Mobile Computing
Lecture 16
Wireless LAN

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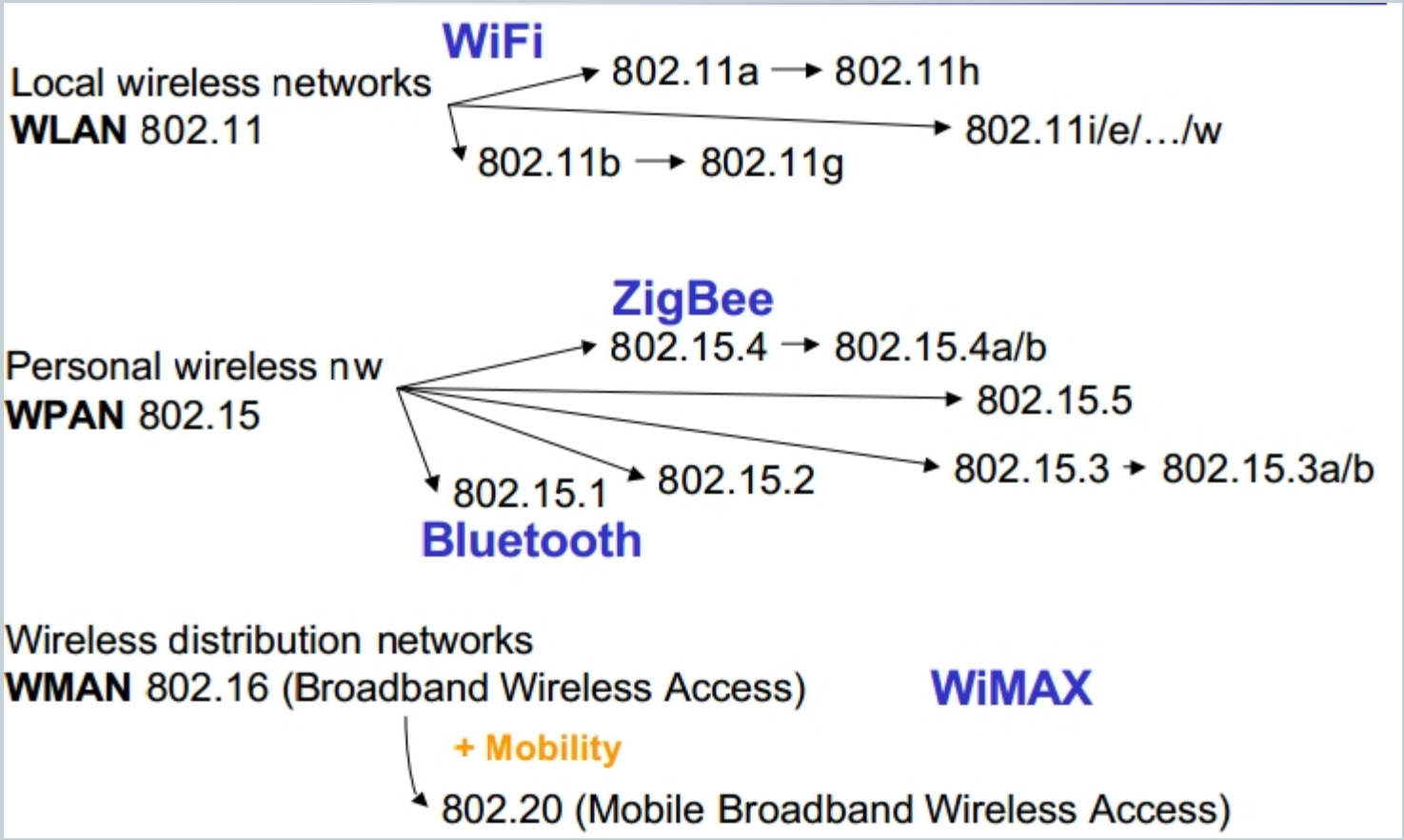
Mobile Communication Technology according to IEEE



Characteristics of wireless LANs

Advantages

- very flexible within reception area
- Ad-hoc networks do not need planning
- (almost) no wiring difficulties (e.g. historic buildings, firewalls)
- more robust against disasters like, e.g., earthquakes, fire

