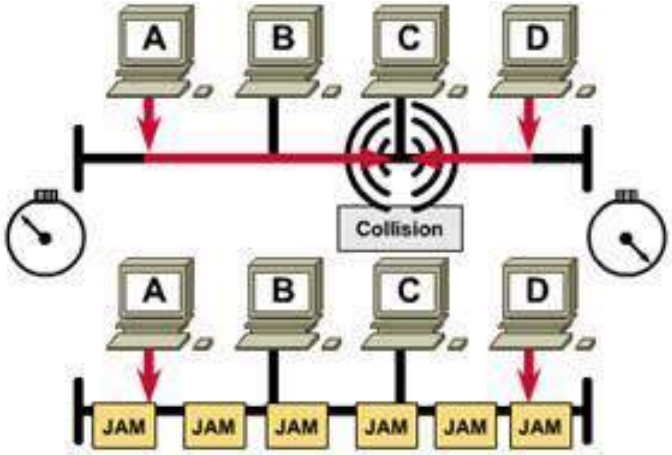
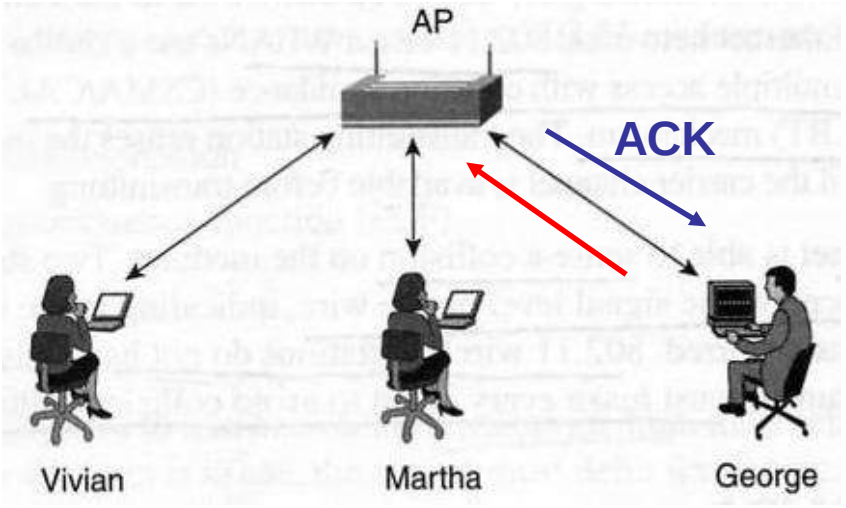
Medium Access – CSMA/CA

