CS 348: Computer Networks

- WiFi (contd.); 16th Aug 2012

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Clicker-1: Wireless v/s wired

- Which of the following differences between Wireless and Wired affect a CSMA-based protocol?

1. Wireless range/RTT is more than Wired.
2. Wireless losses/errors are more than Wired.
3. Wireless bandwidth is less than Wired.
4. Wireless lacks full connectivity.

Clicker-2: RTS-CTS

- Which of the following statements are True?

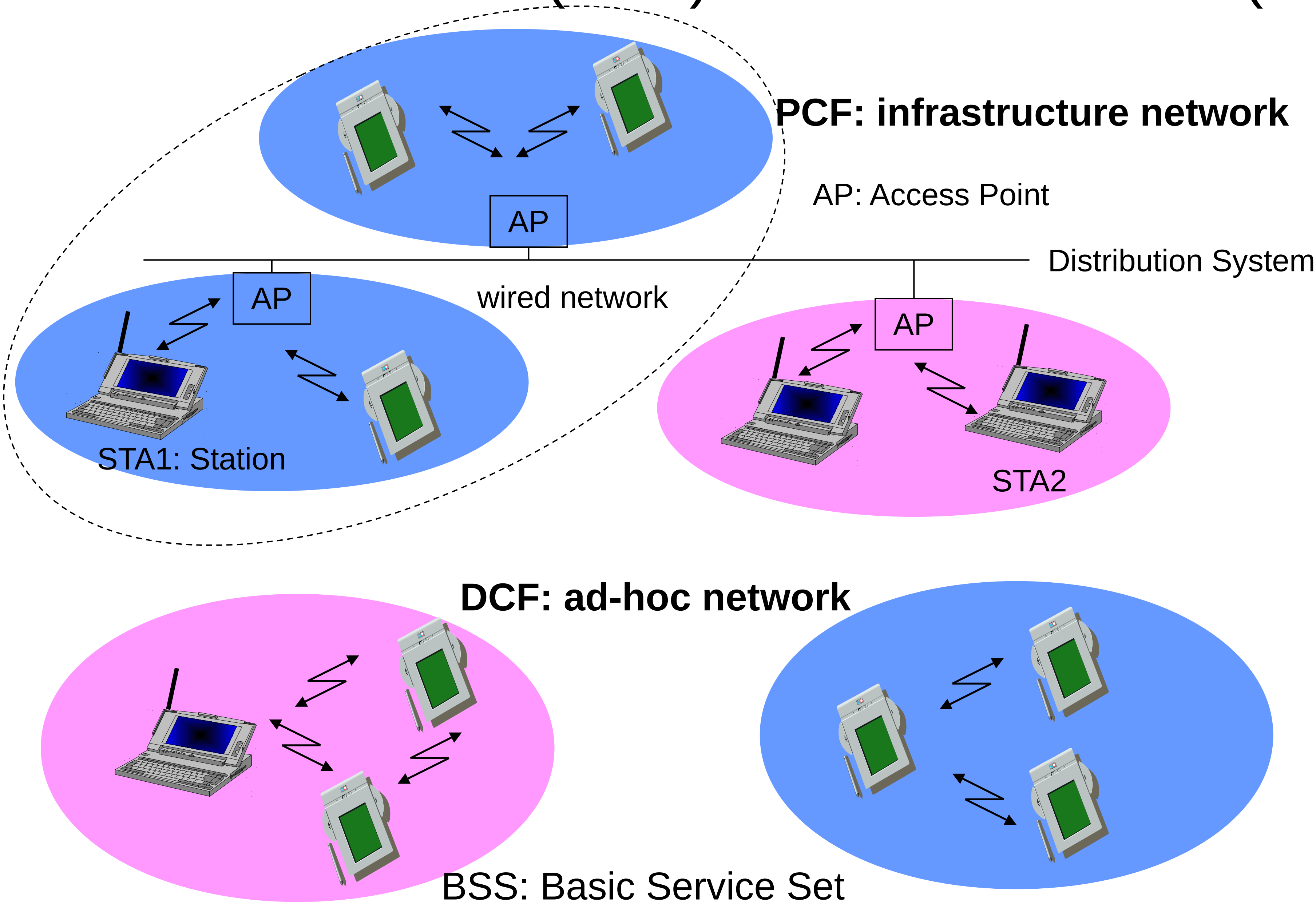
1. RTS-CTS is always required.
2. RTS-CTS is required only when there are too many stations.
3. RTS-CTS is required only for large packets.
4. RTS-CTS can be given as an option to the user.

