Mobile Networking

Mohammad Hossein Manshaei

manshaei@gmail.com

1393

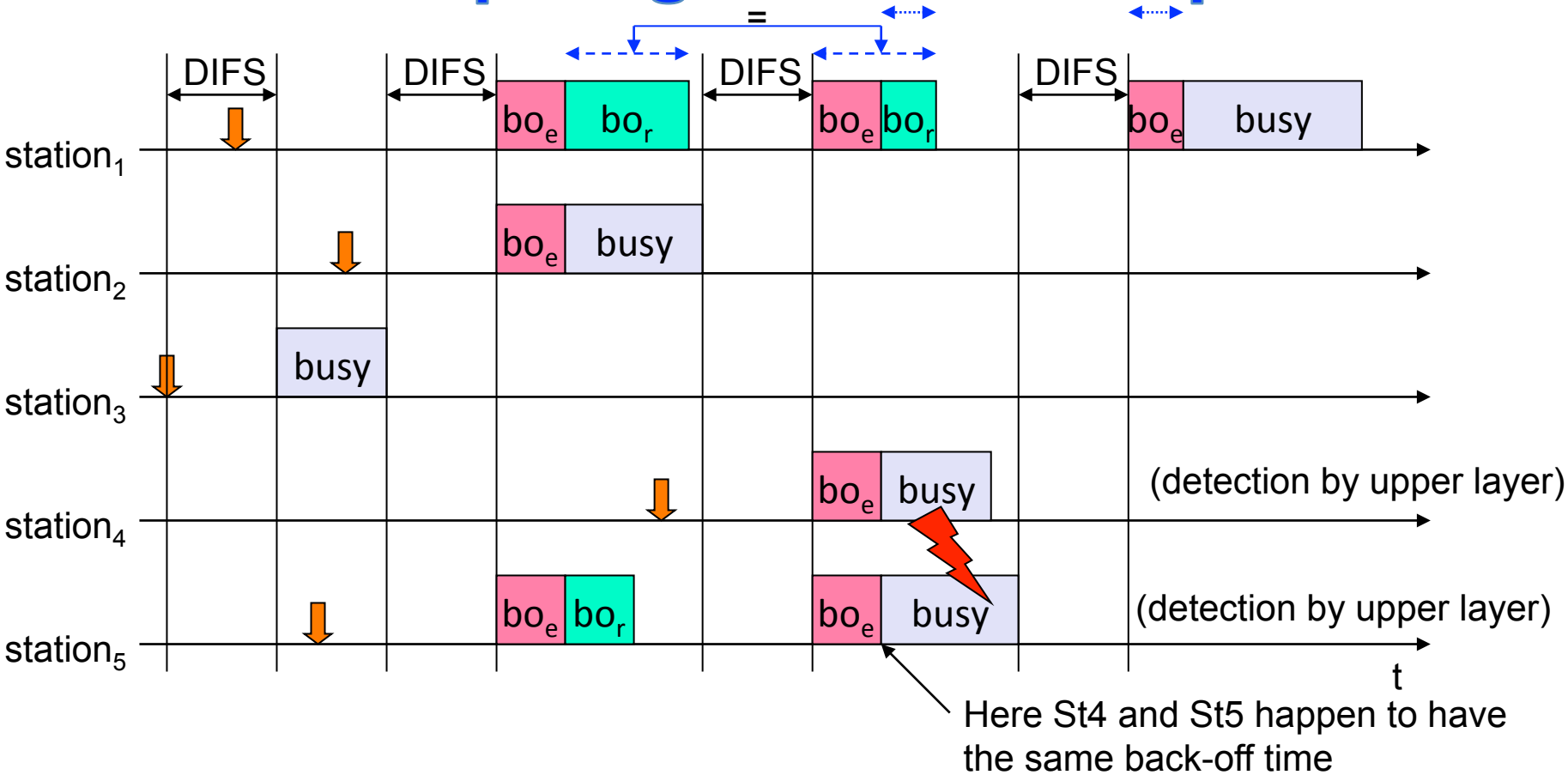
Broadcast, Fragmentation, Power Control, PCF, 802.11e, …

MORE ON 802.11 MAC LAYER

Contents

- Review CSMA/CA
- 802.11 Fragmentation
- 802.11 Point Coordination Function
- 802.11 MAC Management
  - Synchronization
  - Power Control
  - Roaming
- 802.11e: QoS in WiFi

802.11 – Competing Stations - Simple Version



busy — medium not idle (frame, ack etc.)

