Mobile Communications
Chapter 11 : Outlook

Mobile and wireless services – Always Best Connected

- **LAN, WLAN**
  - 100 Mbit/s

- **GSM, Bluetooth**
  - 53 kbit/s
  - 500 kbit/s

- **LTE, UMTS**
  - 2 Mbit/s

- **LAN**
  - 100 Mbit/s
  - WLAN 54 Mbit/s

- **UMTS**
  - 2 Mbit/s

- **GSM/EDGE**
  - 384 kbit/s
  - WLAN 5 Mbit/s

- **GSM**
  - 115 kbit/s
  - WLAN 11 Mbit/s

- **LTE**
  - 10 Mbit/s

- **WLAN**
  - 54 Mbit/s

- **LAN, WLAN**
  - 100 Mbit/s
Wireless systems: overview of the development

1981: NMT 450
1982: AMPS
1983: Inmarsat-A
1988: Inmarsat-C
1992: CDMA
1991: D-AMPS
1991: DCS 1800
1991: CT0
1990: CT1
1991: CT1+
1998: Iridium
1992: Inmarsat-B
1992: Inmarsat-M
1993: PDC
1991: DECT
1992: GSM
1993: GPRS
1990: CT 2
1991: proprietary
1992: PDC
1997: IEEE 802.11
1999: 802.11b, Bluetooth
2000: IEEE 802.11a
1998: GPRS
2001: IMT-2000
2000: IEEE 802.11a
2014: Fourth Generation (Internet based)

4...4.5...5G – fourth to fifth generation: when and how?
Currently rather 3.9 to 4G
Overlay Networks - the global goal

integration of heterogeneous fixed and mobile networks with varying transmission characteristics

vertical handover

metropolitan area

regional

campus-based

horizontal handover

in-car, in-house, personal area
Wireless access technologies

- DAB
- UMTS
- LTE
- EDGE
- GSM, TETRA
- DECT
- 802.11b
- Bluetooth
- 802.11a/g/n/ac

Relative speed [km/h]:
- 250
- 100
- 50
- 5
- 0

Bandwidth:
- 10 kbit/s
- 2 Mbit/s
- 20 Mbit/s
- >300 Mbit/s

Physical/economic border
Key features of future mobile and wireless networks

Improved radio technology and antennas
- smart antennas, beam forming, multiple-input multiple-output (MIMO) – see LTE, 802.11ac
  - space division multiplex to increase capacity, benefit from multipath
- software defined radios (SDR)
  - use of different air interfaces, download new modulation/coding/…
  - requires a lot of processing power (UMTS RF 10000 GIPS)
- dynamic spectrum allocation
  - spectrum on demand results in higher overall capacity

Core network convergence
- IP-based, quality of service, mobile IP

Ad-hoc technologies
- spontaneous communication, power saving, redundancy

Simple and open service platform
- intelligence at the edge, not in the network (as with IN)
- more service providers, not network operators only
Example IP-based 4G/Next G/… network
Software Defined Mobile network Controller

3GPP LTE standardization roadmap toward 5G

Potential problems

Quality of service
- Today's Internet is best-effort
- Integrated services did not work out
- Differentiated services have to prove scalability and manageability
- What about the simplicity of the Internet? DoS attacks on QoS?

Internet protocols are well known…
- …also to attackers, hackers, intruders
  - security by obscurity does not really work, however, closed systems provide some protection

Reliability, maintenance
- Open question if Internet technology is really cheaper as soon as high reliability (99.9999%) is required plus all features are integrated

Missing charging models
- Charging by technical parameters (volume, time) is not reasonable
- Pay-per-application may make much more sense

Killer application? There is no single killer application!
- Choice of services and (almost) seamless access to networks determine the success
Thanks, take care – and have fun with Mobile Communications!

Source: Ed Jones/AFP, Seoul, Südkorea, 22.06.2016