All stations detect the collision



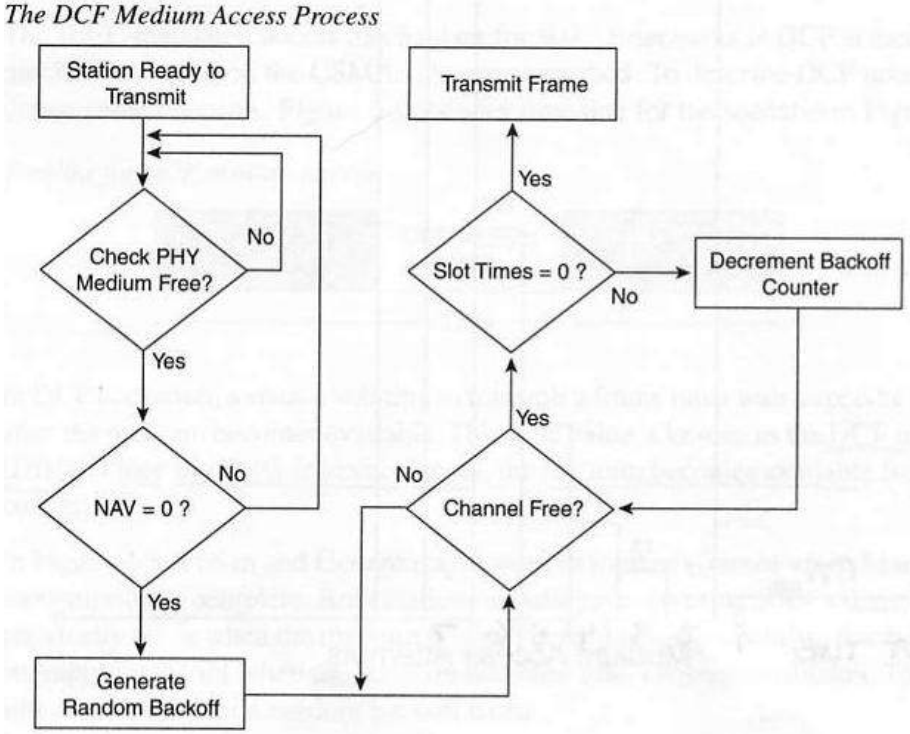
CSMA/CD



CSMA/CA

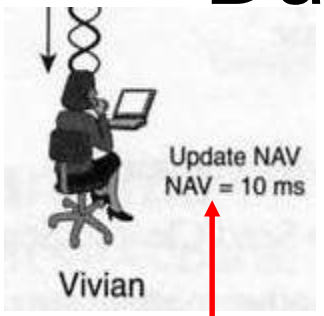
- The 802.11 standard makes it mandatory that all stations implement the DCF (Distributed Coordination Function), a form of carrier sense multiple access with collision avoidance (CSMA/CA).
- CSMA is a contention-based protocol making sure that all stations first sense the medium before transmitting (physically and virtually).
- The main goal of CSMA/CA is to avoid having stations transmit at the same time, which will then result in collisions and eventual retransmissions.
- However, collisions may still occur and when they do stations may or may not be able to detect them (hidden node problem).

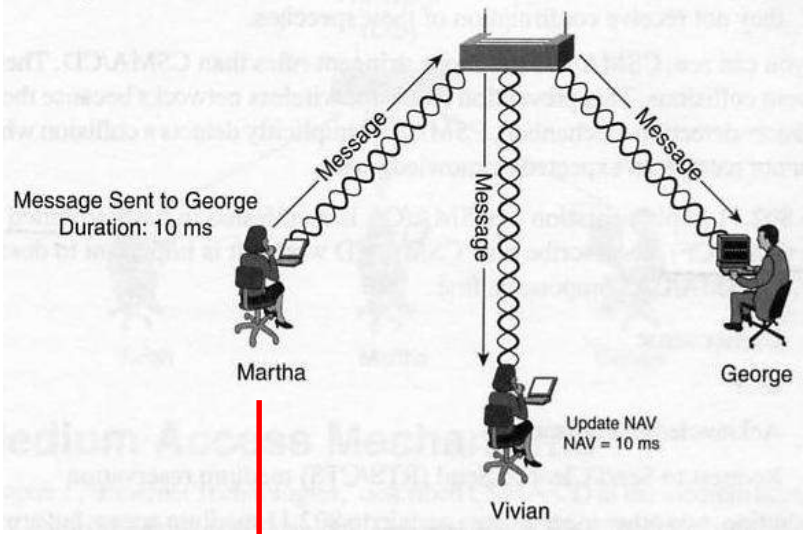
DCF Operation



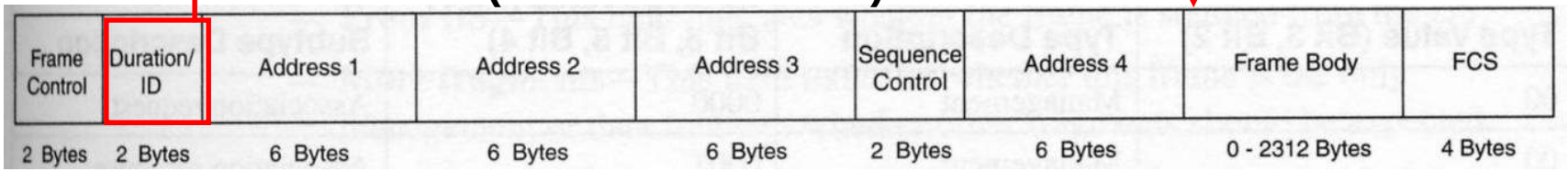
- In **DCF operation**, a station wanting to transmit :
  - Checks to see if **radio link is clear,** CS/CCA – Carrier Sense, Clear Channel Assessment.
  - Checks its **NAV timer** to see if someone else is using the medium.
  - If medium is available DCF uses a **random backoff timer** to avoid collisions and sends the frame.
- Transmitting station only knows the 802.11 frame got there if it receives an **ACK**.
- May also use **CTS/RTS** to reduce collisions.

