# IEEE 802.11 – Wireless LAN: Medium Access Control (MAC)

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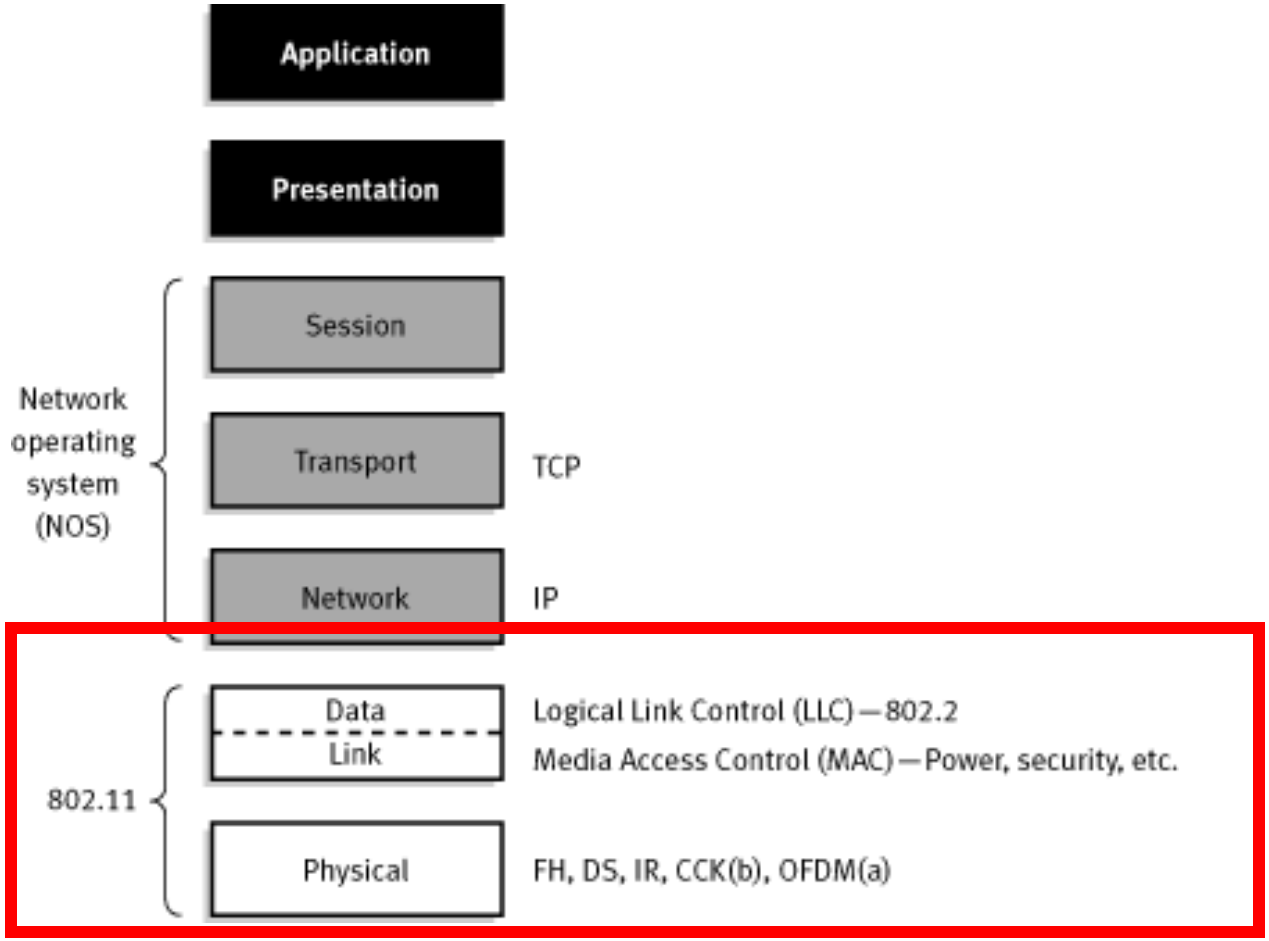
# Protocol Layers



