Certified Wireless Network Administrator (CWNA) PW0-106

Chapter 8

802.11 Medium Access

Chapter 8 Overview

- CSMA/CA vs. CSMA/CD
- Distributed Coordination Function (DCF)
- Point Coordination Function (PCF)
- Hybrid Coordination Function (HCF)
- Block Acknowledgement (BA)
- Wi-Fi Multimedia (WMM)
- Airtime Fairness

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CSMA/CA vs. CSMA/CD

- Both are Media Access Control (MAC) methods
- CSMA/CA – Carrier Sense Multiple Access with Collision Avoidance (used with 802.11)
- CSMA/CD – Carrier Sense Multiple Access with Collision Detection (used with 802.3)
- Wireless devices cannot transmit and receive at the same time
- Therefore, CSMA/CA cannot detect collisions whereas CSMA/CD can

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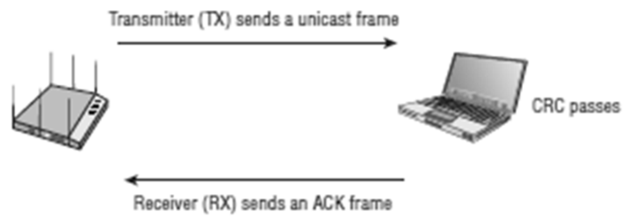
CSMA/CA vs. CSMA/CD (continued)

- Both initially sense if the medium is available
- While CSMA/CD devices can then transmit immediately, CSMA/CA must choose a random back-off value and count down before transmitting
- Since CSMA/CA devices cannot detect collisions, ACK must be received to identify that the frame was received

Collision Detection



- If cyclic redundancy check (CRC) on received frame fails, receiving radio will not send an ACK
- If ACK is not received, 802.11 frame must be retransmitted after CSMA/CA process again
- 802.11 cannot detect if a collision occurs
- Majority of unicast 802.11 frames must be acknowledged
- Broadcast and multicast frames do not require acknowledgements

Distributed Coordination Function (DCF)

- Fundamental access method of 802.11
- Mandatory access method
- Consists of four main components
  - Interframe Space
  - Duration/ID Field
  - Carrier Sense
  - Random Back-off Timer

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Interframe Space (IFS)

- Period of time that exists between transmissions
- Six types of interframe spaces
  - Reduced Interframe Space (RIFS) – highest priority
  - Short Interframe Space (SIFS) – second highest priority
  - PCF Interframe Space (PIFS) – middle priority
  - DCF Interframe Space (DIFS) – lowest priority
  - Arbitration Interframe Space (AIFS) – used by QoS stations
  - Extended Interframe Space (EIFS) – used with retransmissions

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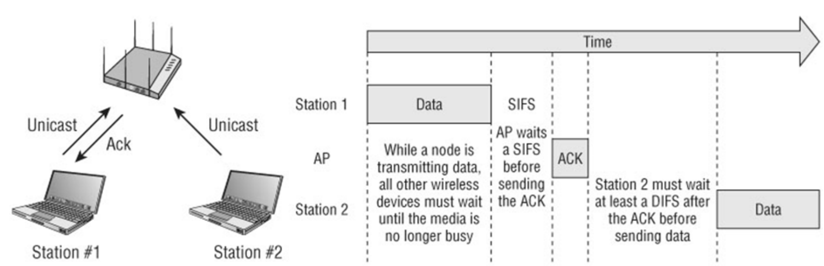
Interframe Space (IFS)

- Time order of interframe spaces
  - RIFS < SIFS < PIFS < DIFS < AIFS < EIFS
- Actual interframe space times vary depending on transmission speed of the network
- SIFS and DIFS are the two most common



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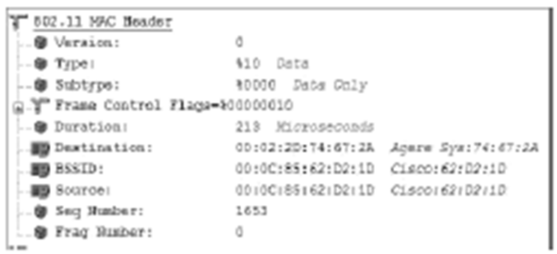
Duration/ID Field

- Field in the MAC header of an 802.11 unicast frame
- Value from 0 to 32,767
- Represents the time in microseconds to transmit the ACK plus one SIFS interval



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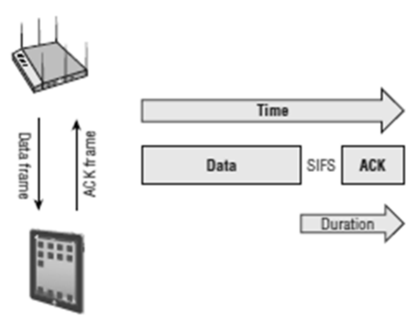
Duration/ID Field