Duration Field



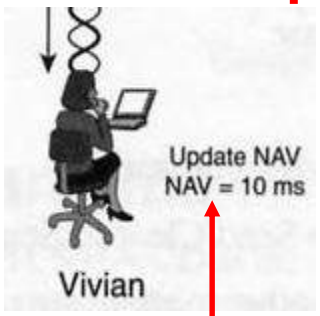


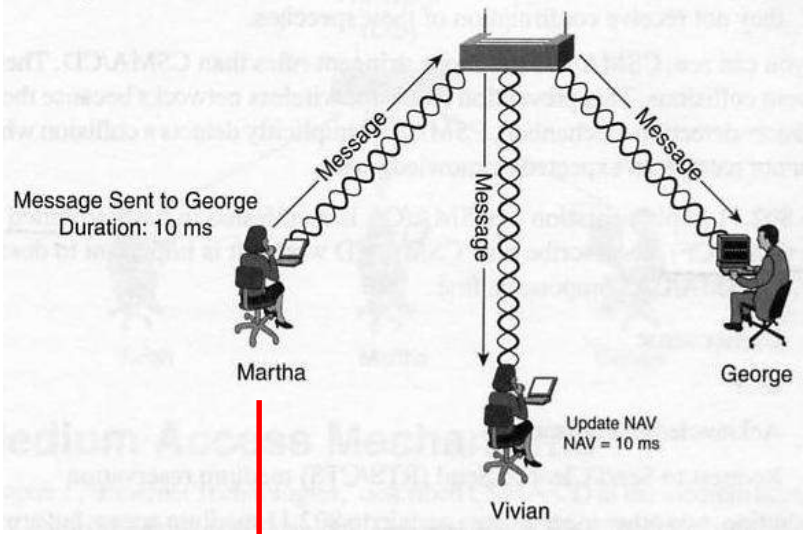
General 802.11 Frame (more on this later)



- **Duration/ID field** – The number of microseconds that the medium is expected to remain busy for transmission currently in progress.
  - Transmitting device sets the Duration time in microseconds.
  - Includes time to:
    - Transmit this frame to the AP (or to the client if from an AP)
    - The returning ACK
    - The time in-between frames, **IFS** (Interframe Spacing)
- All stations monitor this field!
- All stations update their **NAV** timer.

NAV Timer





General 802.11 Frame (more on this later)

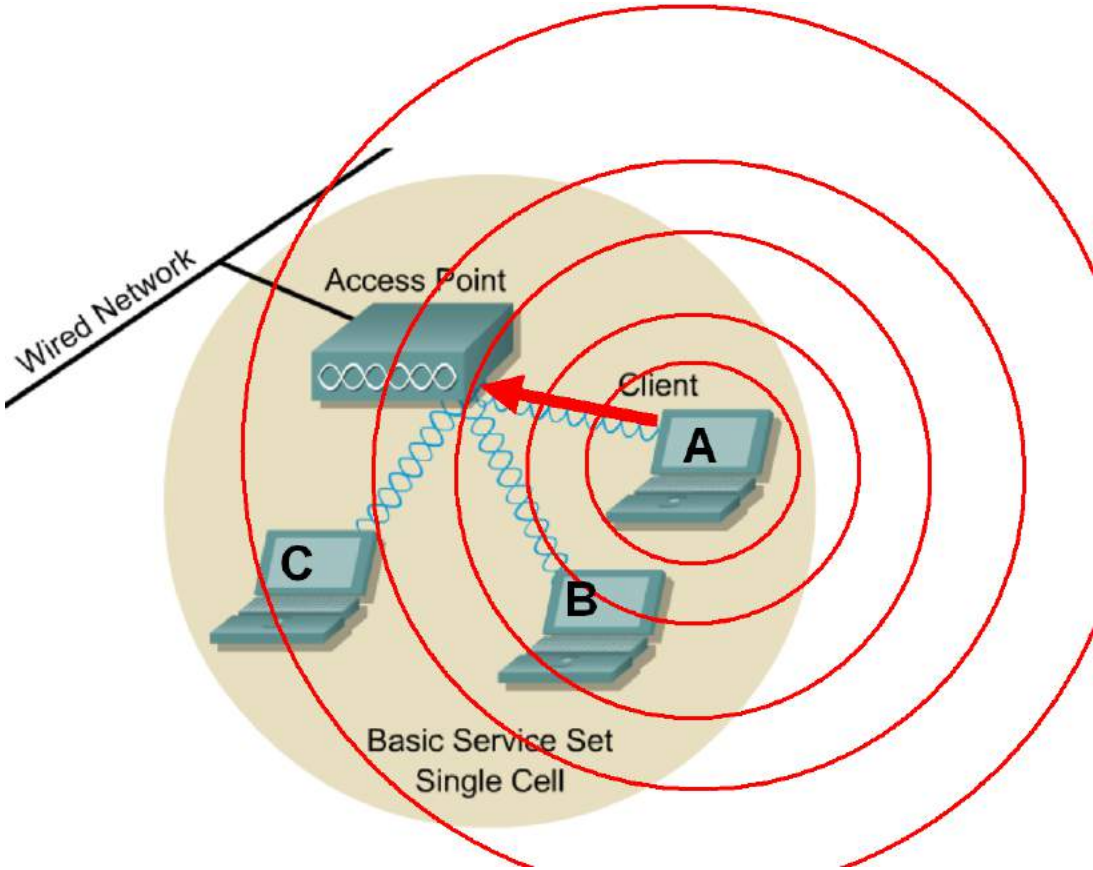
Frame Control	Duration/ ID	Address 1	Address 2	Address 3	Sequence Control	Address 4	Frame Body	FCS
2 Bytes	2 Bytes	6 Bytes	6 Bytes	6 Bytes	2 Bytes	6 Bytes	0 - 2312 Bytes	4 Bytes