# 802.11

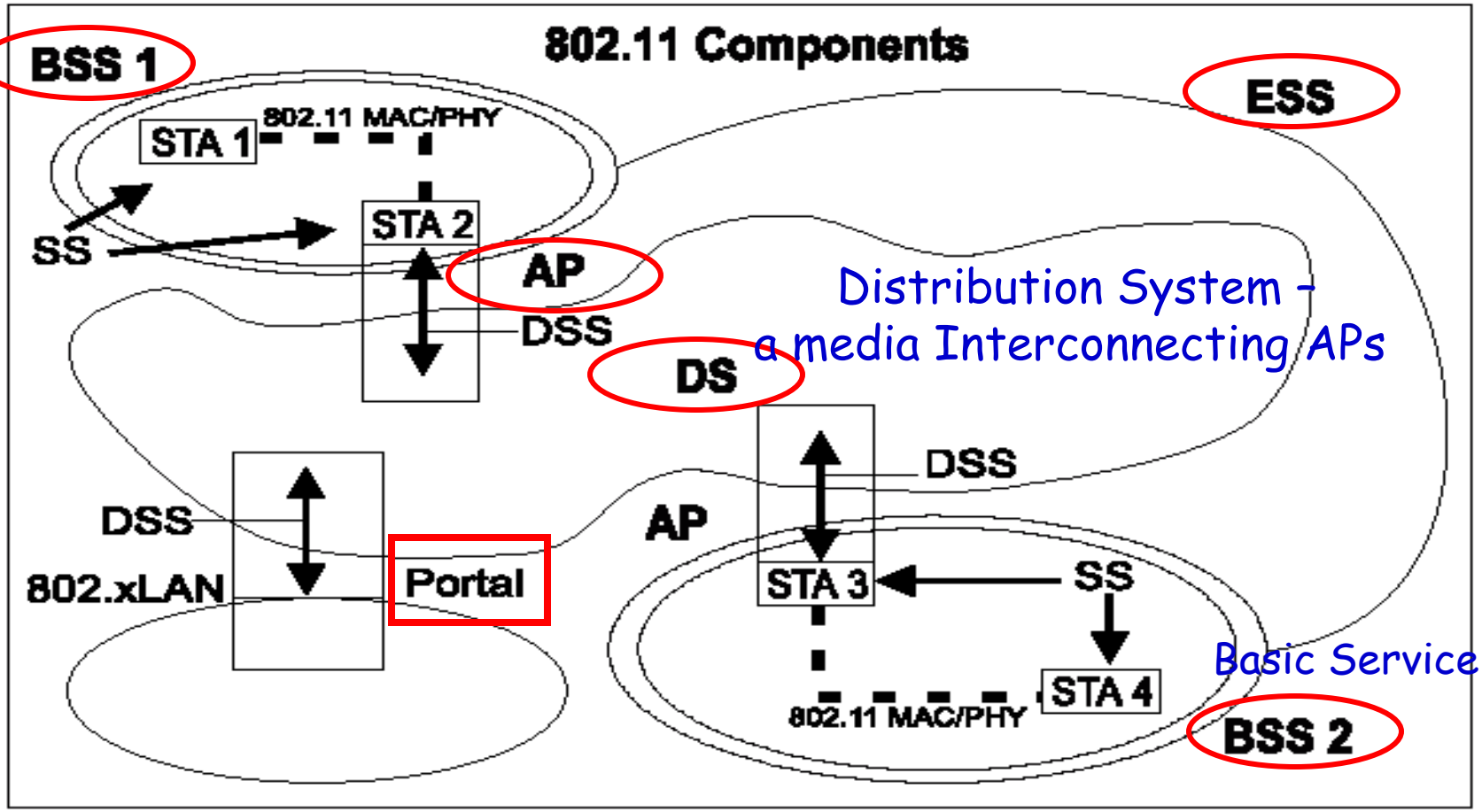
## Equipment

- *A wireless station*
  - usually a computer equipped with a 802.11 PC Card, PCI, or ISA NICs, or embedded solutions in non-PC clients (such as an 802.11-based telephone handset).
- *An access point* (AP)
  - a bridge between the wireless and wired networks.

