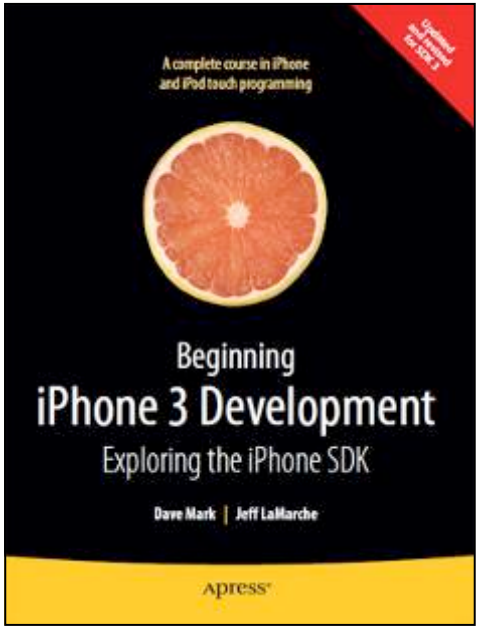
Smartphone Operating Systems

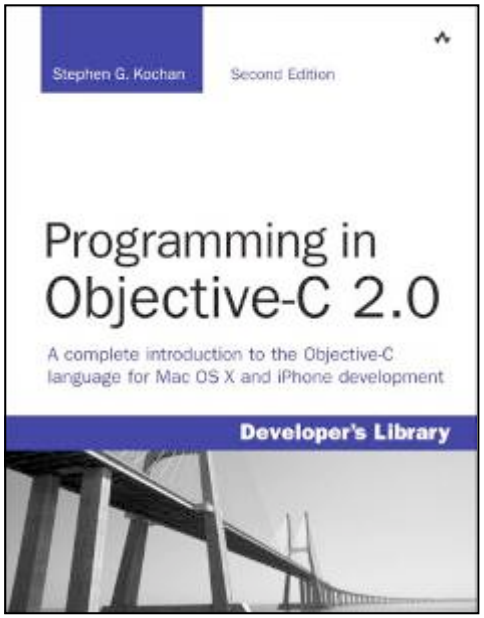


Apple iOS

Books

- iPhone development
  - Dave Mark, Jeff LaMarche: Beginning iPhone 3 Development: Exploring the iPhone SDK. Apress, 2009.
  - http://www.amazon.com/Beginning-iPhone-Development-Exploring-SDK/dp/1430224592/
- Objective C
  - Stephen G. Kochan: Programming in Objective-C 2.0. Addison-Wesley , 2nd edition, 2009.
  - http://www.amazon.com/Programming-Objective-C-2-0-Stephen-Kochan/dp/0321566157/





Apple iOS

- Optimized version of Mac OS X
  - New components for handling touch
  - Memory requirement < 0.5 GB
- Hardware
  - 620 MHz ARM 1176 – 1GHz Apple A4
  - 128-512 MB DRAM
  - 4/8/16/32 GB flash RAM
  - Graphics: PowerVR OpenGL ES chip
  - Camera: 2.0-5.0 megapixels
  - Screen: 320x480 pixels, 163 ppi – 640x960 pixels, 326 ppi
  - Connectivity: GSM/UMTS, Wi-Fi (802.11b/g), Bluetooth
- SDK available since spring 2008

SDK Options

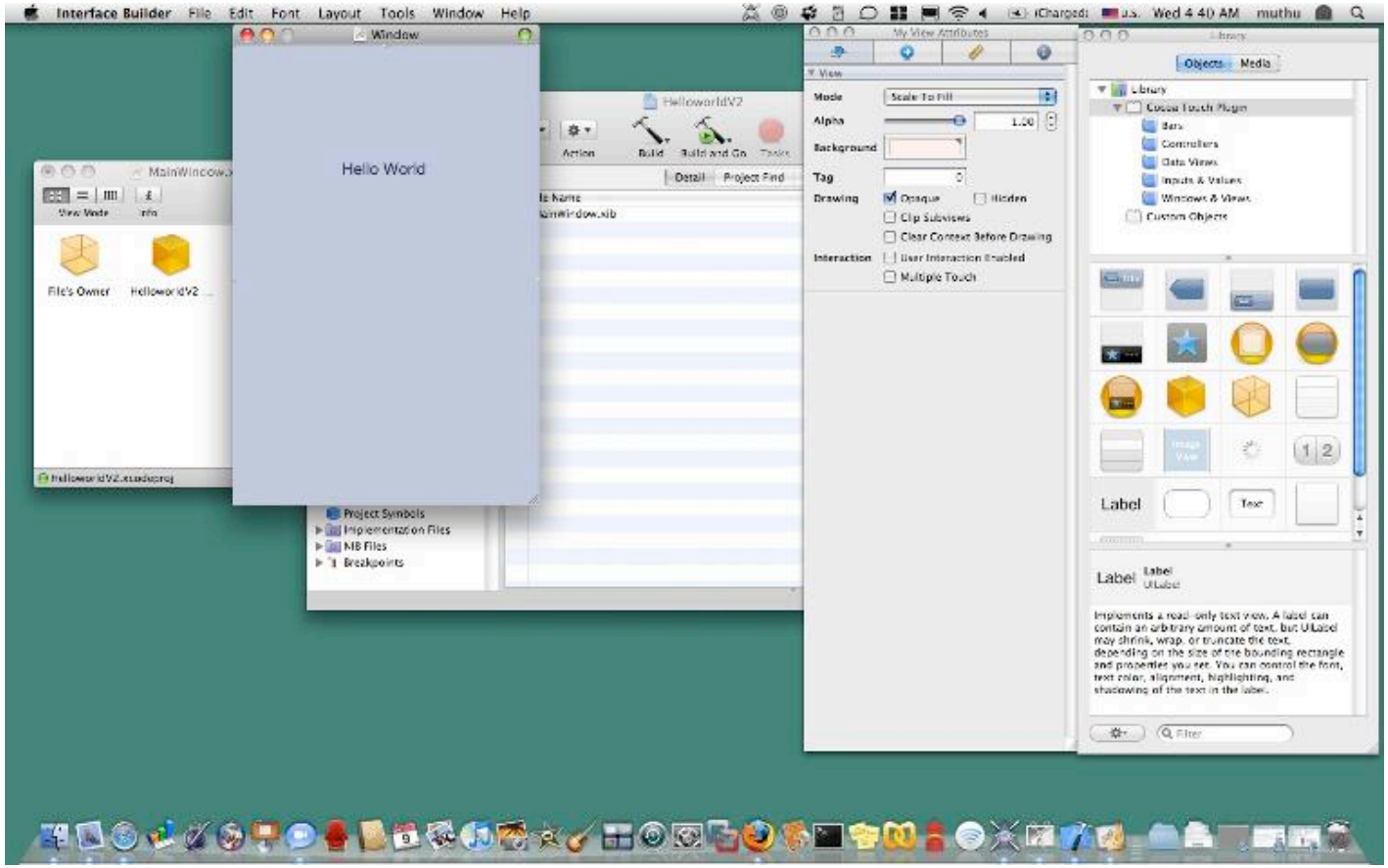
- Official iPhone SDK
  - Requires Mac to develop (IDE/compiler/debugger only for Mac)
  - Requires registration as developer ($99 per year)
  - Official support
  - Possibility to release on Apple App Store
  - http://developer.apple.com/devcenter/ios/
- iPhone toolchain SDK
  - Unofficial SDK
  - Available for Mac, Linux, PC (with varying comfort)
  - Command line gcc compiler (on-device compiling also possible)
  - All features of the phone actually accessible (even closed ones)
  - Requires “jailbreaking” the phone
  - May be legally questionable
  - http://code.google.com/p/iphone-dev/

Development Environment

- Xcode: IDE + integrated compiler, run-time debugger

Development Environment

- Interface Builder: Graphical interface layouter



Development Environment

- iPhone Simulator: Mac simulator of iPhone
  - Most features except tilt, simulated multitouch

Philosophy of the API

- Compatibility with Mac OS X
  - Foundation frameworks: shared, Cocoa Touch: iPhone-only
- Maintains general framework structure
- Benefit
  - Shared code development between iPhone and OS X
  - Rapid porting of applications
  - Developer familiarity (for previous Mac developers)
- Preferred language
  - Objective C (implementation language of the SDK)
  - C/C++ work
- Protective
  - Some APIs are privileged and cannot be accessed
  - Example: AudioCore, LayerKit (direct access to framebuffers)

Cocoa Touch Architecture

- Cocoa Touch
  - High level architecture for building iOS applications
- Cocoa Touch consists of:
- UIKit
  - User interface elements
  - Application runtime
  - Event handling
  - Hardware APIs
- Foundation
  - Utility classes
  - Collection classes
  - Object wrappers for system services
  - Subset of Foundation in Cocoa