- All stations have a **NAV** (Network Allocation Vector) timer.

- Martha sends a frame to George.
- Since wireless medium is a “broadcast-based” (not broadcast frame) shared medium, all stations including Vivian receive the frame.
- Vivian updates her NAV timer with the duration value.
- Vivian will not attempt to transmit until her NAV is decremented to 0.
- Stations will only update their NAV when the duration field value received is grater than their current NAV.

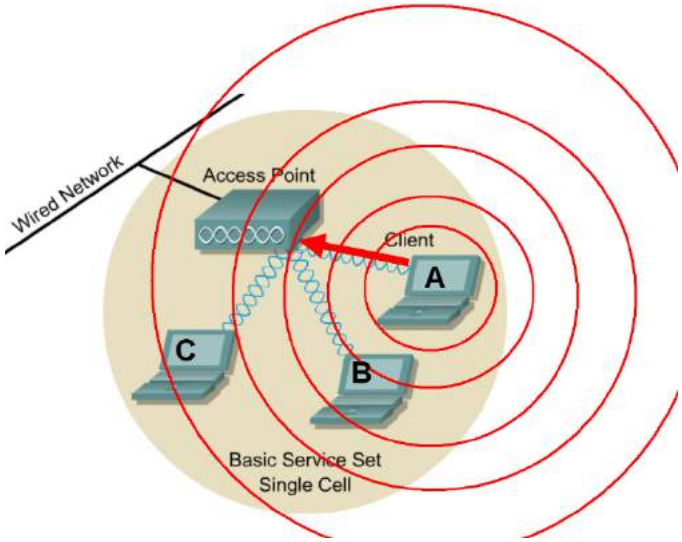
Broadcast-based shared medium

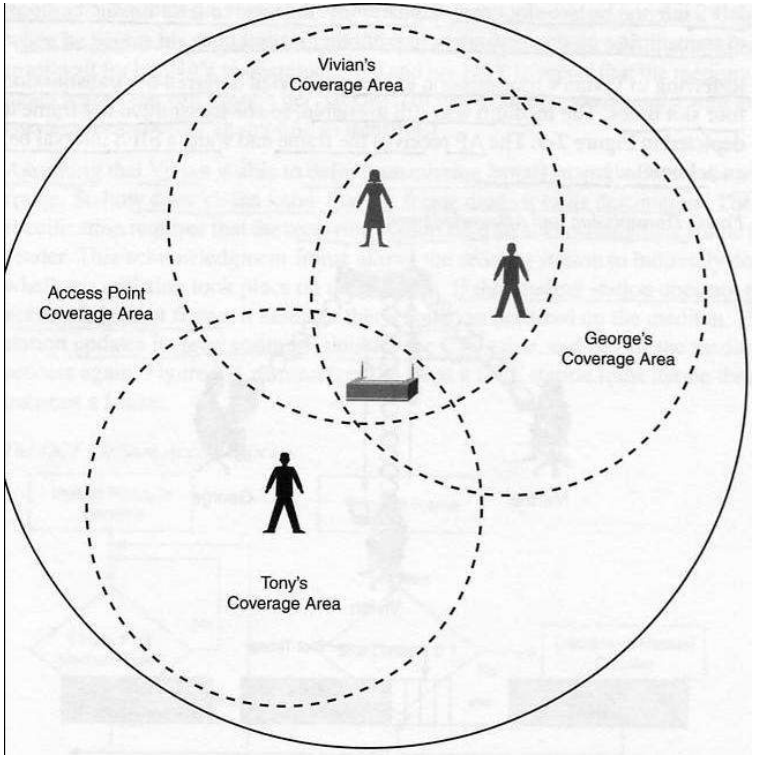
- Host A is sending 802.11 frames to another host via the AP.
- All other 802.11 devices in BSS (on this channel) and within range of the signal will see the frame.
- 802.11 framing provides addressing, so only the AP knows it is the next-hop receiver.
- Other 802.11 devices within this BSS can sense that the medium is in use and will update their NAV values.