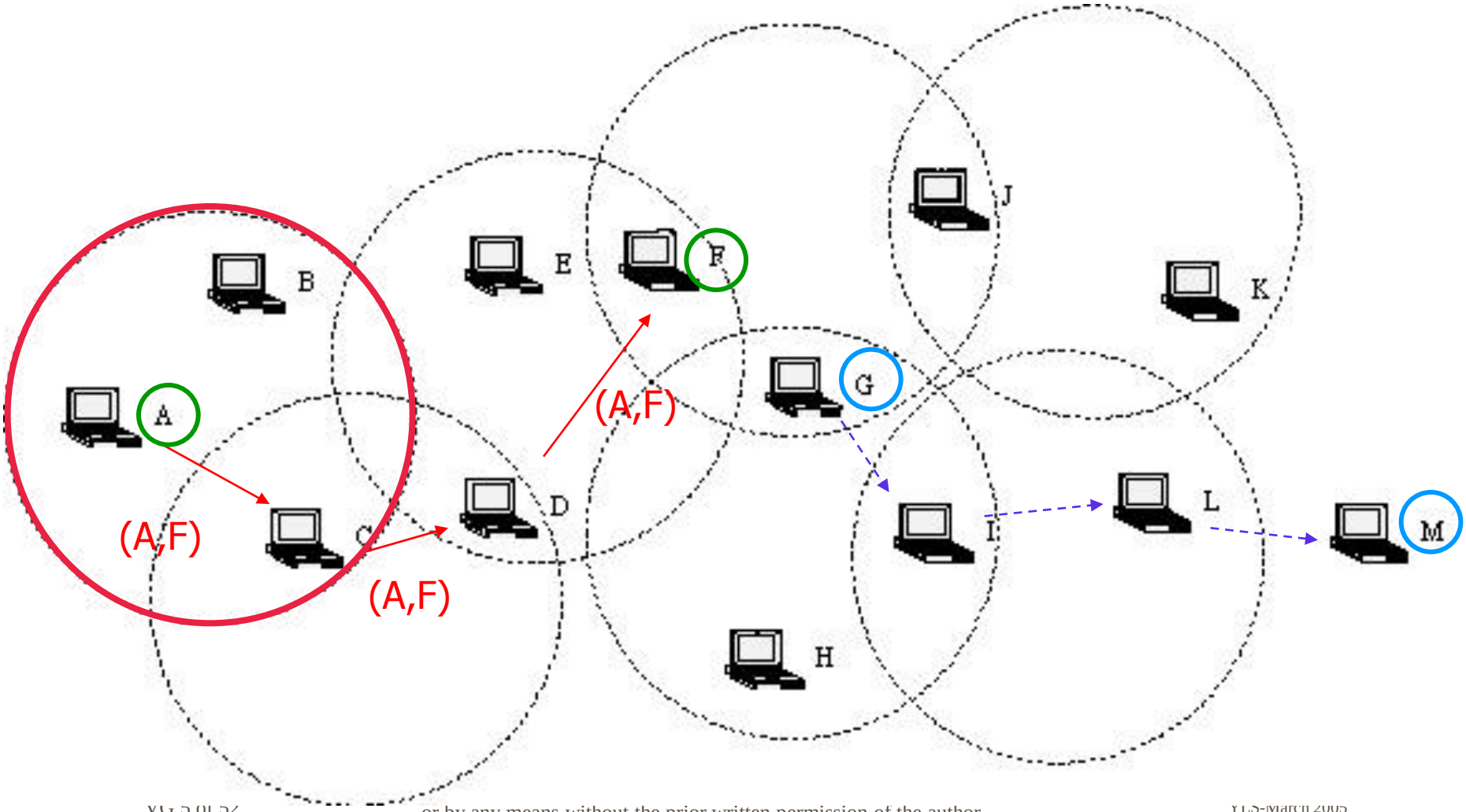
## Operation Modes

- Two network architectures are defined:
  - Infrastructure mode
  - Ad Hoc mode

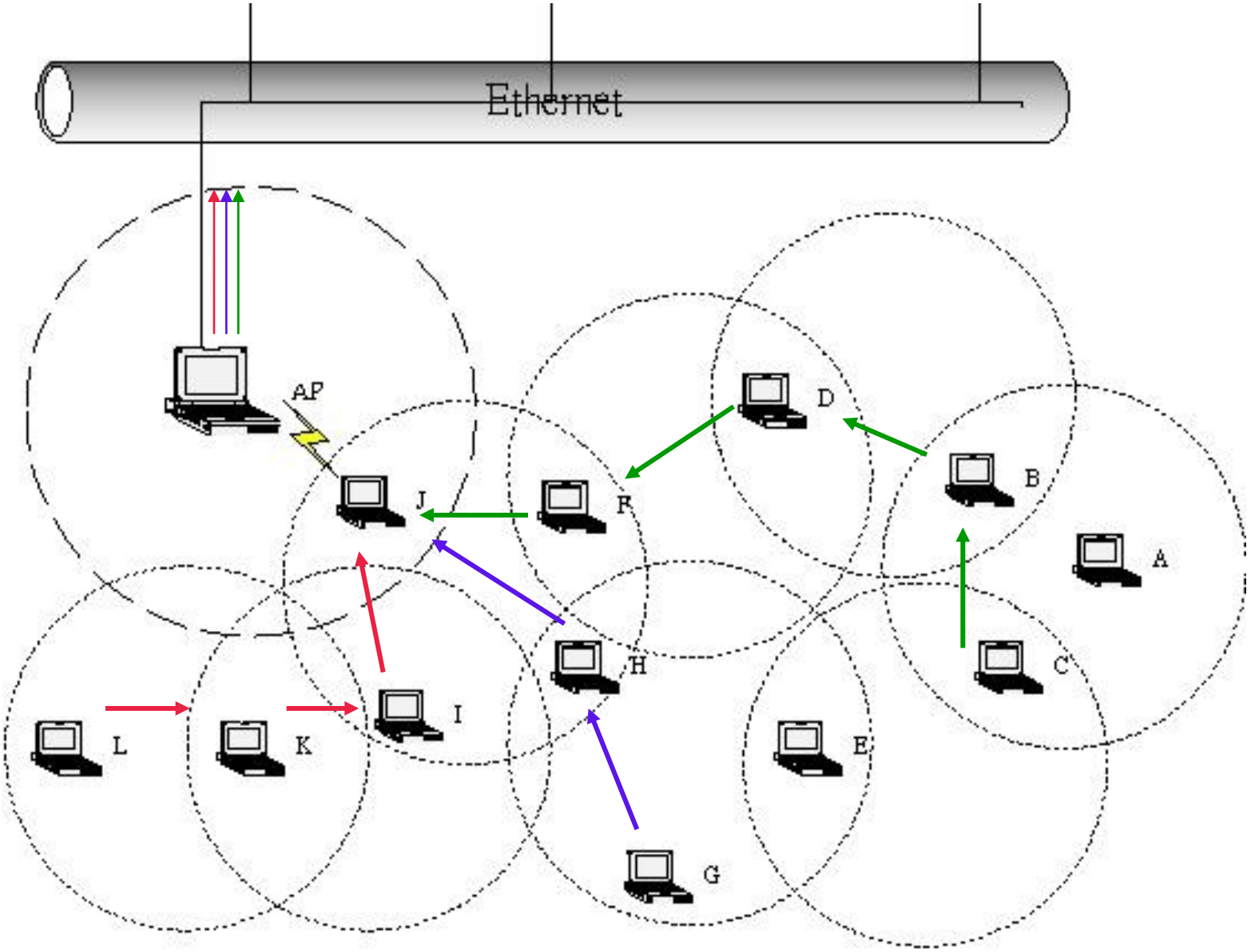
# Components of the IEEE 802.11 architecture



# Ad hoc Wireless Networks



# Ad hoc Wireless Networks



# WLAN Throughput …

- Basically it is a *multi-access* network – medium access control is needed.
- Depends on several factors, including
  - the number of users
  - microcell range
  - interference

# Distributed Coordination Function (DCF)

- Also known as *Carrier Sense Multiple Access with Collision Avoidance* (CSMA/CA) .
- The fundamental access method of 802.11 MAC
- *A random backoff time* following a busy medium condition.
- Immediate positive acknowledgement.