Objective C

- Objective C is superset of C, with OO constructs
  - Unusual Syntax, rarely used outside Apple realm, inspired by SmallTalk
- General syntax for method calls (“messages”):

  object.method(parameter1, parameter2); becomes:

  [object method:parameter1 parameterkey:parameter2];
- Example

```
employee.setSalary(100,20); // arguments base_salary, bonus
[employee setSalary:100 withBonus:20];
```

- Learn more at

  developer.apple.com/documentation/Cocoa/Conceptual/ObjectiveC

Objective C - Methods

- Method declaration syntax

  ± (type) selector:(type)param paramkey:(type)param2;

  Instance methods: - (void) myInstanceMethod;

  Class methods: + (void) myClassMethod;

- Example

  - (void) setSalary:(int)income withBonus:(int)bonus;

- Basic classes, examples
  - NSObject is root class (basics of memory management)
  - NSString
    - Example: s = [NSString stringWithFormat: @"The answer is: %@", myObject];
    - Constant strings are @"this is a constant string"
  - NSLog(NSString); (NSLog is your friend…)
  - NS… also offers collections (NSArray, NSDictionary etc) and other basic language service functionality
    - Prefix "NS" is derived from OS X predecessor, NextStep

Objective C – Features and Pitfalls

- Dynamically typed objects (or hard to find bugs)
  - id someObject
  - id is generic “pointer” without type (“void*”)
  - introspection allows finding out type at runtime
- Nil object pointers (or how to make really hard to find bugs)

  object = nil;

  [object setProperty: nil];
  - Will send message to nil, hard to find if objects didn’t get proper assignment
- id, nil and dynamic typing enable message-passing paradigm
- Memory management done by hand:
  - Object reference life cycle:

  [[myobject alloc] init]; // reference count = 1 after alloc

  [myobject retain]; // increment reference count

  [myobject release]; // decrement reference count

  Partially solved in Objective-C 2.0 (garbage collector on Mac OS X)

Objective C – Practical Aspects

- Based file extension .m
- Header file extension .h (expects Objective-C base file)
- Base file extension for Objective C++ is .mm (not .cpp)
- #import <...> (automatic redundancy check)

Objective C - Class

In .h file:

```
#import <Foundation/Foundation.h>

@interface Employee : NSObject
{ //Instance vars here
    NSString *name;
    int salary;
    int bonus;
}
// methods outside curly brackets
-  (void)setSalary:(int)cash withBonus:(int)extra
@end
```

Objective C - Class

In .m file:

```
#import ”Employee.h”

@implementation Employee
- (void)setSalary:(int)cash withBonus:(int)extra
{
   salary = cash;
   bonus = extra;
}
@end
```

Objective C - Protocols

- Used to simulate multiple inheritance and add functionality on top of existing objects (i.e. for delegates), similar to interfaces in Java:

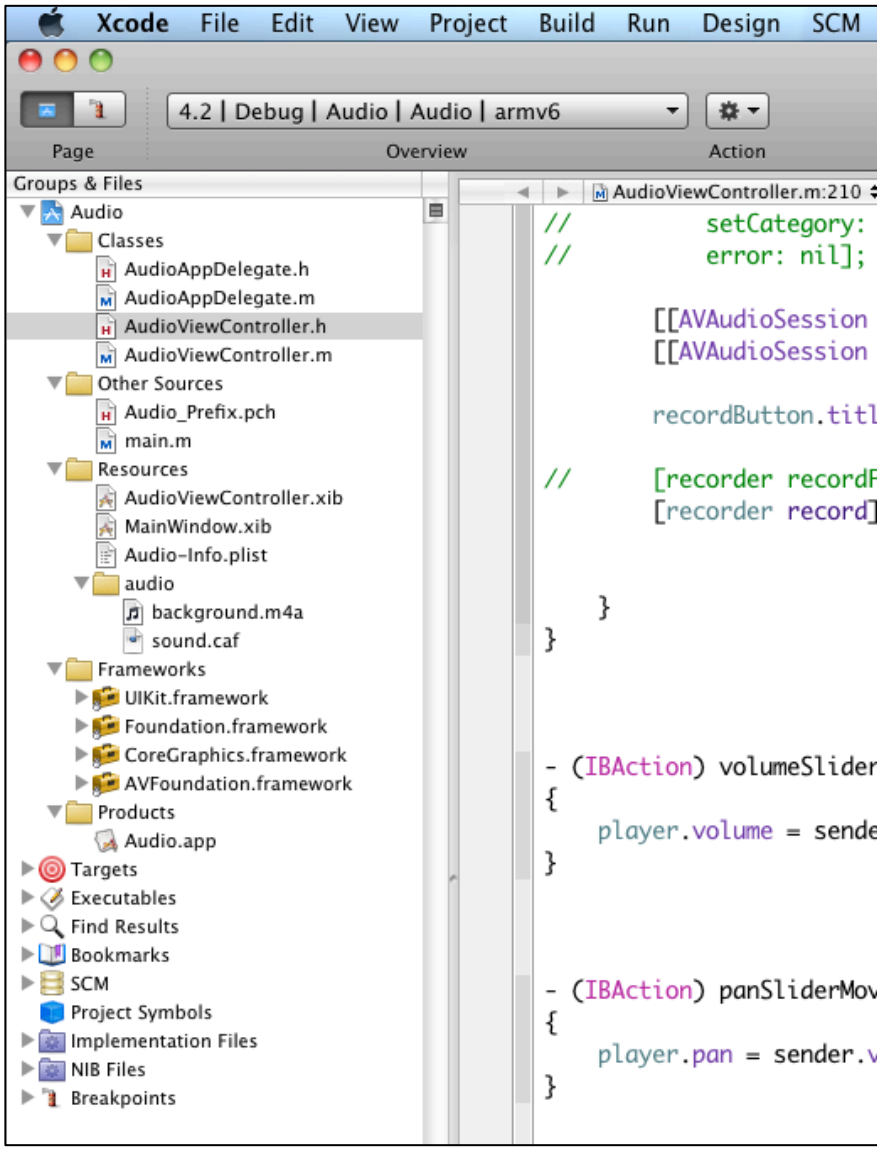
```
@protocol Locking
- (void)lock;
- (void)unlock;
@end
```

- Denotes that there is an abstract idea of „Locking“
- Classes can state that they implement „Locking“ by declaring the following:

```
@interface SomeClass : SomeSuperClass <Locking>
@end
```

Contents of an Xcode iPhone Project

- Source files
- Compiled Code
- Framework code
  - E.g. UIKit.framework
- Nib file (extension .xib)
  - Contains interface builder data
- Resources
  - Media (images, icons, sound)
- Info.plist file
  - Application configuration data



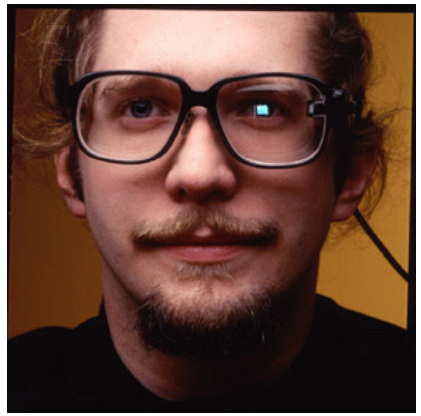
Introduction

When and Why?

- Exercise: When do you use mobile devices?
  What mobile devices do you use?
  - What are the situations, social contexts, interruptions?
  - When have you noticed others using mobile devices?
  - What tasks? (talking, texting, information access, listening)

- Exercise: What negative experiences did you have with mobile UIs?