What if a station is in range of the AP but not the Host A?

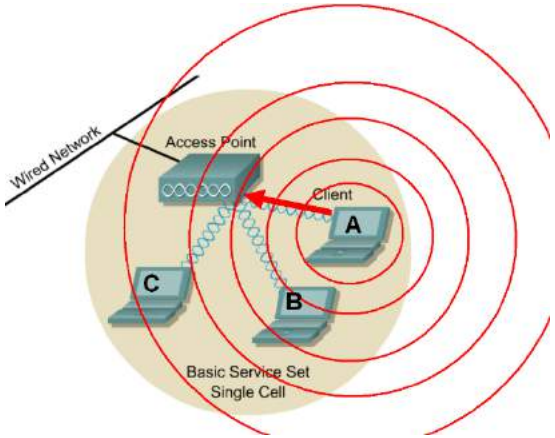
Hidden Node Problem

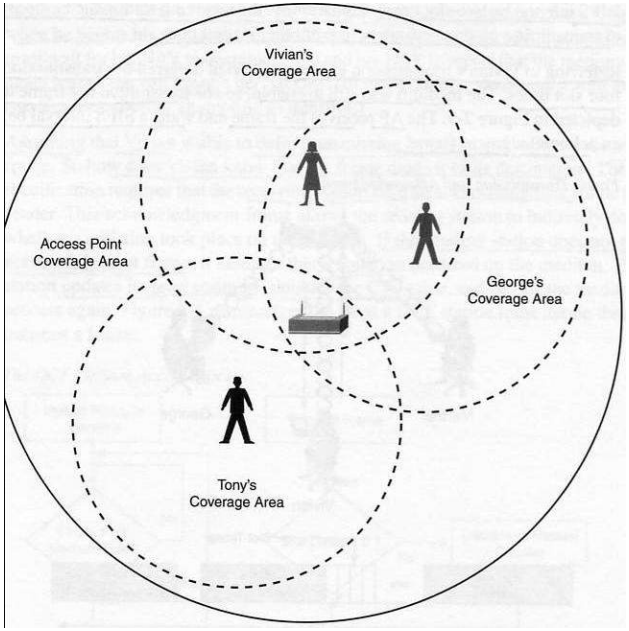




- *What if a station is in range of the AP but not other hosts, like the transmitting host?*
- Hidden nodes can be caused by:
  - Hosts are in range of the AP but not each other.
  - An obstacle is blocking the signal between the hosts.

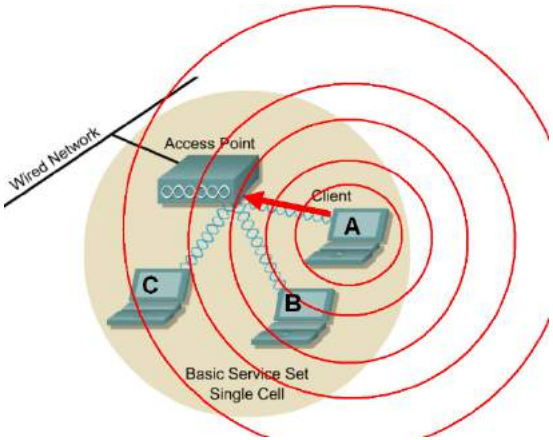
Hidden Node Problem

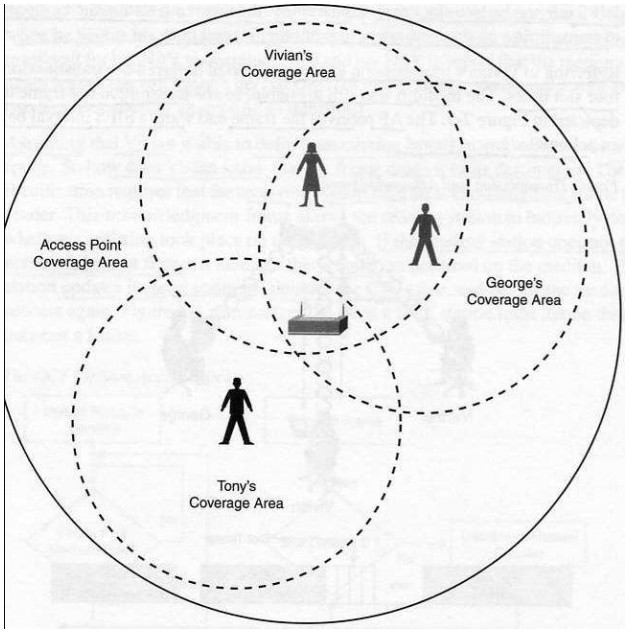




- The problem is collisions.
  - Collisions occur at the AP (or another station in an IBSS).
  - Both stations assume the medium is clear and transmit near the same time, resulting in a collision.
  - The AP cannot properly receive either signal and will not ACK either one.
  - Both stations restransmit, resulting in more collisions.
- Throughput is significantly reduced, up to 40%.

