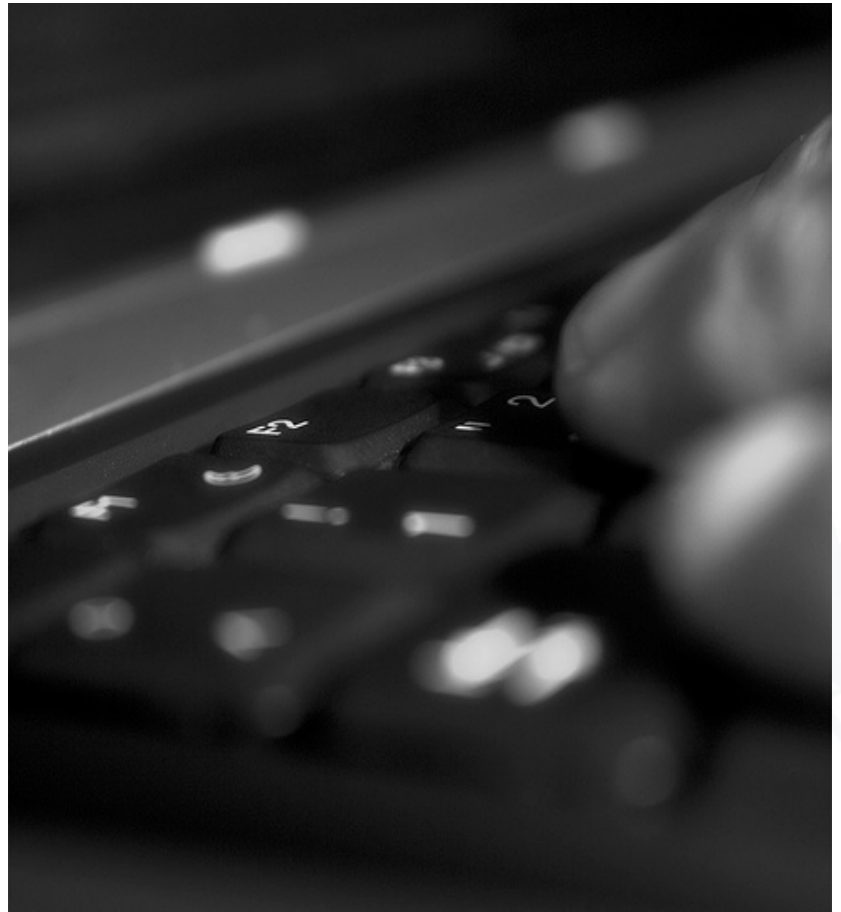## Lecture 4
Business Informatics 2 (PWIN)

## Information Systems III
Mobile Information Systems

WS 2015/2016

Prof. Dr. Kai Rannenberg
www.m-chair.de

Jenser (Flickr.com)

- **What is mobility?**

- Mobile Infrastructure & Ecosystem

- Mobile Information Systems

- Conclusion on Challenges / Benefits of Mobile IS

# What is mobility?



Lat. *mobilitas*:

(1)    Flexibility, velocity, motion;
and as "mobilitas animi": (mental) fitness

(2)    But also (and quite ambivalent to (1)) changeability, inconstancy, unstableness

[SkuStowPets1998]

- **Social implications**

  Mobility not just "*humans' independence from geographical constraints*"

- **Spatial Mobility**
- **Temporal Mobility**
- **Contextual Mobility**

[KakihaSorens2001]

# Agenda

- **What is mobility?**

- **Mobile Infrastructure & Ecosystem**
    - Mobile Voice & Data Communication Services
    - Mobile Devices
    - Smartcards and Subscriber Identity Module (SIM)
    - Mobile Operating Systems
    - Mobile Web Apps vs. Mobile Apps
    - App Markets

- **Mobile Information Systems**

- **Conclusion on Challenges / Benefits of Mobile IS**

- Mobile Device
- Base Station/Mobile Station/Cell
- Connection to the Internet

Transmission channel

User terminal

## Fundamental Mobile Communication Services

- **Mobile Voice**
  - GSM, UMTS

- **Mobile Data**
  - GPRS, EDGE, 3G networks (UMTS, HSDPA), 4G networks (LTE, LTE Advanced)

- **Mobile Messaging**
  - Text Messaging (SMS), Multimedia Messaging (MMS)

- **Mobile Machine-To-Machine**
  - GPRS, EDGE, 3G networks (UMTS, HSDPA), 4G networks (LTE, LTE Advanced)

→ Lecture focuses on Mobile Data Communications

# Mobile Voice & Data Communication Services

- *1st Generation (1G) – Analogue networks*
- *2nd Generation (2G) – GSM networks*
  Global System for Mobile Communications
- *3rd Generation (3G/3.5G) – UMTS/HSPA/HSPA+*
  Universal Mobile Telecommunications System
  High Speed Packet Access / Evolved HSPA = HSPA+
- *3.9G or 4G – LTE*
  Long Term Evolution
- *4th Generation (4G) – LTE Advanced*
- *5th Generation (5G) – Mobile broadband*

Evolution of mobile telecommunication infrastructures

| 2G – GSM | 3.9G/4G – LTE |
| --- | --- |

| 1G | 3G – UMTS | 4G – LTE Advanced |
| --- | --- | --- |

5G

- Cellular networks are radio networks consisting of several transmitters.

- Each transmitter or base station, covers a certain area ➲ *a cell*.

- Cell radii can vary from tens of meters to several kilometres.

- The shape of a cell is influenced by the environment (buildings, etc.) and usually neither hexagonal nor a perfect circle, even though this is the usual way of drawing them.
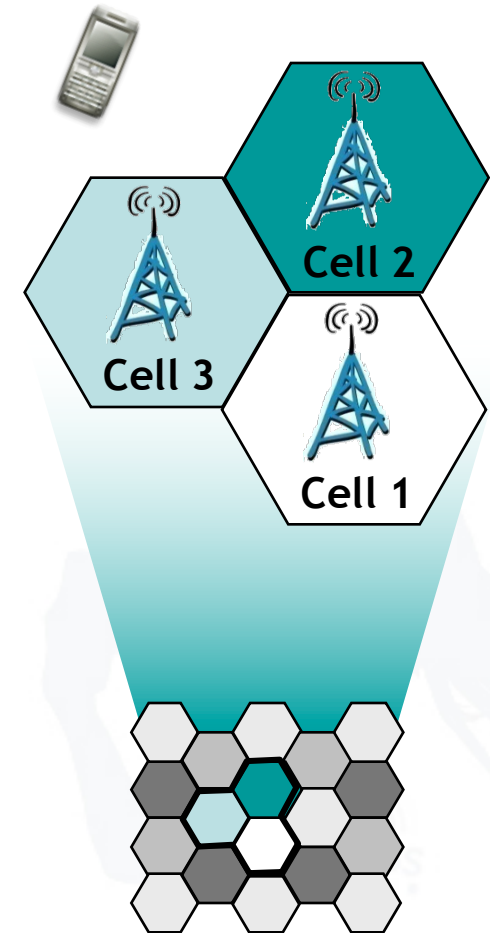
[Schiller2003]

- Cellular networks offer a number of advantages compared to centralised radio systems:

  - *Higher capacity*: Cells offer the possibility to "*reuse*" the transmission frequencies assigned to mobile devices (e.g. by multiplexing). In order to do so, the networks need a thorough planning of the position of base stations and their frequencies.
    - ➲ More users can use the infrastructure
  - *Reduced transmission power*: Reduced power usage for the mobile device, due to the fact that only a limited amount of transmission power is needed in a small cell, compared to a far away base station.
    - ➲ Reduced power consumption for mobile devices

- Cellular networks offer a number of advantages compared to centralised radio systems:

  - *Robustness:* Cellular systems are decentralised with regard to their base stations. In the case that one antenna fails, only a small area gets affected.
    - ➲ Failure of one base station does not affect the complete infrastructure
  - *Better coverage:* Cells can be adapted to geographic conditions (mountains, buildings, etc.).
    - ➲ Better availability of the infrastructure

  *But:* A complex and costly infrastructure is required, in order to link all base stations. This includes switches, antennas, location registers, etc.