- Used to reset other stations' network allocation vector (NAV) time
- Occasionally used in a PS-Poll frame as an ID value of a client station using legacy power management

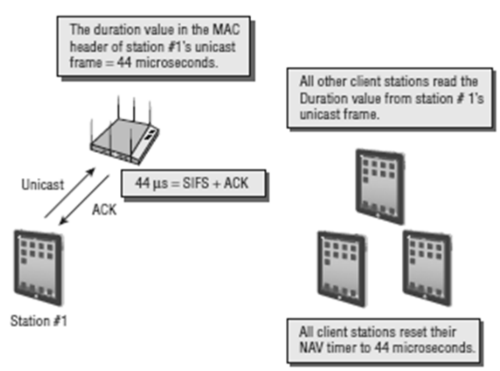


Virtual Carrier Sense

- Uses the network allocation vector (NAV) timer mechanism
- Maintains a predication of future traffic on the medium, based on Duration value information
- When a station is not transmitting
  – Hears a frame transmission from another station
  – Looks at the header and reads the Duration/ID field
  – If the field contains a duration value, it sets the NAV timer to the Duration value
  – Station uses the NAV as a countdown timer, waiting until its NAV timer is 0 before it can contend for the medium again

Virtual Carrier Sense (continued)

- Transmitting station notifies other stations that the medium will be busy



Physical Carrier Sense

- Performed constantly when a station is not transmitting or receiving
- Station listens to see if channel is busy
- Performs two purposes:
  - Determine if a frame transmission is inbound for a station to receive
  - Determine if the medium is busy before transmitting - Clear Channel Assessment (CCA)
- Both virtual and physical carrier sense are always happening at the same time

Random Back-Off Timer

- Occurs after medium is inactive for DIFS interval, and a station wants to transmit
- Back-off value is chosen from a range of 0 to the initial contention window value
- Back-off value is then multiplied by the slot time, which differs among the different PHYs
- When the back-off time equals 0, the client can reassess the channel and begin transmitting if the channel is clear

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Random Back-Off Timer Example

- An OFDM station selects a random number from a contention window of 0–15. For this example, the number chosen is 4.
- The station multiplies the random number of 4 by a slot time of 9µs.
- The random backoff timer has a value of 36µs (4 slots)
- For every slot time during which there is no medium activity, the backoff time is decremented by a slot time.
- The station decrements the backoff timer until the timer is zero.
- The station transmits if the medium is clear

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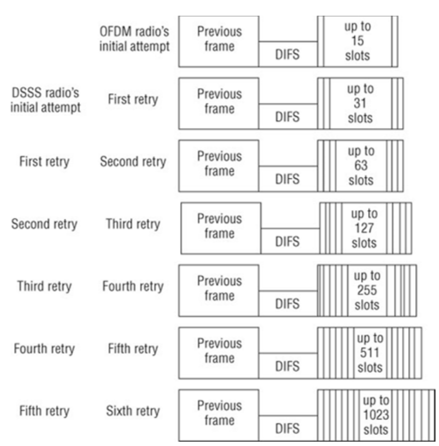
Random Back-Off Timer (continued)

- Contention window length



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Point Coordination Function (PCF)

- Optional 802.11 media access method
- Uses a form of polling
- AP acts as Point Coordinator (PC)
- Will only work with BSS or ESS
- Both AP and station must support PCF
- AP will alternate between PCF and DCF mode
- When functioning in PCF mode, it is known as the contention-free period (CFP)
- When functioning in DCF mode, it is known as contention period (CP)
- PCF has yet to implemented by any vendors

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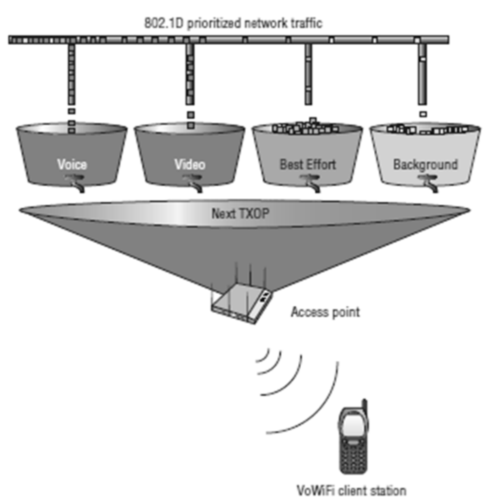
Hybrid Coordination Function (HCF)

