CSE 4215/5431:
Mobile Communications

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Course page: http://www.cse.yorku.ca/course/4215

My research

- Bioinformatics
- Computer Networks
  - Problems in wired networks
  - Wireless Sensor networks
    - MAC protocols
    - Localization
    - Topology management
  - Battery modeling

Administrivia

Lectures: Tue-Thu 5:30 - 7:00 pm
CB 122

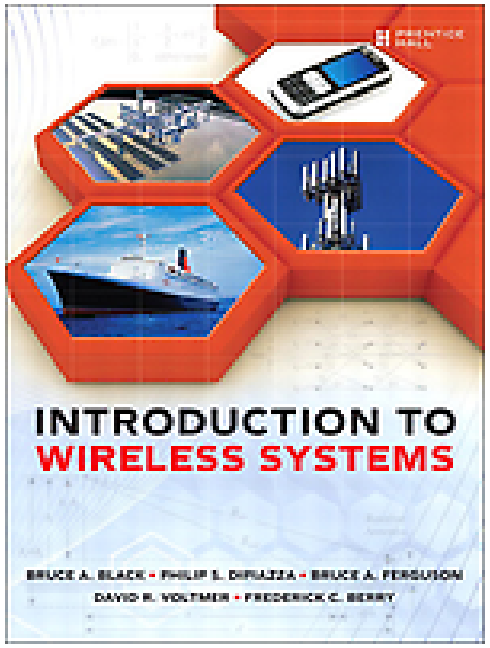
Office hours: Mon 4-6 pm, Tue 3-4 pm, or by appointment.

TA: TBA.

http://www.cse.yorku.ca/course/4215

Webpage: All announcements, handouts will be published on the webpage -- check often for updates)

Textbook:



Introduction to Wireless Systems Bruce A. Black, Philip S. DiPiazza, Bruce A. Ferguson, David R. Voltmer, Frederick C. Berry, Prentice Hall; First edition (2008), ISBN: 0132782243

Administrivia – contd.

Described in more detail on webpage

Grading (4215 only):

Midterm : 20%

Final: 45%

Homework : 25%

Term paper: 10%

Grades: will be on *ePost*.

Term paper details are on the webpage.

Course objectives

- Learn about theoretical and practical aspects of Mobile Communications
- Study similarities and differences with wired networks
- Study solutions to problems specific to Mobile Networks

What I expect from you

- Familiarity with the TCP/IP architecture and mobile communications
- Active interest in your project and assignments
- Willingness to learn about course topics, inside and outside the class

Several of the following slides are adapted from slides by the author of the Schiller text.

Mobile communication

- Two aspects of mobility:
  - user mobility: users communicate (wireless) “anytime, anywhere, with anyone”
  - device portability: devices can be connected anytime, anywhere to the network
- Wireless vs. mobile Examples

✘	✘	stationary computer
✘	✓	notebook in a hotel
✓	✘	wireless LANs in historic buildings
✓	✓	Personal Digital Assistant (PDA)

Mobile communication - 2

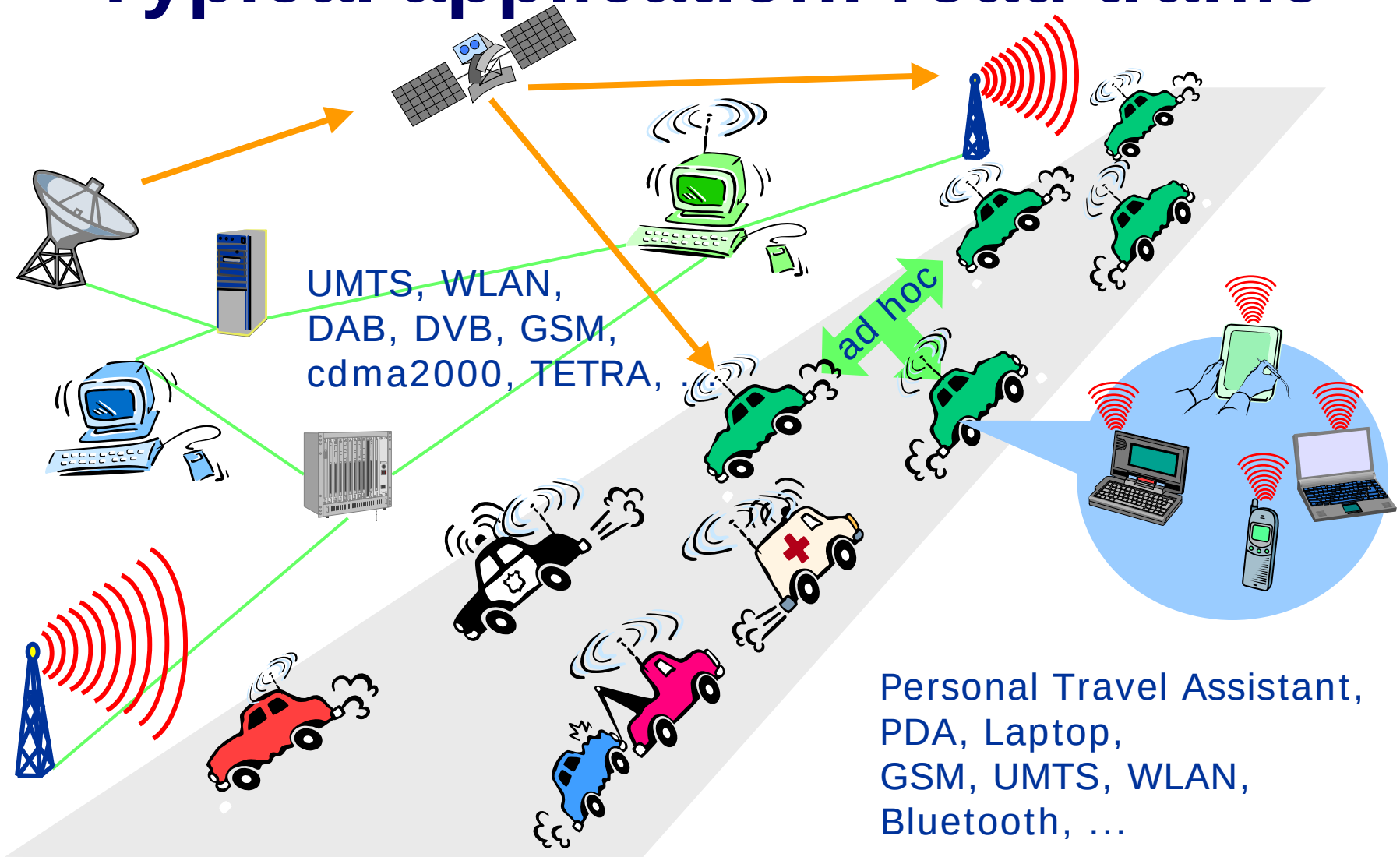
The demand for mobile communication creates the need for integration of wireless networks into existing fixed networks:

- local area networks: standardization of IEEE 802.11
- Internet: Mobile IP extension of the internet protocol IP
- wide area networks: e.g., internetworking of GSM and ISDN, VoIP over WLAN and POTS

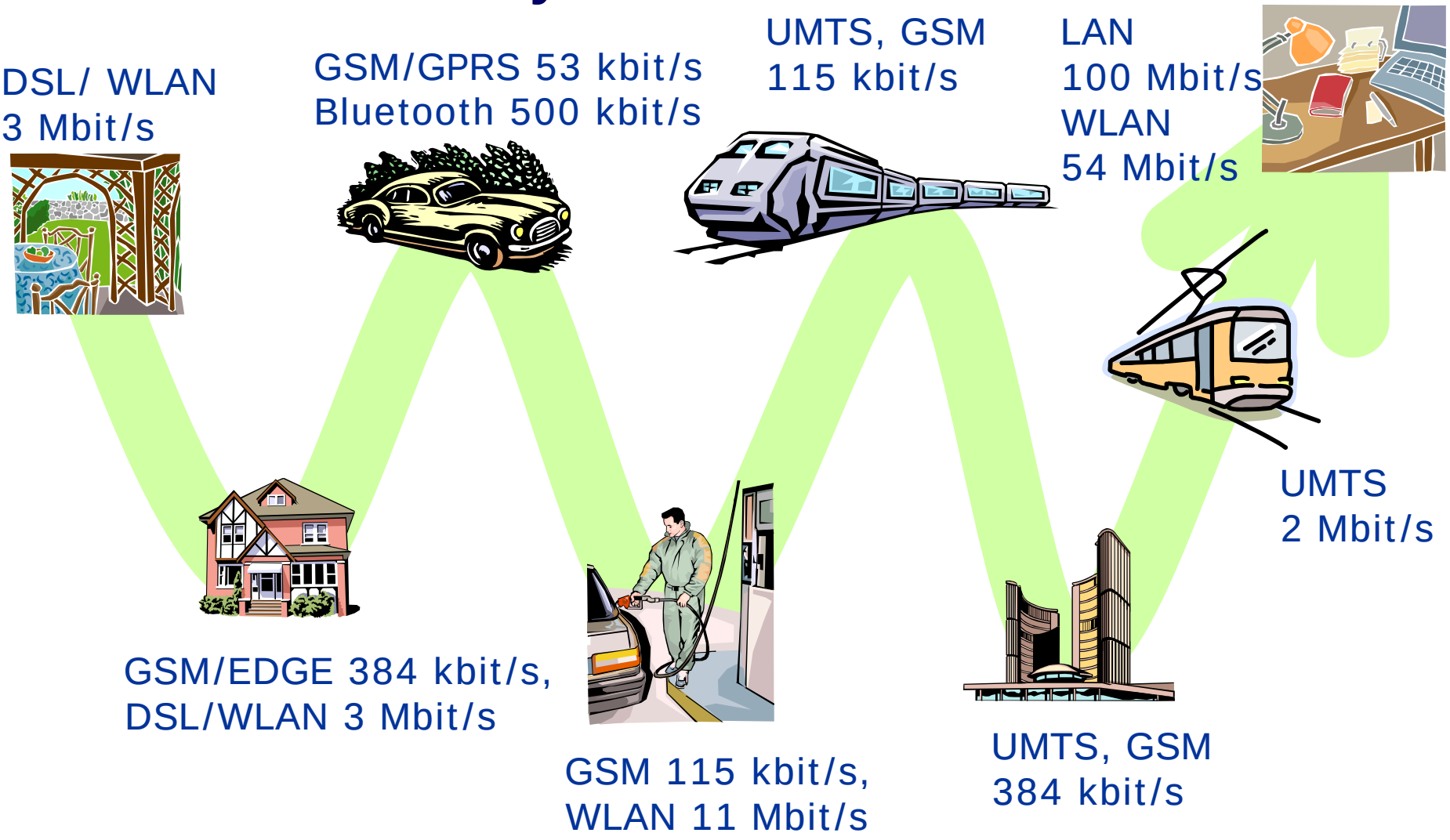
Applications I

- Vehicles
  - transmission of news, road condition, weather, music via DAB/DVB-T
  - personal communication using GSM/UMTS
  - position via GPS
  - local ad-hoc network with vehicles close-by to prevent accidents, guidance system, redundancy
  - vehicle data (e.g., from buses, high-speed trains) can be transmitted in advance for maintenance
- Emergencies
  - early transmission of patient data to the hospital, current status, first diagnosis
  - replacement of a fixed infrastructure in case of earthquakes, hurricanes, fire etc.
  - crisis, war, ...

Typical application: road traffic



Mobile and wireless services –
Always Best Connected



Applications II

- Traveling salesmen
  - direct access to customer files stored in a central location
  - consistent databases for all agents
  - mobile office
- Replacement of fixed networks
  - remote sensors, e.g., weather, earth activities
  - flexibility for trade shows
  - LANs in historic buildings

- Entertainment, education, ...
  - outdoor Internet access
  - intelligent travel guide with up-to-date location dependent information
  - ad-hoc networks for multi user games

Location dependent services

- Location aware services
  - what services, e.g., printer, fax, phone, server etc. exist in the local environment
- Follow-on services
  - automatic call-forwarding, transmission of the actual workspace to the current location
- Information services
  - “push”: e.g., current special offers in the supermarket
  - “pull”: e.g., where is the Black Forest Cheese Cake?
- Support services
  - caches, intermediate results, state information etc. “follow” the mobile device through the fixed network
- Privacy
  - who should gain knowledge about the location

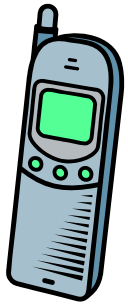
Mobile devices

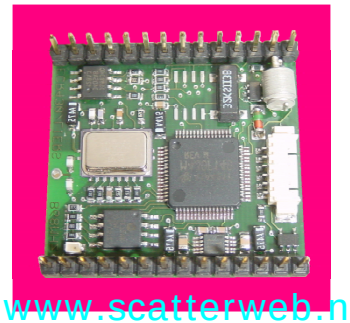
Pager
- receive only
- tiny displays
- simple text messages

