
EEC 687/787 Mobile Computing

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Introduction



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Computers for the next decades?

Computers are integrated

- small, cheap, portable, replaceable - no more separate devices

Technology is in the background

- computer are aware of their environment and adapt ("location awareness")
- computer recognize the location of the user and react appropriately (e.g., call forwarding, fax forwarding, "context awareness")

Advances in technology

- more computing power in smaller devices
- flat, lightweight displays with low power consumption
- new user interfaces due to small dimensions
- more bandwidth per cubic meter
- multiple wireless interfaces: wireless LANs, wireless WANs, regional wireless telecommunication networks etc. („overlay networks“)



Areas of research in mobile communication

Wireless Communication

- transmission quality (bandwidth, error rate, delay)
- modulation, coding, interference
- media access, regulations
- ...

Mobility

- location dependent services
- location transparency
- quality of service support (delay, jitter, security)
- ...

Portability

- power consumption
- limited computing power, sizes of display, ...
- usability
- ...



Mobile devices

Pager

- receive only
- tiny displays
- simple text messages

PDA

- simpler graphical displays
- character recognition
- simplified WWW

Laptop

- fully functional
- standard applications

Sensors,
embedded
controllers



Mobile phones

- voice, data
- simple graphical displays

Palmtop

- tiny keyboard
- simple versions of standard applications



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Effects of device portability

Power consumption

- limited computing power, low quality displays, small disks due to limited battery capacity
- CPU: power consumption $\sim CV^2f$
 - C: internal capacity, reduced by integration
 - V: supply voltage, can be reduced to a certain limit
 - f: clock frequency, can be reduced temporally

Loss of data

- higher probability, has to be included in advance into the design (e.g., defects, theft)

Limited user interfaces

- compromise between size of fingers and portability
- integration of character/voice recognition, abstract symbols

Limited memory

- limited value of mass memories with moving parts
- flash-memory or ? as alternative

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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

x
x
✓
✓

x
✓
x
✓

Examples

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

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, ETSI (HIPERLAN)
- ❑ Internet: Mobile IP extension of the internet protocol IP
- ❑ wide area networks: e.g., internetworking of GSM and ISDN



Wireless networks in comparison to fixed networks

Higher loss-rates due to interference

- ❑ emissions of, e.g., engines, lightning

Restrictive regulations of frequencies

- ❑ frequencies have to be coordinated, useful frequencies are almost all occupied

Low transmission rates

- ❑ local some Mbit/s, regional currently, e.g., 9.6kbit/s with GSM

Higher delays, higher jitter

- ❑ connection setup time with GSM in the second range, several hundred milliseconds for other wireless systems

Lower security, simpler active attacking

- ❑ radio interface accessible for everyone, base station can be simulated, thus attracting calls from mobile phones

