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TGa Preamble Design Considerations

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Author: Naftali Chayat, TGa chair
BreezeCOM
e-Mail: naftalic@breezecom.co.il

Abstract

The document captures a discussion held on May 3, 1999, as a part of processing the Sponsor Ballot comments related to the preamble. Most of the discussion was in an informal TGa meeting and serves as a preparation for discussion in TGa. The conclusions drawn in few places are authors personal opinions and will be debated in TGa.

To summarize, the comments fell into several categories:

1) The short sequence part of the preamble is too short to allow diversity selection, especially since AGC pill-in is required on both antennae. This requires either to provide a document showing that this is doable (comment by Mark Webster) or to increase the duration of the short training sequence (Carl Andren).

2) The detection of transition from short to long sequence is difficult. In order to assist with this we should invert the polarity of the last period (t10) of the short training sequence. This should allow delay-multiply-sliding window approaches to generate a sharper indication that the end of the short sequence is approached (comments from BRAN and).

3) There is a degree of freedom in choosing the phase of the short training sequence relative to the phase of the long training sequence. When correlating with a template consisting of a single repetition of the short training sequence, the corelation sidelobes in the transition region improve (Masahiro Morikura).

4) A better choice of short training sequence. A sequence having lower peak-to average power ratio (2.24 dB) and dynamic range (peak-to-dip ratio) of just 7.3 dB was provided (comment from BRAN).

The discussion of these points identified (1) and (2) as the key points. The (3) and (4) could be used to augment any solution. In order to adress the (1) and (2) we constructed signal processing timelines corresponding to the cases where the sequence “t10” is inverted or not inverted. In the discussion participated Jamshid Khun Jush, Mika Kasslin and Juha Heiskala who represented the BRAN position. The 802.11a preamble requirements were identified as almost identical to those of BRAN in the random access uplink transmissions.

The assumptions about the processing were that
1) After each antenna switching an 0.8 μsec interval is required for settilng
2) The energy integration time required to trigger a search process is at least 0.8 μsec, which are equivalent to energy of 6 bits (+8 dB re Eb/N0) at 6 Mbit/s.
3) We assumed that the signal on the first antenna may go undetected, because tha antenna may be in a fade.
4) The antenna comparison is done by integrating energy over 1.6 μsec period (2 short sequences). This allows also coarse frequency estimation from the collected data.
5) If the detection of short to long training sequence transition is done by correlating with a portion of the long training sequence processing, then we use the (+1.6 to +3.2μsec) part of the long training sequence as the signal being detected. Note that for the frequency offset and channel estimation the (+1.6 to +8.0μsec) part of the long training sequence is used. This leaves the (+0.0 to 1.6 μsec) interval of the long training sequence available (assuming that all the data for the decision is collected by the end of the short training sequence) for the antenna selection suporting calculations , switching to the desired antenna and settling after the switch. This leaves some 0.8 μsec for the antenna selection support calculations, which is quite reasonable.
6) If the detection of short to long training sequence transition is done by a delay-multiply-sliding window processing (with the “t10” inverted), then we need the (+6.4 to +8 μsec) part of the short training sequence (or even a longer part at the end of the short sequence) for detecting the transition. In this case the antenna selection

suporting calculations, switching to the desired antenna and settling after the switch all occur during the short training sequences.

Example timelines

The example timeline for the case of correlating with a portion of the long training sequence is as follows:
1) 0.8 µsec – signal collection and energy integration over antenna A. Signal is present but not detected.
2) 0.8 µsec – setting after switching to antenna B.
3) 0.8 µsec – signal collection and energy integration over antenna B. This time the signal is detected.
4) (Gain adjustment may occur here to avoid A/D saturation)
5) 1.6 µsec – signal collection on antenna B for antenna comparison and frequency coarse estimate.
6) 0.8 µsec – setting after switching to antenna A.
7) (Gain adjustment may occur here to avoid A/D saturation)
8) 1.6 µsec – signal collection on antenna B for antenna comparison and frequency coarse estimate. This needs to be completed by the end of the short training sequence.

Summing the times shows that 6.4 µsec + (two gain adjustments) should not exceed 8.0 µsec. This leaves 0.8 µsec to each gain adjustment. While this is ambitious, this may be accomplished by using, for example, digitally controlled variable gain amplifiers in the receive chain. While this is a nontrivial design choice, we should remember that not implementing an antenna diversity for a wideband signal is less painfull than for narrowband signals because multipath itself provides a certain level of diversity.

The example timeline for the a delay-multiply-sliding window processing (with the “t10” inverted) is as follows
1) 0.8 µsec – signal collection and energy integration over antenna A. Signal is present but not detected.
2) 0.8 µsec – setting after switching to antenna B.
3) 0.8 µsec – signal collection and energy integration over antenna B. This time the signal is detected.
4) 0.8 µsec – additional signal collection on antenna B for antenna comparison and frequency coarse estimate.
5) 0.8 µsec – setting after switching to antenna A.
6) 1.6 µsec – signal collection on antenna A for antenna comparison and frequency coarse estimate
7) (Antenna selection calculations and switch occur here)
8) 0.8 µsec – setting after switching to the antenna selected
9) 1.6 µsec – signal collection on the antenna selected for the detection based on inverted last subsequence. This needs to be completed by the end of the short training sequence.

Summing the times shows that the antenna selection (step 7) needs to occur virtually instantly. Note that the timeline above assumed (based on BRAN uplink assumbtions) that there is a power control in the uplink and there is no need for gain adjustment. This assumption does not necessarily hold for 802.11a. If we add the gain convergence steps to the second case, then the timeline fails to converge.

While somebody may device better schemes for antenna scanning, from the discusion captured here authors personal opinion is that we should not adopt the solution of inverting the “t10” subsequence. This adresses comment category (2).

The fact that we demonstrated a converging timeline (though with ambitious implementation) of detection and antenna selection with a 8 µsec short training sequence addresses the concern expressed in comment category (1).

The author’s position on comment (3) is that we should accept it - the sequence is better (author’s comment – given the better PAPR and the fact that short straining sequence has a 0.35 dB power disadvantage (12 lines, not 13), we may consider increasing the average power of the short training sequence by couple of decibells).

The author’s position on comment (4) is that we should explore this design degree of freedom (phase of short sequence relative to long training sequence). We need an assumption which processing method is being employed, so that we can optimize with respect to it. Note, however, that