Mobile and Wearable Devices



Smart glasses

Smart jacket

Linux wristwatch videoconferencing

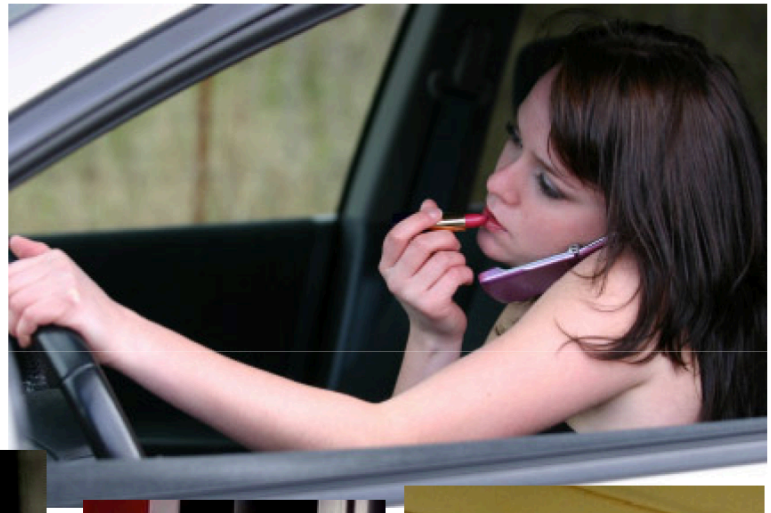
Examples of Mobile HCI

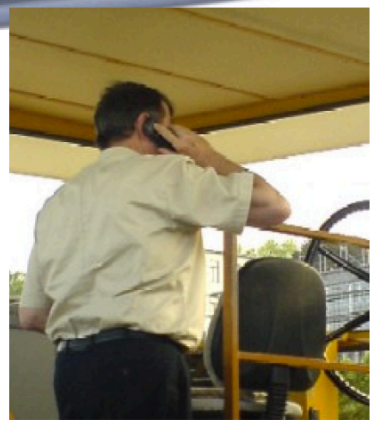
- Looking up an address with a maps application while on the subway
- Taking a picture of a QR code of an advertisement in the subway and opening a URL
- Lowering the volume of an MP3 player when entering a building from a noisy street
- Calling a friend to tell that you are on your way while trying to get a taxi
- Looking at the photos on your camera together with your friends while sitting at a café
- Receiving a phone call while writing a text message
- Resetting the travelled distance on your bike computer

Slide adapted from a talk by Albrecht Schmidt at T-Labs

Mobile Interaction is Usage in Context

- Primary real-world task





Slide adapted from a talk by Albrecht Schmidt at T-Labs

Watch for cars when wearing headphones

Slide adapted from a talk by Albrecht Schmidt at T-Labs

Characteristics of Mobile HCI

- Interacting “in the wild” and “on the go”
- Interaction in parallel with other tasks
  - E.g., walking, standing in a crowd
  - Cognitive capacity shared between tasks
- Interruptions occur frequently
  - Short attention periods
- Presence of others, social situation
  - Incoming call changes social situation
- Environments changes
  - Noise, lighting conditions
- Environment as a resource
  - Environment provides relevant information
  - Acting in the environment based on combination

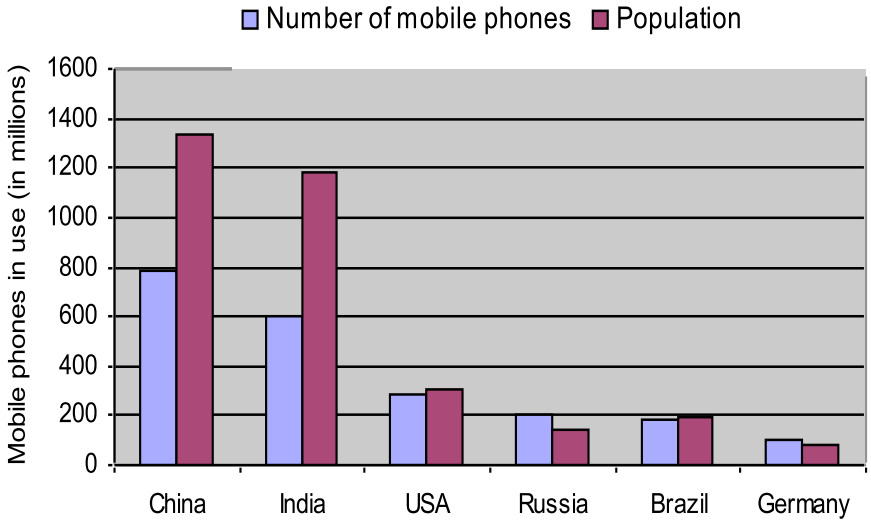
How Times Have Changed

- *"In 1954, the Marquis of Donegal heard that the Duke of Edinburgh possessed a mobile radio set with which he phoned through to Buckingham Palace – and anyone else on the network – while driving in London. The Marquis was more than a little jealous, and enquired of the postmaster general whether he, too, could have such a telephone. The polite but firm reply was "no". In the mid-1950s, if you were the husband of the Queen you could have a mobile telephone connection to the public network. But if you were a mere marquis, you could go whistle."*

  Agar, J.: Learning from the mobile phone. Journal of the Royal Society of Arts, pp. 26-27, January 2004.

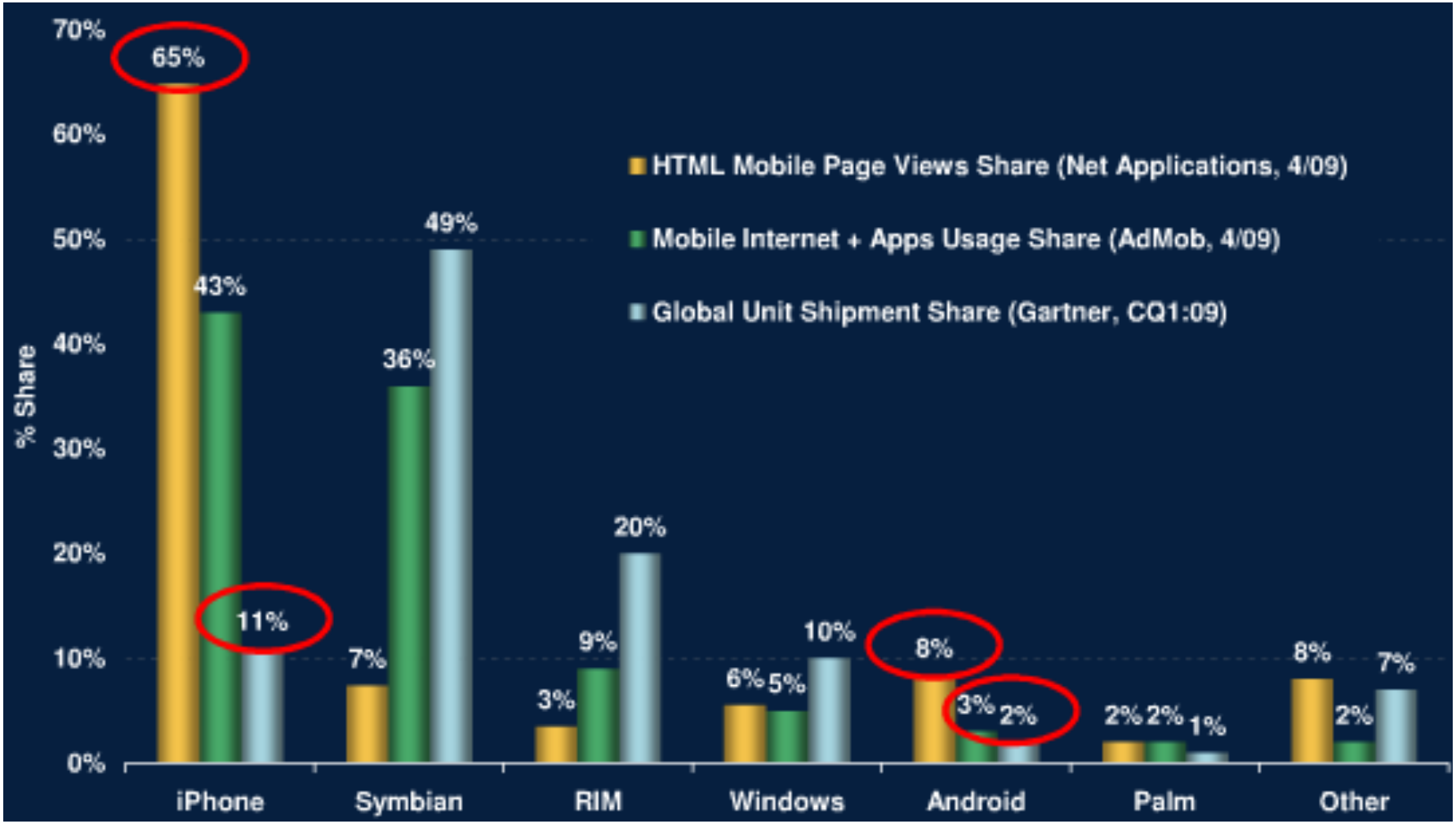
Mobile Phone Statistics

- Today more phones than PCs
  - 4.6 billion mobile phones (2009, ITU)
  - Some countries >100 mobile phones per 100 people
  - BRIC countries fastest growing
- More and more functionality
  - Location-based services
  - Web and email access
  - Apps, Games



Sources: ITU, China MIIT, RBC, eMarketer

iPhone / Android:
Internet Share > Shipment Share



Source: Morgan Stanley, 2009

Mobile Internet Uses (2008)

Mobile Content Consumption: iPhone, Smartphone and Total Market: January 2008

Activity	iPhone	Smartphone'	Market
Any news or info via browser	84.8%	58.2%	13.1%
Accessed web search	58.6%	37.0%	6.1%
Watched mobile TV and/or video	30.9%	14.2%	4.6%
Watched on-demand video or TV programming	20.9%	7.0%	1.4%
Accessed Social Networking Site or Blog	49.7%	19.4%	4.2%
Listened to music on mobile phone	74.1%	27.9%	6.7%

Source: M:Metrics, Inc., Copyright© 2008. Survey of U.S. mobile subscribers. Data based on three-month moving average for period ending 31st January 2008, n = 31,389.

http://www.mmetrics.com/press/PressRelease.aspx?article=20080318-iphonehype

Das iPhone und ich
(www.zeit.de/2008/38/iPhone-38)

www.mmetrics.com/press/PressRelease.aspx?article=20080318-iphonehype

„Unweigerlich landet man in seiner Beschreibung bei menschlichen Eigenschaften. [...] Die Bedienung des iPhones: ein einziges Streicheln und Liebkosen. [...] Ich verspürte den Wunsch, meiner geliebten Iphonia zuliebe meine Wohnung umzuräumen, alles zu entrümpeln, was nicht nach Moderne, Minimalismus, Apple aussah. [...]