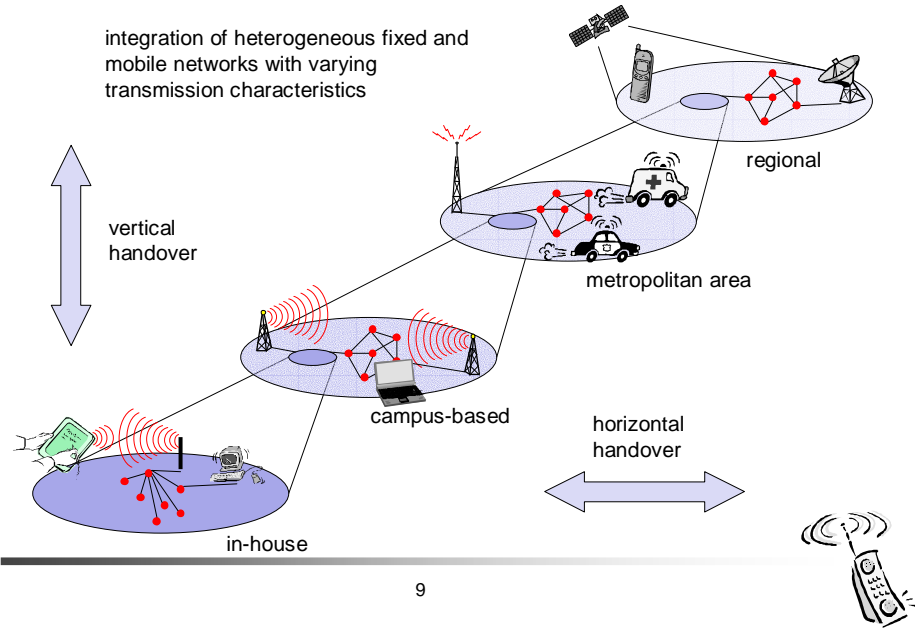
Always shared medium

- ❑ secure access mechanisms important

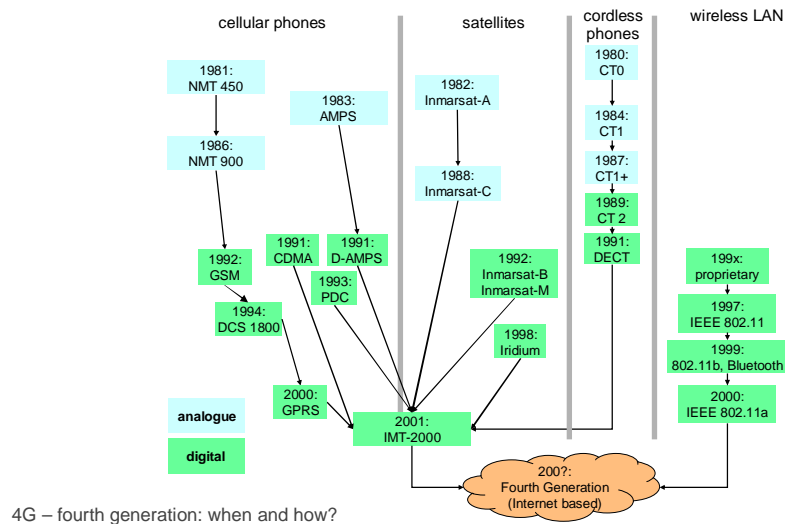


Overlay Networks - the global goal

integration of heterogeneous fixed and mobile networks with varying transmission characteristics



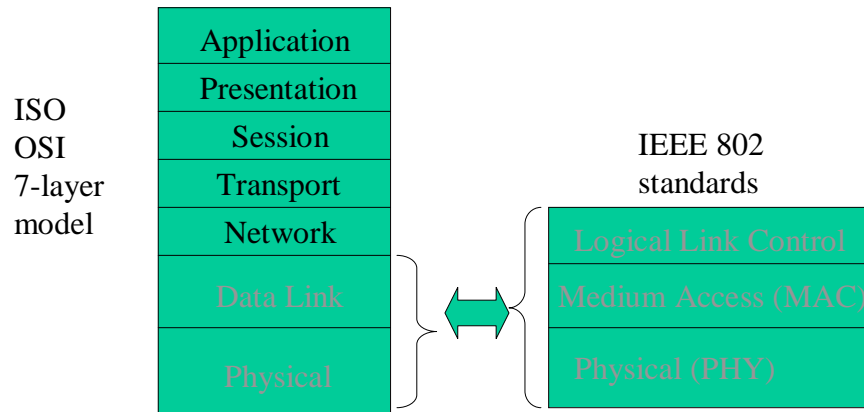
Wireless systems: overview of the development



Standardization of Wireless Networks

Wireless networks are standardized by IEEE.

Under 802 LAN MAN standards committee.



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IEEE 802.11 Protocols

- IEEE 802.11a
 - PHY Standard : 8 channels : 54 Mbps : Products are available.
- IEEE 802.11b
 - PHY Standard : 3 channels : 11 Mbps : Products are available.
- IEEE 802.11d
 - MAC Standard : operate in variable power levels : ongoing
- IEEE 802.11e
 - MAC Standard : QoS support : Second half of 2002.
- IEEE 802.11f
 - Inter-Access Point Protocol : 2nd half 2002
- IEEE 802.11g
 - PHY Standard: 3 channels : OFDM and PBCC : 2nd half 2002
- IEEE 802.11h
 - Supplementary MAC Standard: TPC and DFS : 2nd half 2002
- IEEE 802.11i
 - Supplementary MAC Standard: Alternative WEP : 2nd half 2002

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Applications I

Vehicles

- ❑ transmission of news, road condition, weather, music via DAB
- ❑ personal communication using GSM
- ❑ position via GPS
- ❑ local ad-hoc network with vehicles close-by to prevent accidents, guidance system, redundancy
- ❑ vehicle data (e.g., from busses, high-speed trains) can be transmitted in advance for maintenance