Recap of previous class

Topics covered: CSMA/CA, Backoff

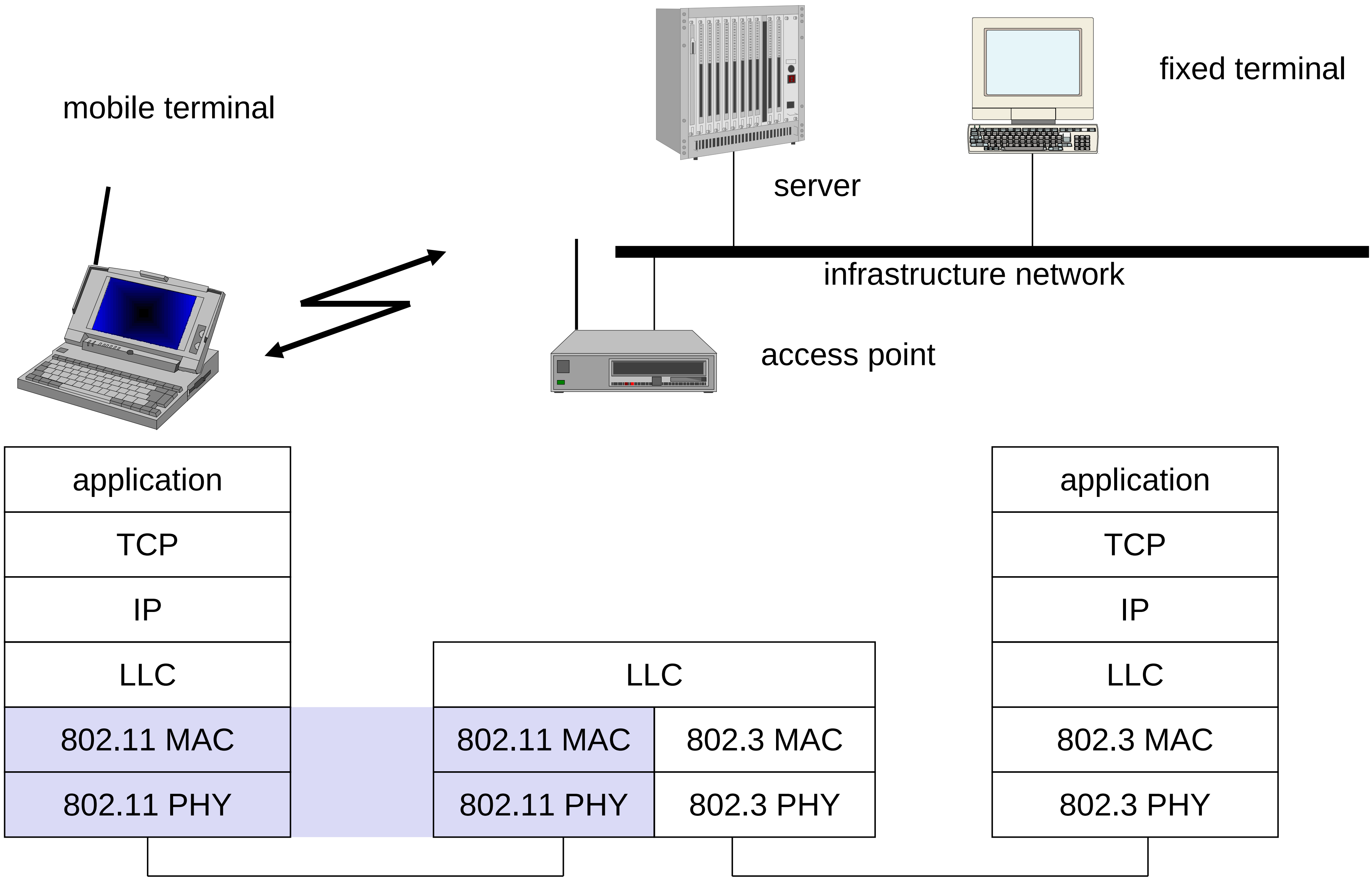
- Difference between wired and wireless:
  - Wireless PHY boundaries are not fixed.
  - Wireless PHY may be time varying and asymmetric.
- Hidden terminal problem
  - CS (carrier sense) fails at sender.
  - CD (collision detection) fails at sender.
- CSMA/CA (Collision Avoidance)
  - RTS-CTS-Data-Ack mechanism.
  - Binary exponential backoff mechanism.