Da das iPhone weiß, ob ich "zu Hause" oder "im Büro" bin oder auch in der Nähe eines bestimmten Buchlädchens, listet es Aufgaben auf, die ich am jeweiligen Ort erledigen kann. Ein sehr sinnvolles Prinzip eigentlich. Allerdings erzieht es, lückenlos implementiert, zur absoluten Passivität gegenüber dem Elektrohirn. [...] Mit so einer GPS-gesteuerten To-do-Liste in der Tasche durchquere ich die Stadt wie ein ferngesteuerter Roboter.

Auf einer Landkarte kann es mir mit kleinen Fähnchen anzeigen, welche Freunde gerade in der Gegend sind (so sie bereit sind, ihren Standort via GPS zu offenbaren). [...] Habe ich das Gefühl, dass ich im Gegensatz zum iPhone nicht mehr weiß, wo ich bin, und langsam verrückt werde, kann ich auf dem iPhone eine Weile "Brain Challenge" spielen, ein Trainingsprogramm für Konzentration und logisches Denken.

Für die Bewältigung des Alltags wurde bis vor ein paar Wochen noch das Gedächtnis benötigt, der Orientierungssinn, Überblick, Eigeninitiative. Intuition, Erfahrung, Entscheidungskraft – all diese wundersamen Kräfte, die etwas mit der eigenen Persönlichkeit zu tun hatten, mit menschlichem Ermessen. Diese Dinge waren, seitdem unsere Vorfahren auf Nahrungssuche die Steppe durchquerten, ganz einfach: das Leben. Zurzeit verwandelt sich das Leben, dank iPhone, in eine Art Computerspiel.

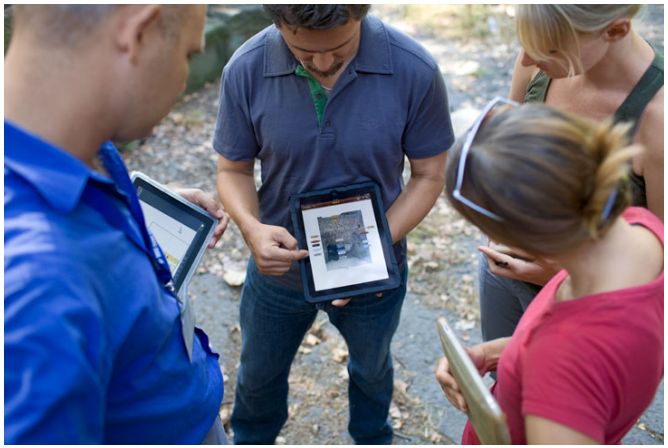
In der psychologischen Forschung steht das allmähliche Verschmelzen von Mensch und Computer schon lange unter Beobachtung. [...] Neu ist, dass so viele Menschen dieses Verschmelzen real erleben, gerade in trivialen Alltagsdingen.“

Commercial Opportunities

- Emerging mobile app industry
  - Apps on mobile phones broadly accepted
  - New categories of apps for mobile and handheld devices
  - Mobile games
- New media distribution channels via mobile devices
  - Print media conversion
  - Television conversion (e.g., YouTube)
  - Education and edutainment
- Embedded interaction
  - Computation embedded in everyday objects
  - Linking smart environment and mobile devices
  - Linking automobiles and mobile devices

Special Application Areas for Mobiles

- Field work supported by tablet PCs
- Example: Work in archaeological sites
  - Capture notes and images
  - Exchange data
  - Match items to databases
- Source:
  - www.apple.com/ipad/pompeii



Active Artifacts

- Example: MediaCup
  - mediacup.teco.edu
- Add “self perception” to everyday things
  - Temperature, fill level, movement
- Communicate their own state
  - Bluetooth, ZigBee
- Determine activity where it occurs
  - “Meeting” if collocated cups with hot liquid
- The artifact digitally supports its own applications

Ambient Umbrella

- “Never forget your umbrella again. The Ambient Umbrella lets you know when rain or snow is in the forecast by illuminating its handle. Light patterns intuitively indicate rain, drizzle, snow, or thunderstorms. Automatically receives local weather data from AccuWeather.com — no setup, no sensors, no wet commute.”
- www.ambientdevices.com/products/umbrella.html

Communication or Information Devices?

- Communication advocates
  - *"…mobile devices will be first and foremost about offering users the ability to keep in touch with friends, family and colleagues, and that this will take precedence over technologies and applications that will offer information access and use."*

    Richard Harper, People versus Information, Mobile HCI 2003
- Information optimists
  - *"Mobile phones […] have suddenly become platforms for entertainment and commerce and tools for information management and media consumption"*

    Christian Lindholm et al., Mobile Usability, 2003
- Convergence
  - Communications power and information access

Information Appliance or Swiss Army Knife?

Many devices with one function?

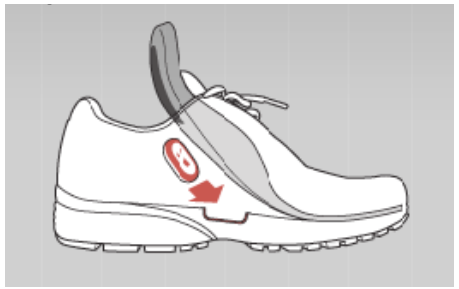
Or one device with many functions?

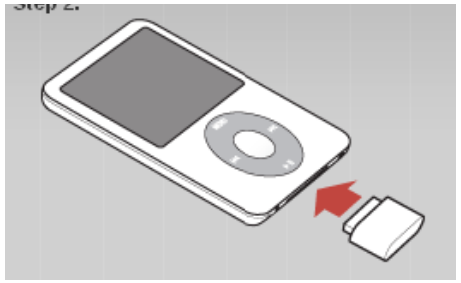
Information Appliances

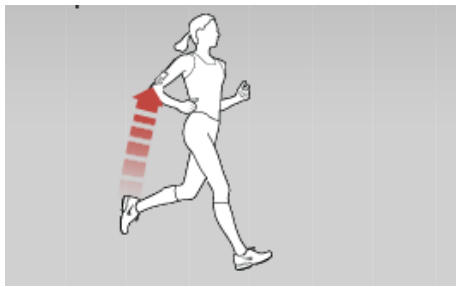
- Support a specific activity
- Connectable to other information appliances

+

Accelerometer







Keitai Culture

- keitai denwa = mobile phones
- Read a book on a cell phone?

Lesen 2.0

Japans meistverkaufte Bücher kommen direkt aufs Handy

Handyromane, sie werden in kleinen Lieferungen verschickt, an die 100 Kapitel, über drei, vier Monate hinweg, drei Minuten ist ein Kapitel ungefähr lang, die Zeit eben zwischen zwei U-Bahn-Stationen. »Keitai« heißt diese Art von Mobilromanen, die bis zu 20 Millionen Mal heruntergeladen werden – und nun auch ganz oben stehen auf den Bestsellerlisten der Literatur 1.0: Vier

nen selbst Erfolg haben. Umgerechnet 60 Millionen Euro setzte die Branche 2006 um, bei 100 Millionen Handys in Japan ist da aber noch Wachstum möglich. »Ich habe ganz neue Leser gewonnen, vor allem Teenager, die noch nie ein Buch in der Hand hatten«, sagt die Schriftstellerin Mica Naitoh, deren erfolgreichster Keitai-Roman *Der Liebeshimmel* heißt.

Georg Diez, Die Zeit

Novel Uses of SMS?