Tablets
- graphical displays
- character recognition
- simplified WWW

Laptop/Notebook
- fully functional
- standard applications

Sensors, embedded controllers





www.scatterweb.net

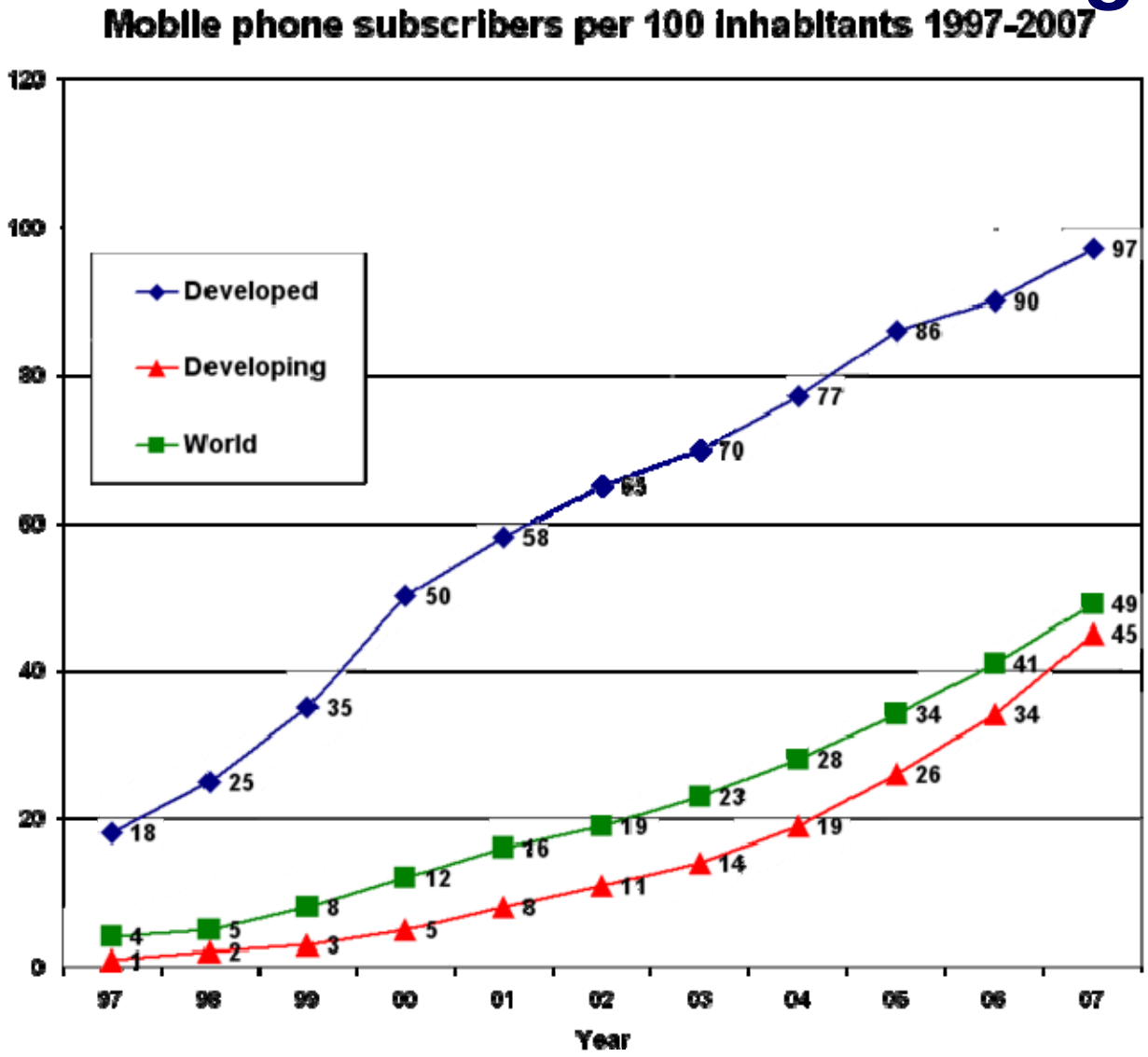
Mobile phones
- voice, data
