Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	**Problem with the AAS Network Entry**
Date Submitted	**2003-03-07**
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Re:	Call for contribution IEEE 802.16d-03/02
Abstract	This document describes a problem with AAS Network Entry method and proposes a solution for the OFDM PHY mode.
Purpose	For inclusion in the 802.16d amendment document
Notice	
Release	
Patent Policy and Procedures	

Problem with the AAS Network Entry

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1. References

[1] IEEE 802.16a

2. Problem statement and Discussion

2.1. Collision during AAS Network Entry

Sections 6.2.7.7.4, 8.3.1.4.5.3, 8.4.5.2 and 8.5.4.2 of [1] describe the network entry for AAS-enabled SSs in an AAS system. However nowhere is it specified how an SS, that is implementing the AAS option, should behave in a non-AAS system (i.e. the BS is not AAS capable). In fact the AAS SS has no way to find out whether the BS is AAS capable or not.

When an AAS SS is installed in a non-AAS system and it cannot decode the MAP messages, it will start network entry according to sections 6.2.7.7.4, 8.3.1.4.5.3, 8.4.5.2 and 8.5.4.2 of [1] and start transmitting at the end of the frame. This will interfere with UL data from other SSs that have been scheduled to transmit during this part of the frame.

This is clearly not an acceptable behavior for a SS with an optional capability. A SS with an optional capability may never disturb the basic mode of operation of a system.

2.2. Correction to Section 6.2.7.7.3 “AAS DL synchronization”

The first paragraph of section 6.2.7.7.3 states that “The process of initial synchronization to the downlink in AAS systems is different from the non-AAS process.” In the second paragraph it is explained that the process is actually the same as for the non-AAS enabled SSs because of the inherent processing gain associated with the preamble. Therefore the first paragraph should be deleted.

3. Solution for the collision problem for the OFDM PHY mode.

A solution should provide a way for the AAS-SS to find out whether the BS is AAS-enabled. It should also provide a way for the BS to signal when an AAS network entry is permitted. The solution should minimize the overhead for the AAS network entry.

In section 6.2.7.7.3 of [1] it is stated that the AAS SS should be able to detect the frame preamble and to synchronize to it. The proposed solution is to define a new preamble that can be detected by the AAS SS. This preamble will signal that the BS is AAS enabled and will indicate the start of the initial ranging slot for AAS-SSs. This solution brings a number of advantages:

1. An AAS-SS will never interfere with the data transmission of other SSs when the BS is not AAS-enabled.

2. The overhead for AAS network entry can be reduced. The BS scheduling program decides when slots for AAS network entry are provided. This is not necessarily every frame.

After the transmission of the preamble enough time has to be reserved for the SS to decode the preamble, transition from RX to TS (TDD case), take into account the round-trip delay and transmission of the initial ranging request. 7 OFDM symbols are sufficient for this: 2 for decoding, 2 for RX-TX transition and round-trip delay compensation and 3 for the initial ranging message.

4. Proposed preamble

The proposed AAS network entry preamble consists of a CP followed by 2 times 128 samples where the sign of the samples in the second part is reversed as shown in figure 1:

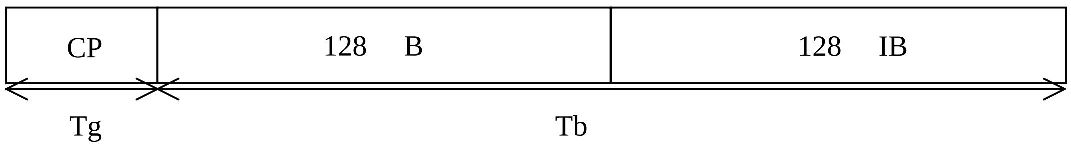

Figure 1 AAS network entry preamble structure

The frequency domain sequency for the 2 times 128 (B, IB) sequence is defined by:

S(-100:100) = { 0 , 1 , 0 , 1 , 0 , -1 , 0 , 1 , 0 , 1 , 0 , 1 , 0 , 1 , 0 , 1 , 0, -1 , 0 , -1 ,
0 , 1 , 0 , 1 , 0 , -1 , 0 , 1 , 0 , 1 , 0 , 1 , 0 , 1 , 0 , 1, 0 , -1 , 0 , -1 ,
0 , -1 , 0 , -1 , 0 , 1 , 0 , -1 , 0 , -1 , 0 , -1 , 0 , -1 , 0, -1 , 0 , 1 , 0 , 1 ,
0 , 1 , 0 , 1 , 0 , -1 , 0 , 1 , 0 , 1 , 0 , 1 , 0 , 1 , 0 , 1, 0 , -1 , 0 , -1 ,
0 , -1 , 0 , -1 , 0 , 1 , 0 , -1 , 0 , 1 , 0 , -1 , 0 , 1 , 0 , 1, 0 , -1 , 0 , -1 ,
0 , 1 , 0 , 1 , 0 , -1 , 0 , 1 , 0 , 1 , 0 , 1 , 0 , 1 , 0 , 1, 0 , -1 , 0 , -1 ,
0 , -1 , 0 , -1 , 0 , 1 , 0 , -1 , 0 , 1 , 0 , -1 , 0 , 1 , 0 , 1, 0 , -1 , 0 , -1 ,
0 , -1 , 0 , -1 , 0 , 1 , 0 , -1 , 0 , 1 , 0 , -1 , 0 , 1 , 0 , 1, 0 , -1 , 0 , -1 ,
0 , 1 , 0 , 1 , 0 , -1 , 0 , 1 , 0 , -1 , 0 , 1 , 0 , -1 , 0 , -1, 0 , 1 , 0 , 1 ,
0 , 1 , 0 , 1 , 0 , -1 , 0 , 1 , 0 , -1 , 0 , 1 , 0 , -1 , 0 , -1, 0 , 1 , 0 , 1 , 0 }*sqrt(2)*sqrt(2)

The PAPR of this sequence is 2.92 dB.

5. CROSS-CORRELATION STUDY

Fig. 2 gives the scheme of the simulation environment.

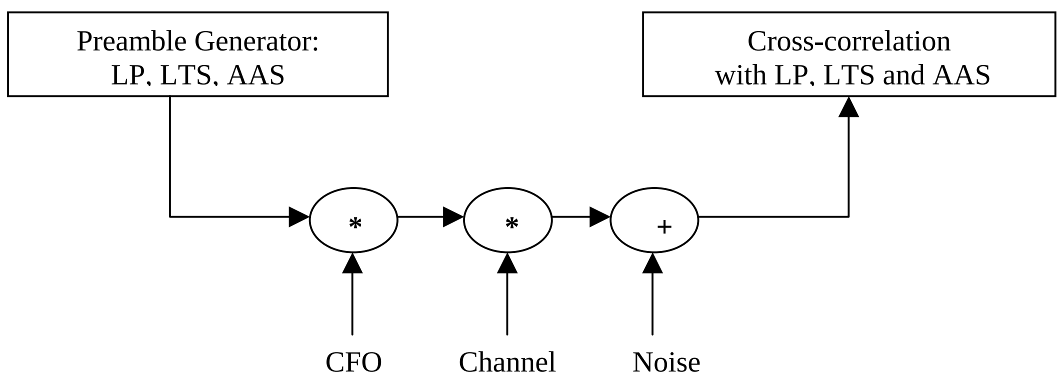

Fig. 2: Simulation Environment

In the simulation, we send the three preambles consecutively through the system, in the order LP, LTS and AAS. Fig. 3, shows the transmitted pattern. The cyclic prefix length was set to 1/8.

Fig. 3: Preamble pattern used for the cross-correlation study.

The preamble pattern is sent through a propagation environment with the following characteristics:

- Channel impulse response: SUI-3.
- SNR: 6 dB
- Frequency offset: 1 kHz
- Channel Bandwidth: 7 MHz.

The received signal was cross-correlated with LP, LTS and AAS separately. The cross-correlation windows used for the first symbol of the long preamble (4 times 64 sequence = LP), the data preamble (2 times 128 = LTS), and the suggested AAS network entry preamble (AAS) are respectively 64, 128 and 128.

Fig. 4 shows a snapshot of the obtained samples for each correlation window.