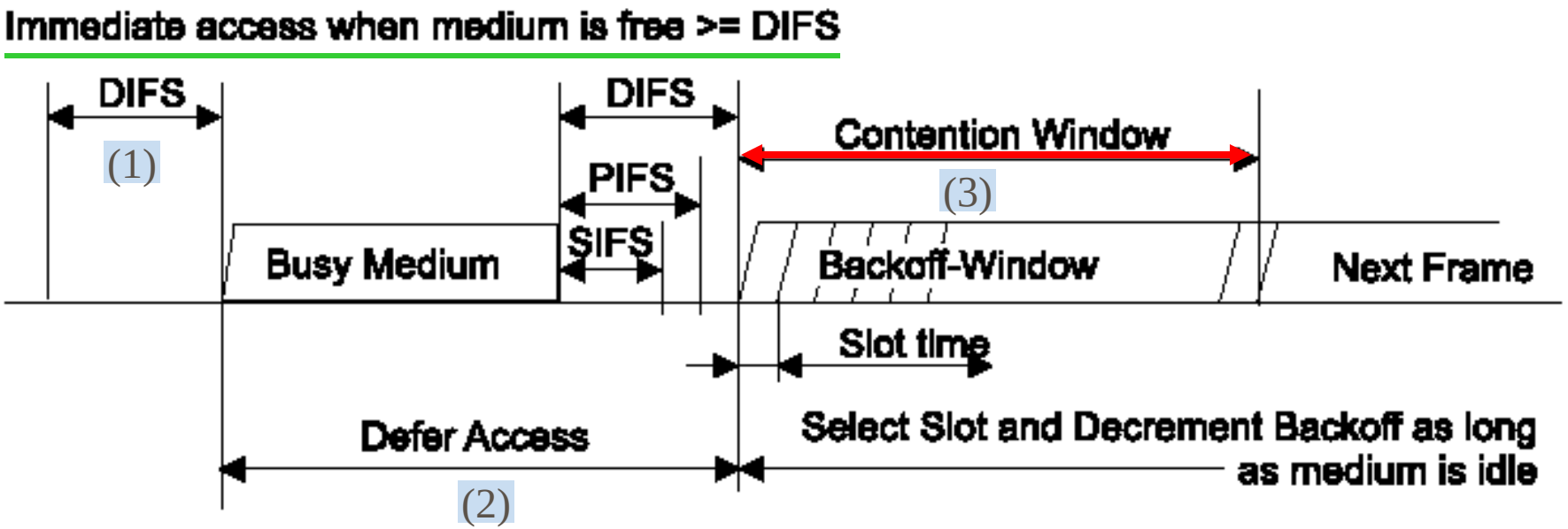
# InterFrame Space (IFS)