packet arrival at MAC

bo_e — elapsed backoff time

bo_r — residual backoff time

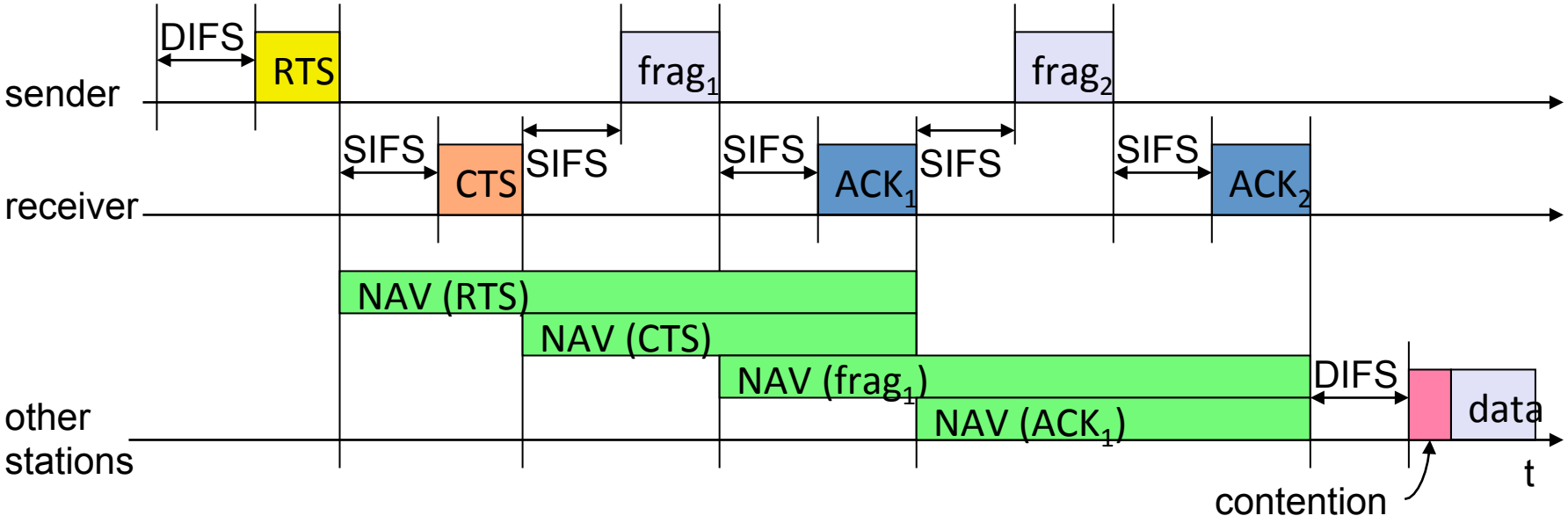
The size of the contention window can be adapted (if more collisions, then increase the size)

Note: broadcast is not acknowledged

Contents

- Review CSMA/CA
- 802.11 Fragmentation
- 802.11 Point Coordination Function
- 802.11 MAC Management
  - Synchronization
  - Power Control
  - Roaming
- 802.11e: QoS in WiFi

Fragmentation Mode

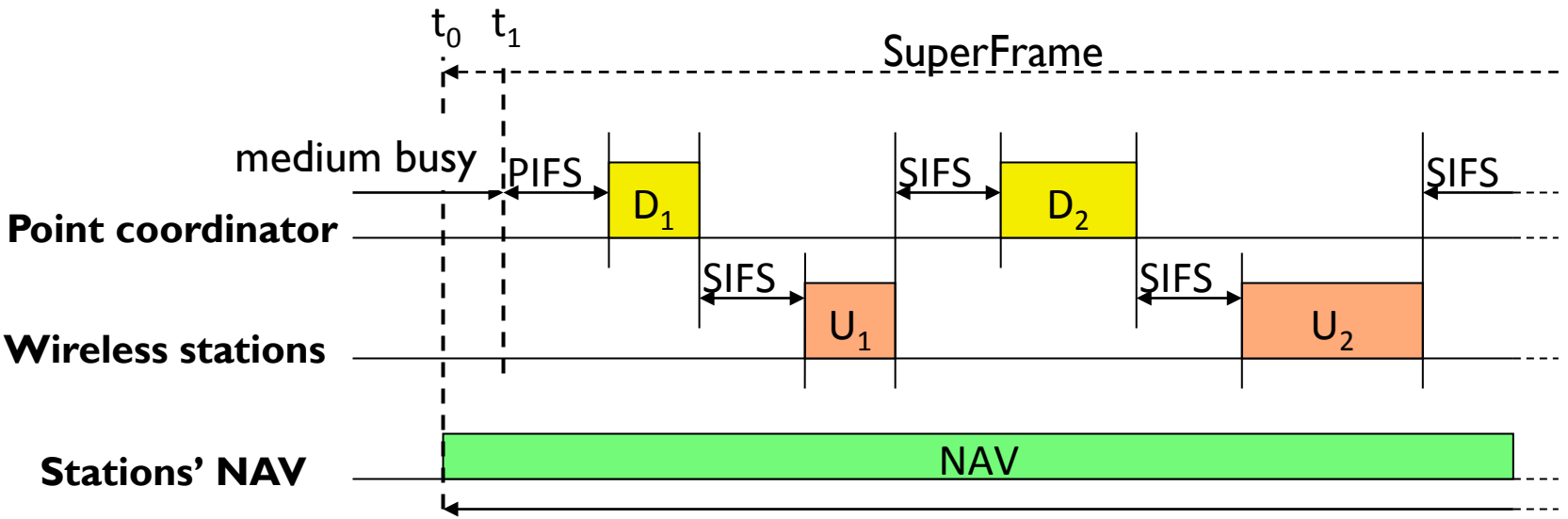


- **Fragmentation** is used in case the size of the packets sent has to be reduced (e.g., to diminish the probability of erroneous frames)
- Each **$frag_i$** (except the last one) also contains a duration (as RTS does), which determines the duration of the NAV
- By this mechanism, fragments are sent in a row
- In this example, there are only 2 fragments