Disadvantages

- low bandwidth compared to wired networks (1-10 Mbit/s)
- many proprietary solutions, especially for higher bit-rates, standards take their time (e.g. IEEE 802.11)
- many national restrictions for wireless, long time to establish global solutions like, e.g., IMT-2000

Design goals for wireless LANs

- global, seamless operation
- low power for battery use
- no special permissions or licenses needed to use the LAN
- robust transmission technology
- simplified spontaneous cooperation at meetings
- easy to use for everyone, simple management
- protection of investment in wired networks
- security (no one should be able to read my data), privacy (no one should be able to collect user profiles), safety (low radiation)
- transparency concerning applications and higher layer protocols, but also location awareness if necessary

Comparison: infrared vs. radio transmission

Infrared

- uses IR diodes, diffuse light, multiple reflections (walls, furniture etc.)

Advantages

- simple, cheap, available in many mobile devices
- no licenses needed
- simple shielding possible

Disadvantages

- interference by sunlight, heat sources etc.
- many things shield or absorb IR light
- low bandwidth

Example

- IrDA (Infrared Data Association) interface available everywhere

Radio

- typically using the license free ISM band at 2.4 GHz

Advantages

- experience from wireless WAN and mobile phones can be used
- coverage of larger areas possible (radio can penetrate walls, furniture etc.)