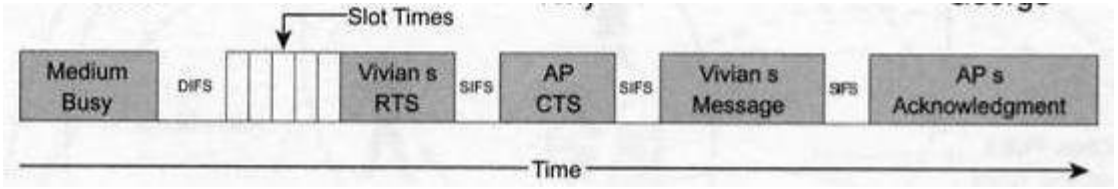
Hidden Node Problem

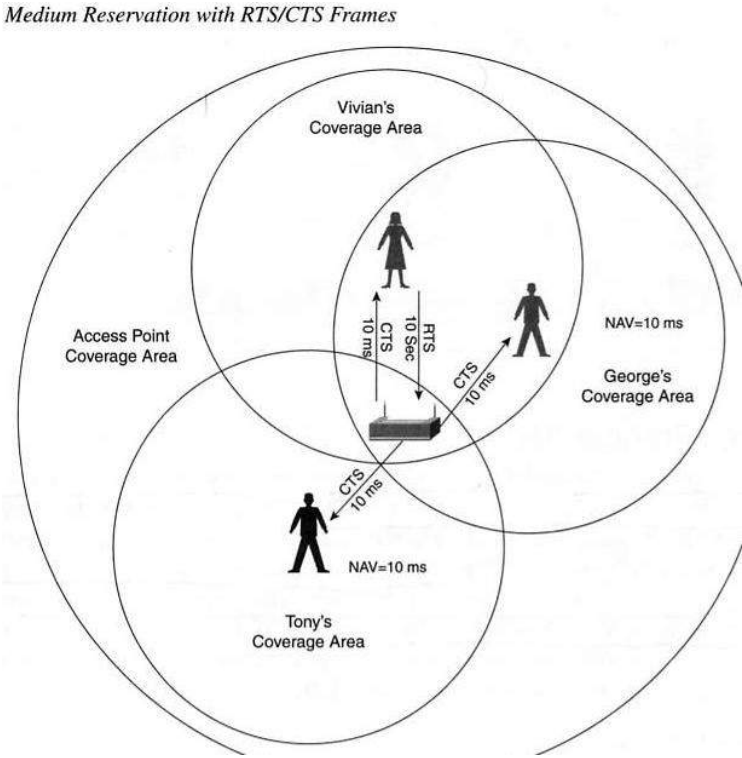




- Solutions:
  - Move the node
  - Remove the obstacle
  - Use RTS/CTS (Request to Send / Clear to Send)