- simple graphical displays

Smartphone
- tiny keyboard
- simple versions of standard applications

performance

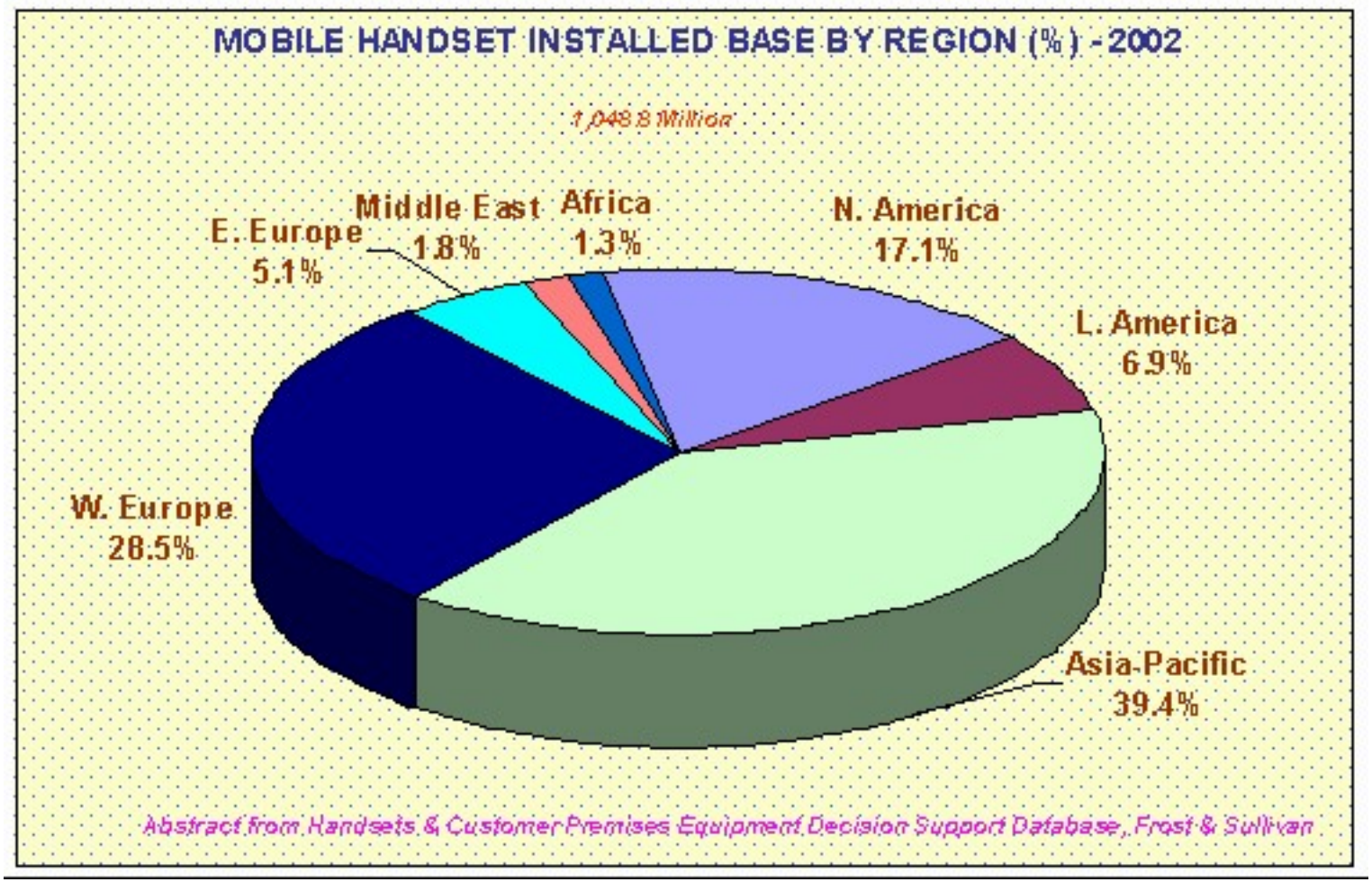
No clear separation between device types possible
(e.g. smart phones, embedded PCs, ...)