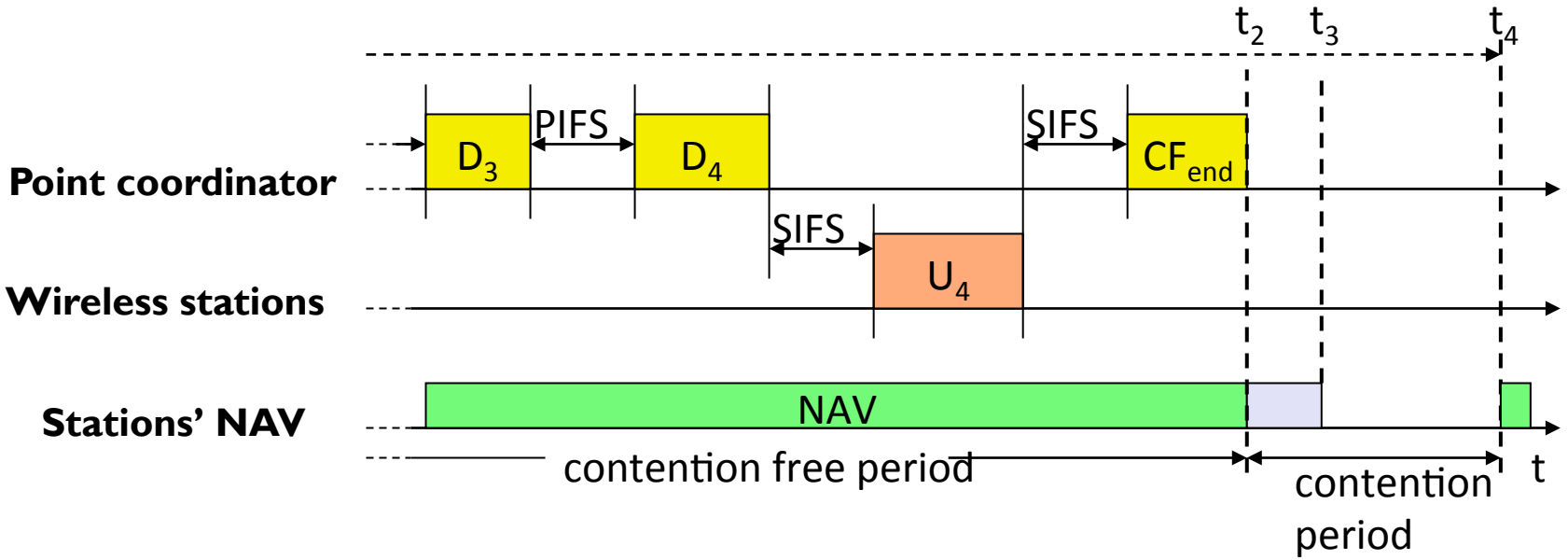
Contents

- Review CSMA/CA
- 802.11 Fragmentation
- 802.11 Point Coordination Function
- 802.11 MAC Management
  - Synchronization
  - Power Control
  - Roaming
- 802.11e: QoS in WiFi

DFWMAC-PCF I
(Point Coordination Function)

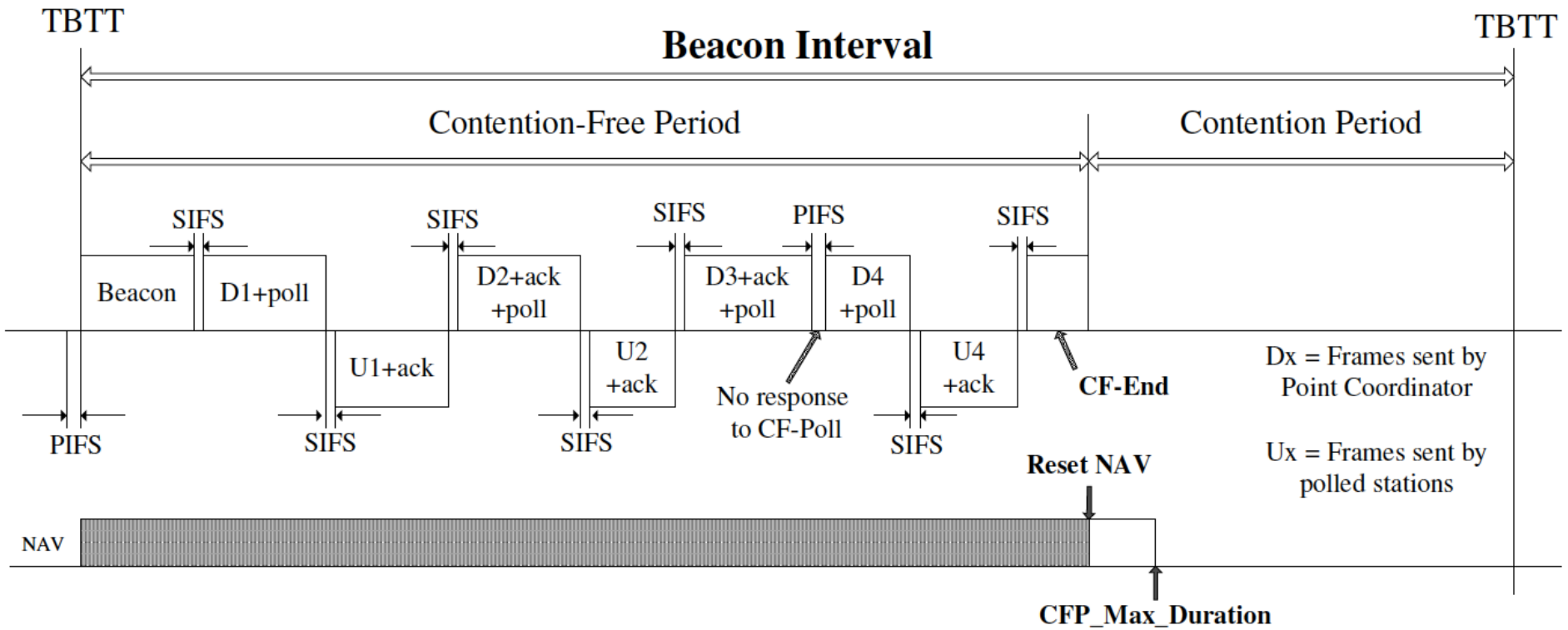


DFWMAC-PCF II (Point Coordination Function)



- Resemble a static, centrally controlled **time division multiple access (TDMA)** system with **time division duplex (TDD)** transmission
- It comes with an **overhead** if nodes have nothing to send,

PCF: Another Example



Contents

- Review CSMA/CA
- 802.11 Fragmentation
- 802.11 Point Coordination Function
- 802.11 MAC Management
  - Synchronization
  - Power Control
  - Roaming
- 802.11e: QoS in WiFi