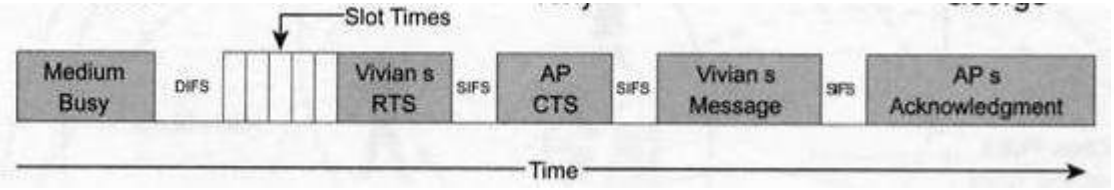
RTS/CTS Solution



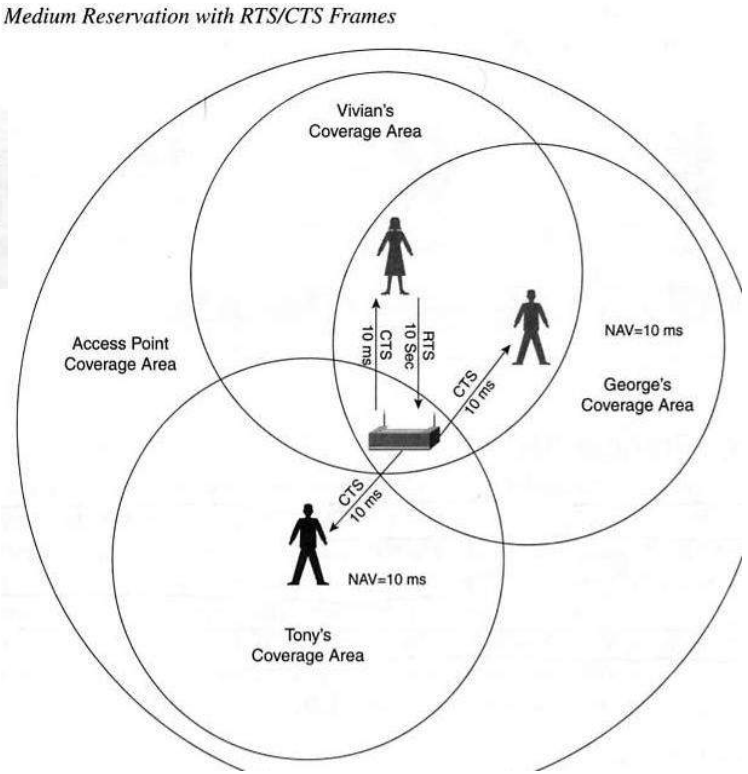


- Vivian attempts to reserve the medium using an RTS control frame to the AP.
- The RTS frame indicates to the AP and all stations within range, that Vivian wants to reserve the medium for a certain duration of time, message, ACK, and SIFS.
  - The hidden node stations cannot see the RTS.
  - The AP replies to Vivian with a CTS, which all nodes, including the hidden node can see.
  - Vivian transmits the frame.
  - The AP returns an ACK to Vivian.
  - The AP sends the message to George who returns an ACK to the AP.

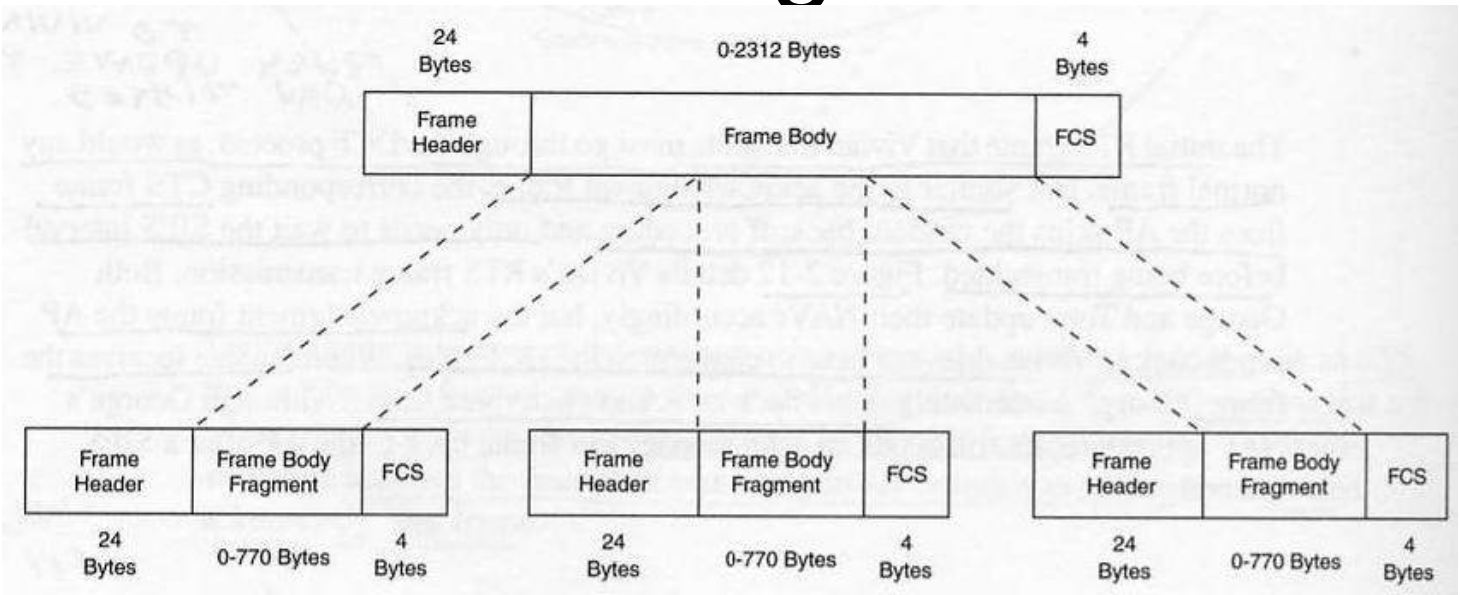
RTS/CTS Solution



- RTS/CTS consumes a fair amount of capacity and overhead, resulting in additional latency.
- Normally used in high capacity environments.