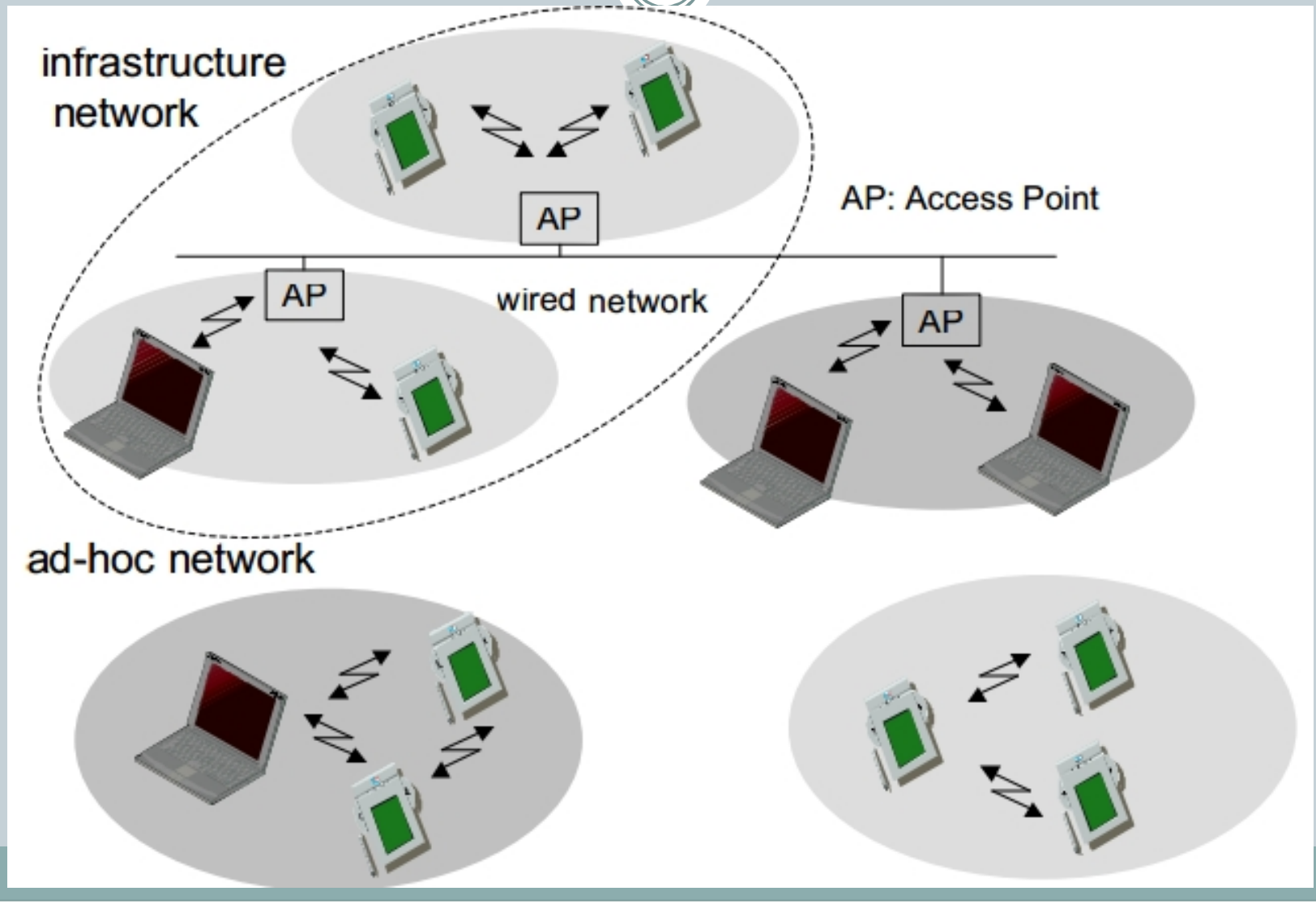
Disadvantages

- limited license free frequency bands
- shielding more difficult, electrical interference

Example

- Many different products

Comparison: infrastructure vs. ad-hoc networks



802.11 - Architecture of an infrastructure network

Station (STA)

- terminal with access mechanisms to the wireless medium and radio contact to the access point

Basic Service Set (BSS)

- group of stations using the same radio frequency

Access Point

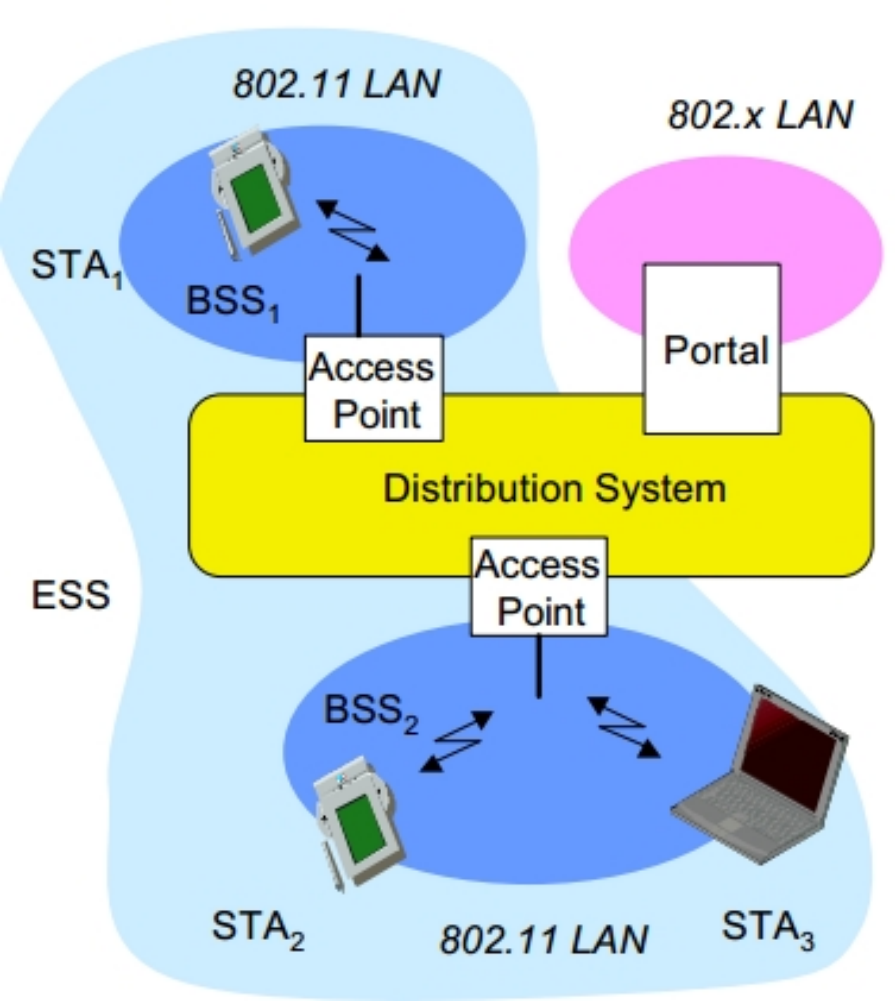
- station integrated into the wireless LAN and the distribution system

