
Active Priority DCF Proposal

CSMA/CA with Active Priority Signalling CSMA/CA-APS

Proposed By:

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&
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DTBS History:

- **Distributed Time Bounded service (DTBS) introduced by Apple in January meeting following Hiperlan approach.**
- **CSMA/CA with priority mechanism introduced in March meeting by AT&T (doc 94/58).**
- **Committee decides to support DTBS, but method is still to be decided.**

Priority proposal History:

- Previous proposal introduced (doc 94/58) in IEEE and ETSI to support DTBS. (Priority through IFS differences).
- Alternative priority mechanism (based on priority signalling) suggested in IEEE by Apple in their January DTBS proposal.
- AT&T, Apple and Symbionics propose in May IEEE meeting to drop the reservation based TBS of the Foundation MAC in favor of the priority based DTBS approach. This was adopted as a recommendation.
- Priority signalling method analysed, and solutions were found for identified potential problems.

Vision:

- It is important to have a World-wide standard for high speed WLANs.
- The 5.2 GHz band is a good candidate to become World-wide available (unused extension band for obsolete MLS).
- Unlike Hiperlan in Europe, the FCC is not expected to exclusively assign such large amount of unlicensed spectrum to a single standard.
 - Etiquette needed to allow coexistence between dissimilar systems in the same band.
- The current (1.9 GHz) Etiquette does not support priority access as would be needed to support the Hiperlan and IEEE services (DTBS) in the 5.2 GHz band.

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IEEE P802.11-94/150a

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World-wide 5.2 GHz standard possible.

- If ETSI and IEEE are coexistent because they are based on the same Channel Access Method (CAM) supporting priority access, then this CAM can be:
 - “The 5.2 GHz Etiquette”
- The 5.2 GHz band is needed for High speed LANs
 - It can be the next unlicensed world-wide band.
 - Adequate spectrum available for High Speed.
 - Non spreading modulation types could be possible.

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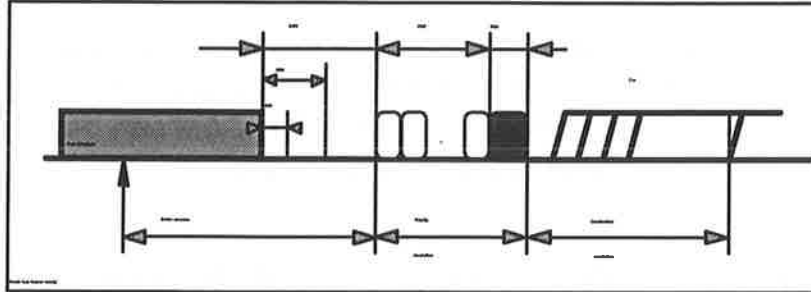
IEEE P802.11-94/150a

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Combined proposal:

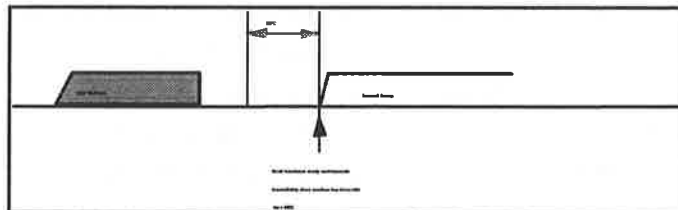
- Updated proposal supported by AT&T and Symbionics in both IEEE 802.11 and ETSI RES10.
 - Priority signalling method accepted for Hiperlan.
 - Contention resolution method still under discussion.
- Original random backoff based CSMA/CA proposal is upgraded with a priority signalling mechanism.
 - Provides for efficient priority separation and contention resolution.
 - Supports multiple priority levels with efficient hierarchical separation.
 - Maintains low criticality on PHY requirements.
 - » Tx-Rx turnaround time is not critical.
- No IPR ownership involved.
 - Original publication by Rom and Tobagi in 1981.

Basic Medium Access Mechanism:



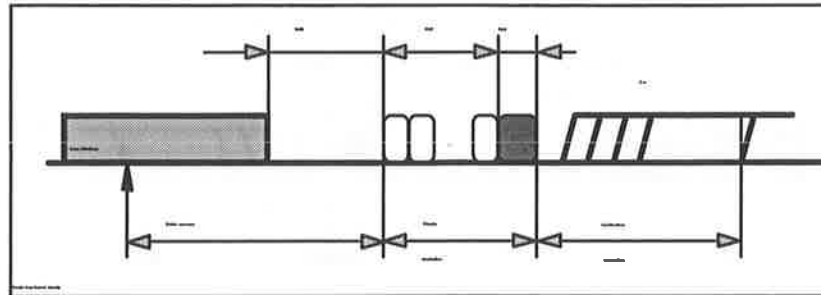
- **Channel Access Mechanism is split into two parts**
 - Priority resolution
 - Contention resolution

Low traffic model:



- **If medium is idle, transmit immediately**
- **Medium Free Condition (MFC) avoids "Channel Idle" decision during a contention.**
- **No priority resolution, no contention resolution needed.**

Priority Resolution:



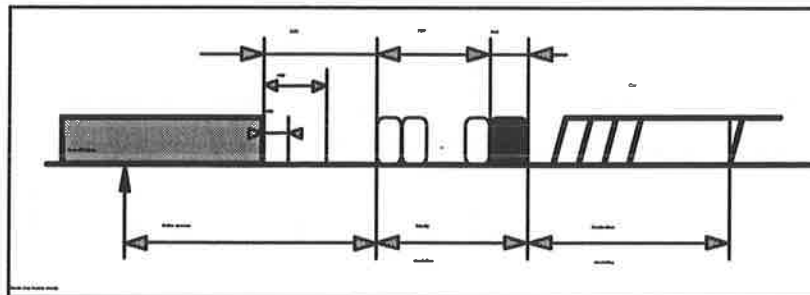
- **Priority Resolution is split into two parts**
 - Priority Detection Period (PDP)
 - Priority Assertion Signal (PaS)

Priority levels:



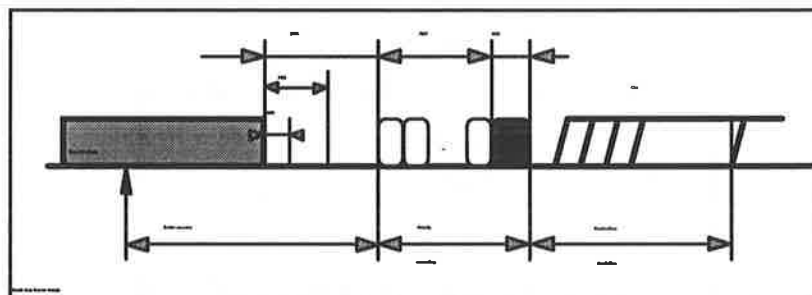
- **Active Priority Signalling**
 - Length of Priority Detection Period (PDP) together with length of PaS period sets priority level.
 - Linear coding (for priority n, the PDP is n-1 units long).

Contention resolution:



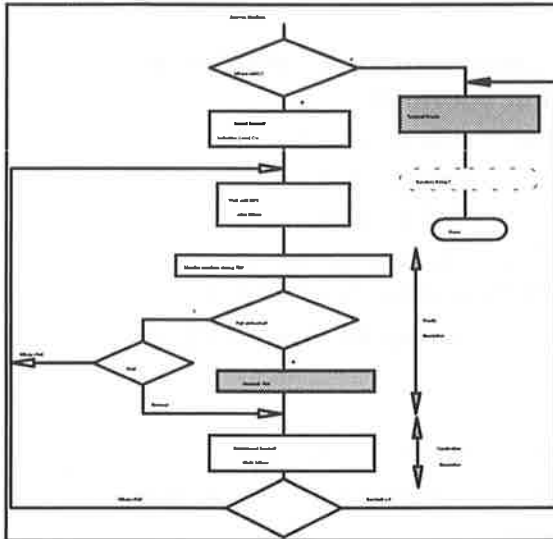
- **No changes compared to Foundation MAC.**
 - Randomly chosen back-off delay
 - Decrement Backoff only while Medium Free
 - Binary exponential CW increase for retransmissions for stability at high loads.

Physical Requirements:



- **Active signalling is one pulse**
 - Lowest priority does not need to send the PaS.
 - All stations need to be able to detect the PaS.
 - PaS detection of multiple overlapping sources, so impacts CCA detection strategy.
- **PaS duration depends on synchronization tolerance**

Transmitter State Machine:



PDP=0 for Highest Priority
PaS=0 for lowest Priority

- Priority resolution phase added.
- When in decrementing backoff, then do not react on a PaS, but wait longer (frame detection) before restarting priority assesment.
- Random delay to randomize subsequent transmissions of the same node.

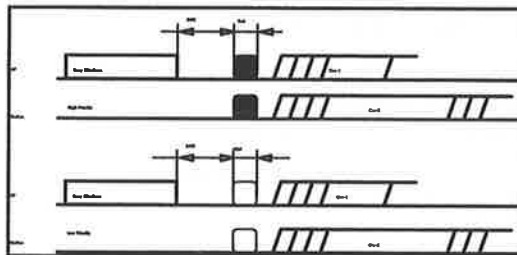
CAM Parameters:

- **Slot Period:** Transmit turn-on time + medium propagation delay + CCA detection time in the receiver.
- **SIFS:** Determined by Tx-Rx or Rx-Tx turnaround time, to allow proper reception of the Ack, whichever is greater. Expected in range of 1 usec to slot time.
- **DIFS:** Period likely determined by the Ack duration. Expected in range of 6-8 slots.
- **PDP:** Duration dependent on signalling delay variance, and (n-1) slots detection time.
- **PAS:** Duration dependent on signalling delay variance, and detection time on one antenna.
- **CW:** Period determines collision probability. Assumed 32 slots.
- **MFC:** Continuous idle medium requirement for period of $IFS + PDP + Cw / n$

How many priorities needed:

- **At least two hierarchical independent priority levels needed to support the main services:**
 - Quality of Service (QoS) should map to priority.
 - Asynchronous service Low priority
 - Distributed TBS (optional) High priority
- **Additional relative priorities possible within a service level using Contention Window size differences.**
- **Relative Priority difference between AP and station makes sense.**
 - Most traffic will be via the AP.
 - So AP would generate close to 50% of frames.
 - Use of separate hierarchical independent levels for AP may not be optimum.

