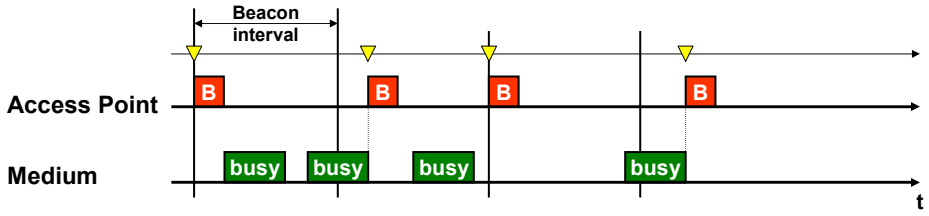
The IEEE 802.11 Protocol

Synchronization and Power Management

Synchronization

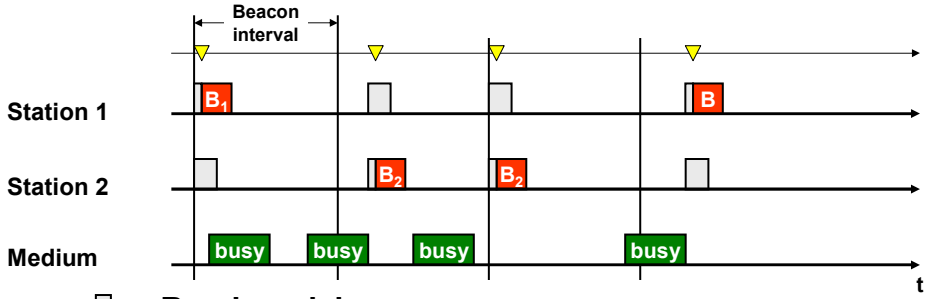
- Timing Synchronization Function (TSF)
  - Used to synchronize all clocks
  - Established by *timestamps* in periodic beacon
- Important for
  - Energy saving mechanism
  - Roaming
  - PCF coordination(!)
  - Synchronization with FHSS systems
- Note: Beacon-frame are not strictly sent periodically
  - Medium might be busy

Synchronization via AP



- ▽ - Time stamp
- B - Beacon Frame
- Infrastructure networks
  - Access point cares for synchronization

Synchronization with Ad-hoc



- ▯ - Random delay
- Each station tries to send beacon frame after each interval

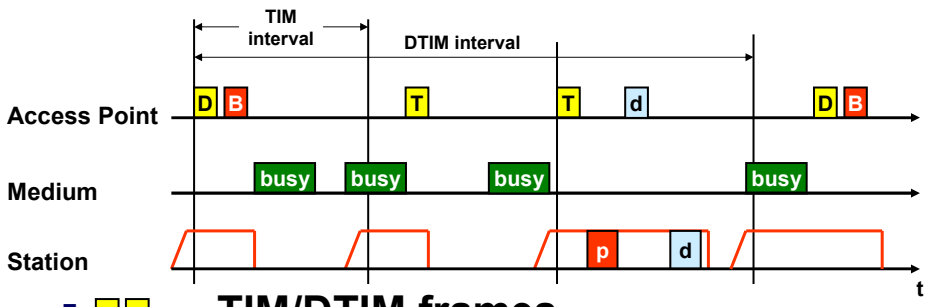
Power Management

- Many devices use batteries: energy saving mechanisms are essential for acceptance
- Typical consumptions (at 100 mW)
  - TX: 450 mA
  - RX: 270 mA
  - Sleep: 15 mA
- IEEE 802.11 standard
  - Transition between modes always initiated by station
- Two system modes
  - 1) Active (power save after configured idle period possible)
  - 2) Power (power save after TX/RX event)
- Two power states
  - 1) Awake
  - 2) Doze
- TSF necessary

Power Management

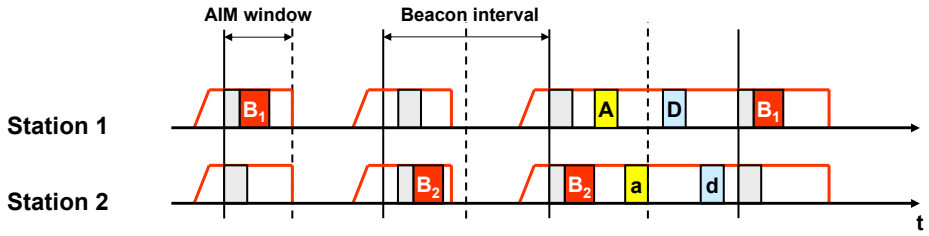
- Traffic Indication Map (TIM)
  - Sent with every beacon
  - Indicates for which stations frames are buffered
- Delivery Traffic Indication Map (DTIM)
  - List for broadcast/multicast receivers
- Every TIM interval the station wakes up and listens for a TIM packet
- If there is data available, the station first emits the PS packet, then receives the data

Power Management via AP



- T D - TIM/DTIM frames
- B - Broadcast
- p - Power Saving (PS) frame = "I am awake, send me data"

Power Management with Ad-hoc



- A a - ATIM packet and ATIM-Ack
- D d - Data and data-Ack
- B - Beacon packet
- - Random delay

Power Management

- Every Beacon interval all stations wake up
- If a station has data for another one, the station sends out an Ad-hoc Traffic Indication Map (ATIM)
- After the right station received this packet, this station sends back an acknowledgment
- Now the station remains in the awake modus