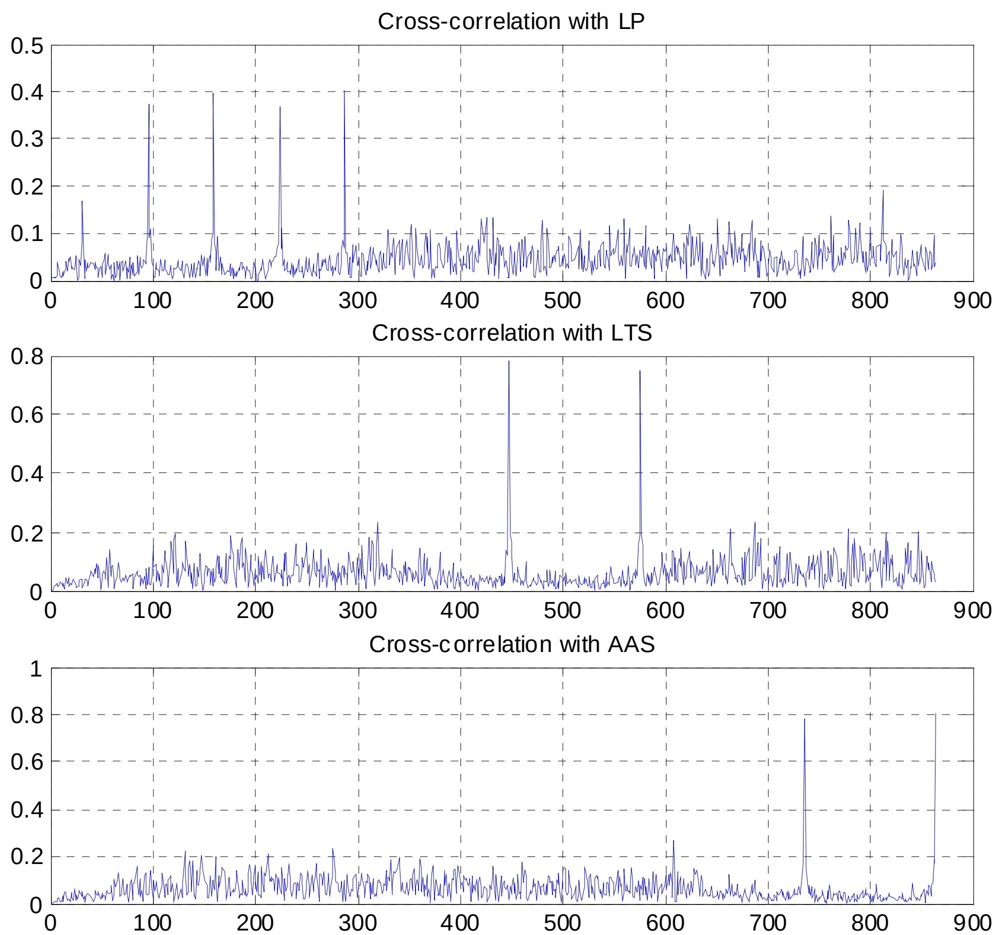

Fig. 4: Single Snapshot of Samples after the cross-correlation
(a) LP cross-correlation, (b) LTS cross-correlation and (c) AAS suggested cross-correlation.

We can see no significant spurious correlation peaks appear for the cross-correlation of different preambles. This visual check is confirmed by computing the relative height of the major spurious correlation peak with respect to the desired correlation peak. Table 1 shows these results.

Correlation window	Relative amplitude of cross-correlation peaks		
	LP symbol	LTS symbol	AAS symbol
LP (64 samples)	1.00	0.36	0.40
LTS (128 samples)	0.28	1.00	0.27
AAS (128 samples)	0.31	0.26	1.00

Tab. 1: Relative amplitude of the spurious correlation peaks averaged over a statistical sample of 100 preamble sequences.

6. Proposals

6.1. Delete the first paragraph of section 6.2.7.7.3 of [1] :

~~The process of initial synchronization to the downlink in AAS systems is different from the non-AAS process. This is because the adaptive array operating in the PHY cannot be effective until the MAC and PHY of the BS identify the new SS. The adaptation of BS antenna array can be accomplished only after the BS has identified the SS.~~

6.2. Change the third paragraph of section 6.2.7.7.3 of [1] to:

An AAS BS may ~~shall~~ reserve ~~a fixed, pre-defined part of the frame as~~ initial-ranging contention slots for this alert procedure. ~~These contention slots shall be located at a well-known location relative to the downlink preamble, so even an SS that can only identify the DL preamble shall be able to locate it.~~ The number of contention slots and their location in the frame is PHY specific (see 8.3.1.4.5.3, 8.4.5.2, 8.5.4.2 respectively). These contention slots shall be called AAS-alert-slots.