- IFS - A time interval that a STA must wait before transmitting a frame

Four IFSs are defined

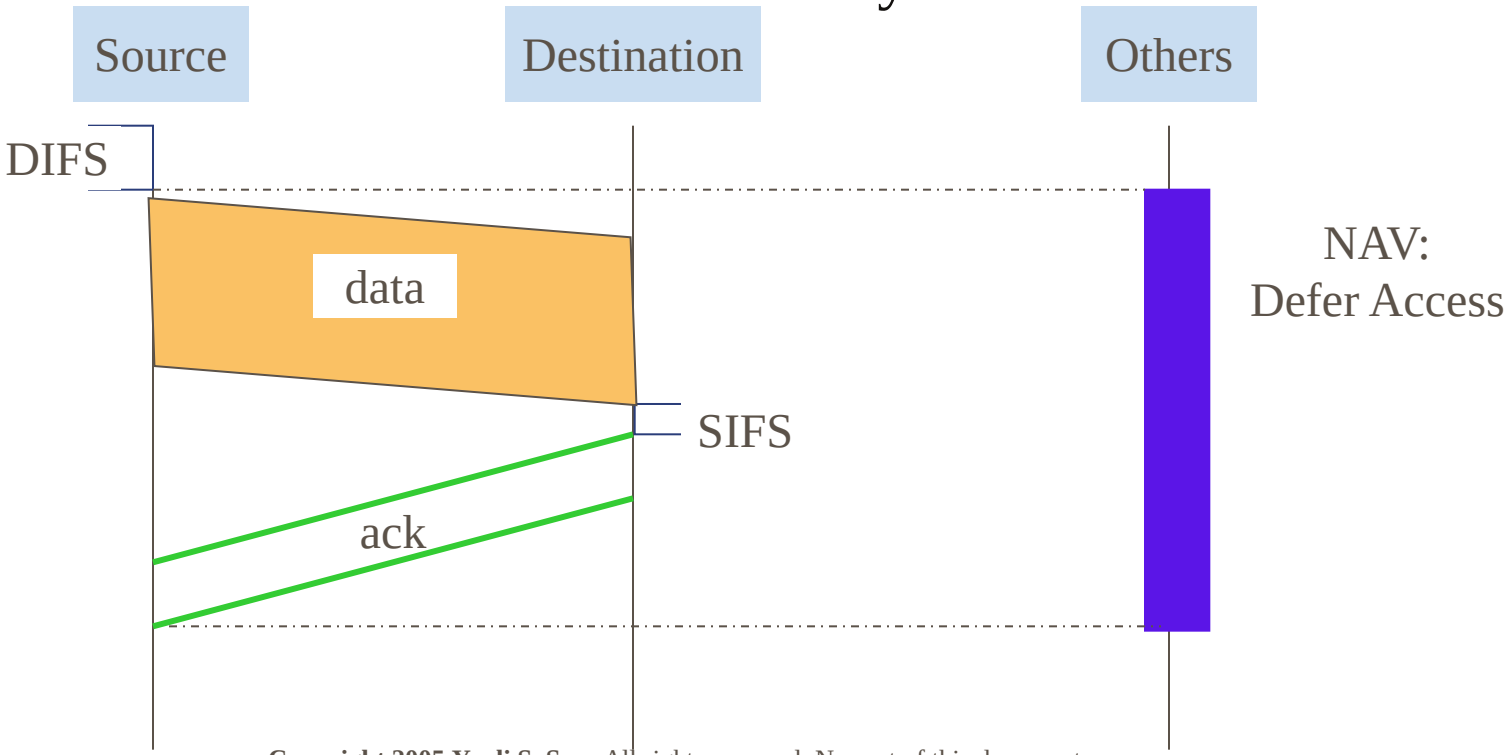
- DIFS (DCF)
  - for frames sent in Contention Period (CP).
- SIFS (short)
  - For control frames like ACK.
- EIFS (Extended)
  - for frame retransmission.
- SIFS < DIFS < EIFS
  - The shorter the IFS, the higher the priority to access WM.
- The IFS timing is independent of the STA bit rate.
- It is fixed for each PHY.

# Four Interframe Spaces (IFSs)



# Data Transmission and MAC-level Acknowledgment

- Immediate Positive ACK frame for error detection
- Retransmission for error recovery



# CSMA/CA Protocol

- Carrier sense
  - When a node has a packet to transmit, it first listens to ensure no other node is transmitting
- Collision avoidance
  - If the channel is *clear*, it chooses a random *"backoff factor".*
  - During periods if the channel is *clear*, the node *decrements* its backoff counter.
  - When the backoff counter reaches *zero*, the node *transmits* the packet.
  - The random *Backoff factor is used to minimize the probability of collision.*

# CSMA/CA Protocol (cont'd)

- Collision is unavoidable!
  - binary expotential backoff of CW range
- In DCF, every STA computes its own backoff time。

  Backoff time =INT(CW*Random())*slot time
  - CW (Contention Window)
    - An integer between [$CW_{min}$, $CW_{max}$]
    - Initial $CW_{min}$ =7 and $Cw_{max}$=255 。
  - Random(): a number within 0 and 1.
  - INT(x): the largest integer <= x.