WiFi: Infrastructure (PCF) and Adhoc Modes (DCF)

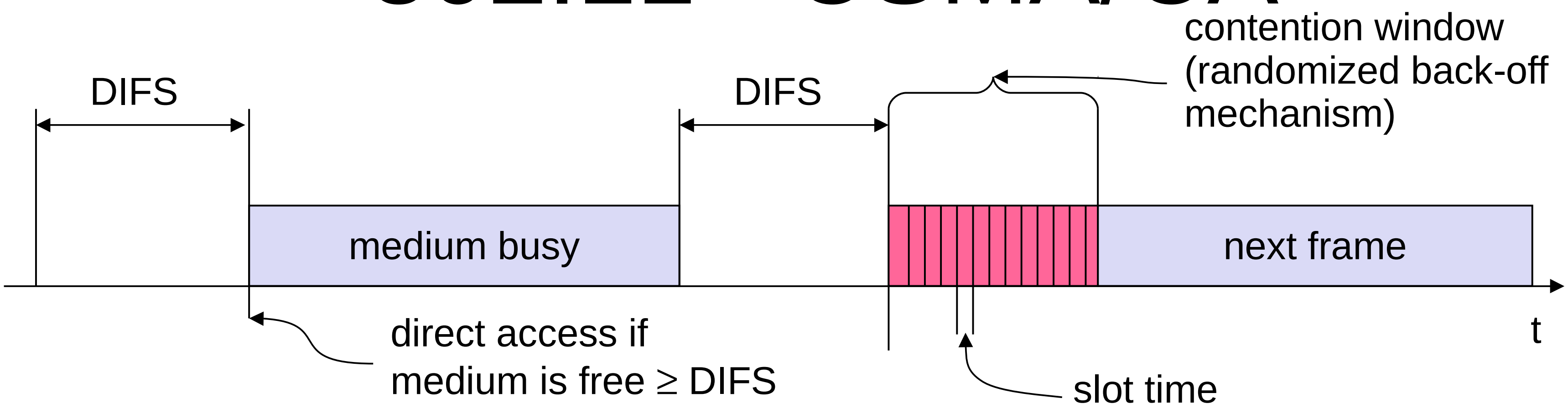


BSS: Basic Service Set
(Group of STA using the same channel)

802.11- in the TCP/IP stack



802.11 - CSMA/CA



- station ready to send starts sensing the medium (Carrier Sense based on CCA, Clear Channel Assessment)