Worldwide cellular subscriber growth



http://en.wikipedia.org/wiki/Mobile_phone

Cellular subscribers by region



From http://www.frost.com/prod/servlet/cpo/28323426

Mobile communications

Bottomline: Mobile communications cannot be ignored!

Basic questions

- How is it similar to static networks?
- How is it different from static networks?

Similarities

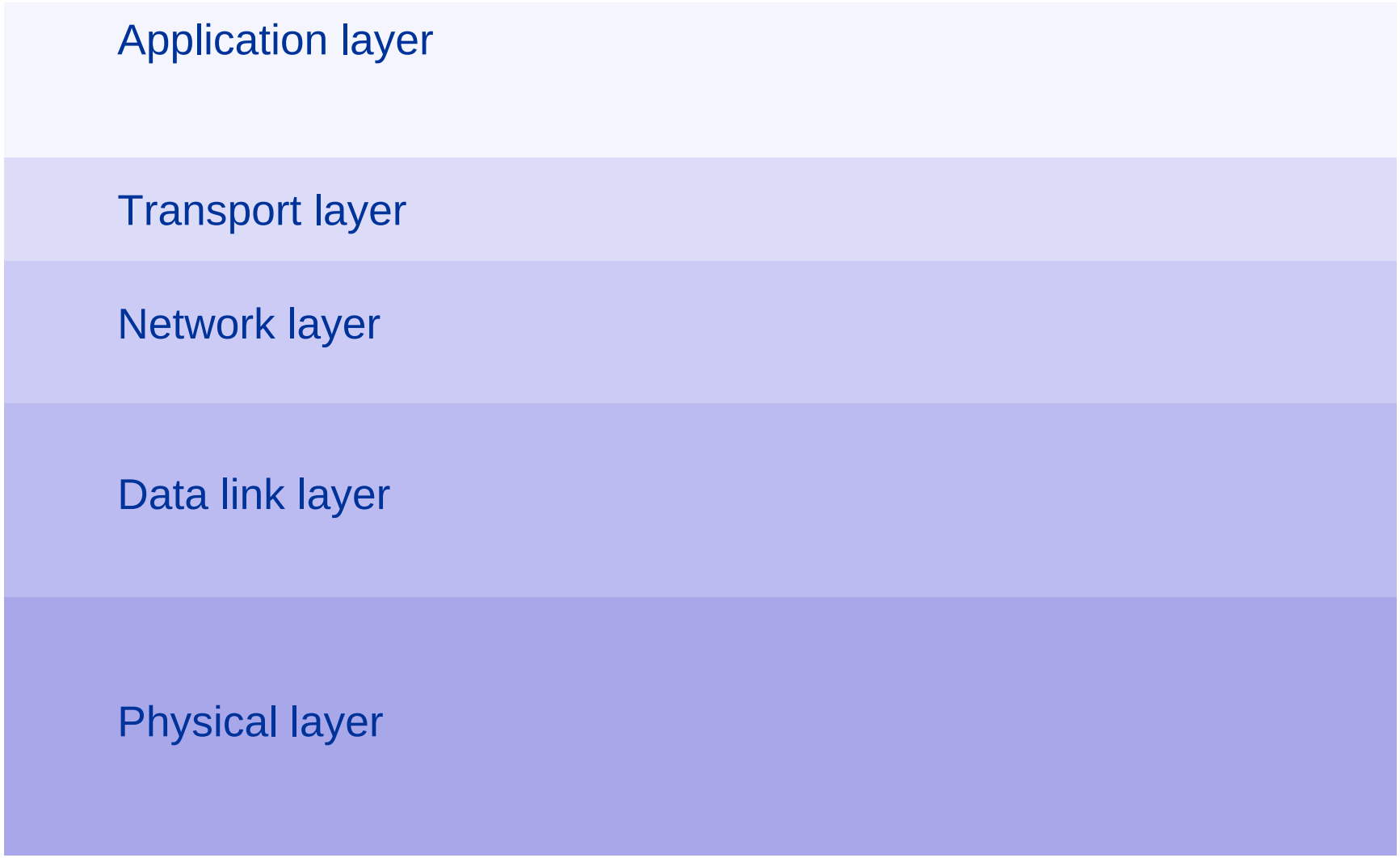
- Same basic architecture
- Layer functionality must be similar to and compatible with those for static networks
- Interoperability (with TCP/IP)

