IEEE P802.11
Wireless Access Methods and Physical Layer Specifications

ELABORATE CLEAR-CHANNEL ASSESSMENT
FOR INDOOR COMMUNICATION SYSTEMS OPERATING IN UNCONTROLLED UHF & MICROWAVE BANDS
(Revision #1)

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Author: Lawrence H. Zuckerman
290 Gaffney Hill Road Easton PA 18042
Mail: PO Box 828 Easton PA 18044 USA
(610) 252-1587

The purpose for this Addendum to the original Submission is to:

- Correct a few errors;
- Extend and generalize the calculations which estimate the increase in WLAN efficiency resulting from implementation of the particular method of Transmission Deferral Assessment (TDA) discussed.
- These two functions are, on occasion, performed simultaneously.

<u>1. Beginning near the bottom of Page 14 and continuing to the top of Page 15:</u>

Next, the test formulas are given. If the following statements are true, S can transmit, thus avoiding a False Deferral:
1. P_S >/= G_{II} - G_{IS} + G_{SS} -67 (dBm)
2. P_S </= G_{SI} - 97 (dBm)
~~3. G_{SI} - G_{SS} >/= 15 (dB)~~

Repeating the above example using these inequalities:
P_S >/= 97 - 112 + 95 - 67---+13 dBm; P_S </= 112 - 97---+ 15 dBm; ~~112 - 95 = 17 dB.~~
The Subject Node is permitted to transmit using any power level between +13 and +15 dBm.
As another example, if, for instance, R_S is moved one intersection to the left in Figure 1, to (-3,2), the path loss numbers become 97, 114, 112, & 99. The formulas then report:
P_S >/= 97 - 114 + ~~95~~ - 67---~~+11~~ dBm; P_S </= 112 - 97---+15 dBm; ~~112 - 99 = 11 dB.~~
The Subject Node ~~must defer; as it cannot transmit with enough power to reach its own Recipient (now 4 dB "further away") without also narrowing the Incumbent's margin below 15 dB.~~

<u>This material should read:</u>

Next, the test formula is given. If the following statement is true, S can transmit, thus avoiding a False Deferral:

$G_{SI} - 97 >/= P_S >/= G_{II} - G_{IS} + G_{SS} -67$ (dBm)

Repeating the above example using these inequalities:
$P_S >/= 97 - 112 + 95 - 67$---+13 dBm; $P_S </= 112 - 97$---+ 15 dBm.
The Subject Node is permitted to transmit using any power level between +13 and +15 dBm.

As another example, if R_S is moved one intersection to the left in Figure 1, to (neg3,2), the path loss numbers become 97, 114, 112, & 99. The formula then reports:
$P_S >/= 97 - 114 + 99 - 67$---+15 dBm; $P_S </= 112 - 97$---+15 dBm.
The Subject Node can still transmit, but at exactly +15 dBm. R_S is further away from S, necessitating it to increase its ERP, but not quite so much that the signal from S is too strong at R_I.

As a third example, R_S remains at (-3,2), but R_I is moved to (9,-2). The path loss numbers become 101, 114, 114, & 99. The formula then reports:
$P_S >/= 101 - 114 + 99 - 67$---+19 dBm; $P_S </= 114 - 97$---+17 dBm.
Inasmuch as Subject's ERP must be at least +19 dBm to achieve the minimum 15 dB margin over Incumbent's signal at R_S but no more than +17 dBm to achieve the minimum 15 dB margin under the Incumbent's signal at R_I, it must Defer. Relative to the last example, R_I moved away from both the Subject and Incumbent. However, as R_I is much closer to I than is S, 4 more dBs were needed from I to make the minimum field at R_I; so S needed to transmit 4 dB higher to make its margin at R_S, yet S's path loss to R_I was reduced by only 2 dB.

<u>Transmit/Deferral Test for Arbitrary Signal to Interference Ratio</u>

The capture effect of GFSK may permit a smaller Signal to Interference Ratio than 15 dB, assumed for the previous Calculation. In this section, the inequality for a general value for this margin (M) is derived. It is still assumed that the minimum allowable Signal to Noise Ratio is 15 dB. The resulting value of P_{II} (the available receive power from the Incumbent Node at its Recipient) is still -82 dBm, and this value falls through to the bottom line.

1. $P_I = P_{II} + G_{II} = -82 + G_{II}$;
2. $MaxP_{SI} = P_{II} - M = -82 - M$;
3. $MaxP_S = MaxP_{SI} + G_{SI} = -82 - M + G_{SI}$, or
4. $P_S </= G_{SI} - M - 82$
5. $MinP_{SS} = P_{IS} + M$
6. Where $P_{IS} = P_I - G_{IS} = -82 + G_{II} - G_{IS}$
7. $MinP_{SS} = -82 + G_{II} - G_{IS} + M$
8. $MinP_S = MinP_{SS} + G_{SS} = -82 + G_{II} - G_{IS} + M + G_{SS}$
9. $P_S >/= G_{II} - G_{IS} + G_{SS} - 82 + M$
10. $G_{SI} - 82 - M >/= P_S >/= G_{II} - G_{IS} + G_{SS} - 82 + M$
11. Also: $G_{SI} - M >/= P_S + 82 >/= G_{II} - G_{IS} + G_{SS} + M$

Notice that the result is independent of the assumed threshold Signal to Noise (shown as available receive power).

Transmit/Deferral Test as a Function of Distances Between Nodes:

Although the hardware in the field would operate entirely with (measured) path losses, it may be easier to complete the calculations which estimate the increase in WLAN efficiency resulting from implementation of this particular method of TDA by expressing P_S as a function of distances between the four relevant nodes:

$$36\log(d_{SI}/8.5) - M >/= P_S + 23.22 >/= M + 36\log(d_{II}d_{SS}/8.5d_{IS}).$$

If M is fixed (again) at 15 dB:

$$36\log(d_{SI}/8.5) - 38.22 >/= P_S >/= 36\log(d_{II}d_{SS}/8.5d_{IS}) - 8.22.$$

Using this formula, it may be possible to complete the probability (network efficiency) calculation by a method of densities, thus eliminating the huge number of computations.