- Designed for users' needs?
  - http://www.textually.org/textually/archives/2006/12/014334.htm

DECEMBER 11, 2006

BRITISH INTELLIGENCE BOMB TALIBAN WITH SMS IN PSYCHOLOGICAL WARFARE

According to an article in The Sun, SMS - instead of leaflets falling from the sky - **are being used in psychological warfare by the British in Afghanistan** - a concept used by military institutions throughout history. [via SMS Text News]

"**Taliban fighters in Afghanistan are being bombarded by a devastating new British weapon — the text message.**

"**Intelligence chiefs** find out the numbers of the enemy's mobile phones then **send them waves of messages to confuse them and destroy morale.**

Texts range from simple abuse such as *"We know who you are, give up"* or *"Go home, you'll never beat us"*. **Others are disguised as messages from comrades to spread duff information.**

The text attacks are carried out by the 15 (UK) Psychological Operations Group, based at the Intelligence Corps' HQ in Chicksands, Beds."

Elsewhere:

-- SMS text messages urge rebels to surrender in exchange for a fair trial - Russia's intelligence services have found a new way of getting a surrender appeal to Chechen separatist rebels. They are sending it on mobile phones by SMS text message.

-- Lebanon. Psychological warfare on phone - Cell phones and land lines across Lebanon have been ringing with automated, recorded messages - part of a propaganda war being waged along with Israel's assault on Lebanon

-- Israel steps up "psy-ops" in Lebanon - Israel is deploying a range of old and new technologies in Lebanon as part of the psychological operations ("psyops") campaign supplementing its military attacks

emily | 8:41 PM | SMS and Politics |
The Permanent Link to this page is: http://www.textually.org/textually/archives/2006/12/014334.htm

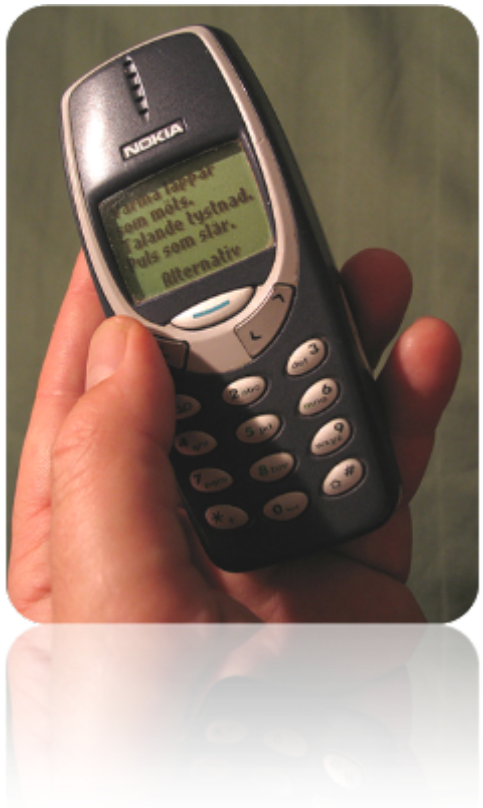
Environmental Impact

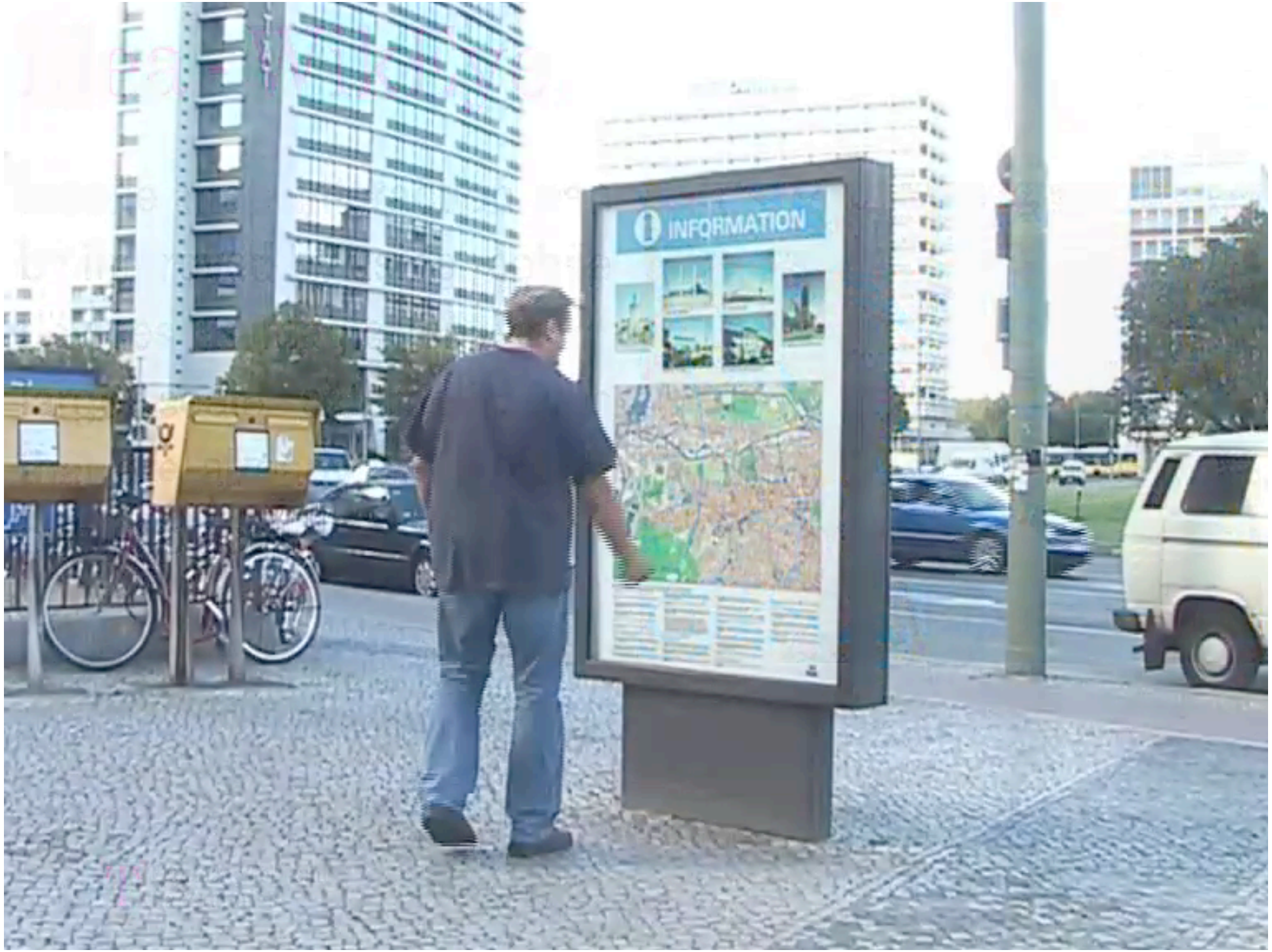
- Mobile phones contain most chemical elements
- Disposable technology paradigm
  - Usage lifetime often shorter than functional lifetime
  - Short upgrade cycles
- Millions of mobile devices discarded each year
  - Toxic electronic waste, ends up in landfills
- Sustainable mobile phone design
  - Nokia 3110 Evolve “Eco-Friendly Device”
    - Cover made of 50% renewable materials
    - Package 60% recycled materials
    - Low energy consumption
    - Energy-efficient charger

More on this topic: Elaine **Huang**, Khai Truong: Situated Sustainability for Mobile Phones, Interactions, 3+4/2008

Impoverished Interactions?

- Design for desktop PCs hard enough
- Mobiles have tiny screens and keypads
- Overcome size limitations
  - Output: Mobile projectors
  - Input: Multitouch, around-device sensing
  - Larger screens
- Use alternative modalities
  - Graphical, textual
  - Audio, tactile, gestural
- Connect to the environment
  - RFID tags, 2D barcodes
  - Image recognition

