# IEEE 802.11

## Define the IFS's: Update to Section 5.2.4 & 5.2.13

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**Abstract:** **This paper describes the changes in section 5.2.4 and section 5.2.13 to reflect the proposed SIFS, PIFS and DIFS definitions as presented in Doc IEEE 802.11-95/86a.**

**Changes to section 5.2.4:**

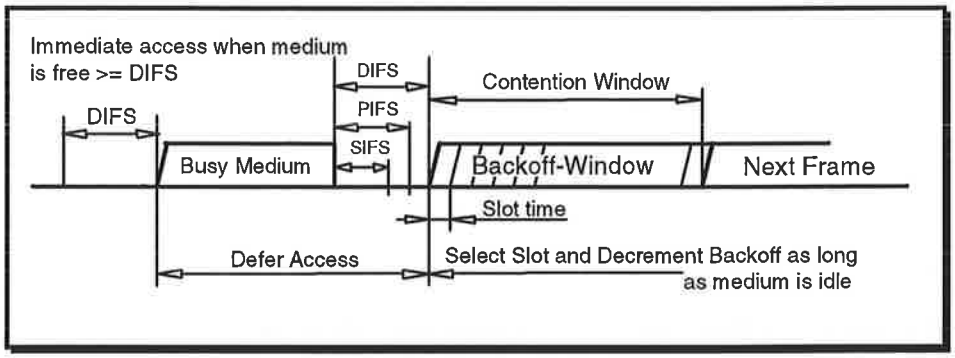
### 0.0.1. Inter-Frame Space (IFS)

The time interval between frames is called the inter-frame space. A STA shall determine that the medium is free through the use of the carrier sense function for the interval specified. Three different IFS's are defined so as to provide a corresponding number of priority levels for access to the wireless media. The following ~~T~~three different IFSs are defined:

| | |
|---|---|
| a) SIFS | Short Interframe Space |
| b) PIFS | PCF Interframe Space |
| c) DIFS | DCF Interframe Space |

It should be noticed that the different IFSs are independent of the station bitrate, and are fixed per each PHY (even in multi-rate capable PHYs),

The IFS timings are defined as time gaps on the medium. The standard shall specify the relation of the relative PHY MIB parameters to achieve the specified timegaps as further specified in section 5.2.13. ~~The timing tolerances are specified in an explanatory section of the MIB.~~




~~New Figure to illustrate IFS relations~~Fig 5-6.

### 0.0.1.1. Short-IFS (SIFS)

This inter-frame space shall be used for an ACK frame, a CTS frame, a Data frame of a fragmented MSDU, and, by a STA responding to any polling as is used by the Point Coordination Function (PCF) (See Section 5.3, Point Coordination Function). ~~Any STA intending to send only these frame types shall be allowed to transmit after the SIFS time has elapsed following a busy medium.~~ The SIFS is the time from the end of the last symbol of the previous frame to the begining of the first symbol of the pre-amble of the listed frame as seen at the air interface. The valid cases where the SIFS interval is used are listed in Frame Exchange Sequences found in section 4.3.

The SIFS timing will be achieved when the transmission of the subsequent frame is started at the TX_SIFS Slot boundary as specified in section 5.2.13.

~~The SIFS has both a minimum and maximum specification. The maximum (SIFSmax) prevents another STA from claiming the medium and in physical terms is the maximum receive to transmit (R2T) turn around time allowed by the specific PHY. The transmit to receive (T2R) time need not be specified because it is only related to the stability of a specific implementation. Clearly T2R must be less than or equal to SIFSmax.~~

~~The minimum time (SIFSmin) prevents a STA from getting onto the medium too soon for another STA to process the transition. This minimum time may be very short. It is related to the need by a STA to see a minimum number of preamble bytes, so the length of the preamble needs to accommodate the difference between the minimum and maximum allowable SIFS timing. The assumption on the minimum is that the number of preamble bytes is fixed for a given PHY.~~

### 0.0.1.2. PCF-IFS (PIFS)

This PCF priority level shall be used only by the PCF to send any of the Contention Free Period (CFP) frames. The PCF shall be allowed to transmit after it detects the medium free at the Tx-PIFS slot boundary as defined in section 5.2.13~~for the period PIFS (PCF Interframe Space~~ This can occur ~~)~~, at the start of and during a CF-Burst .

### 0.0.1.3. DCF-IFS (DIFS)

The DCF priority level shall be used by the DCF to transmit asynchronous MPDUs. A STA using the DCF shall be allowed to transmit if it detects the medium to be free at the Tx_DIFS slot boundary as defined in section 5.2.13 ~~after it detects the medium free for the period DIFS~~ , and its backoff time has expired.

