IEEE 802.11
Wireless Access Method and Physical Specifications

Title: Proposed Change to MAC Draft: A More Reliable Contention Free Access Scheme

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Abstract:
The 802.11 MAC access scheme is examined with the focus on the PCF Contention Free area. A potential problem is described -- that of relying on *lack* of information for access to the medium -- and a solution is proposed. I contend the solution adds little, but some, complexity to STA, and the system achieves a higher overall throughput through the use of this significantly more robust access scheme. This effect is most pronounced when the system is heavily loaded.

Current Situation

The 802.11 MAC is based on a DCF, but can use a PCF. When using a PCF, the ability to convey Contention Free (CF) traffic is added through the use of a SuperFrame (SF) and the prioritization of MPDUs within that SF. The PCF takes "control" of the channel by transmitting frames with higher priority at the beginning of the SF.

The present MAC requires each STA within a BSS to perfectly hear (i.e. detect a valid carrier) each PCF transmission, *and* the response of each remote STA. In other words, a great deal of reliance is placed on total coverage of the BSA by all members of the BSS. If at any time during the CF period, a STA experiences a dropout or imperfect Carrier Sense (CS) for a Distributed InterFrame Space (DIFS) time, an enqueued MPDU could be transmitted. This error of CS could be described as "not sensing carrier when there is one".

Why This Might Be A Problem

Sensitivity of the MAC to CS errors can be categorized as: sensing carrier when there is none, and not sensing carrier when there is.

The former error is less important in two ways. First, there are good, more reliable ways of detecting "carrier" that are more sophisticated than energy detection. And second, a mistake of detecting carrier when in fact there is none effects throughput for ONLY THAT SINGLE STA. Other STA's continue to operate nominally.

Actual Channel	PHY Reports: No Carrier	PHY Reports: Valid Carrier
Valid Carrier	Serious Error	OK
No Carrier	OK	Less Serious Error

The latter error; that of not sensing a carrier when in fact there is one, is much more serious. An error here can effect throughput for the entire BSS. The problem can be described by a STA that finds itself in a deep fade just as a CF area is occurring in it's BSS (a "hidden STA"). Such a STA would listen, hear nothing, delay a DIFS and then transmit, corrupting any traffic to or from

STA within range. The STA could effect *any* STA within range, even those in other BSS. What is needed is a POSITIVE indication that the CF period is over.

Proposed Solution

You may say the special "ACK" frame at the end of the CF period already does this. Almost. I propose to REQUIRE all STA to hear a CF-ACK (CFACK) frame type before concluding that the CF period has ended. Thus if a STA missed this short control frame, it would defer until the worst-case boundary (Max. CF period) and for that superframe, suffer a penalty in lost bandwidth. We now have altered the protocol such that the *presence* of information allows access instead of the *lack* of information. As pointed out by others within 802.11, this is always a better situation.

A mitigating factor is if such a STA heard any other STA use a Contention area frame type (contained in the TYPE and CONTROL fields), it could assume the CF period were over and it simply missed the CFACK. Contention type traffic could resume. Now we have penalized one STA's throughput to gain a higher total throughput within the BSS; a good trade off.

If there is no CF period:

This CFACK would even be required if there were no CF period at all. Why? If STA were operating in "PCF mode" how would they know when the Contention periods starts? Remember that each STA sets the NAV to the worst case CF period length at the beginning of each SF. It is only one of two events that truncate the NAV: 1.) the CFACK frame from the PCF or 2.) Any other Contention type traffic. Since the only STA allowed media access is the PCF, the later condition would only work if the STA containing the PCF had a queued MPDU; a dubious bet.

The CFACK then becomes very similar to a Beacon at the start of each SF. More thought should be put into what information should be contained in the CFACK, since it will be transmitted each SF when a PCF is used. Indeed it should be kept as short as possible, but Beacon and perhaps TIM contents could be contained in it.

Definition of the CFACK will be left for later work, mainly because I want this issue of media access to be the focus. It is the critical issue..

Summary of Rules for STA

If BSS using PCF: (if Ad-Hoc or only using a DCF, none of this applies)

```
Event (Super_Frame_Start) {
    Set NAV to SFLength - (Max. Asynch MPDU + ACK);        ; worst case
}

WHILE (NAV)                                                ; NAV is set
    Event (Receive_CFACK) {
        Reset NAV;
        other actions based on contents of CFACK;
    }

    Event (Receive_Contention_Frame_Type) {
        Set NAV to length depending on MPDU received;      ; NAV is essentially
                                                           ; reset after current
                                                           ; traffic finishes.
    }
ENDWHILE
```