Portal

- bridge to other (wired) networks

Distribution System

- interconnection network to form one logical network (EES: Extended Service Set) based on several BSS



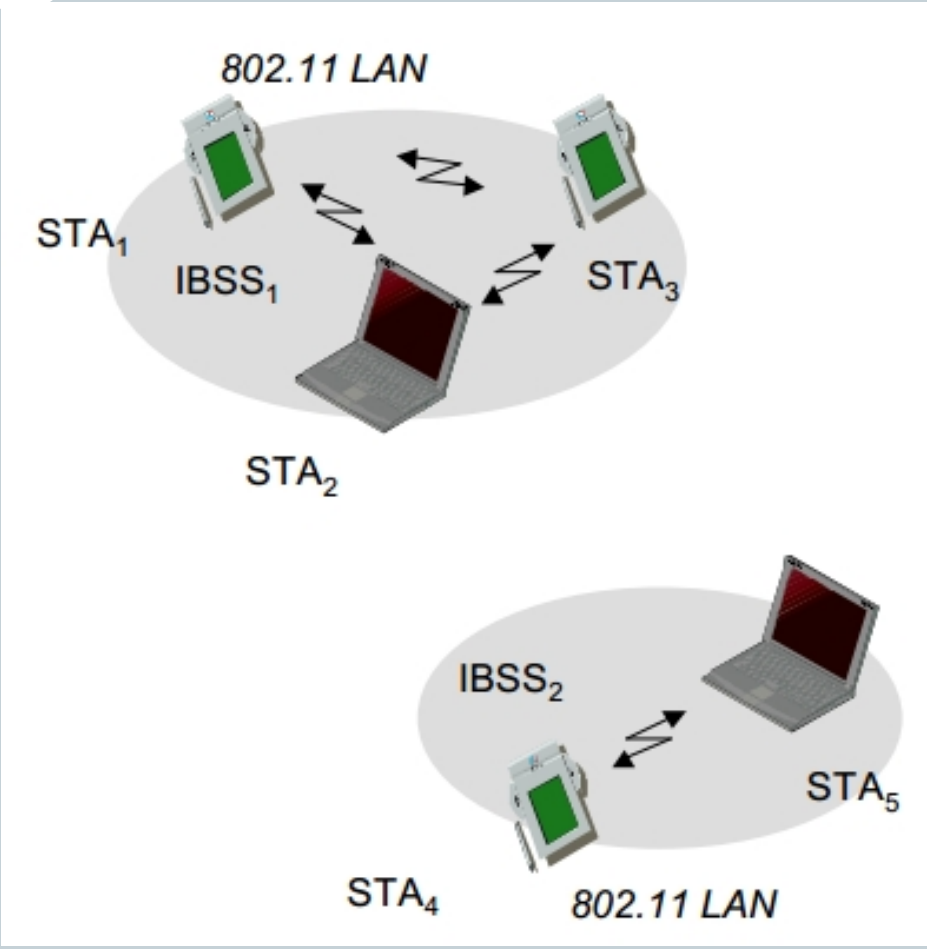
802.11 - Architecture of an ad-hoc network

- Direct communication within a limited range
- Station (STA):