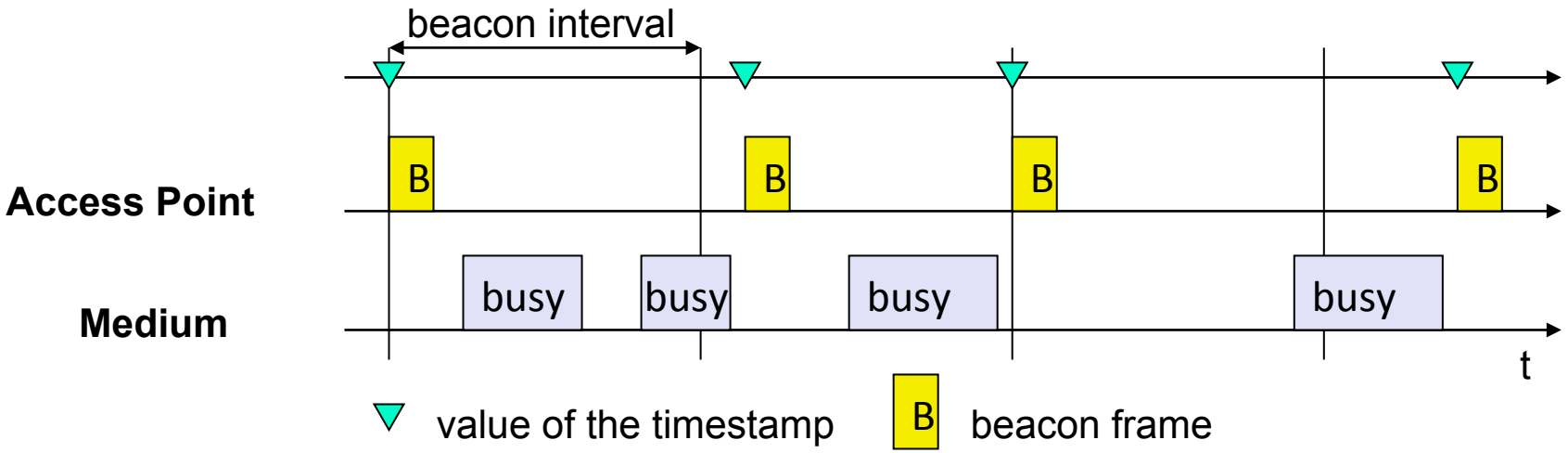
802.11 - MAC management

- **Synchronization**
  - Try to find a LAN, try to stay within a LAN
  - Timer etc.
- **Power management**
  - Sleep-mode without missing a message
  - Periodic sleep, frame buffering, traffic measurements
- **Association/Re-Association**
  - Integration into a LAN
  - Roaming, i.e. change networks by changing access points
  - Scanning, i.e. active search for a network
- **MIB - Management Information Base**
  - Managing, Read, Write

Synchronization

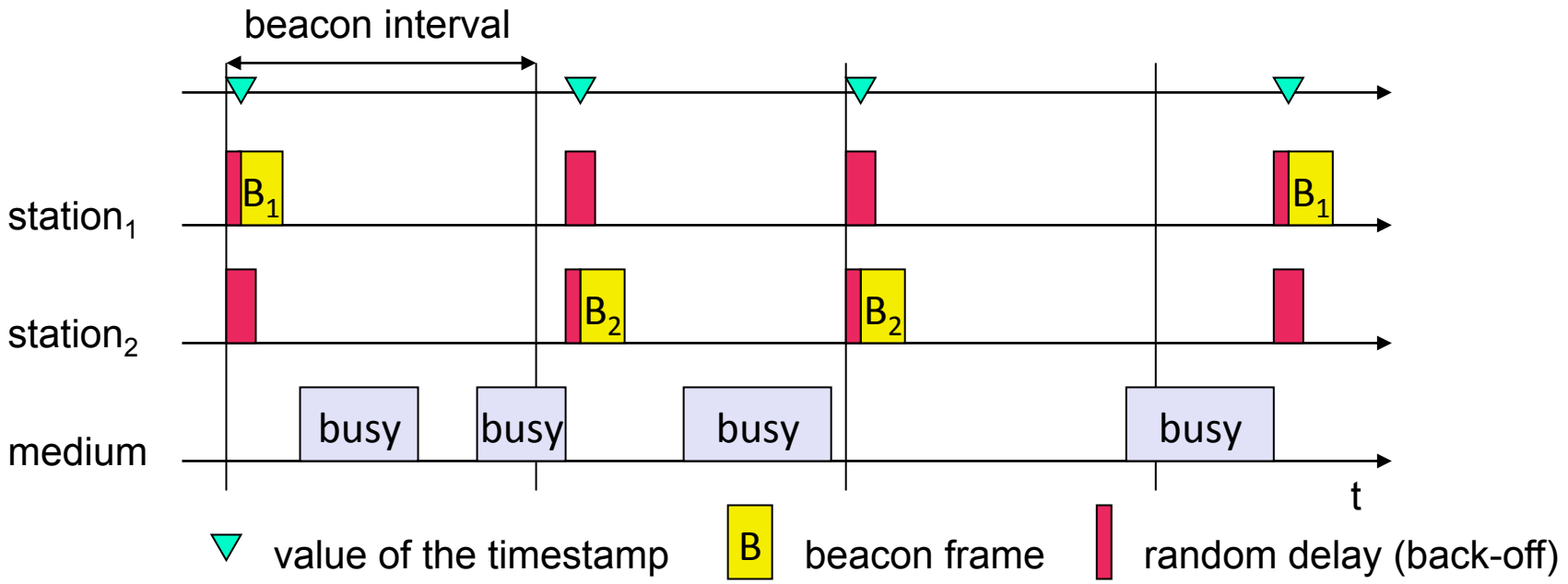
- We need for:
  - Power management
  - Coordination of the PCF
  - Synchronization of the hopping sequence in an FHSS system

Synchronization (Infrastructure)



