November 1993 Doc: IEEE P802.11-93/208a

A Complete Description of Frame Prioritization in a CSMA/CA MAC Protocol

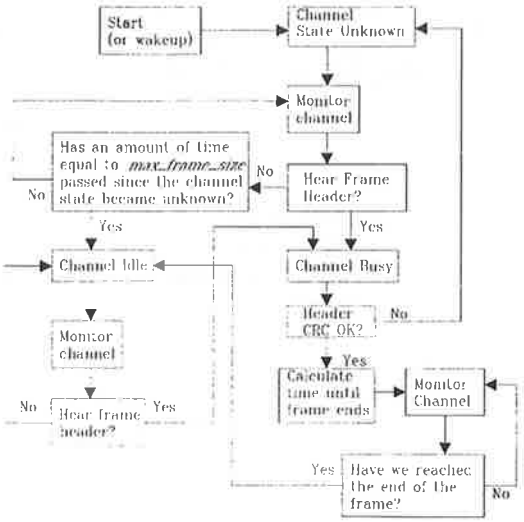
Rick White
Motorola
Wireless Data Group

November 1993 Doc: IEEE P802.11-93/208a

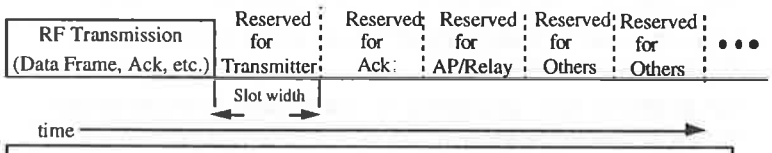
CSMA/CA Protocol

- The basic channel access method is P-persistent CSMA with a MAC-level acknowledgment.
- The protocol requires devices to "listen before talk".
- If the channel is busy, the devices must wait until the channel becomes idle.
- The protocol also provides an additional feature which allows some devices priority to initiate the next transmission after the channel becomes idle.

Determining the Channel State via Packet Detection



Channel Priority Mechanism Following a Transmission



Slots give some devices priority over other devices to initiate the next transmission. A device can initiate a transmission in its assigned slot only if channel remains idle. Devices wishing to transmit in the "others" slot execute P persistence algorithm.

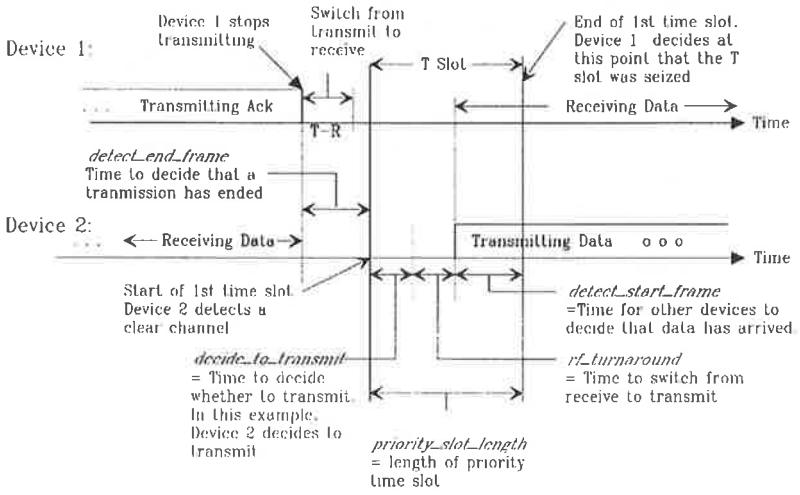
November 1993 Doc: IEEE P802.11-93/208a

Length of a Priority Time Slot

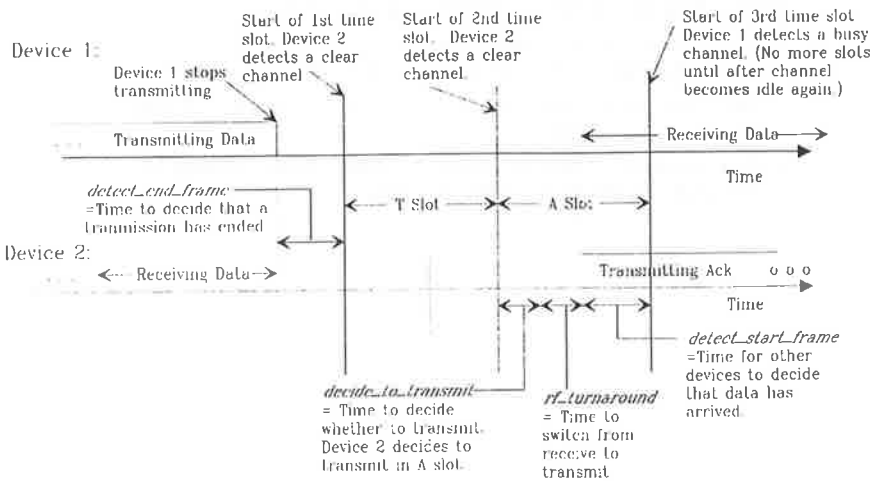
- The Priority Time Slot is made up of three components :
  - The amount of time required to make a decision to transmit when a clear channel is detected.
  - The amount of time it takes for the radio to change from receive to transmit.
  - The amount of time required for a device to determine that another device is transmitting