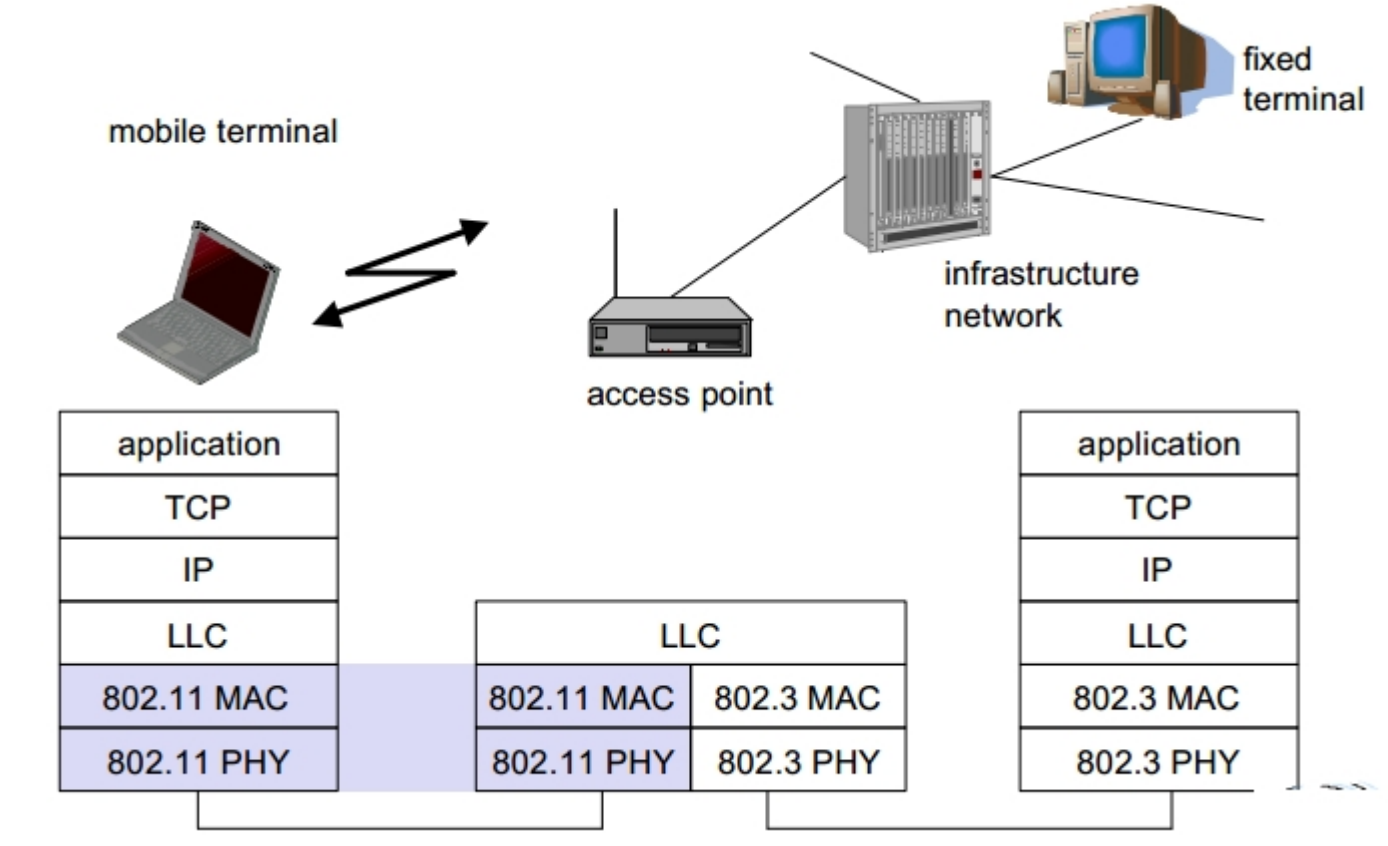
  terminal with access mechanisms to the wireless medium
- Independent Basic Service Set