### 0.0.2. Random Backoff Time

STA desiring to initiate transfer of asynchronous MPDUs shall utilize the carrier sense function to determine the state of the media. If the media is busy, the STA shall defer until after a DIFS gap is detected, and then generate a random backoff period for an additional deferral time before transmitting. This process resolves contention between multiple STA that have been deferring to the same MPDU occupying the medium.

Backoff Time = INT(CW * Random()) * Slot time

where:

CW = An integer between $CW_{min}$ and $CW_{max}$

Random() = Pseudo random number between 0 and 1

Slot Time = Transmitter turn-on delay + medium propagation delay + medium busy detect response time (including MAC delay) and is PHY dependent.

The Contention Window (CW) parameter shall contain an initial value of $CW_{min}$ for every MPDU queued for transmission. The CW shall double at every retry until it reaches Cwmax. The CW will remain at CWmax for the remaining of the retries. This is done to improve the stability of the access protocol under high load conditions. See Figure 5-6.

Suggested values are for: CWmin=31, Cwmax = 255.

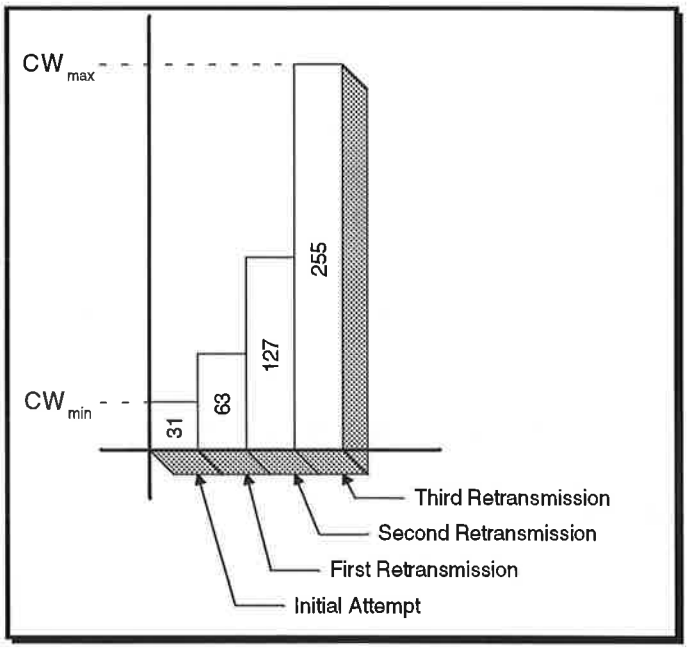



**Figure 5-6: Exponential Increase of CW**

CWmin and CWmax are MAC constants that should be fixed for all MAC implementations, because they effect the access fairness between stations.

### 0.0.3. DCF Access Procedure

The CSMA/CA access method is the foundation of the Distributed Coordination Function. The operational rules vary sligthly between Distributed Coordination Function and Point Coordination function.

#### 0.0.3.1. Basic Access

Basic access refers to the core mechanism a STA uses to determine whether it has permission to transmit.

Both the Physical and Virtual Carrier Sense functions are used to determine the busy state of the medium. When either of them indicate a busy medium, the medium shall be considered busy. The opposite of a busy medium shall be known as a free medium.

A STA with a pending MPDU may transmit when it detects a free medium for greater than or equal to a DIFS time. This rule applies both when using the DCF access method exclusively and when using the PCF access method in the Contention Area.

If the medium is busy when a STA desires to initiate an RTS, Data, Poll, and Management MPDU transfer, and only a DCF is being used to control access, the Random Backoff Time algorithm shall be followed.

Likewise, if the medium is busy when a STA desires to initiate an RTS, Data, Poll, and Management MPDU transfer, and a Contention Period portion of a Superframe is active (See 5.3 PCF), the Random Backoff Time algorithm shall be followed.

The basic access mechanism is illustrated in the following diagram.