Differences

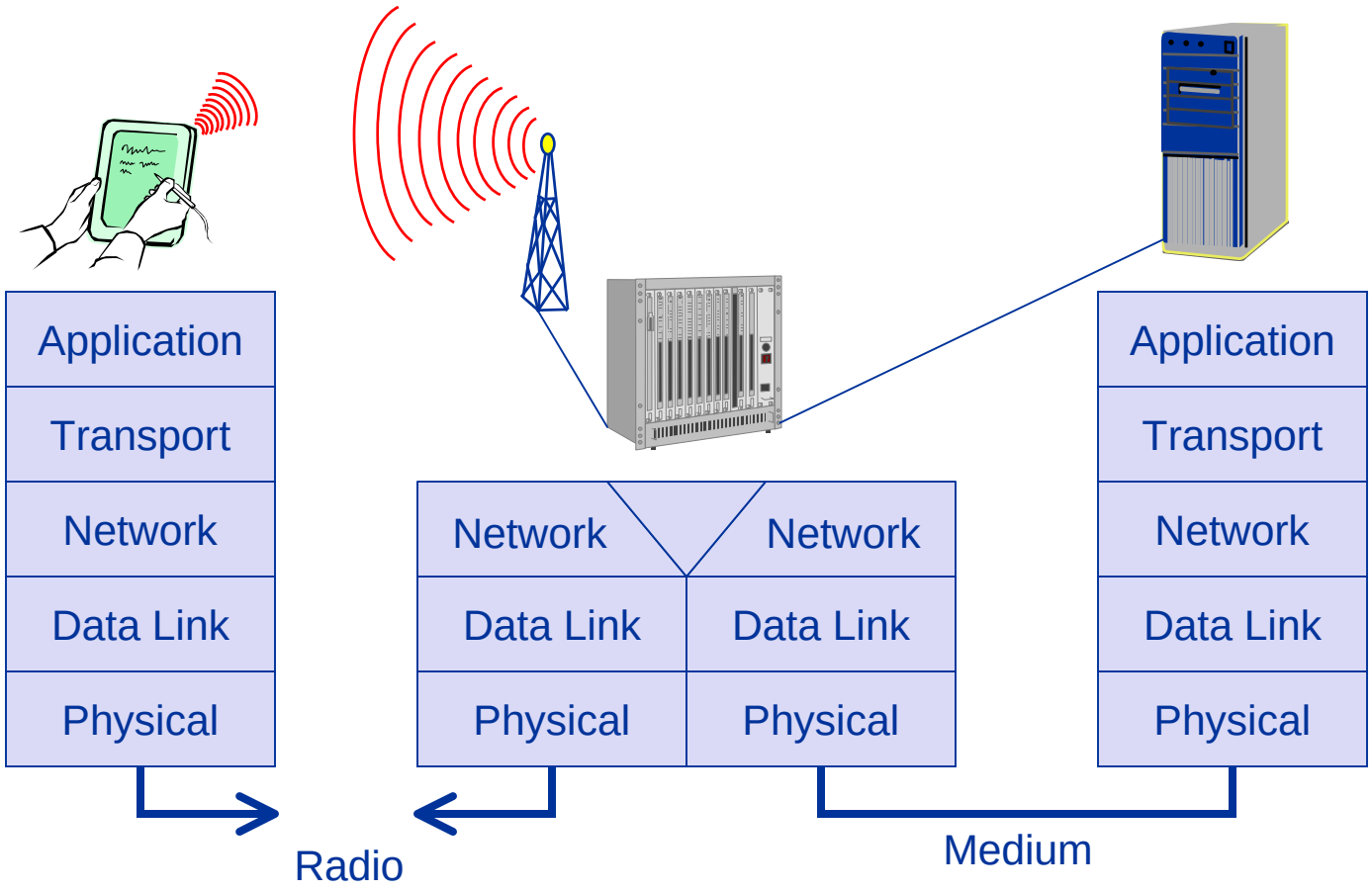
Mobility introduces difficulties

- Power limitations
- Bandwidth/noise issues
- Topology management
- Routing
- Localization
- Medium access control
- Deployment scheme
- Security
- Computational limitations