  (IBSS):

  group of stations using the same radio frequency



IEEE standard 802.11



802.11 - Layers and functions

MAC
- access mechanisms, fragmentation, encryption

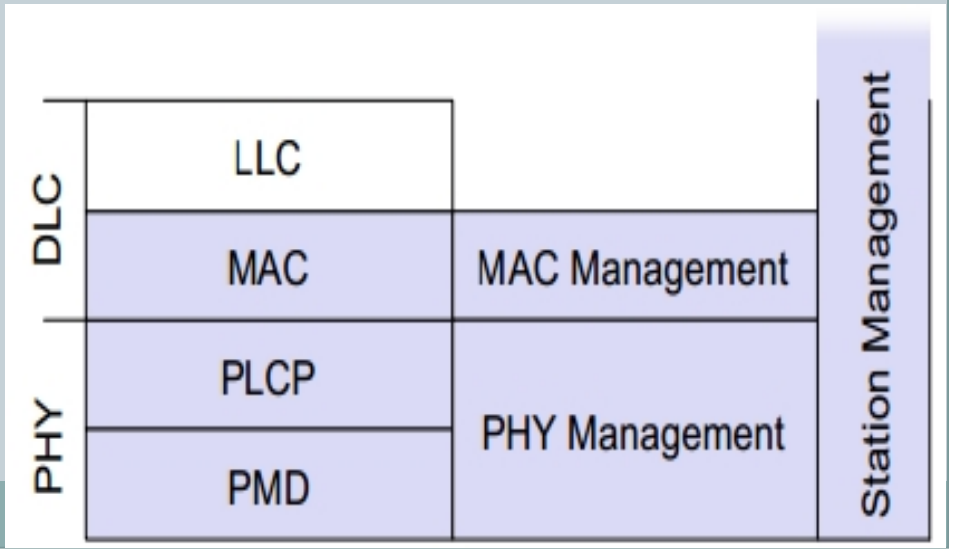
MAC Management
- synchronization, roaming, MIB, power management

PLCP Physical Layer Convergence Protocol
- clear channel assessment signal (carrier sense)

Station Management
- coordination of all management functions

PMD Physical Medium Dependent
- modulation, coding

PHY Management
- channel selection, MIB



802.11 - Physical layer (classical)

3 versions: 2 radio (typ. 2.4 GHz), 1 IR

- data rates 1 or 2 Mbit/s

FHSS (Frequency Hopping Spread Spectrum)

- spreading, despreading, signal strength, typ. 1 Mbit/s
- min. 2.5 frequency hops/s (USA), two-level GFSK modulation

DSSS (Direct Sequence Spread Spectrum)

- DBPSK modulation for 1 Mbit/s (Differential Binary Phase Shift Keying), DQPSK for 2 Mbit/s (Differential Quadrature PSK)
- preamble and header of a frame is always transmitted with 1 Mbit/s, rest of transmission 1 or 2 Mbit/s
- chipping sequence: +1, -1, +1, +1, -1, +1, +1, +1, -1, -1, -1 (Barker code)
- max. radiated power 1 W (USA), 100 mW (EU), min. 1mW

Infrared

- 850-950 nm, diffuse light, typ. 10 m range
- carrier detection, energy detection, synchronization

802.11 - MAC layer I - DFWMAC

Traffic services

- Asynchronous Data Service (mandatory)
  - exchange of data packets based on “best-effort”
  - support of broadcast and multicast
- Time-Bounded Service (optional)
  - implemented using PCF (Point Coordination Function)