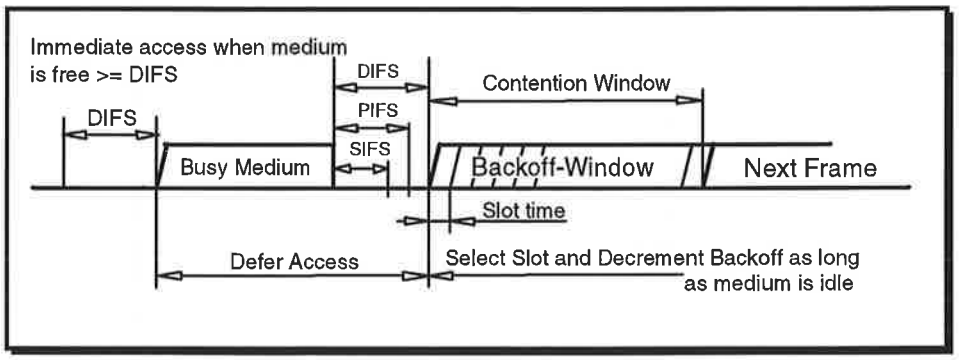



**Figure 5-7: Basic Access Method**

#### 0.0.3.2. Backoff Procedure

The backoff procedure shall be followed whenever a STA desires to transfer an MPDU and finds the medium busy.

The backoff procedure consists of selecting a backoff time from the equation in Section 5.2.5 Random Backoff Time. The Backoff Timer shall decrement by slottime amount after every slottime, while the medium is free. The Backoff Timer shall be frozen while the medium is sensed busy. Decrementing the Backoff Timer shall resume whenever the medium is detected to be free at the Tx_DIFS slot boundary as defined in section 5.2.13~~a medium free period longer than DIFS is detected~~. Transmission shall commence whenever the Backoff Timer reaches zero.

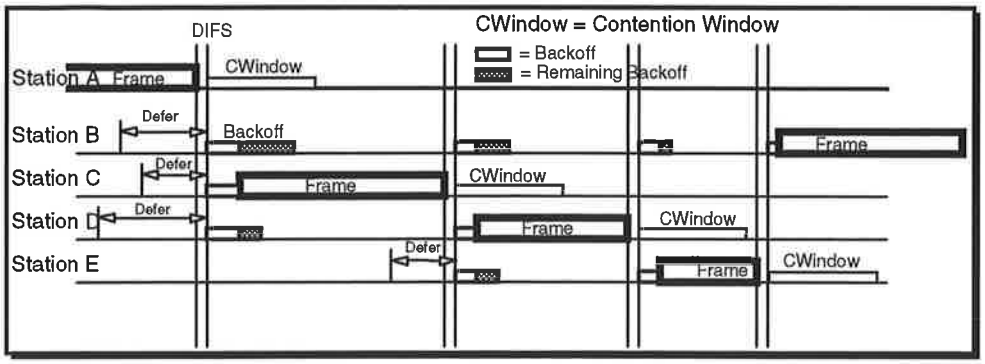



**Figure 5-8: Backoff Procedure**

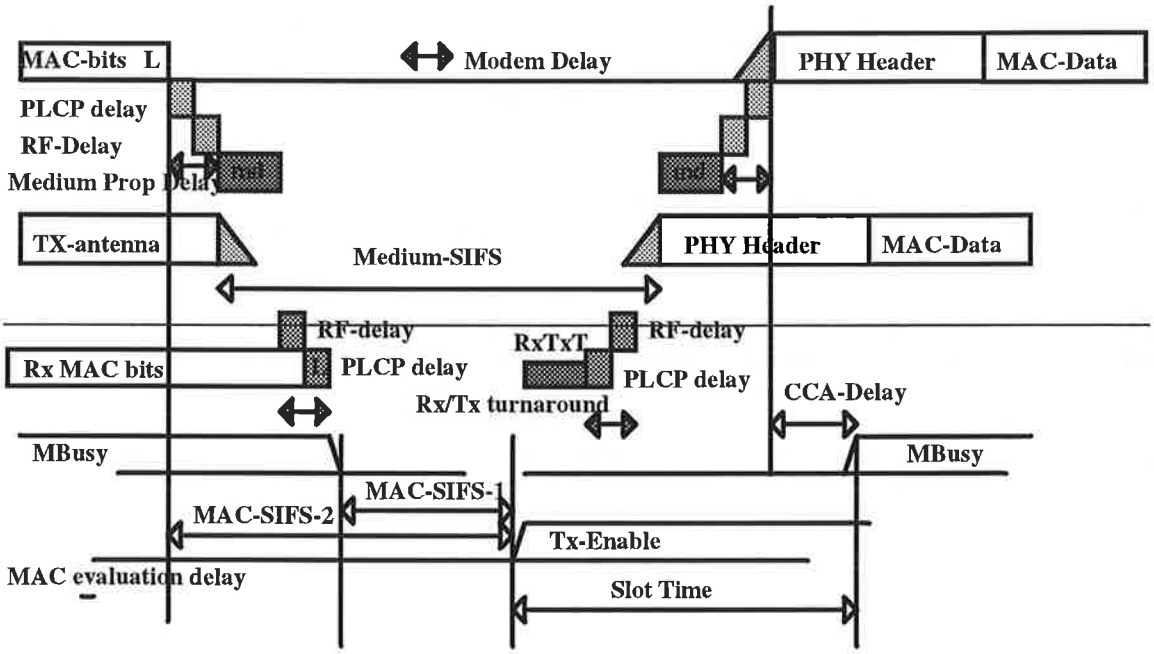
A station that has just transmitted an MSDU and has another MSDU ready to transmit (queued), shall perform the backoff procedure. This requirement is intended to produce a level of fairness of access amongst STA to the medium.