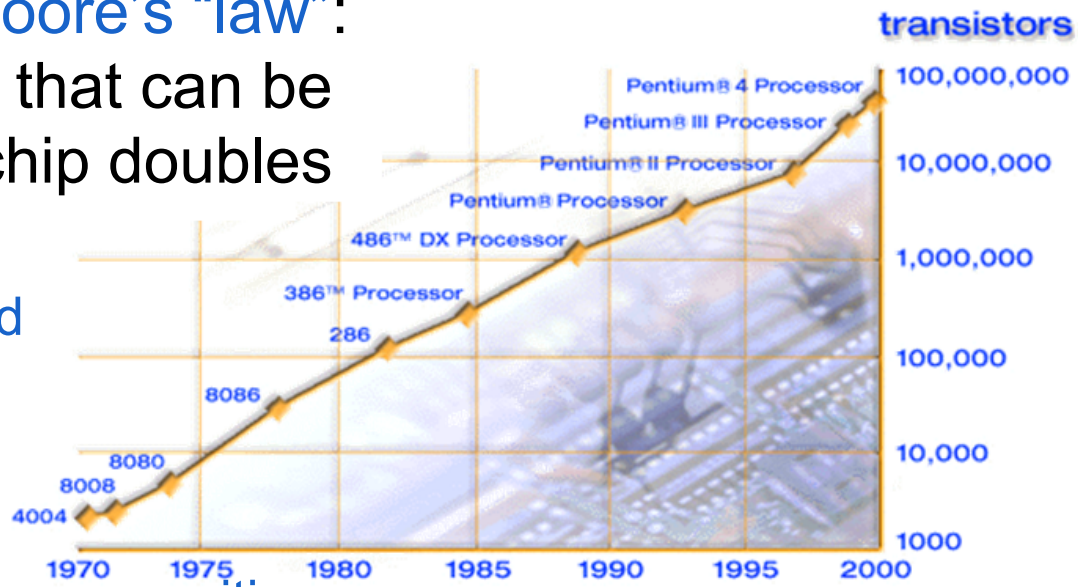



INFORMATION

Technological Evolution of Mobile Computing

Technological Enablers for Mobile and Ubiquitous Computing

- Microelectronics and Moore's "law": number of components that can be integrated on a single chip doubles every 18 months
  - Likely to continue to hold for at least a decade
  - Chip sizes decrease
  - Clock rates increase
  - Memory chips have higher capacities
- Energy per unit of computation falls
  - Size and energy consumption often more important than processing power



1 zoll 8GB (2007)
1 zoll 340 MB (2001)
500 GB USB drive for 99€

Technological Enablers for Mobile and Ubiquitous Computing

- Wireless communication technologies
  - Essential for mobile communication
  - Sometimes just need to transfer a few sensor readings over a short distance
  - Medium to long-range communication
    - WLAN (range 100m, 11Mbps or 54 Mbps)
    - GSM (some tens of kbps)
    - UMTS (up to 1920 kbps)
  - Low power short range communication
    - Bluetooth (range 10-100m, 1 Mbps)
    - ZigBee (128 kbps)
  - Ultra-short range communication
    - RFID, NFC, IrDA, 2D barcodes

Technological Enablers for Mobile and Ubiquitous Computing

- Displays / Output devices
  - LCD / OLED screens
  - Loudspeakers
  - Vibrotactile motors
  - Handheld projectors

- Sensors as “eyes and ears” of mobile devices
  - Low-power MEMS sensors
    - Sound, acceleration, magnetic field, pressure, capacitance, temperature
  - CCD cameras
    - Powerful class of mobile sensors

Technological Enablers for Mobile and Ubiquitous Computing

- Energy capacity does not grow exponentially
  - Lead Acid — 30 Wh/kg — since 1948
  - Nickel Cadmium — 40-60 Wh/kg — toxic, memory effect
  - Nickel Metal Hydride — 60-80 Wh/kg — 1990s
  - Circular Lithium Ion — 90 to 100 Wh/kg — 1990s, flammable
  - Prismatic Lithium Ion — 100 to 110 Wh/kg
  - Polymer Lithium Ion — 130 to 150 Wh/kg — gel, mouldable
- Future
  - Zinc-air batteries — up to 350 Wh/kg
  - Direct-methanol fuel cells?
  - Harvest energy from environment?

Brief History of Mobile Devices and Telecommunication Devices

- 1876 telephone invented by Alexander Graham Bell
  - February 14, 1876: “Improvement in Telegraphy” was filed at the USPTO
  - A few hours later Elisha Gray filed “Transmitting Vocal Sounds Telegraphically”
  - Bell was the 5th entry of that day, Gray was 39th

ALEXANDER GRAHAM BELL, OF SALEM, MASSACHUSETTS.

IMPROVEMENT IN TELEGRAPHY.

Specification forming part of Letters Patent No. **174,465**, dated March 7, 1876; application filed February 14, 1876.

To all whom it may concern:

Be it known that I, ALEXANDER GRAHAM BELL, of Salem, Massachusetts, have invented certain new and useful Improvements in Telegraphy, of which the following is a specification:

In Letters Patent granted to me April 6, 1875, No. 161,739, I have described a method of, and apparatus for, transmitting two or more telegraphic signals simultaneously along a single wire by the employment of transmitting-instruments, each of which occasions a succession of electrical impulses differing in rate from the others; and of receiving-instruments, each tuned to a pitch at which it will be put in vibration to produce its fundamental note by one only of the transmitting-instruments; and of vibratory cir-

ally breaking the circuit. The current produced by the latter method I shall term, for distinction sake, a pulsatory current.

My present invention consists in the employment of a vibratory or undulatory current of electricity in contradistinction to a merely intermittent or pulsatory current, and of a method of, and apparatus for, producing electrical undulations upon the line-wire.

The distinction between an undulatory and a pulsatory current will be understood by considering that electrical pulsations are caused by sudden or instantaneous changes of intensity, and that electrical undulations result from gradual changes of intensity exactly analogous to the changes in the density of air occasioned by simple pendulous vibrations. The electrical movement, like the aerial mo-

Brief History of Mobile Devices and Telecommunication Devices

- 1894 Guglielmo Marconi invents the radiotelegraph
  - 1909 Nobel Prize in Physics *"in recognition of contributions to the development of wireless telegraphy"*

- 1921 combination of telephone and radio
  - Officers at Detroit Michigan Police Department communicate from petrol car to petrol car

Brief History of Mobile Devices and Telecommunication Devices

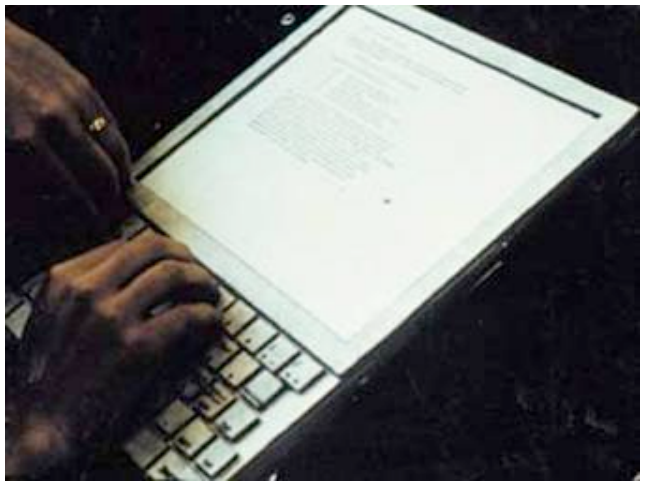
- 1938 Canadian Alfred J. Gross invents the walkie-talkie (also invented telephone pager and cordless telephone)
  - *"I was born thirty-five years too soon. If I still had the patents on my inventions, Bill Gates would have to stand aside for me."*
- *1946 AT&T first commercial mobile telephone service for private customers*
  - Equipment weighted 36kg

Brief History of Mobile Devices and Telecommunication Devices

- 1962 Telstar first active communications satellite
  - Designed to transmit telephone and high-speed data communications

- 1968 Alan Kay's Dynabook
  - Vision of a mobile computer with focus on UI
  - A portable interactive personal computer, as accessible as a book
  - Envisioned as a learning aid for children
  - Problem: software that facilitates dynamic interactions between the computer and its user

    http://www.squeakland.org/content/articles/attach/dynabook_revisited.pdf

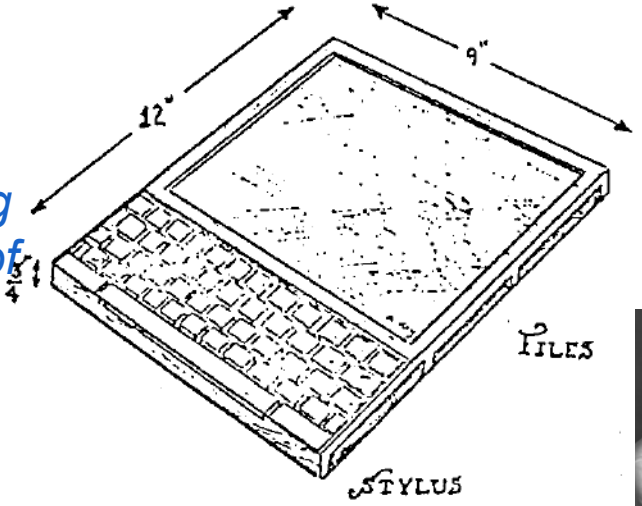


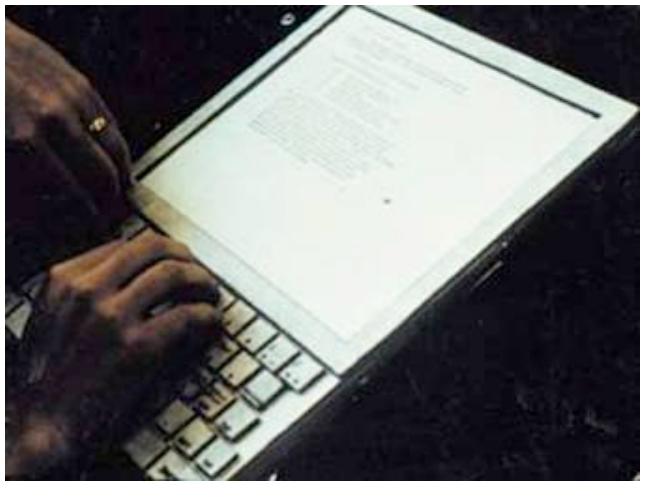
http://www.artmuseum.net/w2vr/archives/Kay/01_Dynabook.html