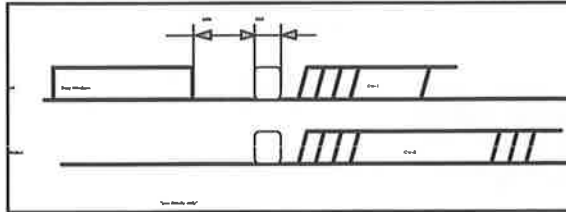
Priority levels in the standard.



- **High priority:**
PDP = 0; PaS = x
- **Low Priority:**
PDP = x; PaS = 0

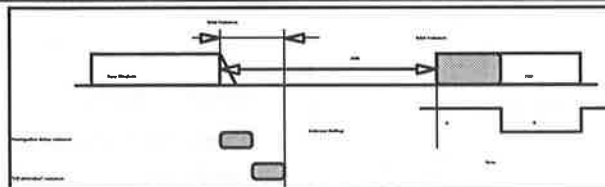
- **If number of levels could increase in future.**
 - Then need manageable PDP and PaS parameters.
- **AP and Station priority separation by CWmin parameter.**

Minimum conformance level:



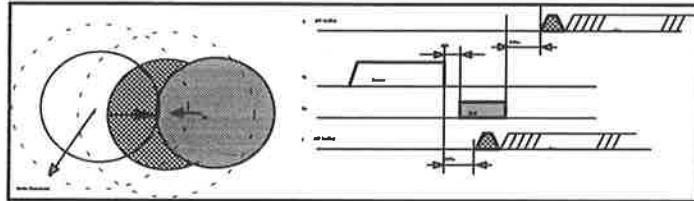
- **“Low Priority only” implementations are possible.**
 - They do not need PaS generation capability.
 - But they do need PaS detection capability.
- **“Low Priority only” is very similar to current Foundation behaviour.**
 - No PaS generation required but detection facility is mandatory.

PaS and PDP duration:



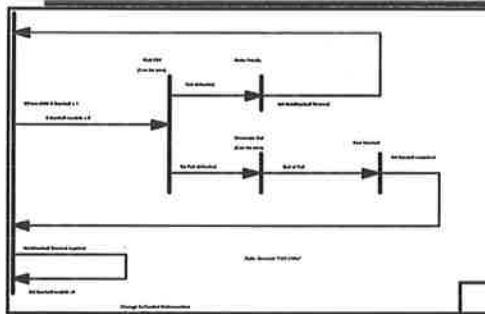
- **Duration depends on:**
 - “Busy Medium” -off detection tolerance.
 - Medium propagation delay.
 - Energy/signal detect time.
 - » Only single antenna measurement acceptable.
- **Antenna slotting synchronization will help decrease tolerances.**
- **PaS detection can effect CCA method.**
 - Multiple PaS signals will overlap

DIFS duration:

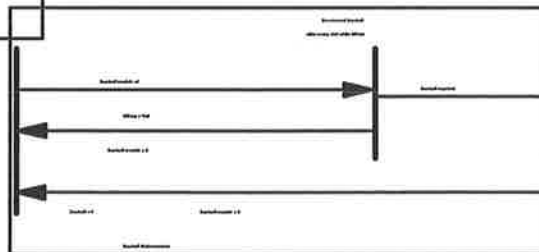


- PaS impact of the “Hidden node problem” which depends on the Defer threshold.
 - PaS may jam the Ack consistently.
 - Solution: DIFS should be $> SIFS + Ack$
- Also shows the unsynchronized PaS case due to the same phenomena.
 - Will cause leakage between priority levels.

Draft standard updates needed:



- Change “Medium Free DIFS” into: “MFC”.
- Text changes in several sections.



Performance:

- **No simulation environment currently available to assess total system behaviour.**
- **Within priority level the following can be said relative to the doc 94/58 proposal (Multiple IFS priority).**
 - Performance very similar to results presented sofar.
 - Less overhead for Low Priority traffic.
 - Little more overhead of High Priority traffic.
 - Delay distribution as function of priority traffic load has different characteristics (more hierarchical separation).
- **The RFMACSIM simulator should be upgraded.**
 - evaluate “Hidden node” behaviour.
 - evaluate parameterization.

Conclusion:

- **Efficient priority method proposed to support the defined Foundation MAC services.**
- **Priority based DCF definition is needed now to assure coexistence with optional (future) Time Bounded Services.**
 - Low priority only is very similar to current Foundation
 - » No PaS generation required but detection facility is mandatory.
- **Different AP and Station priorities can be achieved through different CWmin parameters**

Motions:

- **Move**

That 802.11 should adopt the priority based DCF proposal as documented in 94/150.

- **Move**

That 802.11 should adopt two hierarchical independent priority levels mapped to the services provided by the Foundation MAC.

- **Move**

That 802.11 should specify different CWmin parameters for AP and Stations, to allow relative priority difference.