NSS: Network- & Switching Subsystem

OSS: Operating Subsystem

RSS: Radio Subsystem
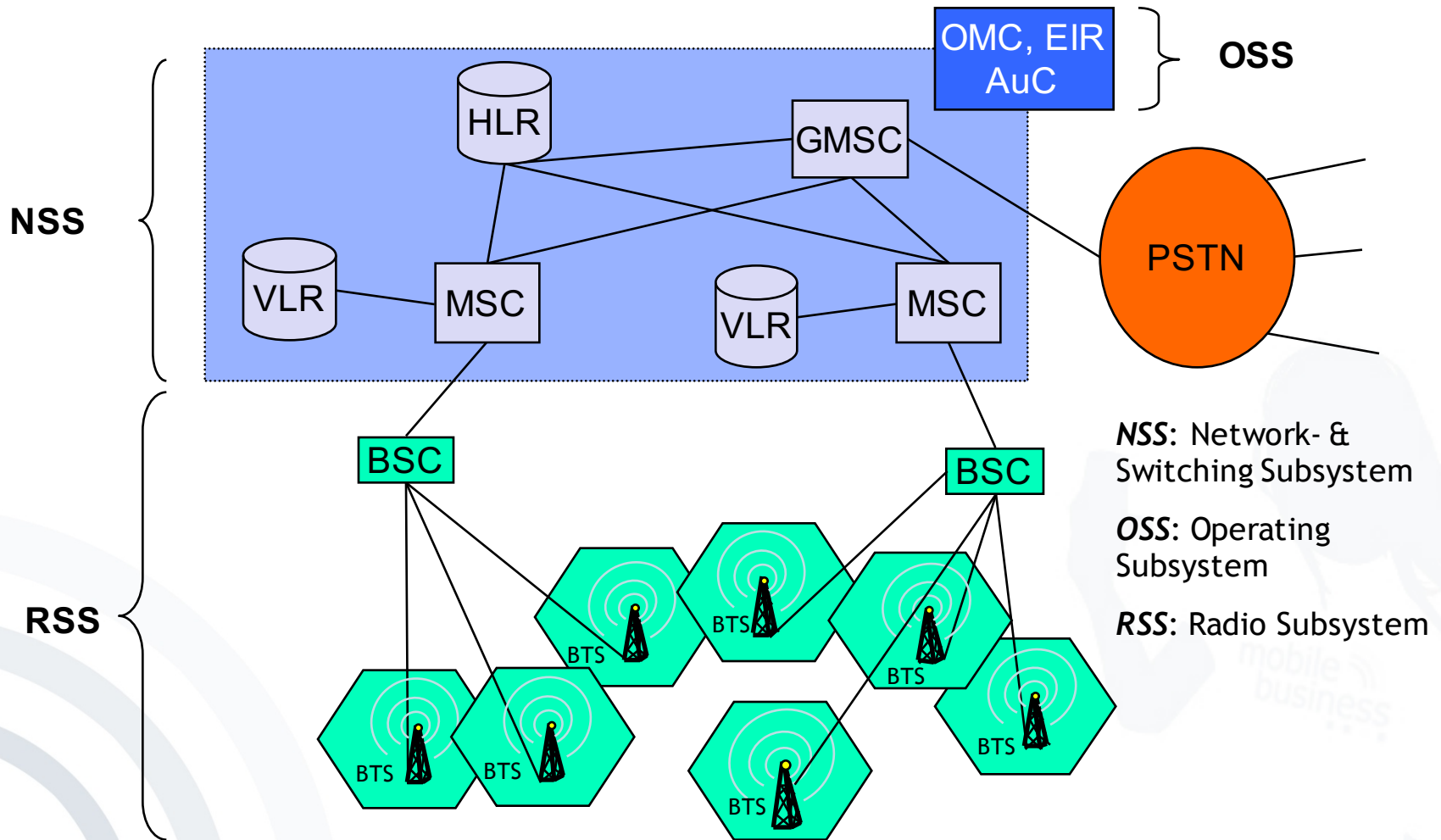
Based on [Schiller2003]

- *UTRAN:* UMTS Terrestrial Radio Access Network

- *RNS:* Radio Network Subsystem

- *RNC:* Radio Network Controller (controls the Node Bs)

- *Node B:* UMTS base stations (equivalent to base transceiver stations (BTS) in GSM
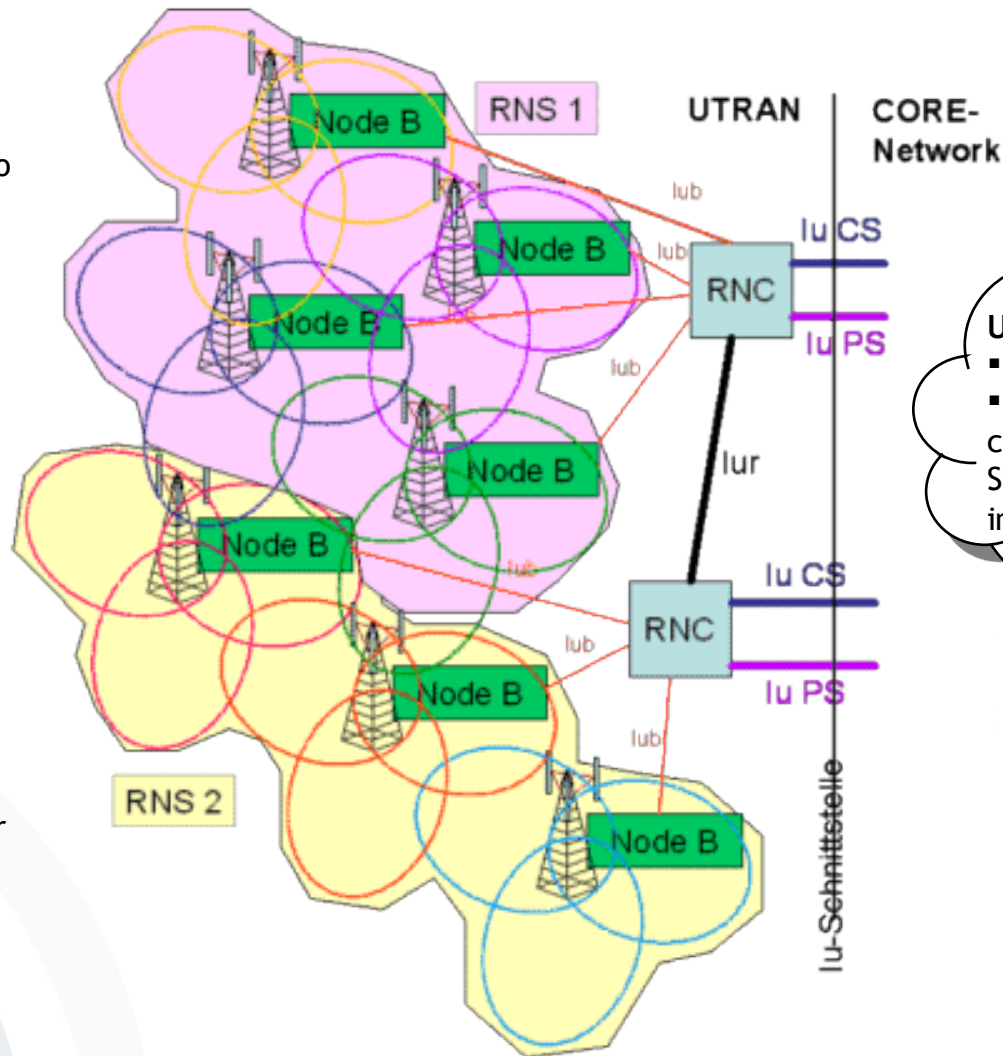


**UMTS Core network**
- is not shown here in detail
- UMTS Core network corresponds to Network- & Switching Subsystem (NSS) in GSM

Source: UMTSlink.at (2011)