Quick recap of TCP/IP

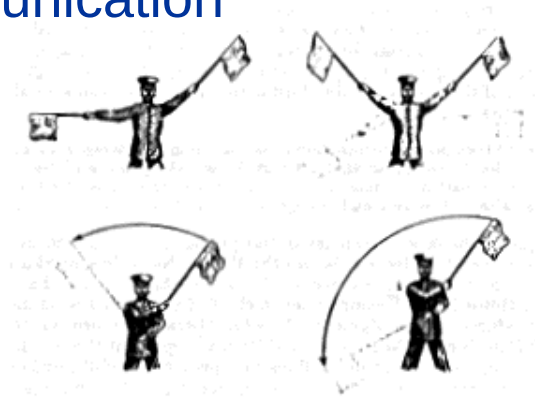


Simple reference model used here



Early history of wireless communication

- Many people in history used light for communication
  - heliographs, flags (“semaphore”), ...
  - 150 BC smoke signals for communication; (Polybius, Greece)
  - 1794, optical telegraph, Claude Chappe



- Here electromagnetic waves are of special importance:
  - 1831 Faraday demonstrates electromagnetic induction
  - J. Maxwell (1831-79): theory of electromagnetic Fields, wave equations (1864)
  - H. Hertz (1857-94): demonstrates with an experiment the wave character of electrical transmission through space (1888, in Karlsruhe, Germany)

History of wireless communication I

- 1896 Guglielmo Marconi
  - first demonstration of wireless telegraphy (digital!)
  - long wave transmission, high transmission power necessary (> 200kW)

- 1907 Commercial transatlantic connections
  - huge base stations (30 100m high antennas)
- 1915 Wireless voice transmission New York - San Francisco
- 1920 Discovery of short waves by Marconi
  - reflection at the ionosphere
  - smaller sender and receiver, possible due to the invention of the vacuum tube (1906, Lee DeForest and Robert von Lieben)
- 1926 Train-phone on the line Hamburg - Berlin
- wires parallel to the railroad track

History of wireless communication II

- 1928 many TV broadcast trials (across Atlantic, color TV, news)
- 1933 Frequency modulation (E. H. Armstrong)
- 1958 A-Netz in Germany
  - analog, 160MHz, connection setup only from the mobile station, no handover, 80% coverage, 1971 11000 customers
- 1972 B-Netz in Germany
  - analog, 160MHz, connection setup from the fixed network too (but location of the mobile station has to be known)
  - available also in A, NL and LUX, 1979 13000 customers in D
- 1979 NMT at 450MHz (Scandinavian countries)
- 1982 Start of GSM-specification
  - goal: pan-European digital mobile phone system with roaming
- 1983 Start of the American AMPS (Advanced Mobile Phone System, analog)
- 1984 CT-1 standard (Europe) for cordless telephones

History of wireless communication III

- 1986 C-Netz in Germany
  - analog voice transmission, 450MHz, hand-over possible, digital signaling, automatic location of mobile device
  - was in use until 2000, services: FAX, modem, X.25, e-mail, 98% coverage
- 1991 Specification of DECT
  - Digital European Cordless Telephone (today: Digital Enhanced Cordless Telecommunications)
  - 1880-1900MHz, ~100-500m range, 120 duplex channels, 1.2Mbit/s data transmission, voice encryption, authentication, up to several 10000 user/km^2, used in more than 50 countries
- 1992 Start of GSM
  - in D as D1 and D2, fully digital, 900MHz, 124 channels
  - automatic location, hand-over, cellular
  - roaming in Europe - now worldwide in more than 200 countries
  - services: data with 9.6kbit/s, FAX, voice, ...

History of wireless communication IV

- 1994 E-Netz in Germany
  - GSM with 1800MHz, smaller cells
  - as Eplus in D (1997 98% coverage of the population)
- 1996 HiperLAN (High Performance Radio Local Area Network)
  - ETSI, standardization of type 1: 5.15 - 5.30GHz, 23.5Mbit/s
  - recommendations for type 2 and 3 (both 5GHz) and 4 (17GHz) as wireless ATM-networks (up to 155Mbit/s)
- 1997 Wireless LAN - IEEE802.11
  - IEEE standard, 2.4 - 2.5GHz and infrared, 2Mbit/s
  - already many (proprietary) products available in the beginning
- 1998 Specification of GSM successors
  - for UMTS (Universal Mobile Telecommunications System) as European proposals for IMT-2000
  - Iridium
    - 66 satellites (+6 spare), 1.6GHz to the mobile phone