- The access point transmits **the (quasi) periodic beacon signal**
- The beacon contains **a timestamp** and other **management information** used for **power** management and **roaming**
- Beacon intervals are **not shifted** if one beacon is delayed
- All other wireless nodes adjust their local timers to the timestamp

Synchronization (Ad-hoc)



- Each node maintains its own synchronization timer and starts the transmission of a beacon frame after the beacon interval
- **Contention** → back-off mechanism → only 1 beacon wins
- The beacon intervals **can be shifted** slightly
- All other stations adjust their internal clock according to the received beacon and suppress their beacon for the current cycle

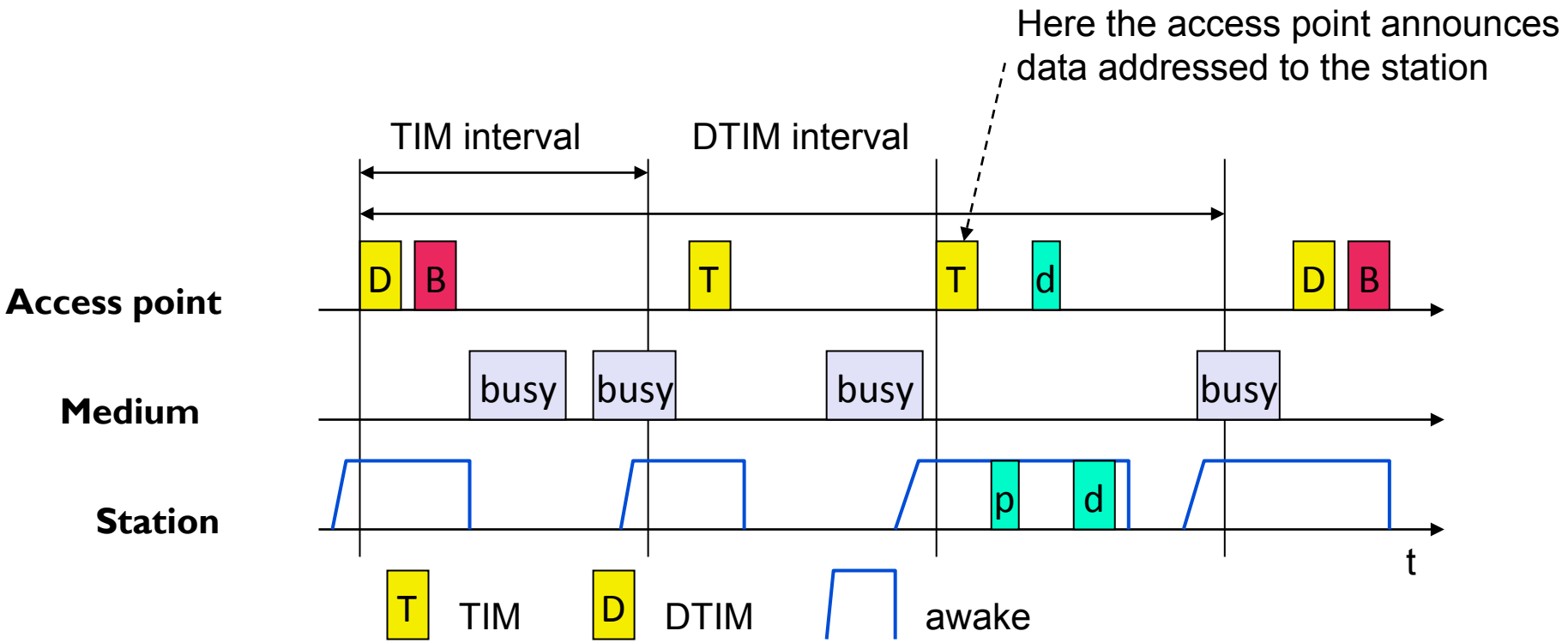
Power Management

- **Idea**:
  - Switch the transceiver off if not needed
- **States of a station**:
  - **Sleep** and **Awake** (Buffering of data in sender)
- We need **Timing Synchronization Function (TSF)**
  - Stations wake up at the same time

Power Management

- **Infrastructure Case**
  - **Traffic Indication Map (TIM)**
    - List of unicast receivers transmitted by AP
  - **Delivery Traffic Indication Map (DTIM)**
    - List of broadcast/multicast receivers transmitted by AP
- **Ad-hoc Case**
  - **Ad-hoc Traffic Indication Map (ATIM)**
    - Announcement of receivers by stations buffering frames
    - More complicated - no central AP
    - Collision of ATIMs possible (scalability?)

Power Saving (Infrastructure)