# Data retention of cell-based location data
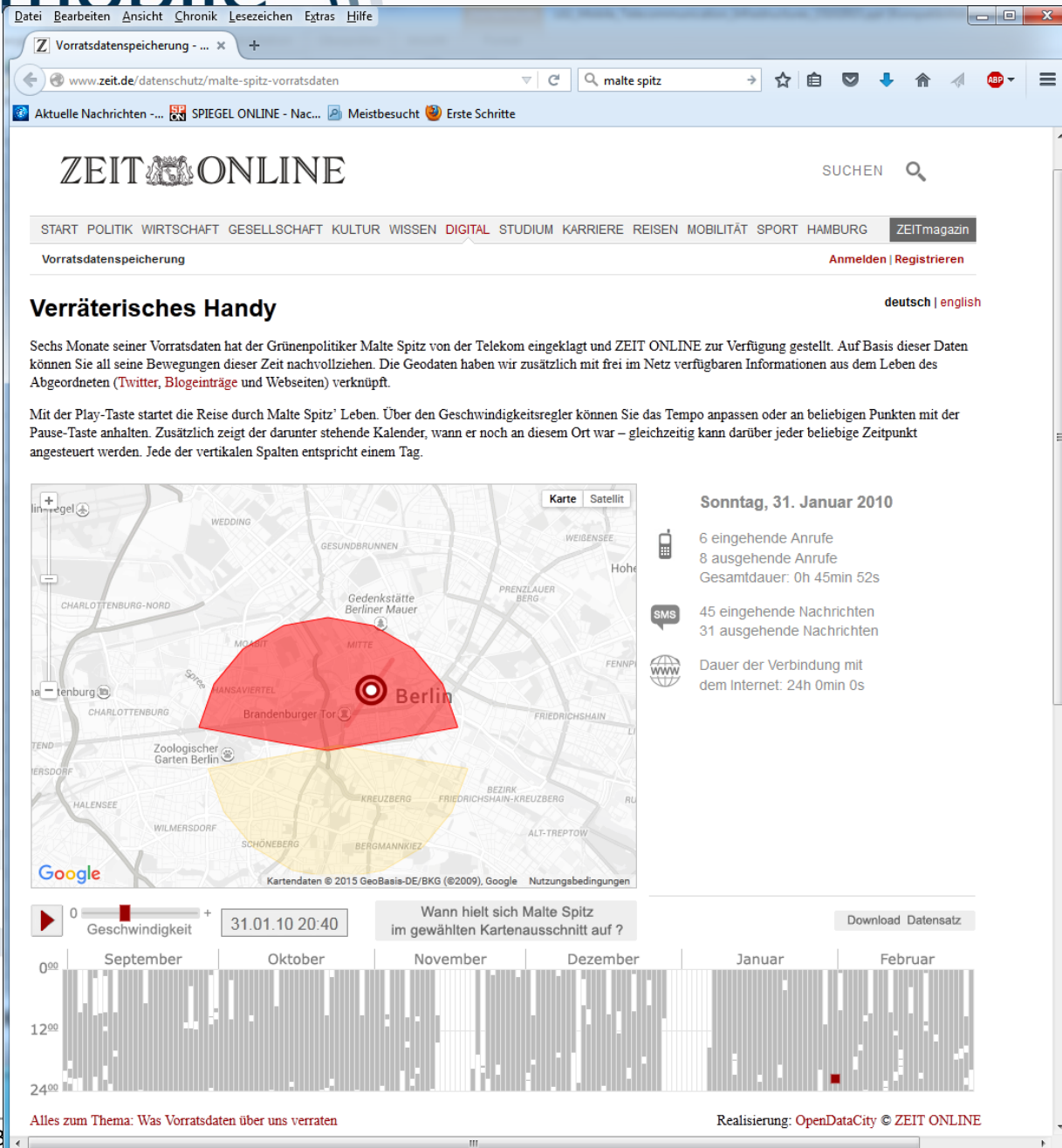


[www.zeit.de/datenschutz/malte-spitz-vorratsdaten]

- # Categories of mobile devices
  - Mobile phones (low-end „Feature Phones")
  - Smartphones
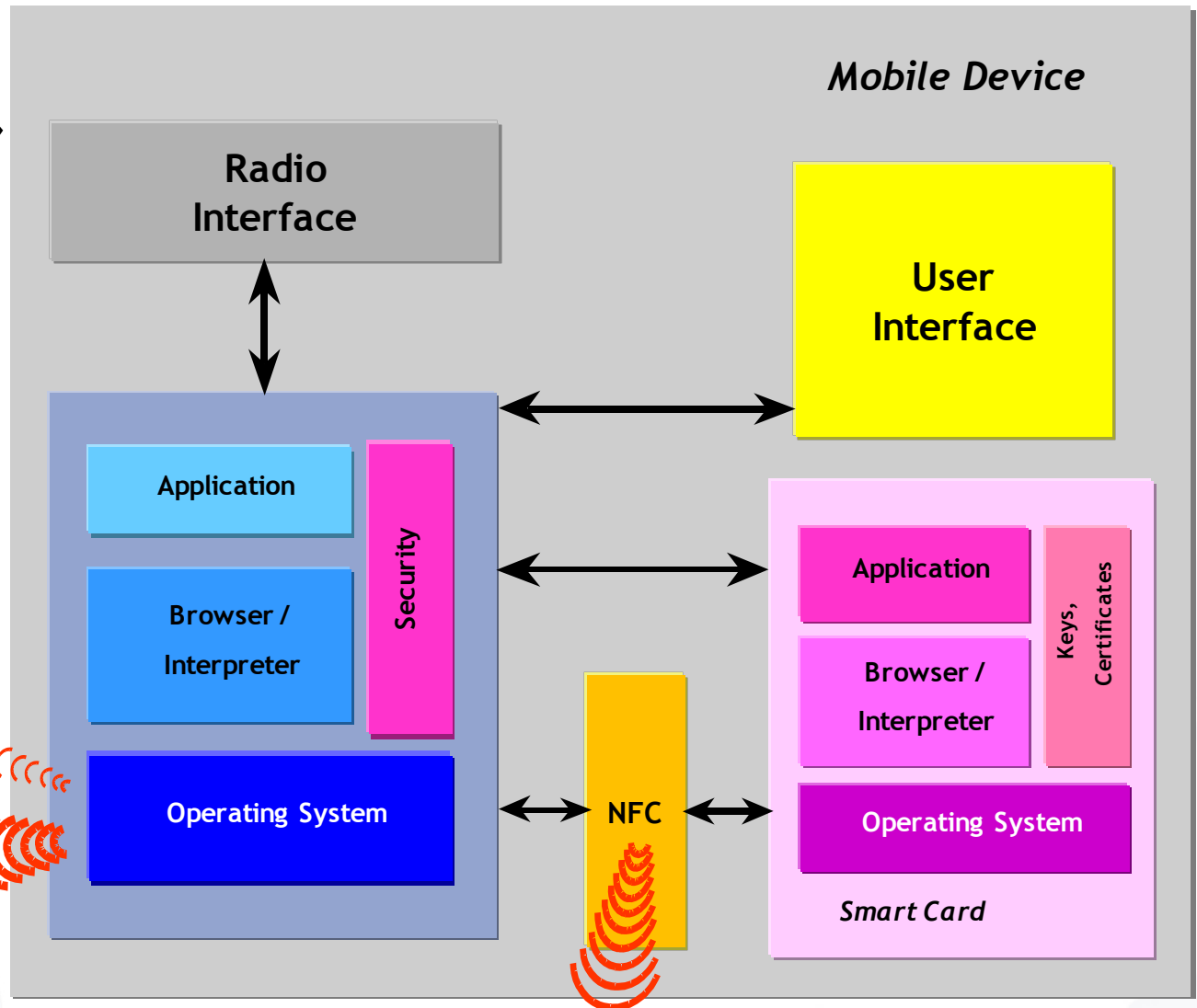  - Tablet PCs
  - Netbooks
  - Notebook



Source: Nokia Booklet 3G (2010)

- **Terminal of users differ in technical specifications**
  - **Heterogeneous and fragmented system landscape**
    - Display resolution
    - Different web browsers
    - Keyboard
    - Mobile Operating Systems
    - Application software that can be installed
    - Other features

**Mobile Device**

**Radio Link**

**Radio Interface**

**User Interface**

**Application**

**Browser / Interpreter**

**Security**

**Operating System**

**Global Positioning System (GPS)**

**PAN: Bluetooth, Infrared, …**

Bluetooth

Infrared Data Association

**NFC**

**Smart Card**

**Application**

**Browser / Interpreter**

**Keys, Certificates**

**Operating System**
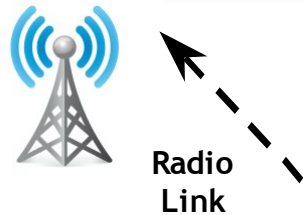
Based on [Posegga2001]

# Evolution of Mobile Phones Capabilities

*Time*

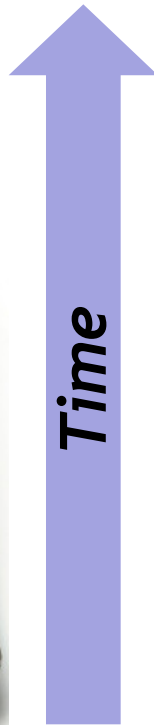- Near Field Communication (NFC)
- Possibility to execute 3rd party software
- Multimedia applications (MP3, radio, camera, video, TV, etc.)
- Data Services (GPRS, UMTS, LTE Internet connectivity, Wi-Fi)
- Bluetooth
- Interactive Voice Response (IVR)
- Short Message Service (SMS)
- General telephony capabilities