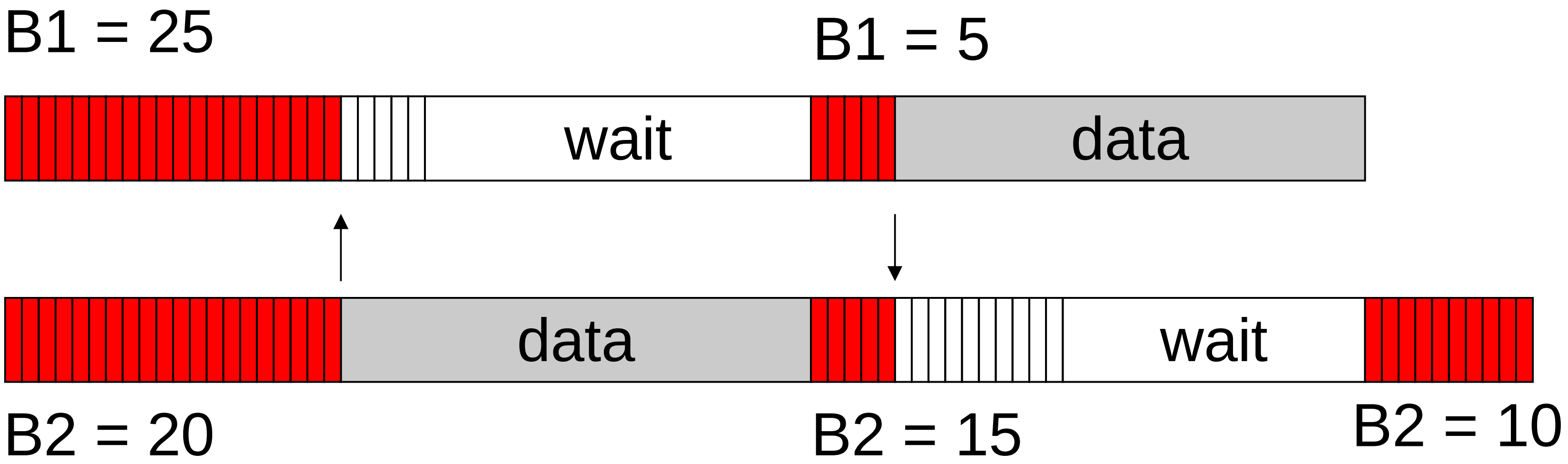
- if the medium is free for the duration of an Inter-Frame Space (IFS), the station can start sending (IFS depends on service type)

802.11 – CSMA/CA

- 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, after the medium becomes free again. (collision avoidance, multiple of slot-time)
- if another station transmits during the back-off time of the station, the back-off timer is paused. (fairness)
- When back-off counter reaches 0, transmit.

DCF Example

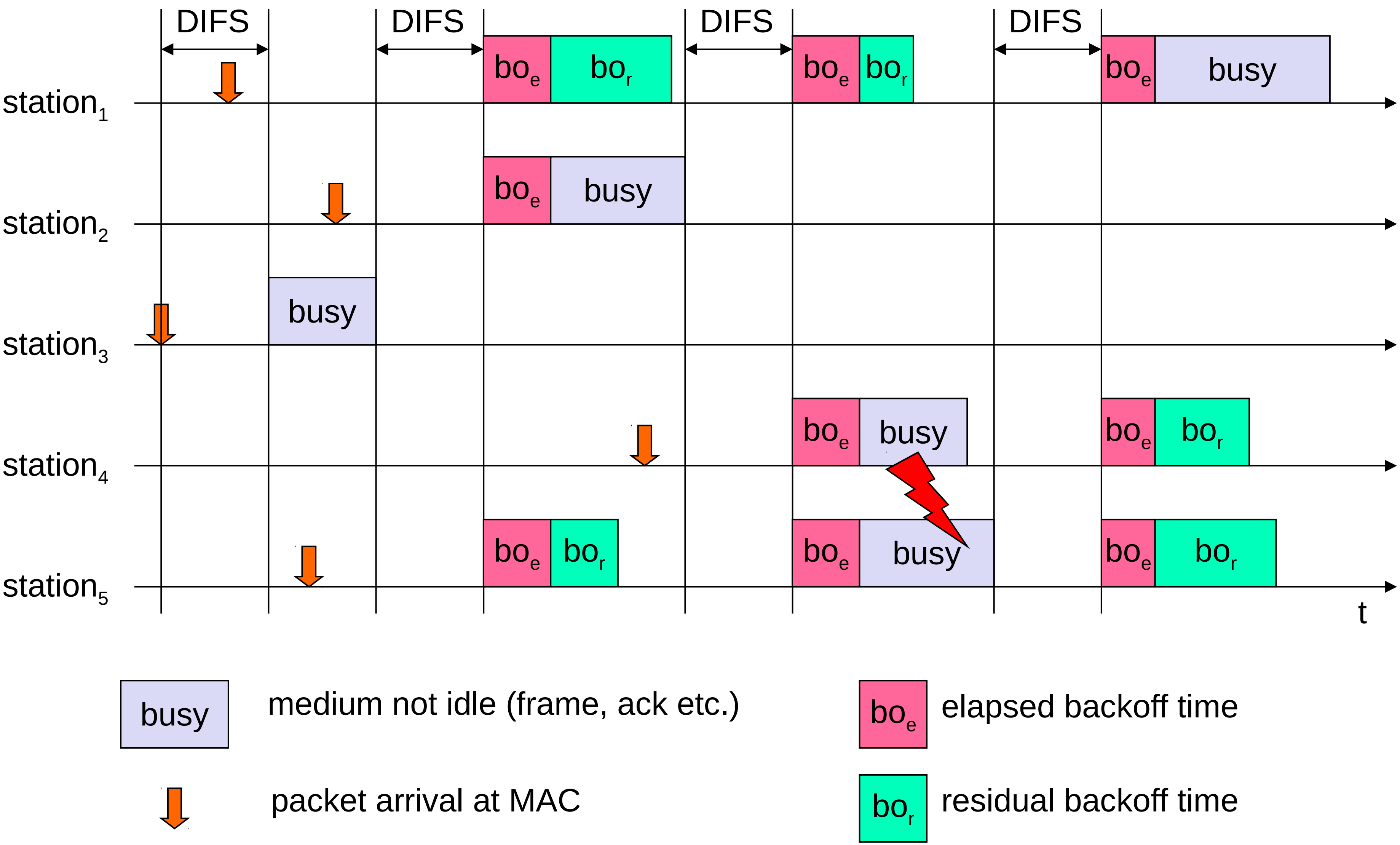
- When transmitting a packet, choose a backoff interval in the range [0,cw]; cw is contention window