# Why Collision Avoidance …

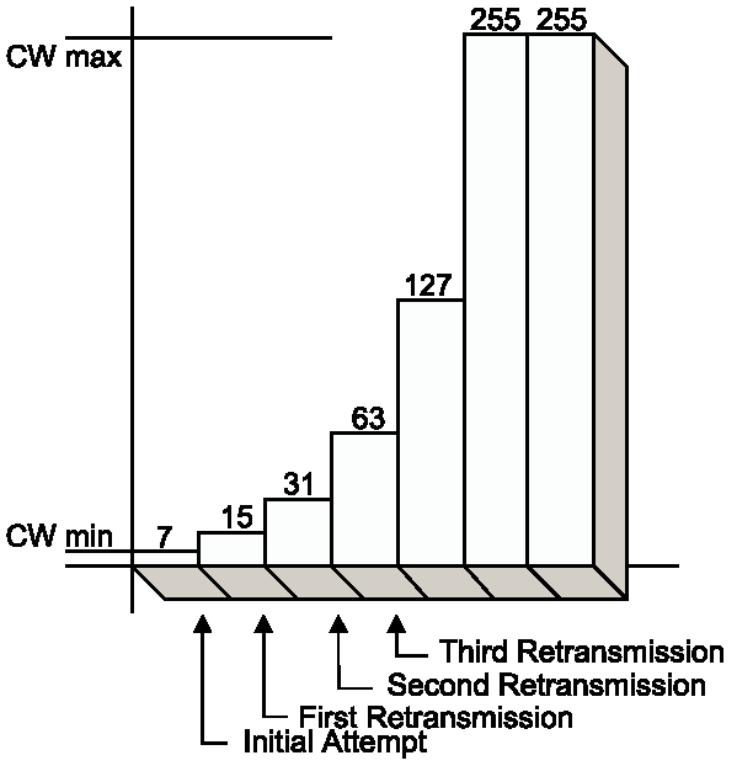
- Collision detection, as is employed in Ethernet, *cannot* be used for the radio frequency transmissions.
  - When a node is transmitting it ***cannot*** hear any other node in the system which may be transmitting.
  - Its own signal will drown out any others arriving at the node.
- Since the probability that two nodes will choose the same backoff factor is *small*, collisions between packets are *minimized*.