# Device Manufacturers and Brands
## (including some historic ones)

- Alcatel
- Apple
- Audiovox
- Benefon
- BenQ Mobile
- Blackberry
- Bosch
- Ericsson
- Google
- HTC
- Huawei
- LG Electronics
- Microsoft
- Motorola
- NEC
- Nokia
- Panasonic

- Philips
- Sagem
- Samsung
- Sendo
- Siemens
- Sony
- TCL Communication
- Telepong
- Telit
- Telme
- Toshiba
- Trium
- Windhorst
- Xelibri
- Yulong
- ZTE

- **SIM**s are **Smartcards:**
  - **SIM cards** serve as security medium.
  - Tamper-resistance prevents counterfeiting.
  - robust design

- Contain **International Mobile Subscriber Identity (IMSI)** for subscriber identification and the key $K_i$ provided by the mobile operator

- Reliably execute computational functions for the mobile device

cf. [EffingRankl2008]

- In GSM and UMTS since 1991, upcoming for WLAN
- **Represents** contract **between subscriber & network operator**
- Authorises **a "phone"** to **use** the network by linking it to a **subscription**
- By November 2014 more than **7.2 billion** mobile-cellular subscriptions [ITU2014, GSMAI2014]
- **More** countries with **SIM** infrastructure (219, 2013-Q3) **than** with **McDonald's** (118, 2013-Q3) and **more than UN** member states (193, 2013-Q3) [GSM2013, McDonalds2013, UN2013]
- More and more called "Subscriber **Identification** Module" to reflect progress in the general field of **Identity Management**

[Telekom2011]

# What is a mobile operating system (OS)?

- An OS is a program that serves as a mediator between the user and the hardware.

- It enables the users to execute programs

- *Other properties:* Multi-user, multi-thread, high availability, real-time, …

---

- *Primary goal of an OS*: Easy usage of the actual hardware

- *Secondary goal of an OS*: Efficient usage of the hardware

---

[Silberschatz, Galvin 1999]

- ## Controlling and sharing of resources

  - Computation time, real-time processing
    "Who is computing how much? How long does it take?"

  - Memory (RAM, Disk)
    "Who gets which part of the memory?"

- ## Security functions

  - Protection of the data (memory, hard disk):
    "Who is allowed to access resources?"

  - Process protection (computation time, code, isolation):
    "Who is allowed to compute?"

  - Security module support

- ## Communication

  - Allocation of I/O-Resources

  - Processing of the communication

  - User interface (UI)

- Originally, most mobile phone manufacturers used their own "closed" operating systems for their mobile devices.

    - *Palm OS (Garnet OS)*
        - *Latest release: 6.0 for most devices*

    - Apple *iOS* (Unix-based)
        - Latest release: iOS 9

    - *BlackBerry OS*
        - Latest release: BlackBerry OS 10.3.1

    - *LuneOS* (formerly WebOS, initially developed by Palm, later HP)
        - Latest release: LuneOS Café de Olla
        - Not to be confused with Palm OS (now: Garnet OS) that was also initially developed by Palm

    - *Samsung bada*
        - Latest release: v2.0, e.g. on Samsung Wave 3 S8600

- *Advantage:* Tend to be not as much affected by malware than "open" operating systems

- *Disadvantage*: Less flexible, as 3rd-party software cannot be easily installed and executed

- Later, more and more platforms switched to more open and interoperable operating systems (e.g. Windows CE, Symbian OS, Android).

# Mobile OS unavailable to other device manufacturers - Example: Apple iOS

- Developed by Apple for iPhone, iPod Touch, iPad and Apple TV

- Latest release: iOS 9

- iOS derived from Mac OS X, a Unix-based operating system

- Apple does not permit the OS to run on third-party hardware

- User-interface uses multi-touch gestures

# Manufacturer-independent mobile OS
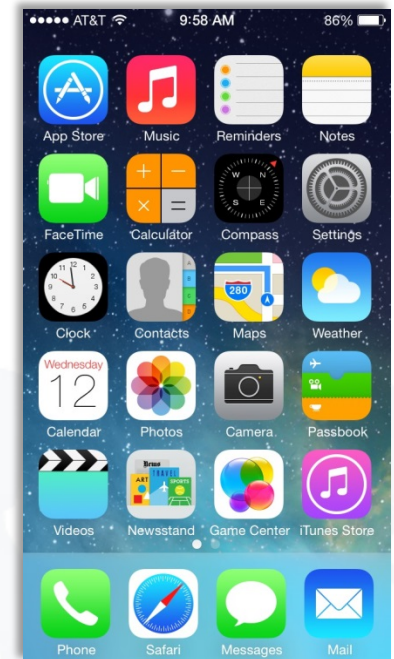
- Linux: LiMo (Linux Mobile), Openmoko Linux, Qt Extended (Qtopia)

- Symbian platform
    - Latest release: "Nokia Belle Feature Pack 2" for Symbian^3 devices

- Android (by Open Handset Alliance)
    - Latest release: 6.0 (Marshmallow)

- Windows Mobile
    - Latest release: Windows Mobile 6.5.5

- Windows Phone
    - Latest release: Windows Phone 8.1

- Maemo (by Nokia) → MeeGo (by Nokia, Intel) → Sailfish OS (by Jolla)
    - Latest release: Sailfish OS v1.1.2.16 (February 2015)

- Tizen (by Samsung, Intel, Linux Foundation)
    - Latest release: 2.3 (November 2014)

- Firefox OS (by non-profit organisation Mozilla)
    - Latest release: 1.4 (August 2014)

- China-Focused Mobile OS
    - Currently under development by Taiwan-based HTC    [WSJ2013]

= Linux-based

- Google and other members of the **Open Handset Alliance** collabora-ted to develop and release Android.

- Open Handset Alliance (OHA) established in 2007

- Android based on modified version of Linux kernel

- October 2008: First commercially available phone running Android: T-Mobile G1

- October 2015: Version 6.0 Marshmallow
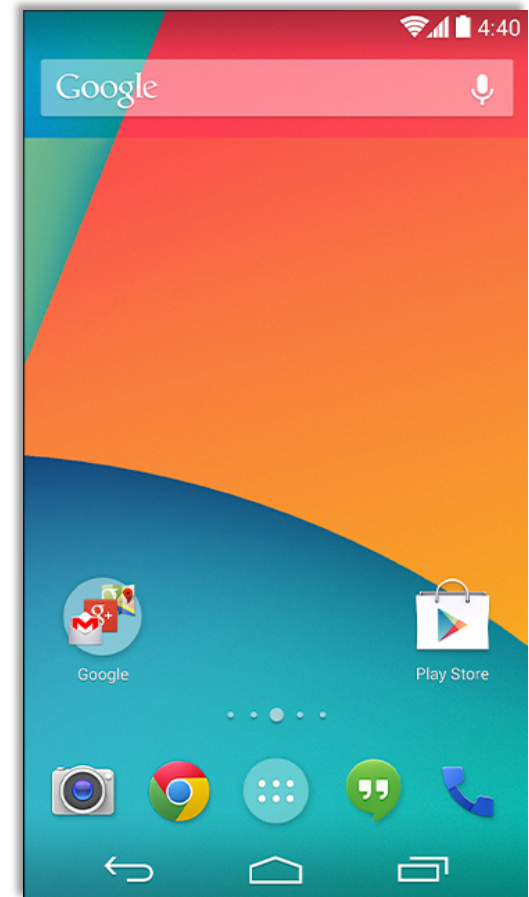
# Mobile Web App