cw = 31

B1 and B2 are backoff intervals at nodes 1 and 2

CSMA/CA – Group Activity 1



- Choose values of the backoff counters so that the above timing diagram is valid.

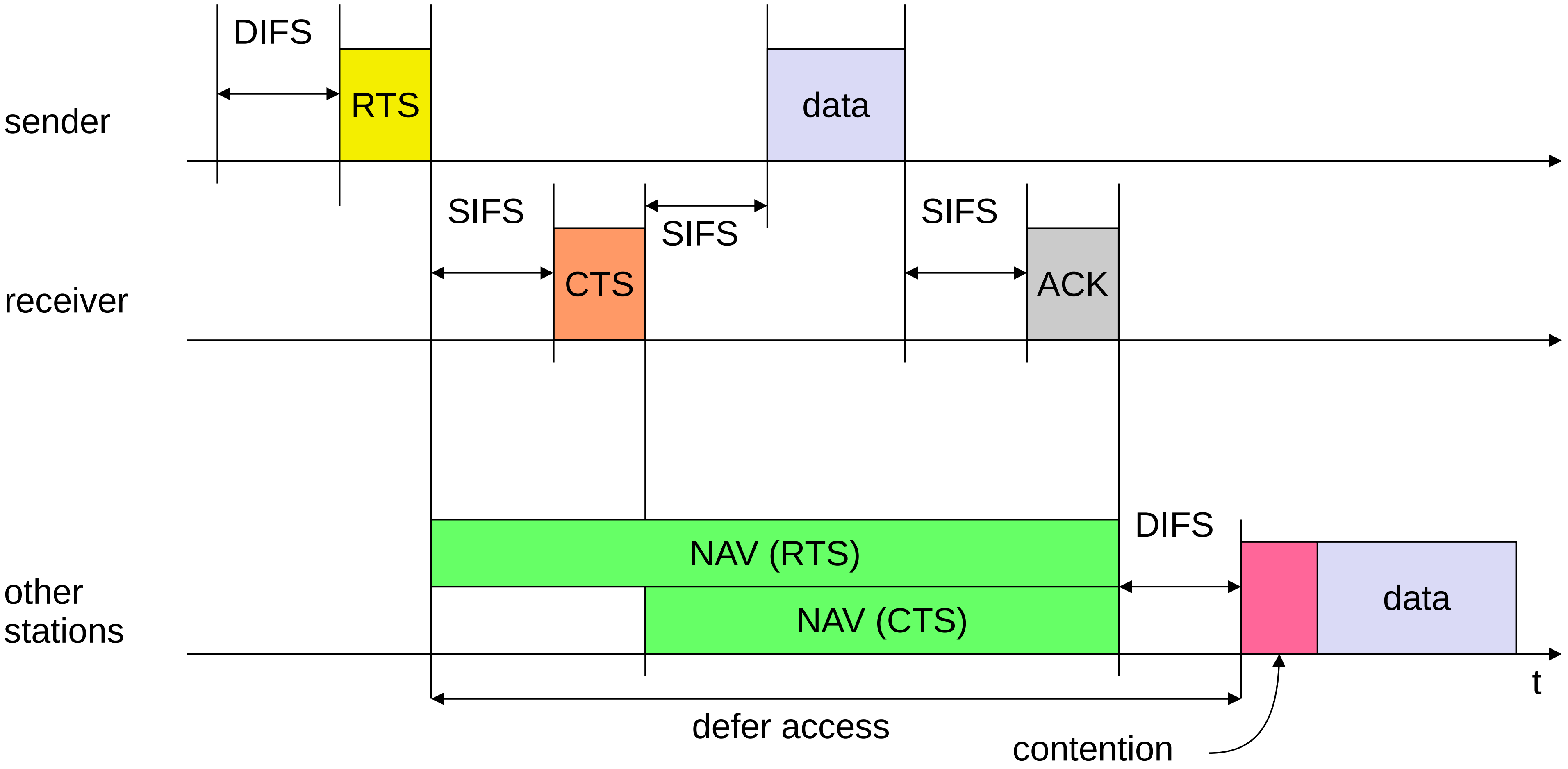
802.11 - Congestion Control