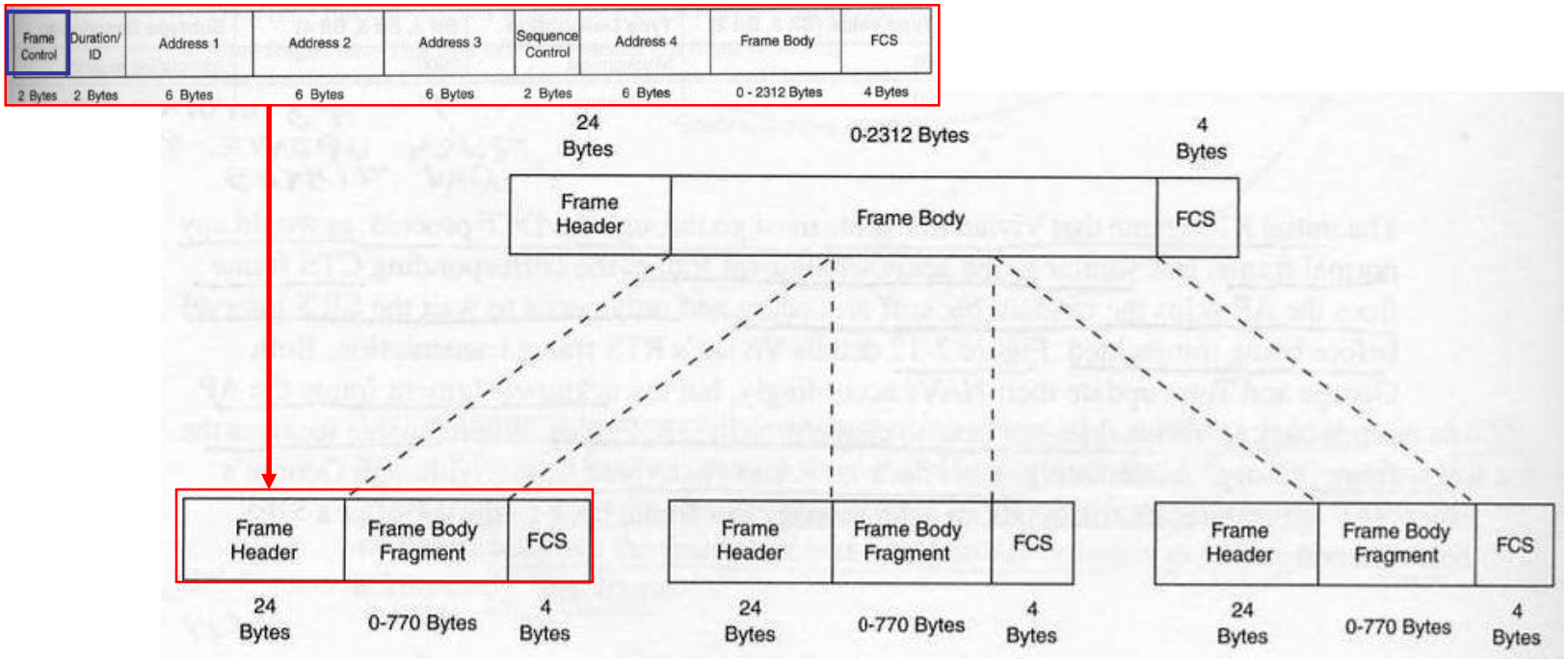


Frame Fragmentation



- In a “hostile wireless medium” (interference, noise) larger frames may have more of a problem reaching the receiver without any errors.
- By decreasing the size of the frame, the probability of interference during transmission can be reduced.
- Breaking up a large frame into smaller frames, allows a larger percentage of frames to arrive undamaged (without errors).

Frame Fragmentation



- Frame fragmentation can increase the reliability of frame transmissions but there is **additional overhead**:
  - Each frame fragment includes the 802.11 MAC protocol header.
  - Each frame fragment requires a corresponding acknowledgement.
- If a frame fragment encounters errors or a collision, only that fragment needs to be retransmitted, not the entire frame.
- The frame control field includes information that this is a fragmented frame.