Brief History of Mobile Devices and Telecommunication Devices

- 1968 Alan Kay's Dynabook

  "The Dynabook will have considerable local storage and will do most computing locally, it will spend a large percentage of its time hooked to various large, global information utilities which will permit communication with others of ideas, data, working models, as well as the daily chit-chat that organizations need in order to function. The communications link will be by private and public wires and by packet radio."





http://www.artmuseum.net/w2vr/archives/Kay/01_Dynabook.html

Brief History of Mobile Devices and Telecommunication Devices

- 1969 DARPA begins the Internet programme
- 1971 Ray Tomlinson invents electronic mail (including “@”)
- 1971 James Fergason invents Liquid Crystal Displays, first LCD watches,
  - Electro-optical effect discovered in 1962
  - 1970 “twisted nematic field effect” patented in Switzerland
- 1973 Sharp LCD calculator

Brief History of Mobile Devices and Telecommunication Devices

- 1972 Motorola prototype for Portable Radio Telephone “DynaTAC” (Dynamic Adaptive Total Area Coverage)
  - First mobile phone call April 3, 1973
  - DynaTAC 8000X first mobile telephone
    - could connect to the telephone network
    - could be carried about by the user

  www.cbc.ca/news/background/tech/cellphones/firstcellphone.html

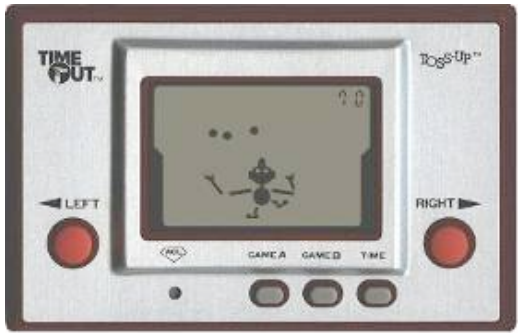
Martin Cooper (considered as the inventor of the mobile phone)

- 1978 Commercial mobile phone service in Japan by NTT
  - First city-wide cellular network

- 1979 Sony Walkman TPS-L2

Brief History of Mobile Devices and Telecommunication Devices

- 1980 Nintendo “Ball”
  - First commercially successful mobile LCD screen game



- 1982 Digital phone exchange in Europe

- 1984 Psion 1
  - First PDA (personal digital assistant)
  - Clock, calendar, address book, calculator

Brief History of Mobile Devices and Telecommunication Devices

- 1987 text message service is launched in Japan
- 1989 first of 24 GPS satellites of current constellation is put into orbit (Block II)
- 1992 first mobile phone for digital networks
  - Motorola International 3200 (500g)
- 1993 Apple Newton MessagePad 100
  - 5.5" screen, 240x320 pixels, touch screen

Brief History of Mobile Devices and Telecommunication Devices

- 1996 Palm Pilot
  - 4" screen, 160x160 pixels
- 1996 Nokia Communicator smartphone

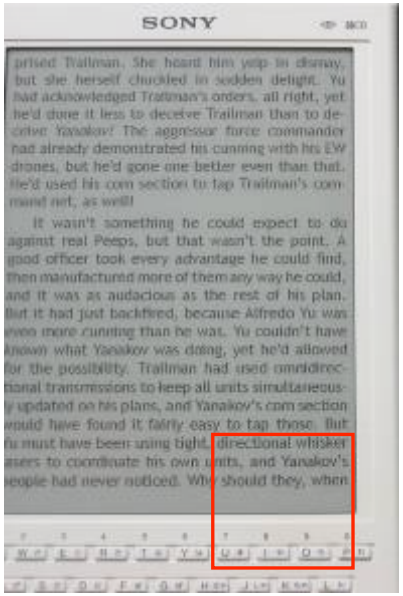
- 1999 DoCoMo lauches i-mode
  - First mobile Internet service

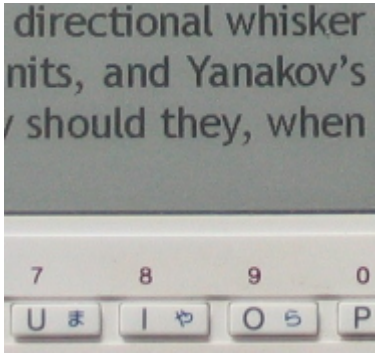
- 2000 first Bluetooth phone
  - Ericsson T36

- 2000 first camera phone
  - Sharp J-SH04
  - 110k pixel CMOS sensor

Brief History of Mobile Devices and Telecommunication Devices

- 2001 debut of the iPod
  - 2" screen, 160x128 pixels, 10000 songs
- 2002 number of mobile phone subscribers exceeds number of landline subscribers
- 2004 first device using e-paper
  - Sony LIBRIé ebook reader
  - 6" screen, 800x600 pixels, 170 dpi

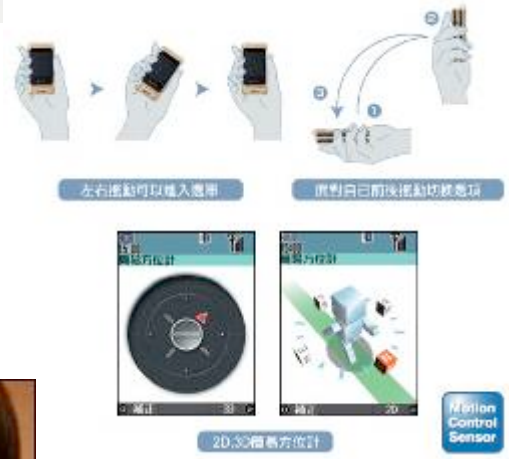




Brief History of Mobile Devices and Telecommunication Devices

- 2004 Playstation Portable
  - 4.3" 16:9 wide screen, 480x272 pixels

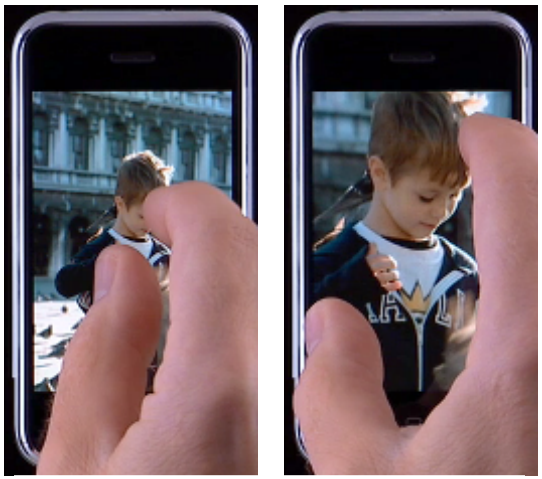
- 2005 first mobile phone with integrated motion control sensor
  - Sharp V603SH
  - 2.4" screen, 320x240 pixels



Brief History of Mobile Devices and Telecommunication Devices

- 2007 iPhone
  - GSM EDGE, WiFi, Bluetooth
  - 3.5" screen, 320x480 pixels
  - Multi-touch display, no keypad
  - Accelerometer to sense orientation
  - Slide and multi-touch interactions

sliding

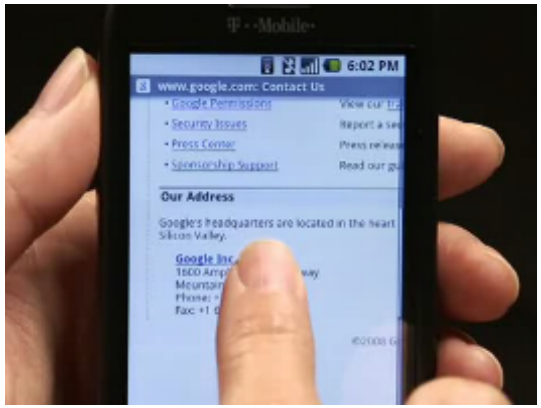


multi-touch (“pinch out”)