November 1993 Doc: IEEE P802.11-93/208a

Length of the Priority Time Slots: A Device Seizes the First Time Slot



Length of the Priority Time Slots: A Device Seizes the Second Time Slot



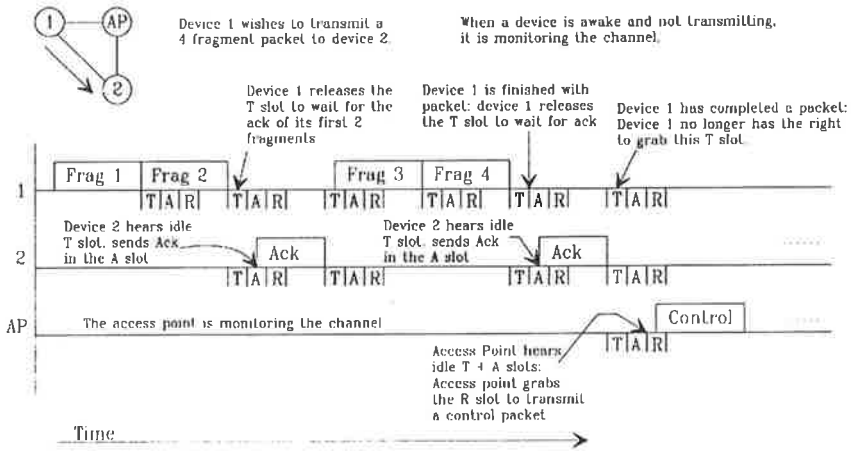
Transmitter Slot Usage

- **A device will only use the Transmitter Slot if the following conditions are met:**
  - **Either the device has just finished transmitting a data fragment or the device has just received an acknowledgment of its own data fragment.**
  - **The device has previously transmitted at least one fragment of a data packet and more fragments of the same packet require transmission.**
  - **The number of consecutive T slots the device has grabbed (without waiting for an acknowledgment) has not exceeded the *fragment_window_size*.**

Acknowledgment Slot Usage

- A device will only use the Acknowledgment Slot if the following conditions are met:
  - The device has just received a frame that requires acknowledging.
  - The T slot is detected idle.

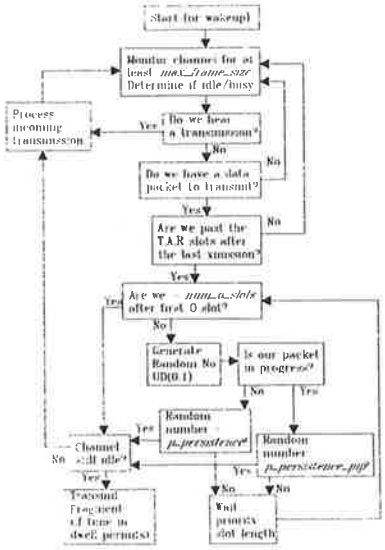
Transmitter, Acknowledgment, and Relay Slots



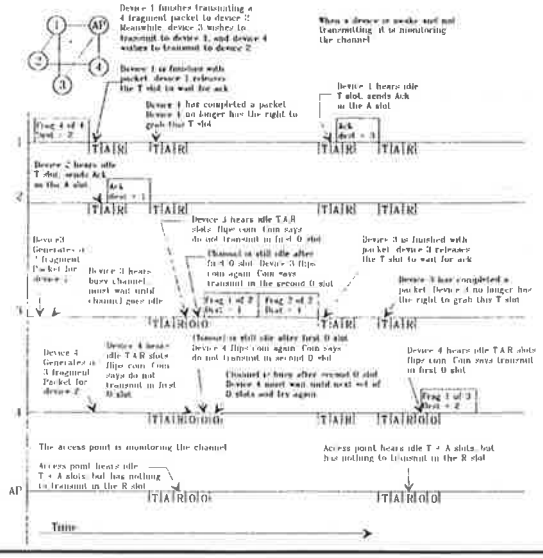
The "Others" Slots

- The "Others" slots are used by all devices that do not have a higher priority.
- These slots are the contention portion of the protocol.
- There are multiple "Others" slots.
- A P-Persistent algorithm is used by the device to determine which "Others" slot will be used.

P-Persistence Algorithm



The "Others" Slots and P-Persistence



Backoff

- There are two condition when the WMAC must refrain from transmitting
  - The device has a packet to transmit and the radio channel is sensed busy. This causes the MAC to use the Other Slot and P-Persistence.
  - The devices transmits a packet but fails to receive an acknowledgment. This causes the WMAC to execute the Backoff Algorithm.
    - » The data frame failed to reach its intended receiver.
    - » The acknowledgment frame was not received by the source device.
    - » A header CRC failure on a short fragment causes the receiving device to monitor the channel for *max_payload*. Meanwhile, another device hears an idle channel following the end of the frame and grabs an O slot before the receiving device can send its acknowledgment.

Backoff Timer Calculation

- The binary exponential backoff time can be calculated in the following manner. Assume a configurable system parameter, *mean_backoff_time*, which is the mean backoff time for the first retry.
  - Generate a random variable uniformly distributed between 0 and 1 (U(0,1)).
  - Generate the backoff time for the i^{th} retry with the following formula:

    backoff = $-mean\_backoff\_time * \ln(U(0,1)) * 2^{(i-1)}$

Backoff Algorithm