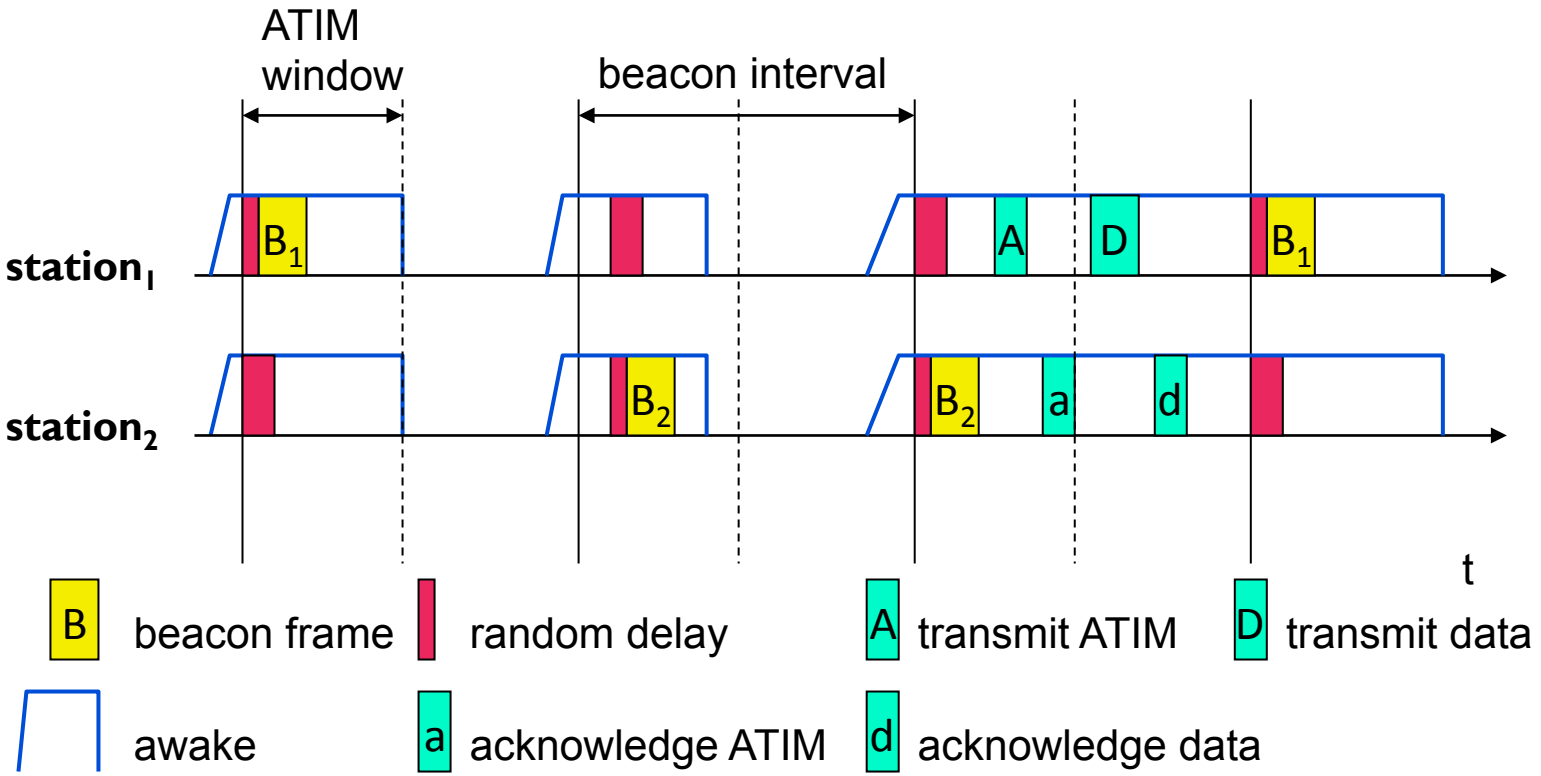


B broadcast/multicast

d data transmission to/from the station

p Power Saving poll: I am awake, please send the data

Power Saving (Ad-hoc)



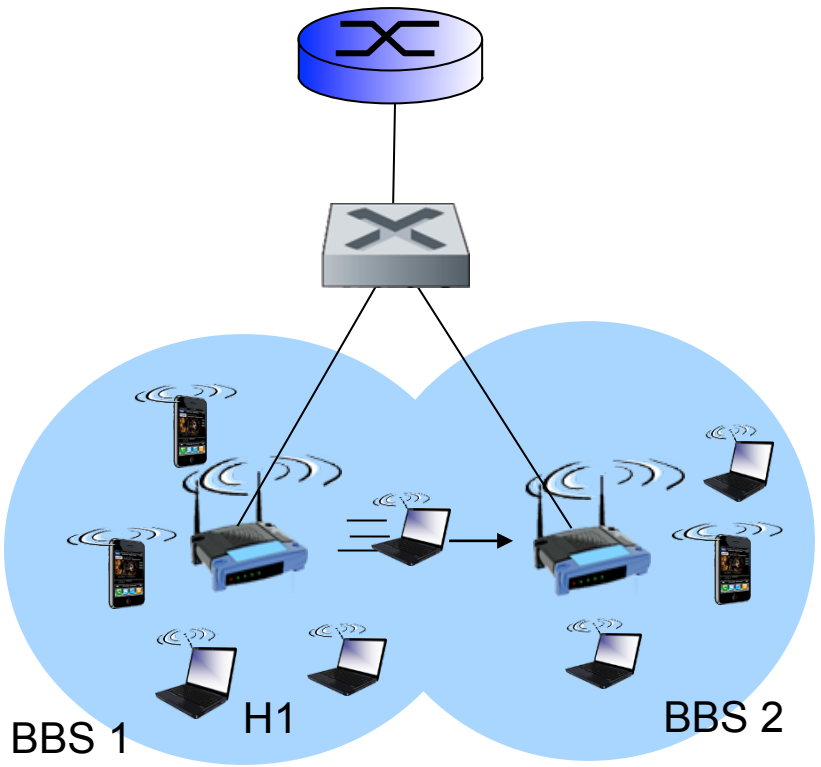
- ATIM: Ad hoc Traffic Indication Map (a station announces the list of buffered frames)
- Potential problem: scalability (high number of collisions)

802.11f - Roaming

- **No or bad connection? Then perform:**
  - **Scanning (Passive or Active)**
    - Scan the environment, i.e., listen into the medium for beacon signals or send probes into the medium and wait for an answer
- **Reassociation Request**
  - Station sends a request to one or several AP(s)
- **Reassociation Response**
  - Success: AP has answered, station can now participate
  - Failure: continue scanning
- AP accepts Reassociation Request
  - Signal the new station to the distribution system
  - The distribution system updates its data base (i.e., location information)
  - Typically, the distribution system now informs the old AP so it can release resources

802.11: Mobility within Same Subnet

- H1 remains in same IP subnet: IP address can remain same
- Switch: which AP is associated with H1?
  - self-learning: switch will see frame from H1 and "remember" which switch port can be used to reach H1