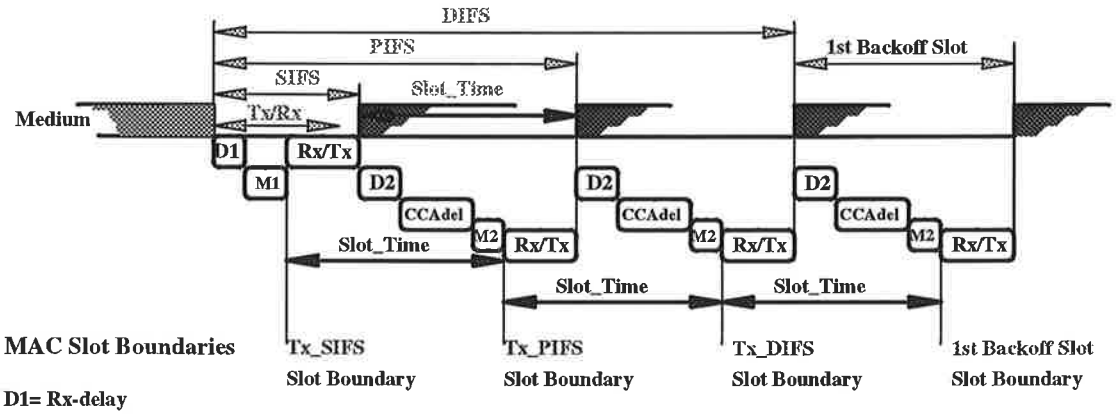
The effect of this procedure is that when multiple stations are deferring and go into random backoff, then the station selecting the lowest delay through the random function will win the contention. The advantage of this approach is that stations that lost contention will defer again until after the next Tx_DIFS slot boundary as defined in section 5.2.13~~DIFS period~~, and will then likely have a shorter backoff delay than new stations entering the backoff procedure for the first time. This method tends toward fair access on a first come, first served basis.

## Section 5.2.13 changes:

### 0.0.4.DCF Timing Relations

This section formulates the relation between the IFS specifications as have been defined as time gaps on the medium, and the associated MIB variables that are provided per PHY.




**D1= Rx-delay**

**D2= Medium + Rx-delay**

**Rx/Tx=Full Tx delay including rampup**

**M1 / M2= MAC decision delay**

**CCAdel= CCA evaluation time**

**Assumption:**
**SIFS= minimum (components listed OR Tx/Rx_Turnaround time)**

**Fig 5-14**

All timings are referenced to the end of the last symbol of a frame on the medium.

The SIFS, and Slot_Time are defined in the MIB, and are fixed per PHY.

SIFS is based on: Rx_Delay + MAC_Delay-1 + Rx/Tx_Delay.

Slot_Time is based on: Rx/Tx_Delay + Medium_Delay + Rx_Delay + CCA_Delay + MAC_Delay-2

The PIFS and DIFS are derived by the following equations, as illustrated in figure 5-14.

PIFS = SIFS + Slot_Time

DIFS = SIFS + 2 * Slot_Time

The Medium_Delay component is fixed at 1 usec.

Figure 5-14 illustrates the relation between the SIFS, PIFS and DIFS as they are measured on the medium and the different MAC Slot Boundaries Tx_SIFS, Tx_PIFS and Tx_DIFS. These Slot Boundaries define when the transmitter can be turned on by the MAC to meet the different IFS timings on the medium, after subsequent detection of the CCA result of the previous Slot_Time.

The following equations define the MAC Slot Boundaries, using parameters defined in the MIB, which are such that they compensate for implementation timing variations. The reference of these slot boundaries is again the end of the last symbol of the previous frame on the medium.

Tx_SIFS = SIFS - a Rx/Tx_Turnaround_Time (MIB variable)

Tx_PIFS = Tx_SIFS + Slot_Time

Tx_DIFS = Tx_SIFS + 2 * Slot_Time.

The tolerances are specified in the MIB, and will only apply to the SIFS specification, so that tolerances will not accumulate.