6.3.Add to section 8.4.3.6 of [1]:

The AAS network entry preamble consists of a CP followed by 2 times 128 samples where the sign of the samples in the second part is reversed as shown in figure 5:

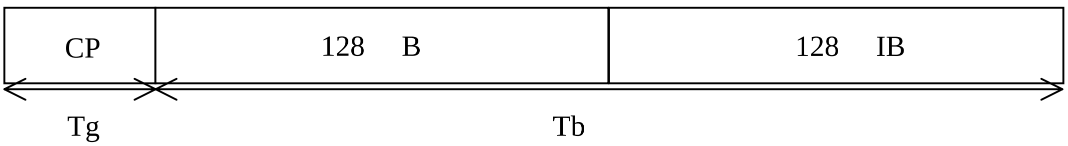

Figure 128ala: AAS network entry preamble structure

The frequency domain sequency for the 2 times 128 (B, IB) sequence is defined by:

S(-100:100) = { 0 , 1 , 0 , 1 , 0 , -1 , 0 , 1 , 0 , 1 , 0 , 1 , 0 , 1 , 0 , 1 , 0, -1 , 0 , -1 ,
0 , 1 , 0 , 1 , 0 , -1 , 0 , 1 , 0 , 1 , 0 , 1 , 0 , 1 , 0 , 1, 0 , -1 , 0 , -1 ,
0 , -1 , 0 , -1 , 0 , 1 , 0 , -1 , 0 , -1 , 0 , -1 , 0 , -1 , 0, -1 , 0 , 1 , 0 , 1 ,
0 , 1 , 0 , 1 , 0 , -1 , 0 , 1 , 0 , 1 , 0 , 1 , 0 , 1 , 0 , 1, 0 , -1 , 0 , -1 ,
0 , -1 , 0 , -1 , 0 , 1 , 0 , -1 , 0 , 1 , 0 , -1 , 0 , 1 , 0 , 1, 0 , -1 , 0 , -1 ,
0 , 1 , 0 , 1 , 0 , -1 , 0 , 1 , 0 , 1 , 0 , 1 , 0 , 1 , 0 , 1, 0 , -1 , 0 , -1 ,
0 , -1 , 0 , -1 , 0 , 1 , 0 , -1 , 0 , 1 , 0 , -1 , 0 , 1 , 0 , 1, 0 , -1 , 0 , -1 ,
0 , -1 , 0 , -1 , 0 , 1 , 0 , -1 , 0 , 1 , 0 , -1 , 0 , 1 , 0 , 1, 0 , -1 , 0 , -1 ,
0 , 1 , 0 , 1 , 0 , -1 , 0 , 1 , 0 , -1 , 0 , 1 , 0 , -1 , 0 , -1, 0 , 1 , 0 , 1 ,
0 , 1 , 0 , 1 , 0 , -1 , 0 , 1 , 0 , -1 , 0 , 1 , 0 , -1 , 0 , -1, 0 , 1 , 0 , 1 , 0 }*sqrt(2)*sqrt(2)

The PAPR of this sequence is 2.92 dB.

6.4. Replace the last paragraph of section 8.4.5.2 of [1] by:

A BS supporting the AAS option may allocate in the UL subframe a 8 OFDM symbol initial ranging slot for AAS SSs that have to initially alert the BS of their presence. This period shall be marked in the UL-MAP as Initial-Maintenance (UIUC=2), but shall be marked by a non-used CID such that no non-AAS subscriber (or AAS subscriber that can decode the UL-MAP message) uses this interval for initial maintenance. During the first OFDM symbol of this AAS initial ranging slot, the BS shall transmit the AAS network entry preamble. In TDD mode the BS can use the last OFDM symbol of the DL subframe to transmit the AAS network entry preamble and mark this symbol as Gap (DIUC=13) in de DL-MAP. The AAS intial ranging slot shall then be at the beginning of the UL subframe. This eliminates unnecessary TX-RX switching.