- App not installed on the device
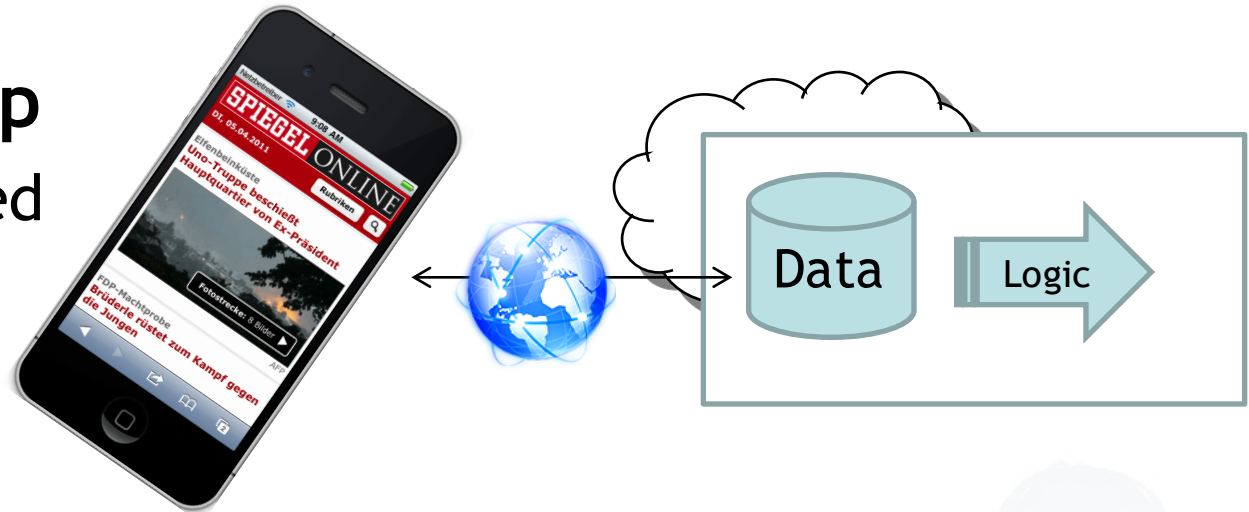
# Mobile App ("Native App")

- App is downloaded and installed

Data

Logic

Data

Logic

optional

# Mobile Web Apps vs. Mobile Apps

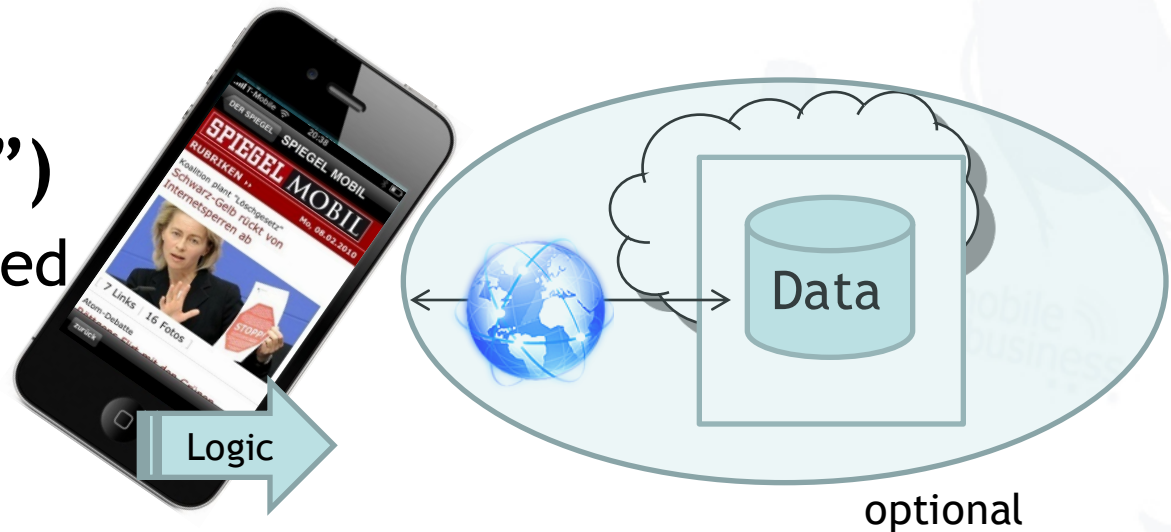| Mobile App ("Native App") | Mobile Web App |
|---|---|
| Supports offline use | Needs constant internet connectivity (network coverage) |
| Can be found easily in App Store(s) | Distribution via URL, e.g. QR-codes |
| Business Model: Sold in App Store(s) | Difficult to implement payment and authentication system |
| Can make use of all OS and device functions | Cannot access OS core functions (e.g. 3D graphic processing or access to local storage) |
| Needs to be platform-specific (native code) | Using web browser of the device, hence manufacturer-independent multi-platform support possible; also porting to other devices/platforms is less expensive |
| Based on Objective-C, C#.Net, Java | Based on HTML5, CSS, Javascript |
| Updates/Versioning through App Stores | Easy updates as they are done on the server, not on every client device |

# App Markets

- Mobile App distribution through **App Markets** ("App Stores")
- App Markets are two-sided markets, a base where people can publish their apps
- Payment, hosting, maintenance and marketing through App Market



Users

App Markets

App developers

- Mobile platform for selling content, services (Apps) and hardware
- Offering channels against the *everything is free* culture of the internet
- entering advertising market with iAd since iOS 4

- *„Mobile First"*
  - Eric Schmidt, CEO Google
- Having control over which Search Engine is used on mobile devices
- Making the mobile web attractive to build new *advertising pillars*

- Like Microsoft for desktop computers Android as a rather non-restrictive platform will become a major player on the mobile market.

- Android can profit from Apple's restrictive strategy, but can also be affected by Google's bad image.

- There will not be a monopoly or duopoly on the mobile OS market.

- With the rising complexity of mobiles the challenge will be recognizable trustworthiness.

**Content Providers**
- Developers
- Labels
- Movie-Studios
- Publishers
- …

Content Providers are interested in a wide-spread platform.

Content Providers offer more content.

**Devices**

**Content**

Customers buy devices to use (new types of) content.

Customers want to select content from a big choice

**Customers**

# Google's economic cycle

| Support for spreading the web | Google Services |
|---|---|
| • Web Standards (HTML5)<br>• Chrome<br>• ChromeOS<br>• Android<br>• … | • Search<br>• YouTube<br>• Docs<br>• Picasa<br>• … |