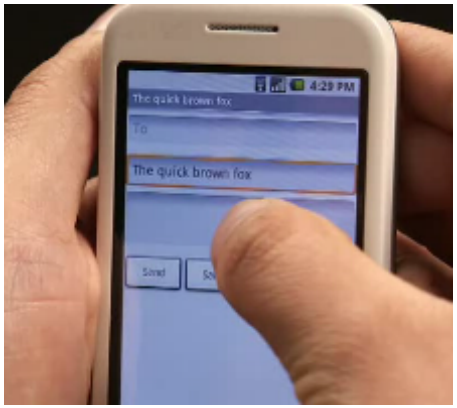
cover flow

Brief History of Mobile Devices and Telecommunication Devices

- 2008 Android
  - http://code.google.com/android/
  - → see previous lecture



Browser links



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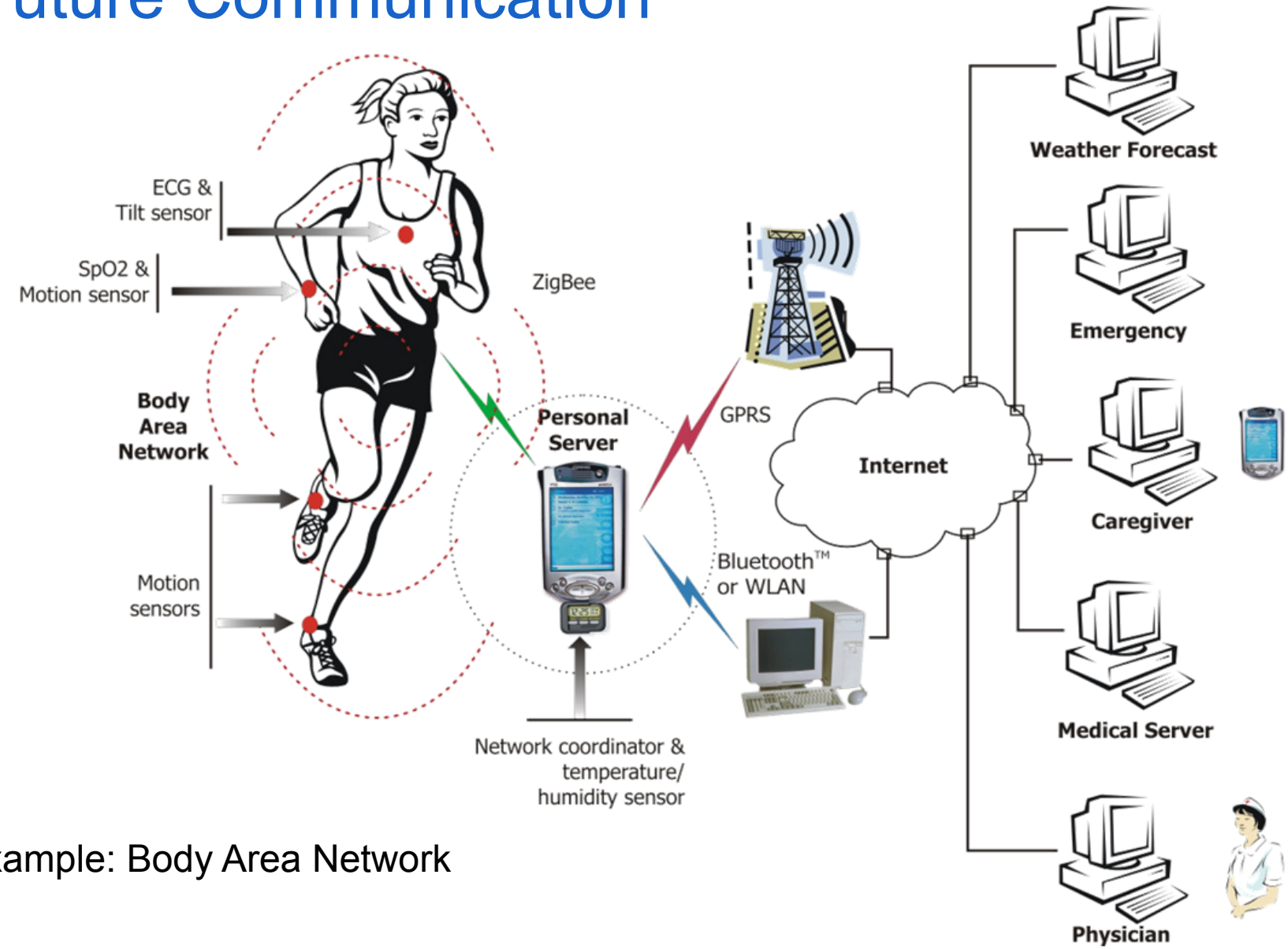
Future Communication



Example: Body Area Network

Future Sensing and Context Recognition

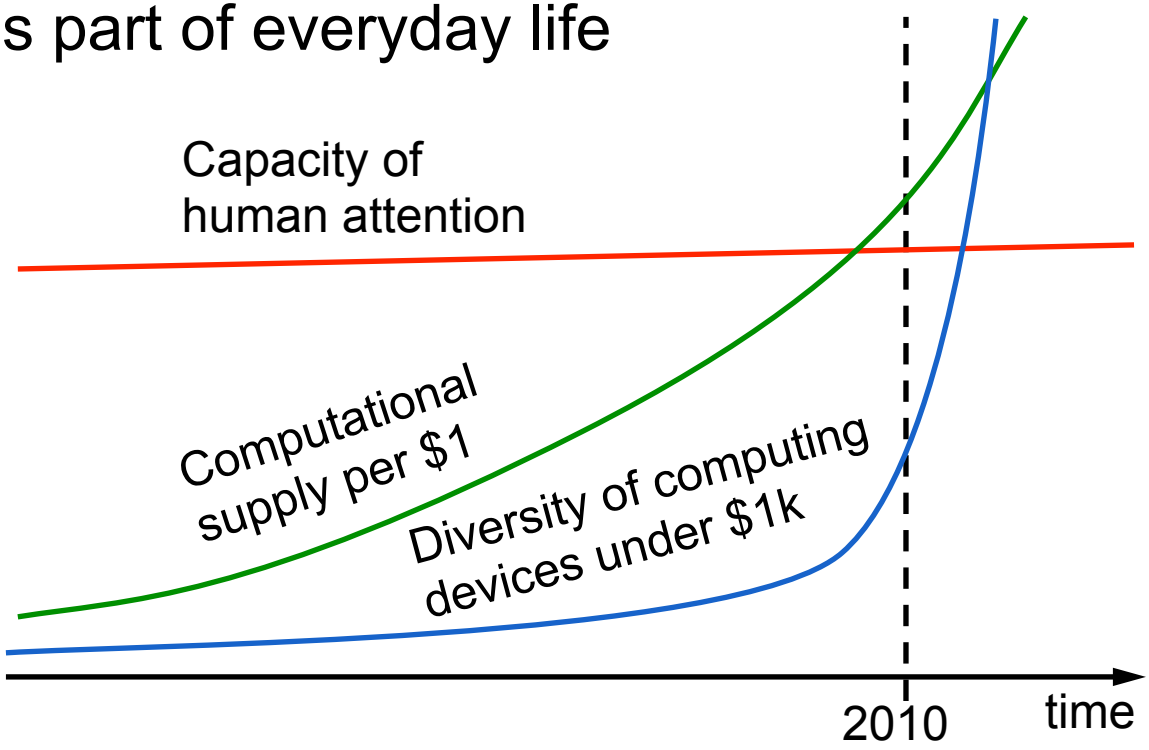
- Sensors for explicit and implicit interaction
- Example: mobile phone
  - Microphone and camera
  - Acceleration sensors
- Today: For entertainment (control music player, sports applications)
- In the future: Context recognition and intelligent behavior of the mobile device

Future Display Technologies

- E-paper
- Flexible displays
- Projection
- Head-mounted displays
- Wall displays
- Tabletop displays

“Computational Surplus”

- Classical limitations of computing systems (processing, storage, bandwidth) are less and less the limiting factor
- UI design becomes discriminating feature
- Interaction becomes part of everyday life



adapted from: Lee: In Search of a Natural Gesture, XRDS, summer 2010, 16(4)

Computing Paradigms

- Main frame computing
  - One computer, many users
- Desktop computing
  - One computer, one user
- Ubiquitous computing
  - Many computers, one user

Vision of Ubiquitous Computing

Mark Weiser

- Vision
  - Computers embedded in everyday things
  - Seamless integration into our environment
  - All components are connected and exchange information
- Ubiquitous computing vs. virtual environments
  - Computers in the world, instead of world in the computer
- Calm Technology
  - Technology moves into the background
- Readiness to hand
  - Good tools should not distract our attention, e.g. pencils