Contents

- Review CSMA/CA
- 802.11 Fragmentation
- 802.11 Point Coordination Function
- 802.11 MAC Management
  - Synchronization
  - Power Control
  - Roaming
- 802.11e: QoS in WiFi

802.11e: QoS at MAC Layer

- **The major enhancement of 802.11e**
  - Traffic differentiation
  - Concept of Transmission Opportunity (TXOP)
  - Enhanced DCF (contention-based)
  - HCP controlled channel access (contention free)
  - Burst ACK (optional)
  - Direct link protocol (DLP)

Hybrid Coordination Function (HCF)

- HCF combines functions from the DCF and PCF with enhanced QoS-specific mechanisms
- HCF consists of
  - **Enhance DCF (EDCF)** for contention-based access
  - **HCF Controlled Channel Access (HCCA)** for contention-free access

HCF – Definitions

- **Definitions:**
  - **Hybrid coordinator (HC):** the point coordinator for HCF.
  - **QoS access point (QAP):** An access point (AP) that implements the access point functions specified in the IEEE 802.11e standard.
  - **QoS station (QSTA):** An IEEE 802.11 station which implements QoS facility and HCF.
  - **QoS basic service set (QBSS):** A basic service set that supports QoS facility specified in the IEEE 802.11e.

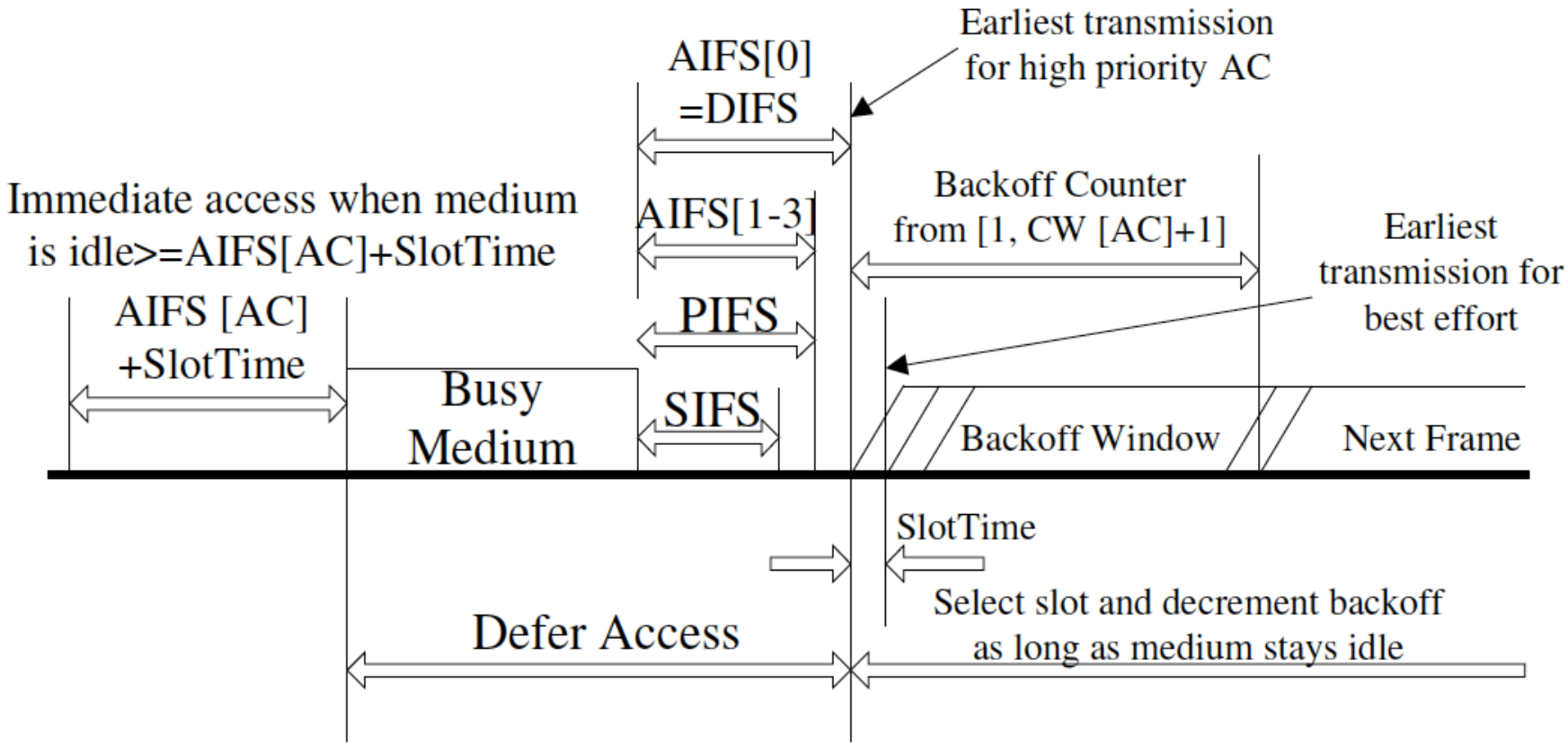
EDCF – Traffic Category

- The EDCF provides differentiated access for **8 priorities**, identical to IEEE 802.1D priority tag, for non-AP STAs.
  - Priorities are numbered from 0 (the lowest priority) to 7 (the highest priority).
- The set of MSDUs with the same priority is refer to a *Traffic Category* (TC).

EDCF – Access Category

- EDCF defines ***access category* (AC)** mechanism to support the priority mechanism at the non-AP QSTAs.
- An AC is an enhanced variant of the DCF which contends for ***transmission opportunity* (TXOP)** using the set of parameters such as **CWmin[AC], CWmax[AC], AIFS[AC]**, etc.