supports                    generates

finances          Experience          User & Traffic          finances

supports                    collects

Awareness  ◀┈┈┈┈  User Data

supports                    supports

| 3rd Party Websites | Organic |
|---|---|
| Google AdSense | Google AdWords |

spend money for advertising

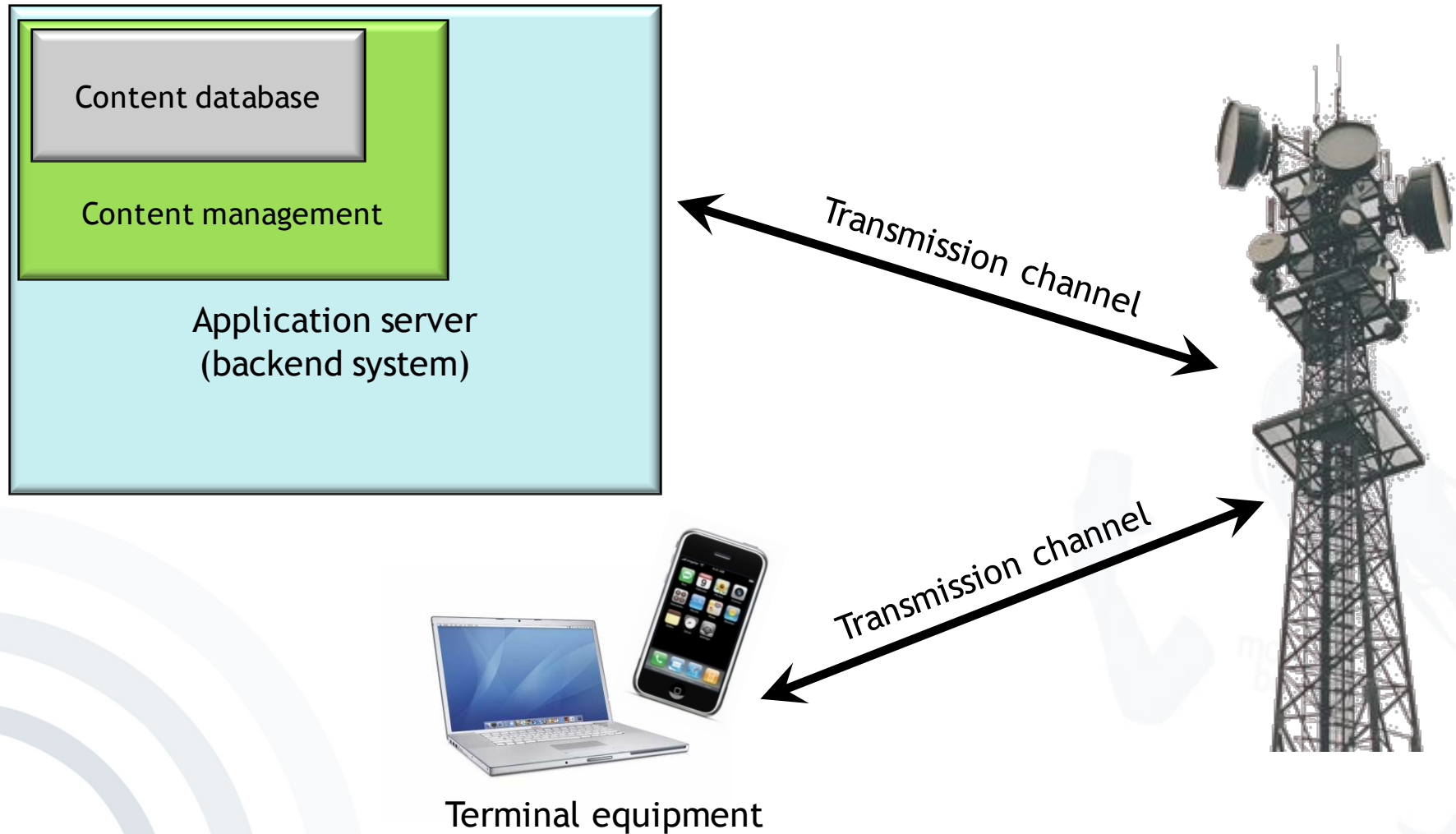Advertisers

# Future of Mobile (Web) Apps

- Mobile Browsers are likely to gain access to more OS core functionality (e.g. 3D graphics processing; location API already available)

- The trio HTML 5, CSS, JavaScript was strongly expected to further improve the graphical user interfaces (GUIs) towards native mobile apps as well as to provide more platform independence

- Consequently, it is likely that Mobile Web Apps will be the future dominating application type in the mobile ecosystem

- Possible consequences for the mobile ecosystem

  - Specific mobile platforms and app markets become less relevant in the mobile market

  - Reduced market power of app market operators such as Apple

- How would/will Apple, Google & Co. react to this scenario?

- **What is mobility?**

- **Mobile Infrastructure & Ecosystem**

- **Mobile Information Systems**
  - Mobile Information System
  - Unique Characteristics of mobile data communications
  - Infrastructure of Mobile Applications
  - Mobile Office
  - Mobile Marketing
  - Mobile CRM Systems
  - Mobile Communities

- **Conclusion on Challenges and Benefits of Mobile IS**

- **Information System (IS):**
  A system which was build to be used in a part of an enterprise. It contains all relevant application systems and is embedded into the organisation and management of an enterprise.

- **Mobile Information System:**
  Information systems in which access to information resources and services is gained through end-user terminals that are easily movable in space, operable no matter what the location, and, typically, provided with wireless connection.

Source: Pernici (2006)

# Unique Characteristics of Mobile Data Communications

- Time and Location Independence
- Instant On of Mobile Devices
- Limited I/O Capabilities
- Location Awareness
- Personal Nature of the Medium
- Identification of Mobile User
- 1:1 Communications
- High Penetration in the Population

Content database

Content management

Application server
(backend system)

Transmission channel

Transmission channel

Terminal equipment

# Mobile Office (Mail, Calender, Tasks, Notes, Files)

- Mobile devices, e.g. smart-phones, allow access to emails, calendar, tasks, notes and files via wireless networks from centralised server.

- Additional mobile channel, which enables users to access and use an office infrastructure anywhere and at any time.



Outlook
(PC or notebook)