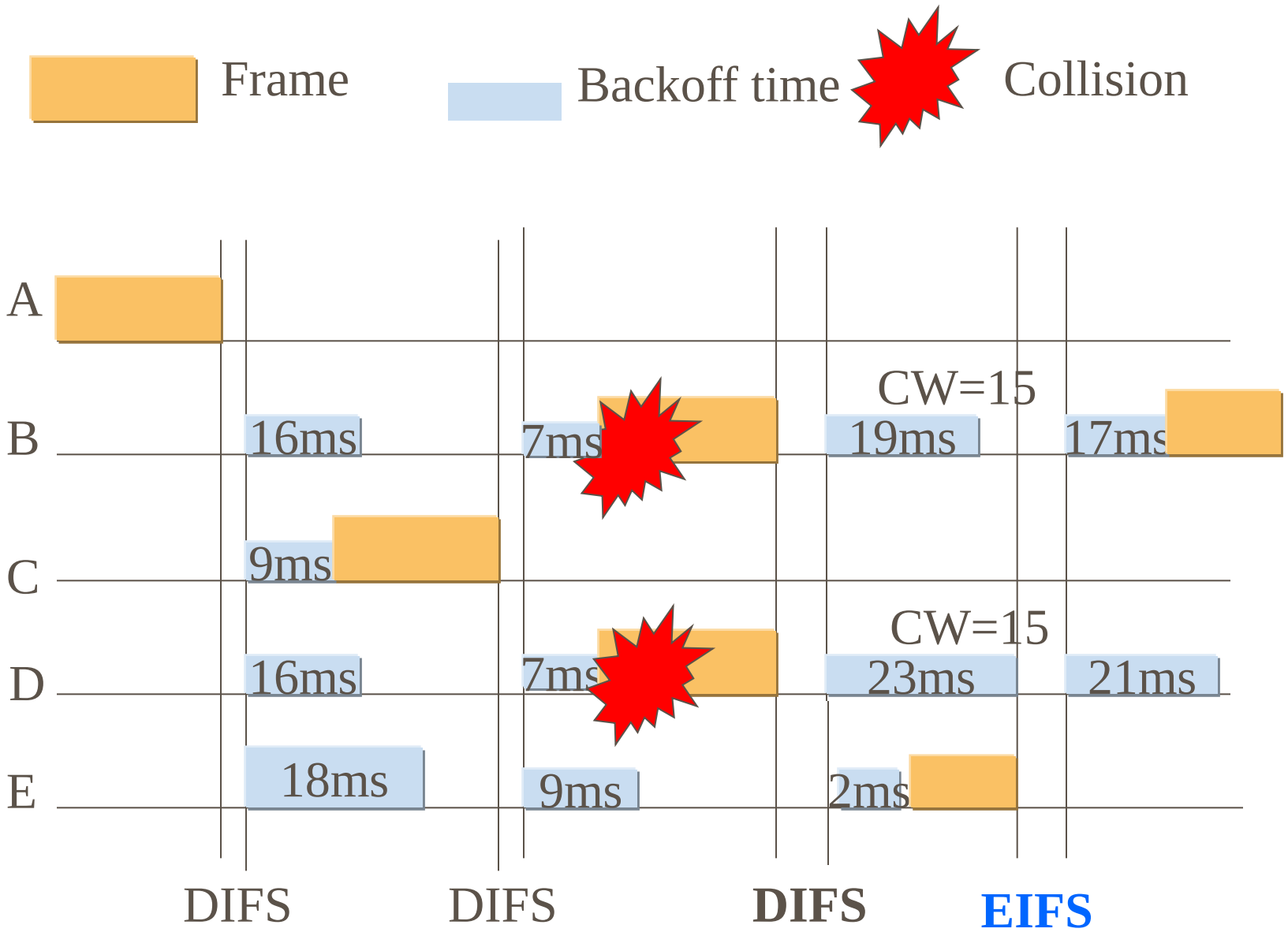
# Collision and Retransmission

- 當兩個以上的STA同時將backoff time減至0時，兩個STA會同時傳輸其Frame，以致發生collision，這時候兩個STA對其送出的Frame都將收不到Ack。
- 發生collision後，STA將進入Retransmission階段，這時候STA進入contention window前要等待的IFS時間將變成EIFS。
- 其計算backoff time的CW參數也將變為原兩倍。
- 若是第一次Retransmission仍發生collision，則CW再變為原來兩倍。直到CW成長到$CW_{max}$為止。

# Collision and Retransmission (cont'd)

- 若同一個Frame持續發生collision，CW值的成長依序為（7,15,31,63,125,255,255,5,…）





# Backoff in CSMA/CA vs. Backoff in CSMA/CD

- IEEE802.11使用的backoff演算法與在IEEE802.3中所使用的backoff演算法基本上是相同的 (exponential backoff for retransmission)。
- 兩者最大不同的地方在於CSMA/CD中，是在STA發生collision後才啟動backoff演算法。而在CSMA/CA中，每個STA在發生collision前就執行backoff演算法。
- CSMA/CA中先執行backoff演算法最主要的目的就是要減少collision發生的機率，因為在wireless環境下collision的監測並不容易實行。解決collision所必須付出的成本遠比在wired情況下大，因此必須盡量減少collision發生。