- Contention window (cw) in DCF: Congestion control achieved by dynamically choosing cw

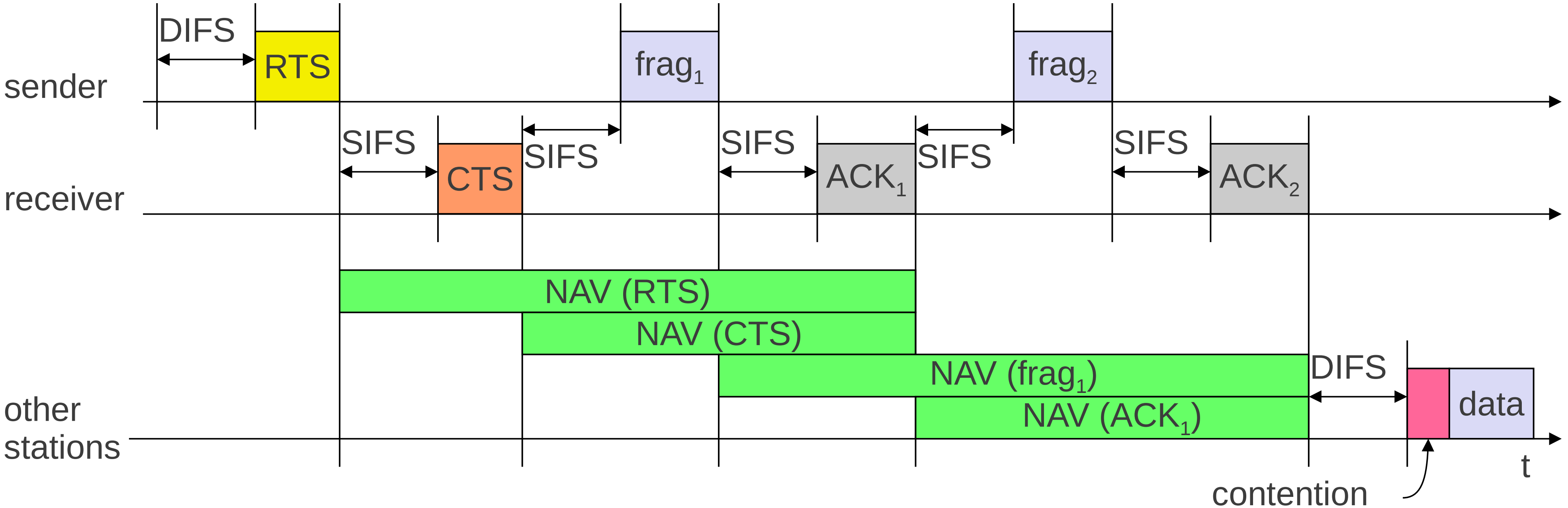
- *large* cw leads to larger backoff intervals
- *small* cw leads to larger number of collisions