Server

Sync

Outlook
Web Access

Mobile device,
e.g. Smartphone
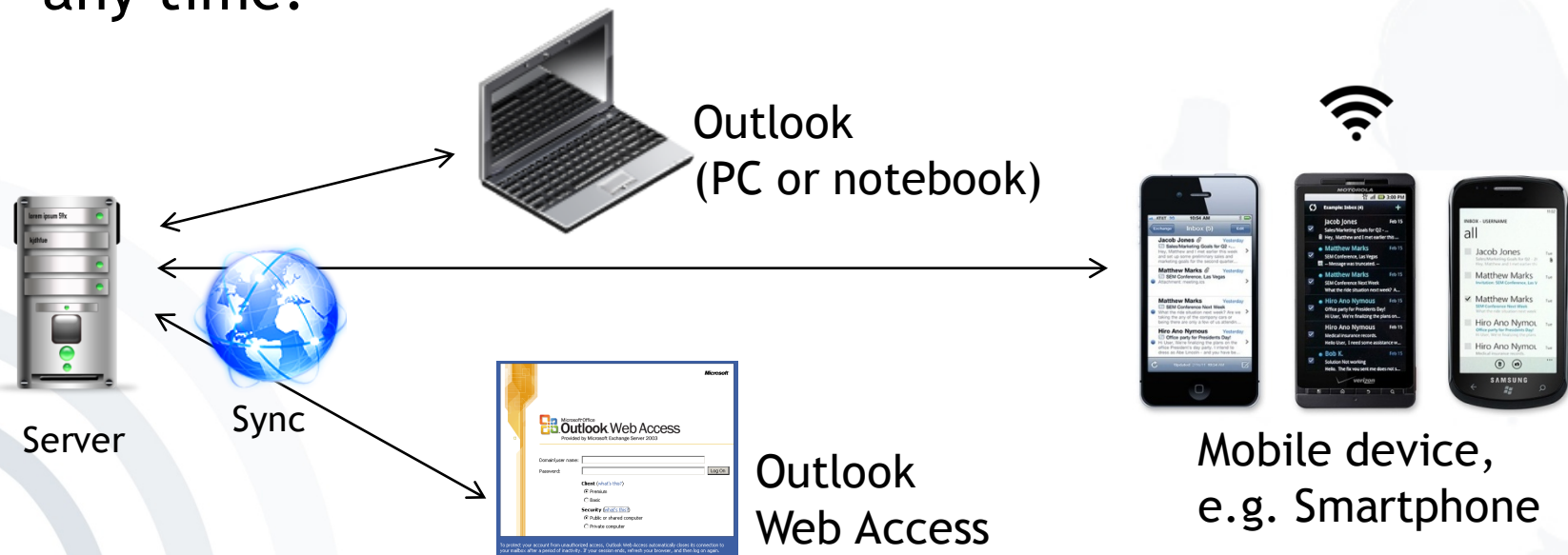
- *Mobile Marketing is a set of practices that enables organizations to communicate and engage with their audience in an interactive and relevant manner through any mobile device or network.*
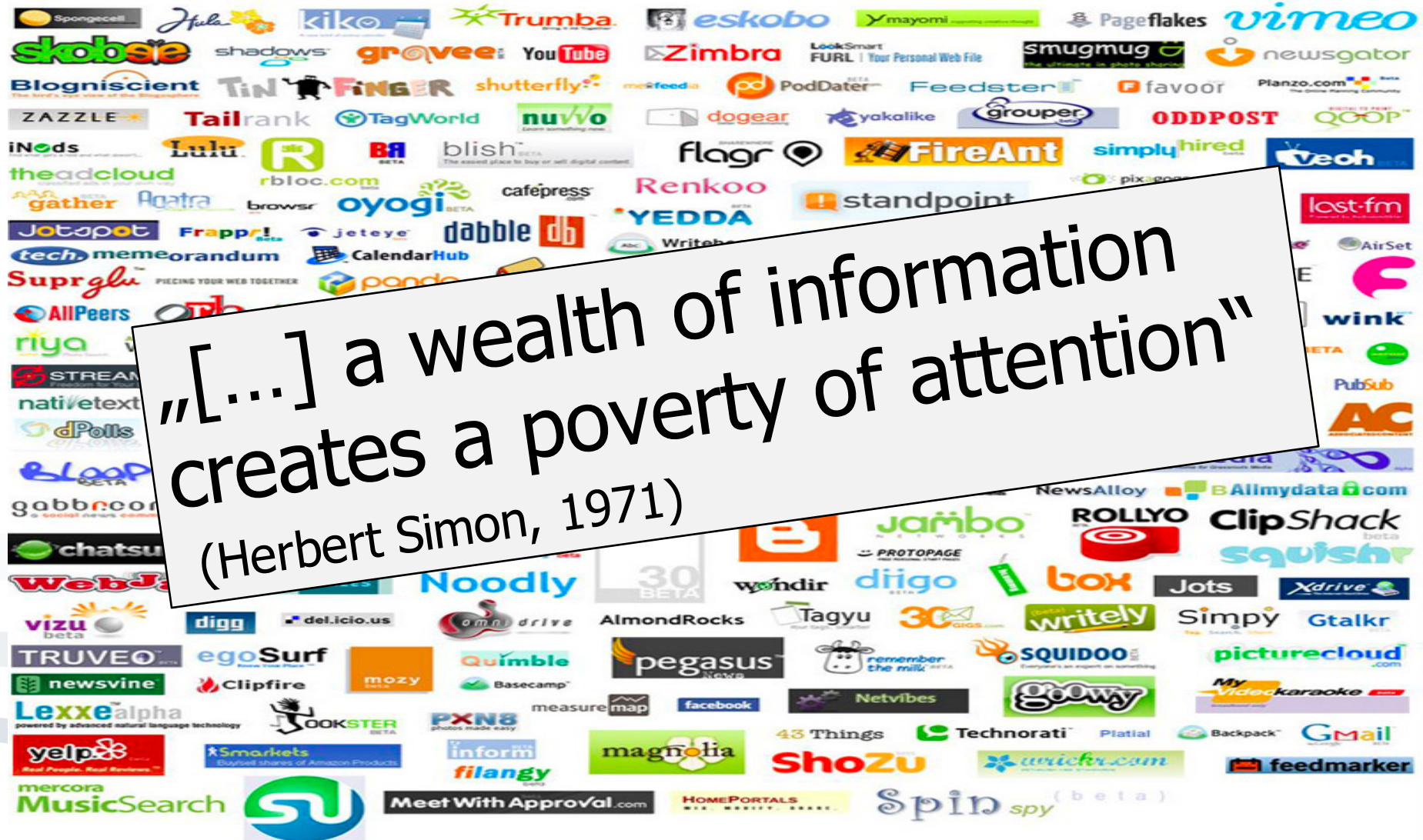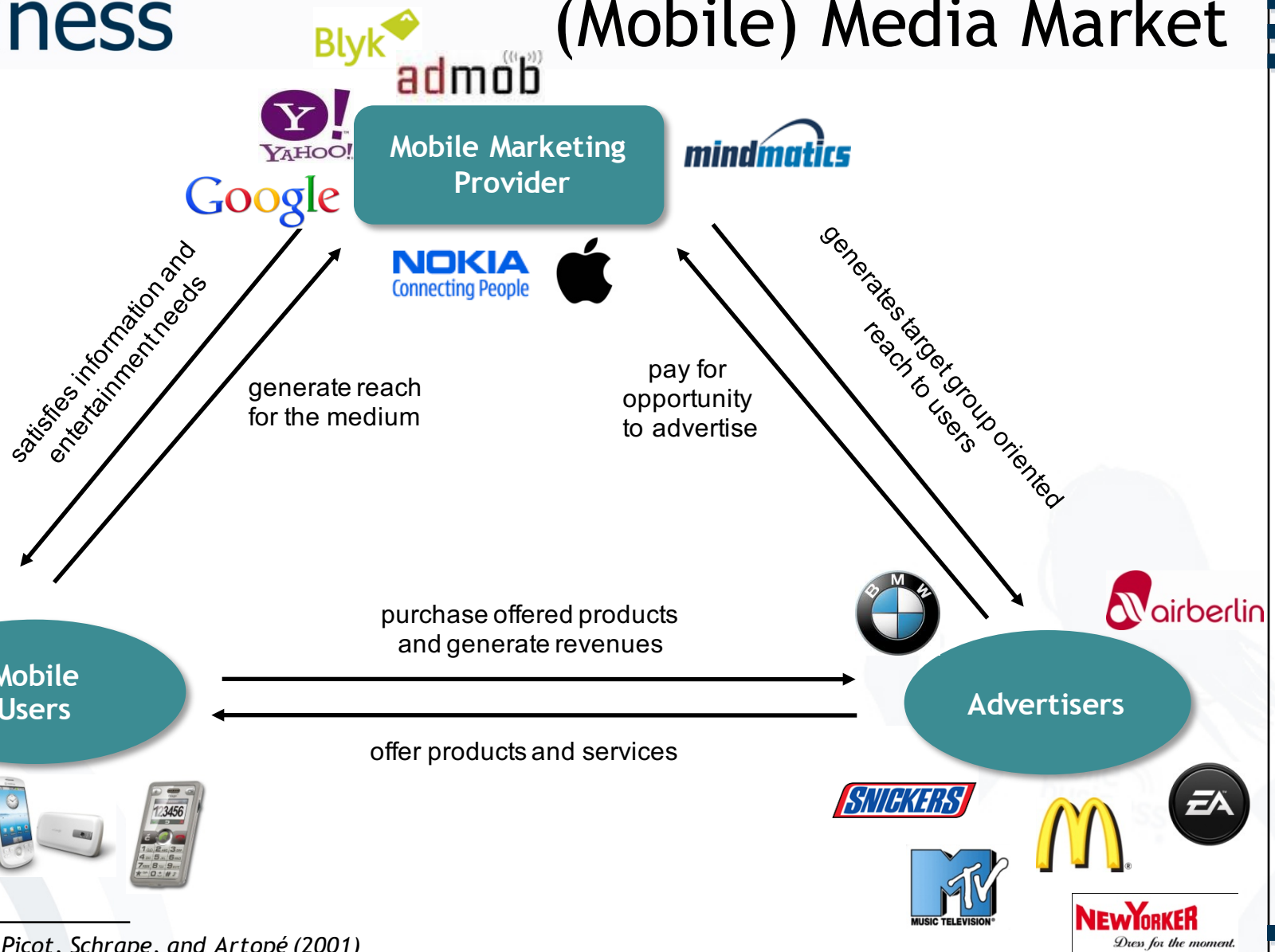
Mobile Portal



Personalised Service-Offering

Source: Mobile Marketing Association (2009)

„[…] a wealth of information creates a poverty of attention"

(Herbert Simon, 1971)

# Idealised Two-sided (Mobile) Media Market

**Mobile Marketing Provider**

**Mobile Users**

**Advertisers**

satisfies information and entertainment needs

generate reach for the medium

pay for opportunity to advertise

generates target group oriented reach to users

purchase offered products and generate revenues

offer products and services

*Based on Zerdick, Picot, Schrape, and Artopé (2001)*
*Die Internet Ökonomie - Strategien für die digitale Wirtschaft.*

High Interactivity

Location-based Recipient Addressability

Time Independent Customer Addressability

Extensive Personalization Capabilities

**Minimised Circulation Waste**

**Maximised Reach**

Mass Media Capabilities

Time-based Recipient Addressability

Location Independent Recipient Addressability

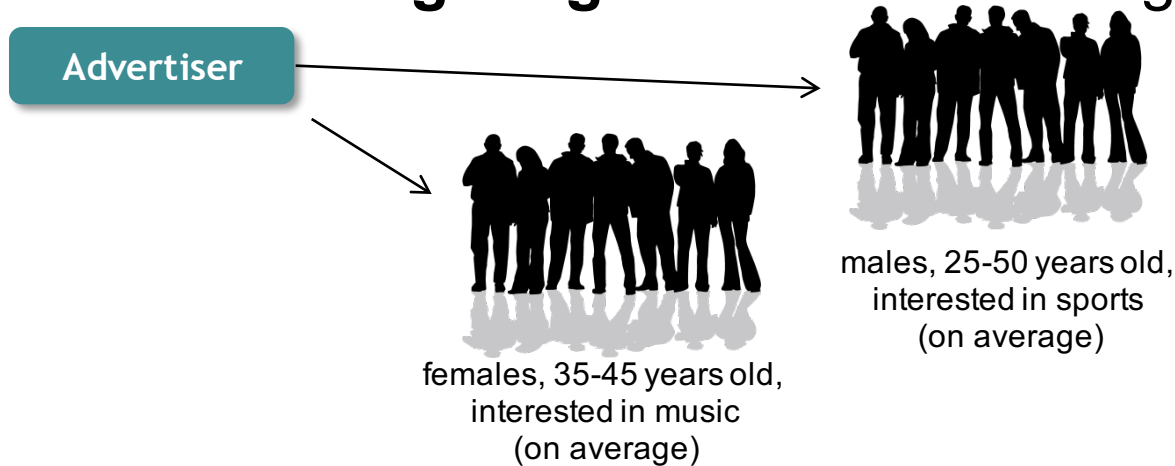# Context Information to alleviate Information Overflow

- Mobile Network allows determination of
  - subscriber's **identity** (i.e. MSISDN)
  - subscriber's **physical location**
  - **time of usage**

- This *context information* can be **compiled into a situation description** of a mobile subscriber
  - Example: Mobile User is 24 years old, student, currently in Munich, at lunchtime ...