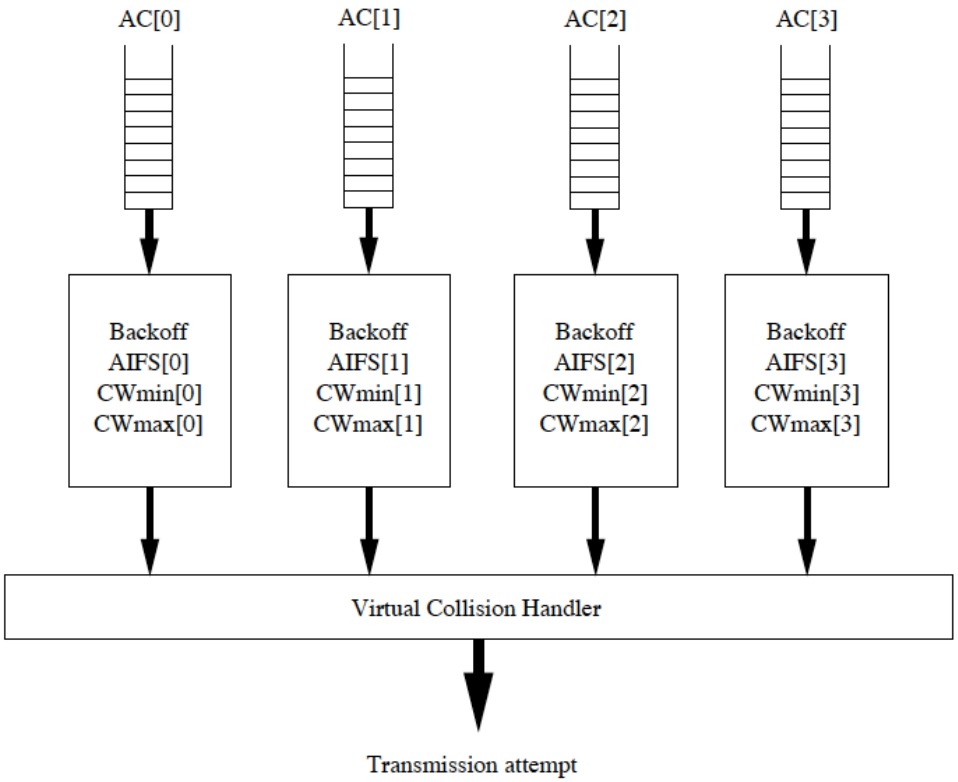
EDCF:Timing



AIFS [AC] = AIFSN [AC] * *aSlotTime* + SIFS

EDCF – Access Category

- An QSTA has four ACs.
- Collision between ACs within a QSTA is called *internal collision*.



EDCF – Access Category

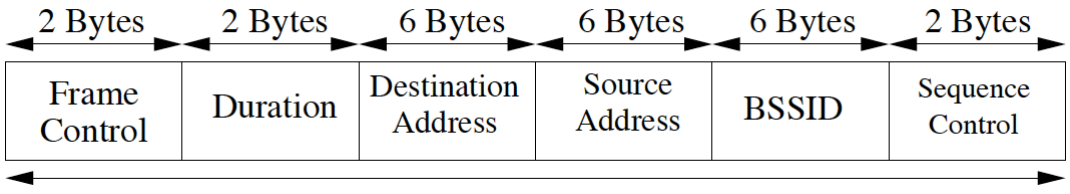
- Internal collision resolution: High priority AC wins the right of transmission, but low priority AC back off as if it experiences a collision.
- The mapping from 8 UP to 4 ACs is:

UP, User Priority (Same as 802.1D)	802.1D Designation	802.11e AC (Access Category)	Service type
2	Not defined	0	Best Effort
1	Background (BK)	0	Best Effort
0	Best Effort (BE)	0	Best Effort
3	Excellent Effort (EE)	1	Video Probe
4	Controlled Load (CL)	2	Video
5	VI (Video <100ms latency and jitter)	2	Video
6	VO (Video <10ms latency and jitter)	3	Voice
7	Network Control (NC)	3	Voice

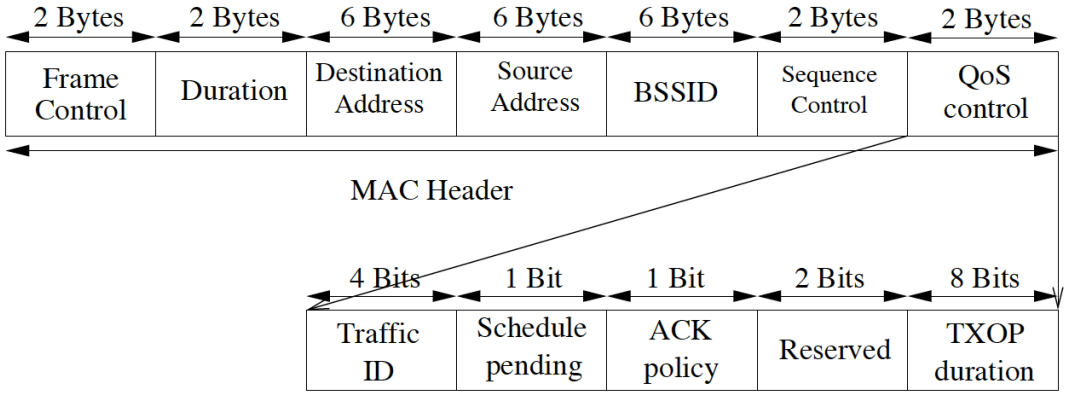
TXOP

- A **TXOP** is defined by a starting time and a maximum duration.
- **Two types of TXOP:** *EDCF TXOP* and *Polled TXOP*.
  - An **EDCF TXOP** begins when the wireless medium is determined to be available under the EDCF rules, and the length of TXOP is specified in beacon frames.
  - An **Polled TXOP** begins when a QSTA receives a QoS(+)CF-Poll from HC, and the length of TXOP is specified in the QoS(+)CF-Poll.

HCF Controlled Access – Frame Formats



IEEE 802.11



IEEE 802.11e