Binary Exponential Backoff in DCF:
When a node fails to receive CTS in response to its RTS, it increases the contention window
cw is doubled (up to a bound CWmax)
Upon successful completion data transfer, restore cw to CWmin

802.11 –RTS/CTS



Thresholds and Fragmentation



- **RTS-Threshold:** Packet Size above which RTS-CTS will be used.
- **Fragmentation-Threshold:** Packet Size above which packets will be sent as fragments.

SIFS/DIFS - Group Activity 2

- What is the need for SIFS?
- What is the need for DIFS?

- Timings:
  - What should be the “slot time”?
  - What should be the SIFS time?
  - What should be the DIFS time?

- Discuss in groups and as a class.

Key points: SlotTime and SIFS

- SlotTime is: CCATime + RxTxTurnaroundTime + AirPropagationTime + MACProcessingDelay
  - CCATime: Clear Channel Assessment
  - ~ (14+5+1+0) = 20 µs for DSSS PHY

- SIFSTime is: RxRFDelay + RxPLCPDelay + MACProcessingDelay + RxTxTurnaroundTime.
  - RxRFDelay - Time between the end of a symbol at the air interface to the notification to PHY processing module.
  - PLCP: Physical Layer Convergence Protocol.
  - ~ (2+1+1+5) = ~10 µs for DSSS PHY

Key points: SIFS and DIFS

- SIFS (Short Inter Frame Spacing):
  - highest priority, for ACK, CTS, polling response
- DIFS (DCF IFS)
  - lowest priority, for asynchronous data service
  - DIFSTime = SIFSTime + 2xSlotTime
- **Question: Why 2xSlotTime?**

Practice Problem: Do it yourself

- Consider a 802.11 BSS with three stations (ST A1 to STA3), all within range of each other and operating in DCF mode. Data frames of various sizes arrive for transmission at the respective MAC layers as follows:

Time	MSDU (Data bytes)	Source	Destination
t=0	500	STA1	STA3
t + 120μs	1400	STA2	STA1
t + 250μs	500	STA3	STA2

- Compute the earliest time by which all the frames can be delivered to their destinations.
- Assume: 200 bytes may be transmitted in one SlotTime; SlotTime = 20μs; SIFSTime = 10μs; RTS Size =CTS Size = ACK Size = 100bytes; FragmentationThreshold = 2400bytes; RTSThreshold = 1200bytes;

Frame format

2	2	6	6	6	2	6	0-2312	4
Frame Control	Duration ID	Address 1	Address 2	Address 3	Sequence Control	Address 4	Data	CRC

version, type, fragmentation, security, ...

bytes

Source: Schiller

MAC address format

scenario	to DS	from DS	address 1	address 2	address 3	address 4
ad-hoc network	0	0	DA	SA	BSSID	-
infrastructure network, from AP	0	1	DA	BSSID	SA	-
infrastructure network, to AP	1	0	BSSID	SA	DA	-
infrastructure network, within DS	1	1	RA	TA	DA	SA

DS: Distribution System
AP: Access Point
DA: Destination Address
SA: Source Address
BSSID: Basic Service Set Identifier
RA: Receiver Address
TA: Transmitter Address

Source: Schiller

Question: MAC addressing

- Consider the scenario in slide 5.
  - Suppose STA1 wants to transmit a frame to STA2.

  - What is the sequence of frame transmissions?
  - What are the addresses in the various frames?