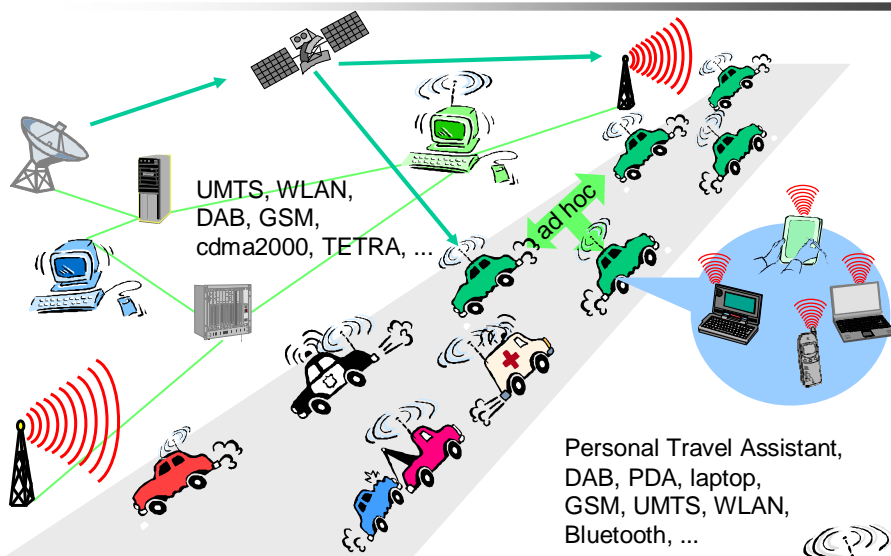
Emergencies

- ❑ 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, ...

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Typical application: road traffic



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Applications II

Travelling 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 Forrest Cherry Cake?

Support services

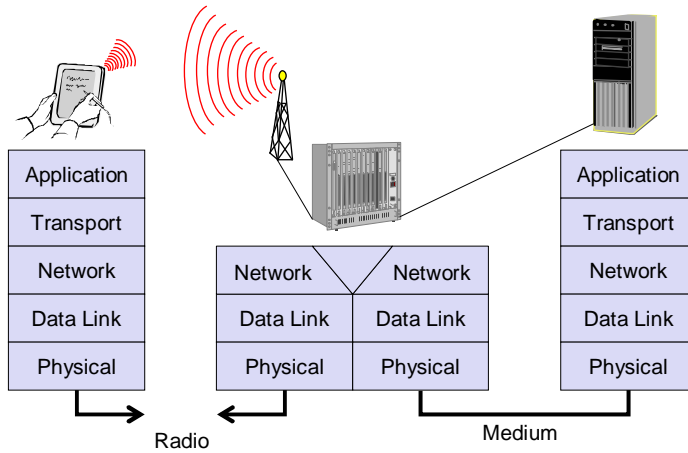
- ❑ caches, intermediate results, state information etc. „follow“ the mobile device through the fixed network

Privacy

- ❑ who should gain knowledge about the location



Simple reference model used here



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Influence of mobile communication to the layer model

| | |
|-------------------|---|
| Application layer | <ul style="list-style-type: none"> <input type="checkbox"/> service location <input type="checkbox"/> new applications, multimedia <input type="checkbox"/> adaptive applications |
| Transport layer | <ul style="list-style-type: none"> <input type="checkbox"/> congestion and flow control <input type="checkbox"/> quality of service |
| Network layer | <ul style="list-style-type: none"> <input type="checkbox"/> addressing, routing, device location <input type="checkbox"/> hand-over |
| Data link layer | <ul style="list-style-type: none"> <input type="checkbox"/> authentication <input type="checkbox"/> media access <input type="checkbox"/> multiplexing <input type="checkbox"/> media access control |
| Physical layer | <ul style="list-style-type: none"> <input type="checkbox"/> encryption <input type="checkbox"/> modulation <input type="checkbox"/> interference <input type="checkbox"/> attenuation <input type="checkbox"/> frequency |

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Overview of the main topics (textbook)

- Introduction
 - Use-cases, applications
 - Definition of terms
 - Challenges, history
- Wireless Transmission
 - frequencies & regulations
 - signals, antennas, signal propagation
 - multiplexing, modulation, spread spectrum, cellular system
- Media Access
 - motivation, SDMA, FDMA, TDMA (fixed, Aloha, CSMA, DAMA, PRMA, MACA, collision avoidance, polling), CDMA
- Wireless Telecommunication Systems
 - GSM, HSCSD, GPRS, DECT, TETRA, UMTS, IMT-2000
- Satellite Systems
 - GEO, LEO, MEO, routing, handover
- Broadcast Systems
 - DAB, DVB
- Wireless LANs
 - Basic Technology
 - IEEE 802.11a/b/g, .15, Bluetooth
- Network Protocols
 - Mobile IP
 - Ad-hoc networking
 - Routing
- Transport Protocols
 - Reliable transmission
 - Flow control
 - Quality of Service
- Support for Mobility
 - File systems, WWW, WAP, i-mode, J2ME, ...



Overview of the main chapters