- Added by 802.11e quality of service amendment
- Combines capabilities from DCF and PCF
- Adds enhancements to create two channel-access methods:
  - Enhanced Distributed Channel Access (EDCA)
  - HCF Controlled Channel Access (HCCA)
- Defines ability to send multiple frames sequentially, known as a *frame burst*
- When contending for the medium, station receives an allotted time to send frames, call *transmit opportunity (TXOP)*

Enhanced Distributed Channel Access (EDCA)

- An extension of DCF
- Media access method that provides differentiated access using 8 *user priority (UP)* levels
- Uses priority tags that are identical to those defined in 802.1D
- Defines four access categories based on the Ups
  - AC_BK (Background) – lowest priority
  - AC_BE (Best Effort)
  - AC_VI (Video)
  - AC_VO (Voice) – highest priority

Enhanced Distributed Channel Access (EDCA)



HCF Controlled Channel Access (HCCA)

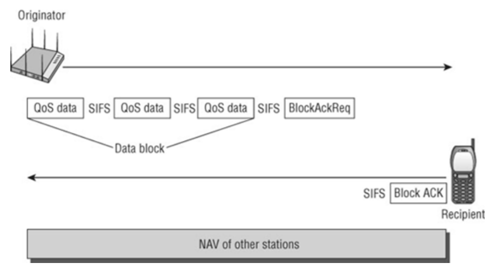
- Media access method that uses a QoS-aware centralized coordinator known as *hybrid coordinator (HC)*
- Operates differently than PCF
- HC is built into the AP and has a higher priority of access to the wireless medium
- AP can allocate TXOPs to itself or other stations
- Provides a limited-duration *controlled access phase (CAP),* providing contention-free transfer of QoS data

Block Acknowledgement (BA)

- Introduced in the 802.11e amendment
- Improves channel efficiency by aggregating several ACKs into one single ACK frame
- Two types of Block ACK mechanisms
  - Immediate Block ACK – designed for use with low-latency traffic
  - Delayed Block ACK – more suited for latency-tolerant traffic
- More efficient and cuts down on medium contention overhead

Block Acknowledgement (BA) (continued)

- Originator station sends a block of QoS data frames to a recipient station
- Originator requests ACK of all the outstanding QoS data frames by sending a BlockAckReq frame
- A single Block ACK will acknowledge all of the QoS data frames



Wi-Fi Multimedia (WMM)

- Introduced by Wi-Fi Alliance as a partial mirror of 802.11e amendment, prior to its completion
- Based on EDCA mechanisms
- 802.1D priority tags are used to direct traffic to four access-category priority queues
- Wi-Fi Alliance also defined
  - WMM-PS (Power Save) to increase battery life
  - WMM-Admission Control, which defines the use of management frames for the signaling between an AP and a client station

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Wi-Fi Multimedia Access Categories

Access Category	Description	802.1D tags
WMM Voice Priority	This is the highest priority. It allows multiple and concurrent VoIP calls with low latency and toll voice quality	7, 6
WMM Video Priority	This supports prioritized video traffic before other data traffic. A single 802.11g or 802.11a channel can support three to four SDTV video streams or one HDTV video stream.	5, 4
WMM Best Effort Priority	This is traffic from applications or devices that cannot provide QoS capabilities, such as legacy devices. This traffic is not as sensitive to latency but is affected by long delays, such as Internet browsing	0, 3
WMM Background Priority	This is low-priority traffic that does not have strict throughput or latency requirements. This traffic includes file transfers and print jobs	2, 1

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Airtime Fairness

- Proprietary and vendor specific
- Goal is to allocate equal time to the media, as opposed to equal opportunity
- Slower devices force faster devices to wait longer before transmitting
- Provides better time management of the RF medium by giving faster transmissions more transmit opportunities
- Mostly used for downstream transmissions from an AP associated clients

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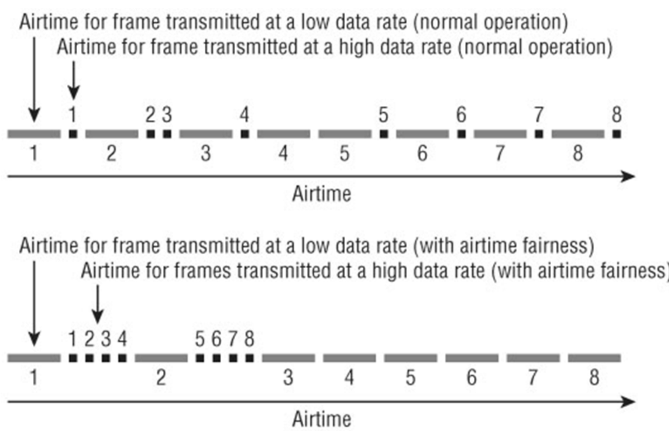
Airtime Fairness (continued)



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