- Benefits of Context-sensitive Mobile Marketing Campaigns
  - **Mobile Users: Personalisation of advertisements** according to immediate needs in current usage situation
  - **Advertisers: Individual selection of relevant mobile users** with highly likelihood consumption need
  - **Mobile Marketing Provider:** Generation of **additional revenues** and **differentiation from competition**

# **Traditional Targeting** of Mobile Marketing Campaigns

Advertiser

males, 25-50 years old,
interested in sports
(on average)

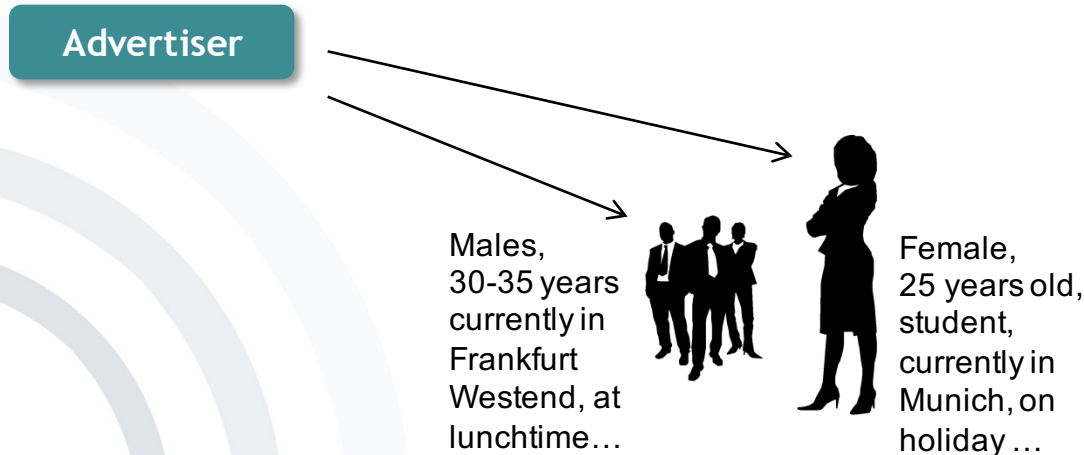females, 35-45 years old,
interested in music
(on average)

**Traditional** Information
• Implicit Information about preferences of mobile users
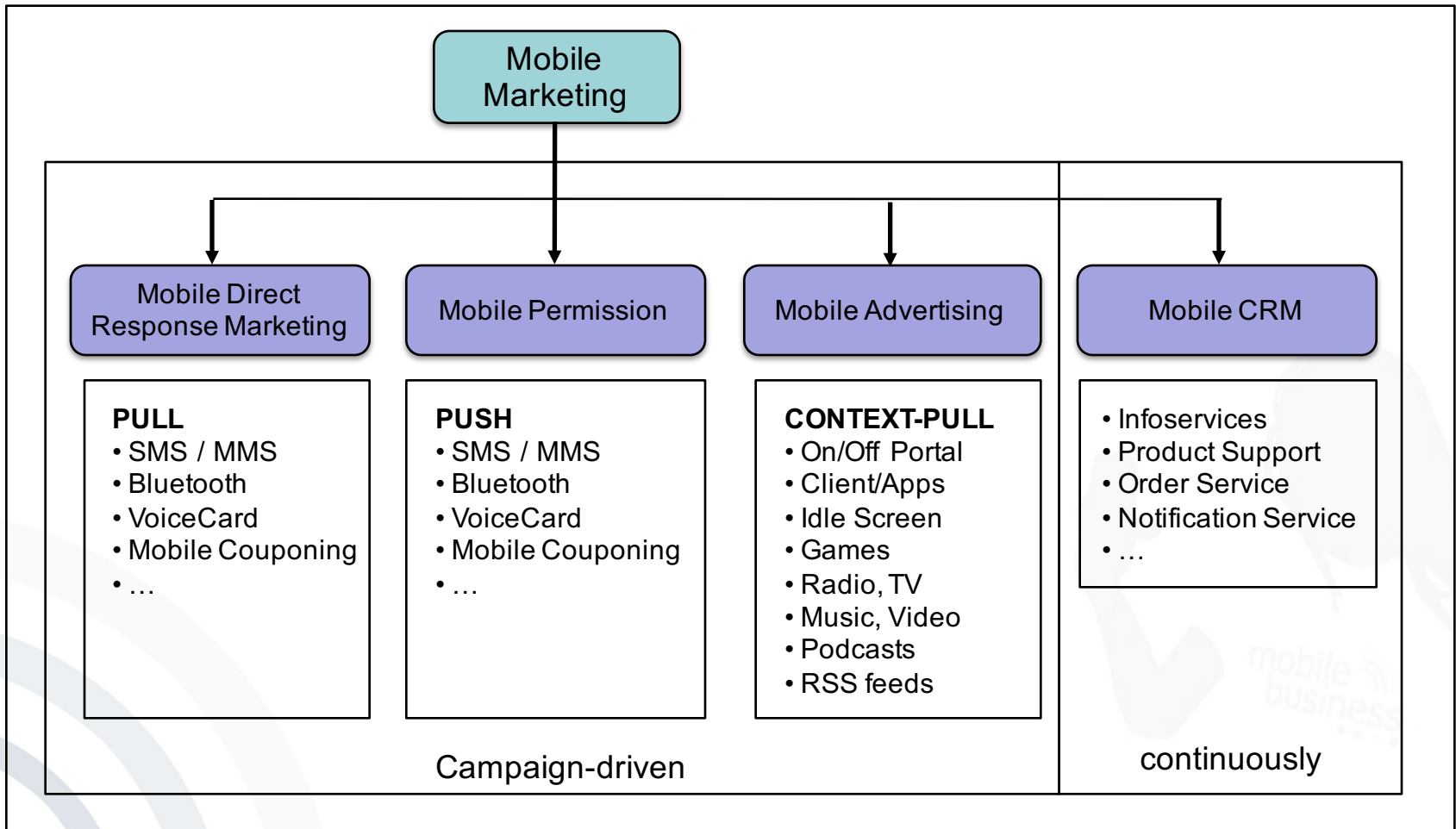• Typically acquired without mobile user's knowledge

≠

# **Context-sensitive Targeting** of Mobile Marketing Campaigns

Advertiser

Males,
30-35 years
currently in
Frankfurt
Westend, at
lunchtime…

Female,
25 years old,
student,
currently in
Munich, on
holiday …

**Context** Information
• Explicit Information about the usage situation of mobile users
• To be actively disclosed by mobile users

**Mobile Marketing**

### Mobile Direct Response Marketing

**PULL**
• SMS / MMS
• Bluetooth
• VoiceCard
• Mobile Couponing
• …

### Mobile Permission

**PUSH**
• SMS / MMS
• Bluetooth
• VoiceCard
• Mobile Couponing
• …

### Mobile Advertising

**CONTEXT-PULL**
• On/Off Portal
• Client/Apps
• Idle Screen
• Games
• Radio, TV
• Music, Video
• Podcasts
• RSS feeds

### Mobile CRM

• Infoservices
• Product Support
• Order Service
• Notification Service
• …

Campaign-driven

continuously

# Mobile CRM (mCRM) services aim at

- nurturing customer relationships
- acquiring or maintaining customers
- support marketing, sales or service processes
- use wireless networks as the medium of delivery to the customer.                              (Camponovo et al., 2005)

- Sales representatives, e.g. insurance agents, bank employees and other field staff, can access customer data during on-site consultations.

- ## Definition of Mobile Community:

*A mobile community is a group of people generally united by shared interests or goals who interact:*

- *considering their context (e.g. time, space, social),*
- *by means of location-independent information technology,*
- *and also including mobile access to existing community infrastructures.*

# Mobile Community Example



What to do
## Share what's going on

Check in to places.
Share updates and photos with friends
on Facebook or Twitter.

- Importance of context information, e.g. **location** information

- Participating users leave private information **traces**.

- Providers of community services need to
  - handle **trust and privacy**
  - meet the participants' needs
  - comply with regulation.

- Infrastructure needs to be opened for **marketing activities.**

- What is mobility?

- Mobile Infrastructure & Ecosystem

- Mobile Information Systems

- Conclusion on Challenges and Benefits of Mobile IS

- **Benefits of Mobile IS on Business & Society**
  - Mobile devices increasingly become the digital identity of a user

- **Challenges**
  - How to further improve the utilisation of unique mobile communication characteristics for mobile applications and services?
  - How to maintain privacy and security?
  - Coping with device & platform fragmentation
  - Coping with limited mobile network bandwidth

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