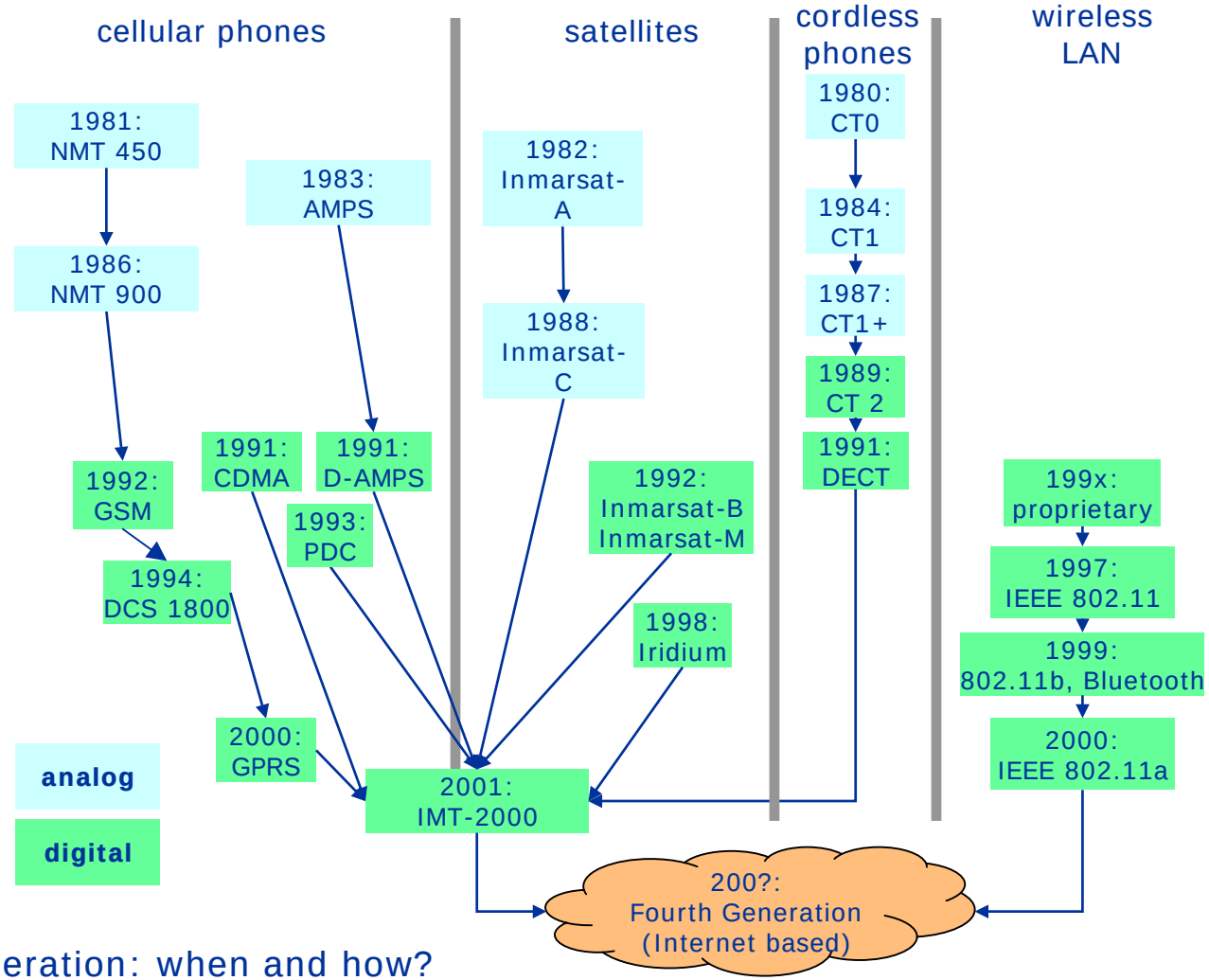
History of wireless communication V

- 1999 Standardization of additional wireless LANs
  - IEEE standard 802.11b, 2.4-2.5GHz, 11Mbit/s
  - Bluetooth for piconets, 2.4GHz, <1Mbit/s
  - decision about IMT-2000
    - several “members” of a “family”: UMTS, cdma2000, DECT, …
  - Start of WAP (Wireless Application Protocol) and i-mode
    - first step towards a unified Internet/mobile communication system
    - access to many services via the mobile phone
- 2000 GSM with higher data rates
  - HSCSD offers up to 57,6kbit/s
  - first GPRS trials with up to 50 kbit/s (packet oriented!)
  - UMTS auctions/beauty contests
    - Hype followed by disillusionment (50 B$ paid in Germany for 6 licenses!)
  - Iridium goes bankrupt
- 2001 Start of 3G systems
  - Cdma2000 in Korea, UMTS tests in Europe, Foma (almost UMTS) in Japan

History of wireless communication VI

- 2002
  - WLAN hot-spots start to spread
- 2003
  - UMTS starts in Germany
  - Start of DVB-T in Germany replacing analog TV
- 2005
  - WiMax starts as DSL alternative (not mobile)
  - first ZigBee products
- 2006
  - HSDPA starts in Germany as fast UMTS download version offering > 3 Mbit/s
  - WLAN draft for 250 Mbit/s (802.11n) using MIMO
  - WPA2 mandatory for Wi-Fi WLAN devices
- 2007
  - over 3.3 billion subscribers for mobile phones (NOT 3 bn people!)
- 2008
  - “real” Internet widely available on mobile phones (standard browsers, decent data rates)
  - 7.2 Mbit/s HSDPA, 1.4 Mbit/s HSUPA available in Germany, more than 100 operators support HSPA worldwide, first LTE tests (>100 Mbit/s)
- 2009 – the story continues with netbooks, iphones, VoIPoWLAN…

Wireless systems: overview of the development



4G – fourth generation: when and how?
... rather an incremental deployment!