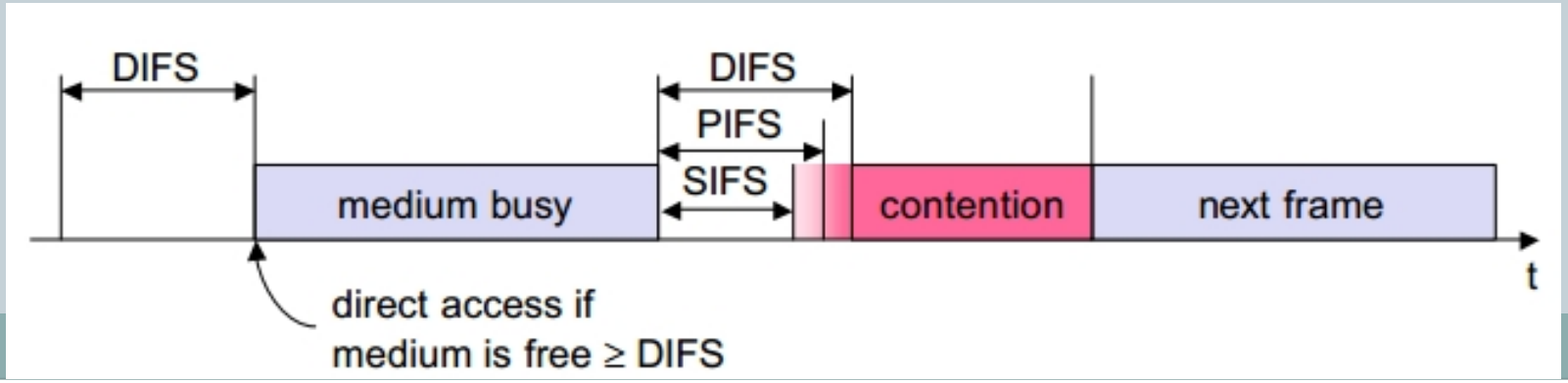
Access methods

- DFWMAC-DCF CSMA/CA (mandatory)
  - collision avoidance via randomized „back-off“ mechanism
  - minimum distance between consecutive packets
  - ACK packet for acknowledgements (not for broadcasts)
- DFWMAC-DCF w/ RTS/CTS (optional)
  - Distributed Foundation Wireless MAC
  - avoids hidden terminal problem
- DFWMAC- PCF (optional)
  - access point polls terminals according to a list

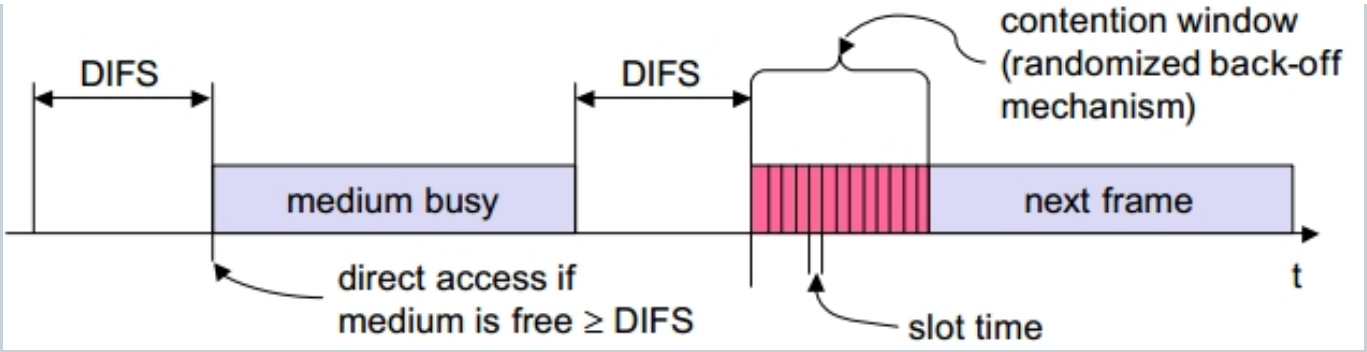
802.11 - MAC layer II

Priorities

- Defined through different inter frame spaces
- No guaranteed, hard priorities
- SIFS (Short Inter Frame Spacing)
  - highest priority, for ACK, CTS, polling response
- PIFS (PCF IFS)
  - medium priority, for time-bounded service using PCF
- DIFS (DCF, Distributed Coordination Function IFS)
  - lowest priority, for asynchronous data service



802.11 - CSMA/CA access method I



- station ready to send senses medium (based on PHY layer CCA, Clear Channel Assessment)
- if the medium is free for the duration of an Inter-Frame Space (IFS), the station can start sending (IFS depends on service type)
- if the medium is busy, the station has to wait for a free IFS, then the station must additionally wait a random back-off time (collision avoidance, multiple of slot-time)
- if another station occupies the medium during the back-off time of the station, the back-off timer stops (fairness)
- If multiple stations have backed off, when 1 timer expires, other timers frozen

802.11 - CSMA/CA access method II

Sending unicast packets

- station has to wait for DIFS before sending data
- receivers acknowledge at once (after waiting for SIFS) if the packet was received correctly (CRC)
- automatic retransmission of data packets in case of transmission errors